RZ/A3UL

Initial Program Loader Application Note (Serial Flash Boot Edition)

Introduction

This application note describes the functions of Initial Program Loader (called IPL), which is a boot loader for booting user programs from Serial Flash Memory connected to RZ/A3UL, the procedure for building the development environment and the debugging method of it.

Target Device

RZ/A3UL

When using this application note with other Renesas Microprocessors, sufficient evaluation is recommended after making modifications to comply with the alternate Microprocessor.

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1. Overview

IPL is a boot program for RZ/A3UL.

When starting the RZ/A3UL device, IPL initializes the peripheral I/O modules, the memory installed on the board, etc., and launch the FSP application.

IPL consists of functions such as peripheral I/O module driver, memory control driver, and FSP application image load module.

1.1 Glossary

Table 1.1 shows the terms related to the operation of IPL explained in this application note.

Table 1.1 The term for IPL operation

Term	Description
Initial Program Loader (IPL)	A loader program that launches an FSP Application for the RZ/A3UL environment. It is called from the BootROM program to initialize the memory and the peripheral I/O modules installed in boards, then copies the FSP application and jumps to the copy destination according to the application header. IPL is developed based on Arm Trusted Firmware and it is equivalent to BL2 of Arm Trusted Firmware. When changing the Serial Flash Memory to be used, the user is requested to create and add the initialization code according to the specifications of the Serial Flash Memory to be used, referring to this application note. By default, optimal settings are made for using the Renesas Electronics Serial Flash Memory(AT25QL128A).
BootROM Program	The BootROM program is the program that executes first after the device starts, and it copies the next boot program from the memory associated with the boot mode to the On-chip RAM and jumps to the next boot program. IPL is premised on operation in Boot Mode 3 (1.8-V Serial Flash Memory), and the IPL written to the Serial Flash Memory is copied to the specified address (H'0001_2000) of the On-chip RAM and the boot process is executed. This program is stored in the RZ/A3UL's internal ROM, so it does not need to be created by the user.
FSP Application	This is a program consisting of BSP and sample programs to use the functions implemented on the board.
Application Header	A header placed at the beginning of the FSP application, used by the IPL to refer to the destination address or entry point address of the FSP application. Before executing IPL, the FSP application image including the application header must be written to the specified address of the Serial Flash Memory. The write destination address of the Application Header can be changed in the IPL build option, and the default is H'2002_0000.
External Address Space Read Mode	This is the operation mode of the SPI Multi I/O Bus Controller. Using this mode, the user can access the Serial Flash Memory connected to the external address space as if it were memory mapped to the RZ/A3UL's address space.

1.2 IPL processing overview

The outline of IPL processing is described below.

1. Release the reset and supply the clock to the module used for the boot process.
2. Initialize the serial communication interface for debug message output and control the message input/output.
3. Change the settings of Serial Flash Memory controller.
4. Initialize DDR SDRAM
5. Copy the FSP Application image from Serial Flash Memory to DDR SDRAM.
6. Jump to the entry point of FSP Application on DDR SDRAM.

2. Operating Environment

IPL runs in the following environment

Table 2.1 Operating Environment

Item	Contents
MPU	RZ/A3UL
Operating Frequency	CPU clock (Iφ): 1.0GHz SRAM MCPU clock (I2φ): 200MHz Peripheral clock 0 (P0φ): 100MHz Peripheral clock 1 / SRAM ACPU clock (P1φ): 200MHz SPI multi I/O main clock (SPI0φ): 66.6MHz
Operating Voltage	Power supply voltage (I/O): 3.3V Power supply voltage (1.8/3.3V switching I/O (SPI_PVDD)):1.8V
Host PC	Windows10 (64bit) installed PC or Ubuntu 20.04 LTS Desktop (64bit) installed PC
Debugger	J-Link Base J-Link Software version: V7.70e
IDE	e² studio 2022-07
Toolchain	Windows10 PC: gcc-arm-10.3-2021.07-mingw-w64-i686-aarch64-none-elf Ubuntu 20.4 LTS PC: gcc-arm-10.3-2021.07-x86_64-aarch64-none-elf
	Compiler option (Excludes the addition of directory paths Release configuration: -march=armv8-a -mgeneral-regs-only -mstrict-align -ffunction-sections -fdata-sections -ffreestanding -fno-builtin -fno-common -Os -std=gnu99 -fno-stack-protector -Werror -Wall -Wmissing-include-dirs -Wunused -Wdisabled-optimization -Wvla -Wshadow -Wno-unused-parameter -Wredundant-decls -Wunused-but-set-variable -Wmaybe-uninitialized -Wpacked-bitfield-compat -Wshift-overflow=2 -Wlogical-op -Wno-error=deprecated-declarations -Wno-error=cpp Debug configuration: -march=armv8-a -mgeneral-regs-only -mstrict-align -ffunction-sections -fdata-sections -ffreestanding -fno-builtin -fno-common -Os -std=gnu99 -fno-omit-frame-pointer -fno-stack-protector -Werror -Wall -Wmissing-include-dirs -Wunused -Wdisabled-optimization -Wvla -Wshadow -Wno-unused-parameter -Wredundant-decls -Wunused-but-set-variable -Wmaybe-uninitialized -Wpacked-bitfield-compat -Wshift-overflow=2 -Wlogical-op -Wno-error=deprecated-declarations -Wno-error=cpp
Operating Mode	Boot Mode3 (1.8-V Serial Flash Memory)
Board	RZ/A3UL-Evaluation-Board-Kit (QSPI version) (In this document, it is called SMARC board)
Device to use (Function used on the board)	● Serial Flash (QSPI Flash) Memory (Store the image of the program) Manufacture's name: Renesas Electronics Model Name: AT25QL128A ● DDR4 SDRAM (Used as an execution area for FSP Application) Manufacture's name: Micron Technology Model Name: MT40A512M16LY-062E

3. Reference Application Notes

For additional information associated with this document, refer to the following application notes.

- RZ/A3UL Initial Program Loader Application Note (Octal Flash Boot Edition) (R01AN6433EJ)

4. Hardware Description

This chapter describes the hardware used by IPL.

4.1 Peripheral Functions used

IPL uses the peripheral features shown in Table 4-1.

Table 4.1 Peripheral functions and uses

Peripheral Function	Use
SPI multi-I/O bus controller (SPIBSC)	Set to external space read mode and generate a signal for the CPU to read directly from the Serial Flash Memory connected to the SPI multi-I/O bus space. IPL uses a driver called “SPIM controller driver” to control SPIBSC
DDR3L/DDR4 SDRAM Memory Controller (MEMC)	Make settings to access DDR3L/DDR4 SDRAM connected to the external bus space.
Clock pulse generator (CPG)	Generate the operating frequency of the RZ/A3UL. Release the module standby mode of the RZ/A3UL's peripheral I/O modules.
General Purpose Input Output Port (GPIO)	Switch multiplexed pin functions for SCIFA channel 0 and set the QSPI dedicated pins.
Serial communication interface with FIFO (SCIFA)	Used for message output to the host PC using SCIFA channel 0.
System Counter (SYC)	Generate the count value used by the generic timer built into the Cortex®-A55 core.
Memory Management Unit (MMU)	Generate a translation table that specifies the cache effective area and memory type for the RZ/A3UL address space.

4.2 Pins Used List

Table 4-2 lists the pins used and their functions.

Table 4.2 Pins used and their functions

Pin name	I/O	Function
QSPI0_SPCLK	Output	Clock signal for a Serial Flash Memory
QSPI0_IO0	Input/Output	Serial Flash Memory data0
QSPI0_IO1	Input/Output	Serial Flash Memory data1
QSPI0_IO2	Input/Output	Serial Flash Memory data2
QSPI0_IO3	Input/Output	Serial Flash Memory data3
QSPI0_SSL	Output	Chip select signal for a Serial Flash Memory
QSPI_RESET#	Output	Serial Flash Memory reset
QSPI_WP#	Output	Serial Flash Memory write protect
SCIF0_RXD	Input	Serial communication receive data signal
SCIF0_TXD	Output	Serial communication transmit data signal

5. Software

This chapter describes the IPL software configuration and functions.

5.1 Operation overview

When the SMARC board is booted in Boot Mode 3 (1.8-V Serial Flash Memory), the Boot ROM program written in the internal ROM will start.

The IPL is copied from the Serial Flash Memory located in the SPI multi I/O bus space to the On-chip RAM by the BootROM program and booted.

IPL gets the copy destination address and entry point address of the FSP application image from the application header placed at the beginning of the FSP application.

After that, copy the FSP application to the obtained address and jump to the entry point address.
Please refer to 5.7 Application Header for application header configuration.

5.1.1 Operation image of boot process

Figure 5.1 shows an operation image of the basic boot process.

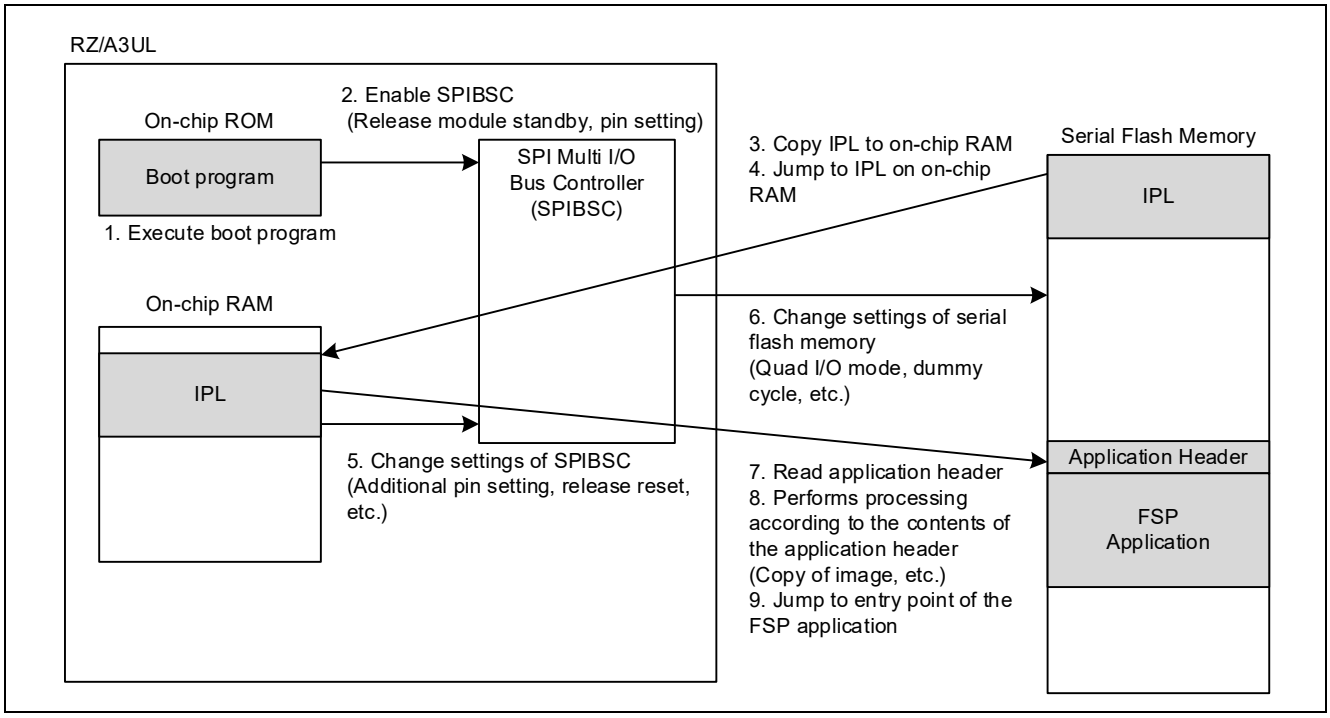


Figure 5.1 Operation image of boot process

Describes the IPL boot process.

1. RZ/A3UL executes the BootROM program after releasing the power-on reset.
2. When the RZ/A3UL operating mode is Boot mode 3, the BootROM program will enable SPIBSC and initialize it. The initial setting is that it can access independently of the model of the Serial Flash Memory.
3. The BootROM program reads the IPL stored in the start address (*1) of the Serial Flash Memory and copies the IPL to the entry point address (*2) on the On-chip RAM.
   Then SPIBSC is reset by the BootROM, and access to the Serial Flash Memory will be prohibited.
4. The BootROM program jumps to the IPL entry point (* 2) on the On-chip RAM.
5. IPL makes additional pin settings and resets for SPIBSC for 4-byte access to the Serial Flash Memory, and changes the settings to the optimum settings for the Serial Flash Memory (AT25QL128A) mounted on the SMARC board.
6. A command is issued via the SPIBSC to the Serial Flash Memory to change the settings.
7. IPL reads the application header.
8. If the application header specifies a copy destination address for the FSP application, IPL copies it.
   As an example of the process is shown in the following chapter.
9. The IPL follows the contents of the application header and jumps to the entry point of the FSP application.

   (*1) This address will be H'2000_0000 when the external address space read mode is set.
   (*2) The IPL entry point address is H'0001_2000.

5.1.2 Boot process to launch FSP application on DDR SDRAM

Figure 5.2 shows an operation image when an FSP application written to Serial Flash Memory is loaded into DDR SDRAM and executed.

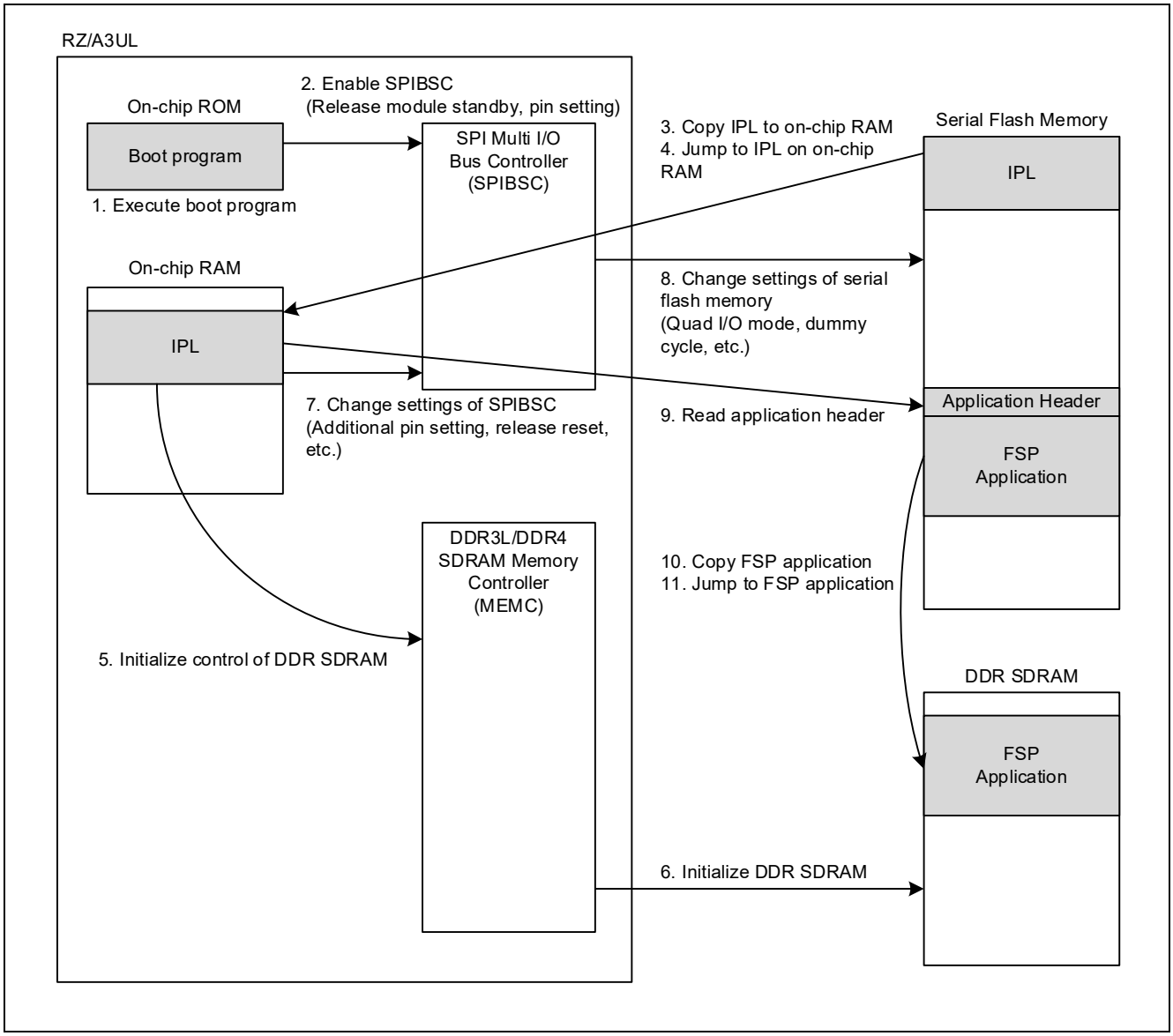


Figure 5.2 Operation image when launching an FSP application on DDR SDRAM

Describes the IPL boot process.

1. RZ/A3UL executes the BootROM program after releasing the power-on reset.
2. When the RZ/A3UL operating mode is Boot mode 3, the BootROM program will enable SPIBSC and initialize it. The initial setting is that it can access independently of the model of the Serial Flash Memory.
3. The BootROM program reads the IPL stored in the start address of the Serial Flash Memory and copies the IPL to the entry point address on the On-chip RAM.
   Then the SPIBSC is reset by BootROM, and access to the Serial Flash Memory will be prohibited.
4. The BootROM program jumps to the IPL entry point on the On-chip RAM.
5. IPL initializes MEMC and controls the initial setting of DDR SDRAM.
6. Initialize the DDR SDRAM by controlling the initial setting of MEMC.
7. IPL makes additional pin settings and resets SPIBSC for 4-byte access to the Serial Flash Memory, and changes the settings to the optimum settings for the Serial Flash Memory (AT25QL128A) mounted on the SMARC board.
8. A command is issued via the SPIBSC to the Serial Flash Memory to change the settings memory.
9. IPL reads the application header.
10. IPL will copy the FSP application to DDR SDRAM according to the contents of the application header.
11. The IPL follows the contents of the application header and jumps to the entry point of the FSP application on DDR SDRAM.

5.1.3 Boot process to launch FSP application on Serial Flash Memory

Figure 5.3 shows an operation image when jumping directly to the FSP application written in the Serial Flash Memory and executing it (XIP execution).

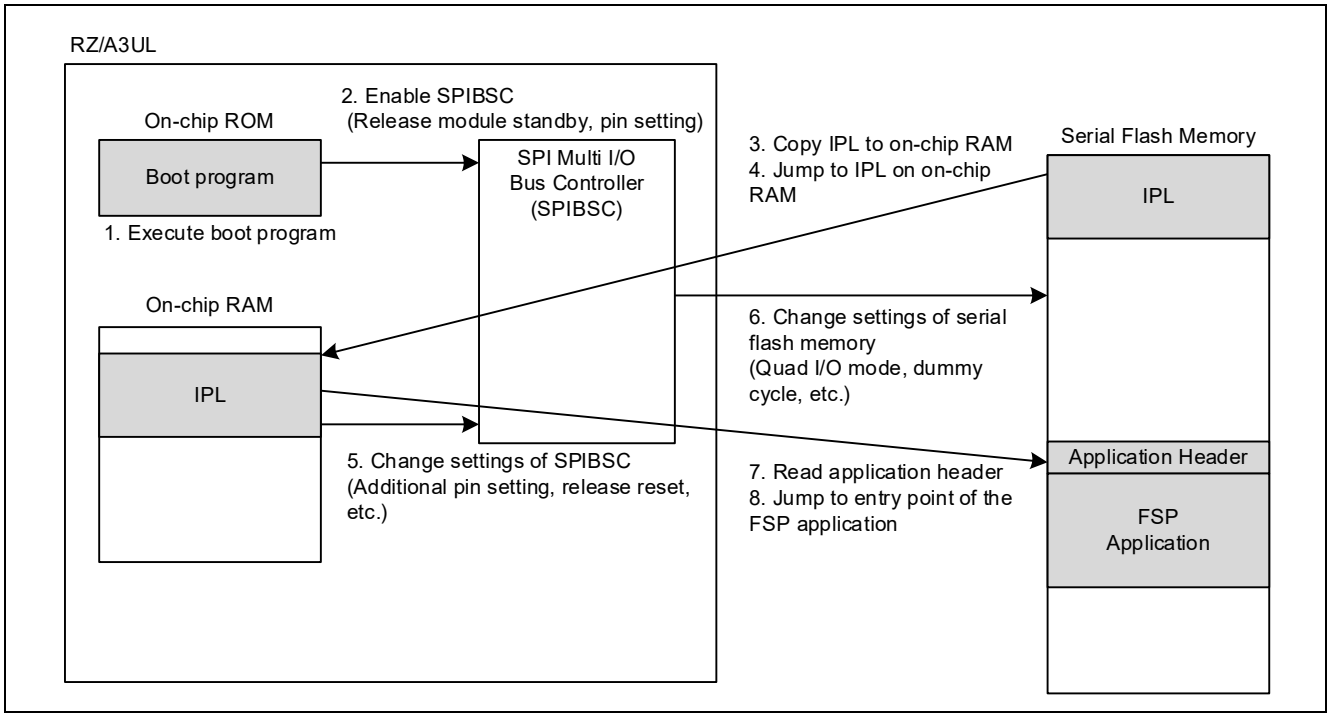


Figure 5.3 Operation image when booting FSP application on Serial Flash Memory

Describes the IPL boot process.

1. RZ/A3UL executes the BootROM program after releasing the power-on reset.
2. When the RZ/A3UL operating mode is Boot mode 3, the BootROM program will enable SPIBSC and initialize it. The initial setting is that it can be access independently of the model of Serial Flash Memory.
3. The BootROM program reads the IPL stored in the start address of the Serial Flash Memory and copies the IPL to the entry point address on the On-chip RAM.
   Then the SPIBSC is reset by the BootROM, and access to the Serial Flash Memory will be prohibited.
4. The BootROM prgoram jumps to the IPL entry point on the On-chip RAM.
5. IPL makes additional pin settings and resets for SPIBSC for 4-byte access to the Serial Flash Memory, and changes the settings to the optimum settings for the Serial Flash Memory (AT25QL128A) mounted on the SMARC board.
6. A command is issued via the SPIBSC to the Serial Flash Memory to change the settings.
7. IPL reads the application header. If the copy destination address of the FSP application is the same as the stored address, IPL will skip the copy process.
8. The IPL will jump to the entry point of the FSP application in Serial Flash Memory according to the contents of the application header.

5.2 Peripheral Function Setting

Table 5.1 Lists the settings for Peripheral Functions during execution of IPL.

Table 5.1 Settings for Peripheral Functions

Module	Settings
CPG	Set the following operating frequencies. ● CPU clock (Iφ): 1.0GHz Set to 1/1 times the frequency of the PLL1 (FOUT) ● Peripheral clock 0 (P0φ): 100MHz Set to 1/8 times the frequency of the PLL2 (FOUT1PH0) ● Peripheral clock 1 / SRAM ACPU clock (P1φ): 200MHz Set to 1/8 times the frequency of the PLL3 (FOUT1PH0) ● SRAM MCPU clock (I2φ): 200MHz Set to 1/8 times the frequency of the PLL3 (FOUT1PH0) ● SPI multi I/O main clock (SPI0φ): 133.25MHz Set to 1/8 times the frequency of the PLL3 (FOUT3) ● QSPI0_SPCLK: 66.625MHz 1/2 times of SPI0φ Supply clock and release reset to the peripherals shown below Release the reset ● AXI Bus ● Peripheral Bus ● On-chip RAM ● Internal ROM ● DDR SDRAM ● OTP ● GIC-600 ● IA55 ● SYSC ● SYC ● DMAC ● WDT ● GPIO ● SPIBSC ● SCIFA (ch0 only) ● CoreSight™
SPIBSC	• Command-Address-Data bits 1-4-4 • Opcode “Fast Read Quad I/O” EBh • Address size 3-byte • Additional data 1-byte 0x55 • Dummy cycles 6 QSPI0_SPCLK • SLCH 1.5 QSPI0_SPCLK (22.5ns) • CLSH 1 QSPI0_SPCLK (15ns) • SHSL 7 QSPI0_SPCLK (105ns)

GPIO	Set the following shared pin ● P6_3 : SCIF0_RXD ● P6_4 : SCIF0_TXD Set the following in P6_3 and P6_4 ● Drive capacity: 4mA ● Slew rate: Fast ● Pull up: None ● Pull down: None Set the following for the decided pins of QSPI0_IO0, QSPI0_IO1, QSPI0_IO2, QSPI0_IO3, QSPI0_SPCLK, QSPI0_SSL ● Output impedance: 66Ω ● Slew rate: Fast ● Pull up: None ● Pull down: None
SCIFA	Set the following for Ch0 ● Operation mode: asynchronous communication mode ● Transfer rate: 115200bps ● Data length: 8bit ● Stop bit length: 1 bit ● Parity: None ● Flow control: disabled
SYC	Input 24MHz clock to Cortex®-A55 built-in Generic Timer

5.2.1 Settings of SPIBSC Register

Table 5.2 shows the SPIBSC register settings after the initial settings are completed.

These setting values include the results that reflect the settings described in the SPIBSC section in Table 5.1 Peripheral Function Settings.

Table 5.2 SPIBSC register setting value after initial setting

Register	Settings
IOn output level while idle	
CMNCR.MOIIO0	B'11 (Hi-Z)
CMNCR.MOIIO1	B'11 (Hi-Z)
CMNCR.MOIIO2	B'11 (Hi-Z)
CMNCR.MOIIO3	B'11 (Hi-Z)
IOn output level while 1 bit transfer	
CMNCR.IO0FV	B'11 (Hi-Z)
CMNCR.IO2FV	B'01 (High)
CMNCR.IO3FV	B'01 (High)
Data bus size	
CMNCR.BSZ	B'00 (Single Serial Flash Memory connected)
Clock delay	
SSLDR.SCKDL	B'000 (1.5 QSPI0_SPCLK)
SSL negation delay	
SSLDR.SLNDL	B'000 (1 QSPI0_SPCLK)
Next access delay	
SSLDR.SPNDL	B'110 (7 QSPI0_SPCLK)
SSL negation	
DRCR.SSLE	B'1 (Negated when the accessed address is not in sequential)
Read burst	
DRCR.RBE	B'1 (Burst enable)
Burst length	
DRCR.RBURST	B'00111 (8 data unit: 64 byte)
Command	
DRCMR.CMD	0xEB (Fast Read Quad I/O operation for AT25QL128A)
Optional command	
DRCMR.OCMD	0x00 (Not used)
Extended external address valid range	
DREAR.EAC	B'000
Extended upper address value	
DREAR.EAV	0x00
Option data	
DROPR.OPD3	0x55
DROPR.OPD2	0x00
DROPR.OPD1	0x00
DROPR.OPD0	0x00

Option data enable DRENR.OPDE	B’1000 (Outs OPD3)
Address enable DRENR.ADE	B’0111 (Outs address [23:0])
Optional command enable DRENR.OCDE	B’0 (Suppress OCMD)
Command enable DRENR.CDE	B’1 (Outs CMD)
Dummy cycle enable DRENR.DME	B’1 (Has dummy cycle)
Data read bit size DRENR.DRDB	B’10 (4 bit)
Option data bit size DRENR.OPDB	B’10 (4 bit)
Address bit size DRENR.ADB	B’10 (4 bit)
Optional command bit size DRENR.OCDB	B’00 (Not used)
Command bit size DRENR.CDB	B’00 (1 bit)
Amount of dummy cycle DRDMCR.DMCYC	B’00011 (4 cycles)
Address DDR enable DRDRENR.ADDRE	B’0 (SDR)
Option data DDR enable DRDRENR.OPDRE	B’0 (SDR)
Data read DDR enable DRDRENR.DRDRE	B’0 (SDR)
Device selection PHYCNT.PHYMEM	B’00 (SDR)
Clock timing switching PHYCNT.CKSEL	B’11
High-speed response mode PHYCNT.HS	B’0 (Disable)
DDR operation timing PHYOFFSET1.DDRTMG	B’11 (SDR)
Serial Flash Memory operation timing PHYOFFSET2.OCTTMG	B’100 (Using Serial Flash Memory)

5.3 Memory Map

Figure 5.4 shows the RZ/A3UL address space and the memory map of the SMARC board.

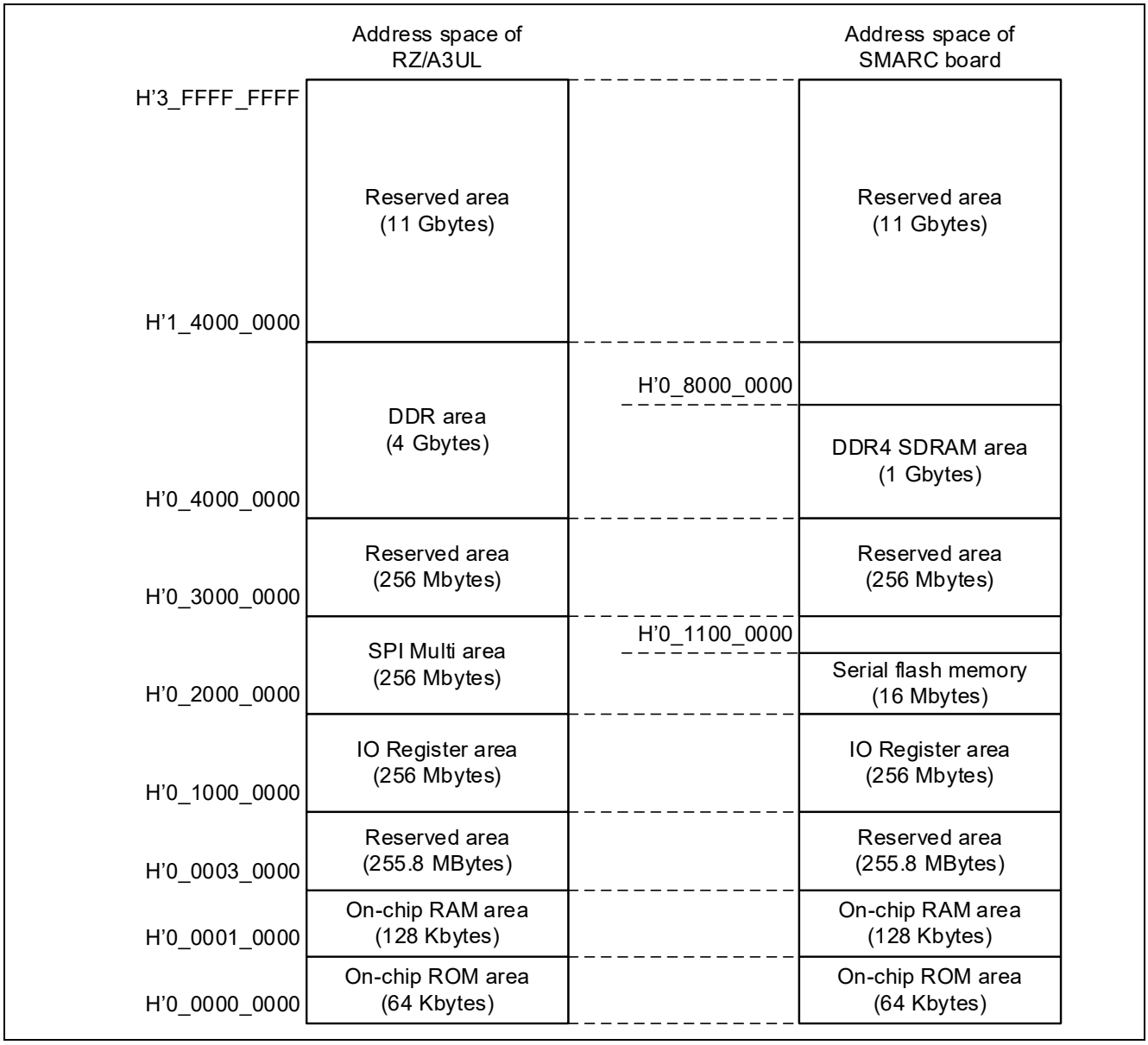


Figure 5.4 Memory MAP

5.4 MMU setting

Figure 5.5 shows the IPL MMU settings.

The MMU is disabled when jumping to the FSP Application.

Make the optimum settings in the FSP application if necessary.

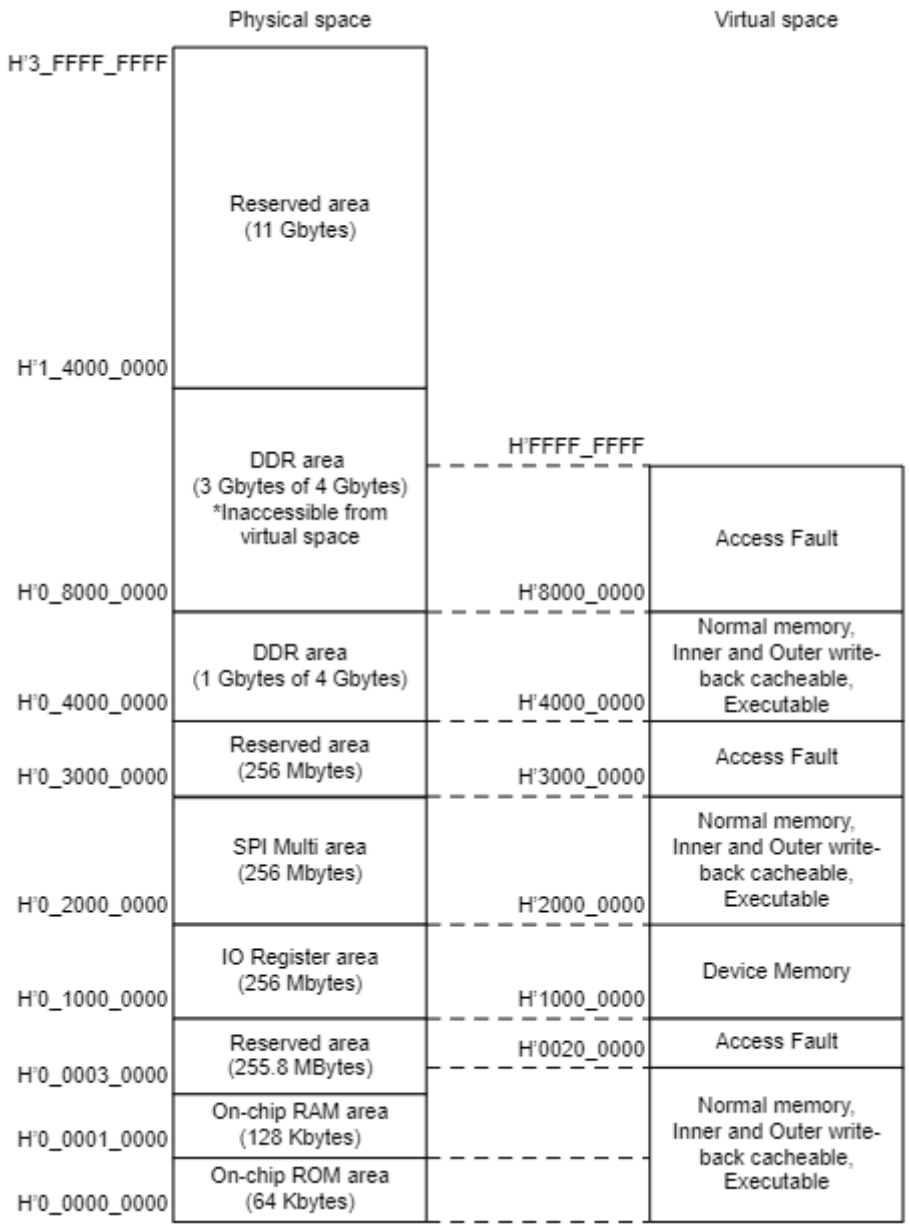


Figure 5.5 MMU setting

5.5 Interrupt used list

IPL does not use interrupt.

5.6 Exception level

IPL operates at exception level EL3.

It also jumps to the FSP Application in the state of EL3.

5.7 Application Header

IPL obtains the save address, copy destination address and entry point of the FSP Application image according to the application header written to the Serial Flash Memory, copies the image, and jumps to the FSP Application.

IPL loads the application header from the address set in “FSP_BASE” in the make option.

Write the application header in advance in the format shown in the figure from the address set in “FSP_BASE” before executing IPL.

If “FSP_BASE” is not specified in the make command, H'2002_0000 is set as the default value. The header structure is shown below.

Table 5.3 Application Header format

offset	size	Description
+0h	QWORD(8bytes)	FSP entry address
+8h	QWORD(8bytes)	Inverted FSP entry point address This is used to check if the header data is correct
+10h	QWORD(8bytes)	Address to copy the FSP image payload If FSP image payload does not need to transfer, this field must be set FSP payload address (FSP_BASE + 200h)
+18h	QWORD(8bytes)	Inverted address to copy the FSP image payload This is used to check if the header data is correct
+20h	QWORD(8bytes)	FSP image payload size
+28h	QWORD(8bytes)	Inverted FSP image payload size This is used to check if the header data is correct
+30h	-	Reserved (as 0)
+1E0h	String (MAX 32 bytes)	Signature “RZ FSP Application” and fill gap as 0
+200h later	-	FSP image payload

5.8 Data Types

Table 5.3 lists the data types used in IPL.

Table 5.3 Data Types used in the IPL

Symbol	Description
bool	Boolean type. Value is true (1) or false (0)
char	8-bit character.
int	Fast integer signed, 32-bit integer in the IPL.
int8_t	8-bit integer, signed (defined in standard library stdint.h)
int16_t	16-bit integer, signed (defined in standard library stdint.h)
int32_t	32-bit integer, signed (defined in standard library stdint.h)
int64_t	64-bit integer, signed (defined in standard library stdint.h)
uint8_t	8-bit integer, unsigned (defined in standard library stdint.h)
uint16_t	16-bit integer, unsigned (defined in standard library stdint.h)
uint32_t	32-bit integer, unsigned (defined in standard library stdint.h)
uint64_t	64-bit integer, unsigned (defined in standard library stdint.h)
unsigned long long	64-bit integer, unsigned
unsigned int	32-bit integer, unsigned
size_t	64-bit integer, unsigned
uintptr_t	Unsigned integer type with pointer type size, 64-bit unsigned integer in the IPL.

5.9 Constants

Table 5.4 lists the constants used in IPL.
Table 5.4 lists only constants used in the RZ/A3UL platform boot process.

Please refer to https://trustedfirmware-a.readthedocs.io/en/latest/ for constants related to behavior of Arm Trusted Firmware.

Table 5.4 Constants used in the IPL

Constant	Setting Value	Description
RZ_IPL_VERSION_STRING	"v1.1.0"	IPL version
CPG_OFF	(0)	Flag to set ON/OFF of CPG register Set the register to off (disable)
CPG_ON	(1)	Flag to set ON/OFF of CPG register Set the register to on (enable)
CPG_T_CLK	(0)	Flag that specifies the type of CPG register to set Set a value in the clock register
CPG_T_RST	(1)	Flag that specifies the type of CPG register to set Set a value in the reset register
CPG_SEL_PLL1_ON_OFF	(0)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL1
CPG_SEL_PLL2_1_ON_OFF	(1)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL2_1
CPG_SEL_PLL2_2_ON_OFF	(2)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL2_2
CPG_SEL_PLL3_1_ON_OFF	(3)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL3_1
CPG_SEL_PLL3_2_ON_OFF	(4)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL3_2
CPG_SEL_PLL3_3_ON_OFF	(5)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL3_3
CPG_SEL_PLL5_1_ON_OFF	(6)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL5_1
CPG_SEL_PLL5_3_ON_OFF	(7)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL5_3
CPG_SEL_PLL5_4_ON_OFF	(8)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL5_4
CPG_SEL_PLL6_1_ON_OFF	(9)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for PLL6_1
CPG_SEL_GPU1_1_ON_OFF	(10)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for GPU1_1

CPG_SEL_GPU1_2_ON_OFF	(11)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for GPU1_2
CPG_SEL_GPU2_ON_OFF	(12)	Number for specifying the element of the source clock selector setting table of PLL Specify selector for GPU2
PFC_OFF	(0)	PFC disable setting flag
PFC_ON	(1)	PFC enable setting flag
XSPI_CLOCK_SPIM	(0)	Clock setting flag for Serial Flash Memory
XSPI_CLOCK_OCTA	(1)	Clock setting flag for Octa Flash Memory/Octa RAM
CPG_CLOCK_SPIM	(20)	CPG clock ID for Serial Flash Memory
CPG_CLOCK_OCTA	(61)	CPG clock ID for Octa Flash Memory/Octa RAM
DEFAULT_SPI_FREQUENCY	(66666667)	Default operating frequency of serial flash memory
RESET_DURATION_US	(10)	SPI device reset time (10usec)
WRITE_STATUS_OK	(0)	xSPI device write status Successful write to xSPI device
WRITE_STATUS_IN_PROGRESS	(1)	xSPI device write status While writing to the xSPI device
WRITE_STATUS_PROTECTED	(2)	xSPI device write status xSPI devices are write protected
WRITE_STATUS_FAIL	(3)	xSPI device write status Write failure to xSPI device
WRITE_STATUS_SUSPENDED	(4)	xSPI device write status Write suspend to xSPI device
SPI_FORM_1_1_1	(0)	Command executes at 1-1-1 form
SPI_FORM_1_1_2	(1)	Command executes at 1-1-2 form
SPI_FORM_1_2_2	(2)	Command executes at 1-2-2 form
SPI_FORM_2_2_2	(3)	Command executes at 2-2-2 form
SPI_FORM_1_1_4	(4)	Command executes at 1-1-4 form
SPI_FORM_1_4_4	(5)	Command executes at 1-4-4 form
SPI_FORM_4_4_4	(6)	Command executes at 4-4-4 form
SPI_FORM_1_1_8	(7)	Command executes at 1-1-8 form
SPI_FORM_1_8_8	(8)	Command executes at 1-8-8 form
SPI_FORM_8_8_8	(9)	Command executes at 8-8-8 form
XSPI_FEATURE_FORM112	(1 << 0)	The driver supports 1-1-2 form.
XSPI_FEATURE_FORM122	(1 << 1)	The driver supports 1-2-2 form.

XSPI_FEATURE_FORM222	(1 << 2)	The driver supports 2-2-2 form.
XSPI_FEATURE_DUAL	(0x07)	The driver supports 1-1-2, 1-2-2, and/or 2-2-2 form(s).
XSPI_FEATURE_FORM114	(1 << 3)	The driver supports 1-1-4 form.
XSPI_FEATURE_FORM144	(1 << 4)	The driver supports 1-4-4 form.
XSPI_FEATURE_FORM444	(1 << 5)	The driver supports 4-4-4 form.
XSPI_FEATURE_QUAD	(0x38)	The driver supports 1-1-4, 1-4-4, and/or 4-4-4 form(s).
XSPI_FEATURE_FORM118	(1 << 6)	The driver supports 1-1-4 form.
XSPI_FEATURE_FORM188	(1 << 7)	The driver supports 1-8-8 form.
XSPI_FEATURE_FORM888	(1 << 8)	The driver supports 8-8-8 form.
XSPI_FEATURE_OCTAL	(0x1C0)	The driver supports 1-1-8, 1-8-8, and/or 8-8-8 form(s).
XSPI_FEATURE_XIP_READ	(1 << 12)	The driver supports read access.
XSPI_FEATURE_XIP_WRITE	(1 << 13)	The driver supports write access.
XSPI_FEATURE_DTROP	(1 << 14)	The driver supports DTR for op code.
XSPI_FEATURE_DTR	(1 << 15)	The driver supports DTR for address and/or data.
XSPI_FEATURE_OCTARAM	(1 << 16)	OctaRAM addressing (RAS/CAS) supported.
XSPI_FLAGS_SEQUENTIAL_DTR	(1u << 0)	Enable inverted order for DTR transfer
XSPI_FLAGS_FORCE_STROBE	(1u << 1)	Force to use of data strobe signal for timing reference
XSPI_FLAGS_DATA_ACCESS	(1u << 2)	Force to use data access method for exec_op
RZ_NOFIP	(0)	How to load the Application image Use the Application Header when loading the Application image
RZ_FIP	(1)	How to load the Application image: Use FIP format image when loading Application image
RZ_APP_PAYLOAD_OFFSET	(0x200)	Offset to payload data in Application header
RZA_MMU_ATTR_NON_CACHEABLE	(0x44)	MMU descriptor normal memory, non-cacheable memory attribute
RZA_MMU_ATTR_DEVICE	(0x04)	MMU descriptor device memory attribute
RZA_MMU_ATTR_IWBWA_OWBWA _NTR	(0xFF)	MMU descriptor normal memory, cacheable memory attribute
RZA_MMU_ATTRIBUTE_ACCESS_FAULT	(0x00000000)	MMU descriptor Access Fault
RZA_MMU_ATTRIBUTE_CONFIG _END	(0xFFFFFFFF)	End of MMU configuration table setting

5.10 Structures/Unions

Table 5.5 lists the structures/unions used in IPL.
Table 5.5 lists only structures/unions used in the RZ/A3UL platform boot process.

Please refer to https://trustedfirmware-a.readthedocs.io/en/latest/ for structures/unions related to behavior of Arm Trusted Firmware.

Table 5.5 List of structures used in the IPL

Structure/Union	Description	Detail
fsp_app_header_t	Structure to store the Application Header	Refer to Table 5.6
qspiflash_at25_ctrl_t	Structure to store the control information of AT25QL128A	Refer to Table 5.7
qspiflash_at25_ext_t	Structure to store the extended information of AT25QL128A	Refer to Table 5.8
spiflash_ctrl_t	Structure to store the control information of Serial Flash Memory driver	Refer to Table 5.9
spiflash_ext_t	Structure to store the extended information of Serial Flash Memory driver	Refer to Table 5.10
spim_ctrl_t	Structure to store the control information of xSPI module	Refer to Table 5.11
spim_ext_t	Structure to store the extended information of xSPI module	Refer to Table 5.12
xspidevice_info_t	Structure to store the device information of xSPI device	Refer to Table 5.13
xspidevice_cfg_t	Structure to store the configure information of xSPI device	Refer to Table 5.14
xspidevice_api_t	Structure to store the API functions that control xSPI device	Refer to Table 5.15
xspidevice_instance_t	Structure to store the instance that control xSPI device	Refer to Table 5.16
xspi_cfg_t	Structure to store the configure information of xSPI interface	Refer to Table 5.17
xspi_op_t	Structure to store the operation of xSPI interface	Refer to Table 5.18
xspi_api_t	Structure to store the API functions of the xSPI interface	Refer to Table 5.19
xspi_instance_t	Structure to store the instance of the xSPI interface	Refer to Table 5.20
CPG_SETUP_DATA	A structure that stores the startup setting data of the CPG register	Refer to Table 5.21
CPG_REG_SETTING	A structure that stores the set values for the CPG registers	Refer to Table 5.22
CPG_PLL_SETDATA_146	Structure to save setting parameters for PLL1/4/6	Refer to Table 5.23
CPG_PLL_SETDATA_235	Structure to save setting parameters for PLL2/3/5	Refer to Table 5.24
cpg_spi_clk_table	Structure to store clock setting parameters for serial flash memory	Refer to Table 5.25
PFC_REG_UINT8	A structure that stores the setting parameters for the 8byte width PFC register	Refer to Table 5.26
PFC_REG_UINT32	A structure that stores the setting parameters for the 32byte width PFC register	Refer to Table 5.27
PFC_REG_UINT64	A structure that stores the setting parameters for the 64byte width PFC register	Refer to Table 5.28
PFC_REGS	A structure that stores the set values for the PFC registers	Refer to Table 5.29
rz_mmu_pgtbl_cfg_t	Structure that stores MMU page table configuration parameters	Refer to Table 5.30

Table 5.6 Application Header structure (fsp_app_header_t)

Member	Description
uint64_t entry_addr	FSP entry point address
uint64_t entry_addr_inv	Inverted FSP entry point address
uint64_t dest_addr	Address to copy the FSP image payload
uint64_t dest_addr_inv	Inverted address to copy the FSP image payload
uint64_t payload_size	FSP image payload size
uint64_t payload_size_inv	Inverted FSP image payload size
uint8_t padding[432]	Reserved
uint8_t signature[32]	Signature
uint8_t app_payload_start	Application image payload

Table 5.7 AT25QL128A control structure (qspiflash_at25_ctrl_t)

Member	Description
bool opened	Opened or not
const xspi_instance_t * xspi	xSPI control driver instance

Table 5.8 AT25QL128A extended information structure (qspiflash_at25_ext_t)

Member	Description
-	Member not defined because extended information is not used

Table 5.9 Serial Flash Memory control structure (spiflash_ctrl_t)

Member	Description
bool opened	Opened or not
const xspi_instance_t * xspi	xSPI control driver instance
bool address_is_4b	Flag to use 4bit command

Table 5.10 Serial Flash Memory extended information structure (spiflash_ext_t)

Member	Description
bool address_is_4b	Flag to use 4bit command

Table 5.11 xSPI module control structure (spim_ctrl_t)

Member	Description
bool opened	Opened or not
uintptr_t reg_base	Pointer to register base address
uintptr_t mmap_base	Pointer to XIP base address
size_t mmap_size	Size (as byte) of XIP area
uint8_t channel	Channel number (0 based)

Table 5.12 xSPI module extended information structure (spim_ext_t)

Member	Description
bool voltage_is_3300mv	Specify the target voltage is 3.3V Only affected is FORCE_VOLTAGE_SETTING is defined as true. Default: false (1.8v)

Table 5.13 xSPI device information structure (xspidevice_info_t)

Member	Description
uint32_t capacity	Amount of memory by bytes.
uint32_t minimum_erase_size	Minimum erase size by bytes.
char[32] decide_vendor	Device vendor name.
char[32]device_product	Device product name.

