RL78/G22, RL78/G23, RL78/G24, RL78/L23

Firmware Update Module

Introduction

This application note describes the firmware update module for the RL78/G22 and RL78/G23, RL78/G24, RL78/L23. The module is referred to below as the firmware update module.

By using the module, users can easily incorporate firmware update functionality into their applications. This application note explains the specifications of the firmware update module and how to incorporate its API functions into user applications.

The release package associated with this application note includes a demo project. You can confirm the basic operation of the firmware update functionality by following the steps described in Section 4.Demo Project, to build an environment to run the demo.

Operation Confirmation Devices

RL78/G22 (R7F102GGE)

RL78/G23 (R7F100GSN)

RL78/G24 (R7F101GLG)

RL78/L23 (R7F100LPL)

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Related Application Notes

Application notes related to this application note are listed below. Refer to them in conjunction with this application note.

- RL78 Family Board Support Package Module Using Software Integration System (R01AN5522)
- RL78 Family Renesas Flash Driver RL78 Type01 User's Manual (R20UT4830)
- RL78 Family Renesas Flash Driver RL78 Type11 User's Manual (R20UT5539)
- RL78 Smart Configurator User's Guide: e^2 studio (R20AN0579)
- Smart Configurator User's Guide: RL78 API Reference (R20UT4852)

Target Compliers

- CC-RL from Renesas Electronics
- IAR C/C++ Compiler for Renesas RL78 from IAR Systems
- IAR Assembler for Renesas RL78 from IAR Systems
- LLVM for Renesas RL78

For details of the environments on which operation has been confirmed, refer to 6.1, Confirmed Operation Environments.

Contents

1. Overview

1.1 About the Firmware Update Module

A firmware update is a process in which a device overwrites its own firmware, the software that controls the device's hardware, with a new version of the firmware (called the "update image" in this document) obtained through unspecified means. Firmware updates may be applied to fix bugs, add new functions, or improve performance.

The firmware update module is middleware that, when firmware update functionality is added to the user's system, provides the following functionality as its components:

- Functionality for importing the update image to the MCU via a communication interface
- Functionality for validating the update image (ECDSA NIST P-256 and SHA256 are used for validation.)
- Functionality for programming the update image to the on-chip flash memory (self-programming)
- Functionality for activating the update image

The firmware update module consists of the following two programs:

- Application program: User program + firmware update program
- Bootloader: A secure boot program that verifies the integrity of the application program and launches it

The bootloader functionality is essential to the proper functioning of the firmware update. It guarantees that the sequence of processing that composes the firmware update, including validation of the update image, is legitimate.

The firmware update module provides functionality for the following four firmware update methods. For details on each method, please refer to Section 1.3.

- Dual-Bank(2 bank) method
- Partial update method
- Full update method (without buffer plane)
- Full update method (with buffer plane) *

*) Use external flash memory. For details, see Section 1.3.4.

A tool (Renesas Image Generator) for creating firmware images is provided as a utility. Renesas Image Generator can generate the following types of images for use by the firmware update module.

- Initial image: An image file containing the bootloader and application program that is programmed using Flash Writer at the time of initial system configuration (extension: mot).
- Update image: An image file containing the firmware update (extension: rsu).

1.2 Configuration of Firmware Update Module

Figure 1.1 shows the configuration of the modules in the bootloader and application program incorporating the firmware update module, and Table 1.1 lists the modules used in the bootloader and application program.

The update image received by the communication interface is self-programmed to the on-chip flash memory of the target device via the firmware update module and the flash memory driver.

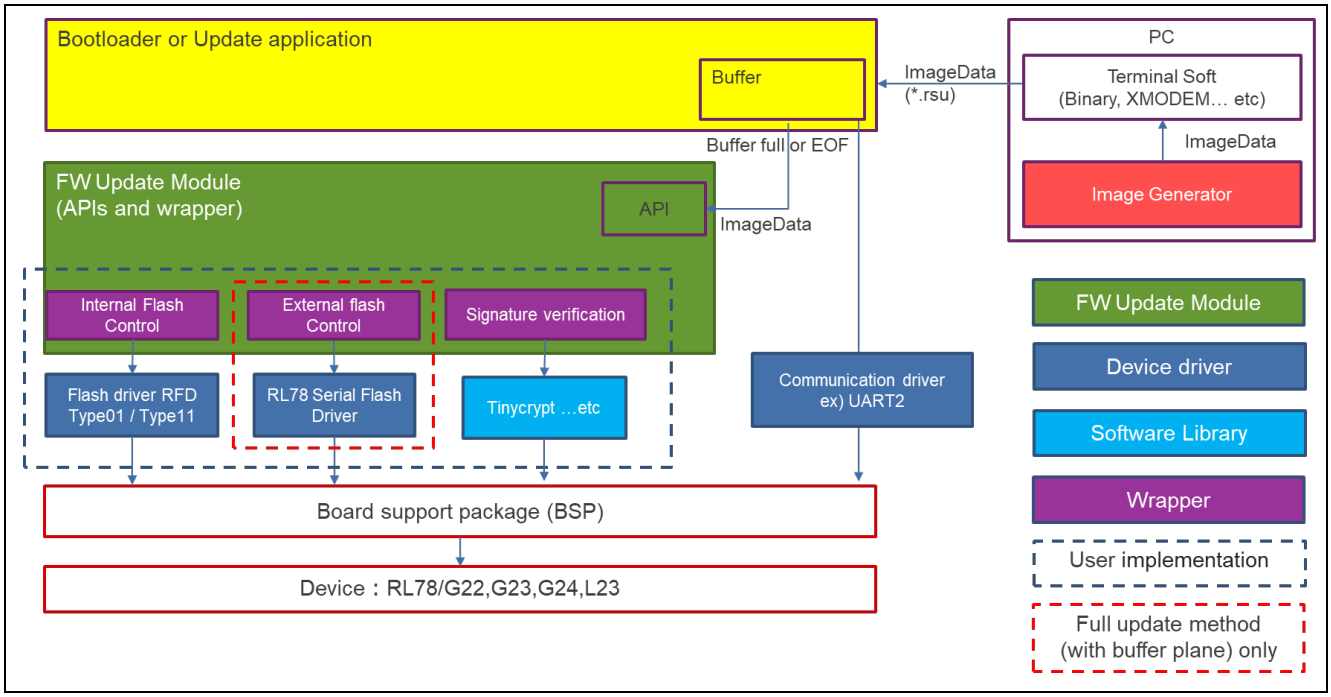


Figure 1.1 Configuration of Modules in Sample Bootloader and Application Program

Table 1.1 List of External Modules Used in Sample Bootloader and Application Program

Function	Module Name	Notes
BSP	r_bsp	Automatic generation by smart configurator
UART	r_Config_UART1 : RL78/G22, RL78/G24, RL78/L23 r_Config_UART2 : RL78/G23	Automatic generation by smart configurator
PORT	r_Config_PORT	Automatic generation by smart configurator
FLASH	RFD RL78 Type01 : RL78/G22, RL78/ G23, RL78/G24 RFD RL78 Type11 : RL78/L23	Automatic generation by smart configurator
CSI	Config_CSI20* ： RL78/G24 Config_CSI31* : RL78/G23、RL78/L23	Automatic generation by smart configurator
Serial Flash	r_nor_flash*	Automatic generation by smart configurator
Crypt Library	Tinucrypt	Implemented in wrapper

*) This module is only required for full update method (with buffer plane). It is not required for any other methods.

1.3 Firmware Update Operation

The RL78 family firmware update module provides two methods: once storing the firmware to be updated (update image) on the buffer plane and once writing it directly to the main plane. The buffer plane can be set in the internal flash memory or external flash memory.

- Main plane: Area for storing the image used for booting
- Buffer plane: Area for storing the image to be applied as an update

The method of writing the update image directly to the main plane allows all of the internal flash memory to be used as the main plane. However, since there is no buffer plane, it is not possible to restore the firmware to its pre-update state in the event of an update failure.

The update method support status varies by device and flash memory capacity, as detailed below.

Table 1.2 Supported Update Methods for Each Product

Product \ Flash	768KB	512KB	384KB	256KB	192KB	128KB	96KB	64KB
RL78/G22	—	—	—	—	—	—	—	L
RL78/G23	L	L	L	L	L	L	L	—
RL78/G24	—	—	—	—	—	L	—	L
RL78/L23	—	DB/L	—	DB/L	—	L	—	L

DB: Dual-Bank Method
L: Partial Update Method / Full Update Method
-: Not supported
red text: Demo Project

1.3.1 Dual-Bank(2-Bank) Method

The update image is stored in the buffer plane in the on-chip flash memory, and, after it is validated, the banks are swapped, exchanging the main plane and buffer plane.
his method allows the application program to contain the firmware update functionality.
This means that if the firmware update fails before bank swapping occurs, the pre-update image in the main plane can be launched to retry the firmware update.
Since the on-chip flash memory is divided into two portions by the dual-bank(2-bank) functionality, the size of the on-chip flash memory available to store the application program is equal to the size of one of the two portions into which the on-chip flash memory has been divided minus the size of the bootloader.

1.3.1.1 Operation of Dual-Bank(2-Bank) Method

The update image is stored in the buffer plane using the dual-bank(2-bank) functionality of the on-chip flash memory, and the firmware update is accomplished by using the bank-swapping functionality to exchange the banks.

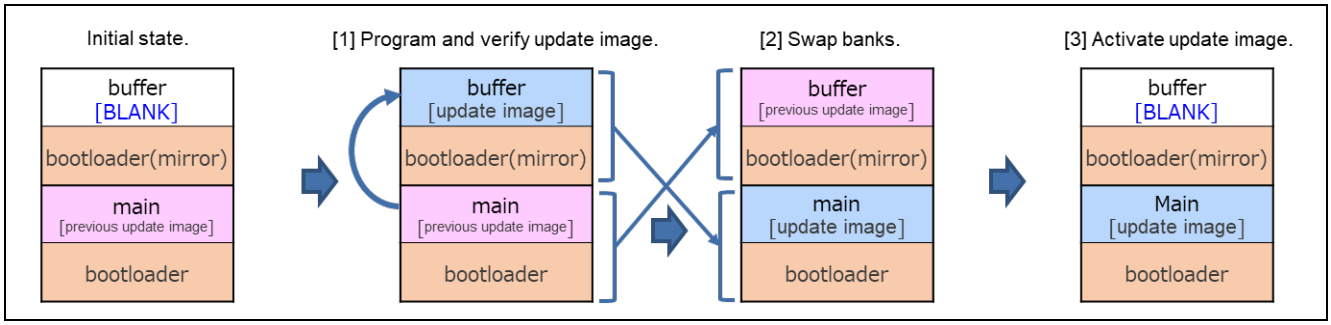


Figure 1.2 Operation of Dual-Bank(2-Bank) Method

[1] Program and verify update image.
The previous update image (application program) stored in the main plane is used to program the update image to the buffer plane and verify it.

[2] Swap banks.
If verification is successful, the banks are swapped.

[3] Activate update image.
The buffer plane is erased by the bootloader.
(The demo program does not erase the buffer plane. If you need to erase the image before updating for rollback measures, please add a process to erase the buffer plane image.)

1.3.2 Partial Update Method

The update image is stored temporarily in the buffer plane in the on-chip flash memory, and, after it is validated, it is self-programmed to the main plane.
This method allows the application program to contain the firmware update functionality.
This means that if the firmware update fails before self-programming to the main plane occurs, the pre-update image in the main plane can be launched to retry the firmware update.
The size that can store the application program is half the size of the remaining internal flash memory minus the bootloader.

1.3.2.1 Operation of Partial Update Method

This method divides the on-chip flash memory into a main plane and a buffer plane and then temporarily stores the update image in the buffer plane. Firmware is updated by storing the update image on the buffer plane and copying it from the buffer plane to the main plane.

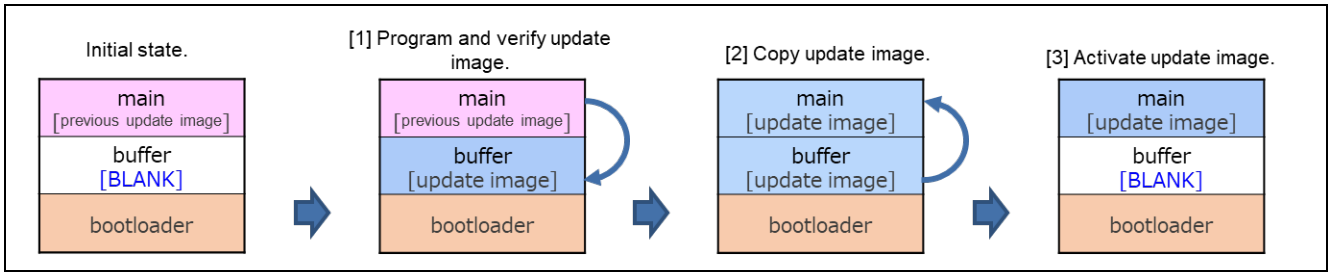


Figure 1.3 Operation of Partial Update Method

[1] Program and verify update image.
The previous update image (application program) stored in the main plane is used to program the update image to the buffer plane and verify it.

[2] Copy update image.
If verification is successful, the system is reset, the main plane is erased by the bootloader, and the updated image is copied from the buffer plane to the main plane.

[3] Activate update image.
The buffer plane is erased by the bootloader.

1.3.3 Full Update Method (without buffer plane)

The update image is self-programmed to the main plane, after which it is validated.
This method requires the bootloader to contain the firmware update functionality. This means that if the firmware update fails, the bootloader functionality can be used to retry the firmware update. The functionality of the application program cannot be used until the firmware update succeeds.
The size that can store the application program is the remaining size of the internal flash memory minus the bootloader.

1.3.3.1 Operation of Full Update Method (without buffer plane)

This method of writing the update image directly to the main plane allows all of the internal flash memory to be used as the main plane, but since there is no buffer plane, it is not possible to restore the firmware to its pre-update state in the event of an update failure.

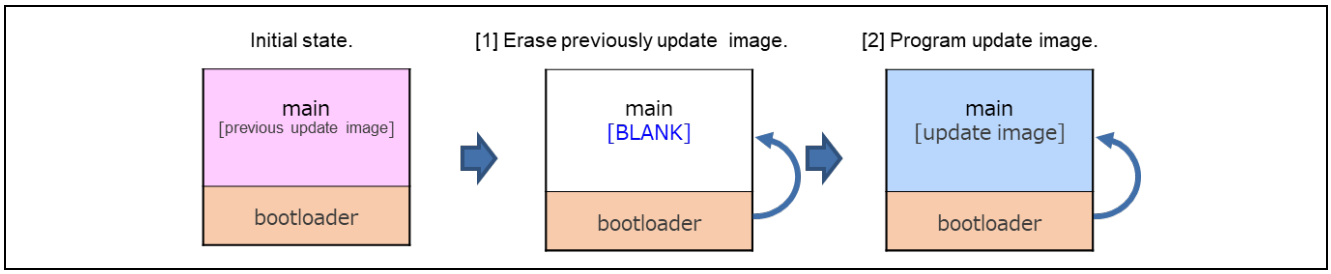


Figure 1.4 Operation of Full Update Method (without buffer plane)

[1] Erase previously update image.
The previous update image (application program) stored in the main plane configures the data indicating updates to the main plane and then applies a reset. After this, the bootloader runs and erases the initial image from the main plane.

[2] Program update image.
The bootloader downloads the update image from an external source and programs it to the main plane. The programmed update image is verified, and if verification is successful, the update image is activated.

1.3.4 Full Update Method (with buffer plane)

The update image is stored temporarily in the buffer plane in the on-chip flash memory, and, after it is validated, it is self-programmed to the main plane.
This method allows the application program to contain the firmware update functionality. This means that if the firmware update fails before self-programming to the main plane occurs, the pre-update image in the main plane can be launched to retry the firmware update.
The size that can store the application program is the size remaining after subtracting the bootloader from the internal flash memory, since only the main plane is provided in the internal flash memory.

1.3.4.1 Operation of Full Update Method (with buffer plane)

The update image is stored once in the buffer plane, with the main plane set in the internal flash and the buffer plane set in the external flash.

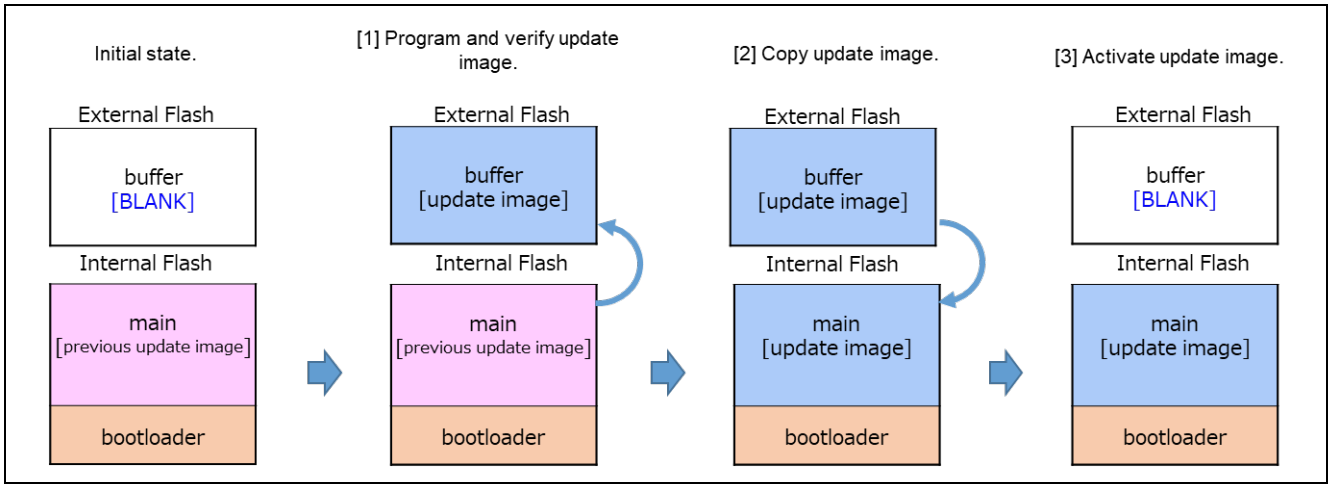


Figure 1.5 Operation of Full Update Method (with buffer plane)

[1] Program and verify update image.
The previous update image (application program) stored in the main plane is used to program the update image to the buffer plane and verify it.

[2] Copy update image.
If verification is successful, the system is reset, the main plane is erased by the bootloader, and the updated image is copied from the buffer plane to the main plane.

[3] Activate update image.
The buffer plane is erased by the bootloader.

1.4 Initial State of Firmware Update

To set the firmware update module using the firmware update module to the initial state, build the system by writing the initial image generated by the Renesas Image Generator to the built-in flash memory with a flash writer or similar device.

As an alternative method, it is also possible to build the system by first writing only the bootloader with a flash writer, etc., and then writing the updated image of the application program with the bootloader function.

1.4.1 Initial State of Dual-Bank(2-Bank) Method Settings Utilizing Renesas Image Generator

The following figure shows the construction of the initial state of the dual-bank(2-bank) method using the Renesas Image Generator.

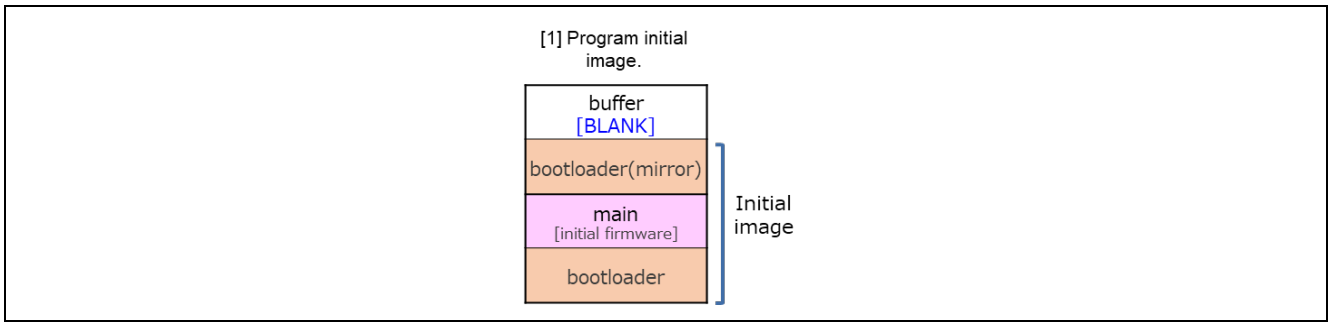


Figure 1.6 Initial Firmware Update Settings Utilizing Renesas Image Generator (Example of Dual-Bank(2-Bank) Method)

[1] Program initial image
The initial image is programmed to the on-chip flash memory using a tool such as Flash Writer.

1.4.2 Initial State of Partial Update Method Settings Utilizing Renesas Image Generator

The following figure shows the construction of the initial state of the partial update method using the Renesas Image Generator.

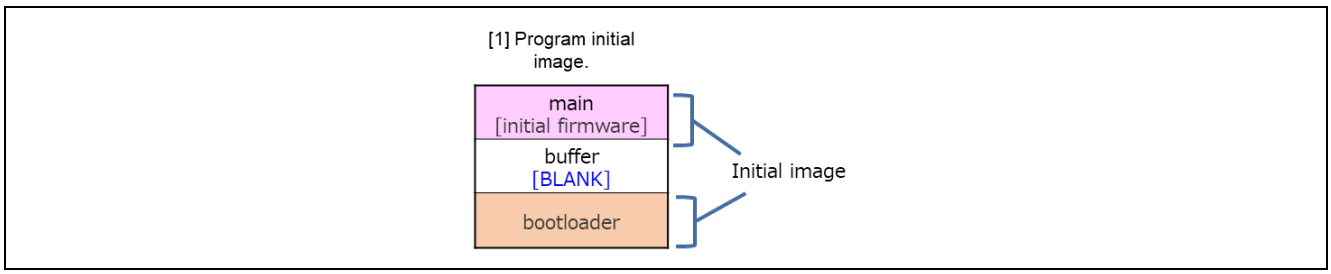


Figure 1.7 Initial Firmware Update Settings Utilizing Renesas Image Generator (Example of Partial Update Method)

[1] Program initial image
The initial image is programmed to the on-chip flash memory using a tool such as Flash Writer.

1.4.3 Initial State of Full Update Method Settings Utilizing Renesas Image Generator

The following figure shows the construction of the initial state of the full update method using the Renesas Image Generator.

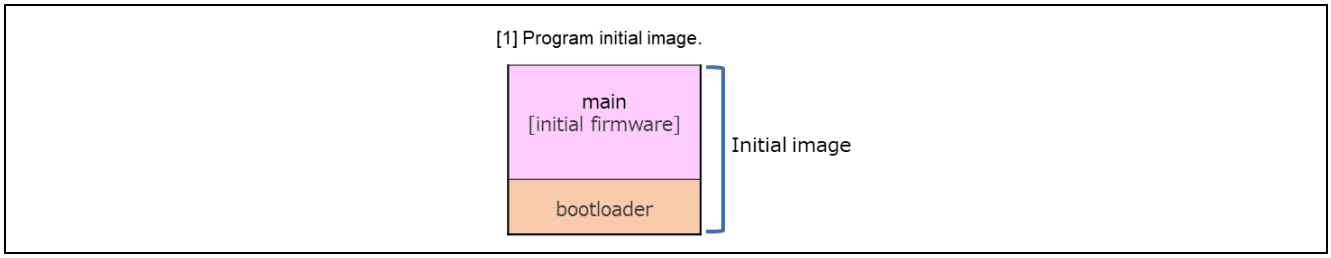


Figure 1.8 Initial Firmware Update Settings Utilizing Renesas Image Generator (Example of Full Update Method)

[1] Program initial image
The initial image is programmed to the on-chip flash memory using a tool such as Flash Writer.

1.4.4 Initial State of Dual-Bank(2-Bank) Method Settings Utilizing Bootloader

The following figure shows the construction of the initial state of the dual-bank(2-bank) method using the bootloader.

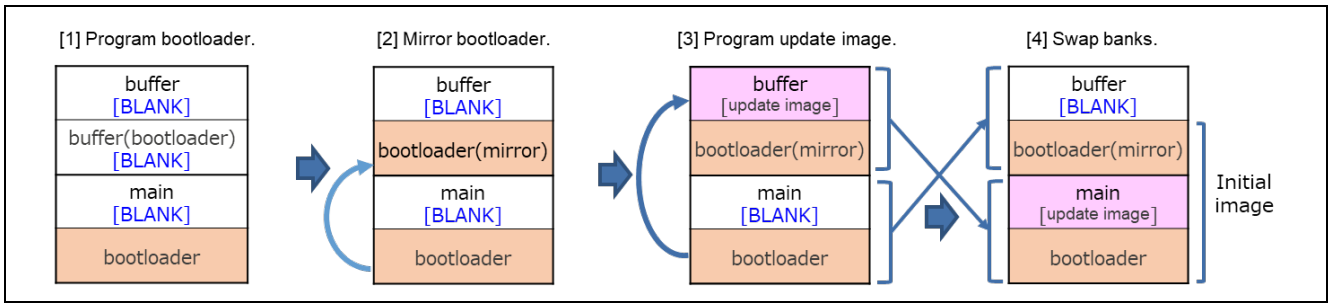


Figure 1.9 Initial Firmware Update Settings Utilizing Bootloader (Example of Dual-Bank(2-Bank) Method)

[1] Program bootloader.
The bootloader is programmed to the on-chip flash memory using a tool such as Flash Writer.

[2] Mirror bootloader.
The bootloader is mirrored to bank 1 by the bootloader.

[3] Program update image.
The initial image is downloaded from an external source and programmed to the buffer plane using the functionality of the bootloader. The programmed firmware is verified.

[4] Swap banks.
If verification is successful, the banks are swapped and processing ends.

1.4.5 Initial State of Partial Update Method Settings Utilizing Bootloader

The following figure shows the construction of the initial state of the dual-bank(2-bank) method using the bootloader.

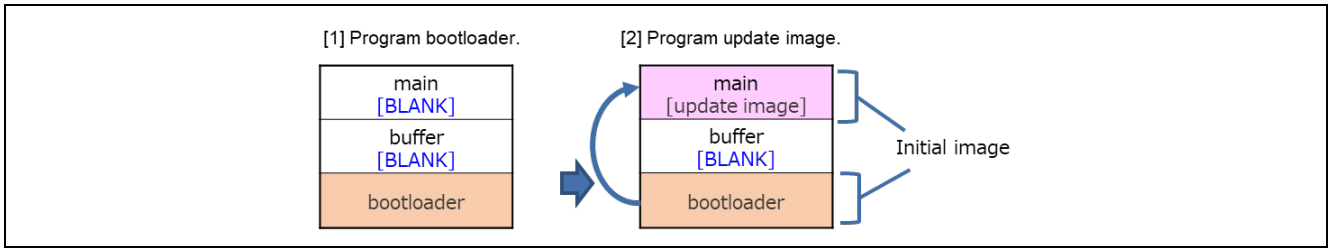


Figure 1.10 Initial Firmware Update Settings Utilizing Bootloader (Example of Partial Update Method)

[1] Program bootloader.
The bootloader is programmed to the on-chip flash memory using a tool such as Flash Writer.

[2] Program update image.
The initial image is downloaded from an external source and programmed to the main plane using the functionality of the bootloader. The programmed firmware is verified, and if verification is successful, processing ends.

1.4.6 Initial State of Full Update Method Settings Utilizing Bootloader

The following figure shows the construction of the initial state of the full update method using the bootloader.