Table 5.14 xSPI device configure structure (xspidevice_cfg_t)

Member	Description
xspi_instance_t *xspi	Associated xSPI instance.
void const *extend	device specific configuration data.

Table 5.15 xSPI device API function structure (xspidevice_api_t)

Member	Description
int (* open)(xspidevice_ctrl_t * ctrl, xspidevice_cfg_t const * cfg)	Open function
int (* close)(xspidevice_ctrl_t * ctrl)	Close function
int (* exec_op)(xspidevice_ctrl_t * ctrl, xspi_op_t const * op, bool is_write)	Operation Execution function
int (* enter_xip)(xspidevice_ctrl_t * ctrl)	Entering in-place access mode function
int (* exit_xip)(xspidevice_ctrl_t * ctrl)	Exiting in-place access mode function
int (* get_info)(xspidevice_ctrl_t * ctrl, xspidevice_info_t * info)	Getting device information function
int (* read)(xspidevice_ctrl_t * ctrl, void * buffer, size_t address, size_t length)	Read function
int (* write)(xspidevice_ctrl_t * ctrl, void const * buffer, size_t address, size_t length)	Write function
int (* erase)(xspidevice_ctrl_t * ctrl, size_t address, size_t length)	Erase function
enum xspidevice_write_status (* get_write_status)(xspidevice_ctrl_t * ctrl)	Getting write status function

Table 5.16 xSPI device instance structure (xspidevice_instance_t)

Member	Description
xspidevice_ctrl_t * ctrl	Control parameter
xspidevice_cfg_t const * cfg	Configuration parameter
xspidevice_api_t const * api	API functions

Table 5.17 xSPI interface control structure (xspi_cfg_t)

Member	Description
uint8_t channel	Channel number
uintptr_t base	Pointer to register base address
void const * extend	IP specific configuration data

Table 5.18 xSPI interface operation structure (xspi_op_t)

Member	Description
xspi_transfer_form_t form	Specify the form to send this operation It is possible to set the parameters shown in the following SPI_FORM_X_Y_Z format X, Y, and Z indicate the number of I/O data lines used when transferring the following information in operation X: Operation Code Y: Address Z: Data SPI_FORM_1_1_1 SPI_FORM_1_1_2 SPI_FORM_1_2_2 SPI_FORM_2_2_2 SPI_FORM_1_4_4 SPI_FORM_4_4_4 SPI_FORM_1_1_8 SPI_FORM_1_8_8 SPI_FORM_8_8_8
uint16_t op	Operation code (high side used as second byte)
uint8_t op_size	Operation code size (0 to 2)
bool op_is_ddr	If true, the op-code phase sends as DDR
uint32_t address	Address on Serial Flash Memory
uint8_t address_size	Address size (0 to 4)
bool address_is_ddr	If true, the address phase sends as DDR
uint8_t additional_size	Additional data size as bytes after the address phase If address_is_ddr is true, this cycle is also as DDR, and this size must be zero or even.
uint32_t additional_value	Additional data value ● [0-byte] Not used ● [1-byte] Use b0-b7 as value ● [2-byte] Use b8-b15 as 1st value and b0-b7 as 2nd value ● [3-byte] Use b16-b23 as 1st value, b8-b15 as 2nd value and b0-b7 as 3rd value ● [4-byte] Use b24-b31 as 1st value, b16-b23 as 2nd value, b8-b15 as 3rd value and b0-b7 as 4th value
uint8_t dummy_cycles	Dummy cycles as the SPCLK count after additional data phase. This cycle does not include additional data phase size.
size_t transfer_size	Transfer size as bytes (ignored for XIP configuration)
void * transfer_buffer	Transfer buffer pointer (ignored for XIP configuration)
bool transfer_is_ddr	Whether the transfer phase is DDR.
uint8_t transfer_flag	Additional transfer flags These flags can be bitwise-or'd ● b0: Enable inverted order for DDR transfer (0: w1 w0 w3 w2, 1: w0 w1 w2 w3) ● b1: Force to use of data strobe for timing reference If not specified, operation executes as register access ● b2: Force to use of data strobe signal for timing reference

uint8_t force_idle_level_mask	Whether or not to force each IO level durint idle state Not all controllers support it The idle state does not include the dummy cycle. The dummy cycle is always Hi-Z ● b0: Ignored b1 – b7: 0: Always Hi-Z, 1: Forcibly outs the force_idle_level_value's state
uint8_t force_idle_level_value	IO level durting idle state Only active if force_idle_mask of the same position is 1 ● b0: Ignored b1 – b7: 0: Low, 1: High
uint8_t slch_value	SSL Low to Clock High delay cycles as the SPCLK count (also known as CS# Active Setup Time)
uint8_t clsh_value	Clock Low to SSL High delay cycles as the SPCLK count (also known as CS# Active Hold Time)
uint8_t shsl_value	SSL High to SSL Low delay cycles as the SPCLK count (also known as CS# Deselect Time)

Table 5.19 xSPI interface API function structure (xspi_api_t)

Member	Description
int (* open)(xspi_ctrl_t * ctrl, xspi_cfg_t const * const cfg)	Open function
int (* close)(xspi_ctrl_t * const ctrl)	Close function
int (* post_init)(xspi_ctrl_t * const ctrl)	ost initialization function
int (* exec_op)(xspi_ctrl_t * const ctrl, xspi_op_t const * const op, bool is_write)	Operation Execution function
int (* configure_xip)(xspi_ctrl_t * const ctrl, xspi_op_t const * const rop, xspi_op_t const * const wop)	Configure for in-place access mode function
int (* start_xip)(xspi_ctrl_t * const ctrl)	Start in-place access mode function
int (* stop_xip)(xspi_ctrl_t * const ctrl)	Stop in-place access mode function
int (* run_manual_calibration)(xspi_ctrl_t * const ctrl)	Manual calibration function
int (* enable_auto_calibration)(xspi_ctrl_t * const ctrl)	Enable auto calibration function
int (* disable_auto_calibration)(xspi_ctrl_t * const ctrl)	Disable auto calibration function
int (* set_frequency)(xspi_ctrl_t * const ctrl, int frequency_hz)	Setting SPI frequency function
int (* inv_mmap)(xspi_ctrl_t * const ctrl)	Invalidate cache for entire MMAP function
int (* clean_mmap)(xspi_ctrl_t * const ctrl)	Clean cache for entire MMAP function
uintptr_t (* get_mmap_base)(xspi_ctrl_t * const ctrl)	Getting MMAP base address
size_t (* get_mmap_size)(xspi_ctrl_t * const ctrl)	Getting MMAP size

Table 5.20 xSPI interface instance structure (xspi_instance_t)

Member	Description
xspi_ctrl_t * ctrl	Pointer to the control structure for instance
xspi_cfg_t const * cfg	Pointer to the configuration structure for instance
xspi_api_t const * api	Pointer to the API structure for instance

Table 5.21 CPG setup data structure (CPG_SETUP_DATA)

Member	Description
uintptr_t reg	Pointer to CPG register
uintptr_t mon	CPG monitor register corresponding to the register specified by "reg”
uint32_t val	Setting value to CPG register
uint32_t type	Select the type of register to be set from the following CPG_T_CLK(clock operation) CPG_T_RST(reset operation)

Table 5.22 CPG register setting structure (CPG_REG_SETTING)

Member	Description
uintptr_t reg	Pointer to CPG register
uint32_t val	Setting value to CPG register

Table 5.23 PLL1/4/6 setting structure (CPG_PLL_SETDATA_146)

Member	Description
CPG_REG_SETTING clk1_dat	Register setting to CPG_SAMPLL1/4/6_CLK1
CPG_REG_SETTING clk2_dat	Register setting to CPG_SAMPLL1/4/6_CLK2
CPG_REG_SETTING stby_dat	Register setting to CPG_SAMPLL1/4/6_STBY

Table 5.24 PLL2/3/5 setting structure (CPG_PLL_SETDATA_235)

Member	Description
CPG_REG_SETTING clk1_dat	Register setting to CPG_SAMPLL5_CLK1 CPG_SAMPLL2/3_CLK1 register is not implemented in RZ/A3UL
CPG_REG_SETTING clk2_dat	Register setting to CPG_SAMPLL5_CLK2 CPG_SAMPLL2/3_CLK2 register is not implemented in RZ/A3UL
CPG_REG_SETTING clk2_dat	Register setting to CPG_SAMPLL5_CLK3 CPG_SAMPLL2/3_CLK3 register is not implemented in RZ/A3UL
CPG_REG_SETTING clk4_dat	Register setting to CPG_SAMPLL5_CLK4 CPG_SAMPLL2/3_CLK2 register is not implemented in RZ/A3UL
CPG_REG_SETTING clk5_dat	Register setting to CPG_SAMPLL5_CLK5 CPG_SAMPLL2/3_CLK2 register is not implemented in RZ/A3UL
CPG_REG_SETTING stby_dat	Register setting to CPG_SAMPLL5_STBY CPG_SAMPLL2/3_STBY register is not implemented in RZ/A3UL

Table 5.25 spi clock table structure (cpg_spi_clk_table)

Member	Description
int frequency	Frequency setting
uint8_t selector	Source clock selector setting
uint8_t devider	Clock divide rate setting

Table 5.26 PFC 8byte register setting structure (PFC_REG_UINT8)

Member	Description
int flag	PFC ON / OFF setting
uintptr_t reg	Pointer to PFC register
uint8_t val	Setting value to PFC register

Table 5.27 PFC 32byte register setting structure (PFC_REG_UINT32)

Member	Description
int flag	PFC ON / OFF setting
uintptr_t reg	Pointer to PFC register
uint32_t val	Setting value to PFC register

Table 5.28 PFC 64byteregister setting structure (PFC_REG_UINT64)

Member	Description
int flag	PFC ON / OFF setting
uintptr_t reg	Pointer to PFC register
uint64_t val	Setting value to PFC register

Table 5.29 PFC register setting structure (PFC_REGS)

Member	Description
PFC_REG_UINT8 pmc	Setting to PMC register
PFC_REG_UINT32 pfc	Setting to PFC register
PFC_REG_UINT64 iolh	Setting to IOLH register
PFC_REG_UINT64 pupd	Setting to PUPD register
PFC_REG_UINT64 sr	Setting to SR register
PFC_REG_UINT64 ien	Setting to IEN register

Table 5.30 MMU page table setting structure (rza_mmu_pgtbl_cfg_t)

Member	Description
uint64_t vaddress	Virtual address (0x200000 aligned address)
uint64_t paddress	Physical address (0x200000 aligned address)
uint64_t size	Page size (0x200000 aligned address)
uint64_t attribute	Memory attribute

5.11 Variables

Table 5.31 lists the variables used in IPL.
Table 5.31 lists only structures/unions used in the RZ/A3UL platform boot process.

Table 5.31 List of variables used in the IPL

variable name	Description	Detail
xspi_api_t spim_api	xSPI control driver API function table	Refer to Table 5.32
xspidevice_api_t qspiflash_at25_api	AT25QL128A driver API function table	Refer to Table 5.33
xspi_op_t op_write_enable	Write Enable operation (H'06)	Refer to Table 5.34
xspi_op_t op_read_status1	Read Status Register-1 operation (H'05)	Refer to Table 5.35
xspi_op_t op_read_status2	Read Status Register-2 operation (H'35)	Refer to Table 5.36
xspi_op_t op_write_status2	Write Status Register-2 operation (H'31)	Refer to Table 5.37
xspi_op_t rop	Fast Reaf Quad I/O operation (H'EB)	Refer to Table 5.38
xspi_op_t op_page_program	Quad Page Program operation (H'33)	Refer to Table 5.39
xspi_op_t op_erase_4k	4Kbytes Block Erase operation (H'20)	Refer to Table 5.40
xspi_op_t op_erase_32k	32Kbytes Block Erase operation (H'52)	Refer to Table 5.41
xspi_op_t op_erase_64k	64Kbytes Block Erase operation (H'D8)	Refer to Table 5.42
CPG_PLL_SETDATA_146 cpg_pll4_setdata	PLL4 operation setting parameters	Refer to Table 5.43
CPG_PLL_SETDATA_146 cpg_pll6_setdata	PLL6 operation setting parameters	Refer to Table 5.44
CPG_SETUP_DATA early_setup_tbl[]	CPG setting table for modules used for IPL initialization	Refer to Table 5.45
CPG_SETUP_DATA cpg_clk_on_tbl[]	CPG setting table for clock supplying module	Refer to Table 5.46
CPG_SETUP_DATA cpg_reset_tbl[]	CPG setting table for modules to be released from reset	Refer to Table 5.47
CPG_REG_SETTING cpg_static_select_tbl[]	Clock selector register table that stops clock supply when register settings are changed	Refer to Table 5.48
CPG_REG_SETTING cpg_dynamic_select_tbl[]	Table of clock selector registers whose settings can be changed while the clock is being supplied	Refer to Table 5.49
PFC_REGS pfc_mux_reg_tbl[]	Pin setting table for modules used in boot processing	Refer to Table 5.50
PFC_REGS pfc_qspi_reg_tbl[]	Serial flash memory pin setting table	Refer to Table 5.51
rza_mmu_pgtbl_cfg_t g_mmu_pagetable_array[]	MMU setting table	Refer to Table 5.52

Table 5.32 xSPI control driver API function table (spim_api)

Member	Setting value	Description
open	spim_open	xSPI control driver open function
close	spim_close	xSPI control driver close function
post_init	spim_post_init	xSPI control driverpost initialization function
exec_op	spim_exec_op	xSPI control driver operation function
configure_xip	spim_configure_xip	xSPI control driver XIP setting function
start_xip	spim_start_xip	xSPI control driver XIP start function
stop_xip	spim_stop_xip	xSPI control driver XIP stop function
run_manual_calibration	spim_run_manual_calibration	xSPI control driver manual calibration function
enable_auto_calibration	spim_enable_auto_calibration	xSPI control driver auto calibration enable function
disable_auto_calibration	spim_disable_auto_calibration	xSPI control driver auto calibration disable function
set_frequency	spim_set_frequency	xSPI control driver operation frequency setting function
clean_mmap	spim_clean_mmap	xSPI control driver cache clean function
inv_mmap	spim_inv_mmap	xSPI control driver cache invalid function
get_mmap_base	spim_get_mmap_base	xSPI control driver memory map region address get function
get_mmap_size	spim_get_mmap_size	xSPI control driver memory map region size get function

Table 5.33 AT25QL128A driver API function table (qspiflash_at25_api)

Member	Setting value	Description
open	flash_open	Serial Flash Memory open function
close	flash_close	Serial Flash Memory close function
exec_op	flash_exec_op	Serial Flash Memory operation function
enter_xip	flash_enter_xip	Serial Flash Memory XIP start function
exit_xip	flash_exit_xip	Serial Flash Memory XIP stop function
get_info	flash_get_info	Serial Flash Memory information get function
read	flash_read	Serial Flash Memory read function
write	flash_write	Serial Flash Memory write function
erase	flash_erase	Serial Flash Memory erase function
get_write_status	flash_get_write_status	Serial Flash Memory write status get function

Table 5.34 Operation: “Write Enable” (op_write_enable)

Member	Setting value	Description
form	SPI_FORM_1_1_1	Command bit width: 1bit、 Address bit width: 1bit、 Data bit width: 1bit
op	0x06	Command code ”Write Enable”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	0	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	0	Data size
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.35 Operation: “Read Status Register-1” (op_read_status1)

Member	Setting value	Description
form	SPI_FORM_1_1_1	Command bit width: 1bit、 Address bit width: 1bit、 Data bit width: 1bit
op	0x05	Command code ”Read Status Register-1”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	0	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer This value is updated when communicating with the serial flash memory
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	1	Data size
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.36 Operation: “Read Status Register-2” (op_read_status2)

Member	Setting value	Description
form	SPI_FORM_1_1_1	Command bit width: 1bit、 Address bit width: 1bit、 Data bit width: 1bit
op	0x35	Command code ”Read Status Register-2”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	0	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer This value is updated when communicating with the serial flash memory
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	1	Data size
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.37 Operation: “Write Status Register-2” (op_write_status2)

Member	Setting value	Description
form	SPI_FORM_1_1_1	Command bit width: 1bit、 Address bit width: 1bit、 Data bit width: 1bit
op	0x31	Command code ”Write Status Register-2”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	0	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer This value is updated when communicating with the serial flash memory
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	1	Data size
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.38 Operation: “Fast Read Quad I/O” (rop)

Member	Setting value	Description
form	SPI_FORM_1_4_4	Command bit width: 1bit、 Address bit width: 4bit、 Data bit width: 4bit
op	0xEB	Command code ”Fast Read Quad I/O”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	3	Address size
additional_value	0x55555555	Option data
additional_size	1	Option data size
dummy_cycles	4	Number of dummy cycles
transfer_buffer	NULL	Data buffer This value is updated when communicating with the serial flash memory
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	0	Data size This value is updated when communicating with the serial flash memory
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.39 Operation: “Quad Page Program” (op_page_program)

Member	Setting value	Description
form	SPI_FORM_1_4_4	Command bit width: 1bit、 Address bit width: 4bit、 Data bit width: 4bit
op	0x33	Command code ” Quad Page Program”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	3	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer This value is updated when communicating with the serial flash memory
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	0	Data size This value is updated when communicating with the serial flash memory
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.40 Operation: “4 Kbytes Block Erase” (op_erase_4k)

Member	Setting value	Description
form	SPI_FORM_1_1_1	Command bit width: 1bit、 Address bit width: 1bit、 Data bit width: 1bit
op	0x20	Command code ”4 Kbytes Block Erase”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	3	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	0	Data size
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.41 Operation: “32 Kbytes Block Erase” (op_erase_32k)

Member	Setting value	Description
form	SPI_FORM_1_1_1	Command bit width: 1bit、 Address bit width: 1bit、 Data bit width: 1bit
op	0x52	Command code ”32 Kbytes Block Erase”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	3	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	0	Data size
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.42 Operation: “64 Kbytes Block Erase” (op_erase_64k)

Member	Setting value	Description
form	SPI_FORM_1_1_1	Command bit width: 1bit、 Address bit width: 1bit、 Data bit width: 1bit
op	0xD8	Command code ”64 Kbytes Block Erase”
op_size	1	Command size
op_is_ddr	false	Command transfer method (SDR)
address	0	Address
address_is_ddr	false	Address transfer method (SDR)
address_size	3	Address size
additional_value	0	Option data
additional_size	0	Option data size
dummy_cycles	0	Number of dummy cycles
transfer_buffer	NULL	Data buffer
transfer_is_ddr	false	Data transfer method (SDR)
transfer_size	0	Data size
force_idle_level_mask	0x08	Keep IO3/HOLD pin to High
force_idle_level_value	0x08	Keep IO3/HOLD pin to High
slch_value	0	Clock Delay SSLDR register SCKDL bit value
clsh_value	0	SSL Negation Delay CHSH: 5ns, CLSH=5ns - 1/SPI frequency = -10ns SSLDR register SLNDL bit value
shsl_value	6	Next Access Delay SSLDR register SPNDL bit value

Table 5.43 PLL4 operation setting parameters (cpg_pll4_setdata)

Member	Setting value	Description
clk1_dat.reg	CPG_PLL4_CLK1	CPG_PLL4_CLK1 register
clk1_dat.val	0xFAE13203	PLL4 = 1600MHz setting Please refer to chapter "PLLn (SSCG) Output Clock Setting Register 1 (CPG_SAMPLLn_CLK2) (n = 1, 4,or 6)" of A3UL Group User's Manual: Hardware for details
clk1_dat.reg	CPG_PLL4_CLK2	CPG_PLL4_CLK2 register
clk1_dat.val	0x00081000	PLL4 = 1600MHz setting Please refer to chapter "PLLn (SSCG) Output Clock Setting Register 2 (CPG_SAMPLLn_CLK2) (n = 1, 4,or 6)" of A3UL Group User's Manual: Hardware for details
stby_dat.reg	CPG_PLL4_STBY	CPG_PLL4_STBY register
stby_dat.val	0x00010001	PLL4 active setting

Table 5.44 PLL6 operation setting parameters (cpg_pll6_setdata)

Member	Setting value	Description
clk1_dat.reg	CPG_PLL6_CLK1	CPG_PLL6_CLK1 register
clk1_dat.val	0x00003Eb3	PLL4 = 500MHz setting Please refer to chapter "PLLn (SSCG) Output Clock Setting Register 1 (CPG_SAMPLLn_CLK2) (n = 1, 4, or 6)" of A3UL Group User's Manual: Hardware for details
clk1_dat.reg	CPG_PLL6_CLK2	CPG_PLL6_CLK2 register
clk1_dat.val	0x00082D02	PLL4 = 500MHz setting Please refer to chapter "PLLn (SSCG) Output Clock Setting Register 2 (CPG_SAMPLLn_CLK2) (n = 1, 4, or 6)" of A3UL Group User's Manual: Hardware for details
stby_dat.reg	CPG_PLL6_STBY	CPG_PLL6_STBY register
stby_dat.val	0x00010001	PLL6 active setting

Table 5.45 CPG setting table for modules used for IPL initialization (early_setup_tbl)

Member	Setting value	Description
early_setup_tbl[0].reg	CPG_CLKON_SYC	CPG_CLKON_SYC register
early_setup_tbl[0].mon	CPG_CLKMON_SYC	CPG_CLKMON_SYC register
early_setup_tbl[0].val	0x00010001	Clock supply setting
early_setup_tbl[0].type	CPG_T_CLK	Set the clock control register
early_setup_tbl[1].reg	CPG_RST_SYC	CPG_RST_SYC register
early_setup_tbl[1].mon	CPG_RSTMON_SYC	CPG_RSTMON_SYC register
early_setup_tbl[1].val	0x00010001	Reset release setting
early_setup_tbl[1].type	CPG_T_RST	Set the release control register

Table 5.46 CPG setting table for clock supplying module (cpg_clk_on_tbl)

Member	Setting value	Description
cpg_clk_on_tbl[0].reg	CPG_CLKON_CM33	CPG_CLKON_CM33 register
cpg_clk_on_tbl[0].mon	CPG_CLKMON_CM33	CPG_CLKMON_CM33 register
cpg_clk_on_tbl[0].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[0].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[1].reg	CPG_CLKON_MHU	CPG_CLKON_MHU register
cpg_clk_on_tbl[1].mon	CPG_CLKMON_MHU	CPG_CLKMON_MHU register
cpg_clk_on_tbl[1].val	0x00010000	Clock supply setting
cpg_clk_on_tbl[1].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[2].reg	CPG_CLKON_DMAC_REG	CPG_CLKON_DMAC_REG register
cpg_clk_on_tbl[2].mon	CPG_CLKMON_DMAC_REG	CPG_CLKMON_DMAC_REG register
cpg_clk_on_tbl[2].val	0x00030003	Clock supply setting
cpg_clk_on_tbl[2].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[3].reg	CPG_CLKON_OSTM	CPG_CLKON_OSTM register
cpg_clk_on_tbl[3].mon	CPG_CLKMON_OSTM	CPG_CLKMON_OSTM register
cpg_clk_on_tbl[3].val	0x00060000	Clock supply setting
cpg_clk_on_tbl[3].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[4].reg	CPG_CLKON_MTU	CPG_CLKON_MTU register
cpg_clk_on_tbl[4].mon	CPG_CLKMON_MTU	CPG_CLKMON_MTU register
cpg_clk_on_tbl[4].val	0x00010000	Clock supply setting
cpg_clk_on_tbl[4].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[5].reg	CPG_CLKON_POE3	CPG_CLKON_POE3 register
cpg_clk_on_tbl[5].mon	CPG_CLKMON_POE3	CPG_CLKMON_POE3 register
cpg_clk_on_tbl[5].val	0x00010000	Clock supply setting
cpg_clk_on_tbl[5].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[6].reg	CPG_CLKON_WDT	CPG_CLKON_WDT register
cpg_clk_on_tbl[6].mon	CPG_CLKMON_WDT	CPG_CLKMON_WDT register
cpg_clk_on_tbl[6].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[6].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[7].reg	CPG_CLKON_DDR	CPG_CLKON_DDR register
cpg_clk_on_tbl[7].mon	CPG_CLKMON_DDR	CPG_CLKMON_DDR register
cpg_clk_on_tbl[7].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[7].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[8].reg	CPG_CLKON_SDHI	CPG_CLKON_SDHI register
cpg_clk_on_tbl[8].mon	CPG_CLKMON_SDHI	CPG_CLKMON_SDHI register
cpg_clk_on_tbl[8].val	0x00FF00FF	Clock supply setting
cpg_clk_on_tbl[8].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[9].reg	CPG_CLKON_ISU	CPG_CLKON_ISU register
cpg_clk_on_tbl[9].mon	CPG_CLKMON_ISU	CPG_CLKMON_ISU register
cpg_clk_on_tbl[9].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[9].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[10].reg	CPG_CLKON_CRU	CPG_CLKON_CRU register
cpg_clk_on_tbl[10].mon	CPG_CLKMON_CRU	CPG_CLKMON_CRU register
cpg_clk_on_tbl[10].val	0x001F0000	Clock supply setting
cpg_clk_on_tbl[10].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[11].reg	CPG_CLKON_LCDC	CPG_CLKON_LCDC register
cpg_clk_on_tbl[11].mon	CPG_CLKMON_LCDC	CPG_CLKMON_LCDC register
cpg_clk_on_tbl[11].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[11].type	CPG_T_CLK	Set the clock control register

cpg_clk_on_tbl[12].reg	CPG_CLKON_SSI	CPG_CLKON_SSI register
cpg_clk_on_tbl[12].mon	CPG_CLKMON_SSI	CPG_CLKMON_SSI register
cpg_clk_on_tbl[12].val	0x00FF0000	Clock supply setting
cpg_clk_on_tbl[12].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[13].reg	CPG_CLKON_SRC	CPG_CLKON_SRC register
cpg_clk_on_tbl[13].mon	CPG_CLKMON_SRC	CPG_CLKMON_SRC register
cpg_clk_on_tbl[13].val	0x00010000	Clock supply setting
cpg_clk_on_tbl[13].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[14].reg	CPG_CLKON_USB	CPG_CLKON_USB register
cpg_clk_on_tbl[14].mon	CPG_CLKMON_USB	CPG_CLKMON_USB register
cpg_clk_on_tbl[14].val	0x000F0000	Clock supply setting
cpg_clk_on_tbl[14].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[15].reg	CPG_CLKON_ETH	CPG_CLKON_ETH register
cpg_clk_on_tbl[15].mon	CPG_CLKMON_ETH	CPG_CLKMON_ETH register
cpg_clk_on_tbl[15].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[15].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[16].reg	CPG_CLKON_I2C	CPG_CLKON_I2C register
cpg_clk_on_tbl[16].mon	CPG_CLKMON_I2C	CPG_CLKMON_I2C register
cpg_clk_on_tbl[16].val	0x000F0000	Clock supply setting
cpg_clk_on_tbl[16].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[17].reg	CPG_CLKON_SCIF	CPG_CLKON_SCIF register
cpg_clk_on_tbl[17].mon	CPG_CLKMON_SCIF	CPG_CLKMON_SCIF register
cpg_clk_on_tbl[17].val	0x001F0001	Clock supply setting
cpg_clk_on_tbl[17].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[18].reg	CPG_CLKON_SCI	CPG_CLKON_SCI register
cpg_clk_on_tbl[18].mon	CPG_CLKMON_SCI	CPG_CLKMON_SCI register
cpg_clk_on_tbl[18].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[18].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[19].reg	CPG_CLKON_IRDA	CPG_CLKON_IRDA register
cpg_clk_on_tbl[19].mon	CPG_CLKMON_IRDA	CPG_CLKMON_IRDA register
cpg_clk_on_tbl[19].val	0x00010000	Clock supply setting
cpg_clk_on_tbl[19].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[20].reg	CPG_CLKON_RSPI	CPG_CLKON_RSPI register
cpg_clk_on_tbl[20].mon	CPG_CLKMON_RSPI	CPG_CLKMON_RSPI register
cpg_clk_on_tbl[20].val	0x00070000	Clock supply setting
cpg_clk_on_tbl[20].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[21].reg	CPG_CLKON_CANFD	CPG_CLKON_CANFD register
cpg_clk_on_tbl[21].mon	CPG_CLKMON_CANFD	CPG_CLKMON_CANFD register
cpg_clk_on_tbl[21].val	0x00010000	Clock supply setting
cpg_clk_on_tbl[21].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[22].reg	CPG_CLKON_GPIO	CPG_CLKON_GPIO register
cpg_clk_on_tbl[22].mon	CPG_CLKMON_GPIO	CPG_CLKMON_GPIO register
cpg_clk_on_tbl[22].val	0x00010001	Clock supply setting
cpg_clk_on_tbl[22].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[23].reg	CPG_CLKON_ADC	CPG_CLKON_ADC register
cpg_clk_on_tbl[23].mon	CPG_CLKMON_ADC	CPG_CLKMON_ADC register
cpg_clk_on_tbl[23].val	0x00030000	Clock supply setting
cpg_clk_on_tbl[23].type	CPG_T_CLK	Set the clock control register
cpg_clk_on_tbl[24].reg	CPG_CLKON_TSU	CPG_CLKON_TSU register
cpg_clk_on_tbl[24].mon	CPG_CLKMON_TSU	CPG_CLKMON_TSU register
cpg_clk_on_tbl[24].val	0x00010000	Clock supply setting

cpg_clk_on_tbl[24].type	CPG_T_CLK	Set the clock control register

Table 5.47 CPG setting table for modules to be released from reset (cpg_reset_tbl)

Member	Setting value	Description
cpg_reset_tbl[0].reg	CPG_RSTON_CM33	CPG_RSTON_CM33 register
cpg_reset_tbl[0].mon	CPG_RSTMON_CM33	CPG_RSTMON_CM33 register
cpg_reset_tbl[0].val	0x00070000	Reset release setting
cpg_reset_tbl[0].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[1].reg	CPG_RSTON_MHU	CPG_RSTON_MHU register
cpg_reset_tbl[1].mon	CPG_RSTMON_MHU	CPG_RSTMON_MHU register
cpg_reset_tbl[1].val	0x00010000	Reset release setting
cpg_reset_tbl[1].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[2].reg	CPG_RSTON_DMAC_REG	CPG_RSTON_DMAC_REG register
cpg_reset_tbl[2].mon	CPG_RSTMON_DMAC_REG	CPG_RSTMON_DMAC_REG register
cpg_reset_tbl[2].val	0x00030003	Reset release setting
cpg_reset_tbl[2].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[3].reg	CPG_RSTON_OSTM	CPG_RSTON_OSTM register
cpg_reset_tbl[3].mon	CPG_RSTMON_OSTM	CPG_RSTMON_OSTM register
cpg_reset_tbl[3].val	0x00060000	Reset release setting
cpg_reset_tbl[3].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[4].reg	CPG_RSTON_MTU	CPG_RSTON_MTU register
cpg_reset_tbl[4].mon	CPG_RSTMON_MTU	CPG_RSTMON_MTU register
cpg_reset_tbl[4].val	0x00010000	Reset release setting
cpg_reset_tbl[4].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[5].reg	CPG_RSTON_POE3	CPG_RSTON_POE3 register
cpg_reset_tbl[5].mon	CPG_RSTMON_POE3	CPG_RSTMON_POE3 register
cpg_reset_tbl[5].val	0x00010000	Reset release setting
cpg_reset_tbl[5].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[6].reg	CPG_RSTON_WDT	CPG_RSTON_WDT register
cpg_reset_tbl[6].mon	CPG_RSTMON_WDT	CPG_RSTMON_WDT register
cpg_reset_tbl[6].val	0x00030000	Reset release setting
cpg_reset_tbl[6].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[7].reg	CPG_RSTON_DDR	CPG_RSTON_DDR register
cpg_reset_tbl[7].mon	CPG_RSTMON_DDR	CPG_RSTMON_DDR register
cpg_reset_tbl[7].val	0x007F0000	Reset release setting
cpg_reset_tbl[7].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[8].reg	CPG_RSTON_SDHI	CPG_RSTON_SDHI register
cpg_reset_tbl[8].mon	CPG_RSTMON_SDHI	CPG_RSTMON_SDHI register
cpg_reset_tbl[8].val	0x00030003	Reset release setting
cpg_reset_tbl[8].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[9].reg	CPG_RSTON_ISU	CPG_RSTON_ISU register
cpg_reset_tbl[9].mon	CPG_RSTMON_ISU	CPG_RSTMON_ISU register
cpg_reset_tbl[9].val	0x00030000	Reset release setting
cpg_reset_tbl[9].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[10].reg	CPG_RSTON_CRU	CPG_RSTON_CRU register
cpg_reset_tbl[10].mon	CPG_RSTMON_CRU	CPG_RSTMON_CRU register
cpg_reset_tbl[10].val	0x00070000	Reset release setting
cpg_reset_tbl[10].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[11].reg	CPG_RSTON_LCDC	CPG_RSTON_LCDC register
cpg_reset_tbl[11].mon	CPG_RSTMON_LCDC	CPG_RSTMON_LCDC register
cpg_reset_tbl[11].val	0x00010000	Reset release setting
cpg_reset_tbl[11].type	CPG_T_RST	Set the release control register

cpg_reset_tbl[12].reg	CPG_RSTON_SSIF	CPG_RSTON_SSIF register
cpg_reset_tbl[12].mon	CPG_RSTMON_SSIF	CPG_RSTMON_SSIF register
cpg_reset_tbl[12].val	0x000F0000	Reset release setting
cpg_reset_tbl[12].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[13].reg	CPG_RSTON_SRC	CPG_RSTON_SRC register
cpg_reset_tbl[13].mon	CPG_RSTMON_SRC	CPG_RSTMON_SRC register
cpg_reset_tbl[13].val	0x00010000	Reset release setting
cpg_reset_tbl[13].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[14].reg	CPG_RSTON_USB	CPG_RSTON_USB register
cpg_reset_tbl[14].mon	CPG_RSTMON_USB	CPG_RSTMON_USB register
cpg_reset_tbl[14].val	0x000F0000	Reset release setting
cpg_reset_tbl[14].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[15].reg	CPG_RSTON_ETH	CPG_RSTON_ETH register
cpg_reset_tbl[15].mon	CPG_RSTMON_ETH	CPG_RSTMON_ETH register
cpg_reset_tbl[15].val	0x00030000	Reset release setting
cpg_reset_tbl[15].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[16].reg	CPG_RSTON_I2C	CPG_RSTON_I2C register
cpg_reset_tbl[16].mon	CPG_RSTMON_I2C	CPG_RSTMON_I2C register
cpg_reset_tbl[16].val	0x000F0000	Reset release setting
cpg_reset_tbl[16].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[17].reg	CPG_RSTON_SCIF	CPG_RSTON_SCIF register
cpg_reset_tbl[17].mon	CPG_RSTMON_SCIF	CPG_RSTMON_SCIF register
cpg_reset_tbl[17].val	0x001F0001	Reset release setting
cpg_reset_tbl[17].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[18].reg	CPG_RSTON_SCI	CPG_RSTON_SCI register
cpg_reset_tbl[18].mon	CPG_RSTMON_SCI	CPG_RSTMON_SCI register
cpg_reset_tbl[18].val	0x00030000	Reset release setting
cpg_reset_tbl[18].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[19].reg	CPG_RSTON_IRDA	CPG_RSTON_IRDA register
cpg_reset_tbl[19].mon	CPG_RSTMON_IRDA	CPG_RSTMON_IRDA register
cpg_reset_tbl[19].val	0x00010000	Reset release setting
cpg_reset_tbl[19].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[20].reg	CPG_RSTON_RSPI	CPG_RSTON_RSPI register
cpg_reset_tbl[20].mon	CPG_RSTMON_RSPI	CPG_RSTMON_RSPI register
cpg_reset_tbl[20].val	0x00070000	Reset release setting
cpg_reset_tbl[20].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[21].reg	CPG_RSTON_CANFD	CPG_RSTON_CANFD register
cpg_reset_tbl[21].mon	CPG_RSTMON_CANFD	CPG_RSTMON_CANFD register
cpg_reset_tbl[21].val	0x00030000	Reset release setting
cpg_reset_tbl[21].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[22].reg	CPG_RSTON_GPIO	CPG_RSTON_GPIO register
cpg_reset_tbl[22].mon	CPG_RSTMON_GPIO	CPG_RSTMON_GPIO register
cpg_reset_tbl[22].val	0x00070007	Reset release setting
cpg_reset_tbl[22].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[23].reg	CPG_RSTON_ADC	CPG_RSTON_ADC register
cpg_reset_tbl[23].mon	CPG_RSTMON_ADC	CPG_RSTMON_ADC register
cpg_reset_tbl[23].val	0x00030000	Reset release setting
cpg_reset_tbl[23].type	CPG_T_RST	Set the release control register
cpg_reset_tbl[24].reg	CPG_RSTON_TSU	CPG_RSTON_TSU register
cpg_reset_tbl[24].mon	CPG_RSTMON_TSU	CPG_RSTMON_TSU register
cpg_reset_tbl[24].val	0x00030000	Reset release setting

cpg_reset_tbl[24].type	CPG_T_RST	Set the release control register

Table 5.48 Clock selector register table that stops clock supply (cpg_static_select_tbl)

Member	Setting value	Description
cpg_static_select_tbl[0].reg	CPG_PL3A_DDIV	CPG_PL3A_DDIV register
cpg_static_select_tbl[0].val	0x01000100	PLL3 clock divide rate setting
cpg_static_select_tbl[1].reg	CPG_PL3_SSEL	CPG_PL3_SSEL register
cpg_static_select_tbl[1].val	0x01000000	PLL3 source clock setting

Table 5.49 Clock selector register table that continues clock supply (cpg_dynamic_select_tbl)

Member	Setting value	Description
cpg_dynamic_select_tbl[0].reg	CPG_PL4_DSEL	CPG_PL4_DSEL register
cpg_dynamic_select_tbl[0].val	0x00010001	PLL4 clock divide rate setting
cpg_dynamic_select_tbl[1].reg	CPG_PL2SDHI_DSEL	CPG_PL2SDHI_DSEL register
cpg_dynamic_select_tbl[1].val	0x00110022	PLL2 source clock setting

Table 5.50 Pin setting table for modules used in boot processing (pfc_mux_reg_tbl)

Member	Setting value	Description
pfc_mux_reg_tbl[0].pmc.flag	PFC_ON	PFC enable flag
pfc_mux_reg_tbl[0].pmc.reg	PFC_PMC10	PFC_PMC10 register
pfc_mux_reg_tbl[0].pmc.val	0x0F	Register setting value
pfc_mux_reg_tbl[0].pfc.flag	PFC_ON	PFC enable flag
pfc_mux_reg_tbl[0].pfc.reg	PFC_PFC10	PFC_PFC10 register
pfc_mux_reg_tbl[0].pfc.val	0x00001111	Register setting value
pfc_mux_reg_tbl[0].iolh.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[0].iolh.reg	PFC_IOLH10	PFC_IOLH10 register
pfc_mux_reg_tbl[0].iolh.val	0x0000000001010101	Register setting value
pfc_mux_reg_tbl[0].pupd.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[0].pupd.reg	PFC_PUPD10	PFC_PUPD10 register
pfc_mux_reg_tbl[0].pupd.val	0x0000000000000000	Register setting value
pfc_mux_reg_tbl[0].sr.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[0].sr.reg	PFC_SR10	PFC_SR10 register
pfc_mux_reg_tbl[0].sr.val	0x0000000001010101	Register setting value
pfc_mux_reg_tbl[0].ien.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[0].ien.reg	NULL	PFC_IEN register NULL is defined for this member because PFC_IEN10 is not implemented
pfc_mux_reg_tbl[0].ien.val	0	Register setting value
pfc_mux_reg_tbl[1].pmc.flag	PFC_ON	PFC enable flag
pfc_mux_reg_tbl[1].pmc.reg	PFC_PMC16	PFC_PMC16 register
pfc_mux_reg_tbl[1].pmc.val	0x18	Register setting value
pfc_mux_reg_tbl[1].pfc.flag	PFC_ON	PFC enable flag
pfc_mux_reg_tbl[1].pfc.reg	PFC_PFC16	PFC_PFC16 register
pfc_mux_reg_tbl[1].pfc.val	0x00066000	Register setting value
pfc_mux_reg_tbl[1].iolh.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[1].iolh.reg	PFC_IOLH16	PFC_IOLH16 register
pfc_mux_reg_tbl[1].iolh.val	0x0000000101000000	Register setting value
pfc_mux_reg_tbl[1].pupd.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[1].pupd.reg	PFC_PUPD16	PFC_PUPD16 register
pfc_mux_reg_tbl[1].pupd.val	0x0000000000000000	Register setting value
pfc_mux_reg_tbl[1].sr.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[1].sr.reg	PFC_SR16	PFC_SR16 register
pfc_mux_reg_tbl[1].sr.val	0x0000000101000000	Register setting value
pfc_mux_reg_tbl[1].ien.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[1].ien.reg	NULL	PFC_IEN register NULL is defined for this member because PFC_IEN16 is not implemented
pfc_mux_reg_tbl[1].ien.val	0	Register setting value

Table 5.51 Serial flash memory pin setting table (pfc_qspi_reg_tbl)

Member	Setting value	Description
pfc_mux_reg_tbl[0].pmc.flag	PFC_OFF	PFC enable flag
pfc_mux_reg_tbl[0].pmc.reg	NULL	PFC_PMC register NULL is defined for this member because PFC_PMC0A is not implemented
pfc_mux_reg_tbl[0].pmc.val	0	Register setting value
pfc_mux_reg_tbl[0].pfc.flag	PFC_OFF	PFC enable flag
pfc_mux_reg_tbl[0].pfc.reg	NULL	PFC_PFC register NULL is defined for this member because PFC_PFC0A is not implemented
pfc_mux_reg_tbl[0].pfc.val	0	Register setting value
pfc_mux_reg_tbl[0].iolh.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[0].iolh.reg	PFC_IOLH0A	PFC_IOLH0A register
pfc_mux_reg_tbl[0].iolh.val	0x0000010101010101	Register setting value
pfc_mux_reg_tbl[0].pupd.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[0].pupd.reg	PFC_PUPD0A	PFC_PUPD0A register
pfc_mux_reg_tbl[0].pupd.val	0x0000000000000000	Register setting value
pfc_mux_reg_tbl[0].sr.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[0].sr.reg	PFC_SR0A	PFC_SR0A register
pfc_mux_reg_tbl[0].sr.val	0x0000010101010101	Register setting value
pfc_mux_reg_tbl[0].ien.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[0].ien.reg	NULL	PFC_IEN register NULL is defined for this member because PFC_IEN0A is not implemented
pfc_mux_reg_tbl[0].ien.val	0	Register setting value
pfc_mux_reg_tbl[1].pmc.flag	PFC_OFF	PFC enable flag
pfc_mux_reg_tbl[1].pmc.reg	NULL	PFC_PMC register NULL is defined for this member because PFC_PMC0B is not implemented
pfc_mux_reg_tbl[1].pmc.val	0	Register setting value
pfc_mux_reg_tbl[1].pfc.flag	PFC_OFF	PFC enable flag
pfc_mux_reg_tbl[1].pfc.reg	NULL	PFC_PFC register NULL is defined for this member because PFC_PFC0B is not implemented
pfc_mux_reg_tbl[1].pfc.val	0	Register setting value
pfc_mux_reg_tbl[1].iolh.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[1].iolh.reg	PFC_IOLH0B	PFC_IOLH0B register
pfc_mux_reg_tbl[1].iolh.val	0x0000010101010101	Register setting value
pfc_mux_reg_tbl[1].pupd.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[1].pupd.reg	PFC_PUPD0B	PFC_PUPD0B register
pfc_mux_reg_tbl[1].pupd.val	0x0000000000000000	Register setting value
pfc_mux_reg_tbl[1].sr.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[1].sr.reg	PFC_SR0B	PFC_SR0B register
pfc_mux_reg_tbl[1].sr.val	0x0000010101010101	Register setting value
pfc_mux_reg_tbl[1].ien.flag	PFC_OFF	PFC disable flag

pfc_mux_reg_tbl[1].ien.reg	NULL	PFC_IEN register NULL is defined for this member because PFC_IEN0B is not implemented
pfc_mux_reg_tbl[1].ien.val	0	Register setting value
pfc_mux_reg_tbl[2].pmc.flag	PFC_OFF	PFC enable flag
pfc_mux_reg_tbl[2].pmc.reg	NULL	PFC_PMC register NULL is defined for this member because PFC_PMC0C is not implemented
pfc_mux_reg_tbl[2].pmc.val	0	Register setting value
pfc_mux_reg_tbl[2].pfc.flag	PFC_OFF	PFC enable flag
pfc_mux_reg_tbl[2].pfc.reg	NULL	PFC_PFC register NULL is defined for this member because PFC_PFC0C is not implemented
pfc_mux_reg_tbl[2].pfc.val	0	Register setting value
pfc_mux_reg_tbl[2].iolh.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[2].iolh.reg	PFC_IOLH0C	PFC_IOLH0C register
pfc_mux_reg_tbl[2].iolh.val	0x0000000000000101	Register setting value
pfc_mux_reg_tbl[2].pupd.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[2].pupd.reg	PFC_PUPD0C	PFC_PUPD0C register
pfc_mux_reg_tbl[2].pupd.val	0x0000000000000000	Register setting value
pfc_mux_reg_tbl[2].sr.flag	PFC_ON	PFC disable flag
pfc_mux_reg_tbl[2].sr.reg	PFC_SR0C	PFC_SR0C register
pfc_mux_reg_tbl[2].sr.val	0x0000000000000000	Register setting value
pfc_mux_reg_tbl[2].ien.flag	PFC_OFF	PFC disable flag
pfc_mux_reg_tbl[2].ien.reg	NULL	PFC_IEN register NULL is defined for this member because PFC_IEN0C is not implemented
pfc_mux_reg_tbl[2].ien.val	0	Register setting value

Table 5.52 MMU setting table (g_mmu_pagetable_array[])

Member	Setting value	Description
g_mmu_pagetable_array[0].vaddress	0x00000000	Virtual address setting
g_mmu_pagetable_array[0].paddess	0x00000000	Physical address setting
g_mmu_pagetable_array[0].size	0x00200000	Virtual memory size
g_mmu_pagetable_array[0].attribute	RZA_MMU_ATTRIBUTE_NORMAL_CACHEABLE	Memory attribute setting: Normal Memory、Cache Enable (Write back)
g_mmu_pagetable_array[1].vaddress	0x00200000	Virtual address setting
g_mmu_pagetable_array[1].paddess	0x00200000	Physical address setting
g_mmu_pagetable_array[1].size	0x0FE00000	Virtual memory size
g_mmu_pagetable_array[1].attribute	RZA_MMU_ATTRIBUTE_ACCESS_FAULT	Memory attribute setting: Access Fault
g_mmu_pagetable_array[2].vaddress	0x10000000	Virtual address setting
g_mmu_pagetable_array[2].paddess	0x10000000	Physical address setting
g_mmu_pagetable_array[2].size	0x10000000	Virtual memory size
g_mmu_pagetable_array[2].attribute	RZA_MMU_ATTRIBUTE_DEVICE	Memory attribute setting: Device Memory
g_mmu_pagetable_array[3].vaddress	0x20000000	Virtual address setting
g_mmu_pagetable_array[3].paddess	0x20000000	Physical address setting
g_mmu_pagetable_array[3].size	0x10000000	Virtual memory size
g_mmu_pagetable_array[3].attribute	RZA_MMU_ATTRIBUTE_NORMAL_CACHEABLE	Memory attribute setting: Normal Memory、Cache Enable (Write back)
g_mmu_pagetable_array[4].vaddress	0x30000000	Virtual address setting
g_mmu_pagetable_array[4].paddess	0x30000000	Physical address setting
g_mmu_pagetable_array[4].size	0x10000000	Virtual memory size
g_mmu_pagetable_array[4].attribute	RZA_MMU_ATTRIBUTE_ACCESS_FAULT	Memory attribute setting: Access Fault
g_mmu_pagetable_array[5].vaddress	0x40000000	Virtual address setting
g_mmu_pagetable_array[5].paddess	0x40000000	Physical address setting
g_mmu_pagetable_array[5].size	0x40000000	Virtual memory size
g_mmu_pagetable_array[5].attribute	RZA_MMU_ATTRIBUTE_NORMAL_CACHEABLE	Memory attribute setting: Normal Memory、Cache Enable (Write back)

g_mmu_pagetable_array[6].vaddress	0x80000000	Virtual address setting
g_mmu_pagetable_array[6].paddess	0x80000000	Physical address setting
g_mmu_pagetable_array[6].size	0x80000000	Virtual memory size
g_mmu_pagetable_array[6].attribute	RZA_MMU_ATTRIBUTE_ACCESS_FAULT	Memory attribute setting: Access Fault
g_mmu_pagetable_array[7].vaddress	0xC0000000	Virtual address setting
g_mmu_pagetable_array[7].paddess	0xC0000000	Physical address setting
g_mmu_pagetable_array[7].size	0xC0000000	Virtual memory size
g_mmu_pagetable_array[7].attribute	RZA_MMU_ATTRIBUTE_ACCESS_FAULT	Memory attribute setting: Access Fault
g_mmu_pagetable_array[8].vaddress	0xFFFFFFFF	Summy address
g_mmu_pagetable_array[8].paddess	0xFFFFFFFF	Dummmy address
g_mmu_pagetable_array[8].size	0xFFFFFFFF	Dummy size
g_mmu_pagetable_array[8].attribute	RZA_MMU_ATTRIBUTE_CONFIG_END	End of MMU configure table

5.12 Function

This chapter shows the functions implemented in IPL.