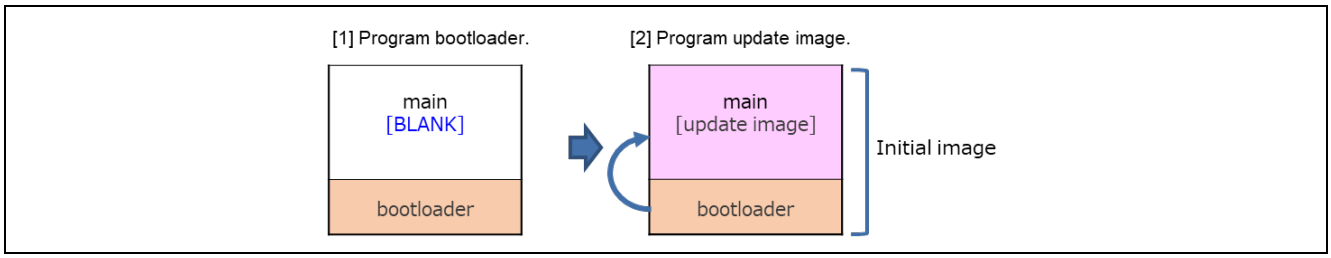


Figure 1.11 Initial Firmware Update Settings Utilizing Bootloader (Example of Full Update Method)

[1] Program bootloader.
The bootloader is programmed to the on-chip flash memory using a tool such as Flash Writer.

[2] Program update image.
The initial image is downloaded from an external source and programmed to the main plane using the functionality of the bootloader. The programmed firmware is verified, and if verification is successful, processing ends.

1.5 Package Contents

The firmware update module package contains several files, including software and tools. These are listed in the table below.

Table 1.3 Folder Structure of Firmware Update Module Package

Folder Name	Description
r01an6374xx0203-rl78g23-fwupdate.zip\	
├demos	Demo projects
│ ├──r_fwup	Firmware update module
│ └──rl	
│ ├──modules	Drivers, libraries, and wrappers
│ │ ├──3rd_party	
│ │ │ └──tinycrypt	Crypto library
│ │ ├──etc	
│ │ │ └──base64	Base64 decode
│ │ └──flash	Flash wrapper
│ ├──rl78g22-fpb	FPB-RL78G22
│ │ └──linear	
│ │ ├──e2_ccrl	CCRL
│ │ │ ├──boot_loader	Bootloader
│ │ │ └──fwup_leddemo	LED illumination application
│ │ ├──iar	IAR
│ │ └──llvm	LLVM
│ ├──rl78g23-fpb	FPB-RL78G23-128p
│ │ └──linear	
│ │ ├──e2_ccrl	CCRL
│ │ │ ├──boot_loader	Bootloader
│ │ │ ├──fwup_leddemo	LED illumination application
│ │ │ └──fwup_main	User applications including firmware update
│ │ ├──iar	IAR
│ │ └──llvm	LLVM
│ ├──rl78g24-fpb	FPB-RL78G24
│ │ └──linear	
│ │ ├──e2_ccrl	CCRL
│ │ │ ├──boot_loader	Bootloader
│ │ │ ├──fwup_leddemo	LED illumination application
│ │ │ └──fwup_main	User applications including firmware update
│ │ ├──iar	IAR
│ │ └──llvm	LLVM
│ └──rl78l23-fpb	FPB-RL78G23-128p
│ ├──dualbank(2bank)	Dual-Bank(2 Bank) method
│ │ ├──e2_ccrl	CCRL
│ │ │ ├──boot_loader	Bootloader
│ │ │ ├──fwup_leddemo	LED illumination application
│ │ │ └──fwup_main	User applications including firmware update
│ │ ├──iar	IAR
│ │ └──llvm	LLVM
│ └──linear	Other than the Dual-Bank method

Folder Name	Description
│ ├──e2_ccrl	CCRL
│ │ ├──boot_loader	Bootloader
│ │ ├──fwup_leddemo	LED illumination application
│ │ └──fwup_main	User applications including firmware update
│ ├──iar	IAR
│ └──llvm	LLVM
└RenesasImageGenerator	Renesas Image Generator
├──image-gen.py	Python program for Renesas Image Generator
├──RL*78_xxxx*_ImageGenerator_PRM.csv	Parameter file for demo project (for CC-RL, IAR)
└──RL*78_xxxx*_ImageGenerator_PRM_llvm.csv	Parameter file for demo project (for LLVM)

1.6 API Overview

Table 1.4 lists the API functions included in the firmware update module.

Table 1.4 API Functions

Function	Function Description
R_FWUP_Open	Opens the module.
R_FWUP_Close	Performs processing to close the module.
R_FWUP_IsExistImage	Confirms the existence of an image in the specified area.
R_FWUP_EraseArea	Erases the specified area.
R_FWUP_GetImageSize	Obtains the size of the image.
R_FWUP_WriteImage	Writes the image (header portion + program portion).
R_FWUP_VerifyImage	Validates the image.
R_FWUP_ActivateImage	Activates a new image.
R_FWUP_ExecImage	Launches an image.
R_FWUP_SoftwareReset	Applies a software reset.
R_FWUP_SoftwareDelay	Applies a software delay.
R_FWUP_GetVersion	Returns the version number of the module.
R_FWUP_WriteImageHeader	Writes the header portion of the image. (For special purpose.)
R_FWUP_WriteImageProgram	Writes the program portion of the image. (For special purpose.)

Note: Special purpose refers to the use of AWS S3(OTA). If you are considering to use Rev2.0x firmware update module on bare metal without AWS S3(OTA), please skip this section.

2. API Information

2.1 Hardware Requirements

The MCU used must support the following functions:

- Flash memory

2.2 Software Requirements

The module is dependent upon the following drivers:

- Board support package (r_bsp)
- UART Driver (r_Config_UART1)
- PORT Driver (r_Config_PORT)
- Renesas Flash Driver RL78 Type01 (RFD)
- Renesas Flash Driver RL78 Type11 (RFD)
- Serial NOR Flash Memory Control Module Software Integration System (r_nor_flash)

2.3 Supported Toolchains

The module has been confirmed to work with the toolchains listed in 6.1, Confirmed Operation Environments.

2.4 Header Files

All API calls and their supporting interface definitions are located in r_fwup_if.h.

2.5 Integer Types

The driver uses ANSI C99. These types are defined in stdint.h.

2.6 Compile Settings

The configuration option settings of the module are contained in r_fwup_config.h.

The names of the options and descriptions of their setting values are listed in Table 2.1.

Table 2.1 Configuration Settings

Configuration options in r_fwup _config.h	
FWUP_CFG_UPDATE_MODE	Update method 0: Dual-Bank(2-Bank) Method (RL78/L23 only) 1: Partial Update Method Method 2: Full Update Method (without buffer plane) 3: Full Update Method (with buffer plane)
FWUP_CFG_FUNCTION_MODE	Specifies how the module is used. 0: Bootloader 1: Application program
FWUP_CFG_MAIN_AREA_ADDR_L	Specifies the start address of the main plane.
FWUP_CFG_BUF_AREA_ADDR_L	Specifies the start address of the buffer plane (in on-chip flash memory).
FWUP_CFG_AREA_SIZE	Specifies the size of the main plane and buffer plane.
FWUP_CFG_CF_BLK_SIZE	Specifies the block size of the on-chip code flash.
FWUP_CFG_CF_W_UNIT_SIZE	Specifies the writing unit for the on-chip code flash.
FWUP_CFG_EXT_BUF_AREA_ADDR_L	Specifies the start address of the buffer plane in external flash memory.
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	Specifies the block size or sector size of the external flash memory.
FWUP_CFG_DF_ADDR_L	Start address of data flash.
FWUP_CFG_DF_BLK_SIZE	Block size of data flash.
FWUP_CFG_DF_NUM_BLKS	Block count of data flash. Specify 0 if there is no data flash.
FWUP_CFG_FWUPV1_COMPATIBLE	FWUP V1 Compatibility Setting (For Special Purpose) 0: Disable (default) 1: Enable (For Special Purpose)
FWUP_CFG_SIGNATURE_VERIFICATION	Verification method 0: ECDSA + SHA256 (default) 1: SHA256
FWUP_CFG_PRINTF_DISABLE	Log display setting 0: Enable 1: Disable (default)

2.7 Demo Project Code Sizes

The table below shows the ROM size, RAM size, and maximum stack size of this module.

The values in the table below are confirmed under the following conditions.

Module revision: Firmware update module for RL78 v2.0.5

Compiler version: Renesas Electronics C Compiler Package for RL78 Family V1.16.0
IAR C/C++ Compiler for Renesas RL78 version 5.20.2
LLVM for Renesas RL78 17.0.1.202512

Configuration options: Configuration option settings are listed in each FPB

CC-RL

Optimization level: size & execution speed (-Odefault)

Delete variables/functions that have never been referenced (-optimize=symbol_delete)

IAR

Optimization level: High (balanced)

LLVM
Optimization level:-Os

Garbage collection(--gc-sections)

2.7.1 Demo Project for FPB−RL78G23-128p

Partial update method configuration settings and memory size.

FWUP_CFG_UPDATE_MODE 1 : Single bank with buffer.

FWUP_CFG_SIGNATURE_VERIFICATION 0 : ECDSA+SHA256. (default)

FWUP_CFG_PRINTF_DISABLE 1 : Disable. (default)

Table 2.2 ROM, RAM, and Stack Code Size for boot_loader

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
boot_loader	ROM	20674	26399	23664
	RAM	865	3192	1088
	Stack	522	1504	508

Table 2.3 ROM, RAM, and Stack Code Size for fwup_main

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
fwup_main	ROM	16790	24449	21079
	RAM	871	3701	958
	Stack	514	1510	508

2.7.2 Demo Project for FPB-RL78G24

Partial update method configuration settings and memory size.

FWUP_CFG_UPDATE_MODE 1 : Single bank with buffer.

FWUP_CFG_SIGNATURE_VERIFICATION 0 : ECDSA+SHA256. (default)

FWUP_CFG_PRINTF_DISABLE 1 : Disable. (default)

Table 2.4 ROM, RAM, and Stack Code Size for boot_loader

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
boot_loader	ROM	20503	26941	23989
	RAM	879	3224	1074
	Stack	558	1504	508

Table 2.5 ROM, RAM, and Stack Code Size for fwup_main

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
fwup_main	ROM	17106	25737	21385
	RAM	877	3734	944
	Stack	514	1510	508

2.7.3 Demo project for FPB-RL78G22

Full update method (without buffer plane) configuration settings and memory size.

FWUP_CFG_UPDATE_MODE 2 : Single bank without buffer.

FWUP_CFG_SIGNATURE_VERIFICATION 1 : SHA256

FWUP_CFG_PRINTF_DISABLE 1 : Disable. (default)

Table 2.6 ROM, RAM, and Stack Code Size for boot_loader

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
boot_loader	ROM	10318	11406	11197
	RAM	789	2057	960
	Stack	398	824	284

2.7.4 Demo Project for FPB−RL78L23

Partial update method configuration settings and memory size.

FWUP_CFG_UPDATE_MODE 1 : Single bank with buffer.

FWUP_CFG_SIGNATURE_VERIFICATION 0 : ECDSA+SHA256. (default)

FWUP_CFG_PRINTF_DISABLE 1 : Disable. (default)

Table 2.7 ROM, RAM, and Stack Code Size for boot_loader

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
boot_loader	ROM	21045	26817	24060
	RAM	861	3204	1030
	Stack	522	1504	508

Table 2.8 ROM, RAM, and Stack Code Size for fwup_main

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
fwup_main	ROM	17123	24683	21448
	RAM	859	3201	900
	Stack	514	1508	508

Dual-bank(2-bank) method configuration settings and memory size.

FWUP_CFG_UPDATE_MODE 0 : Dual-bank(2-bank).

FWUP_CFG_SIGNATURE_VERIFICATION 0 : ECDSA+SHA256. (default)

FWUP_CFG_PRINTF_DISABLE 1 : Disable. (default)

Table 2.9 ROM, RAM, and Stack Code Size for boot_loader

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
boot_loader	ROM	20803	26938	24175
	RAM	725	3622	1028
	Stack	522	1512	508

Table 2.10 ROM, RAM, and Stack Code Size for fwup_main

Items	Category	Memory Used (byte)		
		CC-RL	IAR	LLVM
fwup_main	ROM	17257	24723	21717
	RAM	730	4290	898
	Stack	514	1508	508

2.8 Arguments

The return values of the API functions are shown below. This enumeration is located in r_fwup_if.h, as are the prototype declarations of the API functions.

```
typedef enum fwup_area
{
    FWUP_AREA_MAIN = 0,
    FWUP_AREA_BUFFER,
    FWUP_AREA_DATA_FLASH
} e_fwup_area_t;

typedef enum e_fwup_delay_units
{
    FWUP_DELAY_MICROSECS = 0,
    FWUP_DELAY_MILLISECS,
    FWUP_DELAY_SECS
} e_fwup_delay_units_t;
```

2.9 Return Values

The return values of the API functions are shown below. This enumeration is located in r_fwup_if.h, as are the prototype declarations of the API functions.

```
typedef enum fwup_err
{
    FWUP_SUCCESS = 0,               // Normally terminated.
    FWUP_PROGRESS,                  // Firmware update is in progress.
    FWUP_ERR_FLASH,                 // Detect error of flash module.
    FWUP_ERR_VERIFY,                // Verify error.
    FWUP_ERR_FAILURE,               // General error.
} e_fwup_err_t;
```

2.10 Implementation Examples of APIs

The following is an example implementation of a bootloader and application program for each firmware update method.
For details, please refer to the source code of the demo project included in this application note package.

2.10.1 Implementation Example of Dual-Bank(2-Bank) Method

The following flowchart is an example of implementation of a bootloader in dual-bank(2-bank) method.

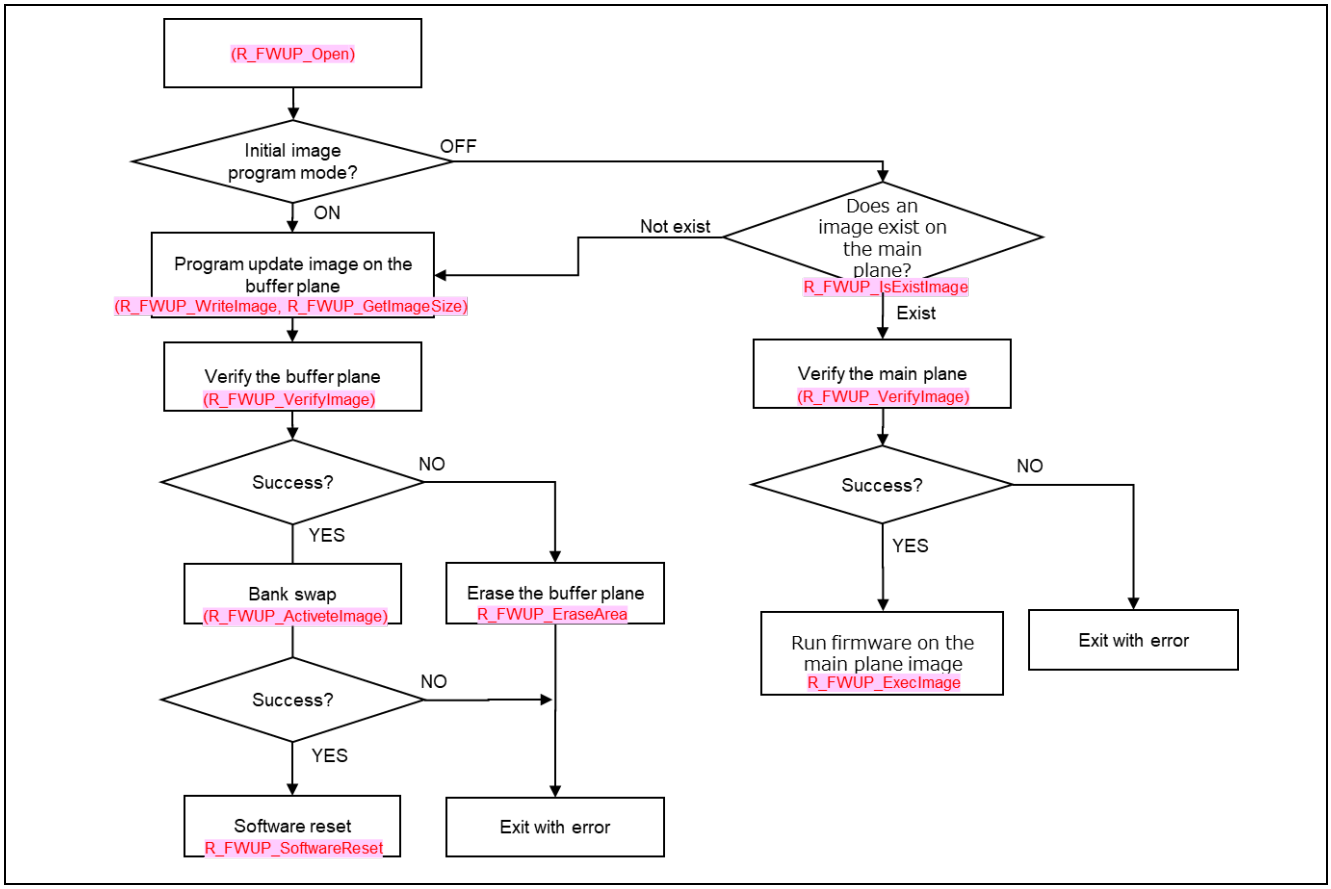


Figure 2.1 Bootloader Implementation Example of Dual-Bank(2-Bank) Method

The following flowchart is an example of implementation of an application program in dual-bank(2-bank) method.

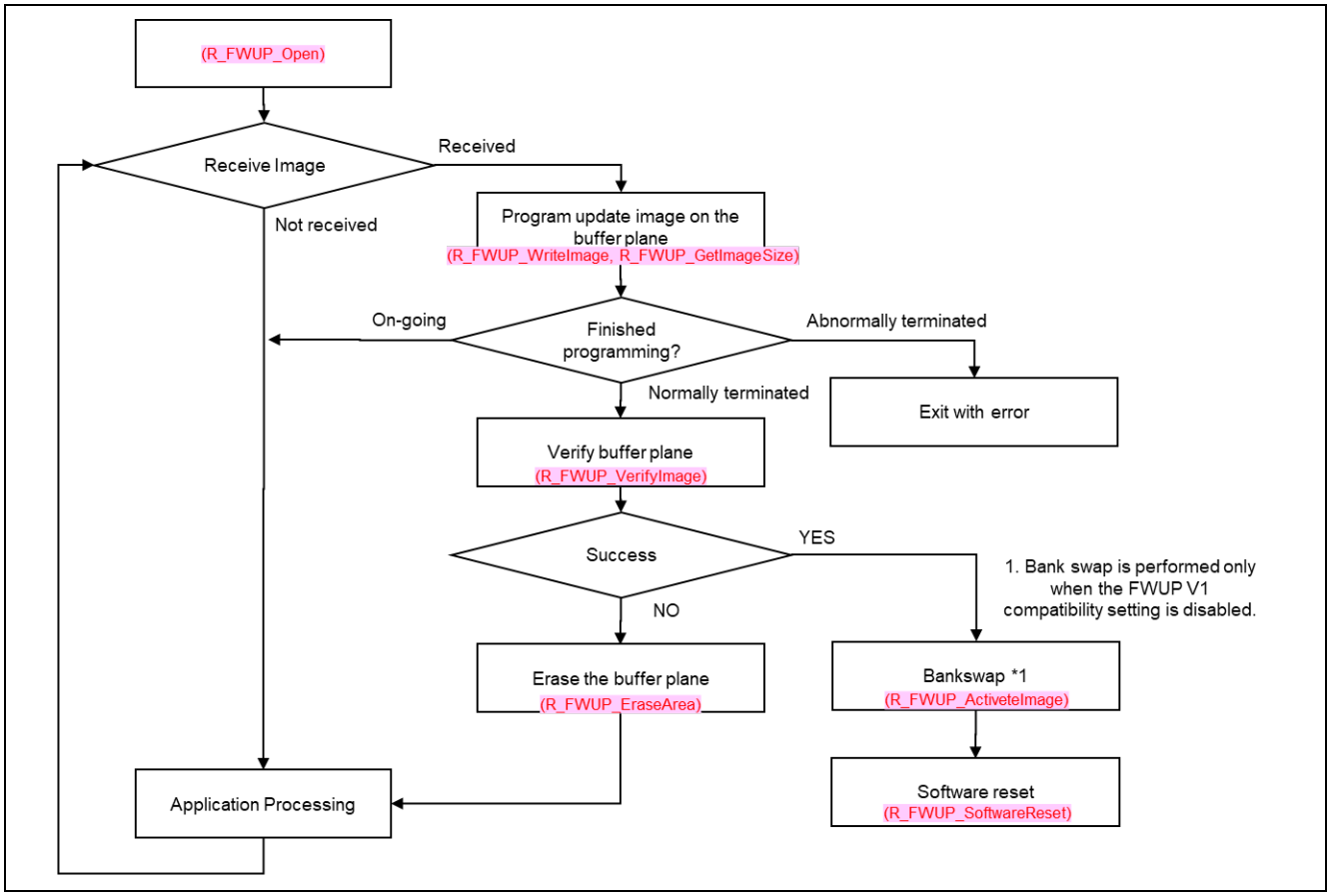


Figure 2.2 Application Program Implementation Example of Dual-Bank(2-Bank) Method

2.10.2 Implementation Example of Partial Update Method and Full Update Method (with buffer plane)

The following flowchart is an example of implementation of a bootloader in partial update method and full update method (with buffer plane).

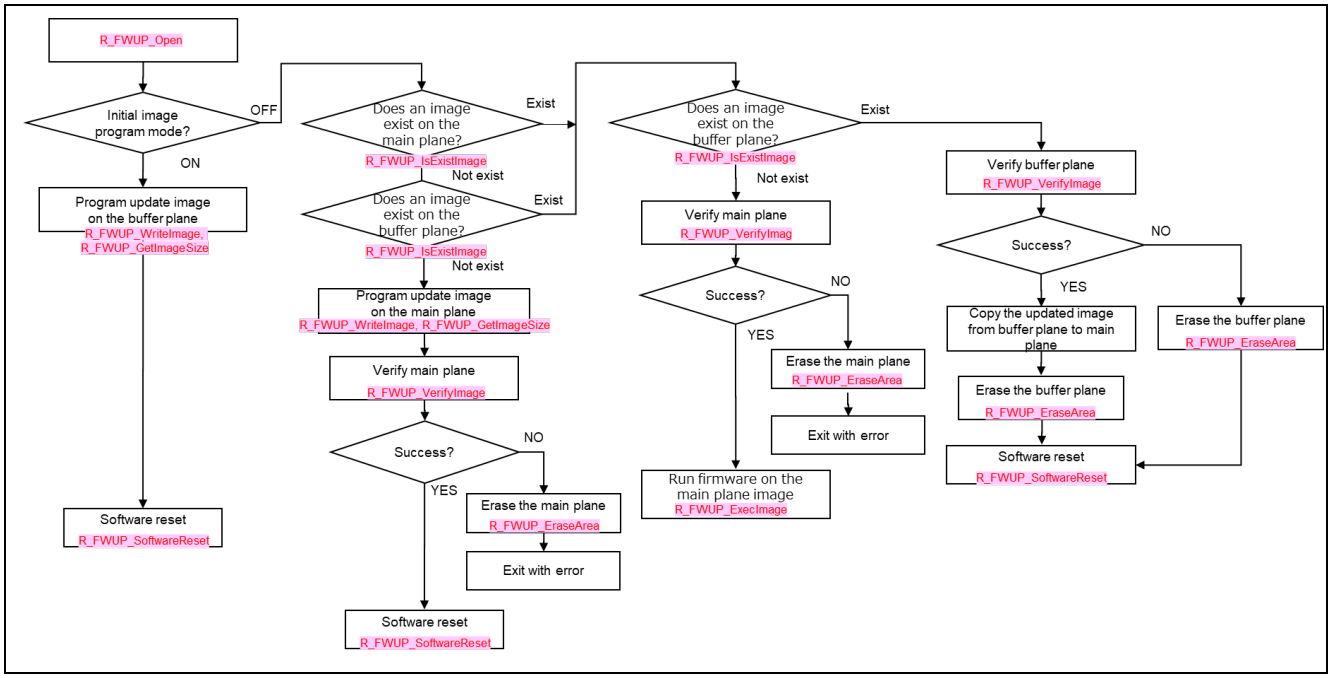


Figure 2.3 Bootloader Implementation Example of Partial Update Method and Full Update Method (with buffer plane)

The following flowchart is an example of implementation of an application program in partial update method and full update method (with buffer plane).

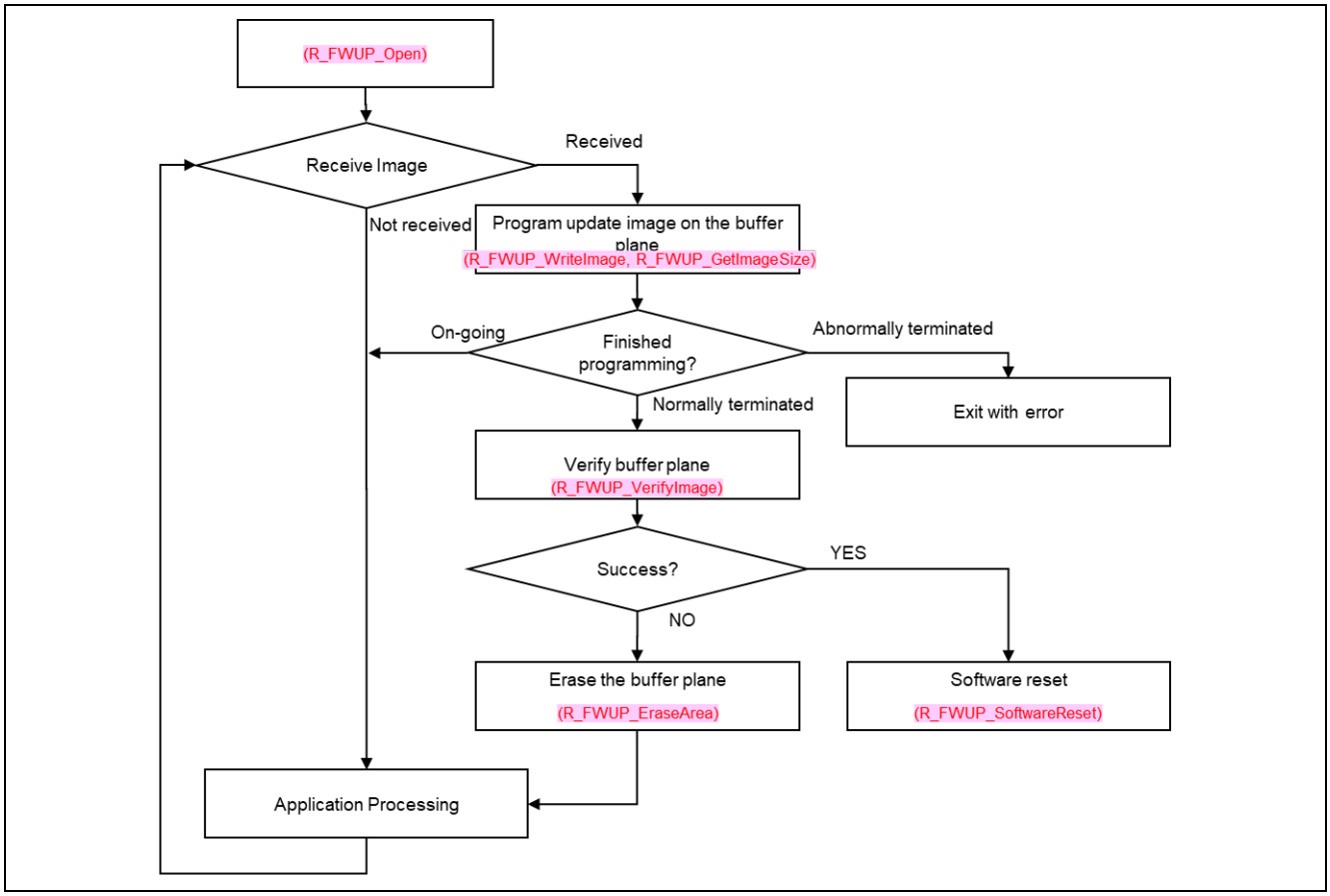


Figure 2.4 Application Program Implementation Example of Partial/Full Update Method (with buffer plane)

2.10.3 Implementation Example of Full Update Method (without buffer plane)

The following flowchart is an example of implementation of a bootloader in full update method (without buffer plane).