This chapter only describes the functions used in the RZ/A3UL platform boot process.

5.12.1 Function List

Table 5.53 - Table 5.56 list the functions used in the RZ/A3UL platform boot process.

Table 5.53 List of IPL control functions

Function name	Description
bl2_el3_early_platform_setup	Initial settings for Renesas platforms
bl2_el3_plat_arch_setup	MMU settings for Renesas platforms
bl2_platform_setup	Memory settings for Renesas platforms
rz_io_setup	Initialize the FSP application image storage destination memory
panic	Jump to panic handler

Table 5.54 List of SPIM controller driver functions

Function name	Description
xspi_setup	Initialize serial flash memory
spim_open	Initialize xSPI controller driver
spim_close	Close xSPI controller driver
spim_post_init	Post-processing of xSPI controller driver initialization
spim_exec_op	Execute operation to serial flash memory
spim_configure_xip	External Address Space Read Mode setting
spim_start_xip	External Address Space Read Mode start
spim_stop_xip	External Address Space Read Mode finish
spim_run_manual_calibration	Execute manual calibration for serial flash memory
spim_enable_auto_calibration	Enable auto calibration for serial flash memory
spim_disable_auto_calibration	Disable auto calibration for serial flash memory
spim_set_frequency	Sets the maximum operating frequency of the serial flash memory
spim_clean_mmap	Clean read cache of serial flash memory
spim_inv_mmap	Invalidate read cache of serial flash memory
spim_get_mmap_base	Get base address where serial flash memory is mapped
spim_get_mmap_size	Get the size of the region where the serial flash memory is mapped
spim_get_features	Get the operation format supported by the xSPI controller

Table 5.55 List of Serial Flash Memory driver functions

Function name	Description
flash_open	Initialize the serial flash memory
flash_close	Close setting to the serial flash memory
flash_exec_op	Execute operation to serial flash memory
flash_enter_xip	External Address Space Read Mode start
flash_exit_xip	External Address Space Read Mode finish
flash_get_info	Get the serial flash memory information
flash_read	Data read from the serial flash memory
flash_write	Data write to the serial flash memory
flash_erase	Data erase of serial flash memory
flash_get_write_status	Get write status of the serial flash memory

Table 5.56 List of module control functions

Function name	Description
syc_init	Initialize the Cortex®-A55 built-in Generic Timer
generic_delay_timer_init	Initialize timer management parameters
pfc_setup	Set up pin
pfc_mux_setup	Set up pin of SCIF
pfc_qspi_setup	Set up pin of SPIBSC
cpg_setup	Set up CPG
cpg_ctrl_clkrst	Write processing to the clock control register and reset control register
cpg_selector_on_off	Clock ON/OFF setting for modules whose clocks are managed by the source clock selector
cpg_pll_start_146	Start process of PLL1/PLL4/PLL6
cpg_pll_setup	Set up PLL
cpg_div_sel_setup	Write process to Division Ratio Setting register and Source Clock Setting regiter
cpg_div_sel_static_setup	Setting of Static Switching Frequency Dividers and Selector
cpg_div_sel_dynamic_setup	Setting of Dynamic Switching Frequency Dividers and Selector
cpg_clk_on_setup	Clock supply setting for each module
cpg_reset_setup	Reset release setting for each module
cpg_active_ddr	DDR PHY clock and reset release settings
cpg_reset_ddr_mc	DDR Memory Controller clock and reset release setting
cpg_early_setup	Clock supply and reset release to modules required for pre-processing of platform boot process
cpg_wdtrst_sel_setup	Watchdog Timer module reset release processing
cpu_cpg_setup	Clock division ratio setting for CPU
cpg_search_spi_clk_table	Search the register setting table corresponding to the clock frequency supplied to the serial flash memory
cpg_research_spi_clk_table	Search for clock frequency value supplied to serial flash memory
cpg_stop_xspi_clock	Clock stop processing for serial flash memory
cpg_start_xspi_clock	Clock supply processing to serial flash memory
cpg_set_xspi_clock	Serial flash memory clock frequency setting processing
cpg_get_xspi_clock	Get the clock frequency supplied to the serial flash memory
wait_until_32	Processing to wait for the end of clock setting
console_rzg2l_register	Console output setting
console_set_scope	Set enable state for console output
plat_get_bl_image_load_info	Get load information of the FSP Application image
plat_get_next_bl_params	Get parameter information of the FSP Application image
rz_check_fsp_header	Check the Application Header
rz_update_descs	Update descriptor parameters
rz_print_descs	Print descriptor parameters
ddr_setup	Initiali setting of DDR SDRAM

5.12.2 Function Specifications

This chapter shows the specification of functions.

5.12.2.1 IPL control functions

The functions related to IPL control are listed below.

bl2_el3_early_platform_setup	
Outline	Perform initial settings for Renesas platform
Declaration	void bl2_el3_early_platform_setup (u_register_t arg1, u_register_t arg2, u_register_t arg3, u_register_t arg4)
Description	Initial settings related to hardware such as clocks, pins, general-purpose timers, console output, etc.
Arguments	arg1 :no use it arg2 :no use it arg3 :no use it arg4 :no use it
Return value	None

bl2_el3_plat_arch_setup	
Outline	Set MMU for Renesas platforms
Declaration	void bl2_el3_plat_arch_setup (void)
Description	set MMU for Renesas platforms.
Arguments	None
Return value	None

bl2_platform_setup	
Outline	Performs memory settings for Renesas platforms
Declaration	void bl2_platform_setup (void)
Description	Initialize memory for Renesas platform and copy FSP application image.
Arguments	None
Return value	None

rz_io_setup	
Outline	Initialize the FSP application image storage destination memory
Declaration	void rz_io_setup (void)
Description	Initializes the serial flash memory where the FSP application image is stored. Additionally, this function checks the boot mode. If the boot mode is set to something other than boot mode 3, the IPL will start an infinite loop and stop the boot process.
Arguments	None
Return value	None

panic	
Outline	Jump to panic handler
Declaration	void panic (void)
Description	When an error occurs, jump to panic handler which stops processing by infinite loop. This function is called when an unrecoverable error occurs.
Arguments	None
Return value	None

5.12.2.2 SPIM controller driver functions

The xSPI control driver functions that control the SPIBSC are shown below.

xspi_setup	
Outline	Initialize the serial flash memory
Declaration	void xspi_setup (void)
Description	This function calls the API function corresponding to the serial flash memory and initializes the memory.
Arguments	None
Return value	None

spim_open	
Outline	Initialize the xSPI controller driver
Declaration	int spim_open (xspi_ctrl_t * ctrl, xspi_cfg_t const * const cfg)
Description	Initialize the xSPI controller driver.
Arguments	*ctrl :Pointer to the control structure for instance *cfg :Pointer to the configuration structure for instance
Return value	0 :Initialization is complete -1 :Initialization is failed

spim_close	
Outline	Close the xSPI controller driver
Declaration	int spim_close (xspi_ctrl_t * ctrl)
Description	Close the xSPI controller driver.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :Close process is complete -1 :Close process is failed

spim_post_init	
Outline	Perform post-processing of xSPI controller driver initialization
Declaration	void spim_post_init (xspi_ctrl_t * ctrl)
Description	Perform post-processing of xSPI controller driver initialization. Processing in this function is not implemented in this version.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :This value is always returned

spim_exec_op	
Outline	Issue the operation to serial flash memory
Declaration	int spim_exec_op (xspi_ctrl_t * const ctrl, xspi_op_t const * const op, bool is_write)
Description	Issue the operation to serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance *op : Pointer to xSPI interface operation structure is_write :Specifies the transmission/reception direction of the operation(0=read、1=write)
Return value	0 :Issue the operation is complete -1 :Issue the operation is failed

spim_configure_xip	
Outline	Set the External Address Space Read Mode
Declaration	int spim_configure_xip (xspi_ctrl_t * const ctrl, xspi_op_t const * const rop, xspi_op_t const * const wop)
Description	Set the External Address Space Read Mode
Arguments	*ctrl :Pointer to the control structure for instance *rop :Pointer to operation structure for read *wop :Pointer to operation structure for write
Return value	0 :Setting is complete -1 :Setting is failed

spim_start_xip	
Outline	Start the External Address Space Read Mode
Declaration	int spim_start_xip (xspi_ctrl_t * const ctrl)
Description	Start the External Address Space Read Mode.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :This value is always returned

spim_stop_xip	
Outline	Stop the External Address Space Read Mode
Declaration	int spim_stop_xip (xspi_ctrl_t * const ctrl)
Description	Stop the External Address Space Read Mode.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :This value is always returned

spim_run_manual_calibration	
Outline	Execute calibration for the serial flash memory
Declaration	int spim_run_manual_calibration (xspi_ctrl_t * const ctrl)
Description	Execute Calibration for the serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :Calibration is complete -1 :Calibration is failed

spim_enable_auto_calibration	
Outline	Enable auto calibration for serial flash memory
Declaration	int spim_enable_auto_calibration (xspi_ctrl_t * const ctrl)
Description	Enable auto calibration for serial flash memory. Processing in this function is not implemented in this version.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	-1 :This value is always returned

spim_disable_auto_calibration	
Outline	Disable auto calibration for serial flash memory
Declaration	int spim_disable_auto_calibration (xspi_ctrl_t * const ctrl)
Description	Disable auto calibration for serial flash memory. Processing in this function is not implemented in this version.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	-1 :This value is always returned

spim_set_frequency	
Outline	Sets the maximum operating frequency of the serial flash memory
Declaration	int spim_set_frequency (xspi_ctrl_t * const ctrl, int frequency_hz)
Description	Sets the maximum operating frequency of the serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance frequency_hz :Maximum operating frequency of the serial flash memory
Return value	0 :This value is always returned

spim_clean_mmap	
Outline	Clean read cache of the serial flash memory
Declaration	int spim_clean_mmap (xspi_ctrl_t * const ctrl)
Description	Clean read cache of the serial flash memory. Processing in this function is not implemented in this version.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :This value is always returned

spim_inv_mmap	
Outline	Invalidate read cache of the serial flash memory
Declaration	int spim_inv_mmap (xspi_ctrl_t * const ctrl)
Description	Invalidate read cache of the serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :This value is always returned

spim_get_mmap_base	
Outline	Get the base address where the serial flash memory is mapped
Declaration	uintptr_t spim_get_mmap_base (xspi_ctrl_t * const ctrl)
Description	Get the base address to which the serial flash memory is mapped.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	Positive number : Base address where the serial flash memory is mapped

spim_get_mmap_size	
Outline	Get the size of the area where the serial flash memory is mapped
Declaration	uintptr_t spim_get_mmap_size (xspi_ctrl_t * const ctrl)
Description	Get the size of the area where the serial flash memory is mapped.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	Positive number : the size of the area where the serial flash memory is mapped

spim_get_features	
Outline	Get the operation format supported by the xSPI controller
Declaration	uint32_t spim_get_features (xspi_ctrl_t * const ctrl)
Description	Get the operation format supported by the xSPI controller
Arguments	*ctrl :Pointer to the control structure for instance
Return value	Positive number :Returns the OR of the following bit values XSPI_FEATURE_XIP_READ :The driver supports read access. XSPI_FEATURE_XIP_WRITE :The driver supports write access. XSPI_FEATURE_FORM112 :The driver supports 1-1-2 form. XSPI_FEATURE_FORM122 :The driver supports 1-2-2 form. XSPI_FEATURE_FORM222 :The driver supports 2-2-2 form. XSPI_FEATURE_DUAL :The driver supports 1-1-2, 1-2-2, and/or 2-2-2 form(s). XSPI_FEATURE_FORM114 :The driver supports 1-1-4 form. XSPI_FEATURE_FORM144 :The driver supports 1-4-4 form. XSPI_FEATURE_FORM444 :The driver supports 4-4-4 form. XSPI_FEATURE_QUAD :The driver supports 1-1-4, 1-4-4, and/or 4-4-4 form(s). XSPI_FEATURE_FORM118 :The driver supports 1-1-8 form. XSPI_FEATURE_FORM188 :The driver supports 1-8-8 form. XSPI_FEATURE_FORM888 :The driver supports 8-8-8 form. XSPI_FEATURE_OCTAL :The driver supports 1-1-8, 1-8-8, and/or 8-8-8 form(s). XSPI_FEATURE_DTROP :The driver supports DTR for op code. XSPI_FEATURE_DTR :The driver supports DTR for address and/or data. XSPI_FEATURE_OCTARAM :OctaRAM addressing (RAS/CAS) supported.

5.12.2.3 Serial Flash Memory driver functions

This chapter shows the serial flash memory driver functions for controlling the serial flash memory.

flash_open	
Outline	Initialize the serial flash memory
Declaration	int flash_open (xspidevice_ctrl_t * ctrl, xspidevice_cfg_t const * cfg)
Description	Initialize the serial flash memory.
Arguments	*ctrl :Pointer to xSPI device control structure
	*cfg :Pointer to xSPI device configure structure
Return value	0 :Initialization is complete
	-1 :Initialization is failed

flash_close	
Outline	Close the serial flash memory
Declaration	int flash_close (xspidevice_ctrl_t * ctrl)
Description	Close the serial flash memory.
Arguments	*ctrl :Pointer to xSPI device control structure
Return value	0 :Close process is complete
	-1 :Close process is failed

flash_exec_op	
Outline	Execute operation to serial flash memory
Declaration	void flash_exec_op (xspidevice_ctrl_t * ctrl, xspi_op_t const * op, bool is_write)
Description	Execute operation to serial flash memory.
Arguments	*ctrl :Pointer to xSPI device control structure
	*op : Pointer to xSPI interface operation structure
	is_write :Specifies the transmission/reception direction of the operation(0=read、1=write)
Return value	0 :Execute the operation is complete
	-1 :Execute the operation is failed

flash_enter_xip	
Outline	Set the External Address Space Read Mode to the serial flash memory
Declaration	int flash_enter_xip (xspidevice_ctrl_t * ctrl)
Description	Set the External Address Space Read Mode to the serial flash memory and start it.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :Setting is complete
	-1 :Setting is failed

flash_exit_xip	
Outline	Finish the External Address Space Read Mode
Declaration	int flash_exit_xip (xspi_ctrl_t * const ctrl)
Description	Finish the External Address Space Read Mode
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :This value is always returned

flash_get_info	
Outline	Get the information of the serial flash memory
Declaration	int flash_get_info (xspidevice_ctrl_t * ctrl, xspidevice_info_t * info)
Description	Get the information of the serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance * info :Information of the serial flash memory
Return value	0 :This value is always returned

flash_read	
Outline	Data read from the serial flash memory
Declaration	int flash_read (xspi_ctrl_t * const ctrl , void * buffer, size_t address, size_t length)
Description	Data read from the serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance * buffer :Pointer to buffer to store read data address:Data read source address Specify the offset address in the serial flash memory for this argument length :Read data size
Return value	0 :This value is always returned

flash_write	
Outline	Data write to the serial flash memory
Declaration	int flash_write (xspi_ctrl_t * const ctrl , void const * buffer, size_t address, size_t length)
Description	Data write to the serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance * buffer :Pointer to buffer where write data is stored address:Data write destination address Specify the offset address in the serial flash memory for this argument length :Write data size
Return value	0 :Data write is sucess -1 :Data write is failed

flash_erase	
Outline	Erase the serial flash memory
Declaration	int flash_erase (xspidevice_ctrl_t * ctrl, size_t address, size_t length)
Description	Data erase the serial flash memory. Data erase is performed with addresses and sizes in units of 4 Kbytes.。
Arguments	*ctrl :Pointer to the control structure for instance address:Start address for data erase Specify the offset address in the serial flash memory for this argument. If a value other than a multiple of 4Kbytes is set, the address obtained by aligning the specified address with 4Kbytes will be the start address of the erase area. length :erase size If a value other than 4Kbyte aligned size is set in this argument, it erases the data up to the 4Kbyte aligned address including the specified range.
Return value	0 :Data erase is success -1 :Data erase is failed.

flash_get_write_status	
Outline	Gets the write status of the serial flash memory
Declaration	int flash_get_write_status (xspidevice_ctrl_t * ctrl)
Description	Gets the write status of the serial flash memory.
Arguments	*ctrl :Pointer to the control structure for instance
Return value	WRITE_STATUS_FAIL :Data write is failed WRITE_STATUS_IN_PROGRESS :Data write in progress WRITE_STATUS_OK :Data write is complete

5.12.2.4 module control functions

The module control functions that control each module are shown below.

syc_init	
Outline	Initialize the Cortex®-A55 built-in Generic Timer
Declaration	void syc_init (unsigned int freq)
Description	Initialize the Cortex®-A55 built-in Generic Timer and start count
Arguments	freq :Frequency of the counter
Return value	None

generic_delay_timer_init	
Outline	Initialize timer management parameters
Declaration	void generic_delay_timer_init (void)
Description	Timer parameter is initialized. By executing the syc_init() function and this function, the following wait functions can be executed. functionudelay():Wait in usec unit. functionmdelay(): Wait in msec unit.
Arguments	None
Return value	None

pfc_setup	
Outline	Set up the pin
Declaration	void pfc_setup (void)
Description	Set up pin setting of SCIF and SPIBSC.
Arguments	None
Return value	None

pfc_mux_setup	
Outline	Set up pin setting of SCIF
Declaration	void pfc_mux_setup (void)
Description	Set up pin setting of SCIF and SCIF. Set the P6 pin as SCIF0.
Arguments	None
Return value	None

pfc_qspi_setup	
Outline	Set up pin setting of SPIBSC
Declaration	void pfc_qspi_setup (void)
Description	Set up pin setting of SPIBSC.
Arguments	None
Return value	None

cpg_setup	
Outline	Set up CPG
Declaration	void cpg_setup (void)
Description	Set up CPG.
Arguments	None
Return value	None

cpg_ctrl_clkrst	
Outline	Execute write processing to the clock control register and reset control register
Declaration	void cpg_ctrl_clkrst (CPG_SETUP_DATA const *array、uint32_t num)
Description	Execute write processing to the clock control register and reset control register.
Arguments	*array :Pointer to CPG setup data table num :Number of elements in CPG setup data table
Return value	None

cpg_selector_on_off	
Outline	Clock ON/OFF setting for modules whose clocks are managed by the source clock selector
Declaration	void cpg_selector_on_off (uint32_t sel, uint8_t flag)
Description	The source clock selector simultaneously turns ON/OFF the clocks of the modules to which the clock is to be supplied. Call this function to turn the clock on/off before and after changing the source clock selector.
Arguments	sel :Specifies the source clock selector to change flag :Set the clock ON/OFF
Return value	None

cpg_pll_start_146	
Outline	Start process of PLL1/PLL4/PLL6
Declaration	void cpg_pll_start_146 (CPG_PLL_SETDATA_146 *pdata)
Description	By operating the registers of PLL1/PLL4/PLL6, the frequency is set, standby is released, and PLL operation is started.
Arguments	*pdata :Pointer to PLL1/4/6 setting table
Return value	None

cpg_pll_setup	
Outline	Set up PLL setting
Declaration	void cpg_pll_setup (void)
Description	Reset the PLL4/PLL6 and set the frequency, start the PLL operation.
Arguments	None
Return value	None

cpg_div_sel_setup	
Outline	Write to Division Ratio Setting Register and Source Clock Setting Register.
Declaration	void cpg_div_sel_setup (CPG_REG_SETTING *tbl, uint32_t size)
Description	Write to Division Ratio Setting Register and Source Clock Setting Register.
Arguments	*tbl :Pointer to CPG register setting table size :Size of CPG register setting table
Return value	None

cpg_div_sel_static_setup	
Outline	Perform Static Switching Frequency Dividers and Selector settings.
Declaration	void cpg_div_sel_static_setup (void)
Description	Perform Static Switching Frequency Dividers and Selector settings. Set the registers registered in cpg_static_select_tbl.
Arguments	None
Return value	None

cpg_div_sel_dynamic_setup	
Outline	Perform Dynamic Switching Frequency Dividers and Selector settings.
Declaration	void cpg_div_sel_dynamic_setup (void)
Description	Perform Dynamic Switching Frequency Dividers and Selector settings. Set the registers registered in cpg_dynamic_select_tbl.
Arguments	None
Return value	None

cpg_clk_on_setup	
Outline	Execute clock supply settings for each module
Declaration	void cpg_clk_on_setup (void)
Description	Execute clock supply settings for each module . Set the registers registered in cpg_clk_on_tbl.
Arguments	None
Return value	None

cpg_reset_setup	
Outline	Execute reset release setting for each module
Declaration	void cpg_reset_setup (void)
Description	Execute reset release setting for each module. Set the registers registered in cpg_reset_tbl.
Arguments	None
Return value	None

cpg_active_ddr	
Outline	Execute DDR PHY clock and reset release settings
Declaration	void cpg_active_ddr (void (*disable_phy)(void))
Description	Execute DDR PHY clock and reset release settings.
Arguments	*disable_phy :Pointer to disable_phy_clk function
Return value	None

cpg_reset_ddr_mc	
Outline	Execute DDR memory controller clock and reset release settings
Declaration	void cpg_active_ddr (void (*disable_phy)(void))
Description	Execute DDR memory controller clock and reset release settings.
Arguments	*disable_phy :Pointer to disable_phy_clk function
Return value	None

cpg_early_setup	
Outline	Executes clock supply to modules required for preprocessing of platform settings and reset release settings
Declaration	void cpg_early_setup (void)
Description	Executes clock supply to modules required for preprocessing of platform settings and reset release settings. This function sets the registers registered in early_setup_tbl.
Arguments	None
Return value	None

cpg_wdtrst_sel_setup	
Outline	Execute reset release setting of Watchdog Timer module
Declaration	void cpg_wdtrst_sel_setup (void)
Description	Execute reset release setting of Watchdog Timer module.
Arguments	None
Return value	None

cpu_cpg_setup	
Outline	Execute clock division ratio setting to CPU
Declaration	void cpu_cpg_setup (void)
Description	Set the clock division ratio to the CPU to 1/1.
Arguments	None
Return value	None

cpg_search_spi_clk_table	
Outline	Search the clock frequency register setting table corresponding to the clock frequency supplied to the serial flash memory
Declaration	int cpg_search_spi_clk_table (int frequency)
Description	Search the element number corresponding to the clock frequency supplied to the serial flash memory from the clock frequency register setting table.
Arguments	frequency :Clock frequency
Return value	Positive number : Element number of register setting table -1 : The element number corresponding to the clock frequency does not exist in the table

cpg_research_spi_clk_table	
Outline	Search for clock frequency value supplied to serial flash memory
Declaration	int cpg_search_spi_clk_table (uint8_t selector, uint8_t divider)
Description	Searches for the clock frequency to be supplied to the serial flash memory from the clock selector and divider settings set in the CPG register.
Arguments	selector :Source clock selector setting divider :Divider setting
Return value	Positive number:Clock frequency -1 :No parameters in table for clock selector and divider settings

cpg_stop_xspi_clock	
Outline	Stop supplying clock to serial flash memory
Declaration	void cpg_stop_xspi_clock (xspi_clock spi)
Description	Stop supplying clock to serial flash memory.
Arguments	spi :Specifies the type of serial flash memory (spi = XSPI_CLOCK_SPIM QSPI Flash memory spi = XSPI_CLOCK_OCTA Octa Flash memory)
Return value	None

cpg_start_xspi_clock	
Outline	Start supplying clock to serial flash memory
Declaration	void cpg_start_xspi_clock (xspi_clock spi)
Description	Start supplying clock to serial flash memory.
Arguments	spi :Specifies the type of serial flash memory (spi = XSPI_CLOCK_SPIM QSPI Flash memory spi = XSPI_CLOCK_OCTA Octa Flash memory)
Return value	None

cpg_set_xspi_clock	
Outline	Execute clock setting processing for serial flash memory
Declaration	void cpg_set_xspi_clock (xspi_clock spi, int frequency_hz)
Description	Execute clock setting processing for serial flash memory.
Arguments	spi :Specifies the type of serial flash memory (spi = XSPI_CLOCK_SPIM QSPI Flash memory spi = XSPI_CLOCK_OCTA Octa Flash memory) frequency_hz :Clock frequency
Return value	None

cpg_get_xspi_clock	
Outline	Get the clock frequency supplied to the serial flash memory
Declaration	int cpg_get_xspi_clock (xspi_clock spi)
Description	Get the clock frequency supplied to the serial flash memory.
Arguments	spi :Specifies the type of serial flash memory (spi = XSPI_CLOCK_SPIM QSPI Flash memory spi = XSPI_CLOCK_OCTA Octa Flash memory)
Return value	positive number:Clock frequency -1 : Failed to get clock frequency

wait_until_32	
Outline	Wait for completion of clock setting
Declaration	int wait_until_32 (uintptr_t addr, uint32_t mask, uint32_t test)
Description	This function reads the CPG monitor register and waits until the clock setting is reflected and the clock stabilizes.
Arguments	addr :CPG monitor register mask :Bitmask to read test :Expected read value of CPG monitor register
Return value	None

console_rzg2l_register	
Outline	Configuring console output
Declaration	int console_rzg2l_register(uintptr_t baseaddr, uint32_t clock, uint32_t baud, console_t *console)
Description	Perform the SCIF settings used for console output. After setting, it is possible to output to the console with printf().
Arguments	baseaddr :SCIF register base address of the channel used clock :Input clock frequency for SCIF module baud :Baudrate setting to console output *console :Parameter of console output This parameter is automatically set when this function is executed
Return value	1 :Console output setting success 0 :Console output registration failure

console_set_scope	
Outline	Set the valid state of the console output
Declaration	void console_set_scope(console_t *console, unsigned int scope)
Description	Set the state in which console output processing is enabled.
Arguments	*console :Console output parameter Set parameters obtained by console_rzg2l_register() scope :Sets the state that enables console output processing Please set (CONSOLE_FLAG_BOOT | CONSOLE_FLAG_CRASH) in the IPL
Return value	None

plat_get_bl_image_load_info	
Outline	Get FSP application image load information
Declaration	bl_load_info_t *plat_get_bl_image_load_info(void)
Description	Get FSP application image load information.
Arguments	None
Return value	Positive number: Pointer to FSP application image load information

plat_get_next_bl_params	
Outline	Get FSP application image parameter information
Declaration	bl_params_t *plat_get_next_bl_params (void)
Description	Get FSP application image parameter information.
Arguments	None
Return value	Positive number: Pointer to FSP application image parameter information

rz_check_fsp_header	
Outline	Perform application header check
Declaration	int rz_check_fsp_header (fsp_app_header_t *header)
Description	Check the contents of the application header. This function will return an error if: - entry_addr != entry_addr_inv - dest_addr != dest_addr_inv - payload_size != payload_size_inv - The image copy area address is outside the On-chip RAM or DDR SDRAM area.
Arguments	*header :Pointer to Application Header
Return value	0 :Application header parameters are valid values -1 :Application header parameters are invalid values

rz_update_descs	
Outline	Update the descriptor parameter with the content obtained from the application header
Declaration	void rz_update_descs (fsp_app_header_t *header)
Description	Update the descriptor parameter with the content obtained from the application header. IPL controls the jump destination address of the FSP application by this discriptor.
Arguments	*header :Pointer to Application Header
Return value	None

rz_load_fsp	
Outline	Load FSP application image
Declaration	void rz_load_fsp (void)
Description	The application header is read and checked, and the FSP application is copied according to its contents and the descriptor is updated. If the application header check fails, the IPL will go into an infinite loop and stop the boot process.
Arguments	None
Return value	None

rz_print_descs	
Outline	Parameters of the descriptor are printed to the console
Declaration	void rz_rz_print_descs (void)
Description	Parameters of the descriptor are printed to the console.
Arguments	None
Return value	None

ddr_setup	
Outline	Initialize DDR SDRAM
Declaration	void ddr_setup (void)
Description	Initializes DDR SDRAM and enables read/write access to DDR SDRAM.
Arguments	None
Return value	None

5.13 Flow Chart

5.13.1 IPL (overall) flow

Figure 5.6, Figure 5.7, Figure 5.8 show the flowchart of IPL (overall)

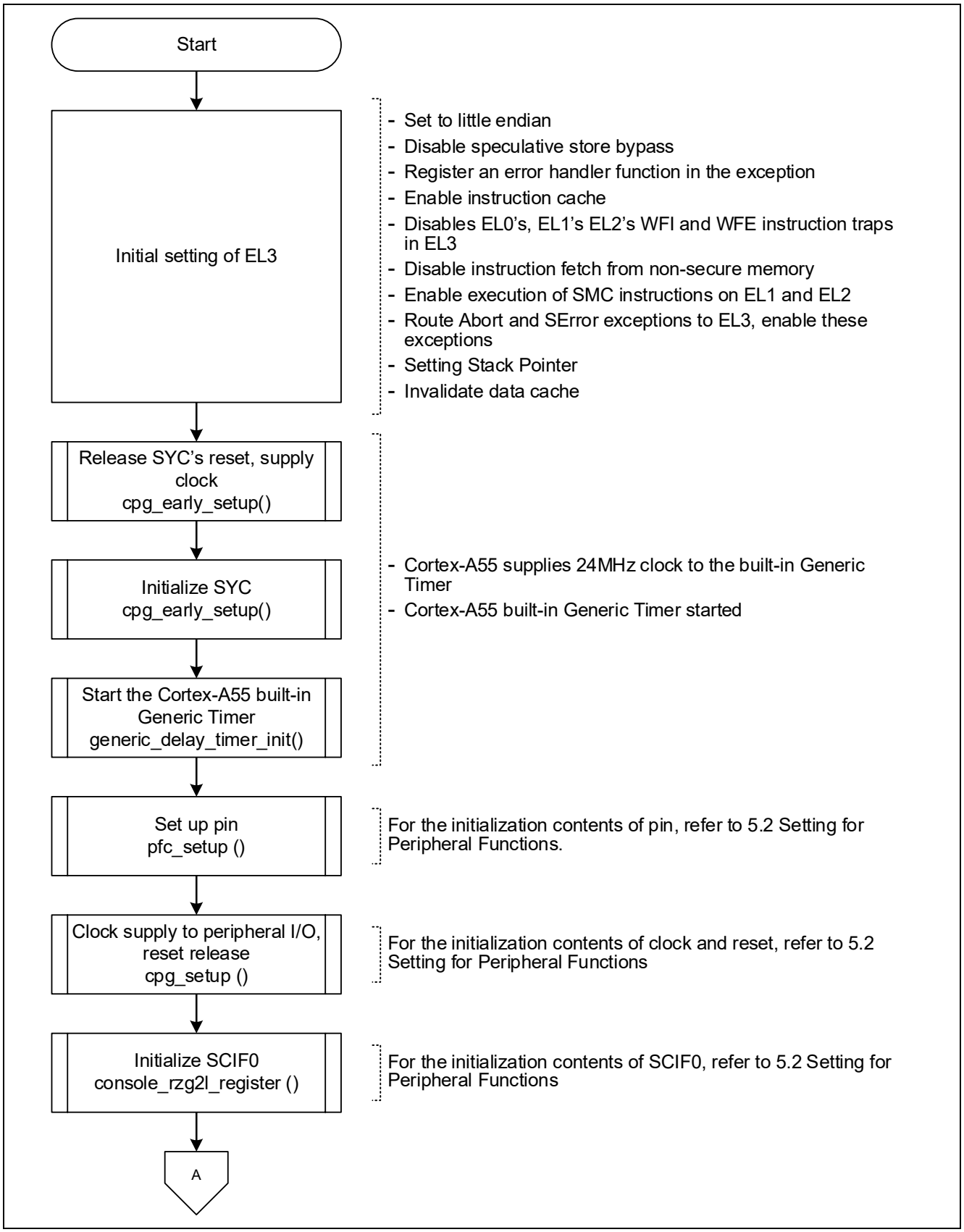


Figure 5.6 IPL Flow Chart part1

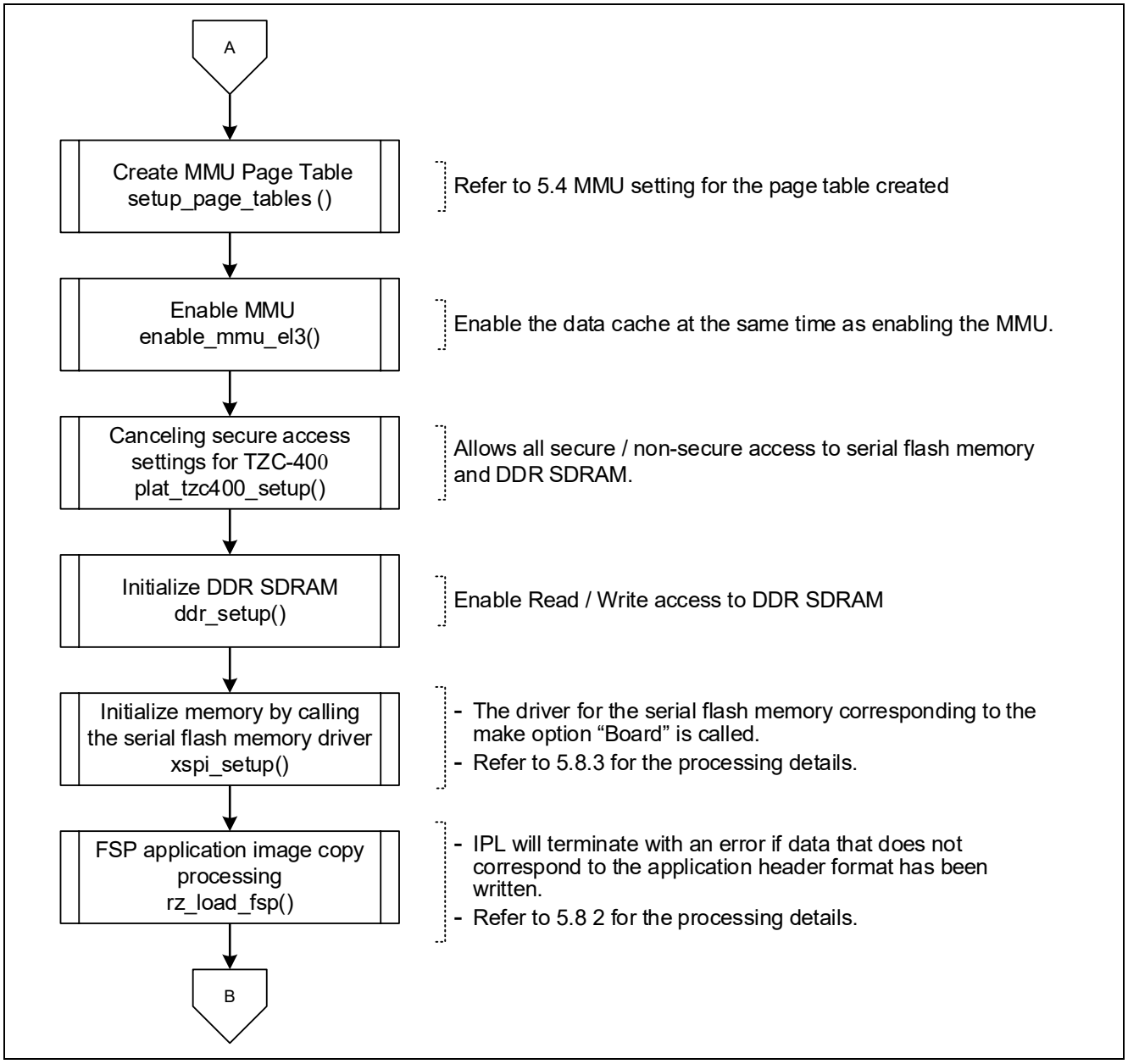


Figure 5.7 IPL Flow Chart part2

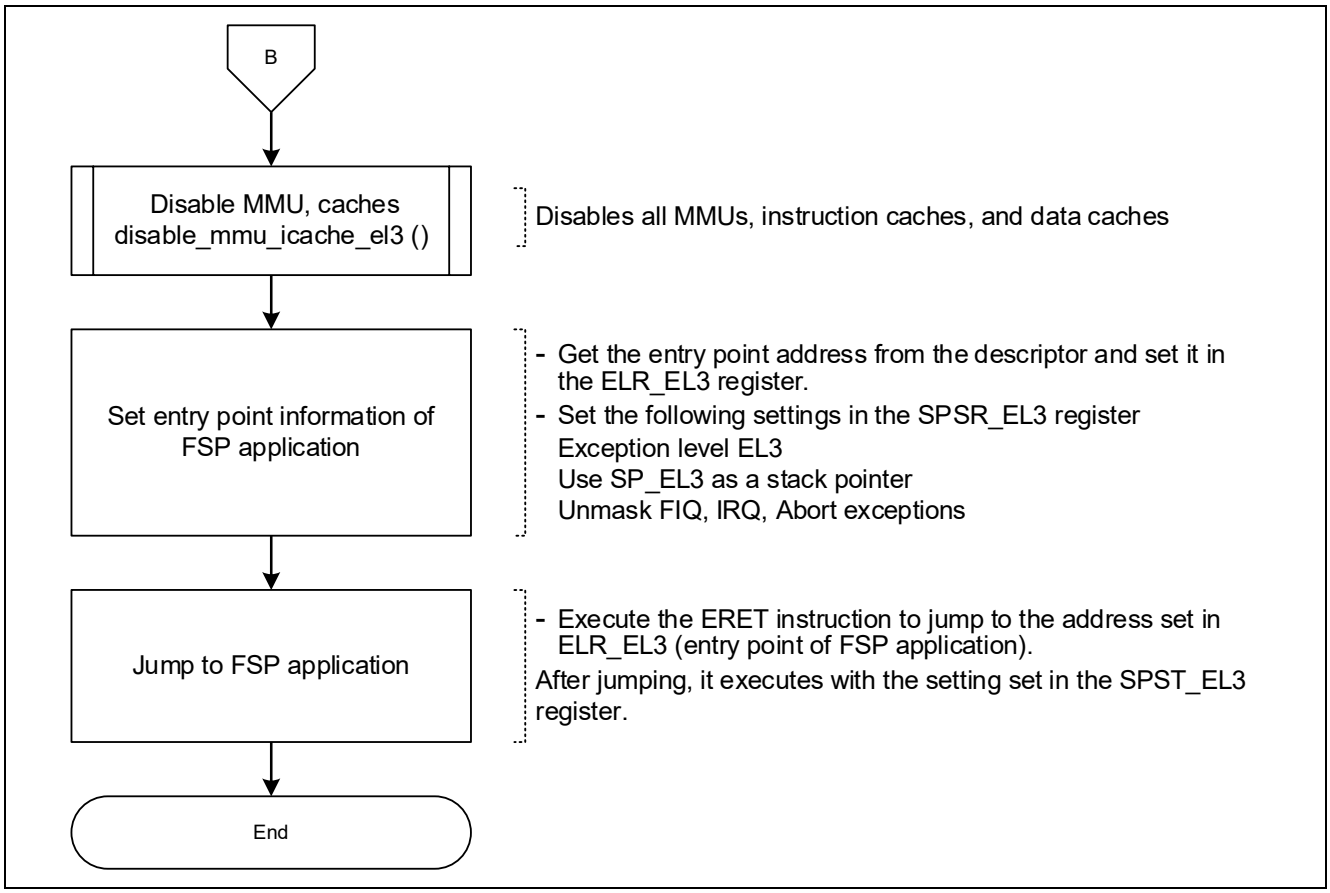


Figure 5.8 IPL Flow Chart part3

5.13.2 FSP Application Image copy process

Figure 5.9 and Figure 5.10 show the flow chart of the FSP Application image copy process.

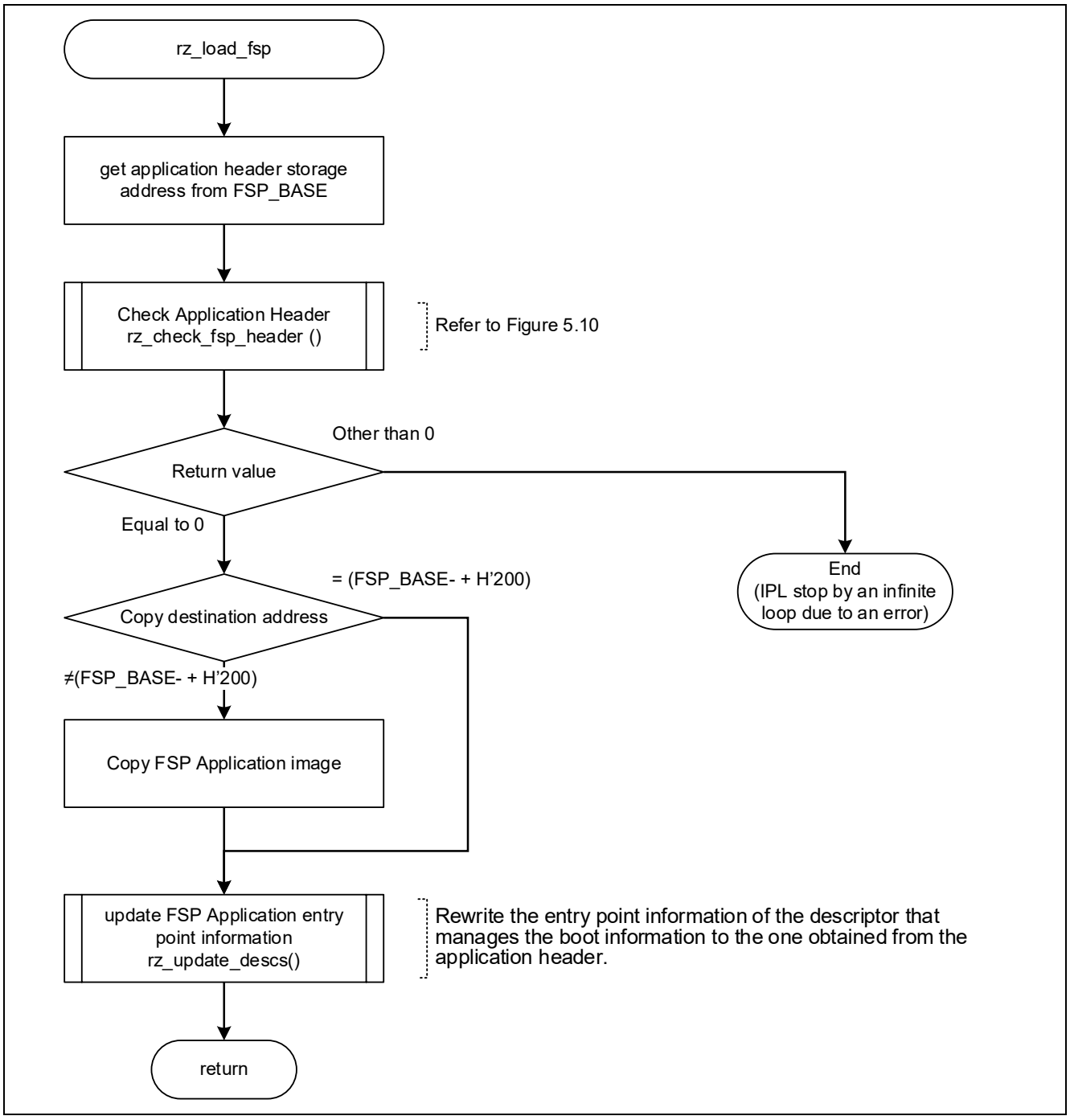


Figure 5.9 Flow Chart of rz_load_fsp()

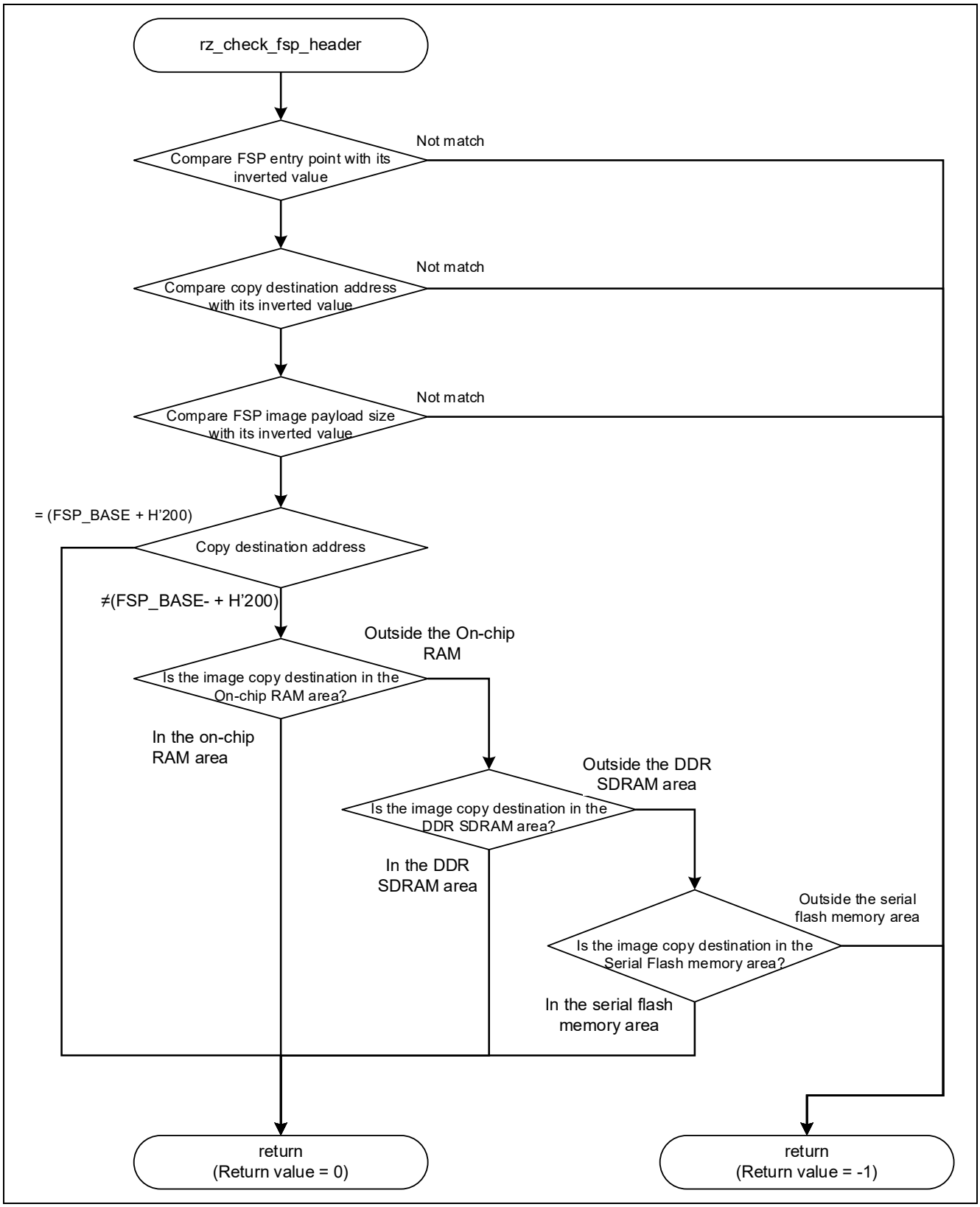


Figure 5.10 Flow Chart of rz_check_fsp_header()

5.13.3 Setting of Serial Flash Memory and SPIBSC

In this IPL, the Renesas Electronics Serial Flash Memory (AT25QL128A) is set so that it can be accessed by XIP (Execute in place) via SPIBSC.

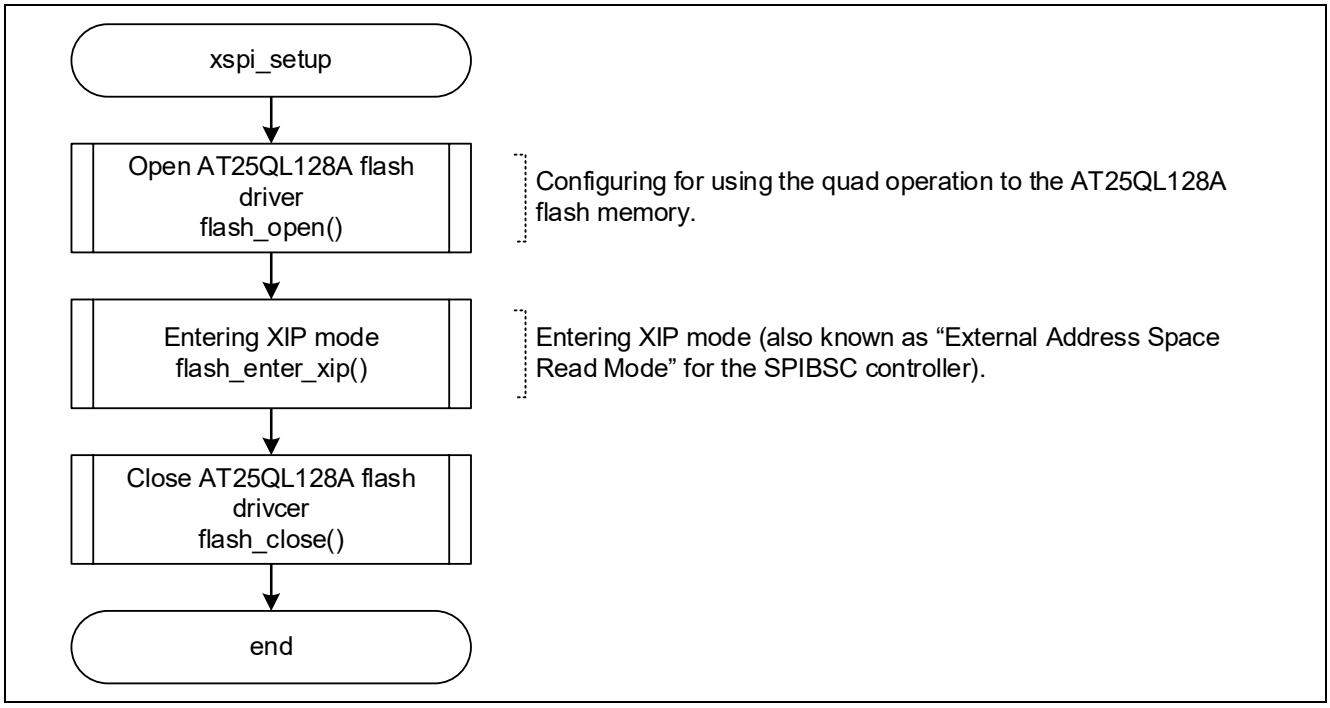


Figure 5.11 Flowchart of xspi_setup

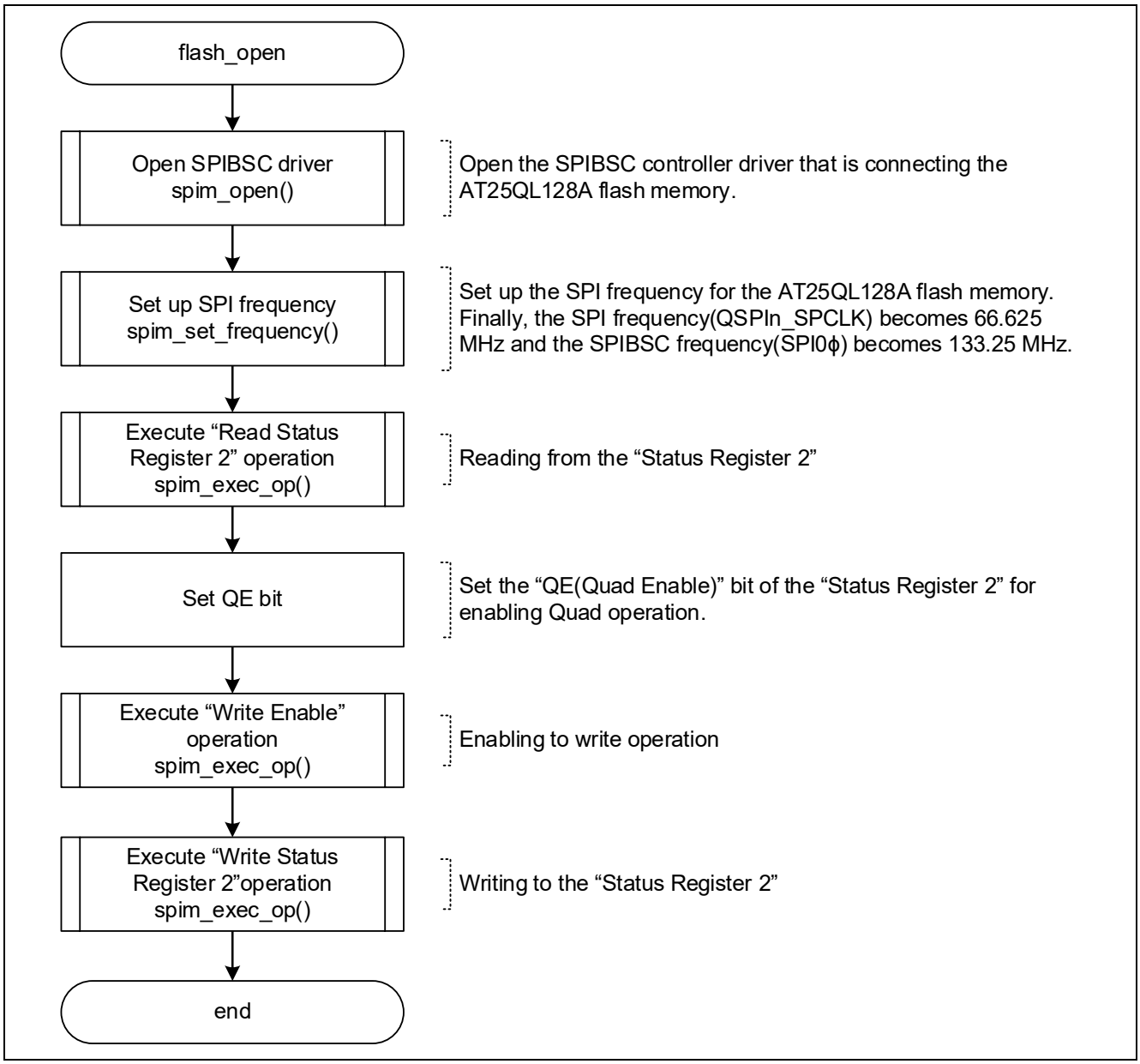


Figure 5.12 Flowchart of flash_open

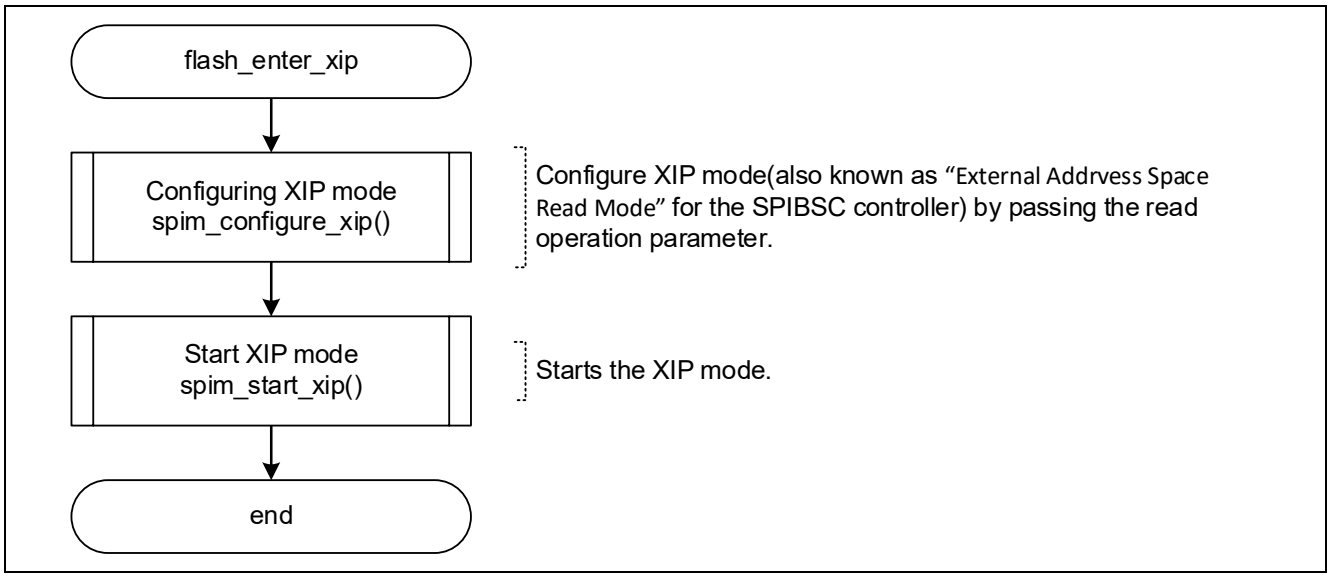


Figure 5.13 Flowchart of flash_enter_xip

6. IPL development environment construction procedure

This chapter describes the procedure for building the IPL development environment.

6.1 Procedure for building a development environment for Widows10 PC

The procedure for building a development environment for the Windows10 environment is shown below.

6.1.1 Installation of IDE (e² studio) for Windows10

IPL uses e² studio as the development environment.

This chapter shows explain the installation procedure for Windows10.

Please download the e² studio installer from the Renesas Electronics web page below.

The toolchain is included in the e² studio installer.

The toolchain is installed while you install e² studio.

https://www.renesas.com/jp/ja/software-tool/e-studio

RZ/A3 FSP packs are required to build an IPL execution environment in e² studio. Please download from the following website.

https://www.renesas.com/us/en/document/scd/rza-fsp-packs-v100

6.1.1.1 e² studio installation (Windows10)

1. Double-click on e² studio installer to invoke the e² studio installation wizard page. Click [Install]

Note: If e² studio had been installed in your PC, the option to modify, remove the existing version or install e² studio to a different location will be displayed
In this case, please select [Install].

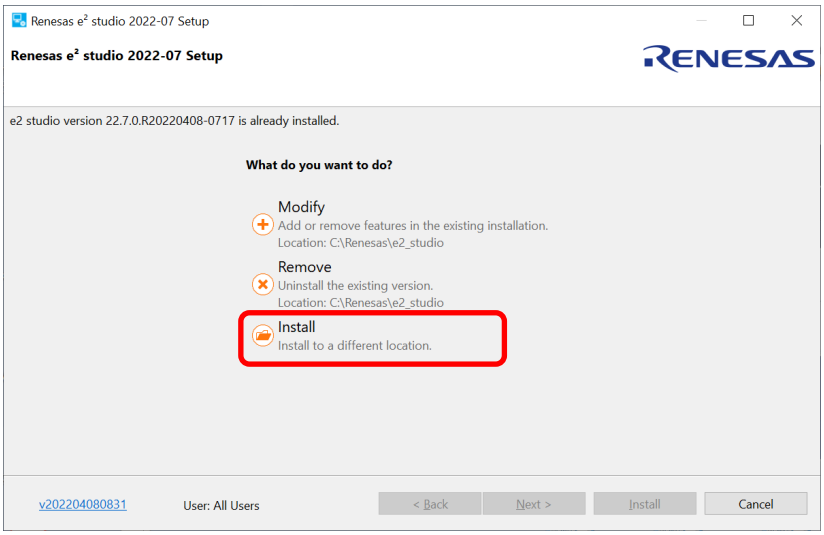


Figure 6.1 e² studio installation wizard

2. Welcome page
   User can change the install folder by clicking [Change...]. Click [Next] to continue.

Note1: If you would like to have multiple versions of e²studio, please specify new folder here.
Note2: Multi-byte characters cannot be used for e²studio installation folder name.

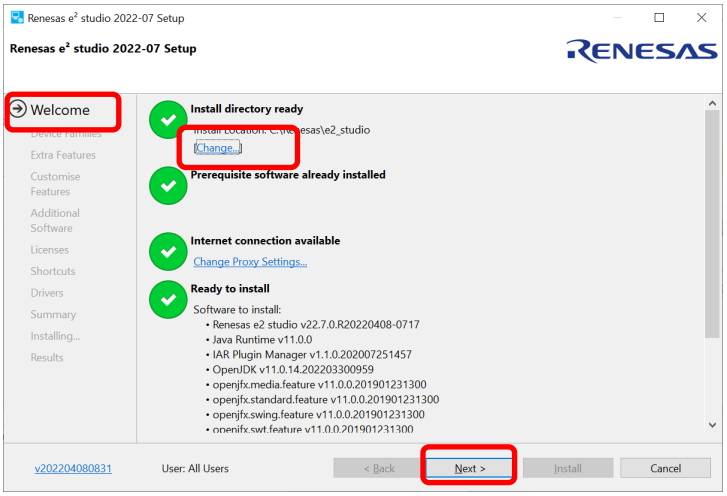


Figure 6.2 Installation of e²studio – Welcome page

3. Device Families
   You can select the device family to install. Select [RZ] Device Families to install. Click the [Next] button to continue.

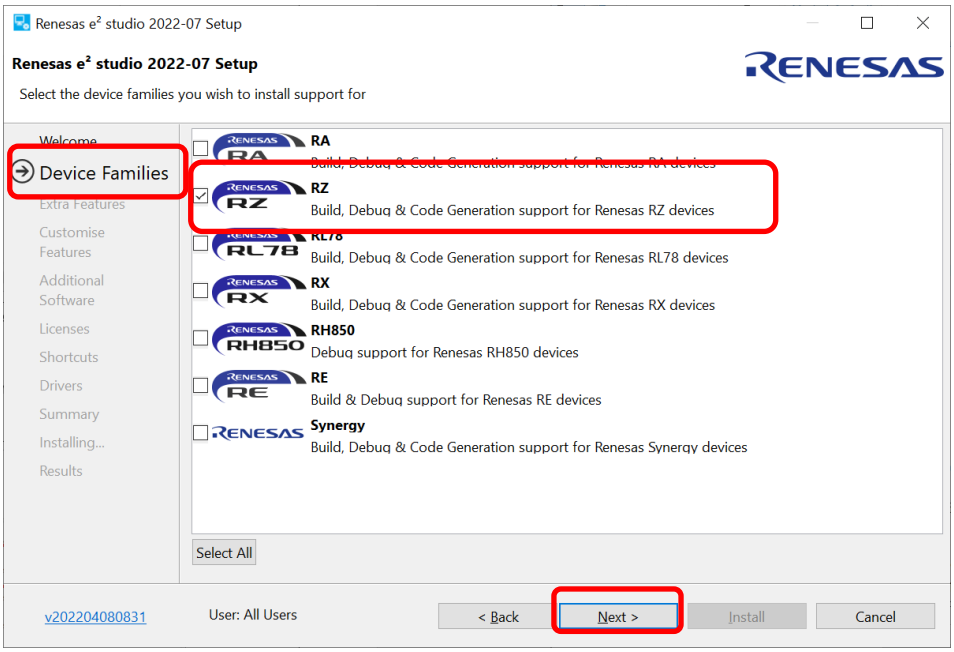


Figure 6.3 Installation of e²studio – Device Families

4. Extra Features
   Select Extra Features (i.e., Language packs, SVN & Git support, RTOS support...) to be installed. For non-English language users, please select Language packs at this step if needed.
   This document describes an example of using e² studio terminal, so please check Terminals.
   Click the [Next] button to continue.

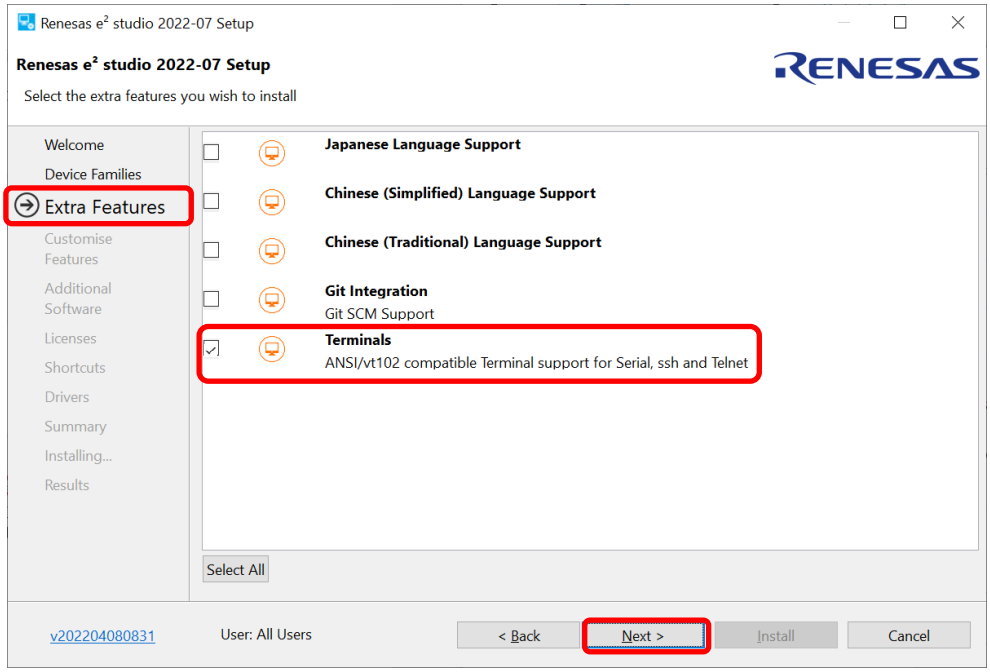


Figure 6.4 Installation of e² studio – Extra Features

5. Customize Features
   Be sure to select “Renesas FSP Smart Configurator Core”.

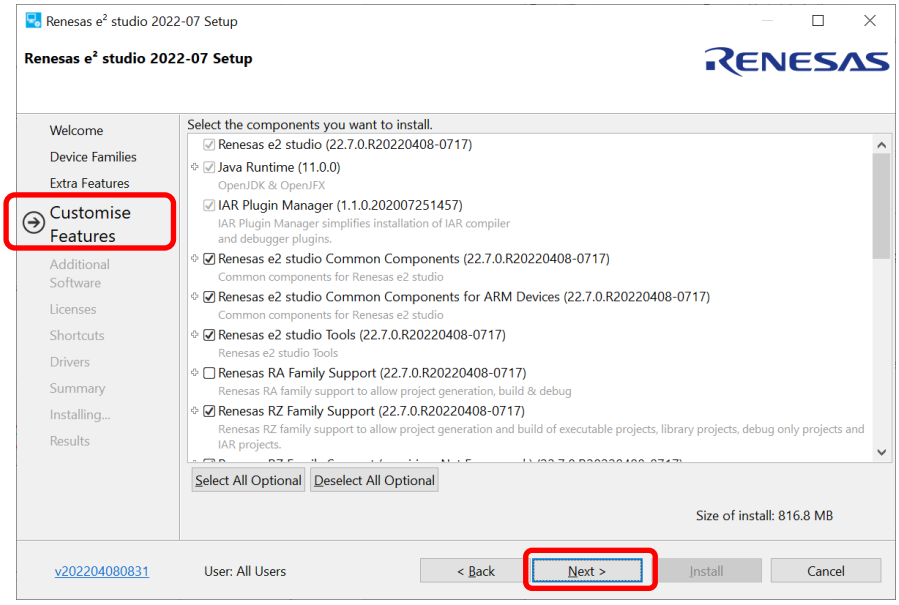


Figure 6.5 Installation of e²studio – Features

6. Additional Software
   Select additional software (i.e., compilers, utilities, QE…) to be installed. Be sure that you select the "GCC ToolChains & Utilities" tab, choose the following items, and click [Next] to continue:

   - GCC ARM A-Profile (AArch64 bare-metal) 10.3.2021.07

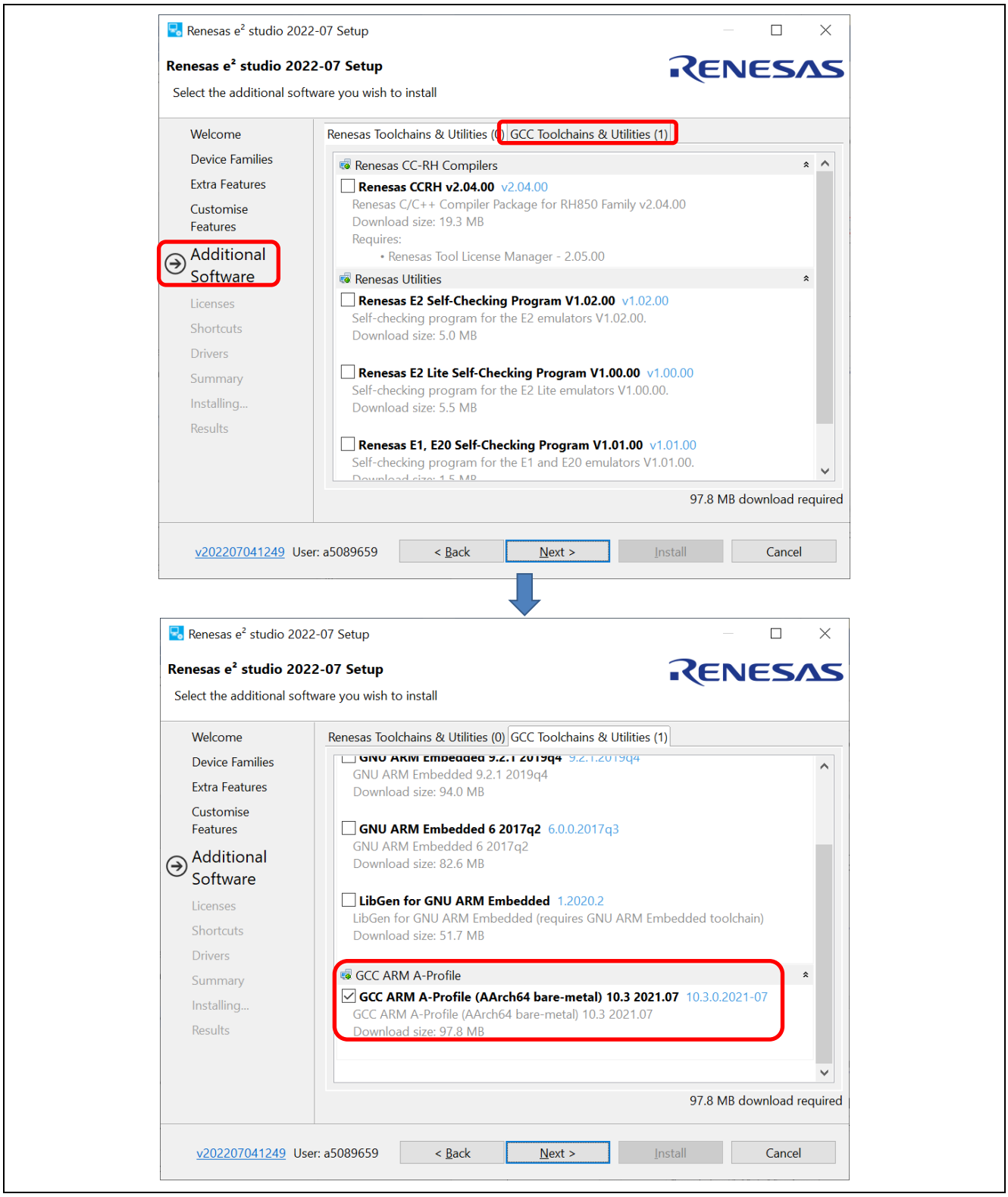


Figure 6.6 Installation of e²studio – Additional Software

7. License Agreement
   Read and accept the software license agreement. Click the [Next] button. Please note that user must accept the license agreement, otherwise installation cannot be continued.

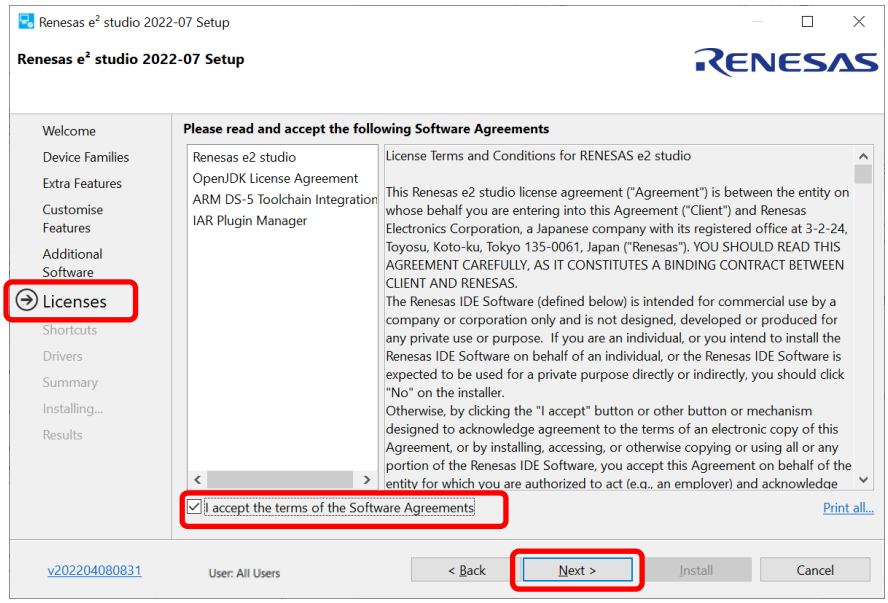


Figure 6.7 Installation of e²studio – Licenses

8. Shortcuts
   Select shortcut name for start menu and click [Next] button to continue.

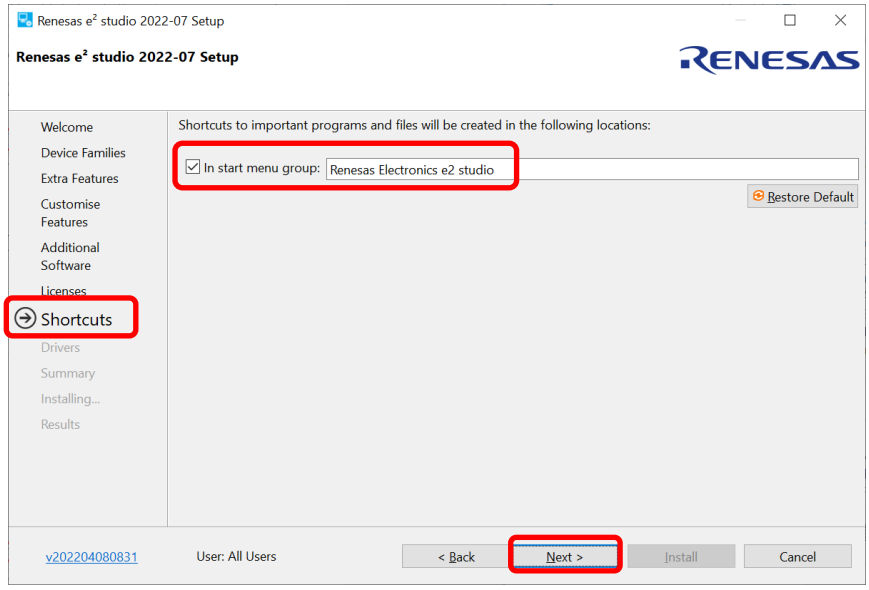


Figure 6.8 Installation of e²studio – Shortcuts

9. Drivers
   Leave the defaults and click [Next].

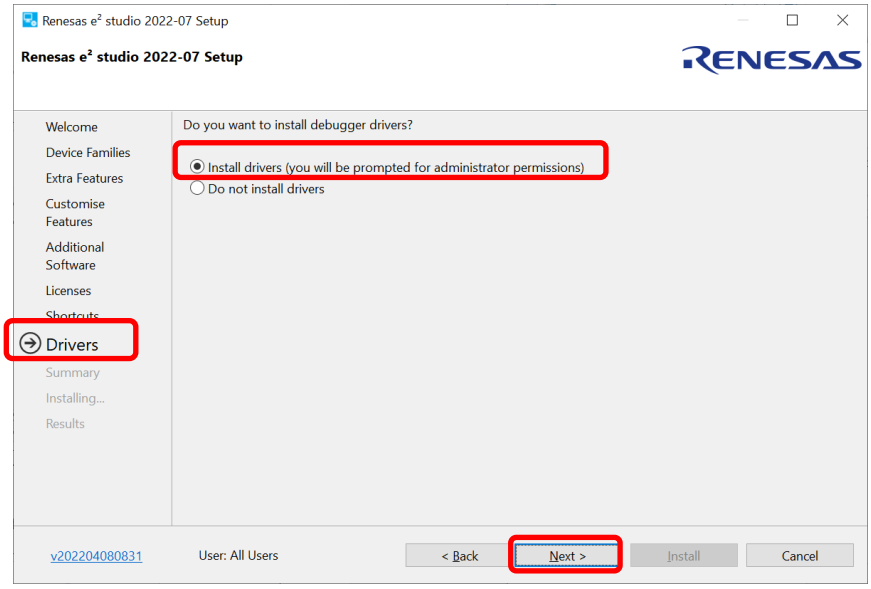


Figure 6.9 Installation of e²studio – Drivers

10. Summary
    Components list to be installed is shown. Please confirm the contents and click the [Install] button to install the Renesas e² studio IDE.

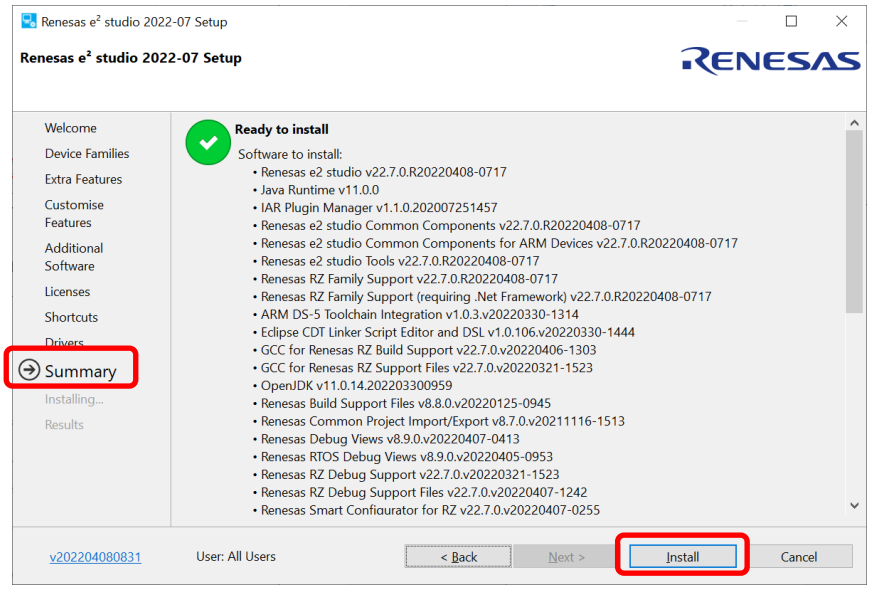


Figure 6.10 Installation of e²studio – Summary

11. Installing
    The installation is performed. Depending on selected items of additional software, new dialog prompts may appear during the installation process.

12. Results
    Click the [OK] button to complete the installation.

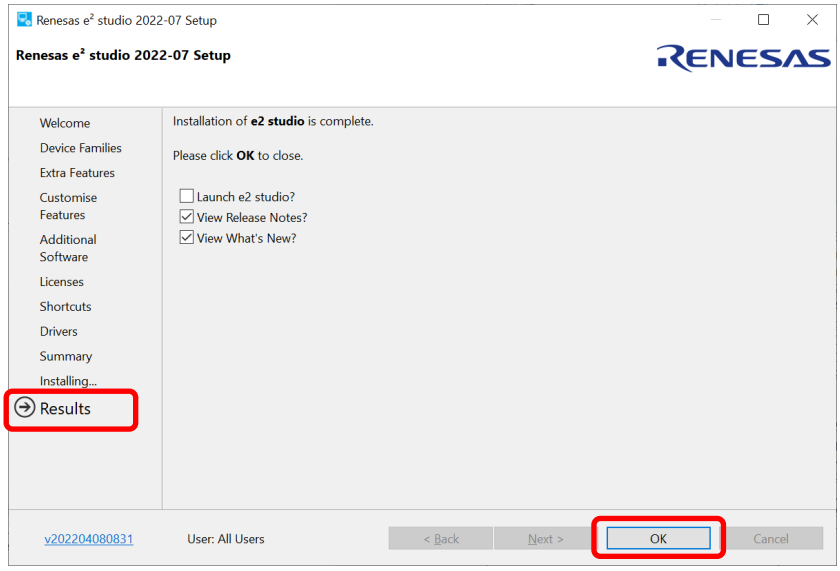


Figure 6.11 Summary Page

6.1.1.2 Installation of RZ/A FSP packs (Windows10)

Install the FSP packs for use in the RZ/A3UL IPL environment.

1. Exit e² studio
2. Extract FSP Packs.
3. Copy the extracted FSP Packs (named “internal”) to the e2studio installation folder as shown below:
   "C:\Renesas\e2_studio\internal\projectgen\rz_fsp\rza\packs"

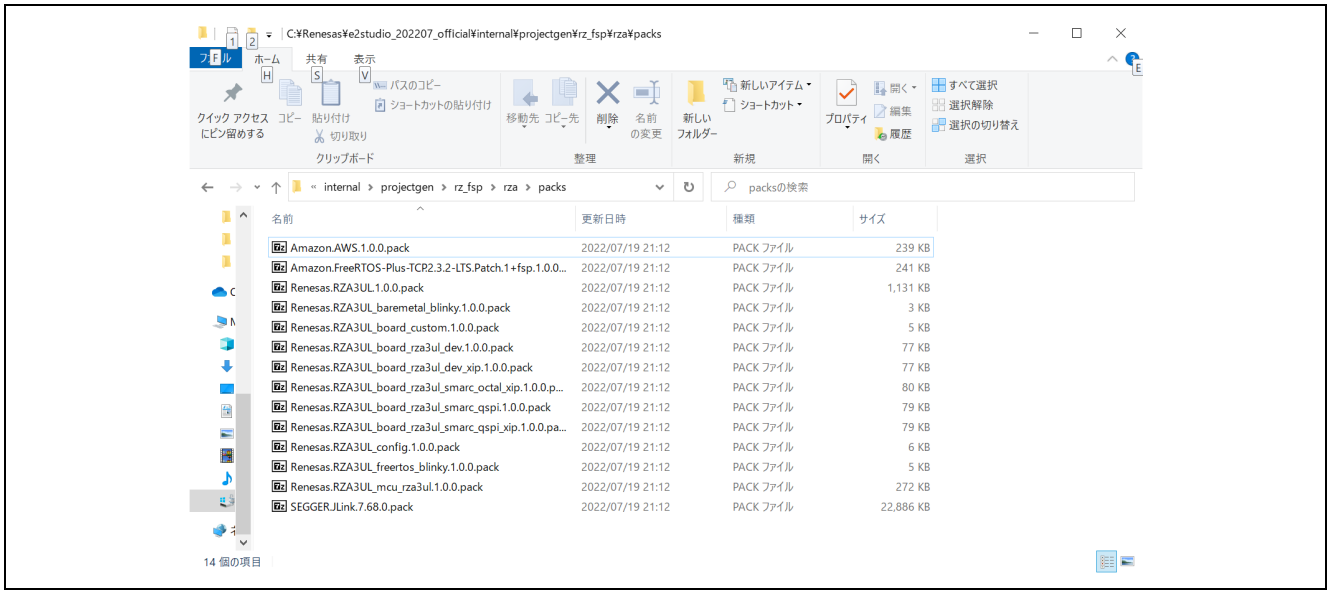


Figure 6.12 Installed packs folder (Windows10)

4. Please re-launch e2 studio
   Then packs will be reflected in the development environment.

6.1.2 MSYS2 Installation

You must install a tool called MSYS2 to build the IPL in Windows10 environment.

1. Download MSYS2 from "Installation" on the following website.
   Please install by following the procedure described in "Installation".
   https://www.msys2.org/
   This document describes the case where MSYS2 is installed in the following folder.
   c:\msys64

2. Install the make command on MSYS2.
   Open the windows start menu and start MSYS2 MSYS.

Figure 6.13 Launch MSYS2

3. A command window will appear.
   Enter "pacman -S make“ on command window the make command on MSYS2.

Figure 6.14 Make command installation (1)

4. Enter ‘y’ when "Proceed with installation" [Y / n] "is output.

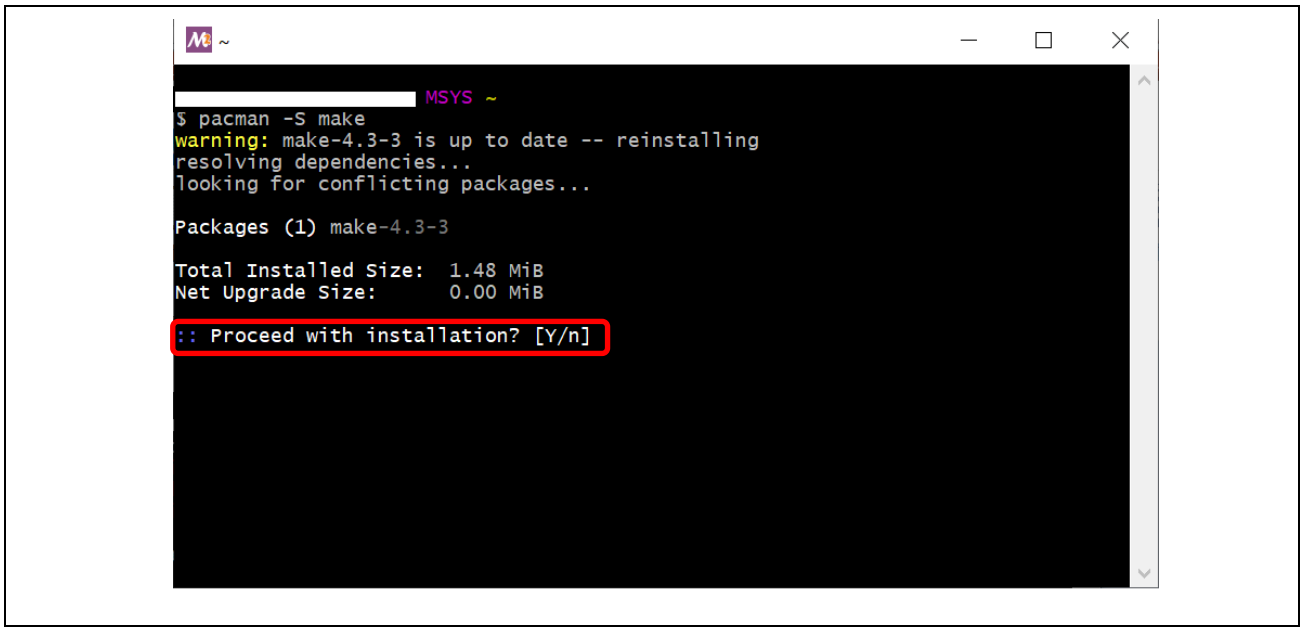


Figure 6.15 Make command installation (2)

5. The make installation is completed.

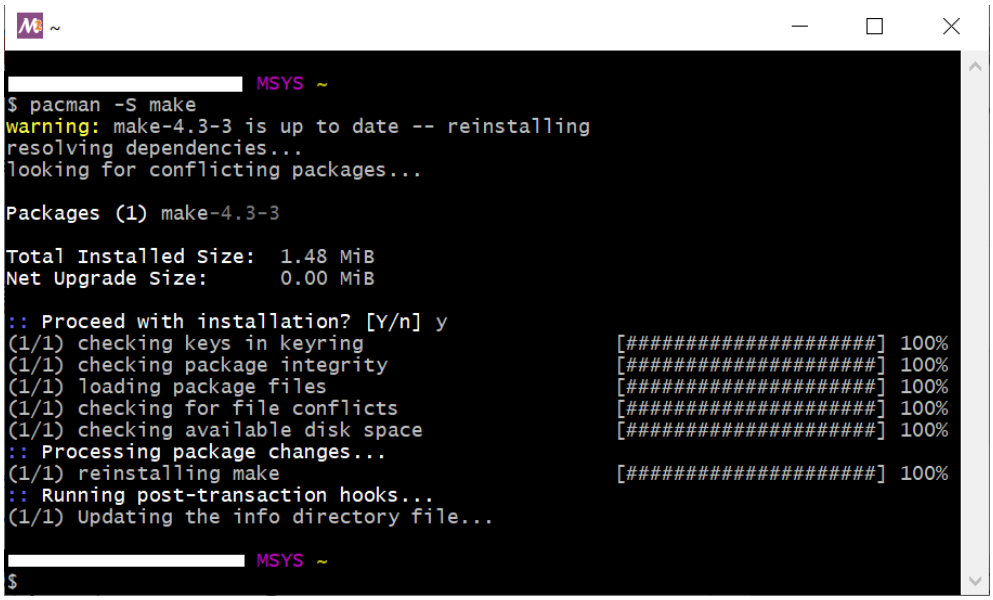


Figure 6.16 Make command installation (3)

6.2 Procedure for building a development environment for Ubuntu 20.04 LTS

The procedure for building a development environment for Ubuntu 20.04 LTS Desktop environment is shown below.

6.2.1 Installation of IDE (e² studio) for Ubuntu 20.4 LTS

IPL uses e² studio as the development environment.

This chapter shows explain the installation procedure for Windows10.

Please download the e² studio installer from the Renesas Electronics web page below.

The toolchain is included in the e² studio installer.

The toolchain is installed while you install e² studio.

https://www.renesas.com/jp/ja/software-tool/e-studio

RZ/A3 FSP packs are required to build an IPL execution environment in e² studio. Please download from the following website.

https://www.renesas.com/us/en/document/scd/rza-fsp-packs-v100

6.2.1.1 e² studio installation (Ubuntu 20.4 LTS)

1. Execute the following command to give execute permission to the e² studio installer.
   Then, run the installer.
   The command is an example when the e² studio installer
   (file name: “e2studio_installer-2022-07_linux_host.run”) is saved in the “~/Downloads” folder.
   Please change the command according to your environment.

```
$ cd ~/Downloads
$ sudo chmod +x e2studio_installer-2022-07_linux_host.run
$ ./e2studio_installer-2022-07_linux_host.run
```

2. Welcome page
   The welcome page will be launched.
   User can change the install folder by clicking [Change...]. Click [Next] to continue.

Note1: If you would like to have multiple versions of e² studio, please specify new folder here.
Note2: Multi-byte characters cannot be used for e² studio installation folder name.

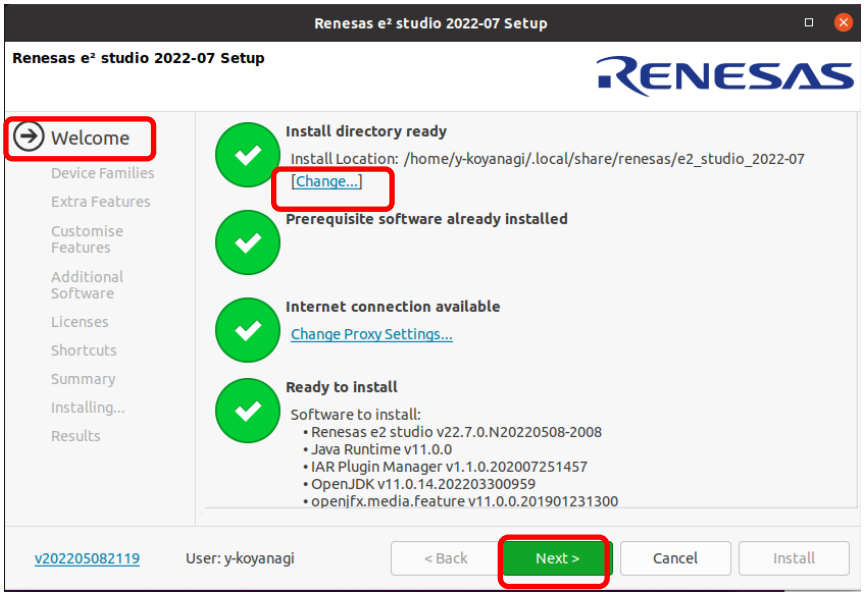


Figure 6.17 Installation of e² studio – Welcome page

3. Device Families
   You can select the device family to install. Select [RZ] Device Families to install. Click the [Next] button to continue.

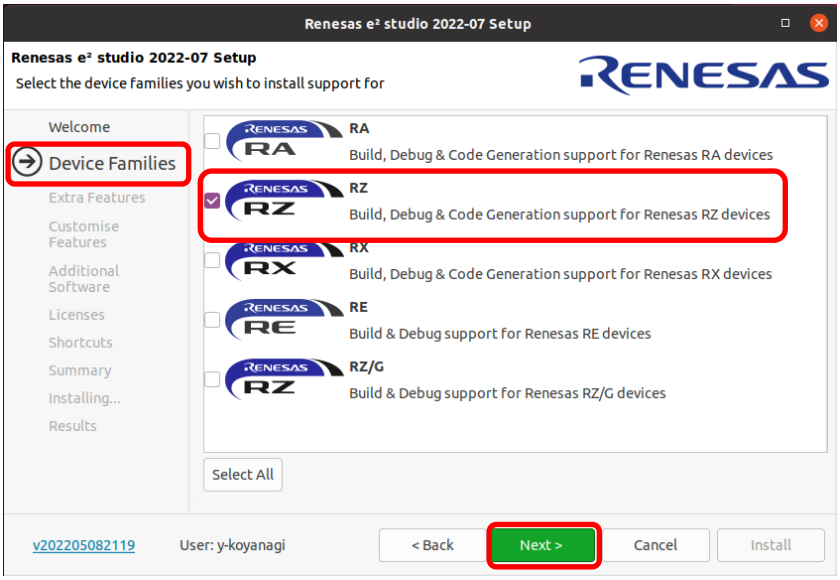


Figure 6.18 Installation of e² studio – Device Families

4. Extra Features
   Select Extra Features (i.e., Language packs, SVN & Git support, RTOS support...) to be installed. For non-English language users, please select Language packs at this step if needed.
   This document describes an example of using e² studio terminal, so please check Terminals.
   Click the [Next] button to continue.

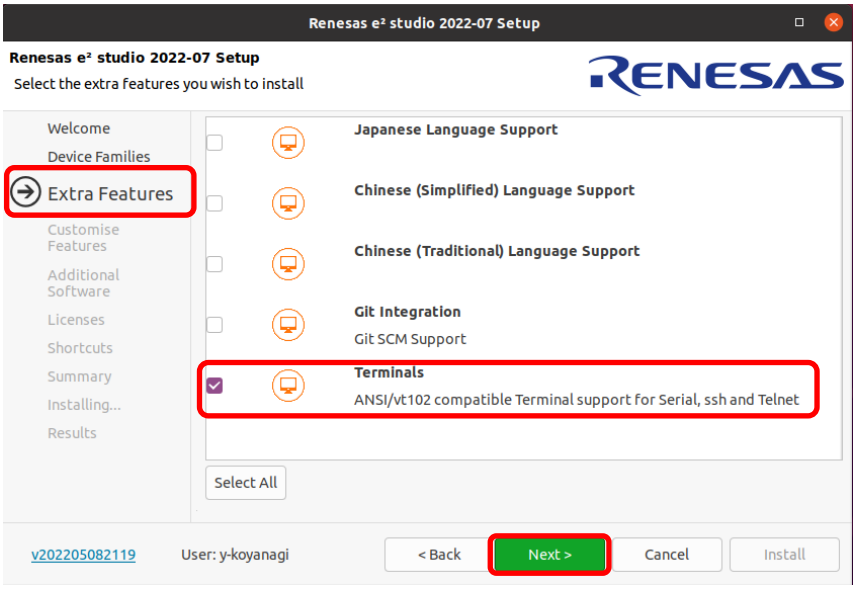


Figure 6.19 Installation of e² studio – Extra Features

5. Customize Features
   Be sure to select “Renesas FSP Smart Configurator Core”.

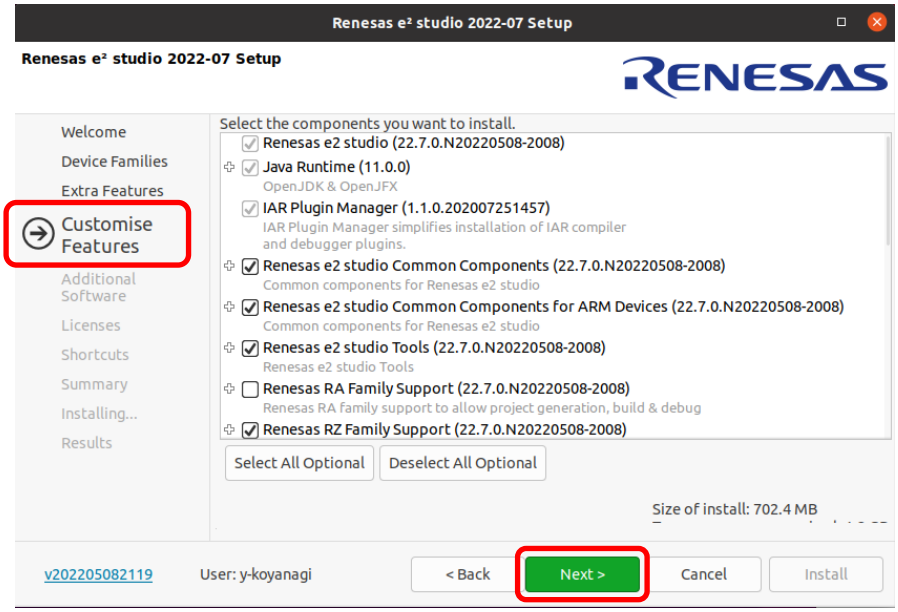


Figure 6.20 Installation of e² studio – Features

6. Additional Software
   Select additional software (i.e., compilers, utilities…) to be installed. Be sure that you choose the following items, and click [Next] to continue:

   - GCC ARM A-Profile (AArch64 bare-metal) 10.3.2021.07

.