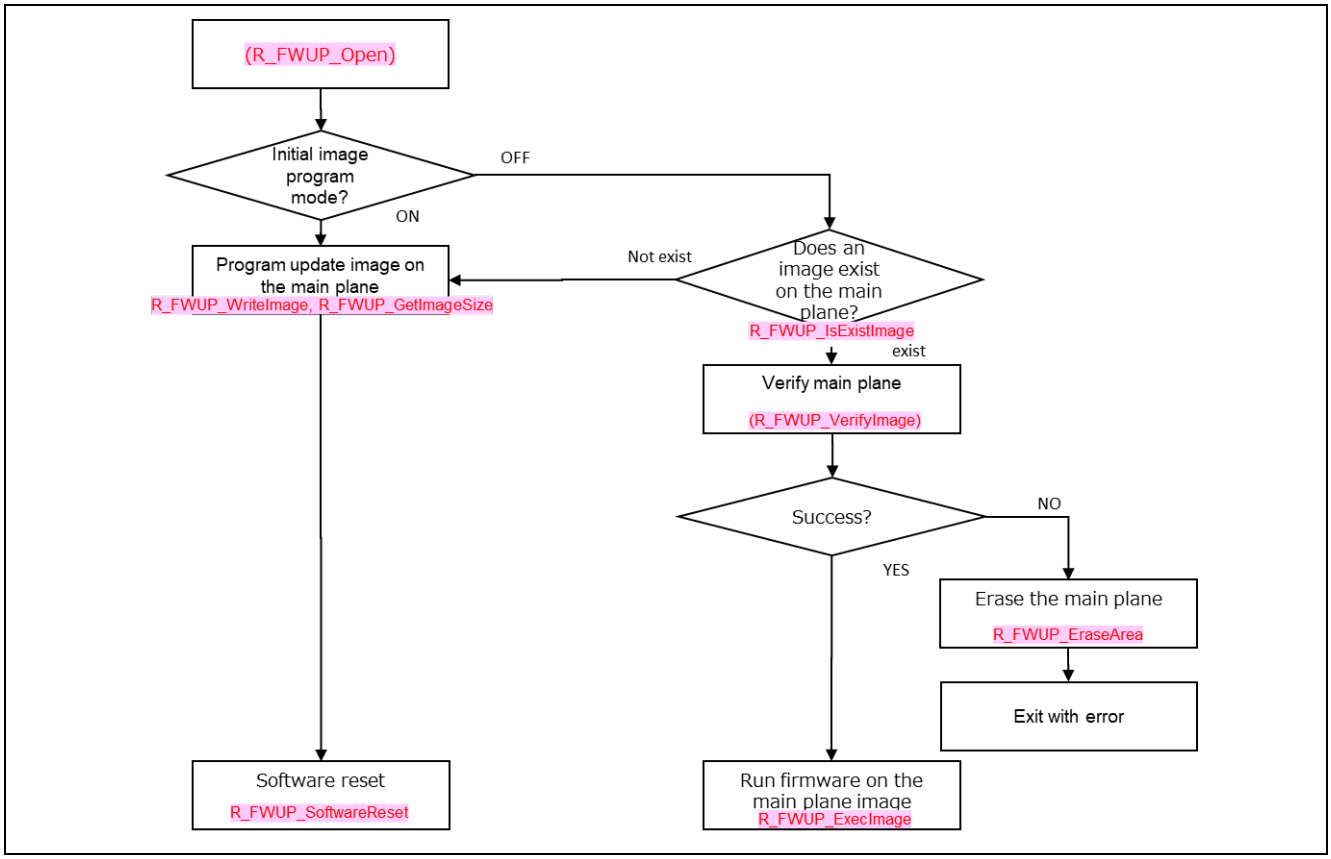


Figure 2.5 Bootloader Implementation Example of Full Update Method(without buffer plane)

3. API Functions

3.1 R_FWUP_Open Function

Table 3.1 R_FWUP_Open Function Specifications

Format	e_fwup_err_t R_FWUP_Open (void)	
Description	Performs processing to open the firmware update module. Implements processing to open the flash module.	
Parameters	None	
Return Values	FWUP_SUCCESS	Normal end
	FWUP_ERR_FLASH	Flash module error
Special Notes	—	

3.2 R_FWUP_Close Function

Table 3.2 R_FWUP_Close Function Specifications

Format	void R_FWUP_Close (void)
Description	Performs processing to close the firmware update module. Implements processing to close the flash module.
Parameters	None
Return Values	None
Special Notes	—

3.3 R_FWUP_IsExistImage Function

Table 3.3 R_FWUP_IsExistImage Function Specifications

Format	bool R_FWUP_IsExistImage(e_fwup_area_t area)	
Description	Confirms the existence of an image in the specified area.	
Parameters	area: Main plane (FWUP_AREA_MAIN) or buffer plane (FWUP_AREA_BUFFER)	
Return Values	true	Image exists.
	false	Image does not exist.
Special Notes	Verify that the magic code is written correctly.	

3.4 R_FWUP_EraseArea Function

Table 3.4 R_FWUP_EraseArea Function Specificationss

Format	e_fwup_err_t R_FWUP_EraseArea(e_fwup_area_t area)	
Description	Erases the specified area.	
Parameters	area: Main plane (FWUP_AREA_MAIN) or buffer plane (FWUP_AREA_BUFFER), Data Flash (FWUP_AREA_DATA_FLASH)	
Return Values	FWUP_SUCCES	Normal end
	FWUP_ERR_FLASH	Flash module error
Special Notes	Erasure of the main plane can only be performed by the bootloader.	

3.5 R_FWUP_GetImageSize Function

Table 3.5 R_FWUP_GetImageSize Function Specificationss

Format	uint32_t R_FWUP_GetImageSize(void)	
Description	Returns the size of the image in bytes. This function obtains the byte size of the image based on the RSU header address information shown in Figure 4.1. Therefore, first write the RSU header address information to code flash using the R_FWUP_WriteImage function or the R_FWUP_WriteImageProgram function.	
Parameters	None	
Return Values	0	Acquisition in progress
	1 or more	Image size
Special Notes	—	

3.6 R_FWUP_WriteImage Function

Table 3.6 R_FWUP_WriteImage Function Specifications

Format	e_fwup_err_t R_FWUP_WriteImage(e_fwup_area_t area, uint8_t *p_buf, uint32_t buf_size)	
Description	Writes an image (header portion + program portion) to the specified area. Continue calling this function until the total size of the image is reached. The image size is obtained by R_FWUP_GetImageSize().	
Parameters	area: Main plane (FWUP_AREA_MAIN) or buffer plane (FWUP_AREA_BUFFER) p_buf: Image (header + program) buffer buf_size: Buffer size*1	
Return Values	FWUP_SUCCES	Writing of all images is completed.
	FWUP_PROGRESS	Writing of all images not completed (Writing of the specified number of images completed)
	FWUP_ERR_FLASH	Flash module error
	FWUP_ERR_FAILURE	Illegal parameter
Special Notes	1. Specify a multiple of the code flash write unit (for example, 64, 128, or 256). This size also applies to data flash. When FWUP_CFG_FWUPV1_COMPATIBLE is enabled, the magic code in the RSU header area used for processing is "Renesas" for FWUP V1.	

3.7 R_FWUP_VerifyImage Function

Table 3.7 R_FWUP_VerifyImage Function Specifications

Format	e_fwup_err_t R_FWUP_VerifyImage(e_fwup_area_t area)	
Description	Verifies an image using the cryptographic library embedded in the module.	
Parameters	area: Main plane (FWUP_AREA_MAIN) or buffer plane (FWUP_AREA_BUFFER)	
Return Values	FWUP_SUCCES	Verification successful
	FWUP_ERR_VERIFY	Verification failed
	FWUP_ERR_FAILURE	Illegal parameter
Special Notes	—	

3.8 R_FWUP_ActivateImage Function

Table 3.8 R_FWUP_ActivateImage Function Specifications

Format	e_fwup_err_t R_FWUP_ActivateImage(void)	
Description	Activates a new image. • Dual-bank(2-bank) method — FWUP_CFG_FWUPV1_COMPATIBLE is disabled: Bank swap. — FWUP_CFG_FWUPV1_COMPATIBLE is enabled: Returns FWUP_SUCCESS without doing anything. • Partial update method, Full update method (with buffer plane) — Bootloader: Copies the buffer plane image to the main plane. — User program: Returns FWUP_SUCCESS without doing anything. • Full update method (without buffer plane) — Returns FWUP_SUCCESS without doing anything.	
Parameters	None	
Return Values	FWUP_SUCCESS	Normal end
	FWUP_ERR_FLASH	Flash module error
Special Notes	—	

3.9 R_FWUP_ExecImage Function

Table 3.9 R_FWUP_ExecImage Function Specifications

Format	void R_FWUP_ExecImage(void)
Description	Runs the program in a valid image.
Parameters	None
Return Values	None
Special Notes	Disable interrupts when transitioning from the bootloader to the application.

3.10 R_FWUP_SoftwareReset Function

Table 3.10 R_FWUP_SoftwareReset Function Specifications

Format	void R_FWUP_SoftwareReset(void)
Description	Execute software reset processing.
Parameters	None
Return Values	None
Special Notes	—

3.11 R_FWUP_SoftwareDelay Function

Table 3.11 R_FWUP_SoftwareDelay Function Specifications

Format	uint32_t R_FWUP_SoftwareDelay(uint32_t delay, e_fwup_delay_units_t units)	
Description	Execute software delay processing.	
Parameters	delay: Delay time units: Unit (µs, ms, or sec.)	
Return Values	0	Normal end
	Other	Abnormal end
Special Notes	—	

3.12 R_FWUP_GetVersion Function

Table 3.12 R_FWUP_GetVersion Function Specifications

Format	uint32_t R_FWUP_GetVersion(void)
Description	Returns the version number of the module.
Parameters	None
Return Values	Version number
Special Notes	—

3.13 R_FWUP_WriteImageHeader Function

This function is an API for special use where header information and program information must be written separately. Normally, use the R_FWUP_WriteImage function.

Table 3.13 R_FWUP_WriteImageHeader Function Specifications

Format	e_fwup_err_t R_FWUP_WriteImageHeader (e_fwup_area_t area, uint8_t FWUP_FAR *p_sig_type, uint8_t FWUP_FAR *p_sig, uint32_t sig_size)	
Description	Writes a signature that the bootloader uses for verification to the header of the image in the designated area.	
Parameters	area: Main plane (FWUP_AREA_MAIN) or buffer plane (FWUP_AREA_BUFFER) p_sig_type: Signature type character string “hash-sha256” or “sig-sha256-ecdsa” p_sig: Signature sig_size: Length of signature (Should be set to 64.)	
Return Values	FWUP_SUCCES	Write completed
	FWUP_ERR_FLASH	Flash module error
	FWUP_ERR_FAILURE	Illegal parameter
Special Notes	When FWUP_CFG_FWUPV1_COMPATIBLE is enabled, the magic code in the RSU header area used for processing is "Renesas" for FWUP V1.	

3.14 R_FWUP_WriteImageProgram Function

This function is an API for special use where header information and program information must be written separately. Normally, use the R_FWUP_WriteImage function.

Table 3.14 R_FWUP_WriteImageProgram Function Specifications

Format	e_fwup_err_t R_FWUP_WriteImageProgram (e_fwup_area_t area, uint8_t *p_buf, uint32_t offset, uint32_t buf_size)	
Description	Writes the program portion of the image to the specified area. Continue calling this function until the total size of the image is reached. The image size is obtained by R_FWUP_GetImageSize(). This function writes a program by offset based on the address information in the RSU header shown in Figure 4.1. Therefore, be sure to set 0x100 bytes of data from the offset (0x200) in Table 4.3 in the first call to this function. (Specify 0x200 for the offset argument and 0x100 or more for the buf_size argument.)	
Parameters	area: Main plane (FWUP_AREA_MAIN) or buffer plane (FWUP_AREA_BUFFER) p_buf: Buffer for program portion of image offset: Offset*1 buf_size: Buffer size*2	
Return Values	FWUP_SUCCES	Writing of all images is completed.
	FWUP_PROGRESS	Writing of all images not completed (Writing of the specified number of images completed)
	FWUP_ERR_FLASH	Flash module error
	FWUP_ERR_FAILURE	Illegal parameter
Special Notes	1. The offset must be 0x200 or greater. 2. Specify a multiple of the code flash write unit (for example, 64, 128, or 256). This size also applies to data flash.	

3.15 Wrapper Functions

This module implements the flash driver and cryptographic operations in a wrapper function. The process is implemented in the following comment section of the source file. Please refer to the demo project for the implementation method.

/**** Start user code ****/

/**** End user code ****/

3.15.1 r_fwup_wrap_com.c, h

3.15.1.1 r_fwup_wrap_disable_interrupt Function

Table 3.15 r_fwup_wrap_disable_interrupt Function Specifications

Format	void r_fwup_wrap_disable_interrupt (void)
Description	Disable Interrupt
Parameters	None
Return Values	None
Special Notes	—

3.15.1.2 r_fwup_wrap_enable_interrupt Function

Table 3.16 r_fwup_wrap_enable_interrupt Function Specifications

Format	void r_fwup_wrap_enable_interrupt (void)
Description	Enable Interrupt
Parameters	None
Return Values	None
Special Notes	—

3.15.1.3 r_fwup_wrap_software_reset Function

Table 3.17 r_fwup_wrap_software_reset Function Specifications

Format	void r_fwup_wrap_software_reset (void)	
Description	Software reset	
Parameters	None	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.1.4 r_fwup_wrap_software_delay Function

Table 3.18 r_fwup_wrap_software_delay Function Specifications

Format	uint32_t r_fwup_wrap_software_delay (uint32_t delay, e_fwup_delay_units_t units)	
Description	Software delay	
Parameters	delay：Delay time uinits: unit (us,ms,sec) FWUP_DELAY_MICROSECS FWUP_DELAY_MILLISECS FWUP_DELAY_SECS	
Return Values	0	: normal end
	Other	: Abnormal end
Special Notes	—	

3.15.2 r_fwup_wrap_flash.c, h

3.15.2.1 r_fwup_wrap_flash_open Function

Table 3.19 r_fwup_wrap_flash_open Function Specifications

Format	e_fwup_err_t r_fwup_wrap_flash_open (void)	
Description	Open the internal flash.	
Parameters	None	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.2.2 r_fwup_wrap_flash_close Function

Table 3.20 r_fwup_wrap_flash_close Function Specifications

Format	void r_fwup_wrap_flash_close (void)
Description	Close the internal flash.
Parameters	None
Return Values	None
Special Notes	—

3.15.2.3 r_fwup_wrap_flash_erase Function

Table 3.21 r_fwup_wrap_flash_erase Function Specifications

Format	e_fwup_err_t r_fwup_wrap_flash_erase (uint32_t addr, uint32_t num_blocks)	
Description	Erase the internal flash in block units.	
Parameters	addr : erase address num_blocks : erase block	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.2.4 r_fwup_wrap_flash_write Function

Table 3.22 r_fwup_wrap_flash_write Function Specifications

Format	e_fwup_err_t r_fwup_wrap_flash_write(uint32_t src_addr, uint32_t dest_addr, uint32_t num_bytes)	
Description	Erase the internal flash in block units.	
Parameters	src_addr: Pointer to write data dest_addr: Write address num_bytes: Write size (bytes)	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.2.5 r_fwup_wrap_flash_read Function

Table 3.23 r_fwup_wrap_flash_read Function Specifications

Format	e_fwup_err_t r_fwup_wrap_flash_read (uint32_t buf_addr, uint32_t src_add, uint32_t size)	
Description	Reads the internal flash.	
Parameters	buf_addr: Address of the buffer to store the read data src_addr: Read address size: Read size	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.2.6 r_fwup_wrap_bank_swap Function

Table 3.24 r_fwup_wrap_bank_swap Function Specifications

Format	e_fwup_err_t r_fwup_wrap_bank_swap (void)	
Description	Perform bank swap processing. This function performs boot bank switching settings using R_RFD_SetExtraBootAreaReq and executes bank swap after a software reset. Boot bank switching settings cannot be used unless in code flash programming mode, so execute R_RFD_SetExtraProgrammingMode immediately beforehand. After completing the boot bank switch setting, execute R_RFD_CheckExtraSeqEndStep1 and R_RFD_CheckExtraSeqEndStep2 to confirm that the extra area sequencer has finished operating. After confirming completion, execute R_RFD_GetExtraSeqErrorStatus and R_RFD_ClearExtraSeqRegister to obtain error information and clear the registers used to control the extra area sequencer. Before executing a software reset, execute R_RFD_SetExtraNonProgrammingMode.	
Parameters	None	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	This function can only be called when FWUP_CFG_UPDATE_MODE is 0. (RL78/L23 dual-bank(2-bank) only)	

3.15.2.7 r_fwup_wrap_ext_flash_open Function

Table 3.25 r_fwup_wrap_ext_flash_open Function Specifications

Format	e_fwup_err_t r_fwup_wrap_ext_flash_open (void)	
Description	Open the external flash.	
Parameters	None	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.2.8 r_fwup_wrap_ext_flash_close Function

Table 3.26 r_fwup_wrap_ext_flash_close Function Specifications

Format	void r_fwup_wrap_ext_flash_close (void)
Description	Close the external flash.
Parameters	None
Return Values	None
Special Notes	—

3.15.2.9 r_fwup_wrap_ext_flash_erase Function

Table 3.27 r_fwup_wrap_ext_flash_erase Function Specifications

Format	e_fwup_err_t r_fwup_wrap_ext_flash_erase (uint32_t offsetadd, uint32_t num_sectors)	
Description	Erase the external flash in sector units.	
Parameters	offsetadd: Starting address of the sector to be erased num_sectors: Number of sectors	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.2.10 r_fwup_wrap_ext_flash_write Function

Table 3.28 r_fwup_wrap_ext_flash_write Function Specifications

Format	e_fwup_err_t r_fwup_wrap_ext_flash_write (uint32_t src_addr, uint32_t dest_addr, uint32_t num_bytes);	
Description	Writes data to external flash.	
Parameters	src_addr: Pointer to write data dest_addr: Write address num_bytes: Write size (bytes)	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.2.11 r_fwup_wrap_ext_flash_read Function

Table 3.29 r_fwup_wrap_ext_flash_read Function Specifications

Format	e_fwup_err_t r_fwup_wrap_ext_flash_read (uint32_t buf_addr, uint32_t src_addr, uint32_t size);	
Description	Reads the external flash.	
Parameters	buf_addr: Address of the buffer to store the read data src_addr: Read address size: Read size	
Return Values	FWUP_SUCCES	: Normal end
	FWUP_ERR_FLASH	: Flash module error
Special Notes	—	

3.15.3 r_fwup_wrap_verify.c, h

3.15.3.1 r_fwup_wrap_sha256_init Function

Table 3.30 r_fwup_wrap_sha256_init Function Specifications

Format	int32_t r_fwup_wrap_sha256_init (void *vp_ctx);	
Description	Start hash value calculation.	
Parameters	vp_ctx: pointer to the context of the cryptographic library	
Return Values	0	: normal end
	Other	: Abnormal end
Special Notes	—	

3.15.3.2 r_fwup_wrap_sha256_update Function

Table 3.31 r_fwup_wrap_sha256_update Function Specifications

Format	int32_t r_fwup_wrap_sha256_update (void *vp_ctx, const uint8_t *p_data, uint32_t datalen)	
Description	Calculates hash values for a specified range.	
Parameters	vp_ctx: pointer to the context of the cryptographic library p_data: starting address datalen: data length (bytes)	
Return Values	0	: normal end
	Other	: Abnormal end
Special Notes	—	

3.15.3.3 r_fwup_wrap_sha256_final Function

Table 3.32 r_fwup_wrap_sha256_final Function Specifications

Format	int32_t r_fwup_wrap_sha256_final (uint8_t *p_hash, void *vp_ctx)	
Description	Finishes computing the hash value and returns the hash value.	
Parameters	p_hash: Pointer to the buffer to store the calculated hash value vp_ctx: pointer to the context of the cryptographic library	
Return Values	0	: normal end
	Other	: Abnormal end
Special Notes	—	

3.15.3.4 r_fwup_wrap_verify_ecdsa Function

Table 3.33 r_fwup_wrap_verify_ecdsa Function Specifications

Format	int32_t r_fwup_wrap_verify_ecdsa (uint8_t *p_hash, uint8_t *p_sig_type, uint8_t *p_sig, uint32_t sig_size)	
Description	Perform verification with ECDSA.	
Parameters	p_hash: Pointer to the buffer where the hash value is stored p_sig_type: signature type p_sig: signature sig_size: signature size	
Return Values	0	: normal end
	Other	: Abnormal end
Special Notes	—	

3.15.3.5 r_fwup_wrap_get_crypt_context Function

Table 3.34 r_fwup_wrap_get_crypt_context Function Specifications

Format	void * r_fwup_wrap_get_crypt_context (void);	
Description	Returns a pointer to the context of the cryptographic library.	
Parameters	None	
Return Values	Void *	Pointer to cryptographic library context
Special Notes	—	

4. Demo Project

The demo project is a sample program that shows how to implement firmware update functionality using the serial communications interface (SCI).

4.1 Demo project Structure

The demo project comprises the module, modules dependent on it, and a main() function that implements the firmware update demonstration. Versions of the demo project for the devices and compilers listed in 1.5 are provided.

The firmware update demo consists of the following projects.

Dual-Bank(2-Bank) method folder structure：Under XXX\dualbank(2bank)\YYY\
Partial/Full Update method folder structure：Under XXX\linear\YYY\

XXX: Board name
YYY: Compiler (e2_ccrl / iar / llvm)

- boot_loader: Bootloader
  This program runs first after a reset. It verifies that the user program has not been tampered with and then, if verification is successful, launches the user program.
- fwup_main: Application program
  An application program (initial firmware) that downloads updated firmware and performs signature verification.
- fwup_leddemo: Application program (for update)
  This is an application program (for updating) that blinks an LED.

4.2 Operating environment preparation

To run the firmware update demo project, you need to install the tools (see 4.2.1 to 4.2.4) on your Windows PC. Also, use a USB serial conversion board (see 4.2.5) that connects the Windows PC and the target board.

4.2.1 Installing TeraTerm

Used to transfer the firmware update image via serial communication from a Windows PC to the target board. In the demo project, we have checked the operation with TeraTerm 5.4.0.

After installation, set the serial port communication settings as shown in Table Table 4.1

Table 4.1 Communication Specifications

Item	Description
Communication system	Asynchronous communication
Bit rate	115,200 bps
Data length	8 bits
Parity	None
Stop bit	1 bit
Flow control	CTS/RTS

4.2.2 Installing the Python execution environment

Used by Renesas Image Generator (image-gen.py) to create initial and update images.

Renesas Image Generator uses ECDSA to generate signature data. In the demo project, environment operation is confirmed with Python 3.11.14.

Install Python 3.11.14 or higher.

In addition, since the Python encryption library (pycryptodome) is used, after installing Python, execute the following pip command from the command prompt to install the library.

```
pip install pycryptodome
```

4.2.3 Installing the OpenSSL execution environment

OpenSSL is used to generate the keys needed to generate and verify ECDSA signature data for initial and update images.

Download the OpenSSL installer from the following URL and install it. There is no problem with the Light version.

https://slproweb.com/products/Win32OpenSSL.html

4.2.4 Installing the Flash Writer

A flash writer is required to write the initial image.

The demo project uses Renesas Flash Programmer v3.22.00.

Renesas Flash Programmer (Programming GUI) | Renesas

4.2.5 USB serial conversion board

Used to transfer the firmware update image via serial communication from a Windows PC to the target board.

For details on how to connect with the target board, refer to the operation confirmation environment (6.2) of the relevant target board.

Use Pmod USBUART (manufactured by DIGILENT).

https://reference.digilentinc.com/reference/pmod/pmodusbuart/start

4.3 Execution environment preparation

4.3.1 Generating Keys for Signature Generation and Verification

Use OpenSSL for key generation. Refer to Section 4.2.3 and install OpenSSL in advance.

Execute the following OpenSSL commands to generate an elliptic curve cryptography (secp256r1) key pair to be used to generate and verify image signatures, and to extract the private and public keys:

```
>openssl ecparam -genkey -name secp256r1 -out secp256r1.keypair
using curve name prime256v1 instead of secp256r1

>openssl ec -in secp256r1.keypair -outform PEM -out secp256r1.privatekey
read EC key
writing EC key

> openssl ec -in secp256r1.keypair -outform PEM -pubout -out
secp256r1.publickey
read EC key
writing EC key
```

4.3.2 Preparing the execution environment for Renesas Image Generator

Unzip ImageGenerator.zip included in the package to any folder on your Windows PC. Make sure the folder name does not contain double-byte characters.

Renesas Image Generator requires a Python execution environment. Refer to Section 4.2.2 and install Python in advance.

4.4 Dual-Bank(2-Bank) Method

This section describes the demo projects using the FPB‑RL78L23 in dual-bank(2-bank) method.

Three demo projects, boot_loader, fwup_leddemo, and fwup_main, are available for the dual-bank(2-bank) method of the FPB‑RL78L23.

The execution procedure of this demo project does not assume a debugger connection. Refer to 4.8 for information on how to debug the application through a debugger connection.

4.4.1 Execution Environment

Refer to Section 6.2.4 and prepare the execution environment.

4.4.2 Build Demo Project

The following steps are used to build three demo projects for the dual-bank(2-bank) method.

The following procedure is described for the e2 studio environment; when using the IAR environment, please read and follow the procedure for IAR's Integrated Development Environment.

1. Import the boot_loader, fwup_leddemo, and fwup_main demo projects into the integrated development environment.

2. Add the public key used to verify the image to the demo project.
   Paste the contents of secp256r1.publickey into code_signer_public_key.h in project boot_loader and fwup_main.