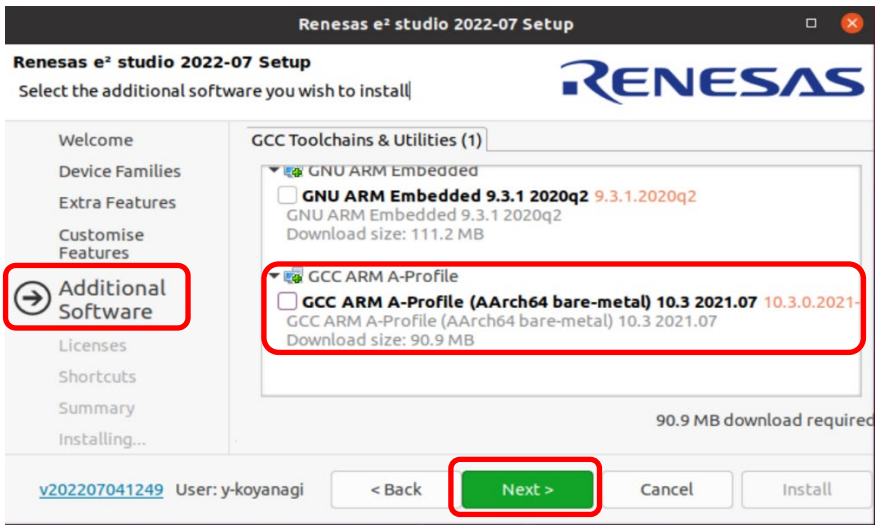


Figure 6.21 Installation of e² studio – Additional Software

7. License Agreement
   Read and accept the software license agreement. Click the [Next] button. Please note that user must accept the license agreement, otherwise installation cannot be continued.

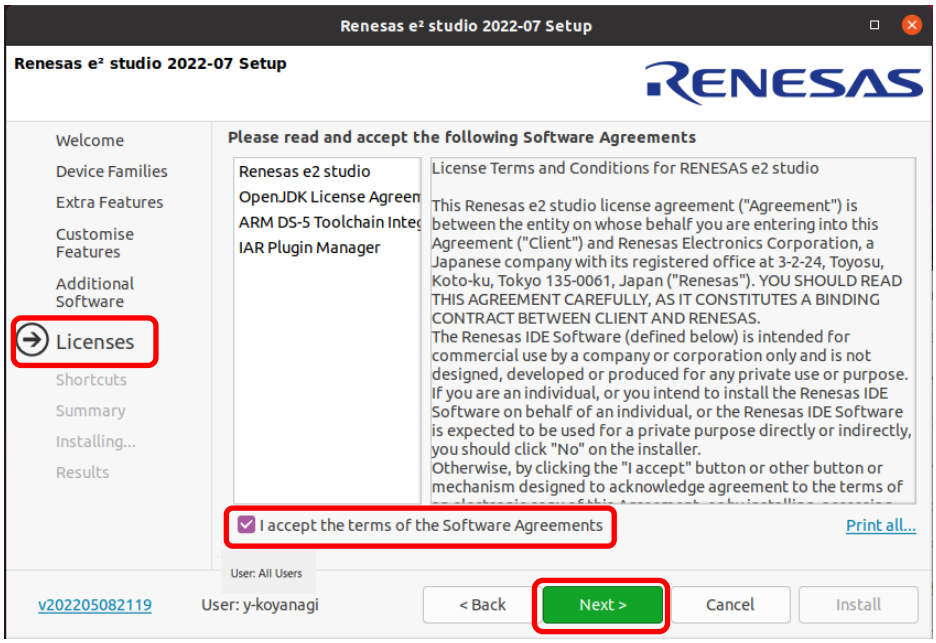


Figure 6.22 Installation of e² studio – Licenses

8. Shortcuts
   Check ”In the Application launcher” to register for the launcher and click [Next] button to continue.

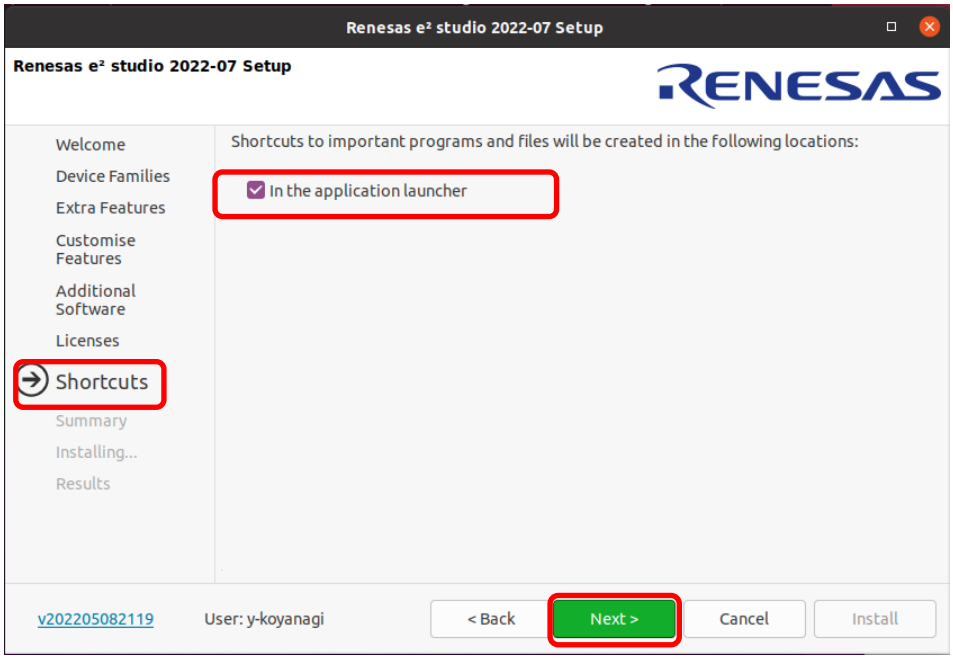


Figure 6.23 Installation of e² studio – Shortcuts

9. Summary
   Components list to be installed is shown. Please confirm the contents and click the [Install] button to install the Renesas e² studio IDE.

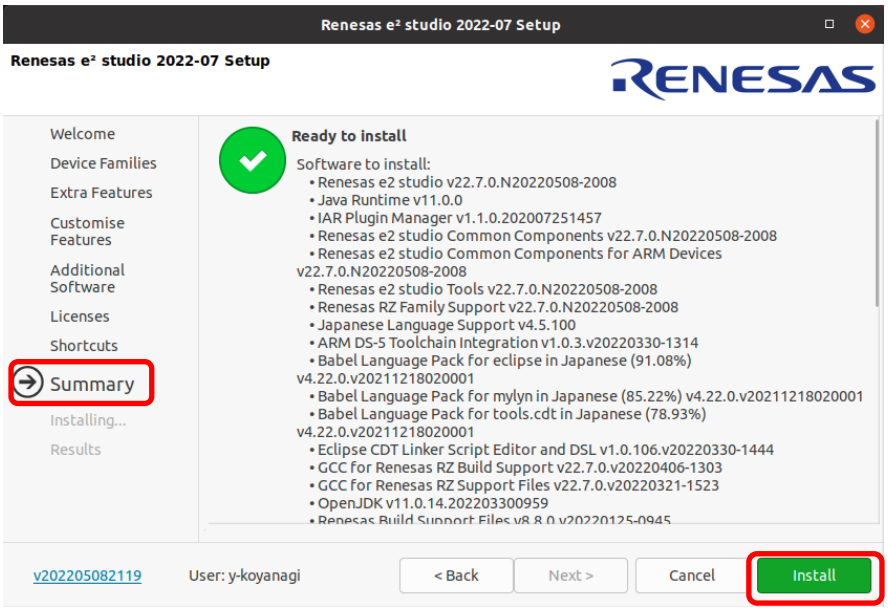


Figure 6.24 Installation of e² studio – Summary

10. Installing
    The installation is performed. Depending on selected items of additional software, new dialog prompts may appear during the installation process.

11. Results

Click the [OK] button to complete the installation.

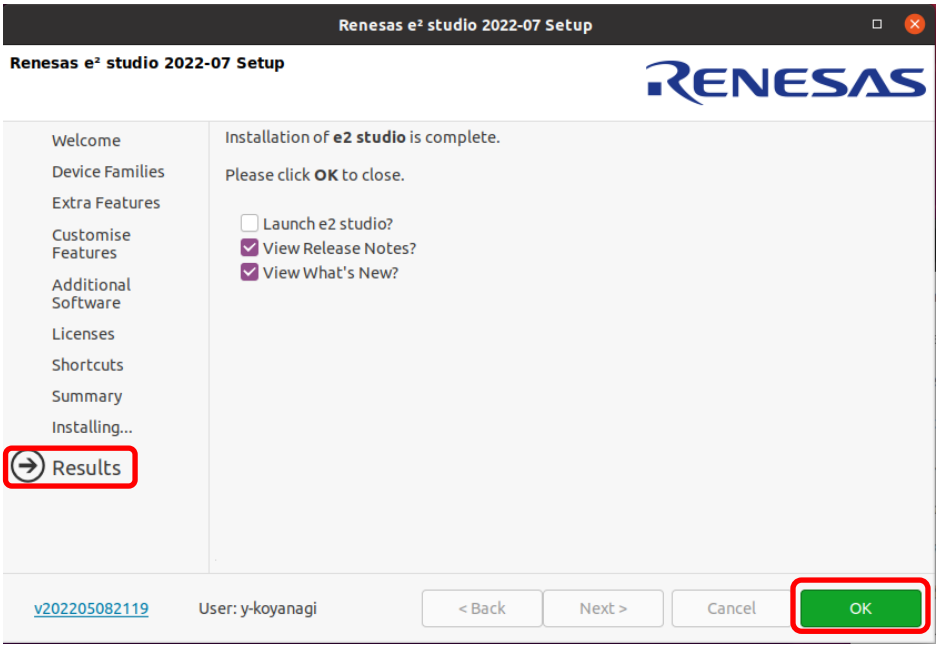


Figure 6.25 Results Page

6.2.1.2 Installation of RZ/A FSP packs (ubuntu 20.4 LTS)

Install the FSP packs for use in the RZ/A3UL IPL environment.

1. Exit e² studio
2. Extract FSP Packs.
3. Copy the extracted FSP Packs (named “internal”) to the e2studio installation folder as shown below:
   "~/.local/share/Renesas/e2_studio/internal/projectgen/rz_fsp/rza/packs"

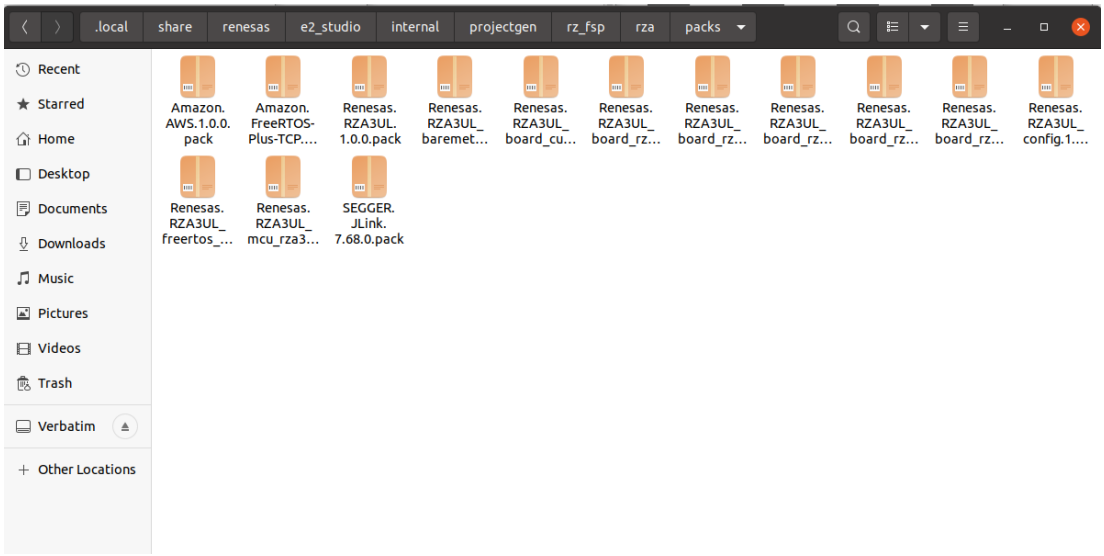


Figure 6.26 Installed packs folder (Ubuntu 20.4 LTS)

4. Please re-launch e2 studio
   Then packs will be reflected in the development environment.

6.2.2 Additional Software Installation

You must install some additional software to build the IPL in ubuntu 20.4 LTS.

1. Execute the following command to install libncurses5.

```
$ sudo apt-get install libncurses5 libncurses5:i386
```

2. Download the Segger J-Link driver file from the "Linux" -> "64-bit DEB installer" link on the following website.

   https://www.segger.com/downloads/jlink/

3. Execute the following command to install driver file.
   The command is an example when the name of the driver file is " JLink_Linux_v770e_x86_64.deb ".
   Change the argument according to the file name.

```
$ sudo dpkg -i JLink_Linux_v770e_x86_64.deb
```

If you get unmet dependencies error, please do the following.

```
$ sudo apt-get -f install
$ sudo dpkg -i JLink_Linux_v770e_x86_64.deb
```

7. IPL build environment construction procedure

This chapter describes the procedure for building the IPL build environment.

The procedure is the same for both Windows 10 version and Ubuntu 20.4 LTS version.

1. Get the IPL source code from the GitHub page shown below.
   This document shows an example when the obtained source code is saved in “C:\work\RZA3UL_IPL”.
   (Please notice that the build might fail if the folder's path is too long.)
   renesas/rza-initial-program-loader (github.com)

2. Launch e² studio.
   Click [Browse] and specify “C:\work” for the workspace on e² studio launcher

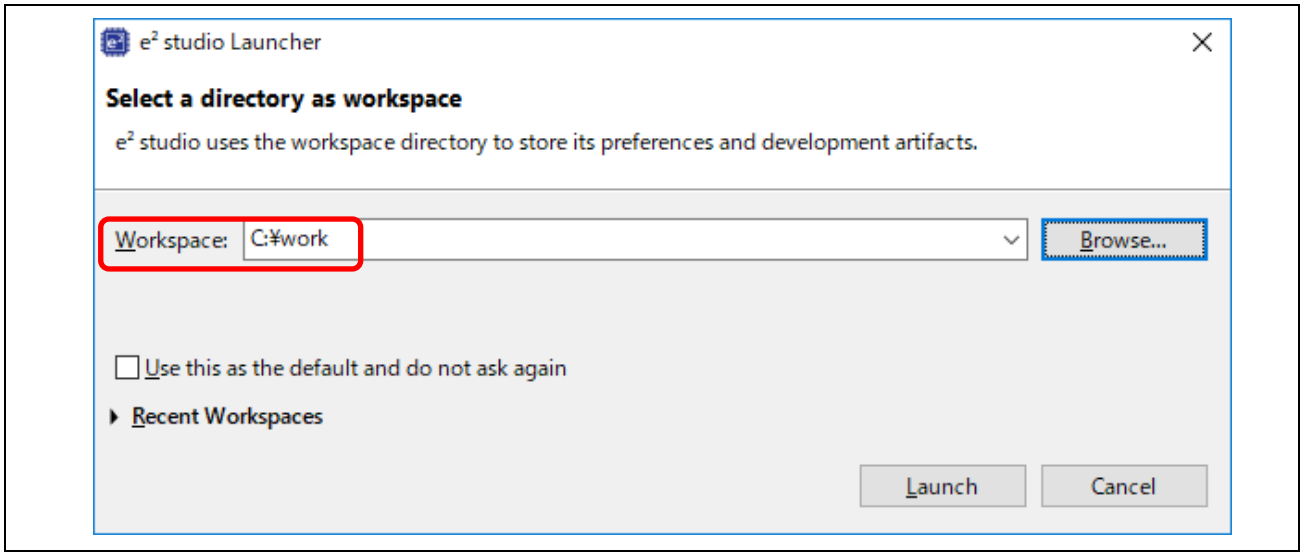


Figure 7.1 Launch e² studio (1)

3. In the Logging/Reporting dialog that is displayed when e² studio is started.
   Please confirm the descriptions, put a check to description that match your privacy policy, and click [Apply].

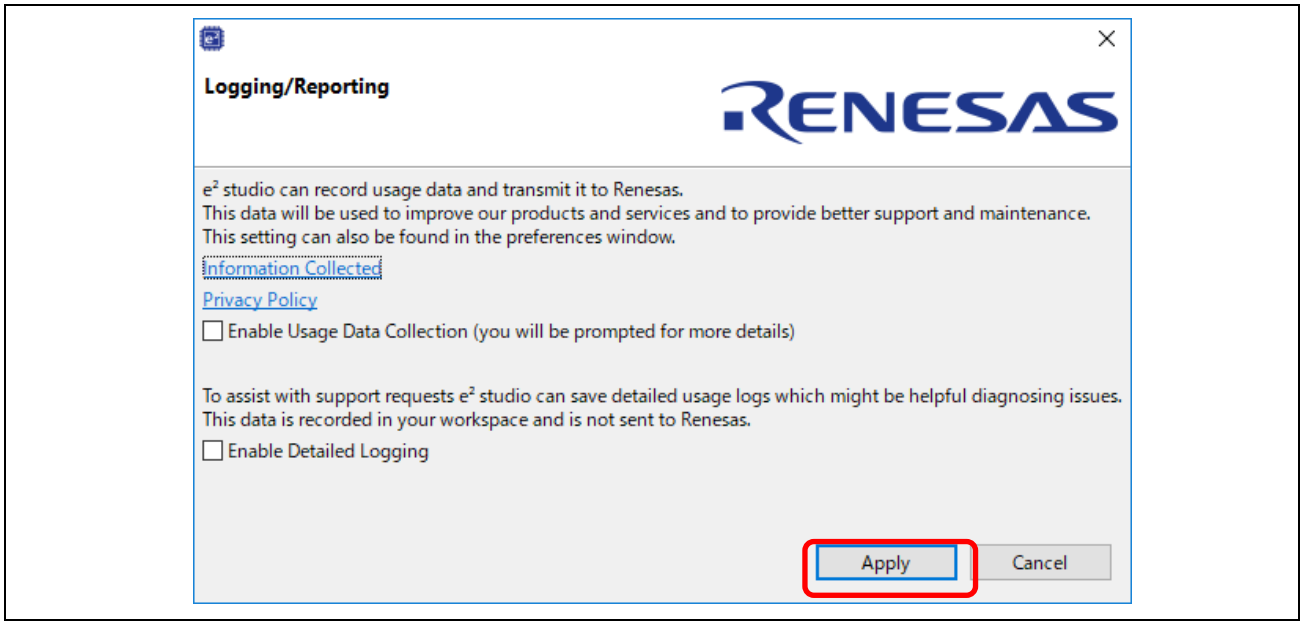


Figure 7.2 Launch e² studio (2)

4. When e² studio starts, click [Hide] to bring up the main window.

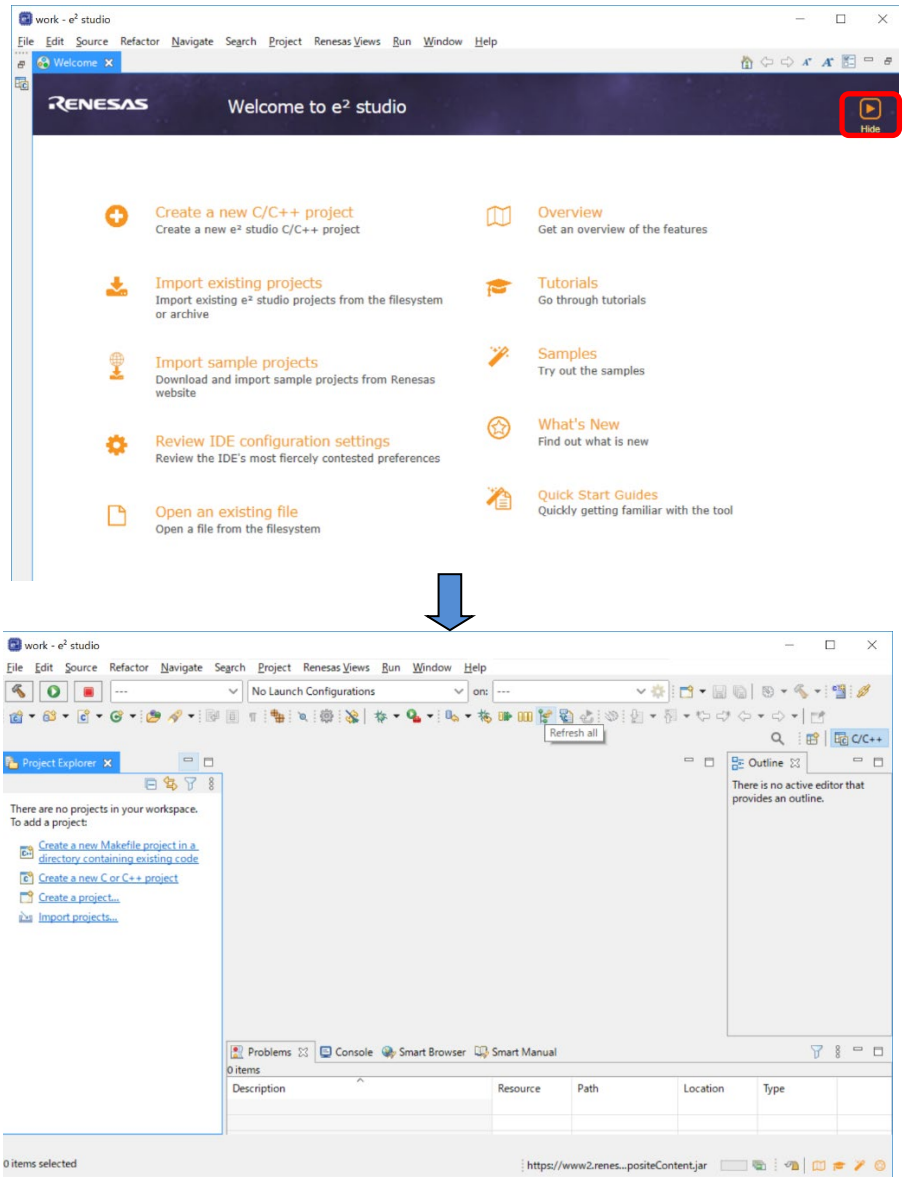


Figure 7.3 Launch e² studio (3)

5. Click [File] -> [New] -> [Makefile Project with Existing Code] in main window.

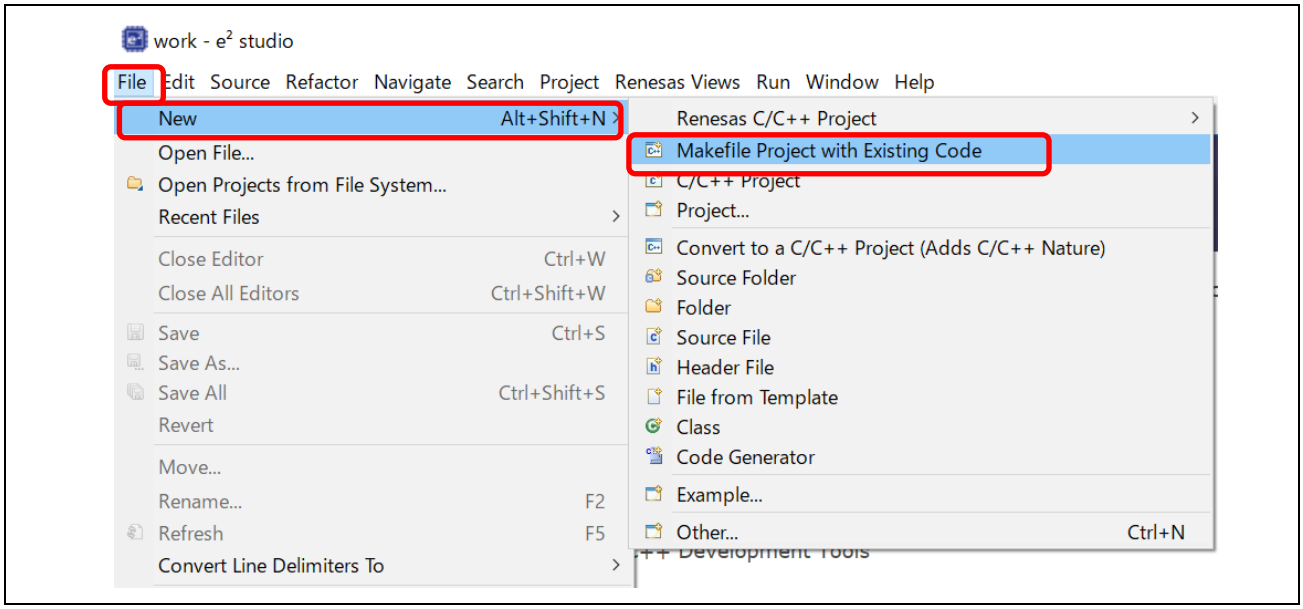


Figure 7.4 Create project (1)

6. Click Browse and choose “C:\work\RZA3UL_IPL”, the folder where you unzipped the IPL.
   Then the folder path will be registered in the Existing Code Location field.
7. Select “GCC for Renesas RZ (A-Profile AArch64 bare-metal)” in the Toolchain for Indexer Settings and click [Finish].

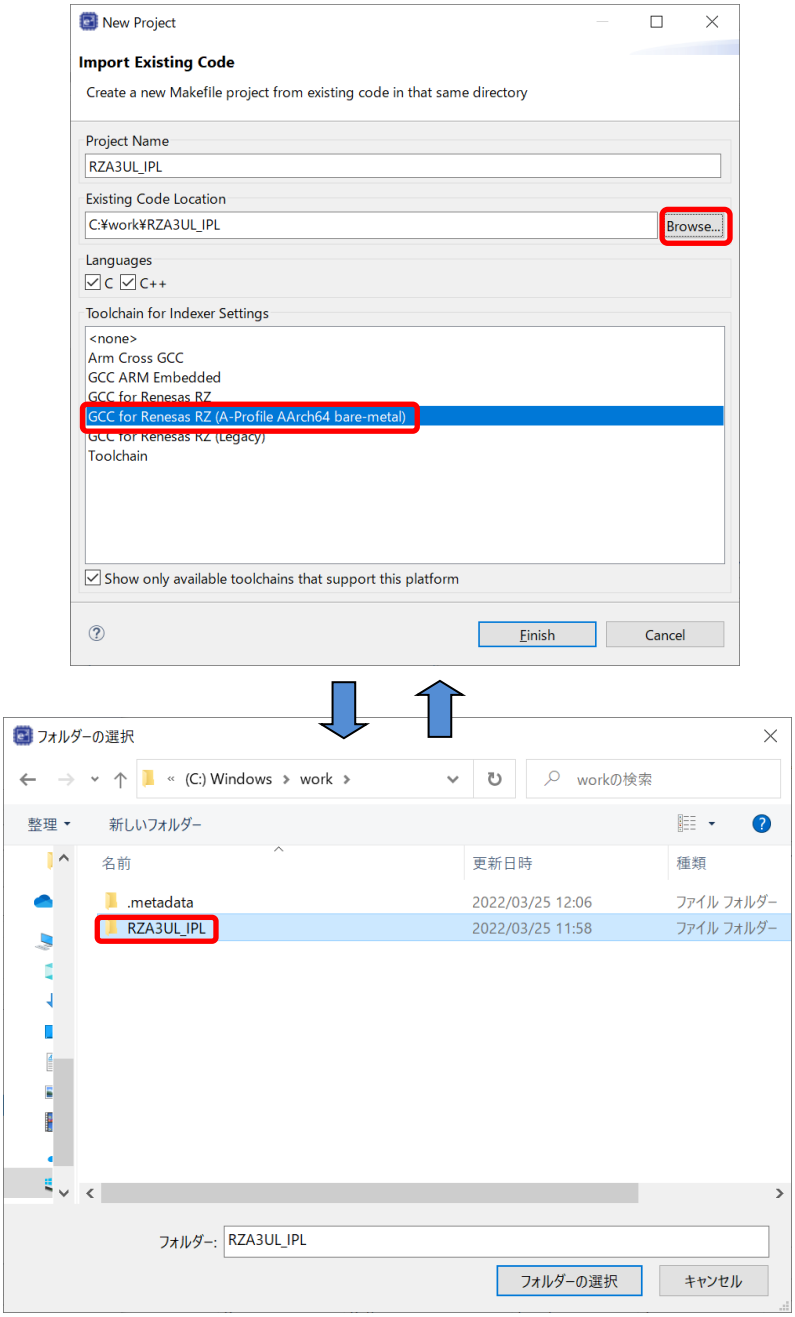


Figure 7.5 Create project (2)

8. Right-click the [RZA3UL_IPL] project generated in Project Explorer and click [Properties].

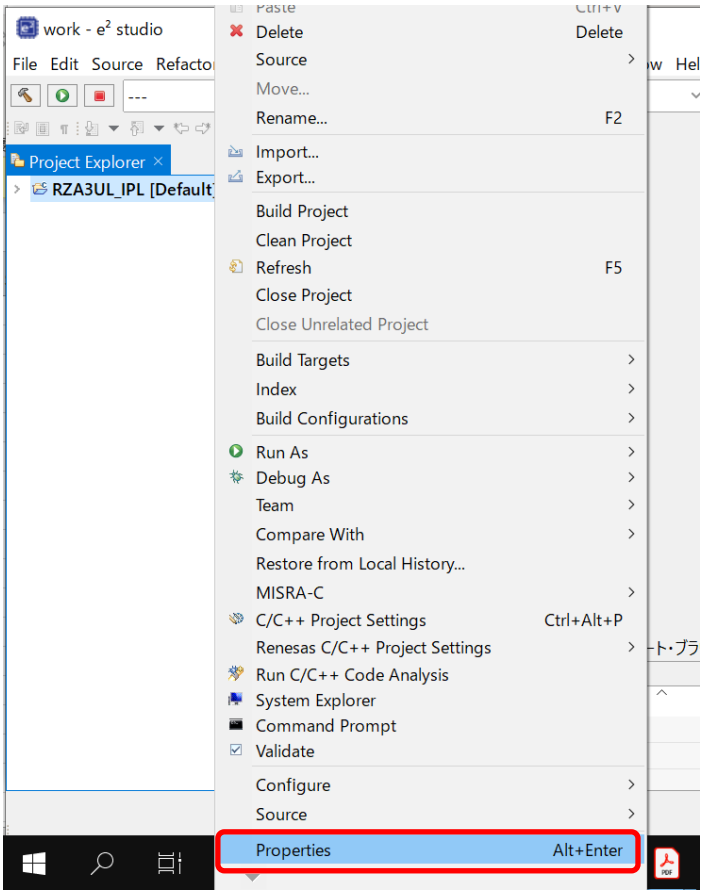


Figure 7.6 Create project (3)

9. Open [C / C ++ Build] -> [Tool Chain Editor] in Properties for [RZA3UL_IPL] and enter the build command.
   Select [GNU Make Builder] in “Current Builder”, then click [Apply and Close].

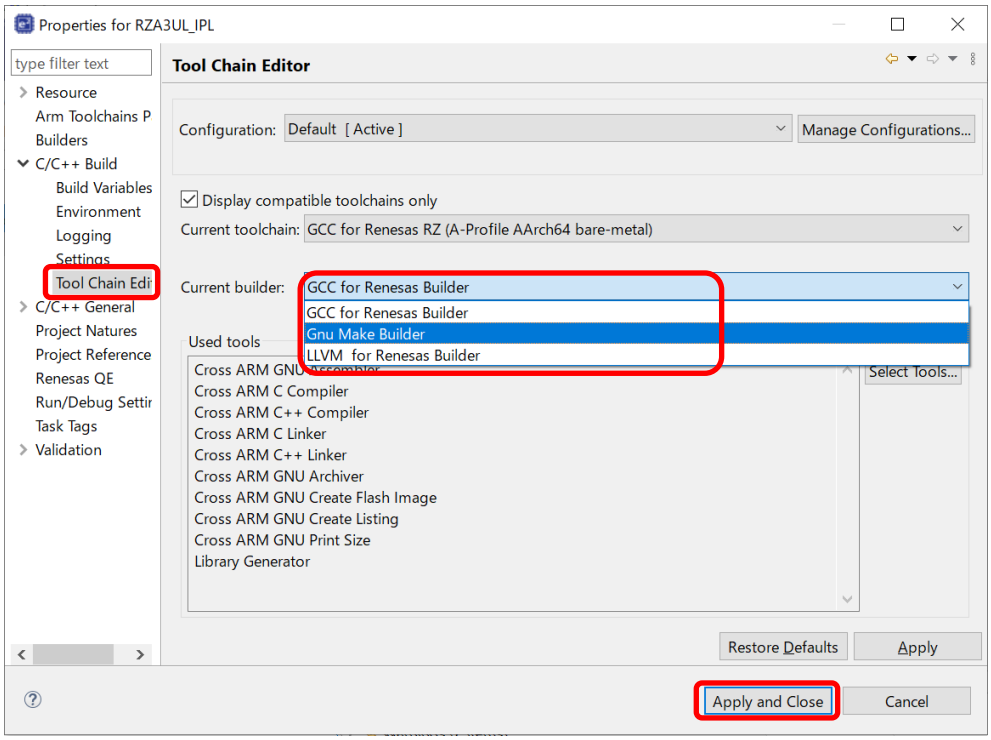


Figure 7.7 Create project (4)

10. Open [C/C ++ Build] -> [Behavior] in Properties for RZA3UL_IPL and enter the build command.
    Check “Use custom build arguments” and set the make option “PLAT=a3ul BOARD=a3ul_smarc_qspi” in the “Build arguments” field, so build and clean will execute with the same make option.
    If you want to use different make options for build and clean, set the make options in the Build and Clean fields respectively.
    Then click [Apply].

(Note1) Options can be added and changed.
They are explained in the Table 7.1.
(Note2) This description is the setting when the same make option is specified for Build and Clean.
If you want to use different make options for build and clean, set the make options in the Build and Clean fields respectively.

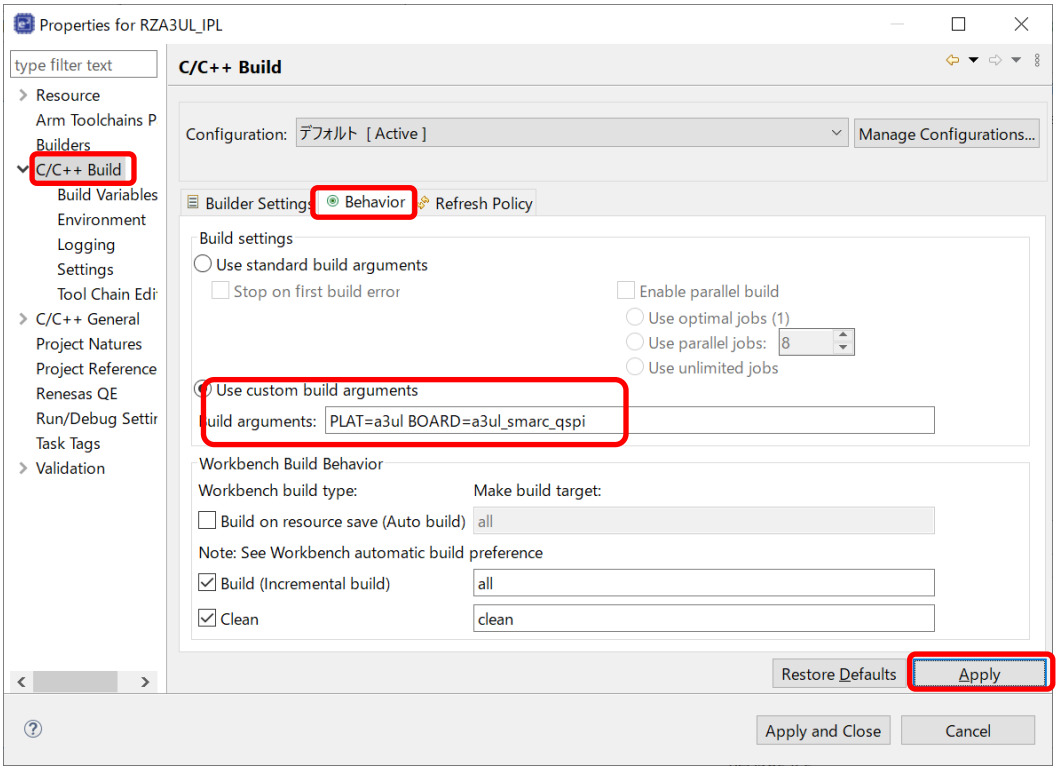


Figure 7.8 Build Command

Table 7.1 Make Option

Name	Explanation	Setting Example
PLAT	Set the platform This option cannot be omitted	a3ul: for RZ/A3UL, this option can’t be changed
BOARD	Set the board This option cannot be omitted	a3ul_smarc_qspi: RZ/A3UL-Evaluation-Board-Kit (QSPI version)
DEBUG	Select debug/release build	1: debug build 0: release build This option can be omitted, in which case a release build will be run.
FSP_BASE	Indicates the start address of the application header	0x20020000 If you do not set this option, 0x20020000 is automatically set as the default value.

11. Open [C / C ++ Build]-> [Environment] in Properties for [RZA3UL_IPL] and enter the Environment Variables.
    When you click [Add], the new variable window will appear.
    Set the environment variables of the combinations shown in the Table 7.2 (Windows10) or Table 7.3 (Ubuntu 20.4 LTS) in the Name and Value fields, then click [Apply].

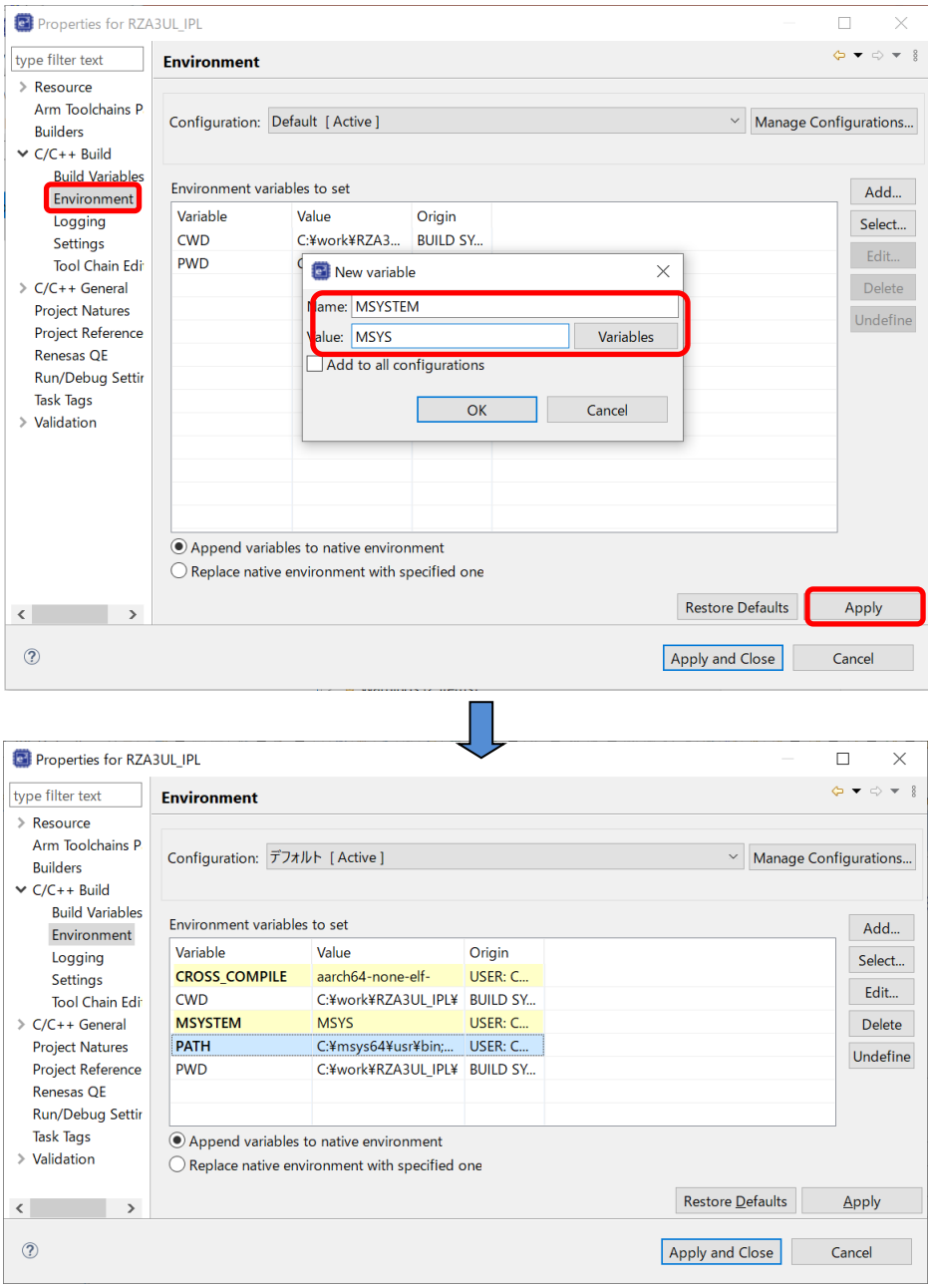


Figure 7.9 Build Environment

Table 7.2 Environment Variables

Name	Value
CROSS_COMPILE	aarch64-none-elf-
MSYSTEM	MSYS
PATH	C:\msys64\usr\bin;C:\Renesas\e2studio\toolchains\gcc_arm_aarch64\10_2021_07\gcc-arm-10.3-2021.07-mingw-w64-i686-aarch64-none-elf\bin (Note1, Note2)

Note1: Change value to match the MSYS2 installation folder.
Note2: Toolchain will be installed under the e² studio installation folder.
Please set the path to that folder.

Table 7.3 Environment Variables (Ubuntu 20.4 LTS PC)

Name	Value
CROSS_COMPILE	aarch64-none-elf-
PATH	home/username/.local/share/renesas/e2_studio/toolchains/gcc_arm_aarch64/10_2021_07/gcc-arm-10.3-2021.07-x86_64-aarch64-none-elf/bin (Note)

Note: Toolchain will be installed under the e² studio installation folder.
Please set the path to that folder.

12. Right-click [RZA3UL_IPL] and click [Build Project] to run the build.
    If you want to clean it, click [Clean Project].

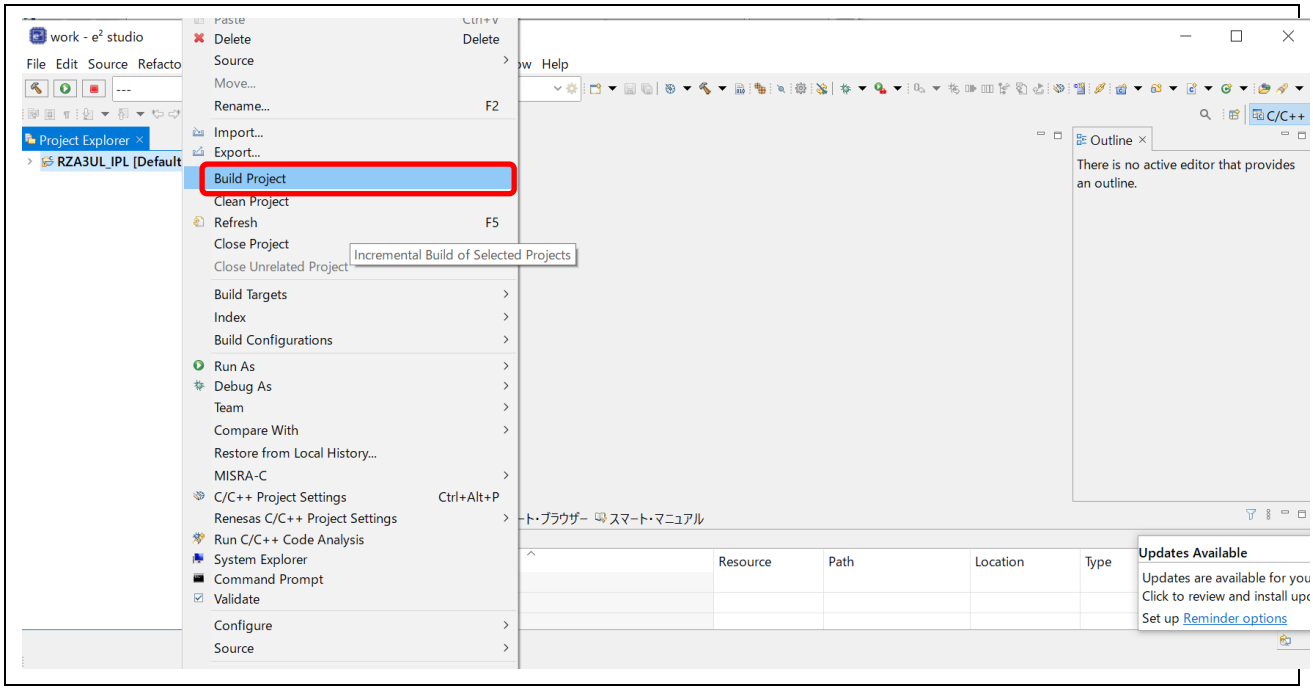


Figure 7.10:Build Environment

If the build is successful, the following files will be generated in “RZA3UL_IPL\build\a3ul\release”.

rza3ul_smarc_qspi_ipl.dump:
This file shows the disassembled data of the IPL code.

rza3ul_smarc_qspi_ipl.map:
Map file of IPL.

rza3ul_smarc_qspi_ipl.bin:
Raw Binary image of IPL.

rza3ul_smarc_qspi_ipl.elf:
Executable file of IPL.
It is used to download and run the IPL to On-chip RAM in e² studio.

rza3ul_smarc_qspi_ipl.srec:
Motorola S format file of IPL.
By writing to the Serial Flash Memory, automatic boot is performed when the SMARC board is reset.
The IPL write destination address (H'2000_0000) is registered in this file itself.
When using the download function of e² studio, the registered address is referenced and written to the memory, so the offset address specified in e² studio is H'0000_0000.
When writing an IPL to the board using Flash Writer, specify the write destination offset address according to specification of it.

bl2.bin、rz_bl2_xspi.env、rz_bl2_xspi_def.c:
Temporary file when building.

8. Execution Environment of IPL

8.1 Create Debug Configuration

This chapter shows how to create a Debug configuration to run IPL.

The procedure is the same for both Windows 10 version and Ubuntu 20.4 LTS version.

1. Select [New Launch Configuration…] on the main window of e² studio as shown in Figure 8.1.

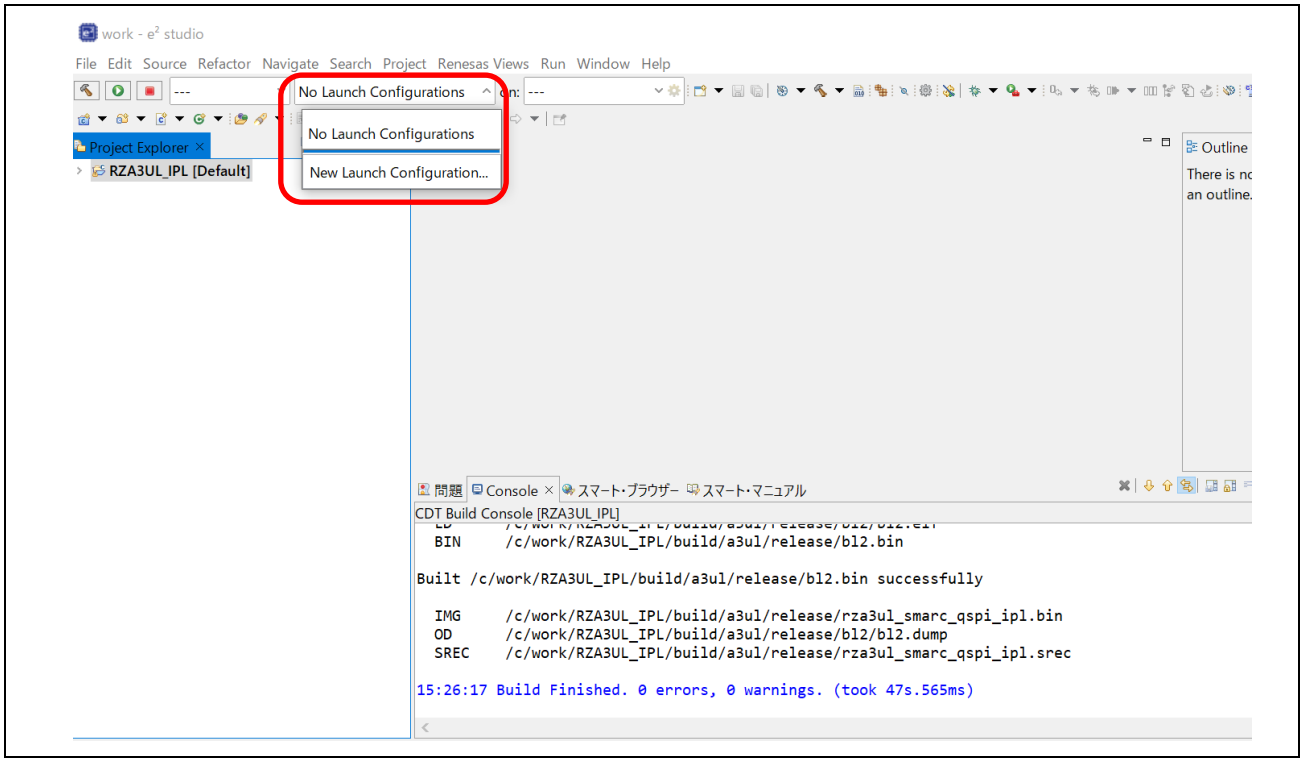


Figure 8.1 Create Debug Configuration (1)

2. Launch Configuration Type is brought up.
   Select [Debug] in Launch Mode field and [Renesas GDB Hardware Debugging] in Launch Configuration Type field and click [Next].

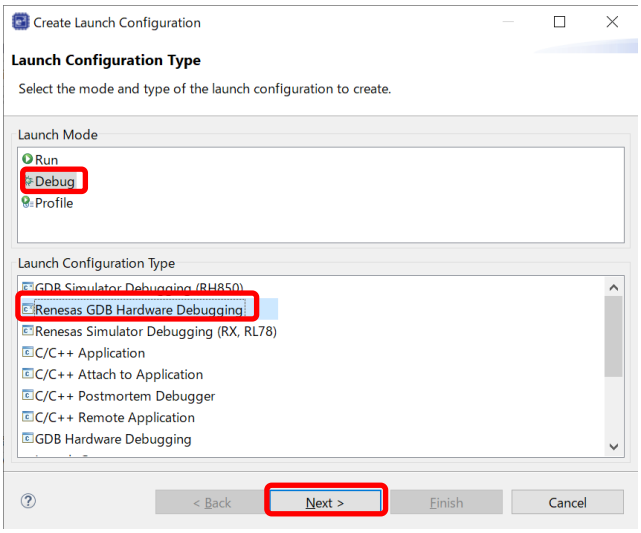


Figure 8.2 Create Debug Configuration (2)

3. The Renesas GDB Hardware Debugging Launch Configuration Properties will show up.
   Click [Search Project] on the Main tab and select "rza3ul_smarc_qspi_ipl.elf" on the Program Selection window.
   Furthermore, after selecting "Use Active" in [Build Configuration], click [Apply].

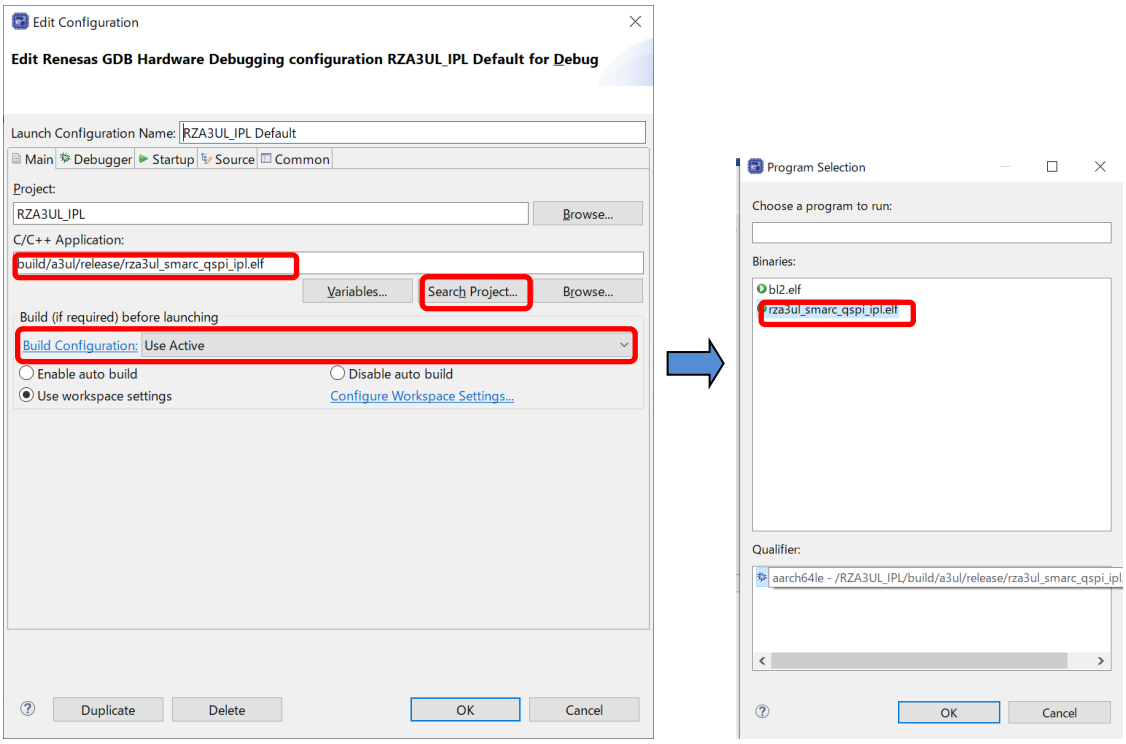


Figure 8.3 Create Debug Configuration (3)

4. Go to the [Debugger] tab.
   Select "J-Link ARM" in the Debug Hardware field.
   Click […] next to Target Device and select “RZ/A3UL” -> “R9A07G063U02GBG” on the Device Selection window.
   At this time, make sure that the description in the GDB Command field of the GDB Settings tab is "aarch64-elf-gdb".

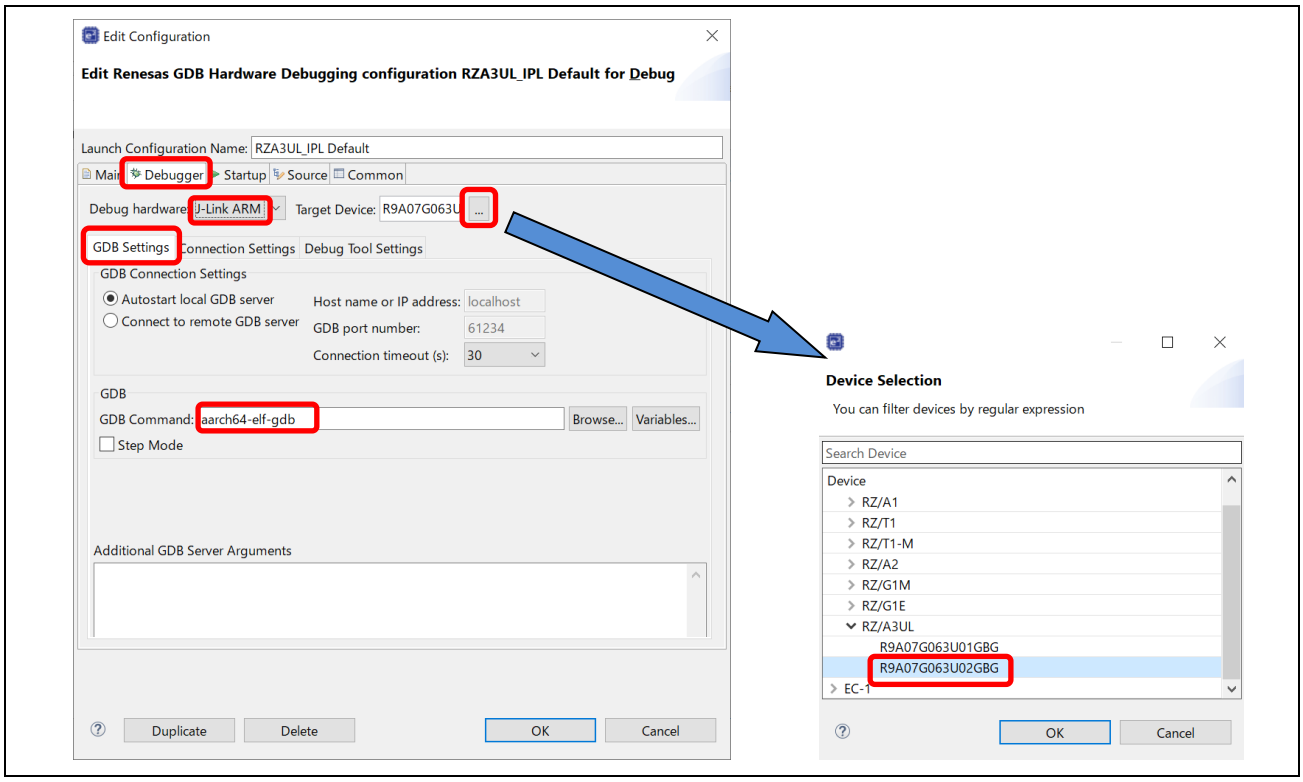


Figure 8.4 Create Debug Configuration (4)

5. Go to the “Debugger” -> “Connection Settings” tab and set” Speed (kHz)” to 15000 to speed up the writing of data to memory.
   In addition, set “Reset before run” to No.

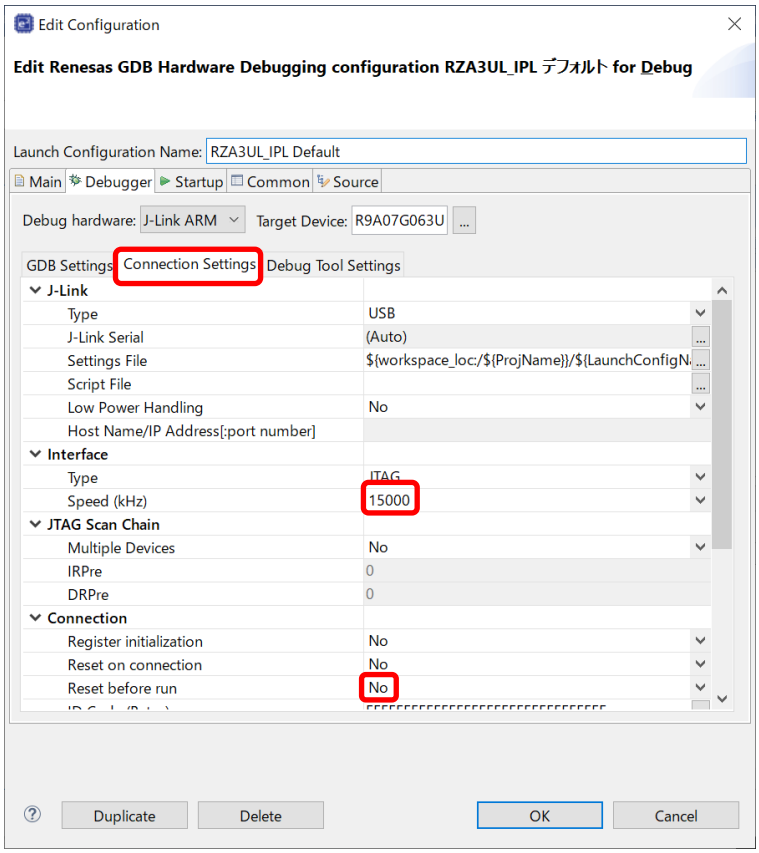


Figure 8.5 Create Debug Configuration (5)

6. Go to the “Debugger”-> “Debug Tool Settings” tab, set “Reset After Reload” and “Run Break Time Measurement” to No.

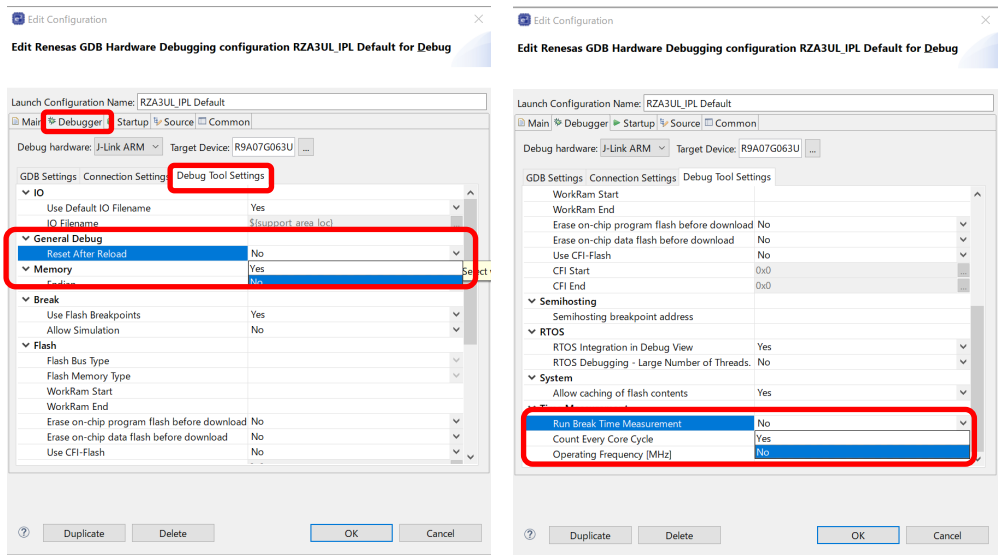


Figure 8.6 Create Debug Configuration (6)

7. Go to “Startup” tab
   Set “On connect” of “Program Binary” to No.

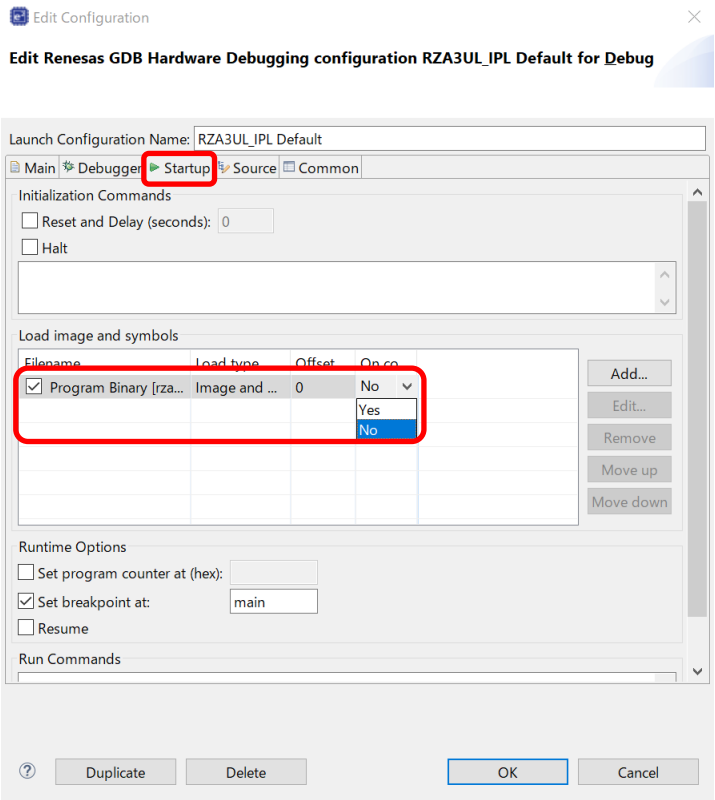


Figure 8.7 Create Debug Configuration (7)

8. Click [Add] to bring up the Add download module window.
   Next click Workspace, select “RZA3UL_IPL\build\a3ul\release\rza3ul_smarc_qspi_ipl.srec”, and then click [OK] to return.
   Then, rza3ul_smarc_qspi_ipl.srec is registered in Load image and symbols.

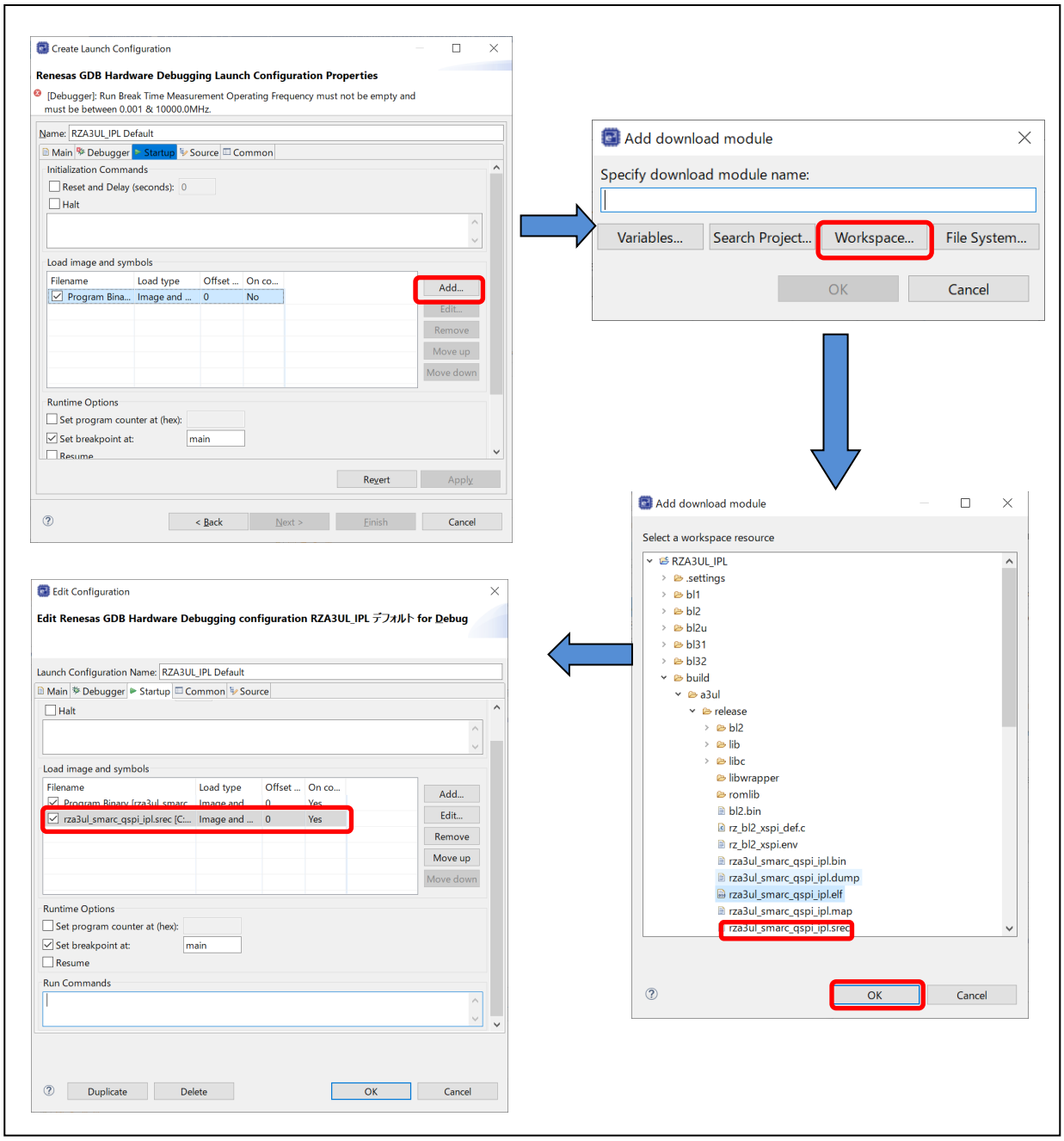


Figure 8.8 Create Debug Configuration (8)

9. Since the IPL write destination address H'2000_0000 is set in the registered rza3ul_smarc_qspi_ipl.srec itself, set "0" to “Offset(hex)”.
   With this setting, the IPL image will be written to H'2000_0000 at the start of debugging.
   Also, set” On connect” to No and uncheck “Set breakpoint at”.

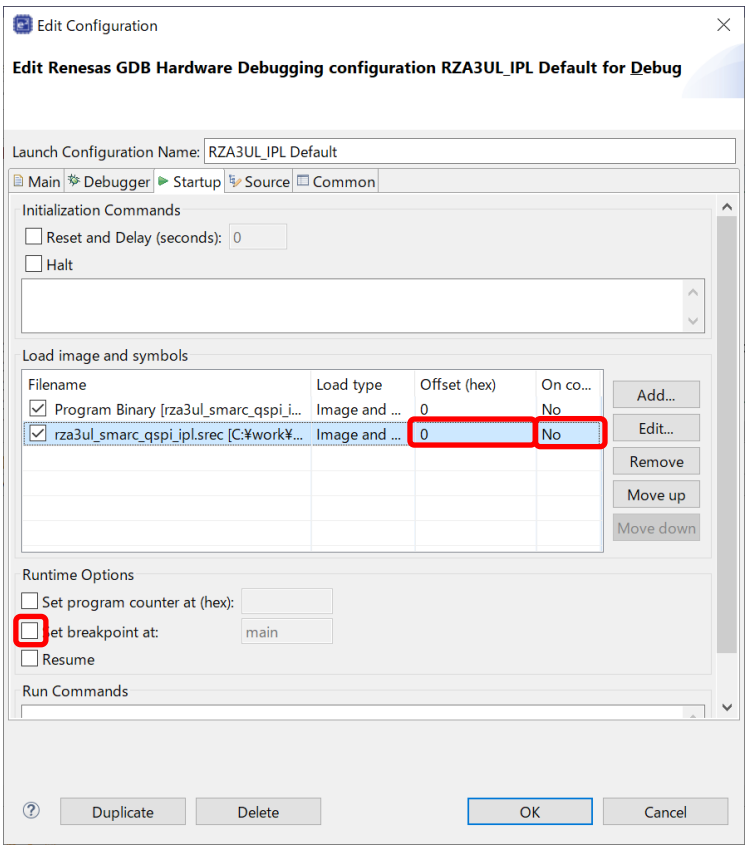


Figure 8.9 Create Debug Configuration of Serial Flash (9)

10. Go to the Common tab and set Save as to Share file:, and set the path to \RZA3UL_IPL.
    Also, uncheck “Launch in background”.
    After completing these settings, click [Apply] -> [Finish] to complete the settings.

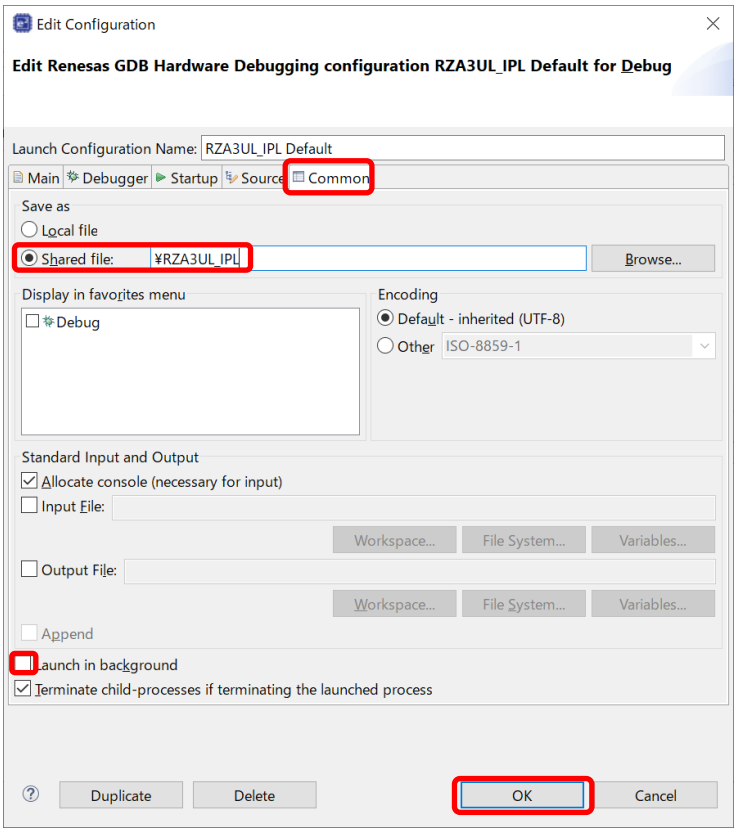


Figure 8.10 Create Debug Configuration (10)

8.2 Connection to SMARC Board

Describes how to connect to the SMARC board.

Figure 8.11 shows the appearance of the SMARC board.

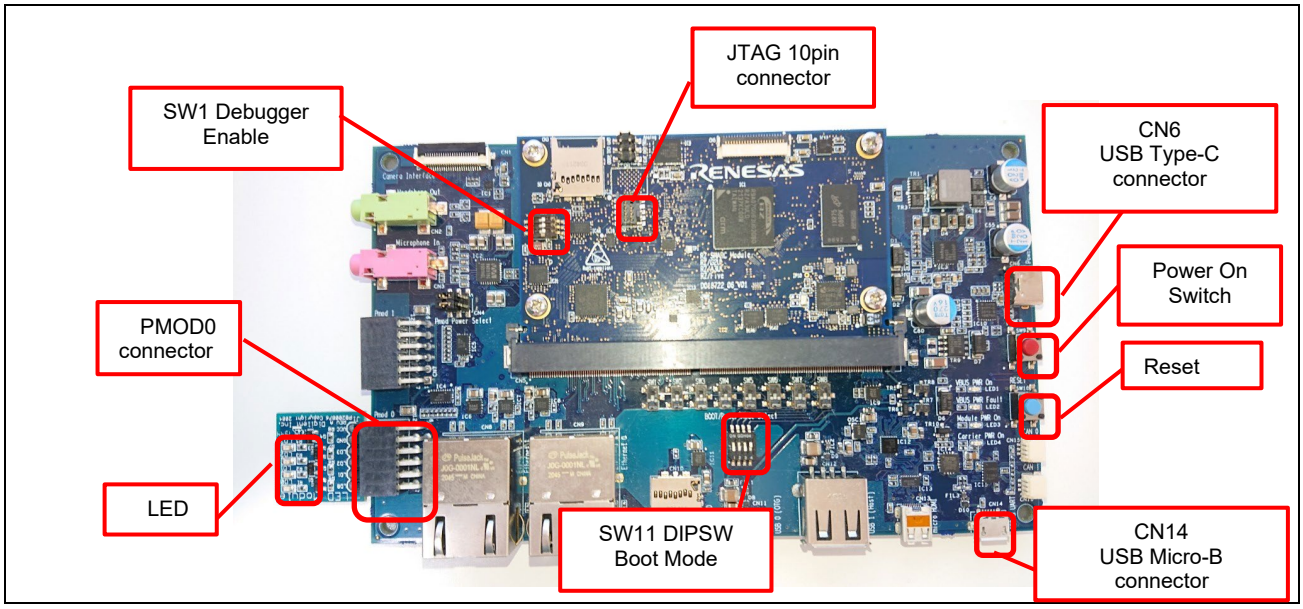


Figure 8.11 SMARC Board

1. Connect the LED board to the PMOD0 connector.
   As shown in Figure 8.12, connect to terminals 7 to 12.

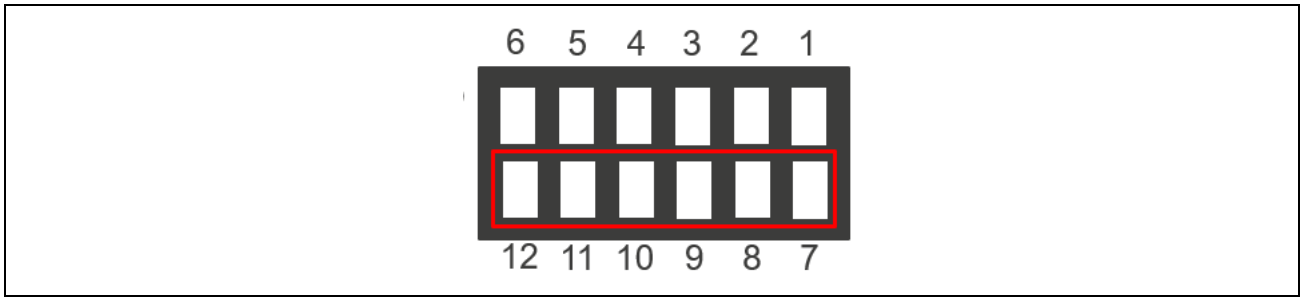


Figure 8.12 PMOD Connector

2. Connect CN14 and Windows 10 PC with a USB cable.
3. Connect J-Link Base 11.0 to the JTAG 10pin connector.
   In addition, connect J-Link Base 11.0 to the host PC with a USB cable.
4. Connect CN6 and USB-PD Power Charger.

5. Set SW1-1 to OFF as shown in Figure 8.13 to enable connectivity with the debugger.
   If you start the board without connecting to J-Link Base, set SW1-1 to ON.

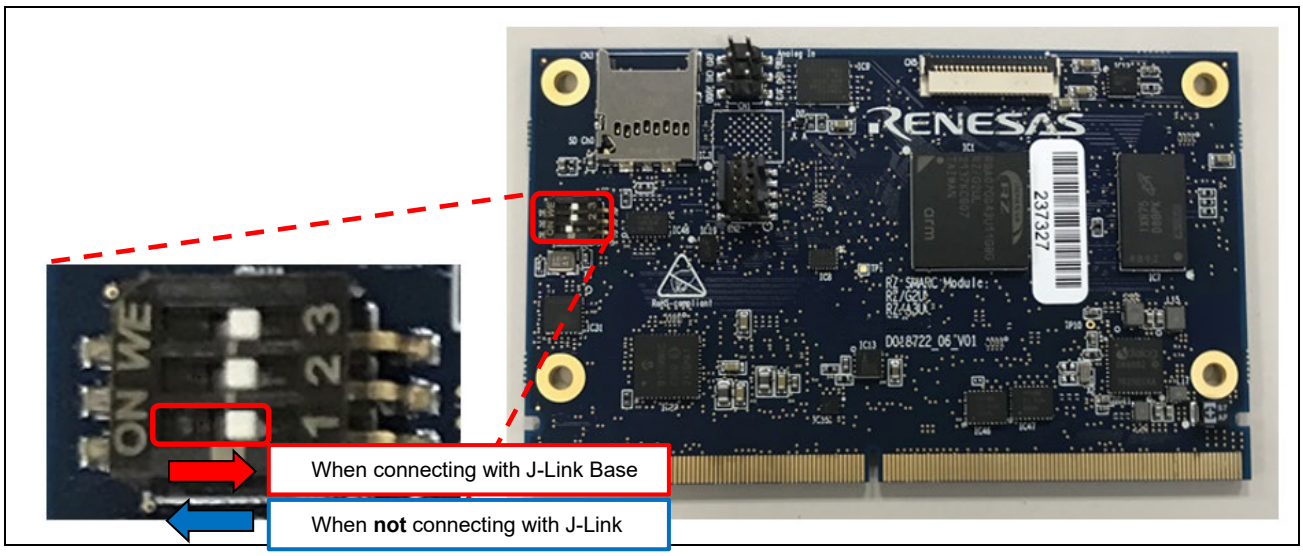


Figure 8.13 SW1 setting

6. Set Boot Mode to Boot Mode3 (1.8-V Serial Flash Memory) by setting SW11-1, SW11-2, SW11-3 as shown in Figure 8.14.

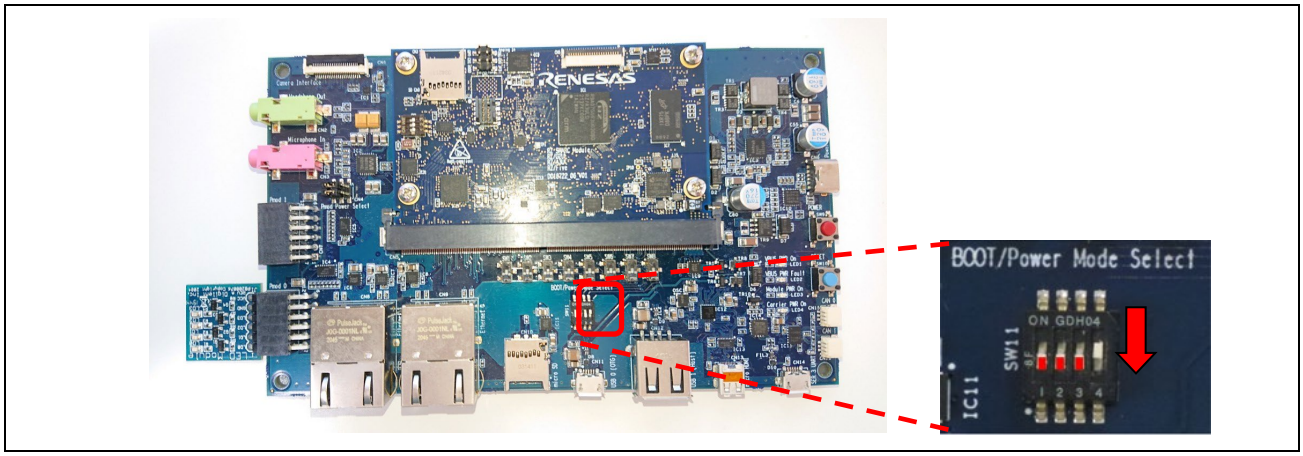


Figure 8.14 SW11 setting

8.3 Setting Serial Terminal

This section describes the procedure for setting the serial terminal to check the message output by IPL.

The procedure is the same for both Windows 10 version and Ubuntu 20.4 LTS version.

1. Set the SMARC board operating mode to Boot Mode3 (1.8-V Serial Flash Memory) and turn on the power.
2. Launch e² studio.
3. Click [Window] -> [Show View] -> [Other].
   The Show View window will bring up.
   Select "Terminal" there and click [Open].

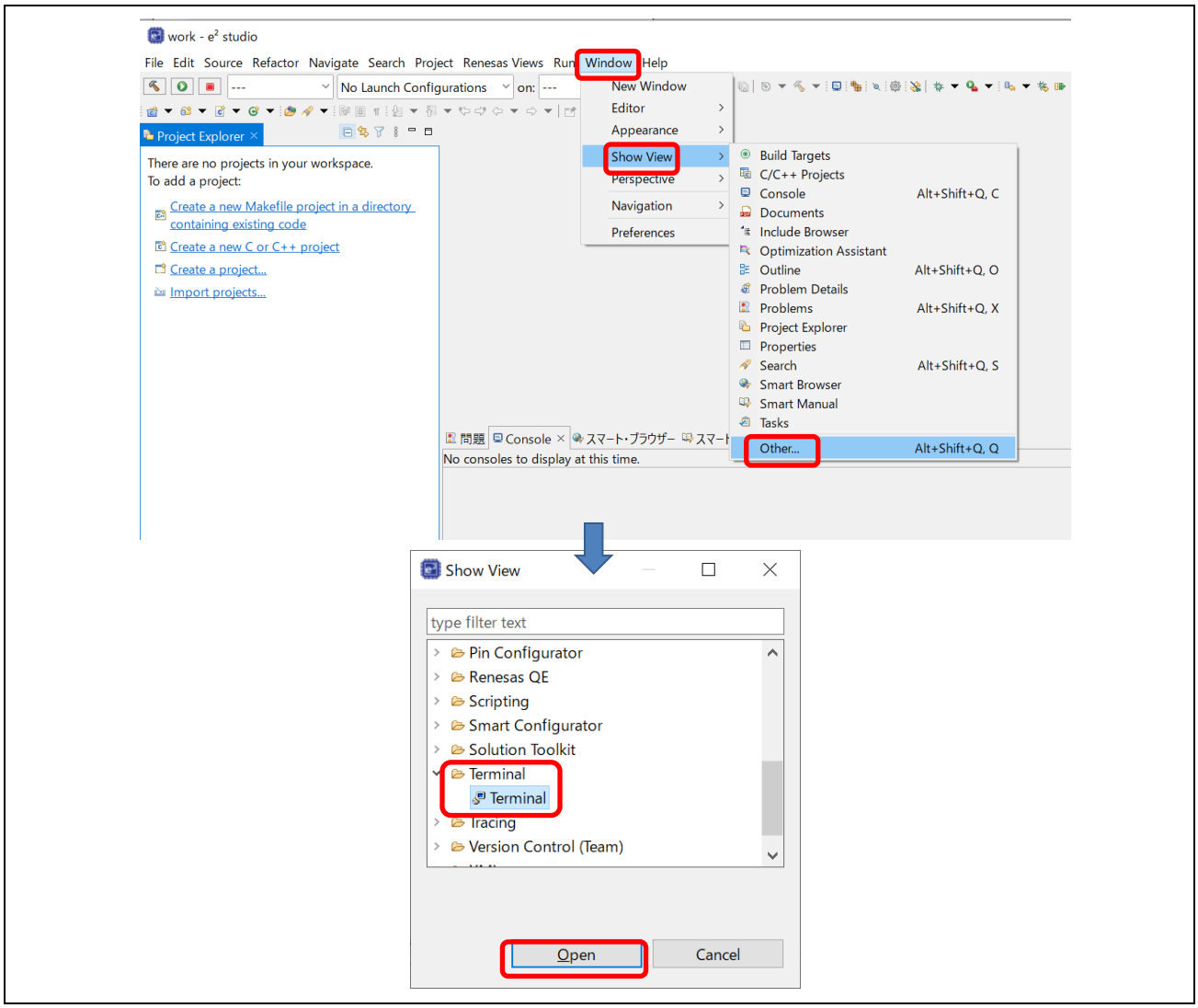


Figure 8.15 Setting Serial Terminal (1)

4. The Terminal window will open.
   Please click the mark.

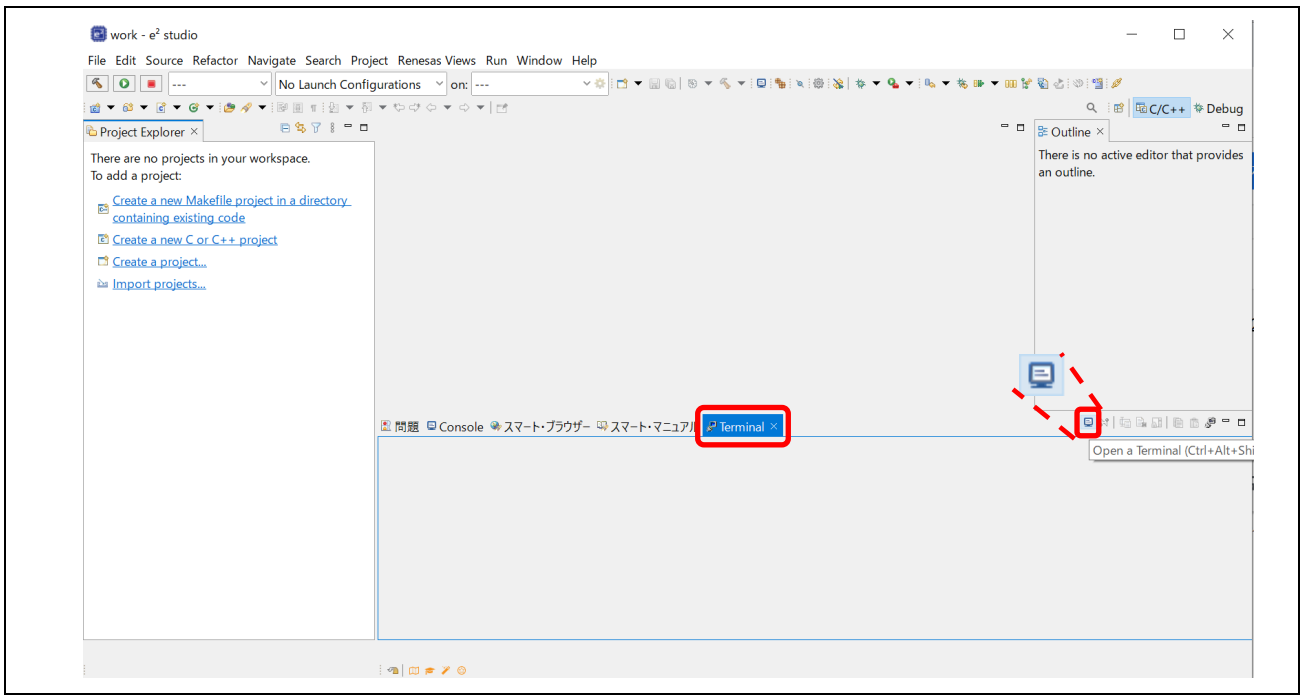


Figure 8.16 Setting Serial Terminal (2)

5. The Lunch Terminal window will bring up.
   Set the parameters as shown in Figure 8.17 on a Windows 10 PC and Figure 8.18 on an Ubuntu 20.4 LTS PC and click OK.
   “Serial port” is a PC environment-dependent port.
   Please set according to your environment.

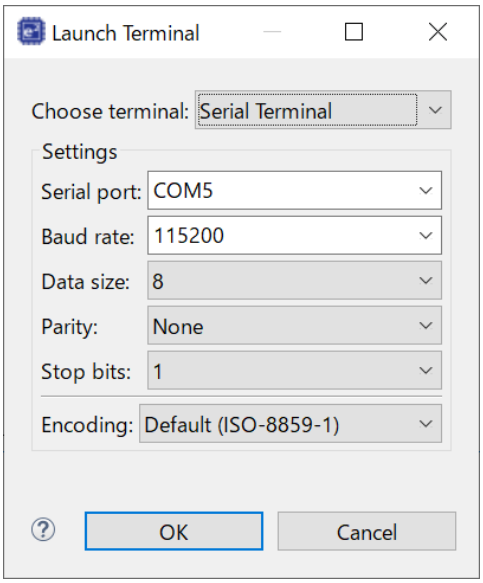


Figure 8.17 Parameter of Serial Terminal (Windows10)

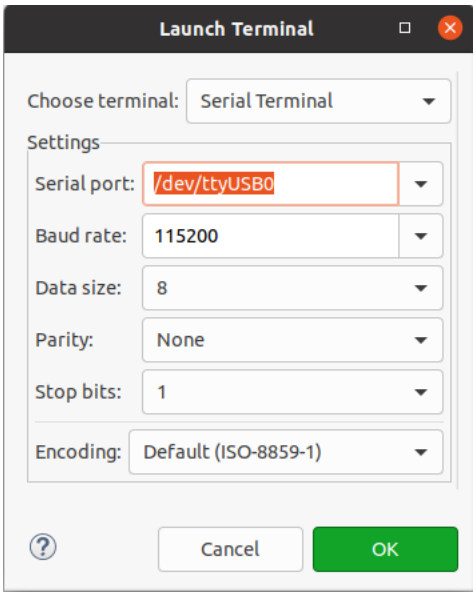


Figure 8.18 Parameter of Serial Terminal (Ubuntu 20.4 LTS)

6. Start the Serial Terminal.

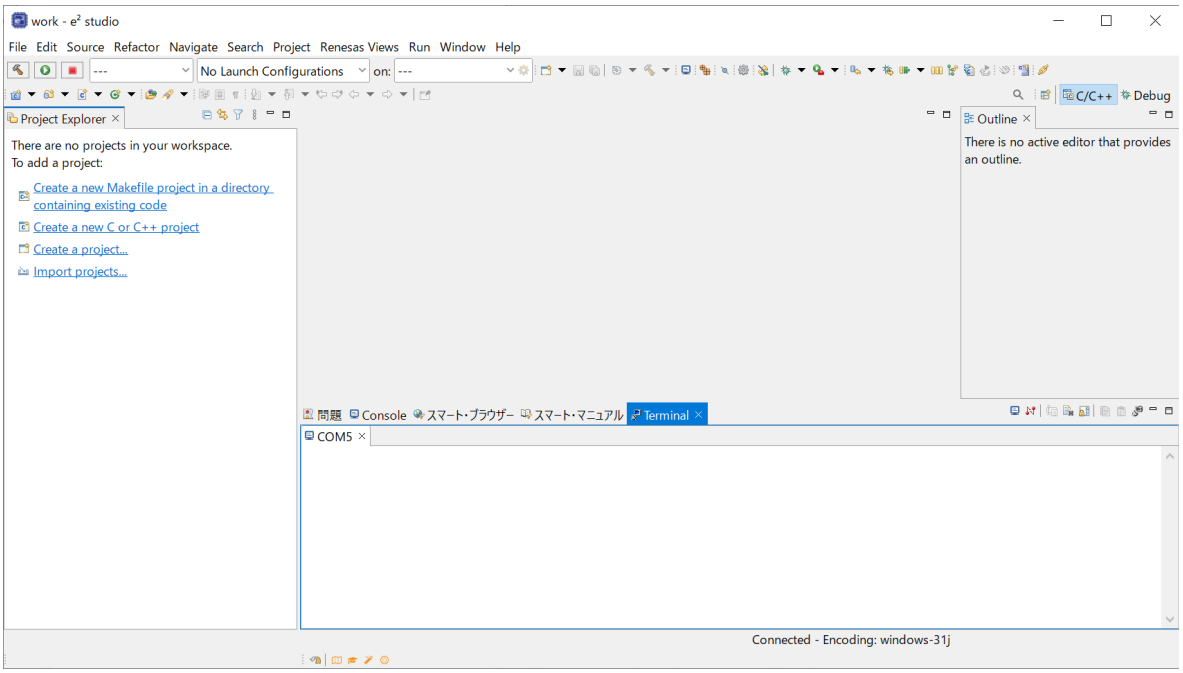


Figure 8.19 Setting Serial Terminal (3)

8.4 Execution procedure of IPL by Serial Flash boot

The procedure for writing the IPL to the Serial Flash Memory and executing the IPL is shown below.

1. As the FSP application must be written to the Serial Flash Memory to confirm the boot operation by IPL, if the FSP application is not written to the Serial Flash Memory, write it.
   For the write procedure, refer to 9.2 Procedure for writing an FSP application to Serial Flash Memory.
2. Set the SMARC board operating mode to Boot Mode3 (1.8-V Serial Flash Memory) and turn on the power.
3. Launch e² studio and click ⚙ mark to the right of the Debug Configuration generated in 8.1 Create Debug Configuration (hereinafter referred to as RZA3UL_IPL Default configuration) to bring up the setting window.

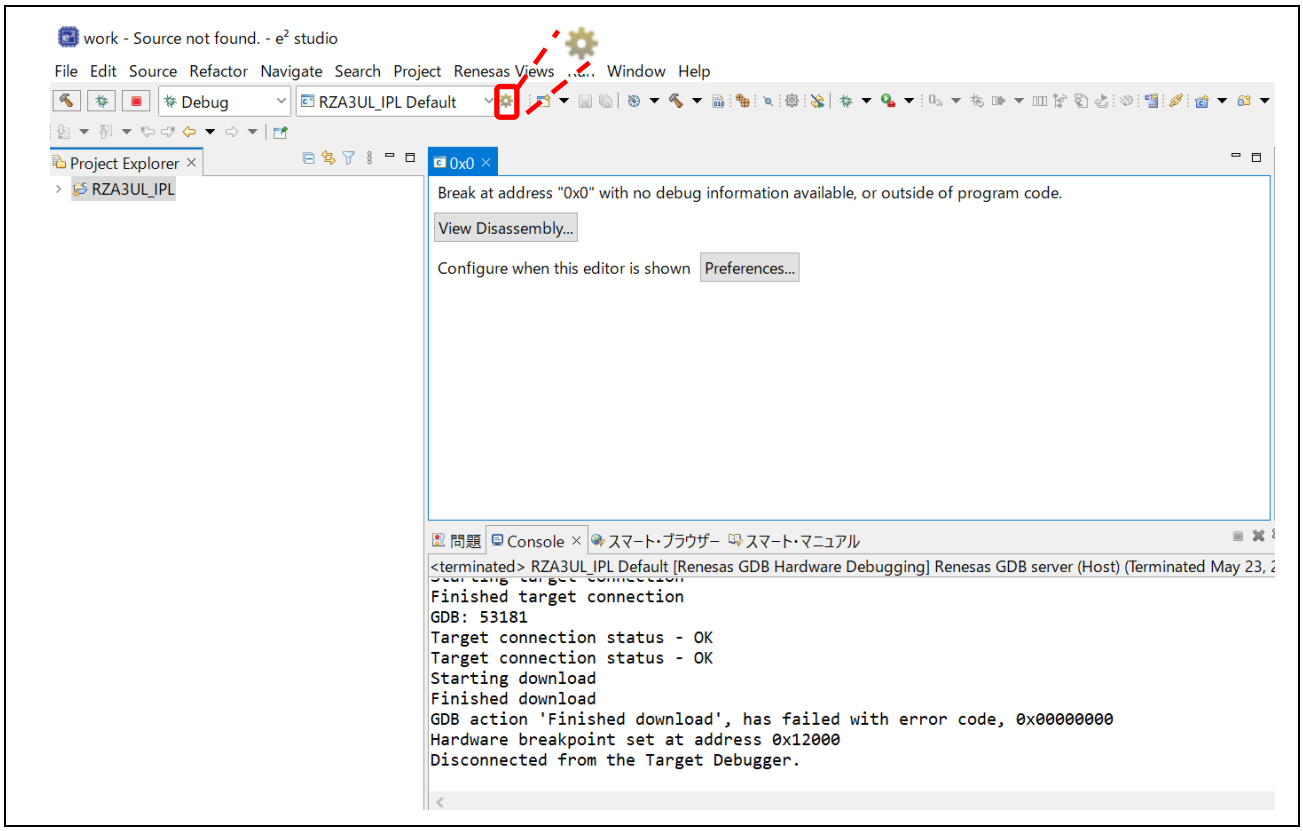


Figure 8.20 Change Debug Configuration of Serial Flash (1)

4. Go to the “Startup” tab and set “On connect” for “rza3ul_smarc_qspi_ipl.srec” to Yes.
   Also, set “On connect” in “Program Binary” to No.
   Then, click [OK] to complete the setting.