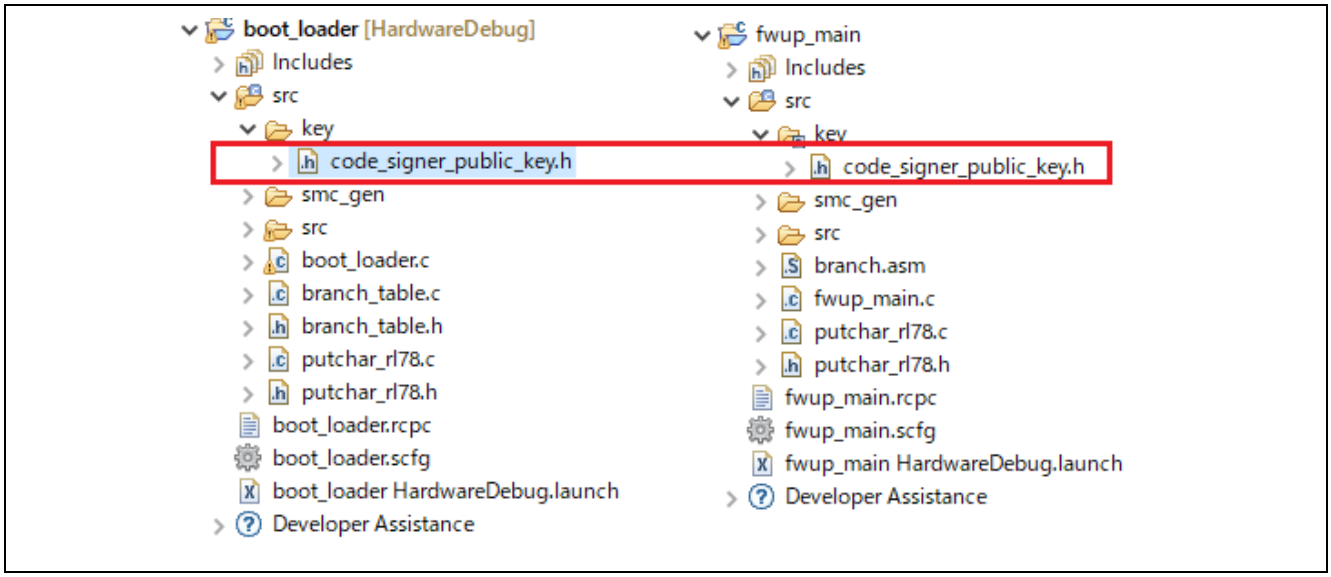


Figure 4.1 Location of the code_signer_public_key.h file for the demo project

```
/*
 * PEM-encoded code signer public key.
 *
 * Must include the PEM header and footer:
 * "-----BEGIN CERTIFICATE-----\n"\
 * "...base64 data...\n"\
 * "-----END CERTIFICATE-----"
 */
#define CODE_SIGNER_PUBLIC_KEY_PEM \
"-----BEGIN PUBLIC KEY-----"\
Paste the contents of secp256r1.publickey here.
"-----END PUBLIC KEY-----"\
#endif /* CODE_SIGNER_PUBLIC_KEY_H_ */
```

3. Set the configuration settings for the firmware update module.
   Open r_fwup_config.h in the project and configure with reference to 6.2.4.1.
   Log output is off by default, so please set the following.
   boot_loader, fwup_main : FWUP_CFG_PRINTF_DISABLE = 0
   fwup_leddemo : FWUP_DEMO_PRINTF_DISABLE = 0

4. Build the demo project.
   Build the three demo projects and verify that the following mot files have been generated:
   boot_loader.mot, fwup_main.mot, fwup_leddemo.mot
   Note: The mot file is renamed srec file in llvm.

4.4.3 Create initial and updated images

This section describes the procedure for creating the initial and updated images, assuming that the initial image name is initial_firm.mot and the updated image name is fwup_leddemo.rsu.

1. Store the mot file of the built demo project and the secret key generated in 4.3.1 in the same folder as the Renesas Image Generator.

```
image-gen.py
RL78_L23_ImageGenerator_PRM_dual.csv
boot_loader.mot
fwup_main.mot
fwup_leddemo.mot
secp256r1.privatekey
```

2. Execute the following command to create the initial image.

```
> python image-gen.py -iup fwup_main.mot -ip
RL78_L23_ImageGenerator_PRM_dual.csv -o initial_firm -ibp boot_loader.mot
-vt ecdsa -key secp256r1.privatekey

Successfully generated the initial_firm.mot file.
```

3. Execute the following command to create the updated image.

```
> python image-gen.py -iup fwup_leddemo.mot -ip
RL78_L23_ImageGenerator_PRM_dual.csv -o fwup_leddemo -vt ecdsa -key
secp256r1.privatekey

Successfully generated the fwup_leddemo.rsu file.
```

Initial and updated images are generated in the same folder as the Renesas Image Generator.

```
image-gen.py
RL78_L23_ImageGenerator_PRM_dual.csv
boot_loader.mot
fwup_main.mot
fwup_leddemo.mot
secp256r1.privatekey
fwup_leddemo.rsu
initial_firm.mot
```

4.4.4 Program Initial Image

Write the initial image (initial_firm.mot) to the MCU board using a flash writer. After writing, turn off the power to the board.

Note: Change the Renesas Flash Programmer settings only when using the dual-bank (2-bank) method.

- Operation Settings > Command
  → Check "Write Flash Options"
  → Check "Verify Flash Options"

- Flash Options > Boot Cluster Size/Bank Swap
  → Setting option: Set
  → BTBLS: 07

4.4.5 Update Firmware

Once the initial image firmware is activated, it waits for the transfer of the updated image via the terminal. The received update image is programmed into flash memory, and after the reception is completed, the signature of the update image is verified and the firmware of the update image is activated.

Follow the steps below to try the firmware update.

1. Connect devices with reference to 6.2.4.
2. Start the terminal software on the PC, select the serial COM port, and configure the connection settings.
3. Turn on power to the board. The following message is output.

```
==== RL78L23 : BootLoader [dual bank, bank0] ====
verify install area main [sig-sha256-ecdsa]...OK
execute new image ...

==== RL78L23 : Update from User [dual bank] ver 1.0.0 ====
send image(*.rsu) via UART.
```

4. Send the updated image through the terminal software.

   Send file>check binary>fwup_leddemo.rsu

   The following message is output during the transfer of the update image.

```
W 0x41000, 128 ... OK
W 0x41080, 128 ... OK
...
W 0x43980, 128 ... OK
W 0x43A00, 128 ... OK
```

5. After installing the updated firmware and verifying the signature, it jumps to the updated firmware and executes the program after processing such as bank swap.

```
verify install area buffer [sig-sha256-ecdsa]...OK
software reset...
```

6. When the bootloader completes signature verification, the update image firmware is activated. When the process completes successfully, the following message is output and the LED flashes.

```
==== RL78L23 : BootLoader [dual bank, bank1] ====
verify install area main [sig-sha256-ecdsa]...OK
execute new image ...

---------------------------------------
FWUP demo (ver 0.1.1)
---------------------------------------
Check the LEDs on the board.
```

Note: The demo program does not erase the buffer plane. If it is necessary to erase the image that existed before the update as a rollback countermeasure, add a procedure to erase the image in the buffer plane.

4.5 Partial Update Method

This section describes the demo projects using the FPB−RL78G23-128p.

See this chapter for a demonstration using the FPB−RL78G24 and FPB−RL78L23, which is the same as the FPB−RL78G23-128p.

Three demo projects (boot_loader, fwup_leddemo, and fwup_main) are available for the FPB−RL78G23-128p.

These demo projects support three firmware update methods: partial update method, full update method (with buffer plane), and full update method (without buffer plane) by changing the configuration settings.

The execution procedure of this demo project does not assume a debugger connection. Refer to 4.8 for information on how to debug the application through a debugger connection.

4.5.1 Execution Environment

Refer to Section 6.2.1 and prepare the execution environment.

4.5.2 Build Demo Project

The following steps are used to build three demo projects for the partial update method (buffer plane is internal flash).

The following procedure is described for the e2 studio environment; when using the IAR environment, please read and follow the procedure for IAR's Integrated Development Environment.

1. Import the boot_loader, fwup_leddemo, and fwup_main demo projects into the integrated development environment.

2. Add the public key used to verify the image to the demo project.
   Paste the contents of secp256r1.publickey into code_signer_public_key.h in project boot_loader and fwup_main.

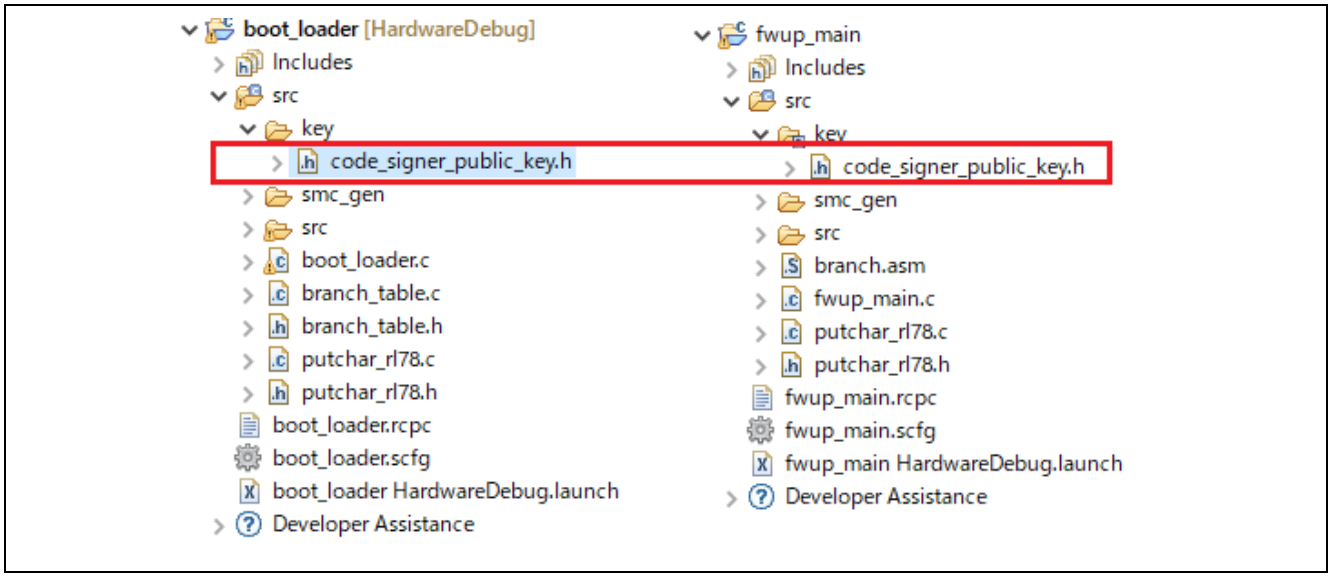


Figure 4.2 Location of the code_signer_public_key.h file for the demo project

```
/*
 * PEM-encoded code signer public key.
 *
 * Must include the PEM header and footer:
 * "-----BEGIN CERTIFICATE-----\n"\
 * "...base64 data...\n"\
 * "-----END CERTIFICATE-----"
 */
#define CODE_SIGNER_PUBLIC_KEY_PEM \
"-----BEGIN PUBLIC KEY-----"\
Paste the contents of secp256r1.publickey here.
"-----END PUBLIC KEY-----"\
#endif /* CODE_SIGNER_PUBLIC_KEY_H_ */
```

3. Set the configuration settings for the firmware update module.
   Open r_fwup_config.h in the project and configure with reference to 6.2.1.1.
   Log output is off by default, so please set the following.
   boot_loader, fwup_main : FWUP_CFG_PRINTF_DISABLE = 0
   fwup_leddemo : FWUP_DEMO_PRINTF_DISABLE = 0

4. Build the demo project.
   Build the three demo projects and verify that the following mot files have been generated:
   boot_loader.mot, fwup_main.mot, fwup_leddemo.mot
   Note: The mot file is renamed srec file in llvm.

4.5.3 Create initial and updated images

This section describes the procedure for creating the initial and updated images, assuming that the initial image name is initial_firm.mot and the updated image name is fwup_leddemo.rsu.

1. Store the mot file of the built demo project and the secret key generated in 4.3.1 in the same folder as the Renesas Image Generator.

```
image-gen.py
RL78_G23_ImageGenerator_PRM.csv
boot_loader.mot
fwup_main.mot
fwup_leddemo.mot
secp256r1.privatekey
```

2. Execute the following command to create the initial image.

```
> python image-gen.py -iup fwup_main.mot -ip RL78_G23_ImageGenerator_PRM.csv
-o initial_firm -ibp boot_loader.mot -vt ecdsa -key secp256r1.privatekey

Successfully generated the initial_firm.mot file.
```

3. Execute the following command to create the updated image.

```
> python image-gen.py -iup fwup_leddemo.mot -ip
RL78_G23_ImageGenerator_PRM.csv -o fwup_leddemo -vt ecdsa -key
secp256r1.privatekey

Successfully generated the fwup_leddemo.rsu file.
```

Initial and updated images are generated in the same folder as the Renesas Image Generator.

```
image-gen.py
RL78_G23_ImageGenerator_PRM.csv
boot_loader.mot
fwup_main.mot
fwup_leddemo.mot
secp256r1.privatekey
fwup_leddemo.rsu
initial_firm.mot
```

4.5.4 Program Initial Image

Write the initial image (initial_firm.mot) to the MCU board using a flash writer. After writing, turn off the power to the board.

4.5.5 Update Firmware

Once the initial image firmware is activated, it waits for the transfer of the updated image via the terminal. The received update image is programmed into flash memory, and after the reception is completed, the signature of the update image is verified and the firmware of the update image is activated.

Follow the steps below to try the firmware update.

1. Connect devices with reference to 6.2.1.
2. Start the terminal software on the PC, select the serial COM port, and configure the connection settings.
3. Turn on power to the board. The following message is output.

```
==== RL78G23 : BootLoader [with buffer] ====
verify install area main [sig-sha256-ecdsa]...OK
execute new image ...

==== RL78G23 : Update from User [with buffer] ver 1.0.0 ====
send image(*.rsu) via UART.
```

4. Send the updated image through the terminal software.

   Send file>check binary>fwup_leddemo.rsu

   The following message is output during the transfer of the update image, and the software resets after installation and signature verification are complete.

```
W 0x59000, 128 ... OK
W 0x59080, 128 ... OK
...
W 0x5BA00, 128 ... OK
W 0x5BA80, 128 ... OK
verify install area buffer [sig-sha256-ecdsa]...OK
software reset...
```

5. Execute the activation process in the bootloader and perform a software reset again.

```
==== RL78G23 : BootLoader [with buffer] ====
verify install area buffer [sig-sha256-ecdsa]...OK
copy to main area ... OK
software reset...
```

6. When the signature verification is completed in the bootloader, the firmware of the updated image will boot. It is normal if the following message is output and the LED is blinking.

```
==== RL78G23 : BootLoader [with buffer] ====
verify install area main [sig-sha256-ecdsa]...OK
execute new image ...

---------------------------------------
FWUP demo (ver 0.1.1)
---------------------------------------
Check the LEDs on the board.
```

4.6 Full Update Method (without buffer plane)

This section describes the demo projects using the FPB-RL78G22.

See this chapter for a demonstration using the FPB-RL78G23-128p, FPB-RL78G24 and FPB-RL78L23, which is the same as the FPB-RL78G22.

Two demo projects (boot_loader and fwup_leddemo) are provided for the FPB-RL78G22.

The execution procedure of this demo project does not assume a debugger connection. Refer to 4.8 for information on how to debug the application through a debugger connection.

4.6.1 Execution Environment

Refer to Section 6.2.3 and prepare the execution environment.

4.6.2 Build Demo Project

The following steps are used to build two demo projects for the full update method (without buffer plane).

1. Import the boot_loader and fwup_leddemo demo projects into the integrated development environment.

2. Set the configuration settings for the firmware update module.
   Open r_fwup_config.h in the project and configure with reference to 6.2.3.1.
   Log output is off by default, so please set the following.
   boot_loader : FWUP_CFG_PRINTF_DISABLE = 0
   fwup_leddemo : FWUP_DEMO_PRINTF_DISABLE = 0

3. Build the demo project.
   a. Build the project (boot_loader) and generate boot_loader.mot.
   b. Build the project (fwup_leddemo) and generate fwup_leddemo.mot.
   c. Rename fwup_leddemo.mot to fwup_leddemo_011.mot.
   d. Change the version of the project (fwup_leddemo) as follows, build and generate fwup_leddemo.mot.

```
fwup_leddemo.c
---
#define FWUP_DEMO_VER_MAJOR        (0)
#define FWUP_DEMO_VER_MINOR        (1)
#define FWUP_DEMO_VER_BUILD        (1)★1->2
```

   e. Rename fwup_leddemo.mot to fwup_leddemo_012.mot.
   Note: The mot file is renamed srec file in llvm.

4.6.3 Create initial and updated images

This section describes the procedure for creating the initial and updated images, assuming that the initial image name is initial_firm.mot and the updated image name is fwup_leddemo_012.rsu.

1. Store the mot file of the built demo project in the same folder as Renesas Image Generator.

```
image-gen.py
RL78_G22_ImageGenerator_PRM_full.csv
boot_loader.mot
fwup_leddemo_011.mot
fwup_leddemo_012.mot
```

2. Execute the following command to create the initial image.

```
> python image-gen.py -iup fwup_leddemo_011.mot -ip
RL78_G22_ImageGenerator_PRM_full.csv -o initial_firm -ibp boot_loader.mot

Successfully generated the initial_firm.mot file.
```

3. Execute the following command to create the updated image.

```
> python image-gen.py -iup fwup_leddemo_012.mot -ip
RL78_G22_ImageGenerator_PRM_full.csv -o fwup_leddemo_012

Successfully generated the fwup_leddemo_012.rsu file.
```

Initial and updated images are generated in the same folder as the Renesas Image Generator.

```
image-gen.py
RL78_G22_ImageGenerator_PRM_full.csv
boot_loader.mot
fwup_leddemo_011.mot
fwup_leddemo_012.mot
fwup_leddemo_012.rsu
initial_firm.mot
```

4.6.4 Program Initial Image

Write the initial image (initial_firm.mot) to the MCU board using a flash writer. After writing, turn off the board power and disconnect the debugger (E2 Lite).

4.6.5 Update Firmware

The LED will blink when the initial image is activated. Enter update mode by pressing RESET_SW while holding down USER_SW on the board and wait for the transfer of the update image via the terminal. Program the received update image into flash memory, verify the update image after the transfer is complete, and then boot the firmware of the update image.

Follow the steps below to try the firmware update.

1. Connect devices with reference to 6.2.3.
2. Start the terminal software on the PC, select the serial COM port, and configure the connection settings.
3. Power on the board. The following message is output.

```
==== RL78G22 : BootLoader [without buffer] ====
verify install area main [hash-sha256]...OK
execute new image ...

----------------------------------------
FWUP demo (ver 0.1.1)
----------------------------------------
```

4. Press RESET_SW while holding down USER_SW. The initial image program mode is switched on.

```
==== RL78G22 : Image updater [without buffer] ====
send image(*.rsu) via UART.
```

5. Send the updated image through the terminal software.

   Send file>check binary>fwup_leddemo_012.rsu

   The following message is output during the transfer of the update image, and the software resets after installation and signature verification are complete.

```
W 0x2000, 64 ... OK
W 0x2040, 64 ... OK
...
W 0x4D00, 64 ... OK
W 0x4D40, 64 ... OK
verify install area 0 [hash-sha256]...OK
software reset...
```

6. When the signature verification is completed in the bootloader, the firmware of the updated image will boot. It is normal if the following message is output and the LED is blinking.

```
==== RL78G22 : BootLoader [without buffer] ====
verify install area main [hash-sha256]...OK
execute new image ...

----------------------------------------
FWUP demo (ver 0.1.2)
----------------------------------------
Check the LEDs on the board.
```

4.7 Full Update Method (with buffer plane)

This section describes the demo projects using the FPB−RL78G23-128p.

See this chapter for a demonstration using the FPB−RL78G24 and FPB−RL78L23, which is the same as the FPB−RL78G23-128p.

Three demo projects (boot_loader, fwup_leddemo, and fwup_main) are available for the FPB−RL78G23-128p.

These demo projects support three firmware update methods: partial update method (buffer plane is internal flash), full update method (buffer plane is external flash), and full update method (without buffer plane) by changing the configuration settings.

The execution procedure of this demo project does not assume a debugger connection. Refer to 4.8 for information on how to debug the application through a debugger connection.

4.7.1 Execution Environment

Refer to Section 6.2.1 and prepare the execution environment.

4.7.2 Build Demo Project

The following steps are used to build three demo projects for the partial update method (with buffer plane).

The following procedure is described for the e2 studio environment; when using the IAR environment, please read and follow the procedure for IAR's Integrated Development Environment.

1. Import the boot_loader, fwup_leddemo, and fwup_main demo projects into the integrated development environment.

2. Add the public key used to verify the image to the demo project.
   Paste the contents of secp256r1.publickey into code_signer_public_key.h in project boot_loader and fwup_main.

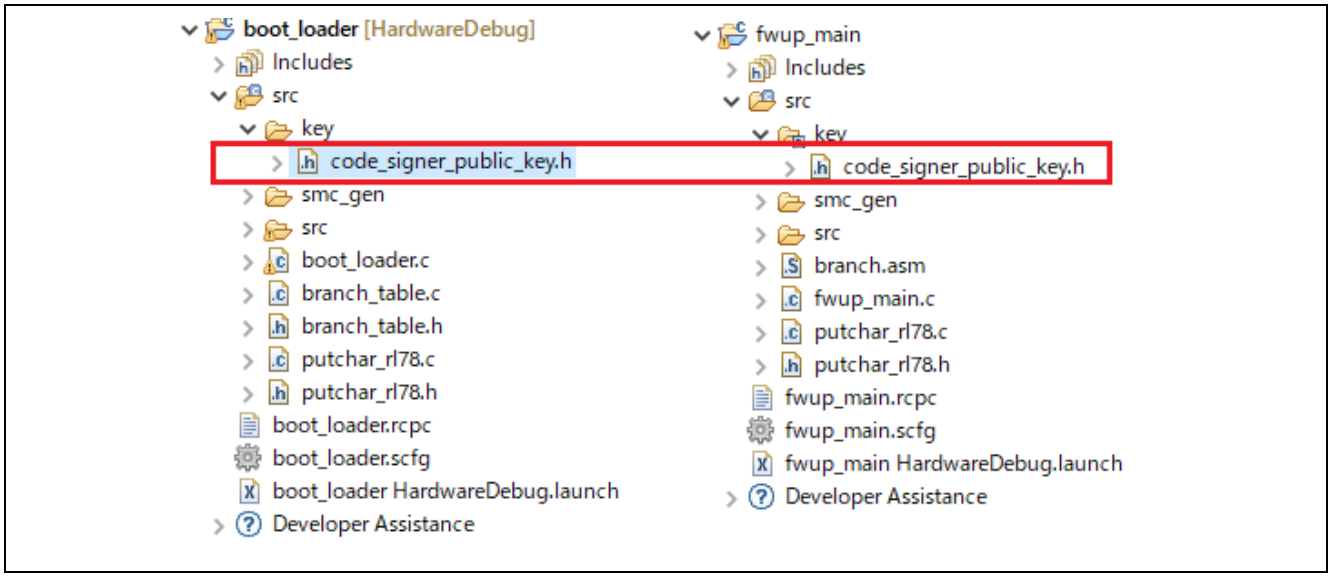


Figure 4.3 Location of the code_signer_public_key.h file for the demo project

```
/*
 * PEM-encoded code signer public key.
 *
 * Must include the PEM header and footer:
 * "-----BEGIN CERTIFICATE-----\n"\
 * "...base64 data...\n"\
 * "-----END CERTIFICATE-----"
 */
#define CODE_SIGNER_PUBLIC_KEY_PEM \
"-----BEGIN PUBLIC KEY-----"\
Paste the contents of secp256r1.publickey here.
"-----END PUBLIC KEY-----"\
#endif /* CODE_SIGNER_PUBLIC_KEY_H_ */
```

3. Set the configuration settings for the firmware update module.
   Open r_fwup_config.h in the project and configure with reference to 6.2.1.2.
   Log output is off by default, so please set the following.
   boot_loader, fwup_main : FWUP_CFG_PRINTF_DISABLE = 0
   fwup_leddemo : FWUP_DEMO_PRINTF_DISABLE = 0

4. Build the demo project.
   Build the three demo projects and verify that the following mot files have been generated:
   boot_loader.mot, fwup_leddemo.mot, fwup_main.mot
   Note: The mot file is renamed srec file in llvm.

4.7.3 Create initial and updated images

This section describes the procedure for creating the initial and updated images, assuming that the initial image name is initial_firm.mot and the updated image name is fwup_leddemo.rsu.

1. Store the mot file of the built demo project and the secret key generated in 4.3.1 in the same folder as the Renesas Image Generator.

```
image-gen.py
RL78_G23_ImageGenerator_PRM_full.csv
boot_loader.mot
fwup_main.mot
fwup_leddemo.mot
secp256r1.privatekey
```

2. Execute the following command to create the initial image.

```
> python image-gen.py -iup fwup_main.mot -ip
RL78_G23_ImageGenerator_PRM_full.csv -o initial_firm -ibp boot_loader.mot -
vt ecdsa -key secp256r1.privatekey

Successfully generated the initial_firm.mot file.
```

3. Execute the following command to create the updated image.

```
> python image-gen.py -iup fwup_leddemo.mot -ip
RL78_G23_ImageGenerator_PRM_full.csv -o fwup_leddemo -vt ecdsa -key
secp256r1.privatekey

Successfully generated the fwup_leddemo.rsu file.
```

Initial and updated images are generated in the same folder as the Renesas Image Generator.

```
image-gen.py
RL78_G23_ImageGenerator_PRM_full.csv
boot_loader.mot
fwup_main.mot
fwup_leddemo.mot
secp256r1.privatekey
fwup_leddemo.rsu
initial_firm.mot
```

4.7.4 Program Initial Image

Use Flash Writer to program the initial image (initial_firm.mot) to the MCU board. After programming, turn off the power to the board and disconnect the debugger (E2 Lite).

4.7.5 Update Firmware

Once the initial image firmware is activated, it waits for the transfer of the updated image via the terminal. The received update image is programmed into flash memory, and after the reception is completed, the signature of the update image is verified and the firmware of the update image is activated.

Follow the steps below to try the firmware update.

1. Connect devices with reference to 6.2.1.
2. Start the terminal software on the PC, select the serial COM port, and configure the connection settings.
3. Turn on power to the board. The following message is output.

```
==== RL78G23 : BootLoader [with ext-buffer] ====
verify install area main [sig-sha256-ecdsa]...OK
execute new image ...

==== RL78G23 : Update from User [with ext-buffer] ver 1.0.0 ====
send image(*.rsu) via UART.
```

4. Send the updated image through the terminal software.

   Send file>check binary>fwup_leddemo.rsu

   The following message is output during the transfer of the update image, and the software resets after installation and signature verification are complete.

```
W 0x0000, 128 ... OK
W 0x0080, 128 ... OK
...
W 0x1A00, 128 ... OK
W 0x1A80, 128 ... OK
verify install area buffer [sig-sha256-ecdsa]...OK
software reset...
```

5. Execute the activation process in the bootloader and perform a software reset again.

```
==== RL78G23 : BootLoader [with ext-buffer] ====
verify install area buffer [sig-sha256-ecdsa]...OK
copy to main area ... OK
software reset...
```

6. When the signature verification is completed in the bootloader, the firmware of the updated image will boot. It is normal if the following message is output and the LED is blinking.

```
==== RL78G23 : BootLoader [with ext-buffer] ====
verify install area main [sig-sha256-ecdsa]...OK
execute new image ...

---------------------------------------
FWUP demo (ver 0.1.1)
---------------------------------------
Check the LEDs on the board.
```

4.8 How to debug the demo project

If you wish to debug this project (bootloader + application program) in the e2 studio environment, the following procedure can be used.

This demo project is set to be powered by the emulator in the debugger (E2 Lite). If you want to connect with other debuggers or supply power from the target board, change the debugger settings.

(1) Build the bootloader and application program without optimization.

Build the bootloader (boot_loader) and application program (fwup_main).

(2) Generate the initial image.

The Renesas Image Generator generates an initial image file (.mot) consisting of a bootloader (boot_loader) and an application program (fwup_main).

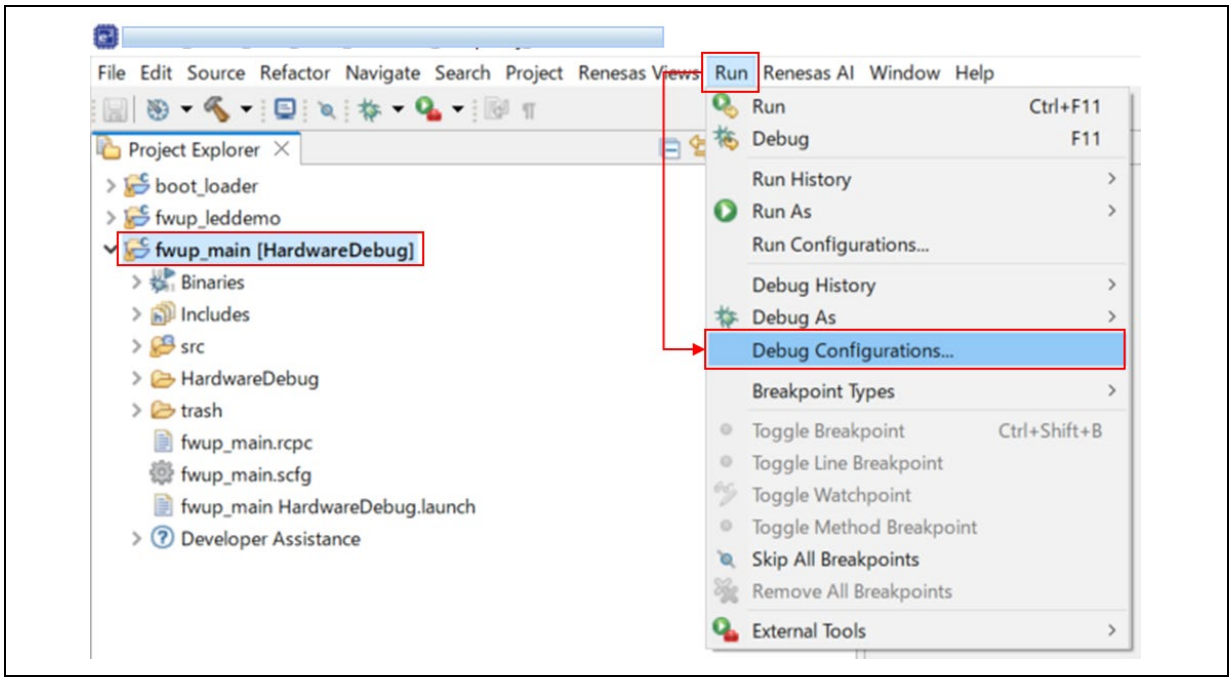
(3) Erase the flash memory. (Dual-bank (2-bank) method only)

Use a flash programmer to perform a chip erase on the flash memory. This step is not required for configurations other than dual-bank (2-bank) method.

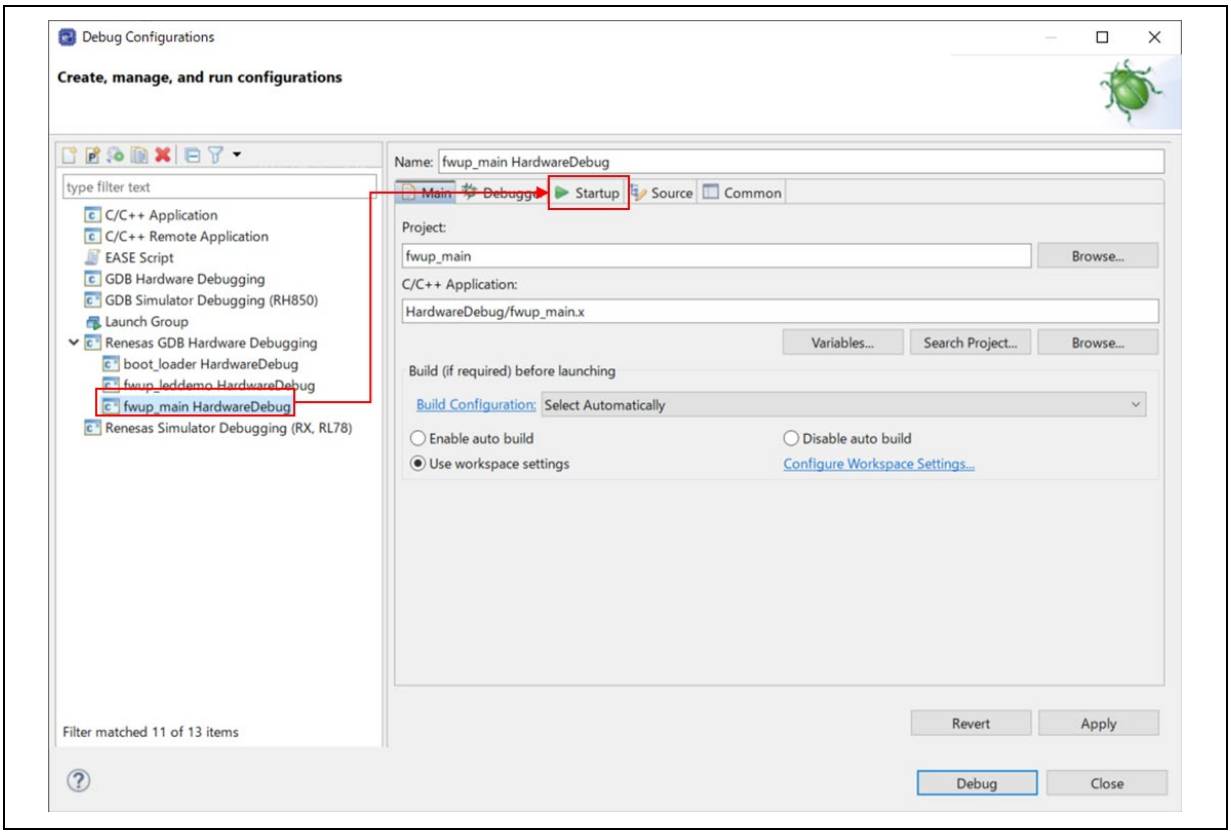
(4) Debug settings for the application program (fwup_main).

Follow the steps below to configure debugging settings for the application program (fwup_main).

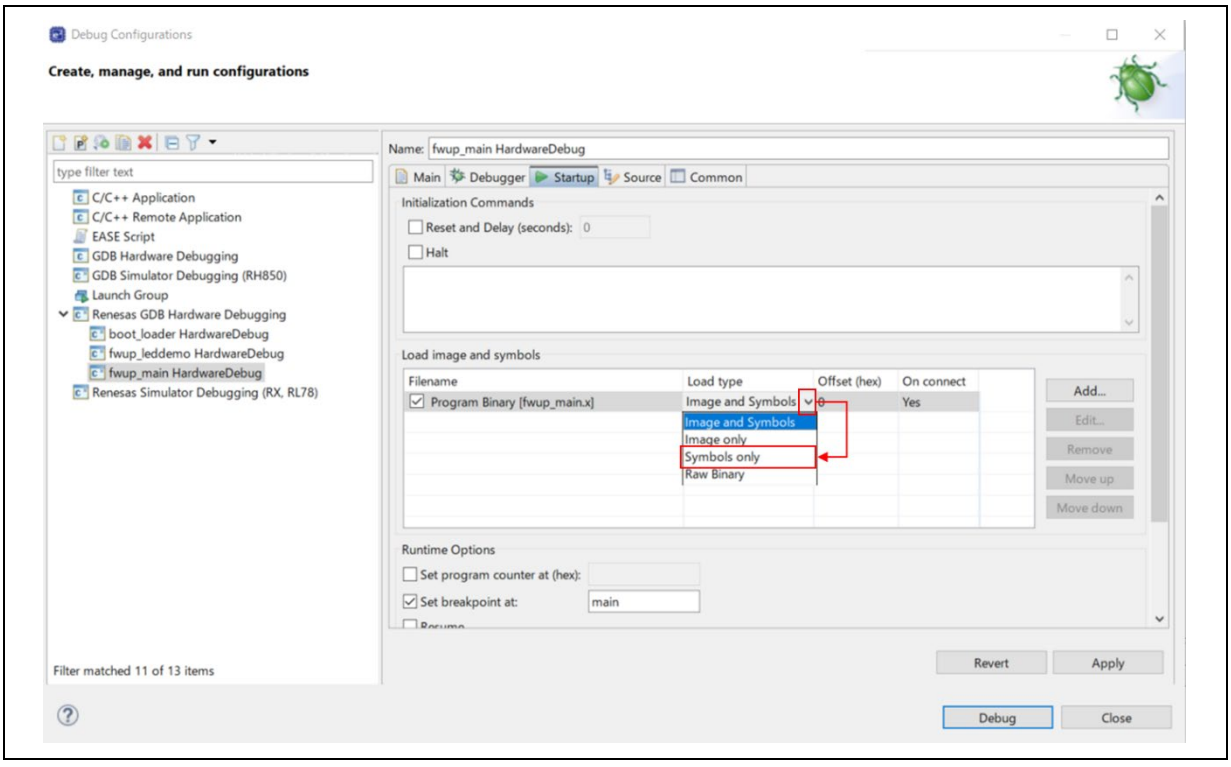
a) Open "Run"->"Debug" Configuration and select fwup_main_HardwareDebug.



b) Select "fwup_main_HardwareDebug" and click "Startup".



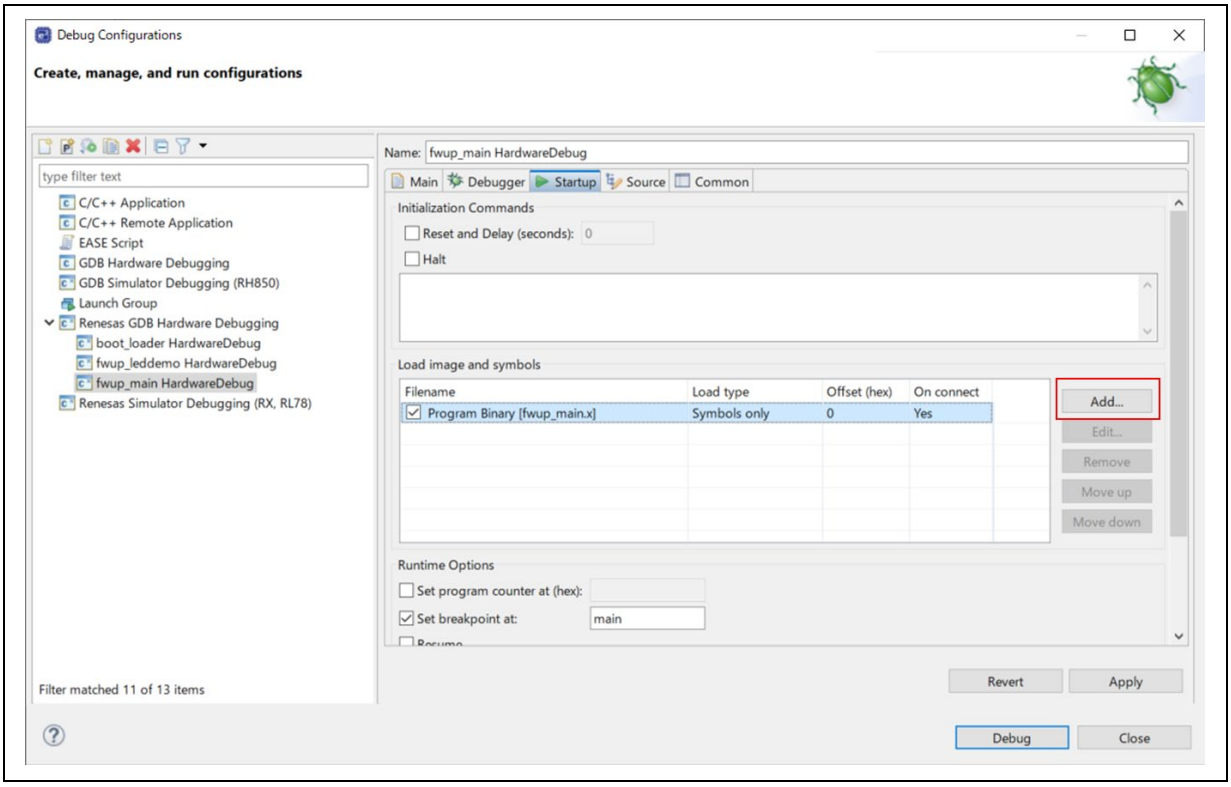
c) Change the load type of the program binary [fwup_main.x] from "Image and Symbol" to "Symbol Only".



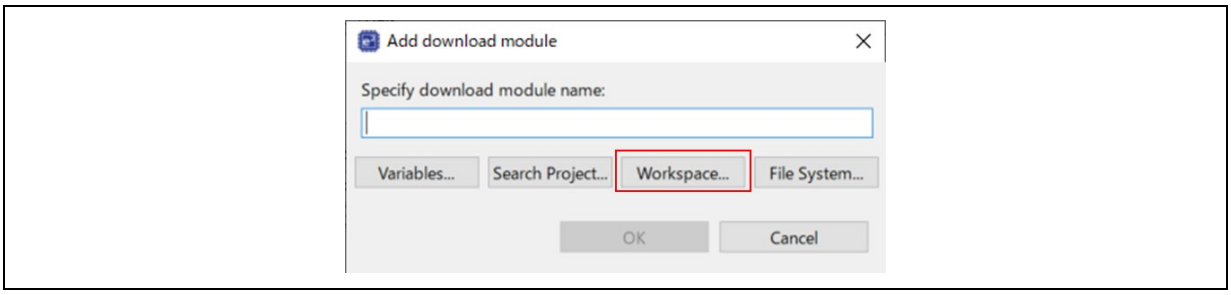
(5) Add the bootloader (boot_loader) symbol.

Follow the procedure below to add the boot loader (boot_loader) symbol built in step (1).

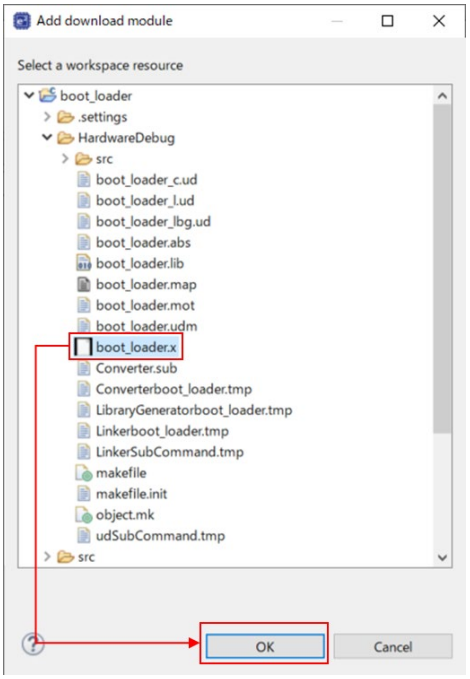
a) Click "Add".



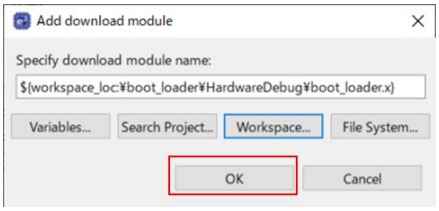
b) Click "Workspace".



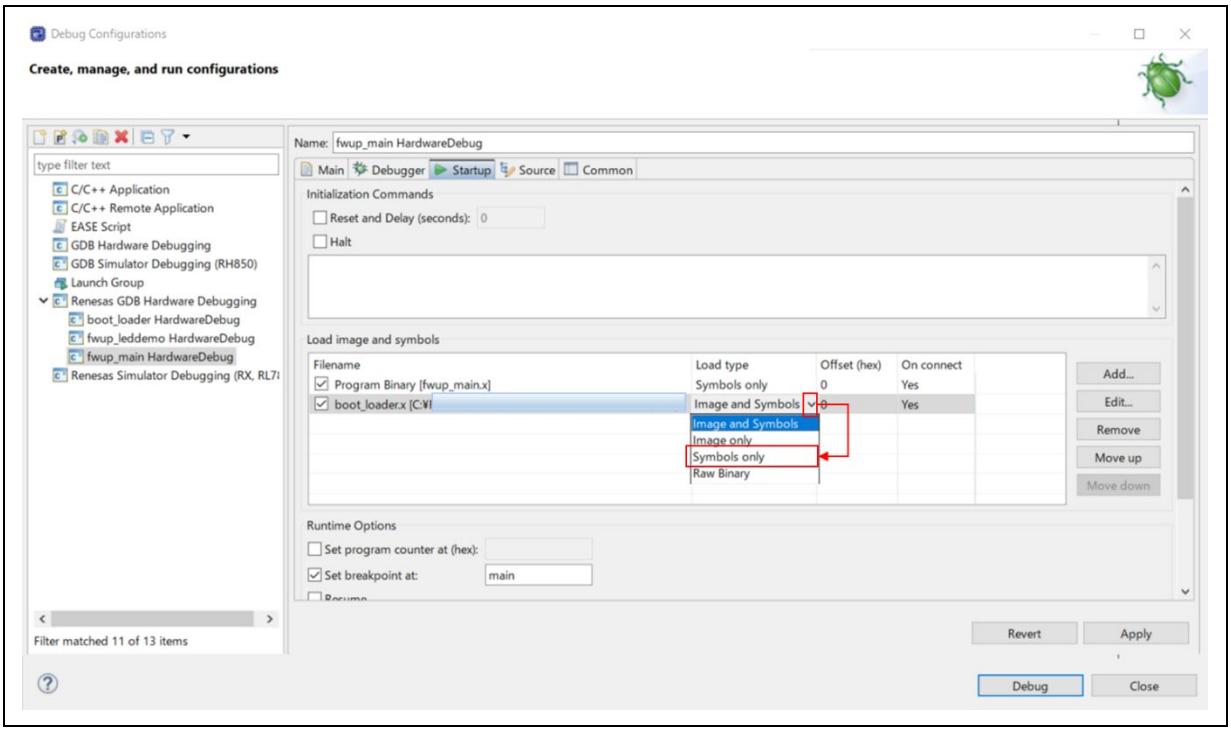
c) Select the bootloader (boot_loader.x) and click "OK.".



d) Confirm that the download module name is set to bootloader (boot_loader.x) and click "OK.



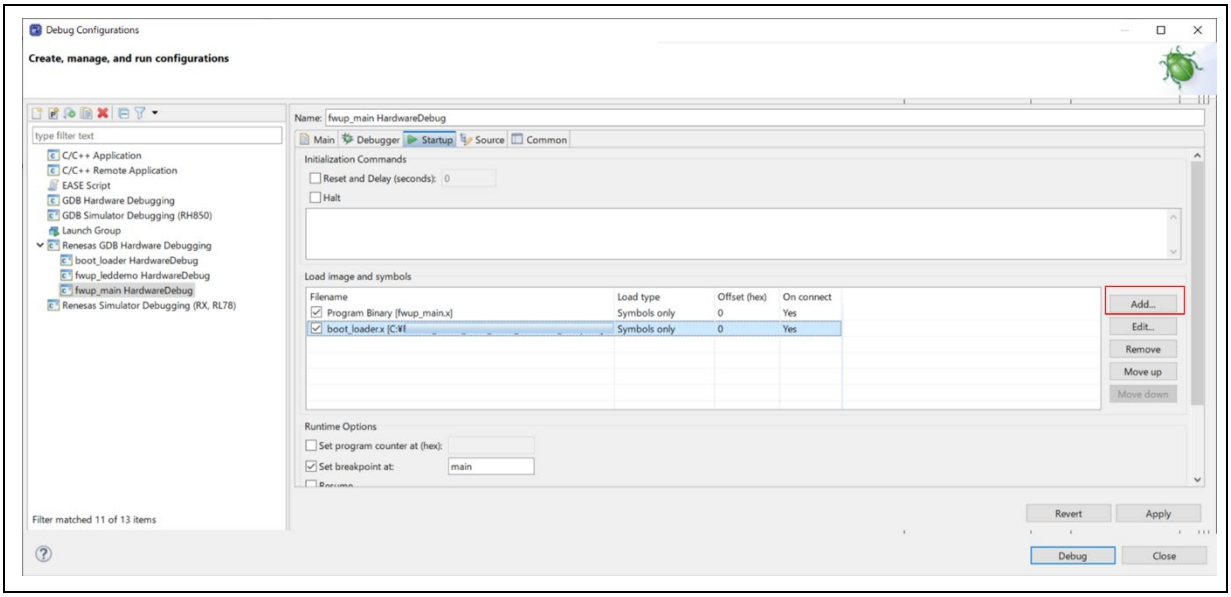
e) Change the load type of the bootloader (boot_loader.x) from "Image and Symbol" to "Symbol only".



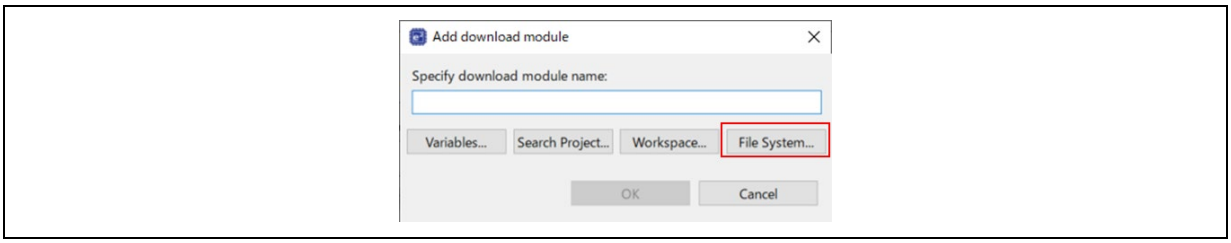
(6) Add the image of the initial image (initial_firm.mot).

Add the image of the initial image (initial_firm.mot) generated in step (2) according to the following procedure.

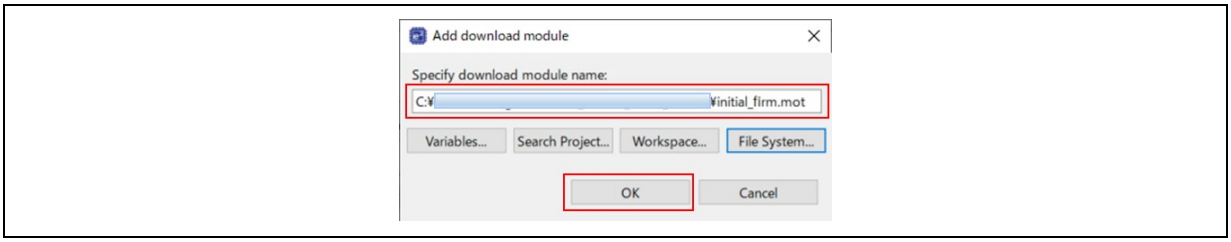
a) Click "Add".



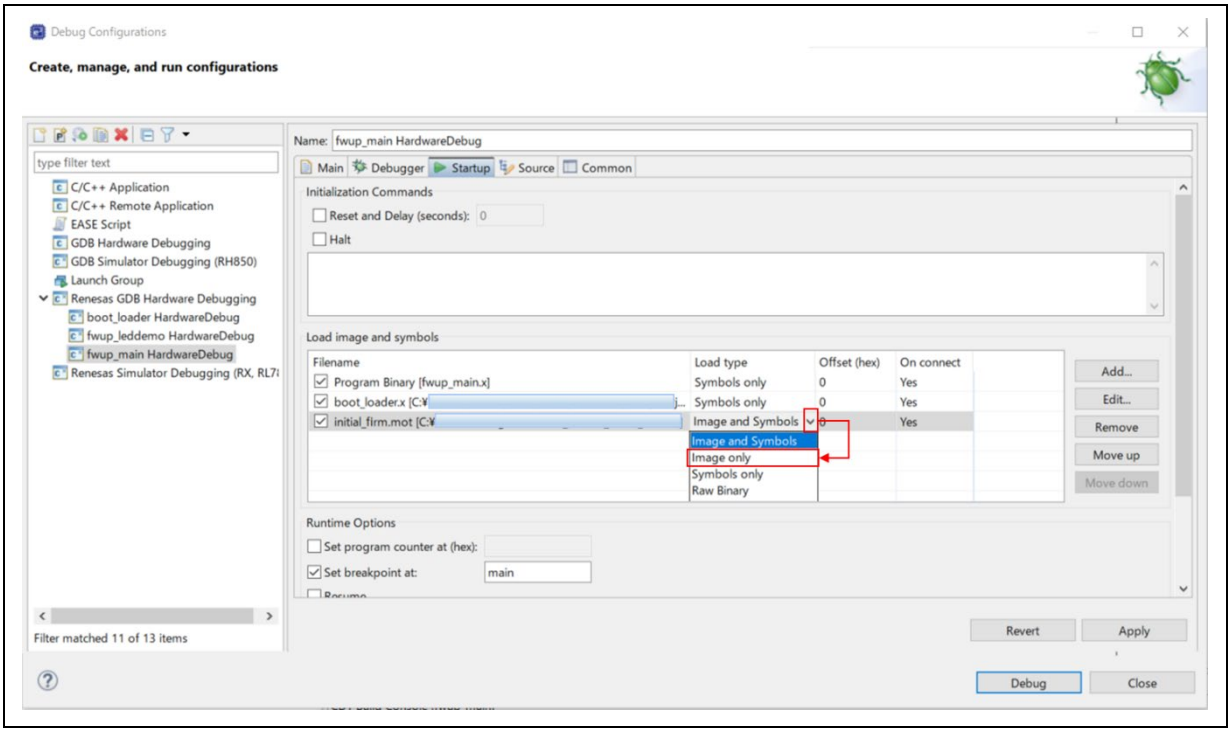
b) Click "File System".



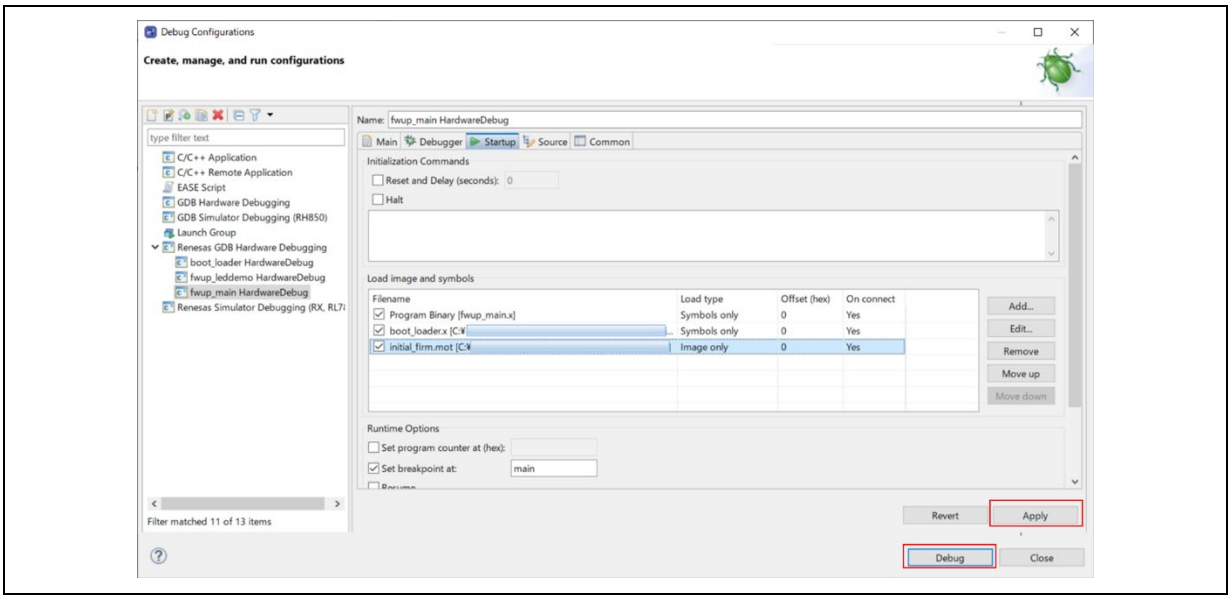
c) Select the initial image (initial_firm.mot) and click "OK".



d) Change the load type of the initial image (initial_firm.mot) from "Image and Symbol" to "Image only" and click "OK".