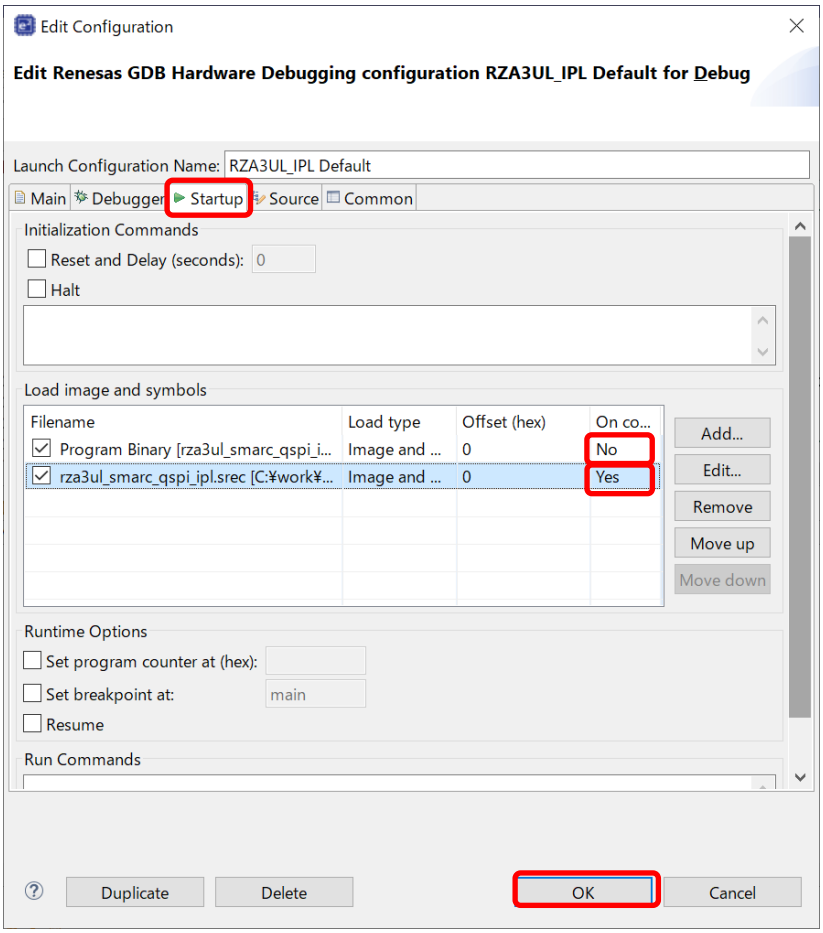


Figure 8.21 Change Debug Configuration of Serial Flash (2)

5. Make sure the RZA3UL_IPL Default configuration is selected on the e² studio window and click mark to launch the program.

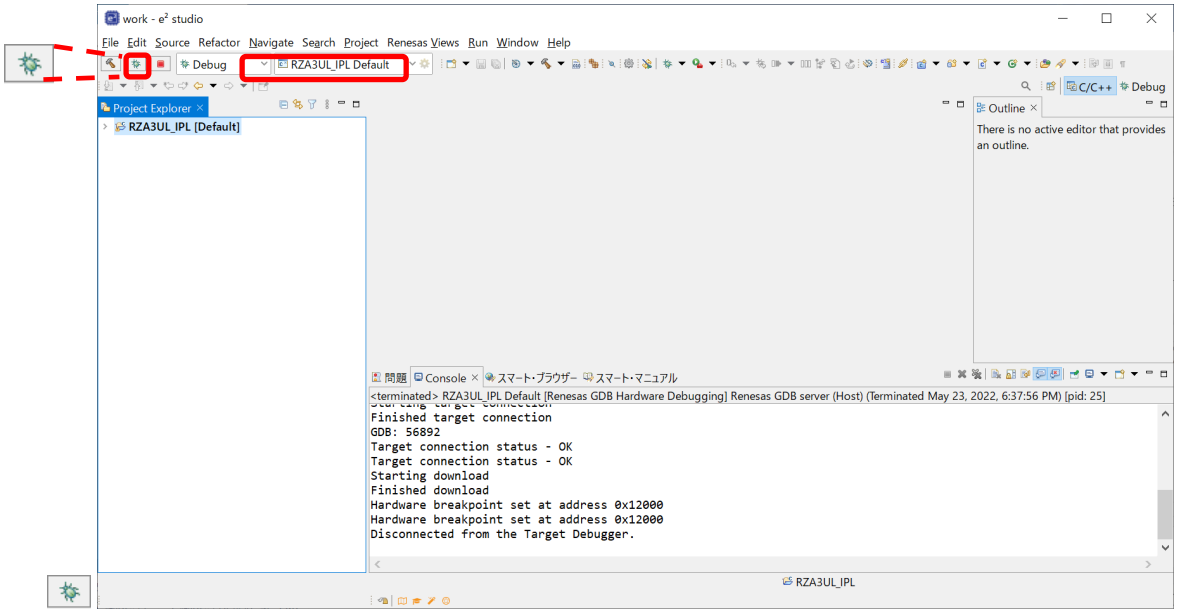


Figure 8.22 Execution of IPL on Serial Flash Memory (1)

6. Writing to the Serial Flash Memory is performed.
   After the write is complete, the perspective for the debug control will be launched.

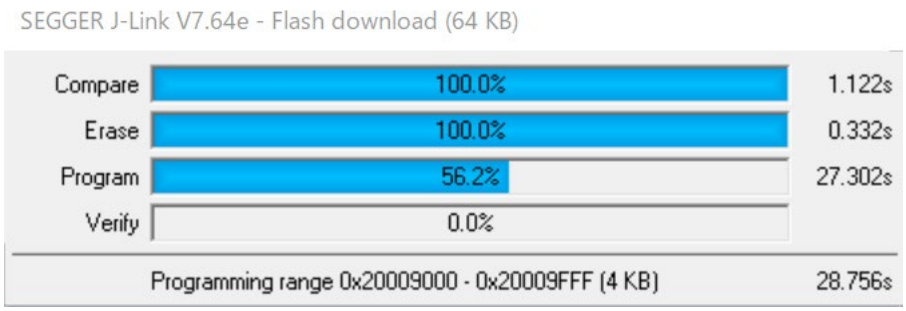


Figure 8.23 Execution of IPL on Serial Flash Memory (2)

7. If Confirm Perspective Switch is displayed during the launch of the perspective, check Remember my decision and select Switch.

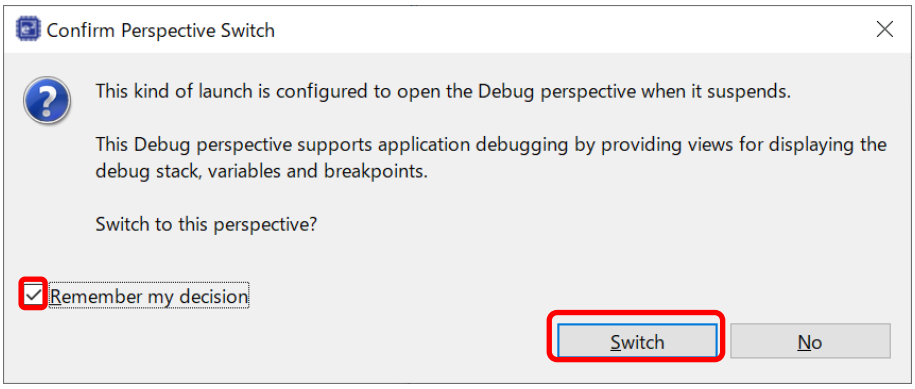


Figure 8.24 Execution of IPL on Serial Flash Memory (3)

8. After writing to the serial flash, click ■ mark in the perspective to disconnect from the SMARC board.
   After that, press the RESET button on the SMARC board to execute the IPL.
   At this time, the log shown in Figure 8.26 is displayed on Terminal.
   In addition, the program written in the Serial Flash Memory starts and the LED of the SMARC board blinks as shown in Figure 8.27.

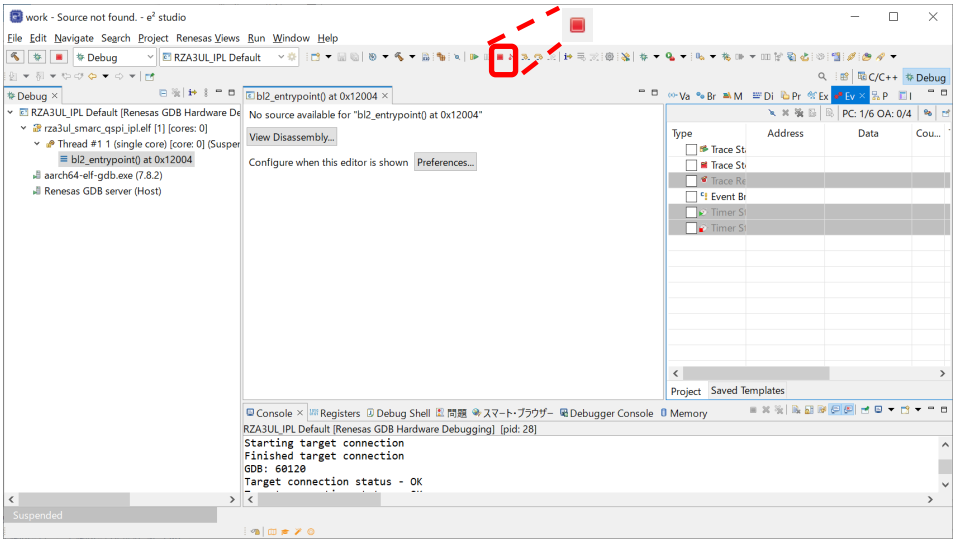


Figure 8.25 Execution of IPL (6)

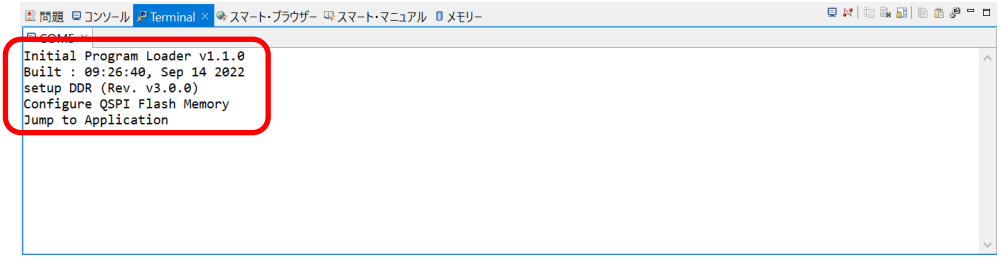


Figure 8.26 IPL execution log

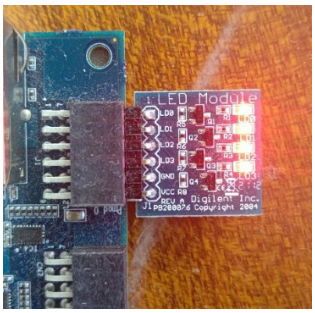


Figure 8.27 LED blinking

9. Application Example

This chapter shows application examples for applying IPL to various environments.

9.1 Execution procedure of IPL by On-chip RAM download

This chapter describes the procedure for writing and executing the IPL to the On-chip RAM for the purpose of facilitating the operation check when customizing the IPL.

1. As the FSP application must be written to the Serial Flash Memory to confirm the boot operation by IPL, if the FSP application is not written to the Serial Flash Memory, write it.
   For the write procedure, refer to 9.2 Procedure for writing an FSP application to Serial Flash Memory.
2. Set the SMARC board operating mode to Boot Mode3 (1.8-V Serial Flash Memory) and turn on the power.
3. Launch e² studio and click ⚙ mark to the right of the RZA3UL_IPL Default configuration to bring up the setting window.

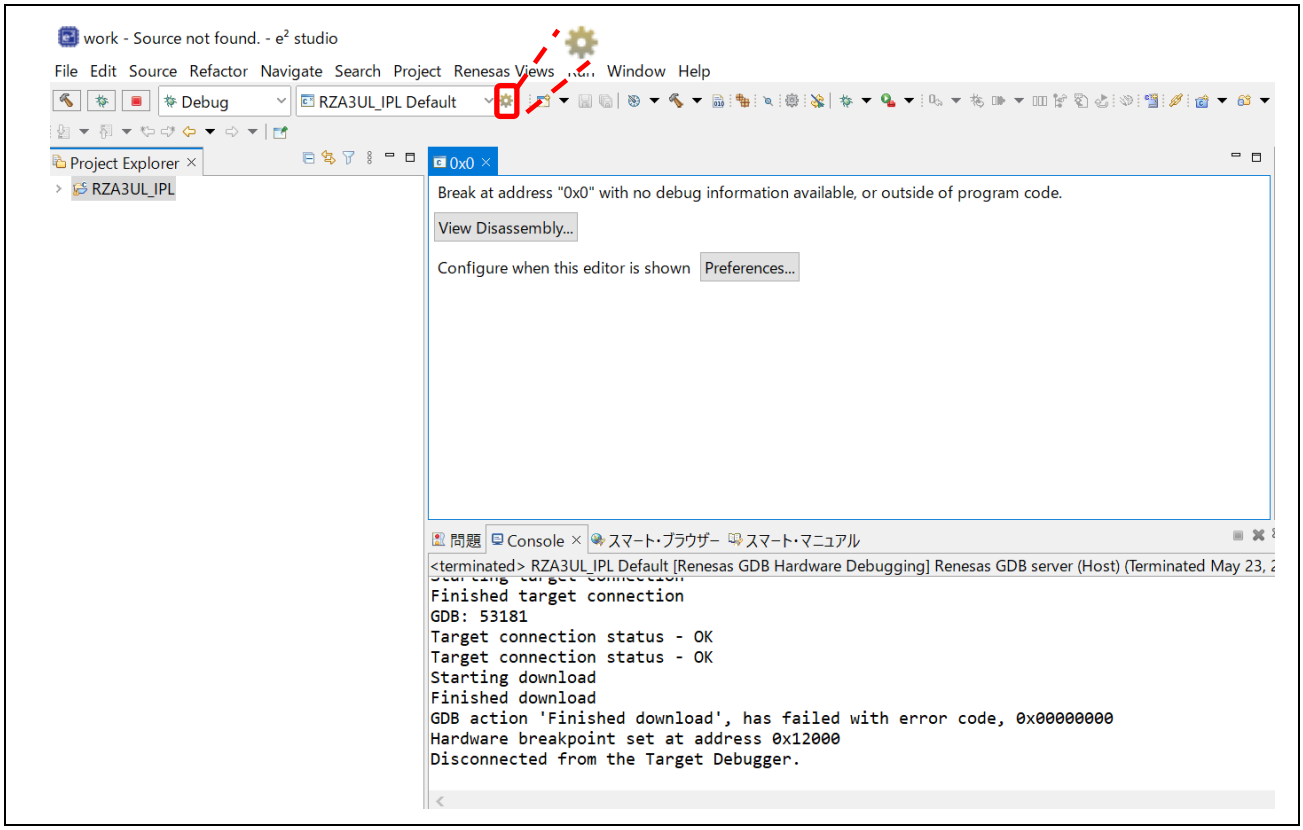


Figure 9.1 Change Debug Configuration of On-chip RAM (1)

4. Go to the “Startup” tab and set “On connect” for “Program Binary.elf” to Yes.
   Also, set “On connect” in “rza3ul_smarc_qspi_ipl.srec” to No.
   Then, click [OK] to complete the setting.

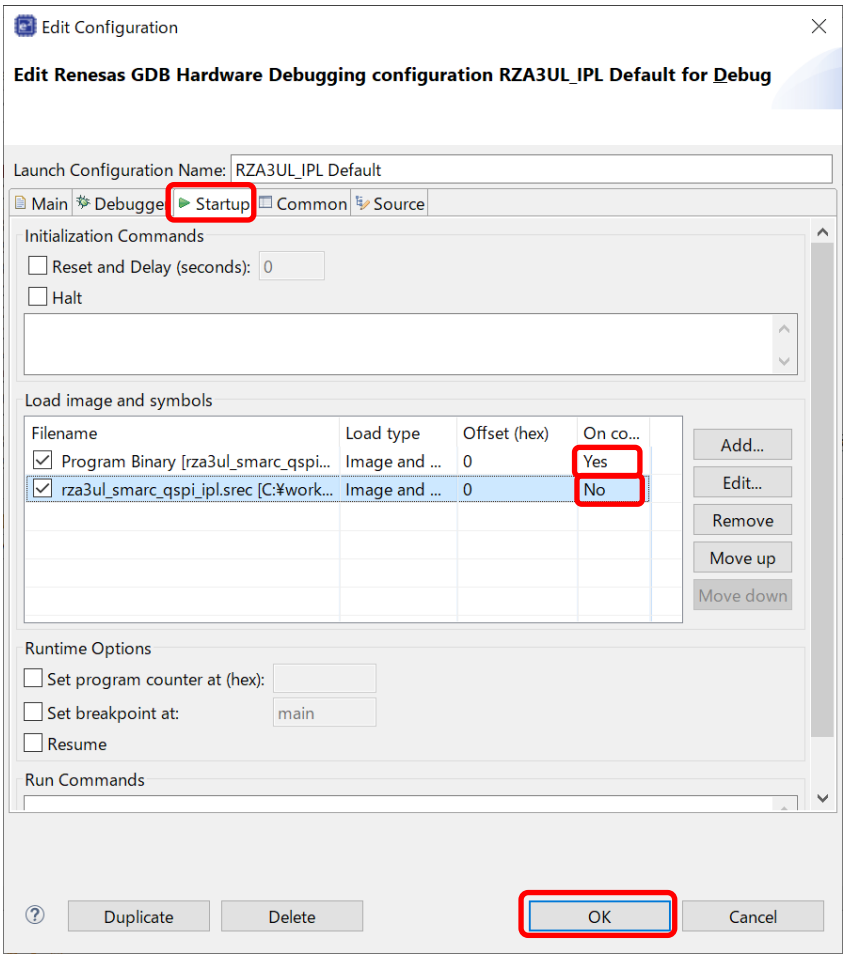


Figure 9.2 Change Debug Configuration of On-chip RAM (2)

5. Make sure the RZA3UL_IPL Default configuration is selected on the e² studio window and click mark to launch the program.
   This will bring up a perspective for the debug control.

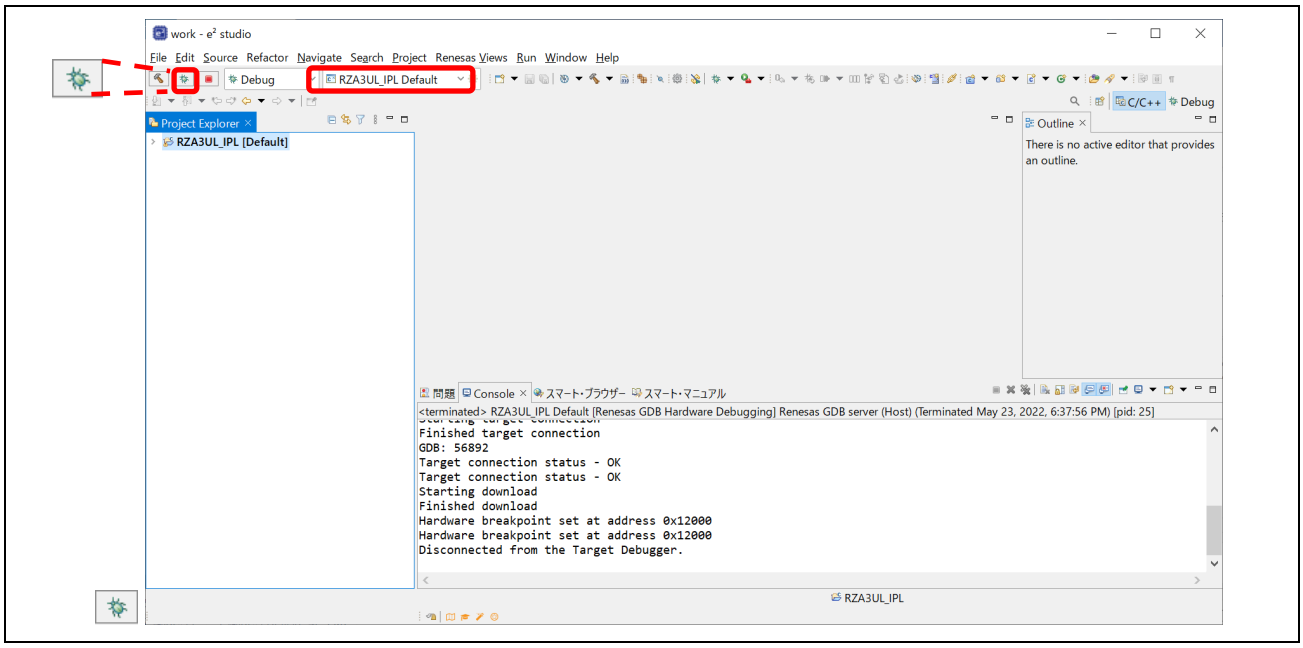


Figure 9.3 Execution of IPL on On-chip RAM (1)

6. Click mark in the perspective to perform the IPL.
   The IPL will start executing and the log shown in Figure 9.5 will be displayed in the terminal.
   At this time, the FSP application written on the Serial Flash Memory starts, and the LED of the SMARC board blinks as shown in Figure 9.6.

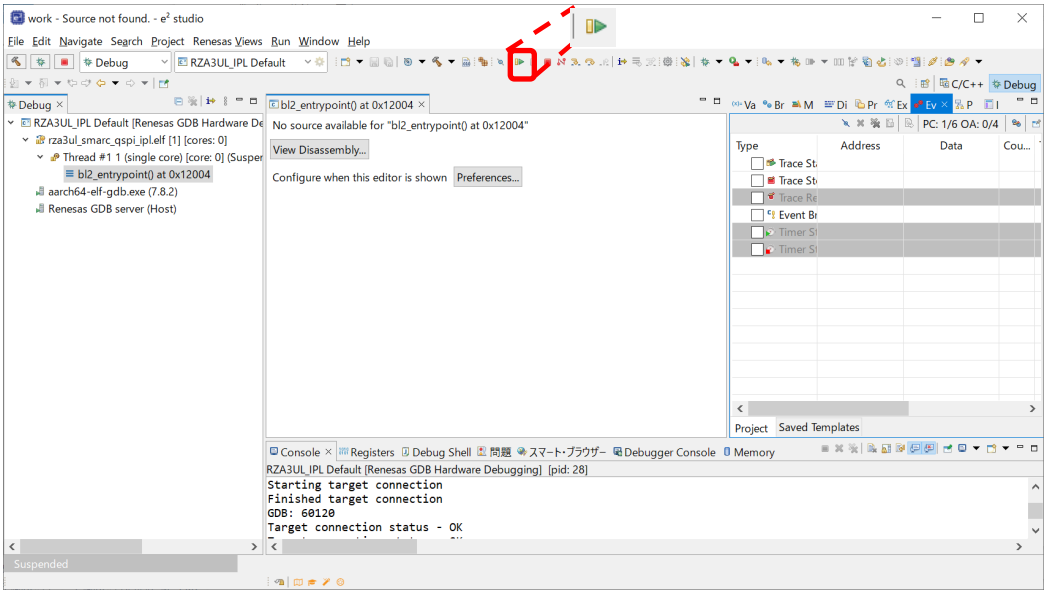


Figure 9.4 Execution of IPL (4)

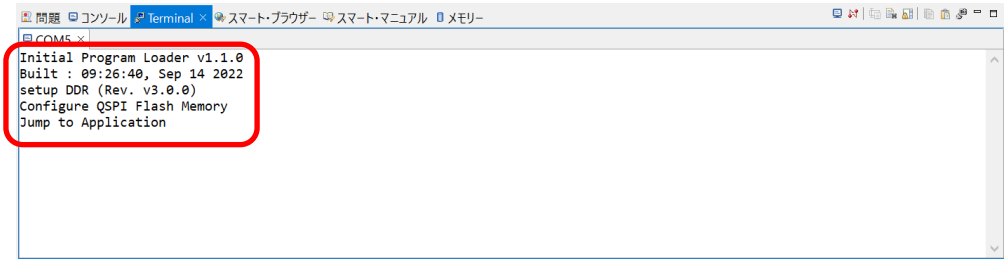


Figure 9.5 IPL execution log

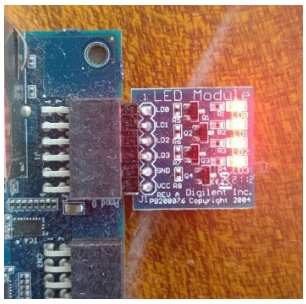


Figure 9.6 LED blinking

9.2 Procedure for writing an FSP application to Serial Flash Memory

This chapter describes the procedure for writing an FSP application to Serial Flash Memory.

Refer to the Getting Started with RZ/A Flexible Software Package (R01AN6499EJ) for building the FSP application.

This chapter shows an example of saving the FSP application binary file in C:\work.

1. Set the SMARC board operating mode to Boot Mode3 (1.8-V Serial Flash Memory) and turn on the power.
2. Launch e² studio and click ⚙ icon to the right of the RZA3UL_IPL Default configuration to bring up the setting window.

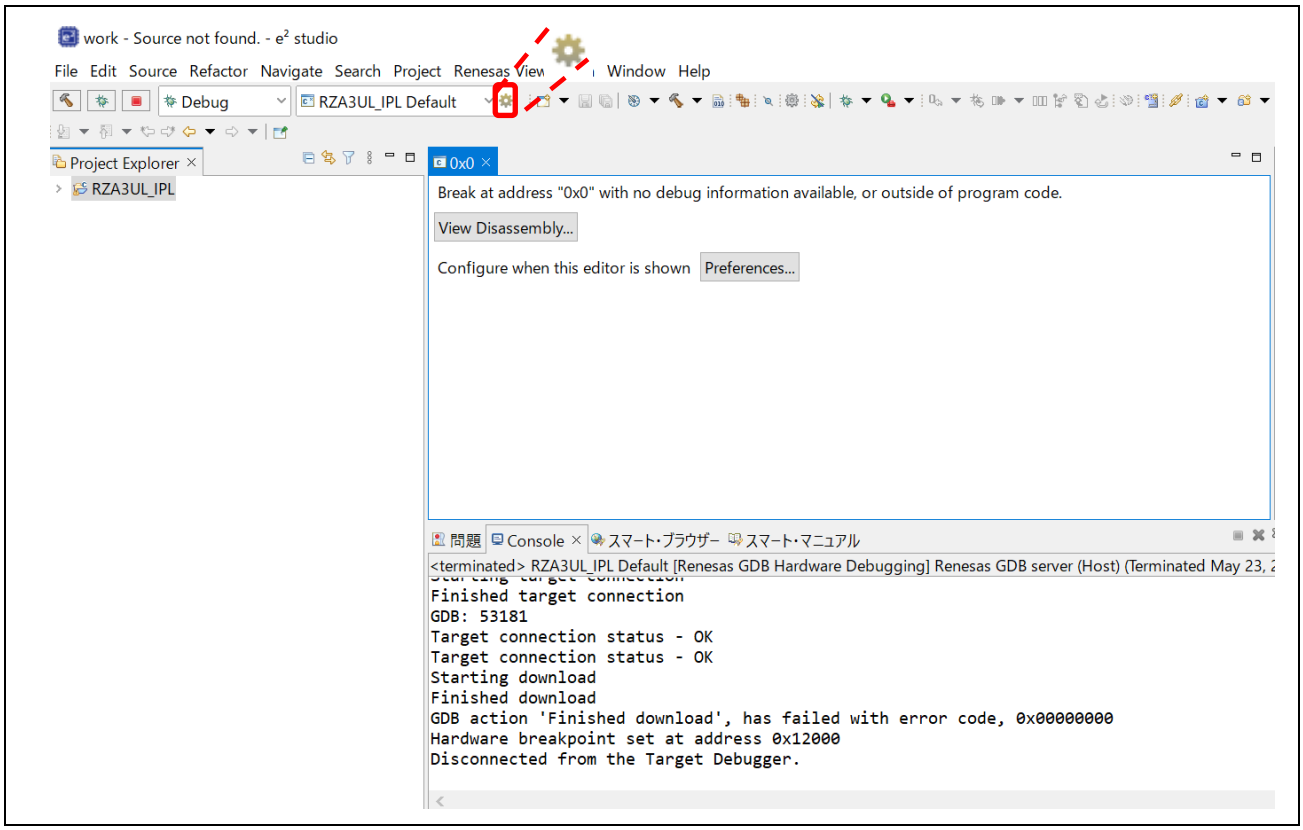


Figure 9.7 Procedure of writing FSP Application (1)

3. Edit Configuration will be launched.
   Set the “On connect” of all registered images to No, set the image not to be downloaded when connecting to the SMARC board, and click OK.

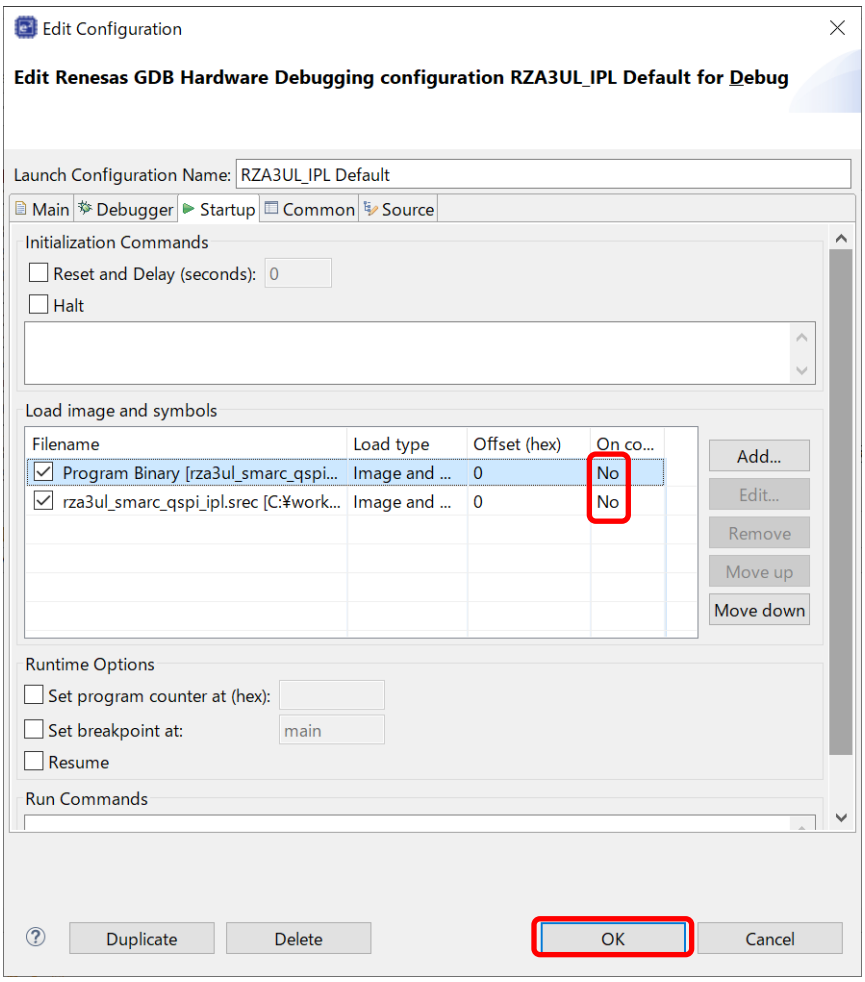


Figure 9.8 Procedure of writing FSP Application (2)

4. Make sure the RZA3UL_IPL Default configuration is selected on the e² studio window and click icon to connect to the SMARC board.
   The perspective for the debug control is launched.

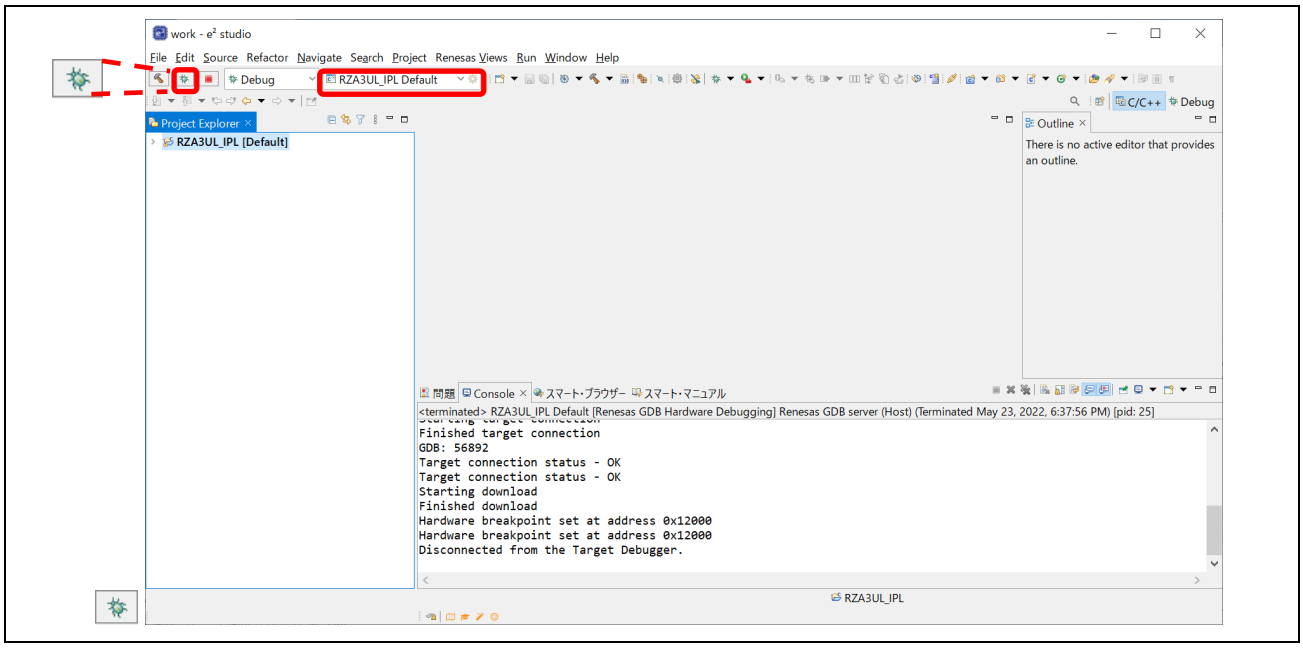


Figure 9.9 Procedure of writing FSP Application (3)

5. If “Confirm Perspective Switch” is displayed during the perspective launch, check “Remember my decision” and select [Switch].

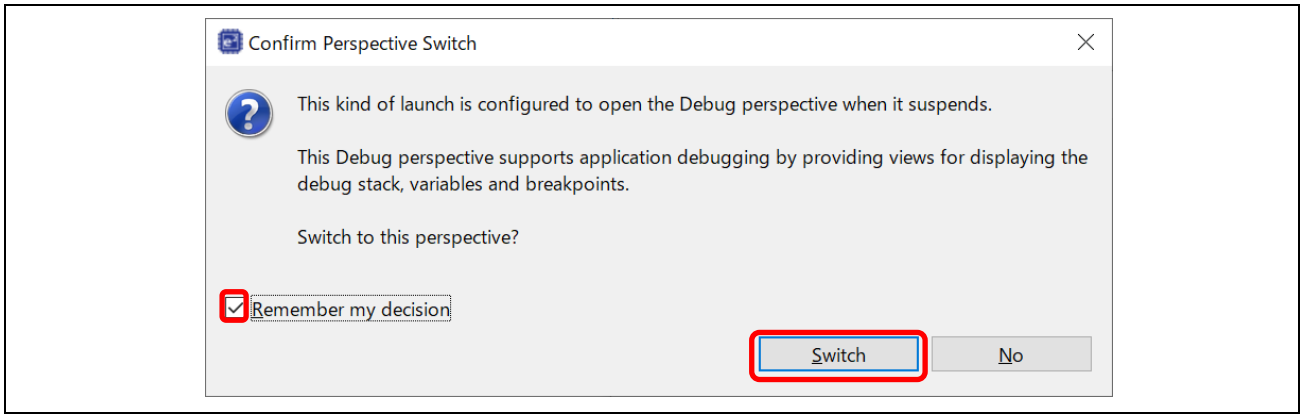


Figure 9.10 Procedure of writing FSP Application (4)

6. The board is connected and the perspective is launched.
   Click Load Ancillary file .

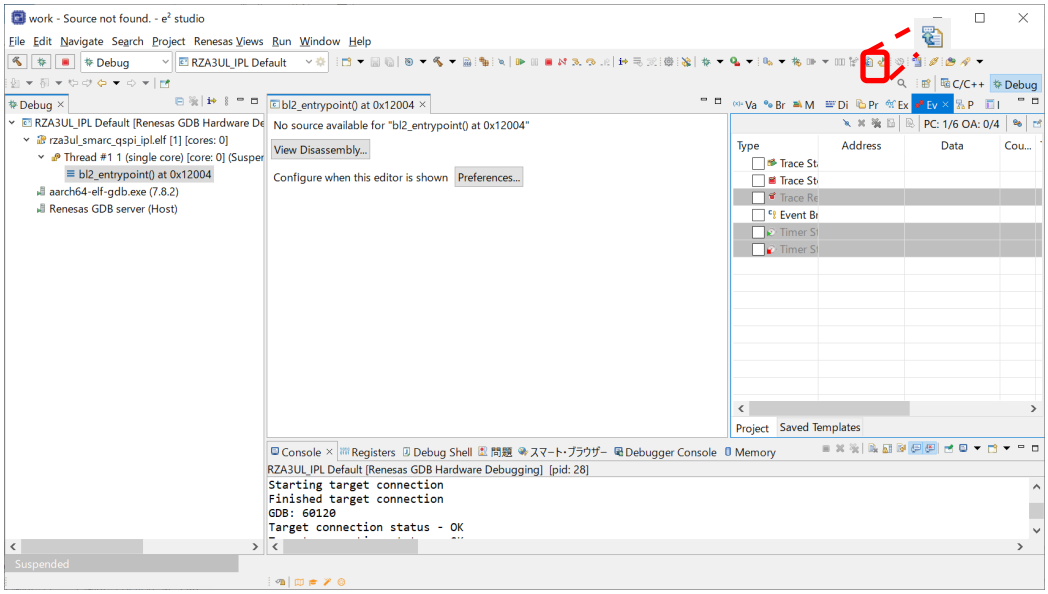


Figure 9.11 Procedure of writing FSP Application (5)

7. The Load Ancillary File window will be launched.
   Click [File System] and select C:\work\RZA3UL_CA55_BLINKY.srec.
   Also, uncheck “Load as raw binary image”.
   Click [OK] to write to the Serial Flash Memory.

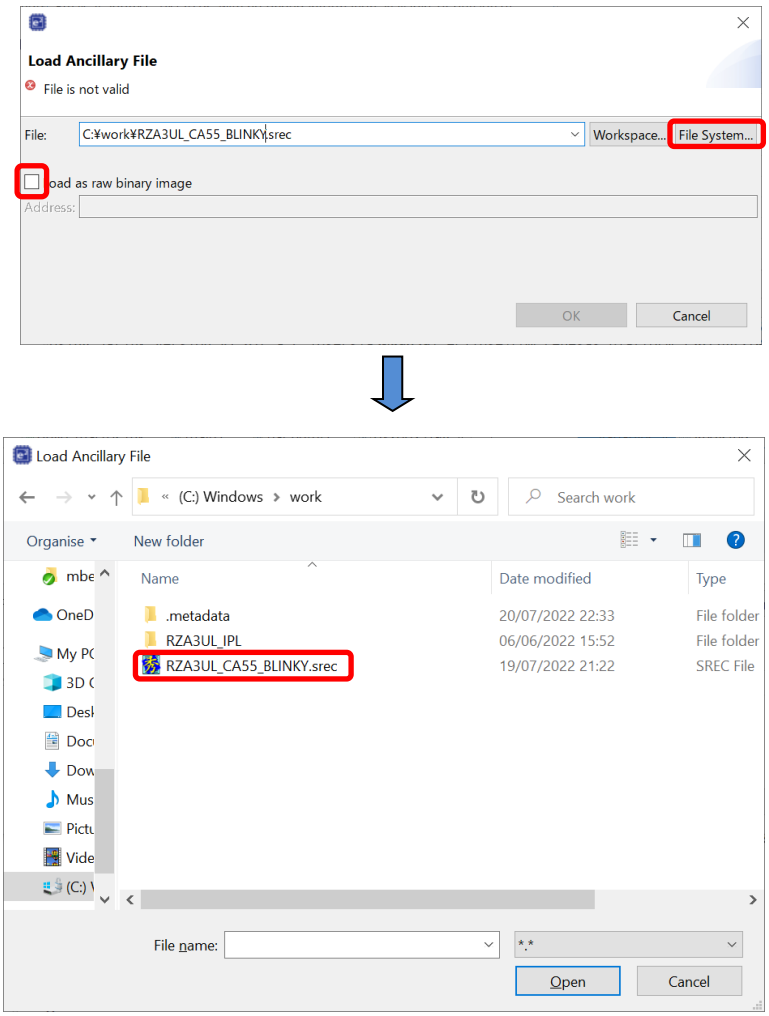


Figure 9.12 Procedure of writing FSP Application (6)

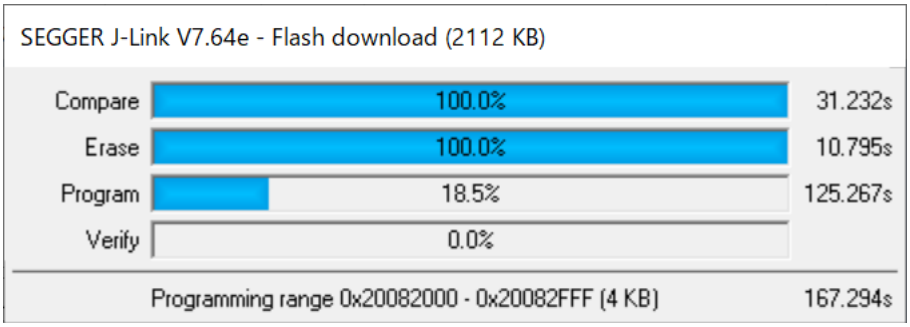


Figure 9.13 Procedure of writing FSP Application (7)

8. After writing, click mark to disconnect from the SMARC board.

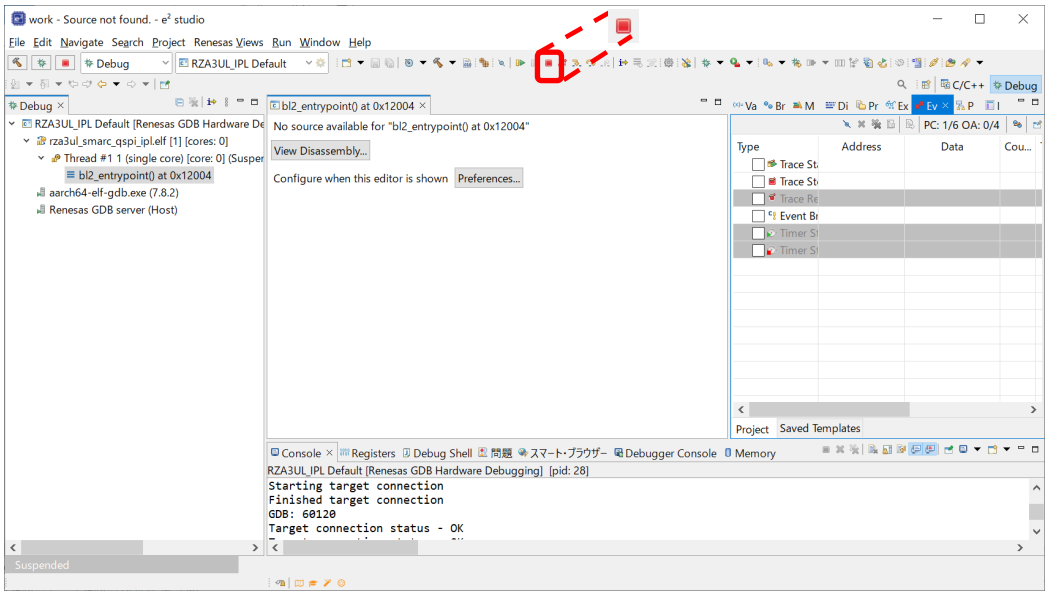


Figure 9.14 Procedure of writing FSP Application (8)

9.3 How to build IPL for custom board

This chapter describes the IPL build environment construction procedure for boards other than SMARC boards (hereafter referred to as custom boards).

9.3.1 How to add a serial flash memory driver

When adding a serial flash memory to be used for IPL, it is necessary to create and add a driver for that serial flash memory.

This chapter describes how to add a serial flash memory driver.

1. Open the c:\work\RZA3UL_IPL\plat\renesas\rz\common\drivers\xspidevice folder, copy the "qspiflash_at25" folder and rename it to any name.
   This time, rename the folder name to "qspiflash_custom".

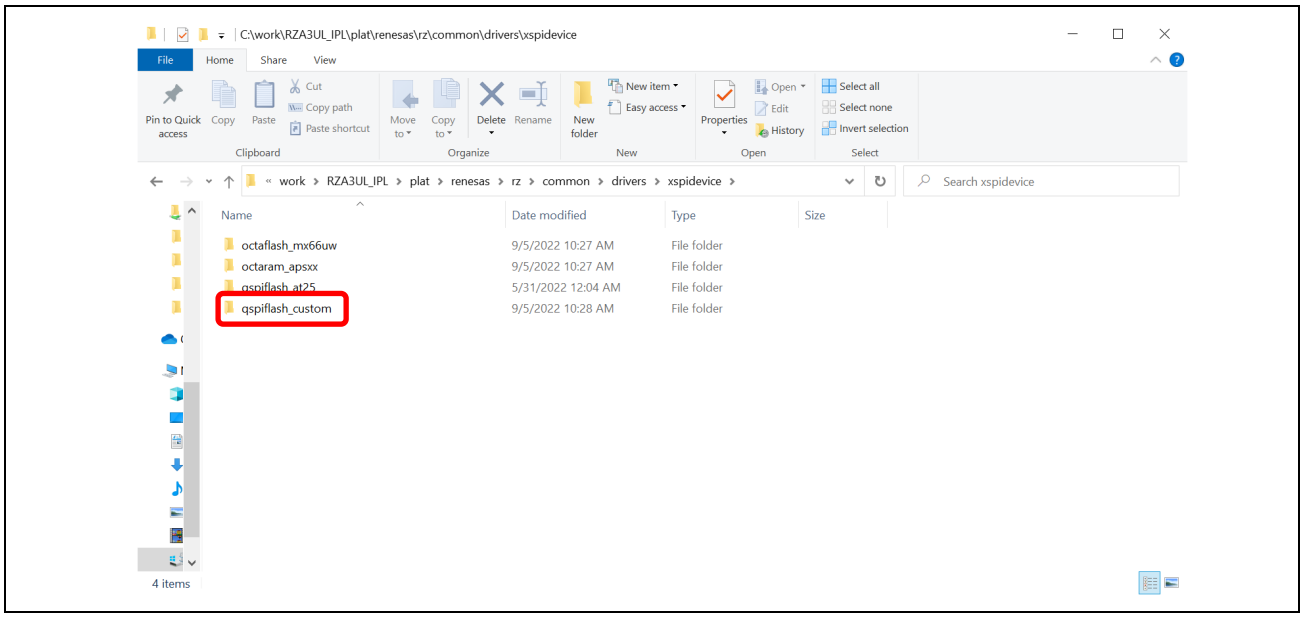


Figure 9.15 Rename Serial Flash Memory driver folder

2. Open “qspiflash_custom” folder and change ”qspiflash_at25.c”, ”qspiflash_at25_api.h” to ”qspiflash_custom.c”, ”qspiflash_custom_api.h”.