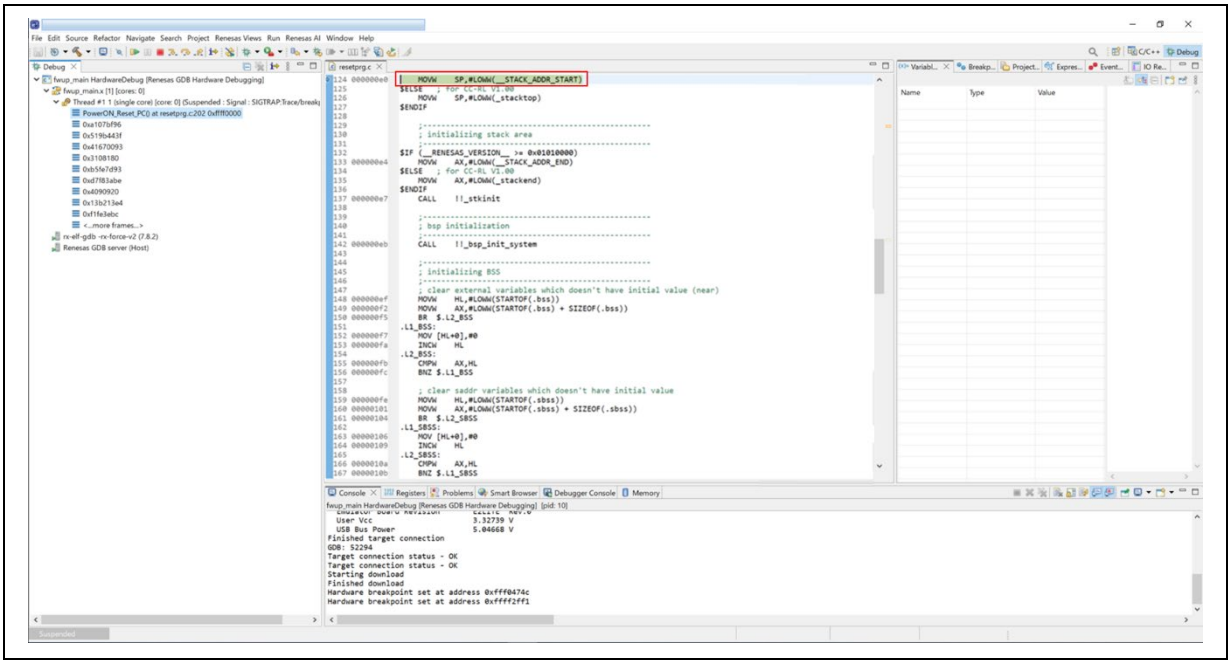


e) Click "Apply" and click "Debug".



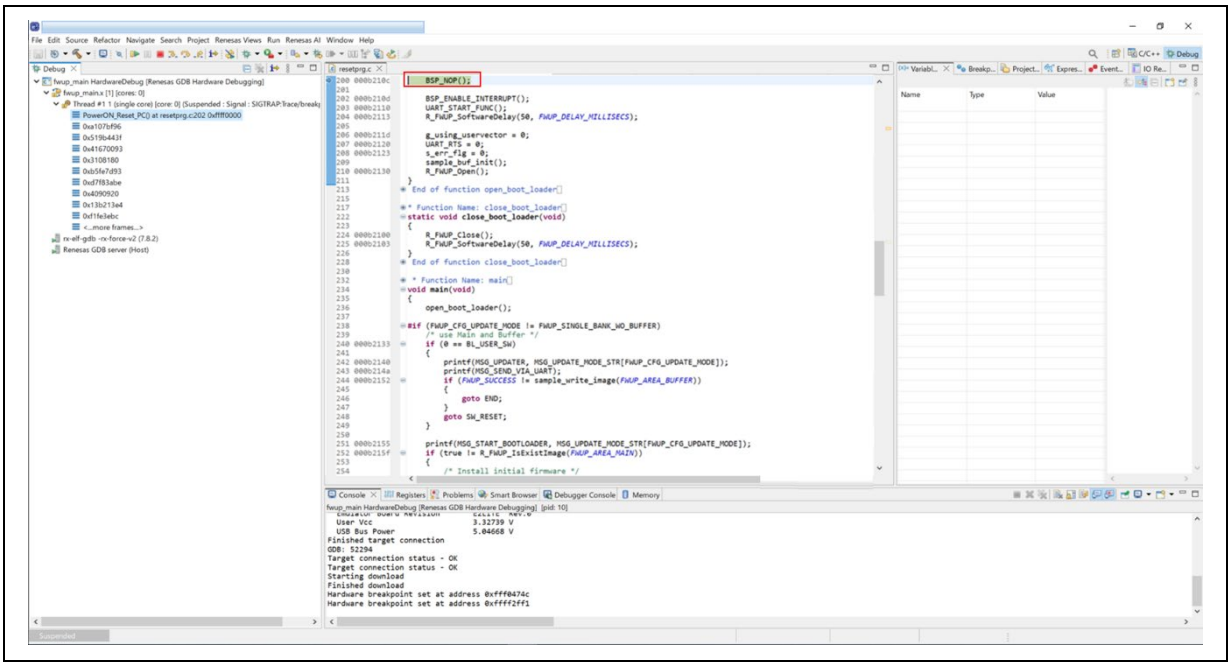
(7) Start the debugger.

When the debugger starts, it jumps to cstart.asm in the boot_loader project.



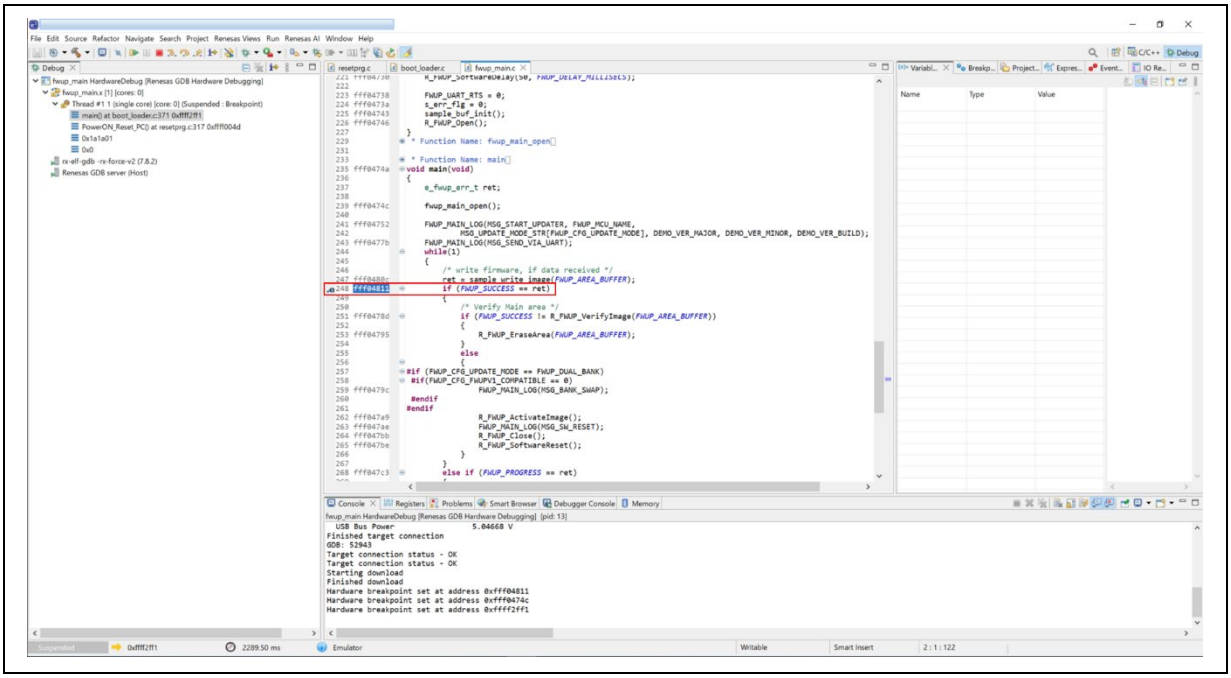
(8) Resume the program.

When you click "Resume", the program stops at the beginning of the main() function in boot_loader.c. project.



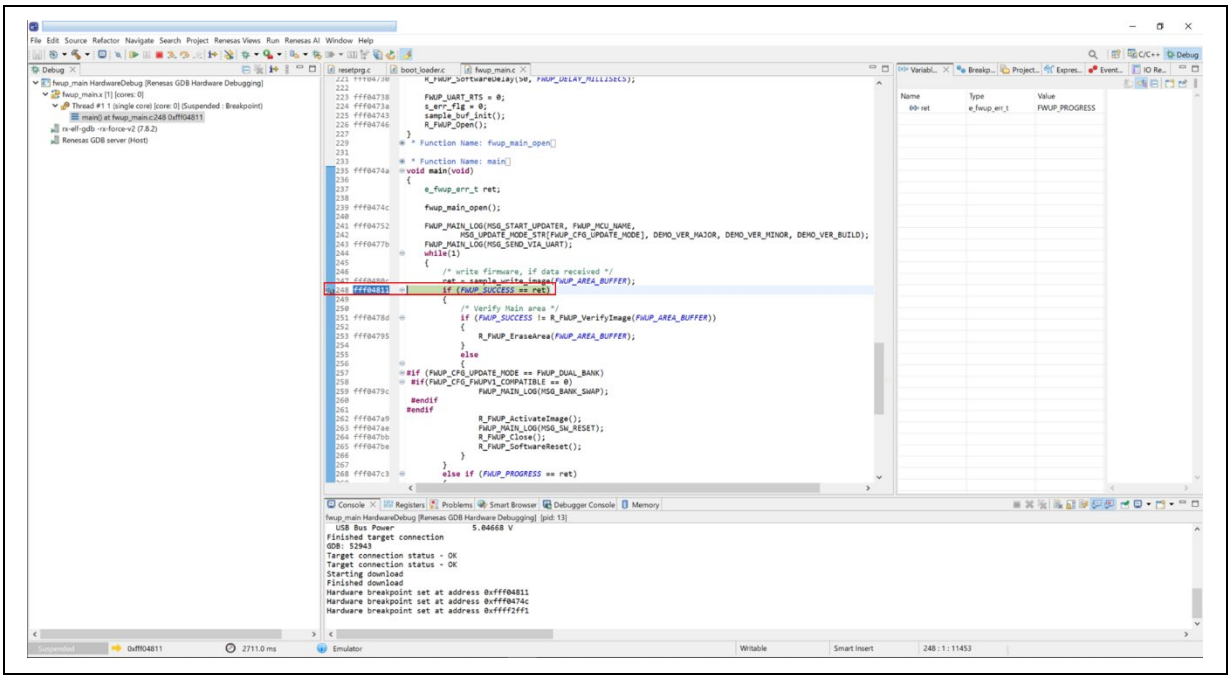
(9) Set a breakpoint in main() of the fwup_main project.

Set a breakpoint in the following red frame in main() of the fwup_main project.



(10) Resume the program.

Click "Resume" and stop at the breakpoint set in (8).



4.9 How to Change the Update Image Retrieval Path for the Demo Project

In this demo project, the update image is retrieved from a PC via serial communication. This section describes cases where the retrieval path for this image is changed (e.g., SD card, USB memory, etc.).

Figure 4.4 show the flowchart of the demo project (the main function in fwup_main.c). Please first refer to the demo project when considering how to change the retrieval path for the update image.

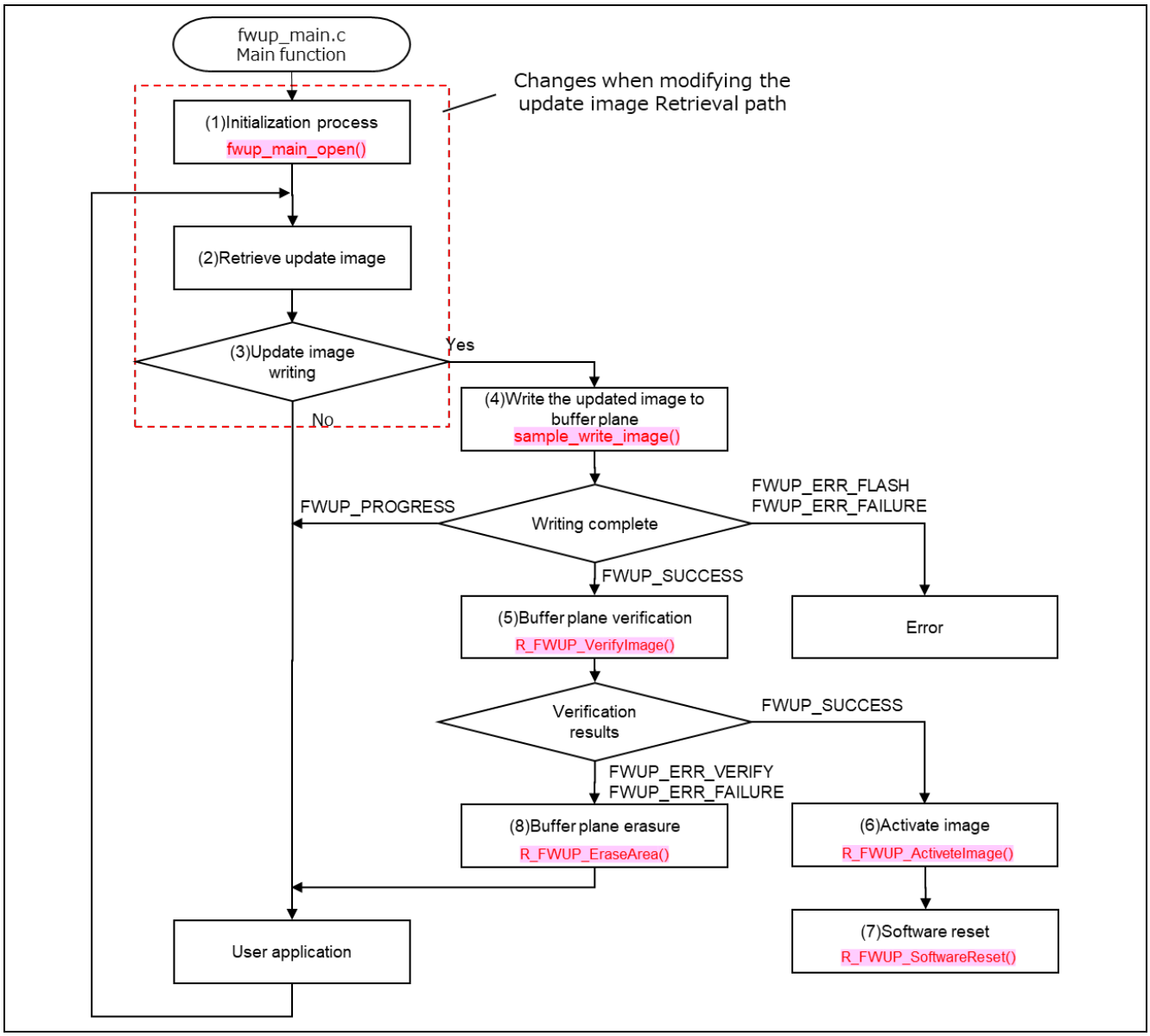


Figure 4.4 Flowchart for fwup_main in the demo project

Note: For full update method (without buffer plane), the bootloader is responsible for retrieving the update image. Therefore, if you are considering using this method, please interpret the explanations in this document as applying to the bootloader instead.

The sections that need to be modified when changing the retrieval path of the update image are parts (1), (2), and (3). Sections (4) and onward relate to the update process itself, so in principle, no changes are required.

(1) For the initialization process, not only the Firmware Update Module initialization but also the initialization of various modules used to retrieve the update image is performed.

In the demo project, the initialization of the Serial Communication module, the Firmware Update module, and the related variables is performed.

(2) Buffer the update image obtained from external sources in RAM or similar memory.

Various methods can be used to obtain the update image from external sources (e.g., SD cards, USB flash drives). For image acquisition, refer to Renesas application notes and other relevant documents, and implement the method on the user side.

In the demo project, the Serial Communication module is used, and the update image is retrieved through the callback function (sci_callback) that is invoked upon completion of the communication interrupt. Once buffering of the update image is completed, the RTS pin (FWUP_UART_RTS) is asserted to provide notification.

(3) Once buffering of the update image is complete, proceed with the write operation.

It is not necessary to prepare the entire update image at once. You may retrieve and buffer the update image in chunks of a size convenient for your system, and perform the write operation sequentially. However, note that each product has a specific minimum write unit for its flash memory, so ensure that processing is performed in multiples of that write unit.

Example: For the RL78/G23, since the code flash write unit is 4 bytes, valid settings include 64, 128, and 256 bytes.

When writing the update image, interrupts will be disabled during the flash operation. Therefore, if the update image is retrieved via interrupt processing, there is a possibility of data loss during the write period. To avoid this, consider implementing a mechanism to temporarily suspend the retrieval of the update image—similar to the RTS control used for serial communication in the demo project.

In the demo project, the state of the RTS pin (FWUP_UART_RTS) is monitored, and the write operation is initiated once it is asserted.

The following summarizes additional notes for understanding the demo project.

<Notes regarding *fwup_main.c*>

- In the demo project, serial communication is used to retrieve the update image. Due to the characteristics of serial communication, there may be a delay before the transmission from the communication peer stops in response to RTS control. To prevent loss of update image data, a delay process is inserted before initiating the write operation.
- (4) Regarding the writing of the update image, please write the data sequentially from the beginning of the update image.
  If the order of the data may be altered depending on the communication method, ensure that the data is rearranged into the correct order before writing.
  Since the update image cannot be written in a single operation—depending on the buffer size—you must perform the write process in multiple iterations. During this period, until all data corresponding to the full size of the update image has been written, the function will return the status ‘in progress’ (FWUP_PROGRESS). Please continue retrieving and writing the update image until the entire image has been written.
  Once all writing operations have been completed successfully, the function will return FWUP_SUCCESS.
- If the flash error (FWUP_ERR_FLASH) is returned during the update-image write process (4), it is highly likely that an error has occurred in the flash memory. In this case, please erase the buffer plane and restart the entire procedure from the beginning.

- The size of the update image is obtained using the R_FWUP_GetImageSize function. Since the size information is stored in the RSU header located at the beginning of the update image, the correct size cannot be obtained until the writing of the RSU header portion has been completed. Until it can be retrieved correctly, this API will return 0.
- (6) The process for activating the update image differs depending on the update method.
  Dual-bank method: A bank-swap operation is performed.
  Non–dual-bank methods: No special operation is performed.
  Therefore, for non–dual-bank methods, the activation process for the update image is not required. In update methods other than dual-bank, operations such as copying from the buffer plane to the main area are handled by the bootloader.
- (7) Regarding software reset, while the demo project performs it immediately after writing completion, you may perform it at a convenient time for each system without issue.
- (8) Regarding the erasure of the buffer plane, the update image is erased if signature verification of the buffer plane fails. The behavior after erasure depends on the customer's system.
  If signature verification fails in the field, it may indicate that the device is being updated with an invalid update image. Therefore, it is recommended to stop the update process in such cases.

<Notes regarding *bootloader.c*>

- The bootloader is designed to be used in a general-purpose manner, so it can essentially be used as is.
- In linear mode full update method (without buffer), the bootloader acquires the update image. Therefore, if considering this method, please review the processing within the bootloader.
  The process from acquiring the update image in the bootloader to performing the update is nearly identical to the corresponding section in fwup_main.
- In the demo project for the dual-bank method, the buffer plane is not erased after the update.
  If you do not want to retain the pre-update image—for example, to prevent rollback—please add a process to erase the buffer plane after the bootloader successfully verifies the signature of the main area.
  In methods other than dual-bank, the buffer plane is erased after the bootloader completes the update process (copying from the buffer plane to the main area).
- If you are modifying and using the bootloader, please also refer to 7.1.

4.10 How to Add Interrupt Handling to the Demo Project

This section describes the flow of interrupt processing in the demo project, as well as how to add user-defined interrupt handling.

4.10.1 Flow of Interrupt Processing in the Demo Project

On the RL78, the vector table addresses (0x00 to 0x7F) are fixed; therefore, a common vector table must be used by both the bootloader and the user application. As a result, when an interrupt occurs, it is necessary to determine whether the interrupt is intended for the bootloader or the user application and dispatch it accordingly. These processes are handled by the bootloader.

This section describes the flow of interrupt processing using the RL78/G23 demo project.

(1) An Interrupt occurs.

(2) Control jumps to the interrupt handler registered in the vector table.

(3) The interrupt handler determines the execution mode (Flag in RAM):

- Flag = 0: Execute the bootloader interrupt callback
- Flag = 1: Execute the user application interrupt callback

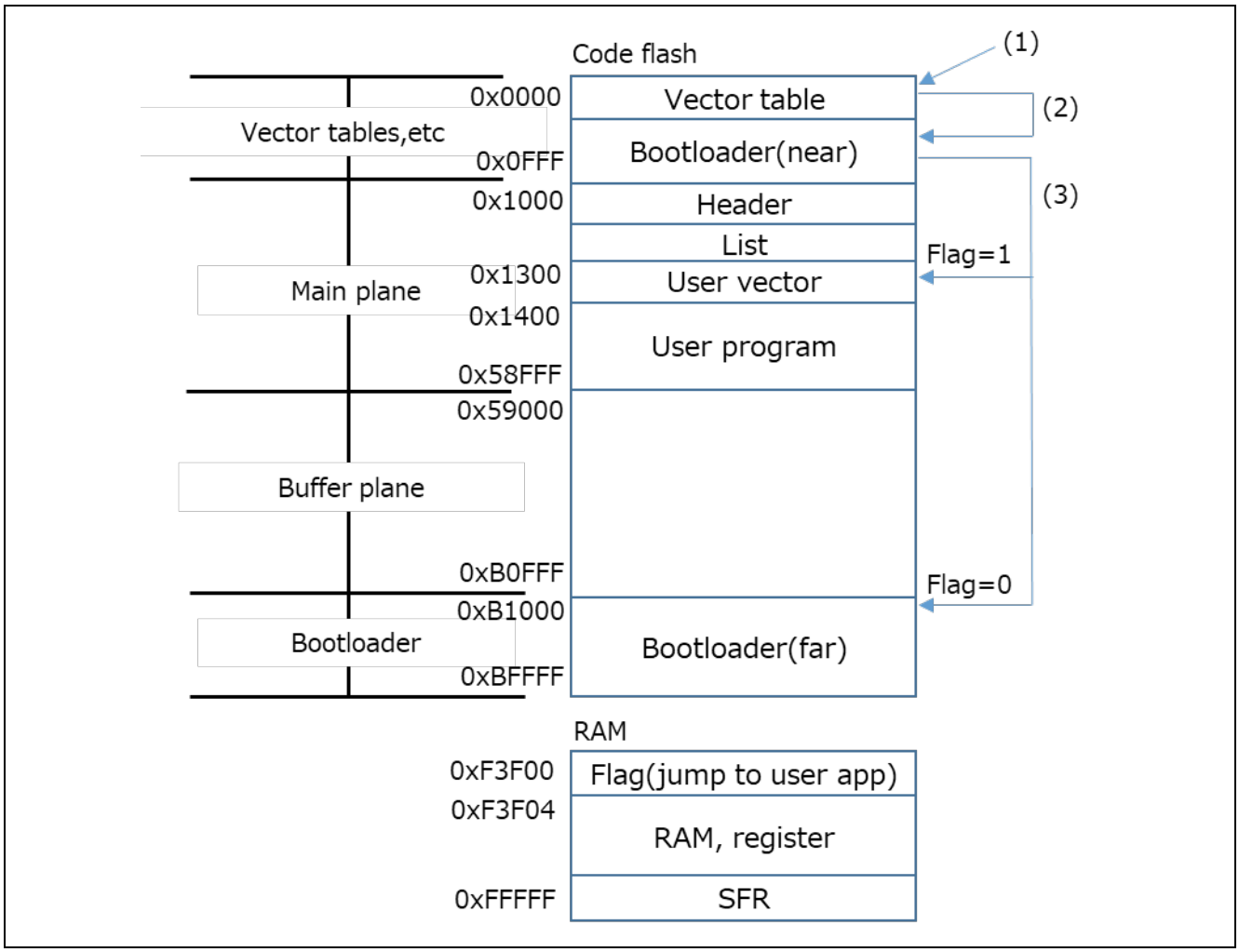


Figure 4.5 Interrupt Handling Flow

4.10.2 How to Add Interrupt Processing to the Demo Project

This section describes the procedure for adding interrupt handling to the demo project (fwup_main.c).

(1) Add the component that uses interrupts by using the code generation function.

(2) Remove the hardware interrupt handler definition from the added source code.

For example, when UART2 is added, remove the hardware interrupt handler definition from Config_UART2_user.c.

```
fwup_main\src\Config_UART2\Config_UART2_user.c
/***********************************************************************
Includes
***********************************************************************/
#include "r_cg_macrodriver.h"
#include "r_cg_userdefine.h"
#include "Config_UART2.h"
/* Start user code for include. Do not edit comment generated here */
/* End user code. Do not edit comment generated here */

/***********************************************************************
Pragma directive
***********************************************************************/
#pragma interrupt r_Config_UART2_interrupt_send(vect=INTST2)                Remove
#pragma interrupt r_Config_UART2_interrupt_receive(vect=INTSR2)
#pragma interrupt r_Config_UART2_interrupt_error(vect=INTSRE2)
/* Start user code for pragma. Do not edit comment generated here */
```

(3) Create a global interrupt handler function and replace the existing function with it.

For UART2, replace the following function in Config_UART2_user.c.

- static void __near r_Config_UART2_interrupt_send(void) ⇒ void r_isr_txi(void)
- static void __near r_Config_UART2_interrupt_receive(void) ⇒ void r_isr_rxi(void)
- static void __near r_Config_UART2_interrupt_error(void) ⇒ void r_isr_eri(void)

fwup_main\src\Config_UART2\Config_UART2_user.c

```
static void r_Config_UART2_callback_error(uint8_t err_type)
{
    /* Start user code for r_Config_UART2_callback_error. Do not edit comment generated here */
    /* End user code. Do not edit comment generated here */
}
```

Remove

```
static void __near r_Config_UART2_interrupt_send(void)
  . . .
static void __near r_Config_UART2_interrupt_receive(void)
  . . .
static void __near r_Config_UART2_interrupt_error(void)
  . . .
```

```
/* Start user code for adding. Do not edit comment generated here */
```

Add

```
void r_isr_txi(void)
{
    if (g_uart2_tx_count > 0U)
    {
        TXD2 = *gp_uart2_tx_address;
        gp_uart2_tx_address++;
        g_uart2_tx_count--;
    }
    else
    {
        r_Config_UART2_callback_sendend();
    }
}

void r_isr_rxi(void)
{
    uint8_t rx_data;
    rx_data = RXD2;
    sample_buffering(rx_data);
}

void r_isr_eri(void)
{
    uint8_t err_type;

    *gp_uart2_rx_address = RXD2;
    err_type = (uint8_t)(SSR11 & 0x0007U);
    SIR11 = (uint16_t)err_type;
    r_Config_UART2_callback_error(err_type);
}
```

```
/* End user code. Do not edit comment generated here */
```

(4) Register the replaced interrupt handler function in branch.asm.

For UART2, register the function replaced in step (3) in the branch table at addresses 0x14 to 0x18.

```
fwup_main\src\ branch.asm
usr_vect    .cseg at 0x00001300
            br       !!_start        ;reset
            .db4     0xffffffff
            .db4     0xffffffff      ;vect=0x04
            .db4     0xffffffff      ;vect=0x06
            .db4     0xffffffff      ;vect=0x08
            .db4     0xffffffff      ;vect=0x0A
            .db4     0xffffffff      ;vect=0x0C
            .db4     0xffffffff      ;vect=0x0E
            .db4     0xffffffff      ;vect=0x10
            .db4     0xffffffff      ;vect=0x12
            br       !!_r_isr_txi    ;vect=0x14
            br       !!_r_isr_rxi    ;vect=0x16
            br       !!_r_isr_eri    ;vect=0x18
            .db4     0xffffffff      ;vect=0x1A
            .db4     0xffffffff      ;vect=0x1C
            .db4     0xffffffff      ;vect=0x1E
            .db4     0xffffffff      ;vect=0x20
```

Register

4.11 How to Use a Memory Layout Different from That of the Demo Project

If you want to perform a firmware update using a memory size different from that of the demo project, the parameter file included in the package cannot be used as-is. By modifying the required items according to the memory layout, you can generate the initial image and update images.

For details on the memory layout of the demo project, refer to Section 6.2.
For details on the parameter file, refer to Section 5.3.

As Example 1, this section shows the modified items when the parameter file provided for the RL78/G23 partial update method is changed to the following memory layout:

- Product name: RL78/G23
- Update method: Partial update method
- Code flash size: 768 KB -> 256 KB
- Bootloader size: 64 KB -> 48 KB

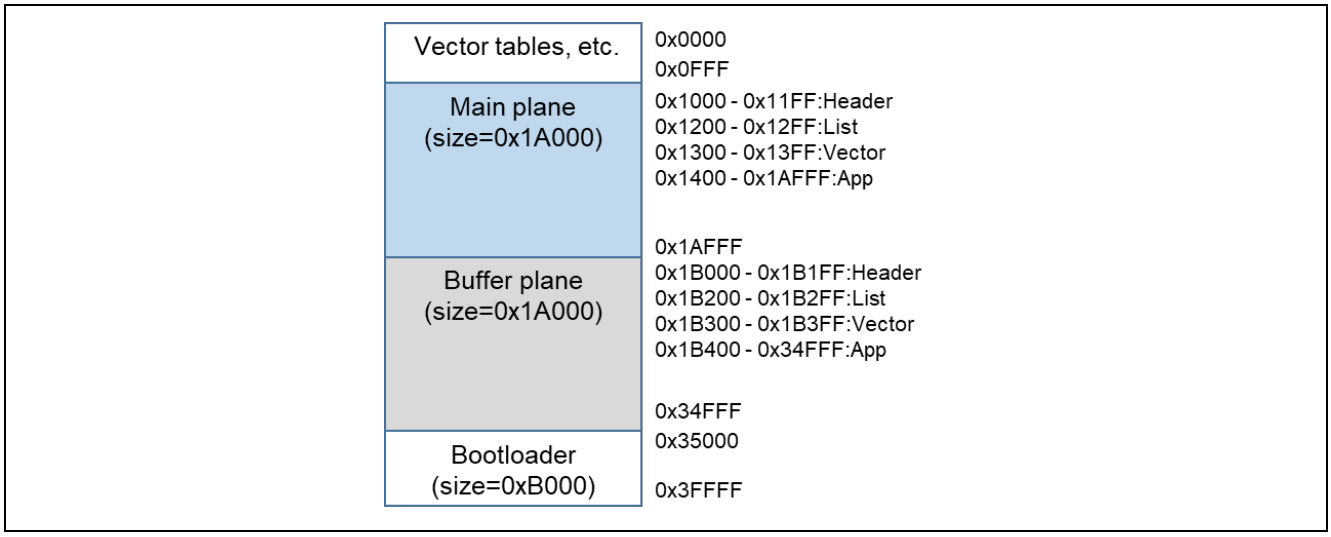


Figure 4.6 Memory map for the RL78/G23 (Code Flash: 256 KB, Bootloader: 48 KB) using the partial update method

In this example, the bootloader size allocated in the demo project is reduced from 64 KB to 48 KB.

Because the bootloader size varies depending on the firmware update configuration options, the memory region not used by the bootloader can be reallocated to the main area and buffer area as appropriate.

Note: The bootloader size includes the vector table, etc.

The modified items in the parameter file are as follows:

- Bootloader Start Address: 0x000B1000 → 0x00035000
- Bootloader End Address: 0x000BFFFF → 0x0003FFFF
- User Program End Address: 0x00058FFF → 0x0001AFFF

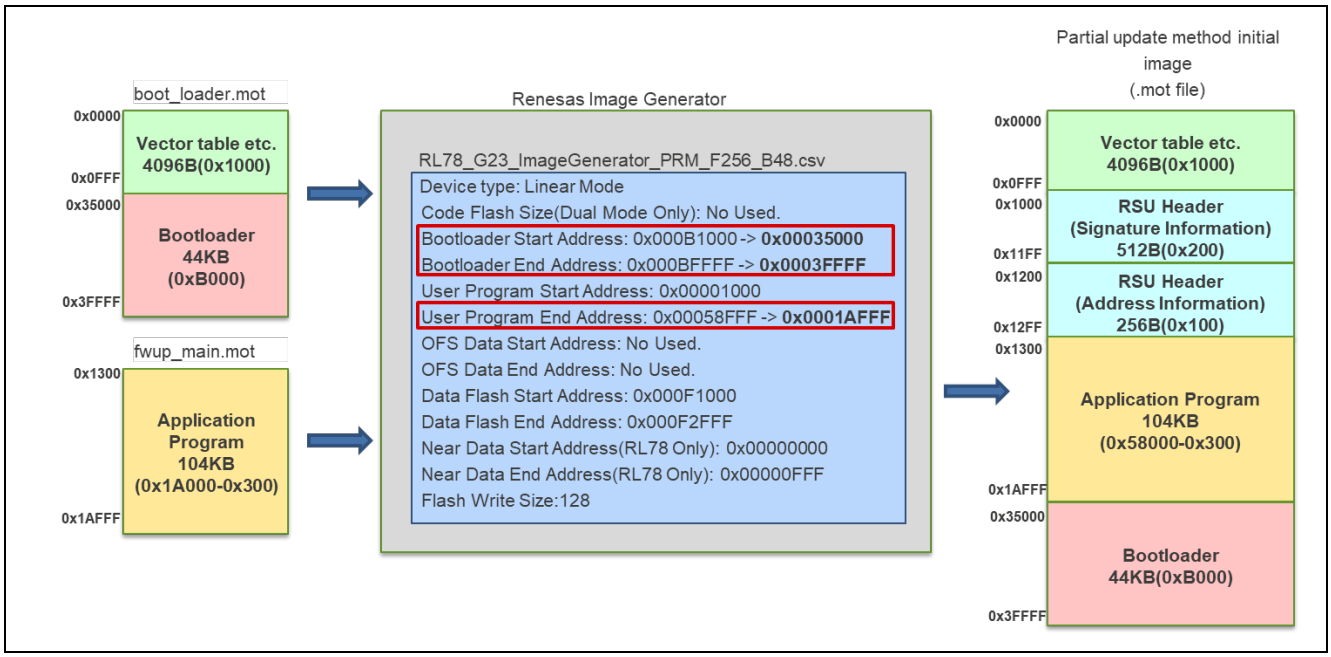


Figure 4.7 Example of parameter file settings for the partial update method
for the RL78/G23 (Code Flash: 256 KB, Bootloader: 48 KB)

As Example 2, this section shows the modified items when the parameter file provided for the RL78/L23 dual-bank (2-bank) update method is changed to the following memory layout:

- Product name: RL78/L23
- Update method: Dual-bank (2-bank) update method
- Code flash size: 512 KB -> 256 KB
- Bootloader size: 64 KB -> 48 KB

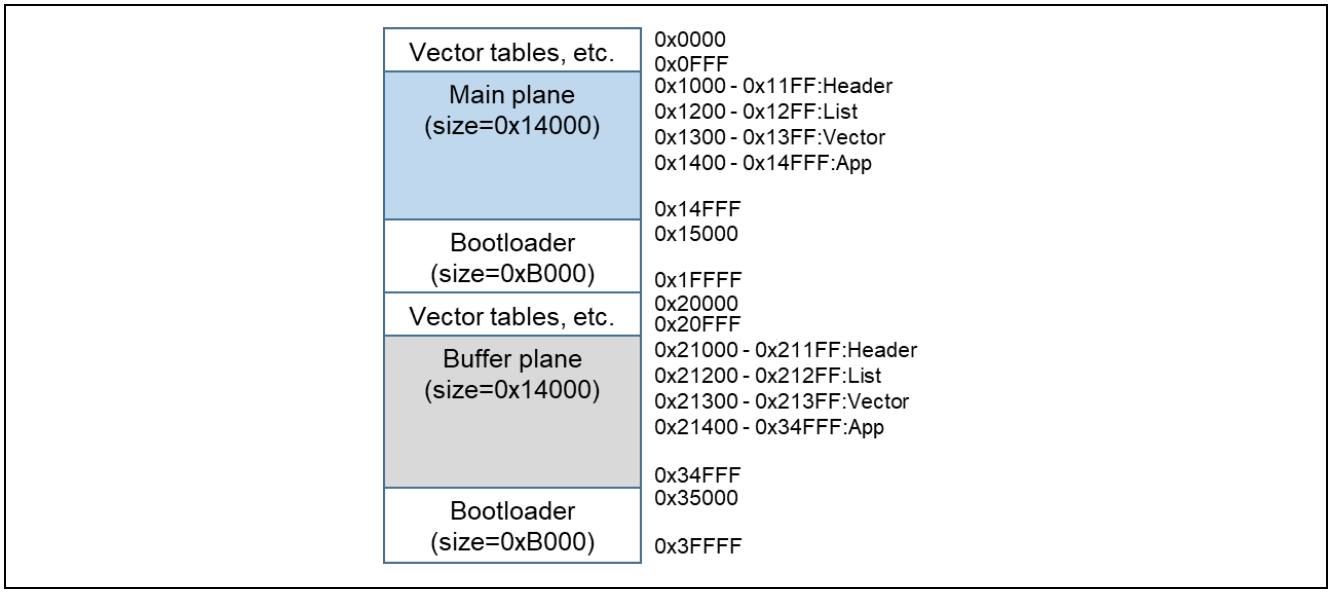


Figure 4.8 Memory map for the RL78/L23 (Code Flash: 256 KB, Bootloader: 48 KB) using the dual-bank(2-bank) method

The modified items in the parameter file are as follows:

- Code Flash Size(Dual Mode Only): 0x00080000 → 0x00040000
- Bootloader Start Address: 0x00031000 → 0x00015000
- Bootloader End Address: 0x0003FFFF → 0x0001FFFF
- User Program End Address: 0x00030FFF → 0x00014FFF

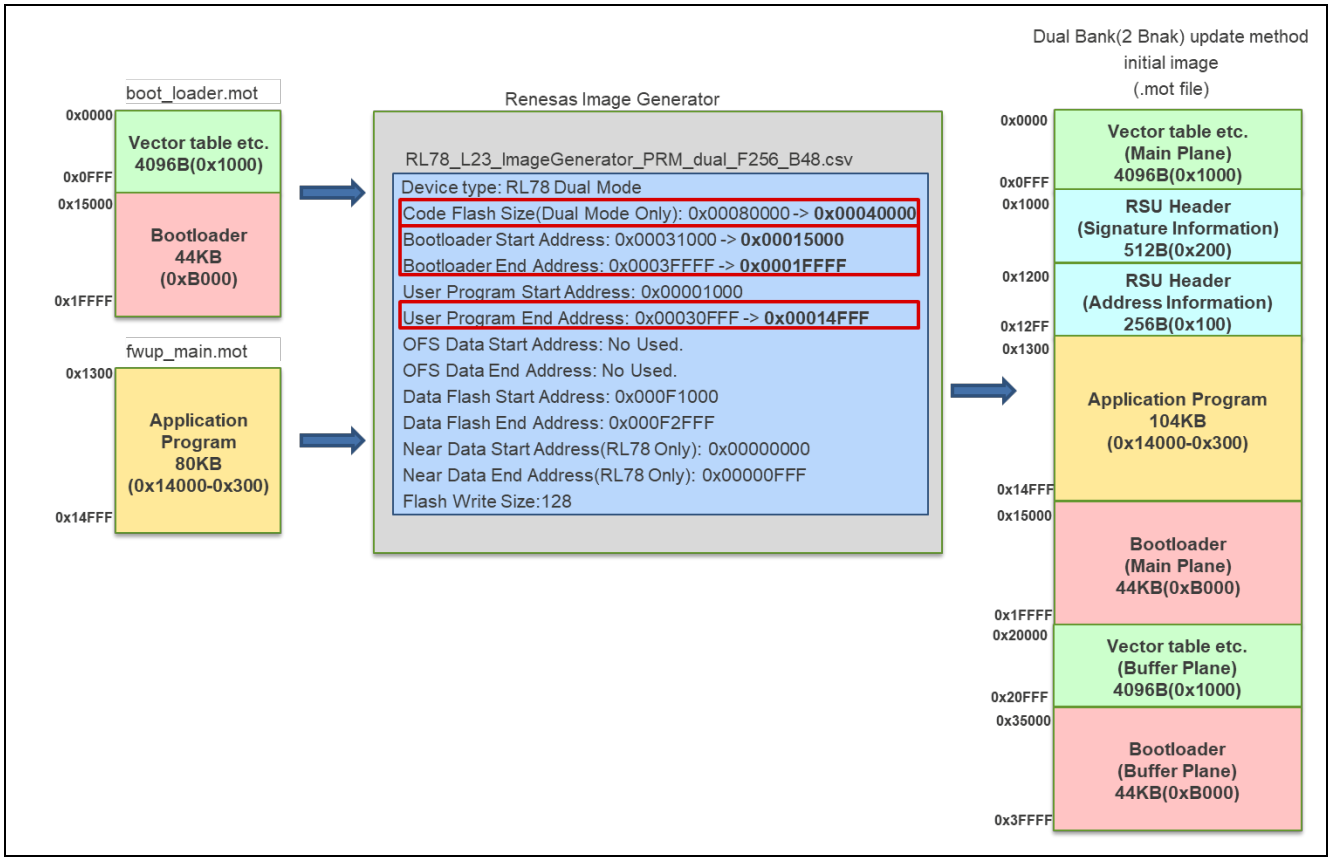


Figure 4.9 Example of parameter file settings for the dual-bank(2-bank) method
for the RL78/L23(Code Flash: 256 KB, Bootloader: 48 KB)

5. Renesas Image Generator

Renesas Image Generator is a utility tool that generates firmware images for use with firmware update modules. The Renesas Image Generator can generate the following images used by the firmware update module.

- Initial image: An image file containing the bootloader and application program that is programmed using Flash Writer at the time of initial system configuration (extension: mot).
- Update image: An image file containing the firmware update (extension: rsu).

See 5.1 for how to generate an image, and 5.2 to 5.3 for details on image configuration and parameter files.

Renesas Image Generator is a program that runs on Python.

5.1 Image Generation Methods

Describes the specifications of Renesas Image Generator (image-gen.py) and how to generate an image file (initial image or update image) using this tool.

See 5.1.1 for how to generate an initial image, and 5.1.2 for how to generate an update image.

The format of the image-gen.py command is as follows:

```
python image-gen.py < options >
```

Some image-gen.py command options are required and others are optional. Table 5.1 lists the required image-gen.py options, and Table 5.2 lists the optional image-gen.py options.

Table 5.1 Required Options of image-gen.py

Option	Description
-iup <file>	Specifies the application program. For the character string < file >, specify the mot file name (the full path including the file name) of the user application program.
-ip <file>	Specifies a parameter file. For the character string < file >, specify the name of the file (the full path including the file name) containing the parameters to be input.
-o <file>	Specifies the file name of the output image. For the character string < file >, specify the file name (the full path including the file name), excluding the extension, of the firmware update image file to be output. The file extension is .mot because the output image is determined to be the initial image when the bootloader is specified with the -ibp <file> option. If you omit the -ibp <file> specification, the output image is determined to be an update image and becomes .rsu.

Table 5.2 Optional Options of image-gen.py

Option	Description
-ibp <file>	Specifies the bootloader. For the character string < file >, specify mot file name (the full path including the file name) of the bootloader program. Specify this option when generating a mot file.
--key <file>	Specify the name of the key file to be used to sign the image using ECDSA. (This option does not need to be set if sha256 is specified for the -vt option.) Store the file **secp256r1.privatekey** in the command execution folder. If the file name has been changed, specify the full path including the file name.
-vt <VerificationType>[sha256 / ecdsa]	Specifies the image verification method in the firmware update module. The following VerificationType can be specified. sha256: Append a hash of the image. If this option is omitted, "sha256" is specified. ecdsa: Adds an image signature. The key file specified by -key is used to generate signature data. An error will result if the key file is not specified with -key.
-ff <FileFormat>	Specifies the RSU format type. The following FileFormat can be specified BareMetal: Generates an image of the application program data with RSU header signature information. This is the RSU format used in the demo project. If this option is omitted, "BareMetal" is specified. RTOS: Generates an updated image for AWS S3 (OTA). Update images for AWS S3 (OTA) do not add RSU header signature information. If you are using a service other than AWS S3 (OTA), please configure BareMetal. BareMetal_FWUP_V2_V1_DATA: For special purpose. RTOS_FWUP_V2_V1_DATA: For special purpose.
-h	Output a list of commands. Specify this option to display help information for the tool.

5.1.1 Initial Image Generation Method

Renesas Image Generator has the bootloader file name (.mot) generated by build, application program (.mot), parameter file name (.csv), output file name (no extension), image verification method in firmware update module. Specify (ecdsa/sha256) as a command line option to generate an initial image file (.mot).

Command input example

```
> python image-gen.py -iup fwup_main.mot -ip
RL78_G23_ImageGenerator_PRM.csv -o initial_firm -ibp boot_loader.mot
-vt ecdsa -key secp256r1.privatekey
```

fwup_main.mot: The mot file name of the user application program
RL78_G23_ImageGenerator_PRM.csv: The name of the file containing the parameters to be input
initial_firm: The file name of the initial image file to be output
boot_loader.mot: The mot file name of the bootloader program
ecdsa: Specifies that ECDSA is used to sign the image.
secp256r1.privatekey: Key file name for signing images with ECDSA.

5.1.2 Update Image Generation Method

The Renesas Image Generator uses the update application program (.mot) generated by the build, parameter file name (.csv), output file name (no extension), image verification method (ecdsa/sha256) for the firmware update module. Set the command line options to generate an update image file (.rsu).

Command input example

```
> python image-gen.py -iup fwup_leddemo.mot -ip
RL78_G23_ImageGenerator_PRM.csv -o fwup_leddemo -vt ecdsa -key
secp256r1.privatekey
```

fwup_leddemo.mot: The mot file name of the user application program to be applied as an update
RL78_G23_ImageGenerator_PRM.csv: The name of the file containing the parameters to be input
fwup_leddemo: The file name of the update image file to be output
ecdsa: Specifies that ECDSA is used to sign the image.
secp256r1.privatekey: Key file name for signing images with ECDSA.

5.2 Image File

5.2.1 Update Image File

Figure 5.1 shows the configuration diagram of the update image file generated by Renesas Image Generator.

For the format of the RSU header, see Table 5.3.

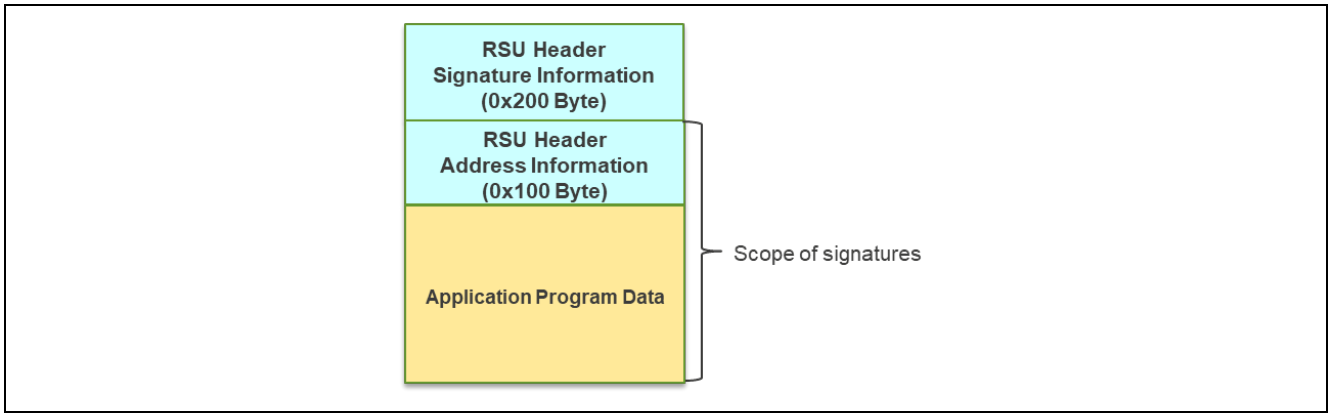


Figure 5.1 Configuring the update image file

The update image file consists of RSU header and application program data. The RSU header stores the application program location information required to verify the validity of the application program, as well as the signature value and hash value of the application program calculated based on the information. Following the RSU header, place the application program data corresponding to the program allocation information stored in the RSU header. The Renesas Image Generator arranges the application program data in the order of the data to be placed in the code flash and the data to be placed in the data flash. Valid code flash data and data flash data are extracted from the user-generated application program file (.mot), converted to binary data, and set.

The update image file has the same configuration for dual-bank(2-bank) method, partial updating method and full updating method.

Table 5.3 RSU Header Signature Information Format

Offset	Item	Length (Bytes)	Description
0x00000000	Magic Code	7	Magic code (“RELFWV2”)
0x00000007	Reserved	1	Reserved area
0x00000008	Firmware Verification Type	32	Image verification method Set sig-sha256-ecdsa to use ECDSA for image verification, and hash-sha256 to use hash.
0x00000028	Signature size	4	Data size of signature value or hash value stored in Signature Set 0x40 if Firmware Verification Type is sig-sha256-ecdsa, and 0x20 if hash-sha256.
0x0000002C	Signature	64	Signature value used for firmware verification For SHA-256 signature data, bytes 33 to 64 are set to 0x00.
0x0000006C	RSU File Size	4	File size of entire update image file
0x00000070	Reserved	400	Reserved area

Table 5.4 RSU Header Address Information Format

Offset	Item	Length (Bytes)	Description
0x00000200	Program Data Num	4	Number of subsequent divided application programs or data flashes (maximum 31)
0x00000204	Start Address[0]	4	Start address of the first application program or data flash
0x00000208	Data Size[0]	4	Size of the first application program or data flash
0x0000020C	Start Address[1]	4	Start address of second application program or data flash
0x00000210	Data Size[1]	4	Second application program or data flash size
:	:		
0x000002F4	Start Address[30]	4	Start address of the 31st application program or data flash
0x000002F8	Data Size[30]	4	Size of the 31st application program or data flash
0x000002FC	Reserved	4	Reserved area

See Figure 5.2 for the mechanism of generating the update image file.

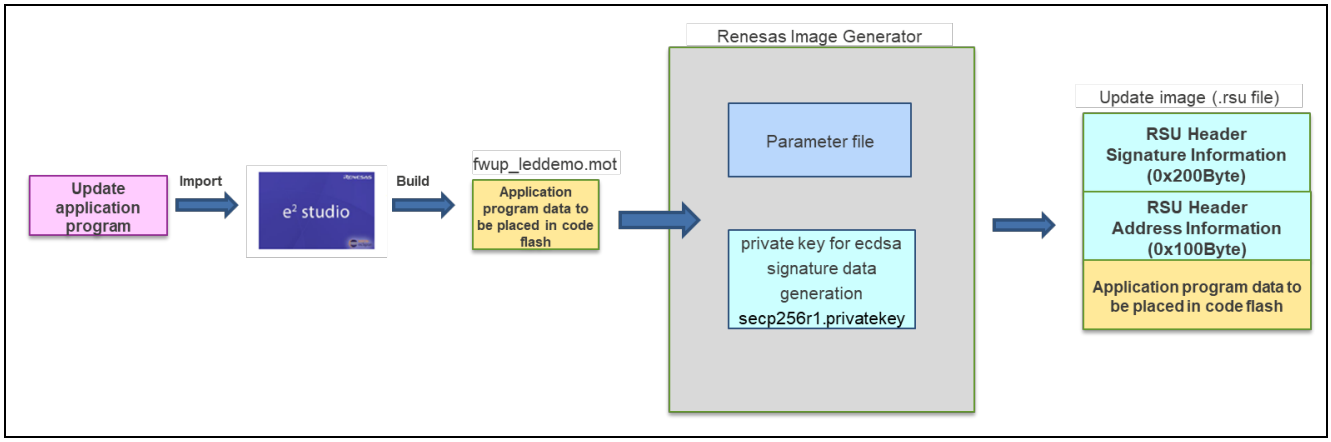


Figure 5.2 Updating image of partial / full updating method

- The parameter file is a CSV format file that contains the device address information required to generate the image file.
- The private key for generating the ecdsa signature value is used when ecdsa is specified as the image verification method in the firmware update module.

5.2.2 Initial Image File

The initial image file is the RSU header and application program data plus the bootloader program data.

Figure 5.3 and Figure 5.4 also show a diagram of the initial image file (partial / full update method).

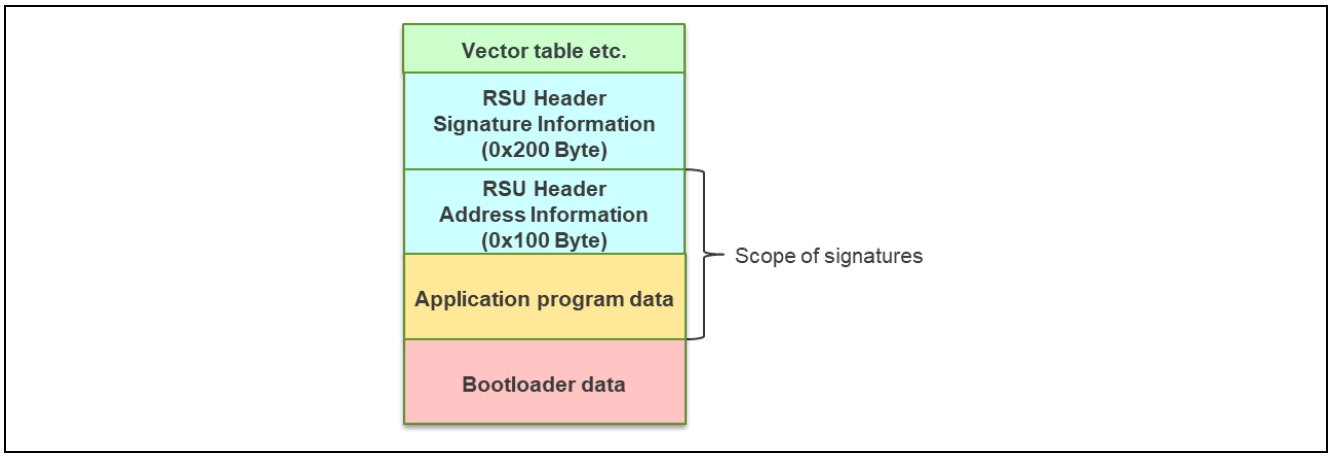


Figure 5.3 Composition of initial image file (partial / full update method)

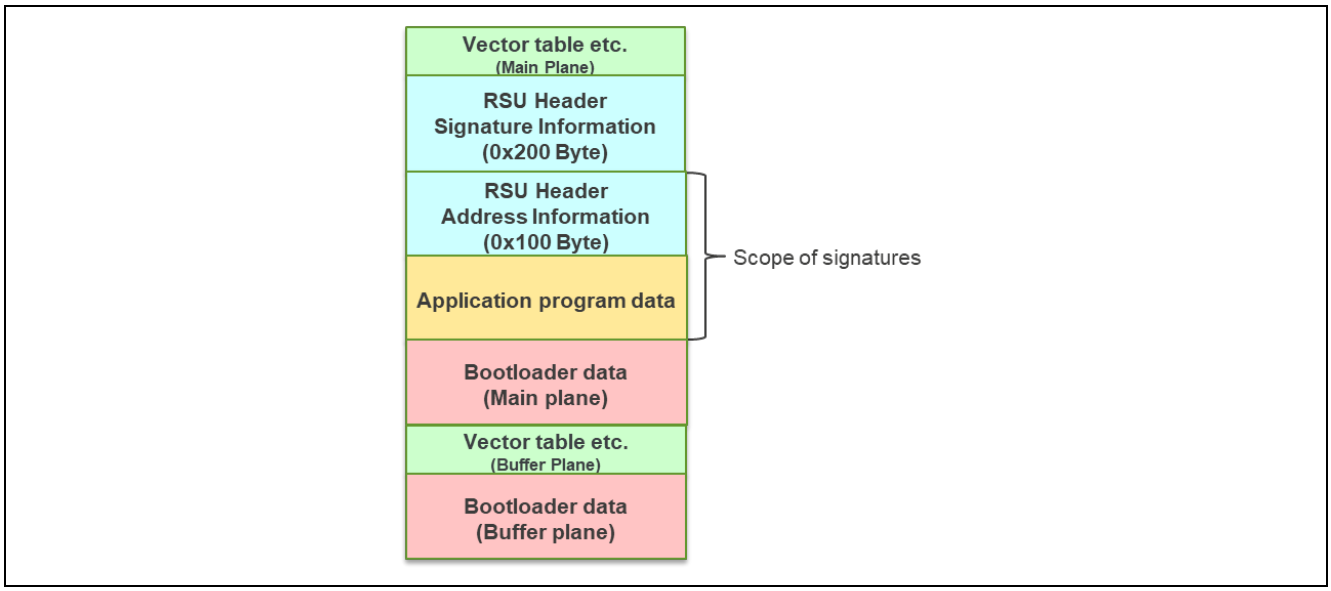


Figure 5.4 Composition of initial image file (dual-bank(2-bank) method)

In the initial image file of partial / full update method, the bootloader data to be placed on the main plane of the code flash uses the data in the user-generated bootloader file (boot_loader.mot) as is.