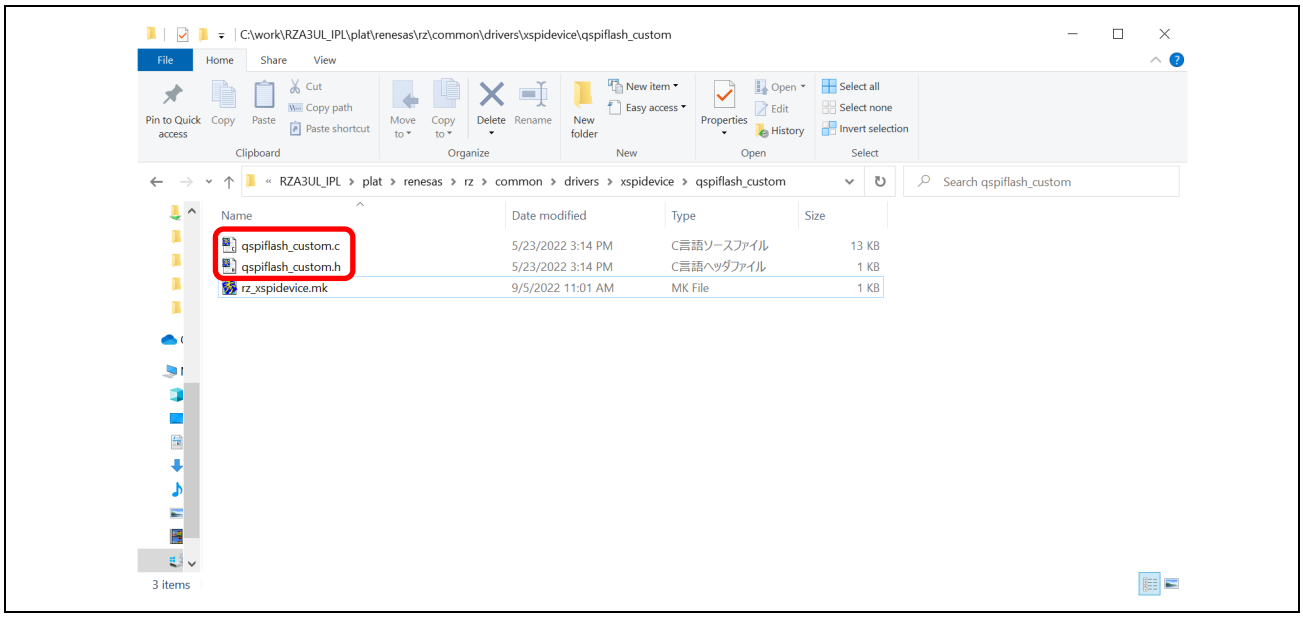


Figure 9.16 Rename Serial Flash Memory driver files

3. Open “rz_xspidevice.mk” and change "_XSPI_DEVICE:=qspiflash_at25" on line 6 to "_XSPI_DEVICE:=qspiflash_custom".

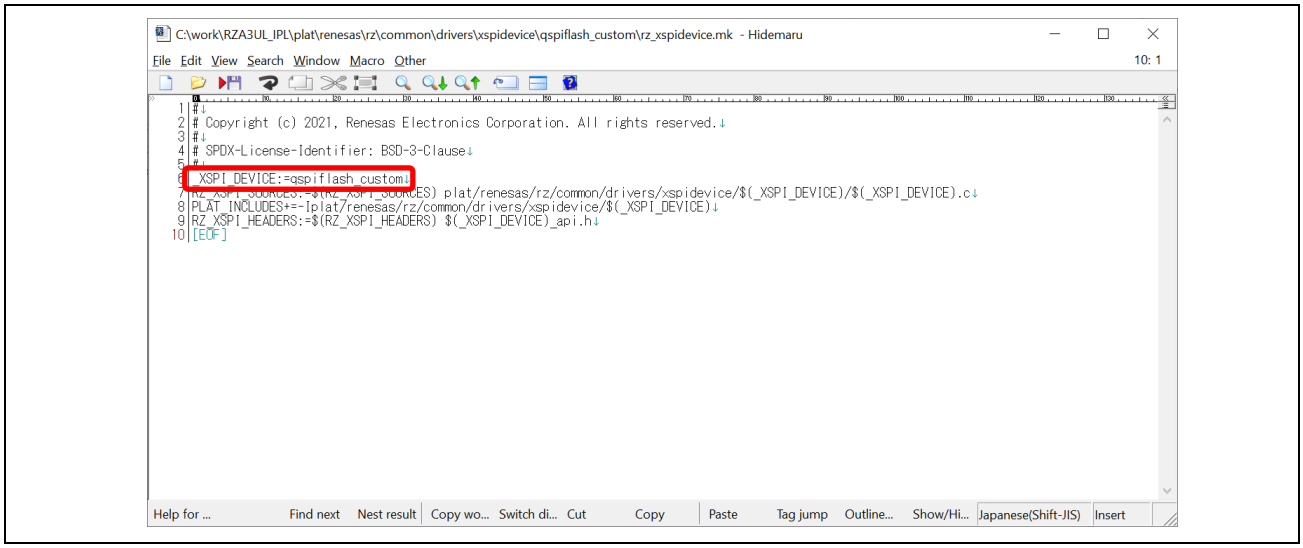


Figure 9.17 Change Serial Flash Memory driver makefile

4. Open “qspiflash_custom_api.h” and replace all structure definitions of “xx_qspiflash_at25_xx” with “xx_qspiflash_custom_xx”.

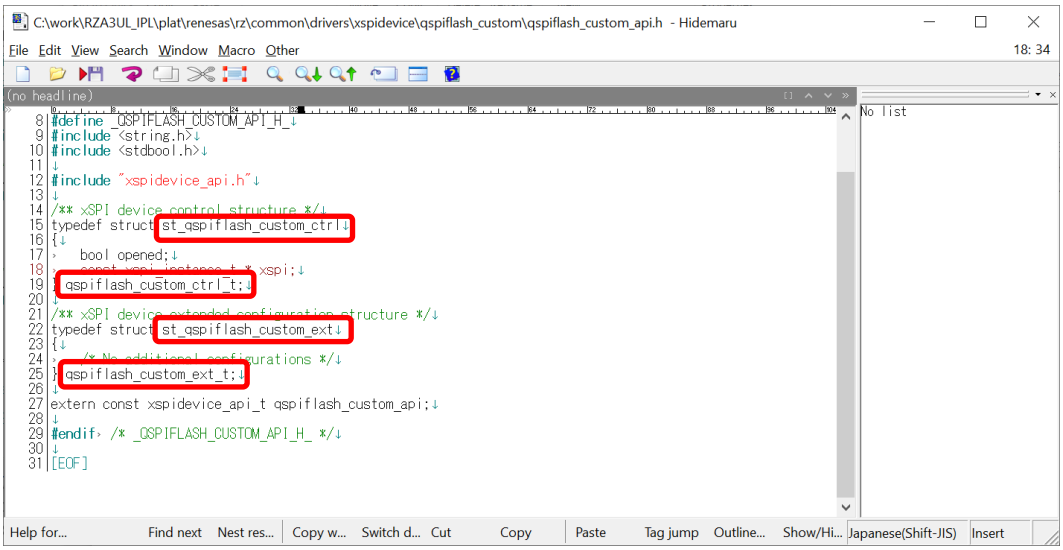
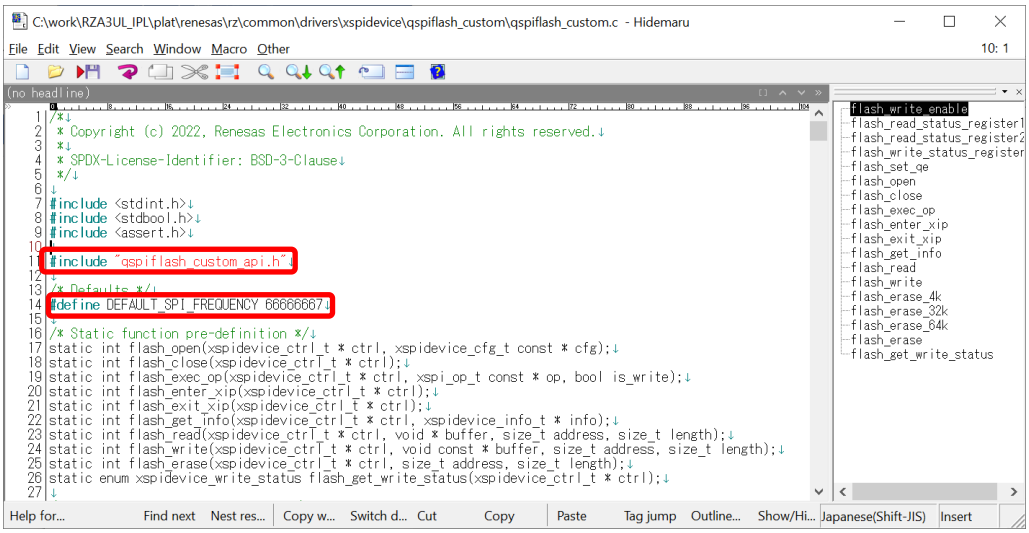


Figure 9.18 Change Serial Flash Memory driver structs name

(Note) The qspiflash_custom_ext_t structure is for extended settings.
If the members corresponding to the parameters required for the serial flash memory you use are not provided in the qspiflash_custom_ctrl_t structure, add those members as extended settings.

5. Open qspiflash_custom.c and replace the included header with “qspiflash_custom_api.h”. Also, reflect the structure name replaced in step 4.
   Set the operating frequency of the serial flash memory to DEFAULT_SPI_FREQUENCY on the line 14.



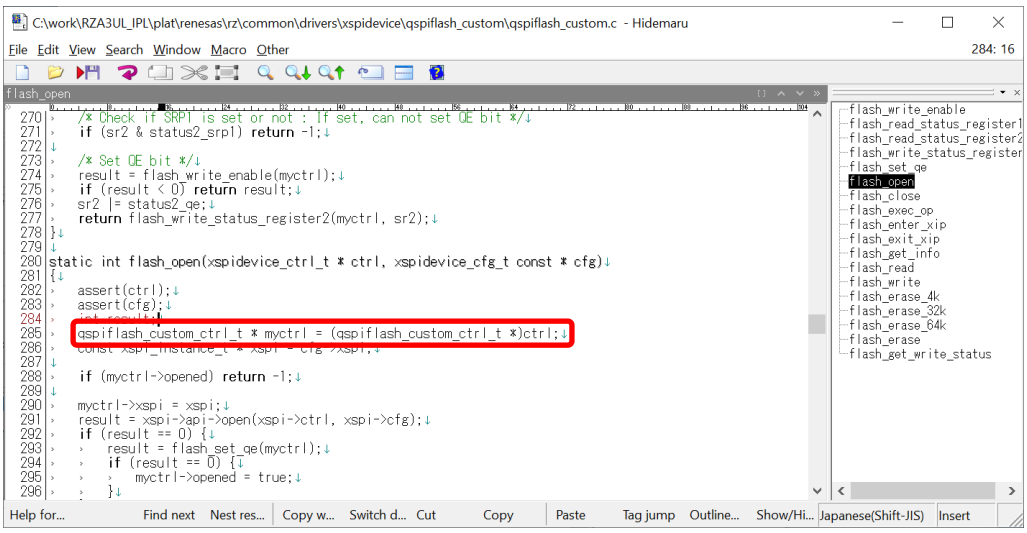


Figure 9.19 Change Serial Flash Memory driver source code

6. Table 9.1 shows the API functions implemented in qspiflash_custom.c.
   When adding a serial flash memory, replace these API functions with implementations that correspond to the serial flash memory you use.
   In addition, qspiflash_custom.c contains an operation table that summarizes the information required for operations to the serial flash memory.
   Rewrite and add to the operation corresponding to the serial flash memory.
   The format of the operation table is shown in Table 5.18.

Table 9.1 API Function

Function Name	Description
flash_open	Serial Flash Memory driver open function
flash_close	Serial Flash Memory driver close function
flash_exec_op	Serial Flash Memory driver operation function
flash_enter_xip	Serial Flash Memory driver XIP start function
flash_exit_xip	Serial Flash Memory driver XIP stop function
flash_get_info	Serial Flash Memory driver information get function
flash_read	Serial Flash Memory driver read function
flash_write	Serial Flash Memory driver write function
flash_erase	Serial Flash Memory driver erase function
flash_get_write_status	Serial Flash Memory driver write status get function

The processing for AT25QL128A of each API function is described below.

Please refer to it when rewriting the implementation contents.

flash_open	
Outline	Initialize the serial flash memory
Declaration	int flash_open (xspidevice_ctrl_t * ctrl, xspidevice_cfg_t const * cfg)
Arguments	*ctrl :Pointer to xSPI device control structure *cfg :Pointer to xSPI device configure structure
Return value	0 :Initialization is complete -1 :Initialization is failed
Operation Table to use	op_read_status2 (Table 5.35) op_write_enable (Table 5.34)
Processing details	1. Call spim_open() to initialize the xSPI control driver and SPIBSC. 2. Pass op_read_status2 to spim_exec_op() and execute it to get the lower 8-bit value of Status Register of AT25QL128A. 3. From the value obtained in step 2, confirm that the QE (Quad Enable) bit is not set. If this bit is set, skip to step 6. 4. From the value obtained in step 2, confirm that the SRP1 (Register Protect1) bit is not set. If this bit is set, terminate function as initialization failure. 5. Pass op_write_enable to spim_exec_op() and execute to release Write Protect of AT25QL128A. 6. Set the driver's opened flag to true.
Note	-

flash_close	
Outline	Close the serial flash memory
Declaration	int flash_close (xspidevice_ctrl_t * ctrl)
Arguments	*ctrl :Pointer to xSPI device control structure
Return value	0 :Close process is complete -1 :Close process is failed
Operation Table to use	None
Processing details	1. If the driver's opened flag is true, call spim_close() to close the xSPI control driver. If the opened flag is false, function exits. At this time, -1 is set to the return value. 2. Set the driver's opened flag to false.
Note	-

flash_exec_op	
Outline	Execute operation to serial flash memory
Declaration	void flash_exec_op (xspidevice_ctrl_t * ctrl, xspi_op_t const * op, bool is_write)
Arguments	*ctrl :Pointer to xSPI device control structure *op : Pointer to xSPI interface operation structure is_write :Specifies the transmission/reception direction of the operation(0=read、1=write)
Return value	0 :Execute the operation is complete -1 :Execute the operation is failed
Operation Table to use	Argument *op
Processing details	1. Pass the argument *op to spim_exec_op() and execute the operation to AT25QL128A.
Note	-

flash_enter_xip	
Outline	Set the External Address Space Read Mode to the serial flash memory
Declaration	int flash_enter_xip (xspidevice_ctrl_t * ctrl)
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :Setting is complete -1 :Setting is failed
Operation Table to use	rop (Table 5.38)
Processing details	1. Pass rop to spim_configure_xip() and execute to set External Address Space Read Mode. 2. If step 1 succeeds, call spim_set_frequency() to set the operating clock frequency of AT25QL128A. 3. If step 2 was successful, call spim_start_xip() to start External Address Space Read Mode.
Note	External Address Space Read Mode automatically converts read accesses to the SPI multi-I/O bus space to serial flash memory read instructions, allowing data to be read as memory mapped to the memory space. Set the Read instruction to be converted to rop. Read access to the serial flash memory is performed according to the instruction set in rop.

flash_exit_xip	
Outline	Finish the External Address Space Read Mode
Declaration	int flash_exit_xip (xspi_ctrl_t * const ctrl)
Arguments	*ctrl :Pointer to the control structure for instance
Return value	0 :This value is always returned
Operation Table to use	None
Processing details	1. Call spim_stop_xip() to exit External Address Space Read Mode.
Note	-

flash_get_info	
Outline	Get the information of the serial flash memory
Declaration	int flash_get_info (xspidevice_ctrl_t * ctrl, xspidevice_info_t * info)
Arguments	*ctrl :Pointer to the control structure for instance * info :Information of the serial flash memory
Return value	0 :This value is always returned
Operation Table to use	None
Processing details	1. Set the argument info->capacity=0. 2. Set the argument info->minimum_erase_size=0. 3. Set the argument info->device_vendor to ”Dialog”. 4. Set the argument info->device_product to ”AT25x”.
Note	-

flash_read	
Outline	Data read from the serial flash memory
Declaration	int flash_read (xspi_ctrl_t * const ctrl , void * buffer, size_t address, size_t length)
Arguments	*ctrl :Pointer to the control structure for instance * buffer :Pointer to buffer to store read data address:Data read source address Specify the offset address in the serial flash memory for this argument length :Read data size
Return value	0 :This value is always returned
Operation Table to use	None
Processing details	1. Get the address where the serial flash memory is mapped by calling get_mmap_base(). 2. Copy data for argument length from (address obtained in step 1 + argument address) to argument *buffer.
Note	In IPL, data read from serial flash memory performs only direct copy in External Address Space Read Mode. Data read using Operation table is not implemented.

flash_write	
Outline	Data write to the serial flash memory
Declaration	int flash_write (xspi_ctrl_t * const ctrl , void const * buffer, size_t address, size_t length)
Arguments	*ctrl :Pointer to the control structure for instance * buffer :Pointer to buffer where write data is stored address:Data write destination address Specify the offset address in the serial flash memory for this argument length :Write data size
Return value	0 :Data write is sucess -1 :Data write is failed
Operation Table to use	op_page_program (Table 5.39)
Processing details	1. Copies the argument buffer to the local variable pointer tmp_buffer. 2. Copy op_page_program to local variable op. 3. Call spim_stop_xip() to exit External Address Space Read Mode. 4. Call flash_get_write_status() until the return value is something other than WRITE_STATUS_IN_PROGRESS. 5. If the return value obtained when exiting the loop in step 4 is other than WRITE_STATUS_OK, skip processing to step 12. At this time, the function ends as data write failure. 6. Pass op_write_enable to spim_exec_op() and release Write Protect of AT25QL128A. If spim_exec_op() results in an error, skip to step 12. At this time, the function ends as data write failure. 7. Set tmp_buffer to op.transfer_buffer and set the value of argument address to -op.address. 8. If the argument length is greater than 256, set op.transfer_size to 256. If length is less than or equal to 256, set the value of length to op.transfer_size. 9. Pass op to spim_exec_op() and execute to write data to AT25QL128A. 10. Add op.transfer_size to address and tmp_buffer, and subtract op.transfer_size to length. 11. Repeat steps 4 through 10 until length=0. 12. Execute spim_start_xip() to start External Address Space Read Mode. 13. Execute spim_inv_mmap() to invalidate the data cache.
Note	-

flash_erase	
Outline	Erase the serial flash memory
Declaration	int flash_erase (xspidevice_ctrl_t * ctrl, size_t address, size_t length)
Arguments	*ctrl :Pointer to the control structure for instance address:Start address for data erase Specify the offset address in the serial flash memory for this argument. If a value other than a multiple of 4Kbytes is set, the address obtained by aligning the specified address with 4Kbytes will be the start address of the erase area. length :erase size If a value other than 4Kbyte aligned size is set in this argument, it erases the data up to the 4Kbyte aligned address including the specified range.
Return value	0 :Data erase is success -1 :Data erase is failed.
Operation Table to use	op_erase_4k (Table 5.40) op_erase_32k (Table 5.41) op_erase_64k (Table 5.42)
Processing details	1. Set the local variable over to (argument address + argument size). 2. Call flash_get_write_status() until the return value is something other than WRITE_STATUS_IN_PROGRESS. 3. If the return value obtained when exiting the loop in step 2 is other than WRITE_STATUS_OK, terminate the function as data erase failure. 4. Eecute op_write_enable to spim_exec_op() to remove Write Protect of AT25QL128A. 5. If spim_exec_op() results in an error, terminate the function as data erase failure. 6. If (address & 0xFFFF) is non-zero and length is greater than or equal to 65536, pass op_erase_64k to spim_exec_op() to perform a 64Kbyte Erase. Then, add 65536 to address and minus 65536 to length. 7. If (address & 0x7FFF) is non-zero and length is greater than or equal to 32768, pass op_erase_32k to spim_exec_op() to perform a 32Kbyte Erase. Then, add 32768 to address and minus 32768 to length. 8. Pass op_erase_4k to spim_exec_op() and execute to Erase 4Kbytes. Then, add 4096 to address and minus 4096 to length. 9. Repeat steps 4 through 8 until address < over.
Note	-

flash_get_write_status	
Outline	Gets the write status of the serial flash memory
Declaration	int flash_get_write_status (xspidevice_ctrl_t * ctrl)
Arguments	*ctrl : Pointer to the control structure for instance
Return value	WRITE_STATUS_FAIL :Data write is failed WRITE_STATUS_IN_PROGRESS :Data write in progress WRITE_STATUS_OK :Data write is complete
Operation Table to use	op_read_status1 (Table 5.35)
Processing details	1. Pass op_read_status1 to spim_exec_op() and execute it to get the upper 8bit value of Status Register of AT25QL128A. 2. If the value obtained in step 1 is less than 0, exit the function with return value as WRITE_STATUS_FAIL. 3. If the 0th bit of the value obtained in step 1 is 1, exit the function with return value as WRITE_STATUS_IN_PROGRESS. 4. If the 0th bit of the value obtained in step 1 is 0, exit the function with return value as WRITE_STATUS_OK.
Note	-

9.3.2 How to add a board setting

1. Open the c:\work\RZA3UL_IPL\plat\renesas\rz\board folder, copy the “a3ul_smarc_qspi” folder and rename it to any name.
   This time, rename the folder name to “a3ul_custom_board_qspi”.

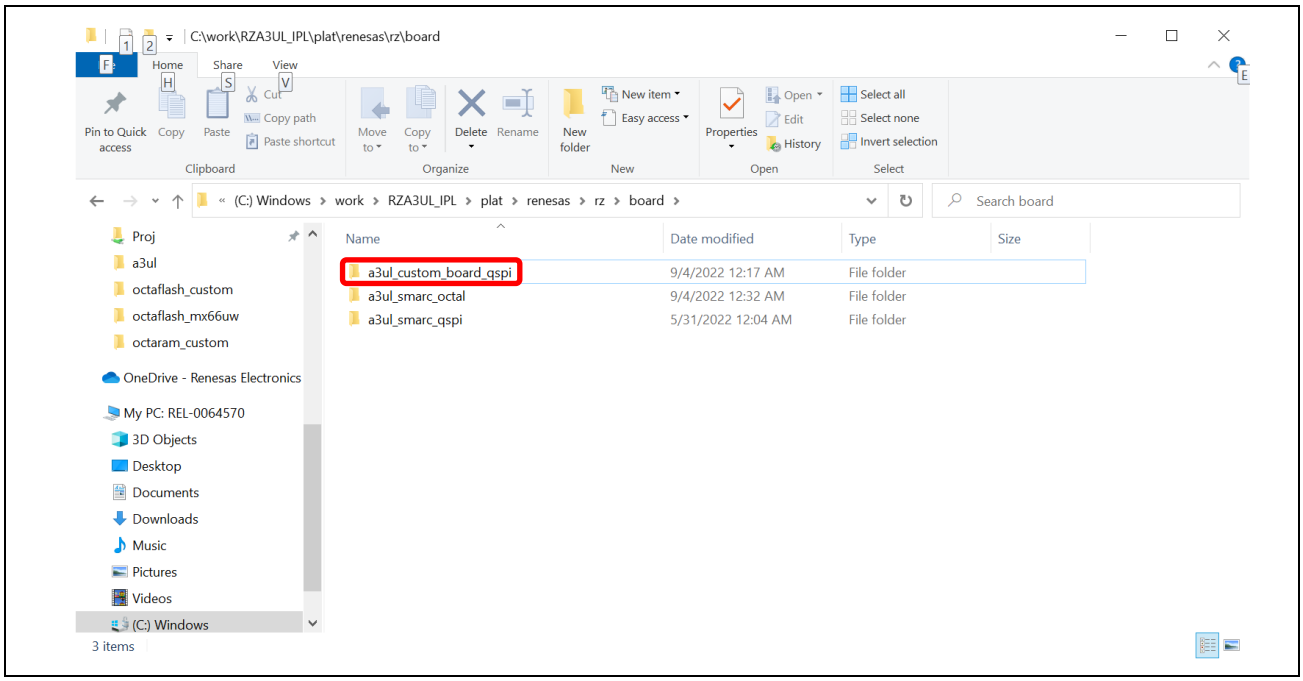


Figure 9.20 Rename board setting folder

2. Open “a3ul_custom_board_qspi” folder and open “rz_board.mk”.
   Rewrite ”_XSPI0_DEVICE:=qspiflash_at25” on line 7 to ”_XSPI0_DEVICE:=qspiflash_custom”.

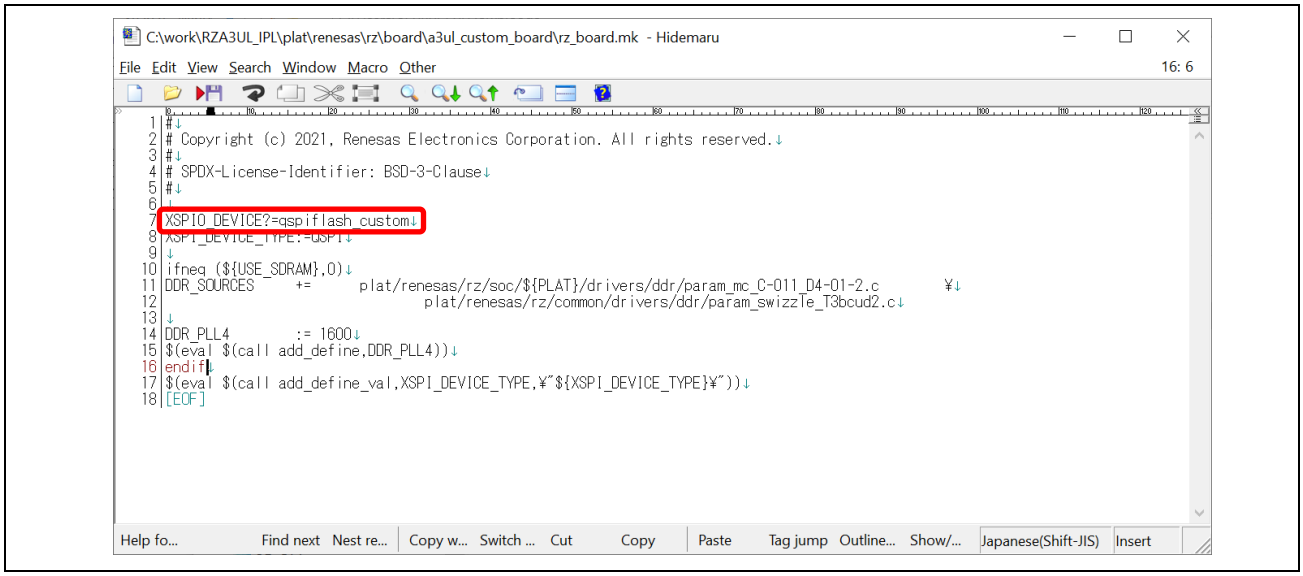


Figure 9.21 Change board setting makefile

3. Launch e² studio.
   Then refer to step 10 of chapter 7. IPL build environment construction procedure to launch Properties for RZA3UL_IPL and move to the [Behavior] tab.
   Change the BOARD value set in the “Build arguments” field to “a3ul_custom_board_qspi”.
   After this, running the build as usual will generate an IPL for your custom board.

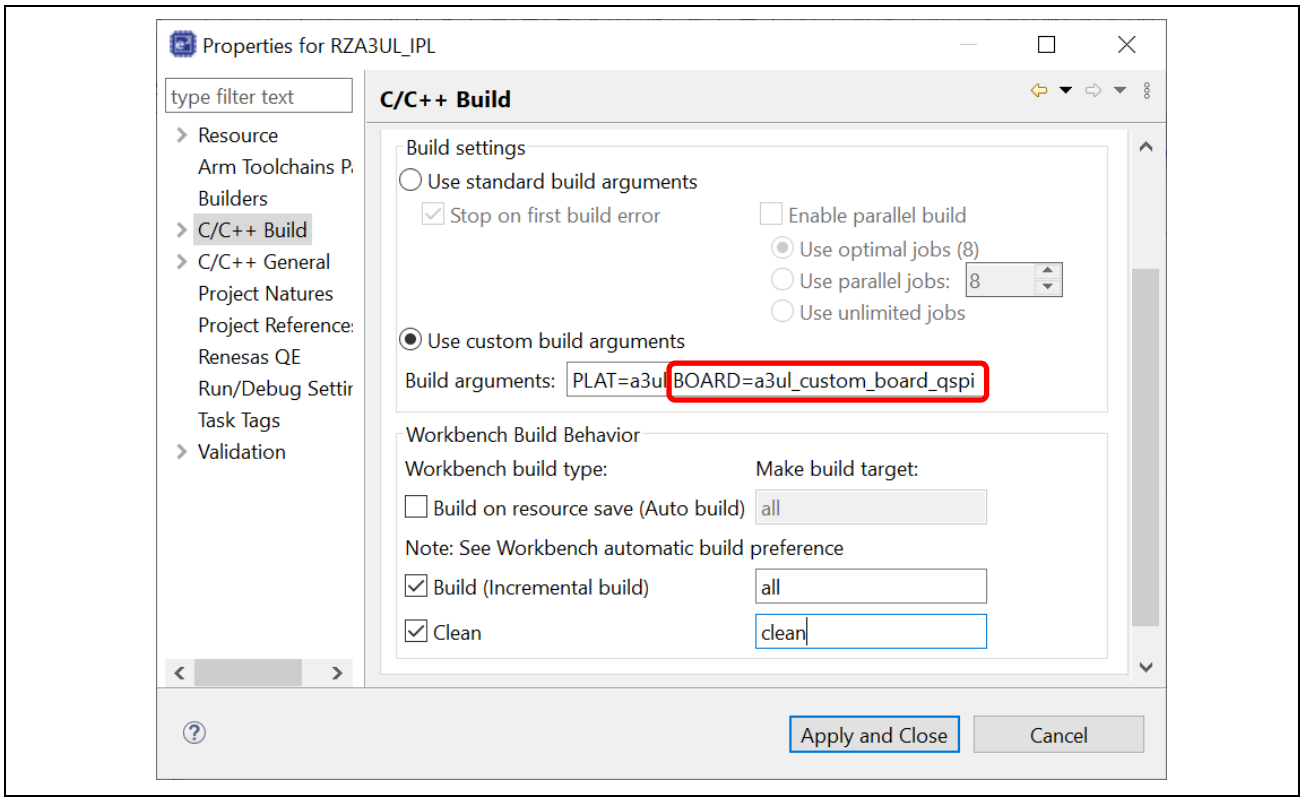


Figure 9.22 Change project setting

Note: When changing DDR SDRAM, set the parameter file corresponding to DDR SDRAM to DDR_SORCEUS in rz_board.mk, and set the operating clock frequency of DDR SDRAM to DDR_PLL4.
Please contact Renesas Electronics for the parameter file corresponding to the DDR SDRAM you use.

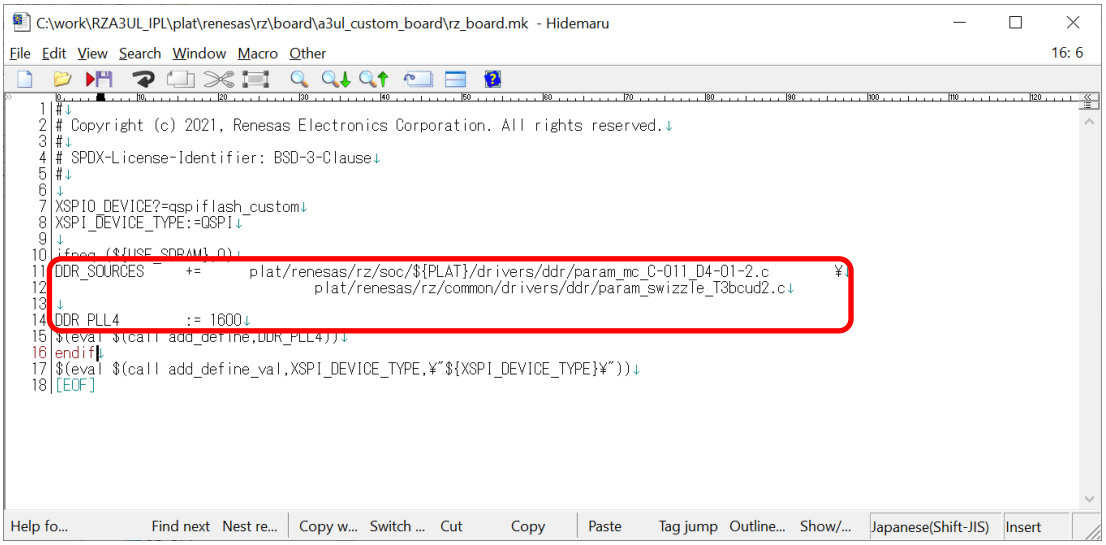


Figure 9.23 Information of DDR SDRAM setting

9.3.3 How to add a Module for Clock Supply

In IPL, clocks are supplied to the modules shown in the CPG column of Table 5.1, resets are released, and the modules are made available.

This chapter describes how to add the settings when adding a module that supplies clocks and resets.

1. Open c:\work\RZA3UL_IPL\plat\renesas\rz\common\drivers\cpg.c.
2. Add the setting table of the module to be supplied with the clock to cpg_clk_on_tbl[].

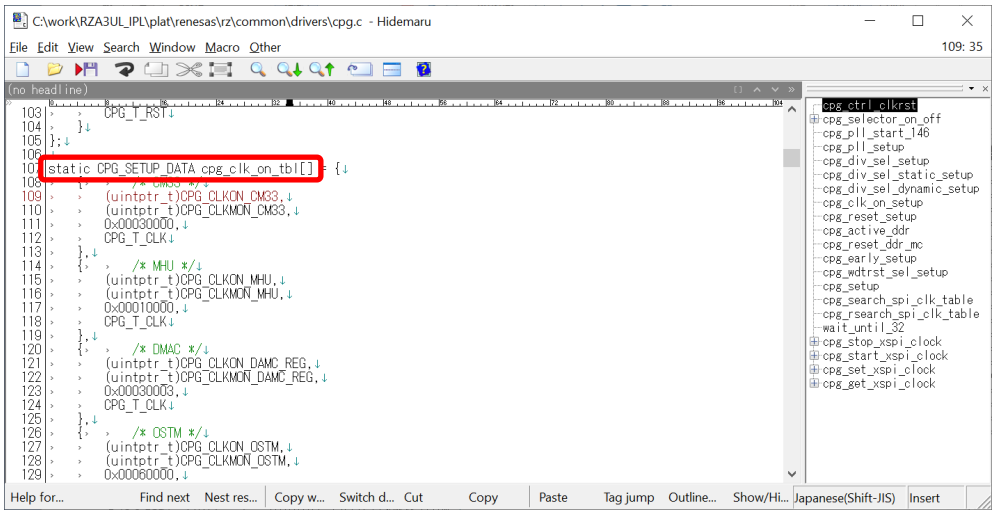


Figure 9.24 Information of cpg_clk_om_tbl[]

3. The setting table has the following format.

```
{
    reg,
    mon,
    val,
    type
}
```

reg: Sets the Clock Control Register address of the module supplying the clock.
mon: Sets the Clock Monitor Register address corresponding to the register set in reg.
val: Sets the value to write to the register set in reg.
type: Set CPG_T_CLK.
For details of Clock Control Register and Clock Monitor Register, refer to RZ/A3UL Group User's Manual: Hardware (R01UH0973EJ).

4. Add the setting table of the module to be reset to cpg_reset_tbl[]

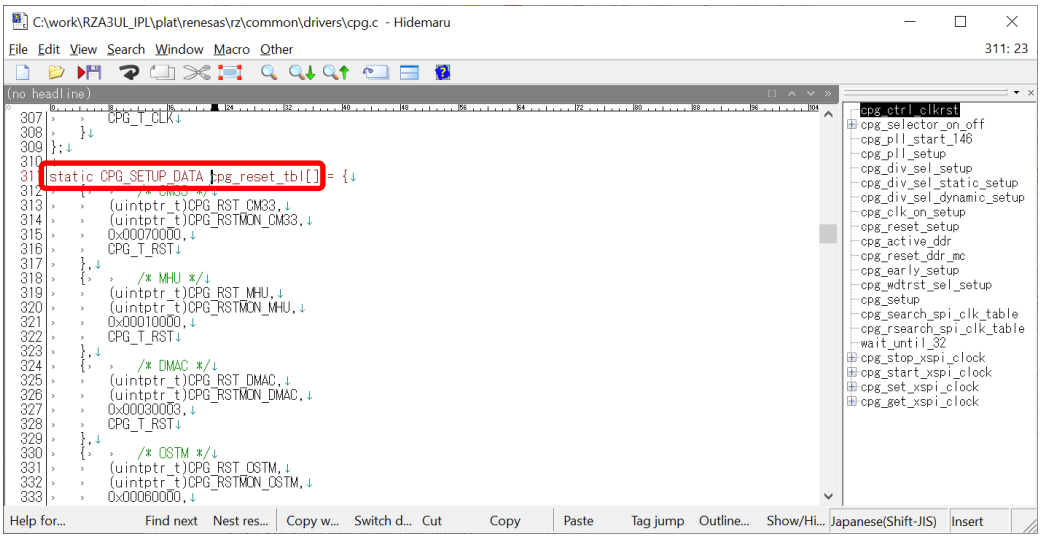


Figure 9.25 Information of cpg_reset_tbl[]

5. The format of the setting table is the same as cpg_clk_on_tbl[].
The values to be set are as follows.
reg: Sets the Reset Control Register address of the module to be reset.
mon: Sets the Reset Monitor Register address corresponding to the register set in reg.
val: Sets the value to write to the register set in reg.
type: Set CPG_T_RST.
For details of Reset Control Register and Reset Monitor Register, refer to RZ/A3UL Group User's Manual: Hardware (R01UH0973EJ).

9.3.4 How to add pin setting

In IPL, the pin setting shown in the GPIO column of Table 5.1 is performed.

This chapter shows how to add pin settings.

1. Open c:\work\RZA3UL_IPL\plat\renesas\rz\common\drivers\pfc.c.
2. Add the pin setting table to pfc_mux_reg_tbl[].

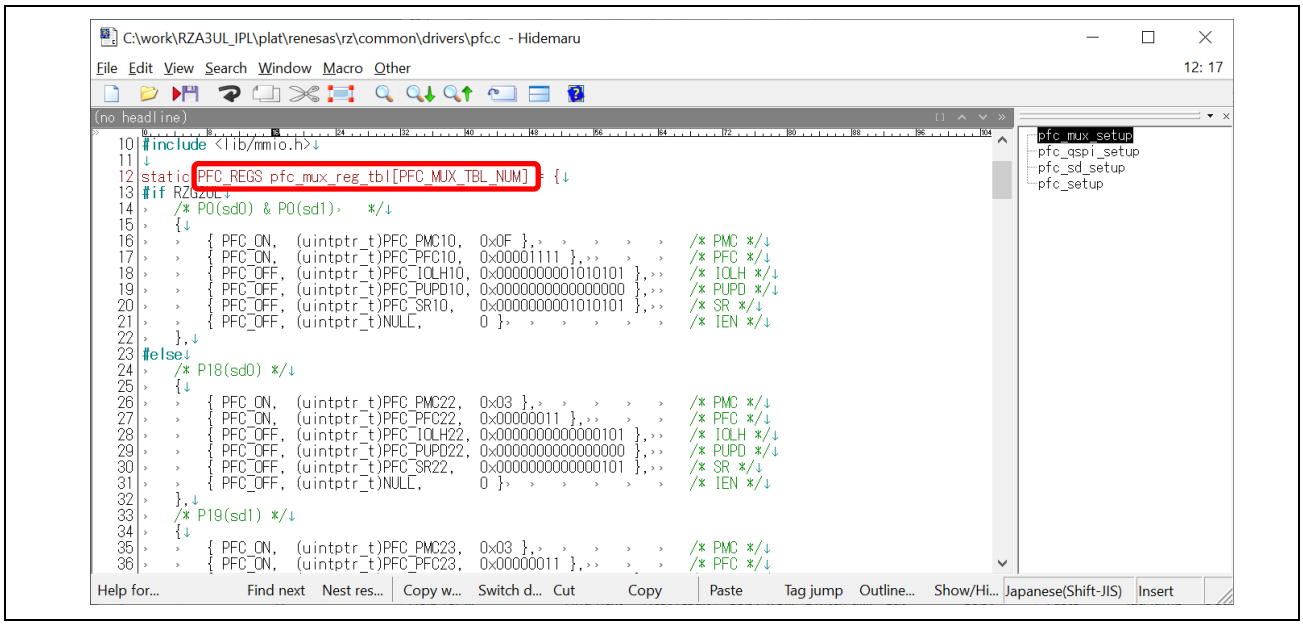


Figure 9.26 Information of pfc_mux_reg_tbl[]

3. The setting table has the following format.

```
{
    {pmc.flag,   pmc.reg,   pmc.val },
    {pfc.flag,   pfc.reg,   pfc.val },
    {iolh.flag,  iolh.reg,  iolh.val },
    {pupd.flag,  pupd.reg,  pupd.val },
    {sr.flag,    sr.reg,    sr.val },
    {ien.flag,   ien.reg,   ien.val }
}
```

   XXX.flag: Set PFC_ON to change the register value registered in the table. Set PFC_OFF if you do not want to change the register value.
   XXX.reg: Set the address of the register to which the parameter is to be set.
   XXX.val: Sets the value to write to the register set in reg.
   XXX indicates PMCn, PFCn, IOLHn, PUPDn, SRn, IENn registers.
   For details of each register, refer to RZ/A3UL Group User's Manual: Hardware (R01UH0973EJ).
4. Open pfc_regs.h and increase the value of PFC_MUX_TBL_NUM by the number of added tables.

9.3.5 How to change MMU setting

This chapter shows how to change MMU settings.

1. Open c:\work\RZA3UL_IPL\plat\renesas\rz\common\bl2_plat_setup.c.
2. Rewrtite the MMU setting table of g_mmu_pagetable_array[].

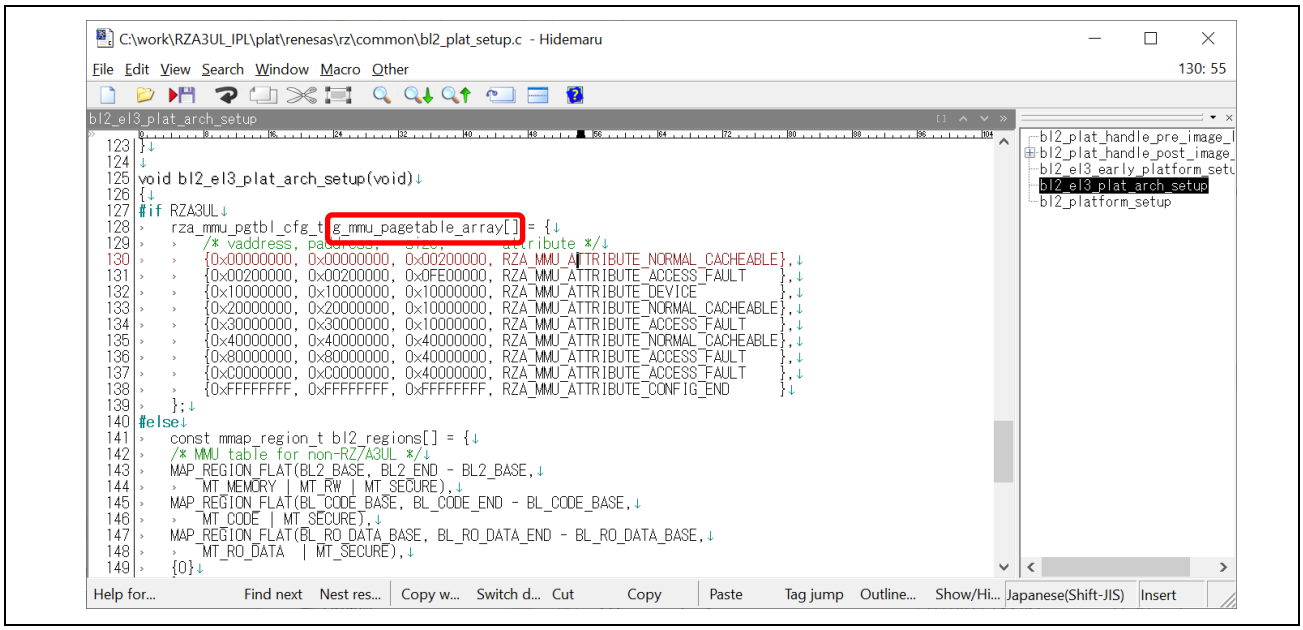


Figure 9.27 Information of g_mmu_pagetable_array[]

3. Each line in g_mmu_pagetable_array[] is the setting for each block in the virtual address space, and consists of the following format.

```
{
    {vaddress,  paddress,  size, attribute },
    ...
    {0xFFFFFFFF, 0xFFFFFFFF, 0xFFFFFFFF, RZA_MMU_ATTRIBUTE_CONFIG_END }
}
```

vaddress: Sets the starting address of the virtual address space. Sets a 2Mbyte aligned address.
paddress: Sets the starting address of the physical address space. Sets a 2Mbyte aligned address.
size: Sets the size of block. Sets a 2Mbyte aligned size.
Attribute: Memory attribute. The following parameters can be specified.

RZA_MMU_ATTRIBUTE_NORMAL_CACHEABLE: Normal Memory, Cache enable (Write-back)
RZA_MMU_ATTRIBUTE_NORMAL_UNCACHE: Normal Memory, Cache disable
RZA_MMU_ATTRIBUTE_DEVICE: Device Memory
RZA_MMU_ATTRIBUTE_ACCESS_FAULT: Areas where access is prohibited.
This attribute is set for areas that are not set in the MMU setting table.
RZA_MMU_ATTRIBUTE_CONFIG_END: Indicates the end of MMU configuration.
Set it to the last element of the MMU setting table.

10. Precautions

10.1 About downloading and executing IPL RAM to On-chip RAM

In this version, if the IPL is written to serial flash, the IPL will stop when the IPL is downloaded to the on-chip RAM and run according to the procedure in 9.1.

Erase the IPL from Serial Flash Memory with Flash Writer in advance.

Please contact Renesas Electronics for information on how to obtain Flash Writer.

10.2 About DDR SDRAM access prohibited area

Test data for DDR SDRAM initialization is stored in the DDR SDRAM area shown below.

If you overwrite the test data, you may not be able to access DDR SDRAM correctly.

Therefore, access to this area is prohibited.

Access prohibited address:

0x40000000 - 0x4000003F

11. Reference Documents

User's Manual: Hardware

RZ/A3UL Group User's Manual: Hardware (R01UH0973EJ)
(Please get the latest version from the Renesas Electronics website)

RZ/G2UL, RZ/A3UL, RZ/FIVE SMARC Module Board User's Manual: Hardware (R01UH0990EJ)
(Please get the latest version from the Renesas Electronics website)

RZ SMARC Series Carrier Board User's Manual: Hardware (R01UH0990EJ)
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Getting Started with RZ/A Flexible Software Package (R01AN6499EJ)
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Arm® Architecture Reference Manual for A-profile architecture
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Arm® Cortex®-A Series Programmer's Guide for ARMv8-A Version:1.0
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Arm® Cortex®-A55 Core Technical Reference Manual Revision; r2p0
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Technical Update/Technical News
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User's Manual: Integrated Development Environment
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Revision History

Rev.	Date	Description	
		Page	Summary
1.0.0	Jul. 28. 22	-	First edition issued
1.1.0	Sep.30.22	6	Table 2.1 Updated Debugger information
		7	Chapter 3. Add information of RZ/A3UL Initial Program Loader Application Note (Octa Flash Boot Edition)
		8	Table 4.2 Modify information of pin
		11	Chapter 5.1.2 Added a new chapter
		20	Figure 5.5 Modify figure
		22	Chapter 5.8 Added a new chapter
		23	Chapter 5.9 Added a new chapter
		26	Chapter 5.10 Added a new chapter
		34	Chapter 5.11 Added a new chapter
		58	Chapter 5.12 Added a new chapter
		90	Chapter 6.1.1.2 Delete chapter
		90	Chapter 6.1.1.3 Delete chapter
		103	Chapter 6.1.2.2 Delete chapter
		103	Chapter 6.1.2.3 Delete chapter
		104	Chapter 6.2.2 Updated driver information of J-link
		124	Figure 8.13 Added SW1 setting when J-Link is not connected
		144	Chapter 9.3 Added a new chapter
		163	Chapter 12 Added a new chapter

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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