See Figure 5.5 and Figure 5.6 for the mechanism that generates the initial image file.

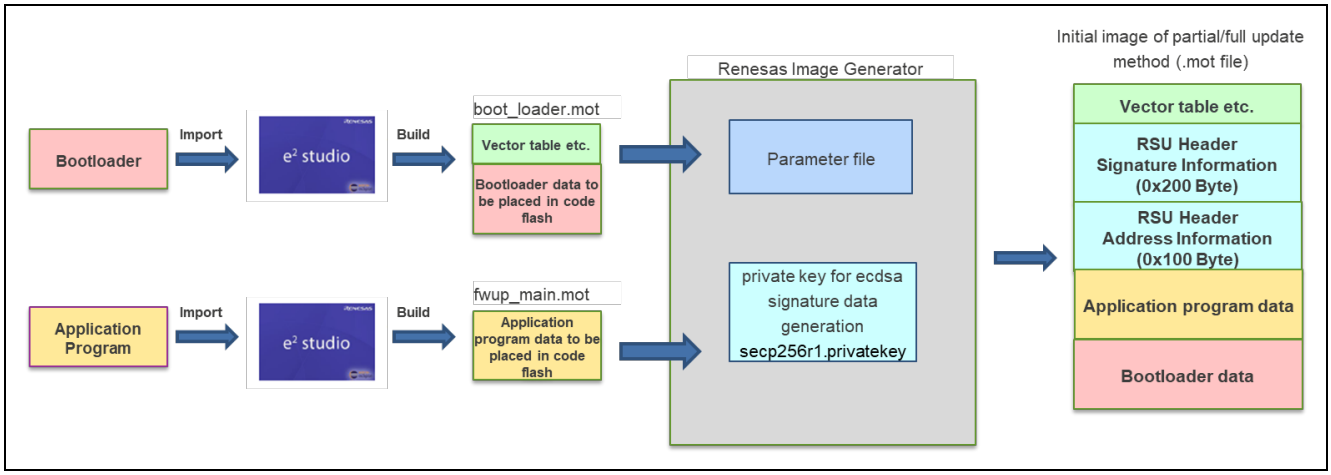


Figure 5.5 Initial image of partial/ full update method

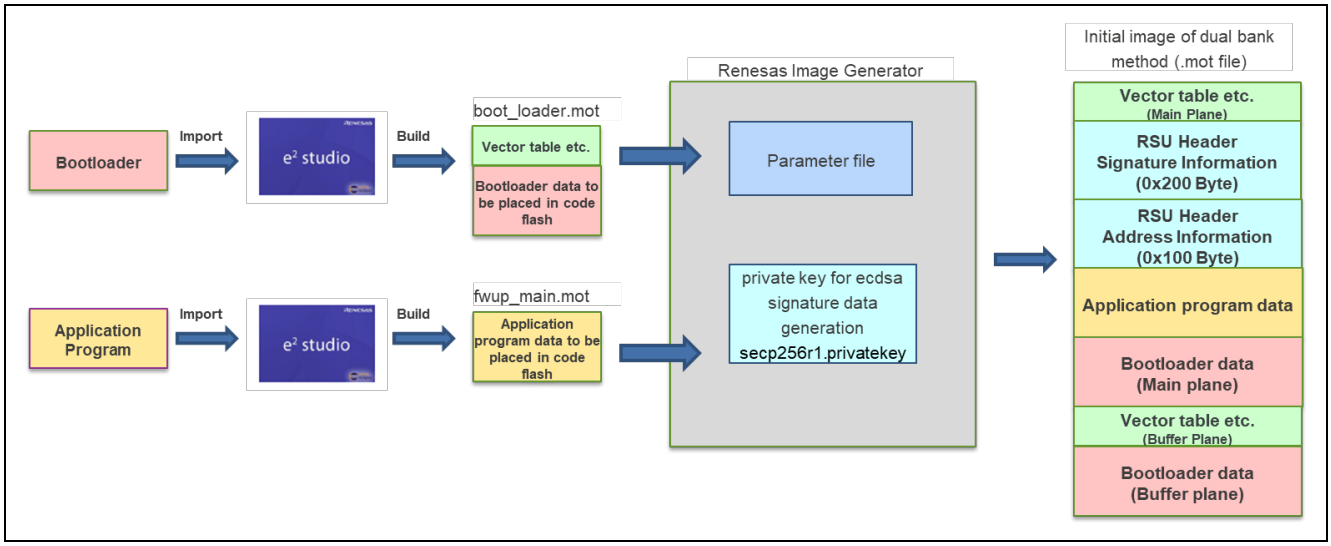


Figure 5.6 Initial image of dual-bank(2-bank) method

- The parameter file is a CSV format file that contains the device address information required to generate the image file.
- The private key for generating the ecdsa signature value is used when ecdsa is specified as the image verification method in the firmware update module.

5.3 Parameter File

The parameter file is the information required for Renesas Image Generator to generate the initial and updated image files for the sample program, and is included in the release package as part of the Renesas Image Generator Python It is included in the release package as part of the Renesas Image Generator Python program set. When a customer generates an initial or updated image for a demo project, there is no need to change the contents of the parameter file.

5.3.1 Contents of Parameter File

Table 5.5 lists the parameters in the parameter file.

The items listed in the parameter file are the same for all devices, but the settings differ for each device.

Table 5.5 Contents of parameter file

Parameter name	Description
Device Type	RL78 Dual Mode: Generation of mot file for dual-bank(2-bank) method Linear Mode : Generation of mot file for partial/full update method
Code Flash Size (Dual Mode Only)	Code Flash Size (Configure only the dual-bank (2-bank) method)
Bootloader Start Address	Bootloader start address
Bootloader End Address	Bootloader end address
User Program Start Address	Starting address of the application program on the main plane
User Program End Address	End address of the application program on the main plane (in dual mode, application program area on main plane)
OFS Data Start Address	OFSM data start address (For RL78, set 'No Used.')
OFS Data End Address	OFSM data end address (For RL78, set 'No Used.')
Data Flash Start Address	Data flush start address (Set 'No Used.' if data flush data is not to be generated)
Data Flash End Address	Data flash end address (Set 'No Used.' if data flash data is not to be generated)
Near Data Start Address (RL78 Only)	Near bootloader start address for RL78
Near Data End Address (RL78 Only)	Near boot loader start address for RL78
Flash Write Size	Flash write size (number of bytes required for one write to the flash in decimal)

The value specified for each parameter is specified in decimal for Flash Write Size and in hexadecimal (with 0x added at the beginning) for other parameters.

Next, the parameters referenced when generating an image file are described.

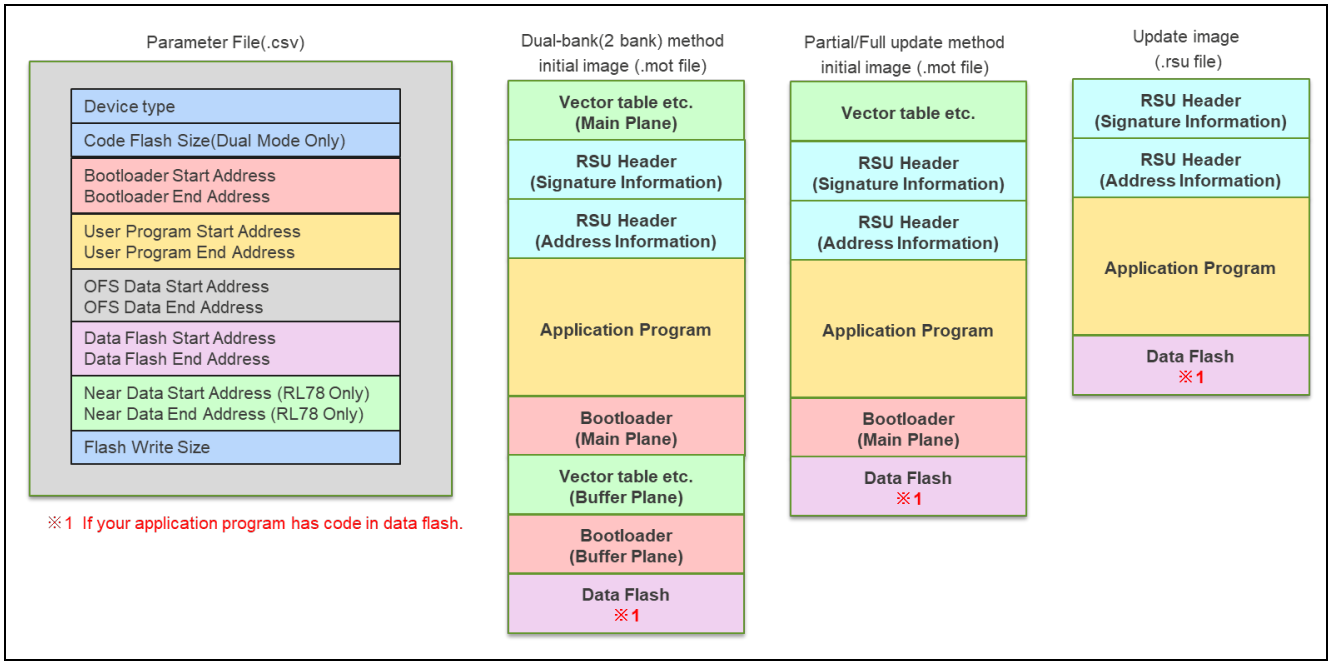


Figure 5.7 Parameters referenced when generating image files

- Device Type:

  Used to determine whether to generate an initial image for the Dual-bank (2 bank) configuration. When the Device Type is set to RL78 Dual Mode, both the bootloader (main plane) and the bootloader (buffer area) are generated. When set to Linear Mode, only the bootloader (main plane) is generated.

- Code Flash Size (Dual Mode Only):

  Used to determine the address at which the bootloader (buffer plane) is placed.

- Bootloader Start Address – Bootloader End Address:

  An image file is generated using the specified address range as the bootloader code.
  The bootloader file (.mot) is used as the input data.

- User Program Start Address – User Program End Address:

  An image file is generated using the specified address range as the application program code.
  The application program file (.mot) is used as the input data.

- Data Flash Start Address – Data Flash End Address:

  An image file is generated using the specified address range as data flash data.
  (Data flash is not used in this demo project.)
  The application program file (.mot) is used as the input data.

- Near Data Flash Start Address (RL78 Only) – Near Data Flash End Address (RL78 Only):

  An image file is generated using the specified address range as code for the bootloader vector table and related components.
  The bootloader file (.mot) is used as the input data.

- Flash Write Size:

  Used to set the data size of the RSU header (address information) as the minimum write unit when writing to flash memory.

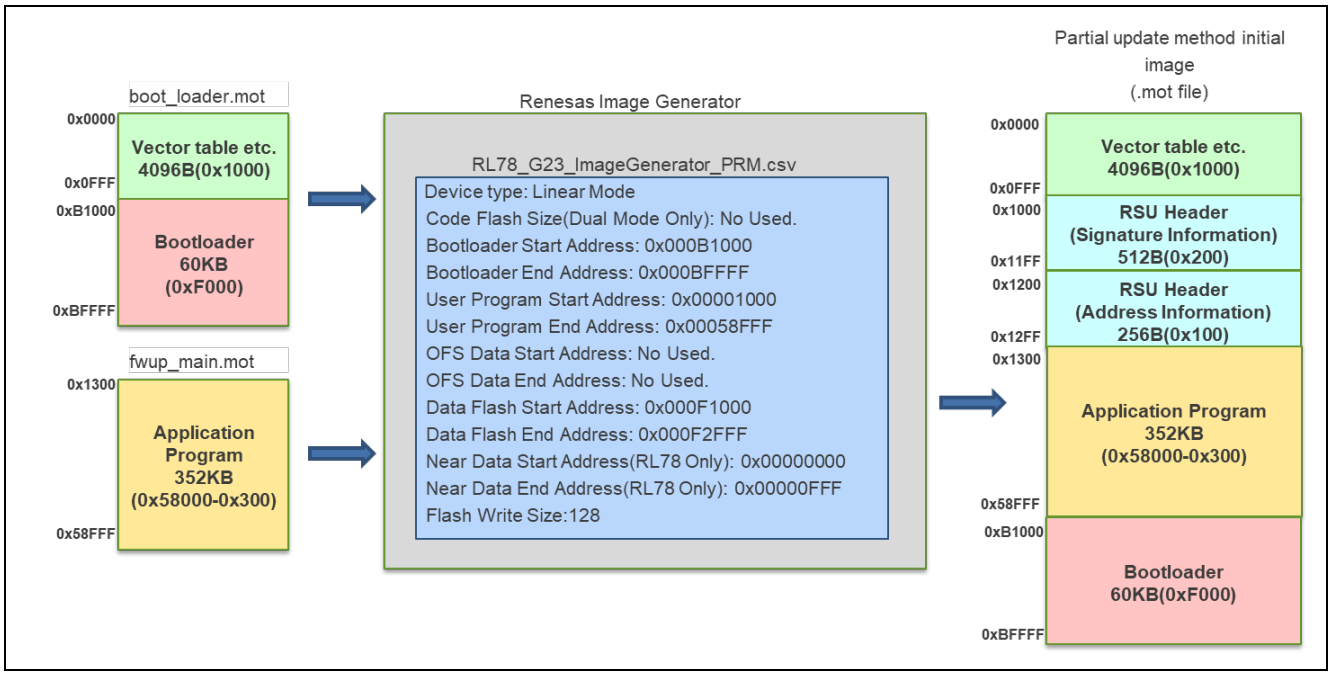


Figure 5.8 Example of parameters referred to when generating the initial image of RL78/G23 partial update method

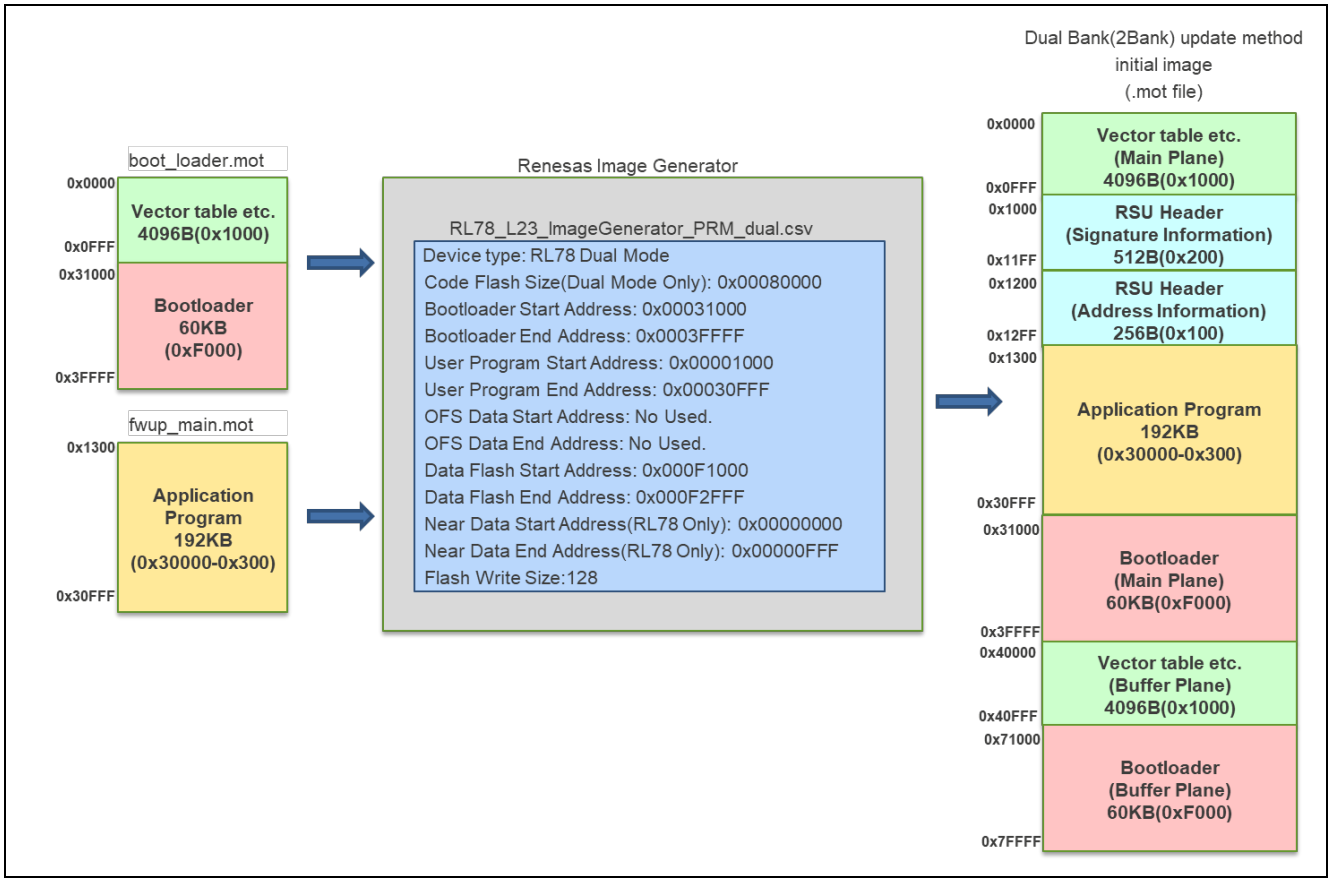


Figure 5.9 Example of parameters referred to when generating the initial image of RL78/L23 Dual-bank (2-bank) method

6. Appendices

6.1 Confirmed Operation Environments

This section describes confirmed operation environment for the module.

Table 6.1 Confirmed Operation Environment (CC-RL)

Item	Description
Integrated development environment	Renesas Electronics e^2 studio 2025-12
C compiler	Renesas Electronics CC-RL V1.16.00 Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian order	Little endian
Revision of the module	Rev.2.05
Board used	RL78/G22 Fast Prototyping Board (RTK7RLG220C00000BJ) RL78/G23-128p Fast Prototyping Board (RTK7RLG230CSN000BJ) RL78/G24 Fast Prototyping Board (RTK7RLG240C00000BJ) RL78/L23 Fast Prototyping Board (RTK7RLL230S00001BJ)

Table 6.2 Confirmed Operation Environment (IAR)

Item	Description
Integrated development environment	IAR Systems IAR Embedded Workbench for Renesas RL78 5.20.2
C compiler	IAR Systems IAR C/C++ Compiler for Renesas RL78 version 5.20.2 IAR Assembler for Renesas RL78 version 5.20.2 Compiler option: Default settings of the integrated development environment.
Endian order	Little endian
Revision of the module	Rev.2.05
Board used	RL78/G22 Fast Prototyping Board (RTK7RLG220C00000BJ) RL78/G23-128p Fast Prototyping Board (RTK7RLG230CSN000BJ) RL78/G24 Fast Prototyping Board (RTK7RLG240C00000BJ) RL78/L23 Fast Prototyping Board (RTK7RLL230S00001BJ)

Table 6.3 Confirmed Operation Environment (LLVM)

Item	Description
Integrated development environment	Renesas Electronics e^2 studio 2025-12
C compiler	LLVM for Renesas RL78 17.0.1.202512
Endian order	Little endian
Revision of the module	Rev.2.05
Board used	RL78/G22 Fast Prototyping Board (RTK7RLG220C00000BJ) RL78/G23-128p Fast Prototyping Board (RTK7RLG230CSN000BJ) RL78/G24 Fast Prototyping Board (RTK7RLG240C00000BJ) RL78/L23 Fast Prototyping Board (RTK7RLL230S00001BJ)

6.2 Operating Environment for Demo Project

This module supports multiple compilers. When using this module, the different settings for each compiler are shown below.

6.2.1 Operation Confirmation Environment for RL78/G23

This section shows the connection diagram and pin assignments for the operation verification environment.

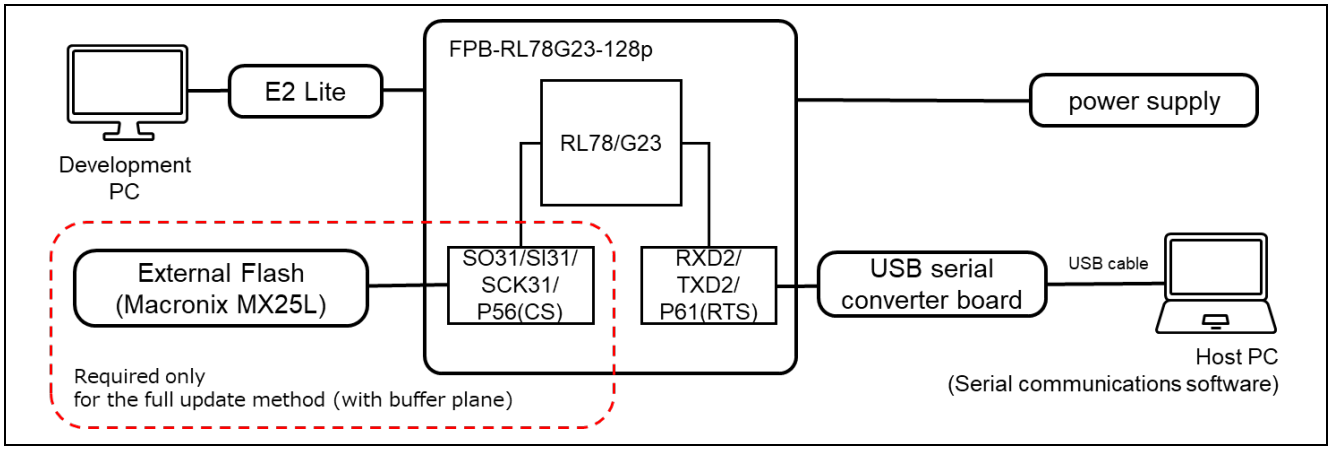


Figure 6.1 FPB–RL78G23-128p Device Connection Diagram

■UART(Red)

Arduino J8		USB-UART
2	P61(RTS)	CTS
3	RXD2	TX
4	TXD2	RX

■External Flash(Green)

MCU Header J1		MX25/66L	Note
14	SO31	SI	1Kohm pull up
15	SI31	SO	1Kohm pull up
16	SCK31	SCLK	1Kohm pull up
18	P56(CS)	CE#	1Kohm pull up

Arduino J5	MX25/66L	Note
4	3V3	VCC
6	GND	GND

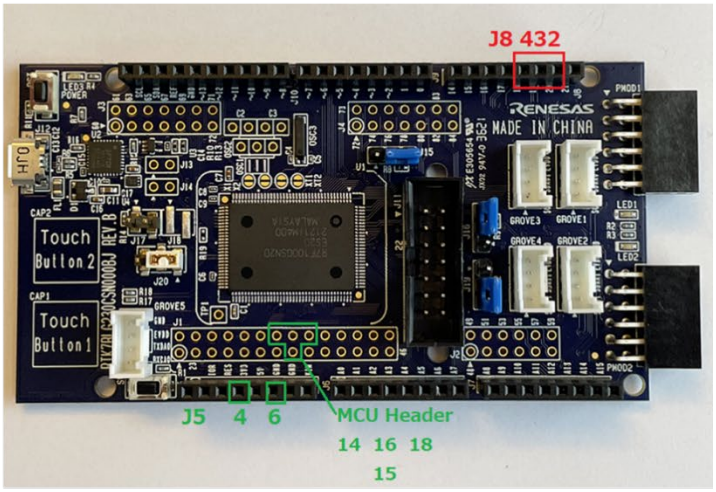


Figure 6.2 FPB–RL78G23-128p Device Connection Pin Information

6.2.1.1 Information on demo project for partial update method

Shown below are the memory map of the RL78/G23 partial update method demo project and the memory map of the configuration settings.

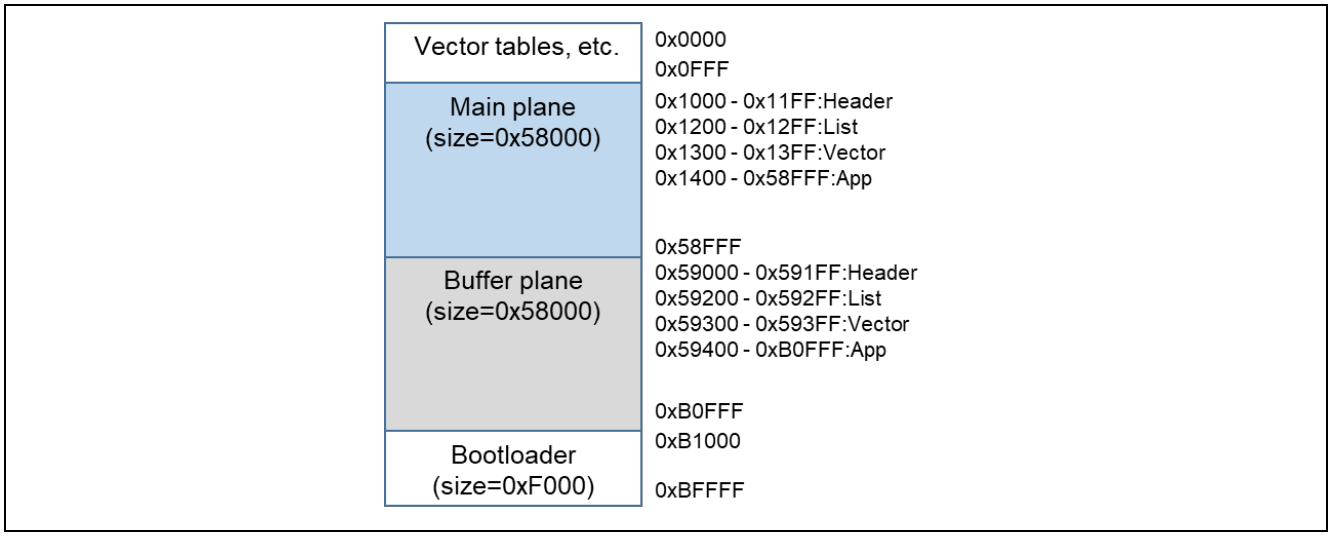


Figure 6.3 RL78/G23 partial update method demo project memory map (For CC-RL and IAR)

Table 6.4 RL78/G23 partial update method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	1	1
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_BUF_AREA_ADDR_L	0x59000	0x59000
FWUP_CFG_AREA_SIZE	0x58000	0x58000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

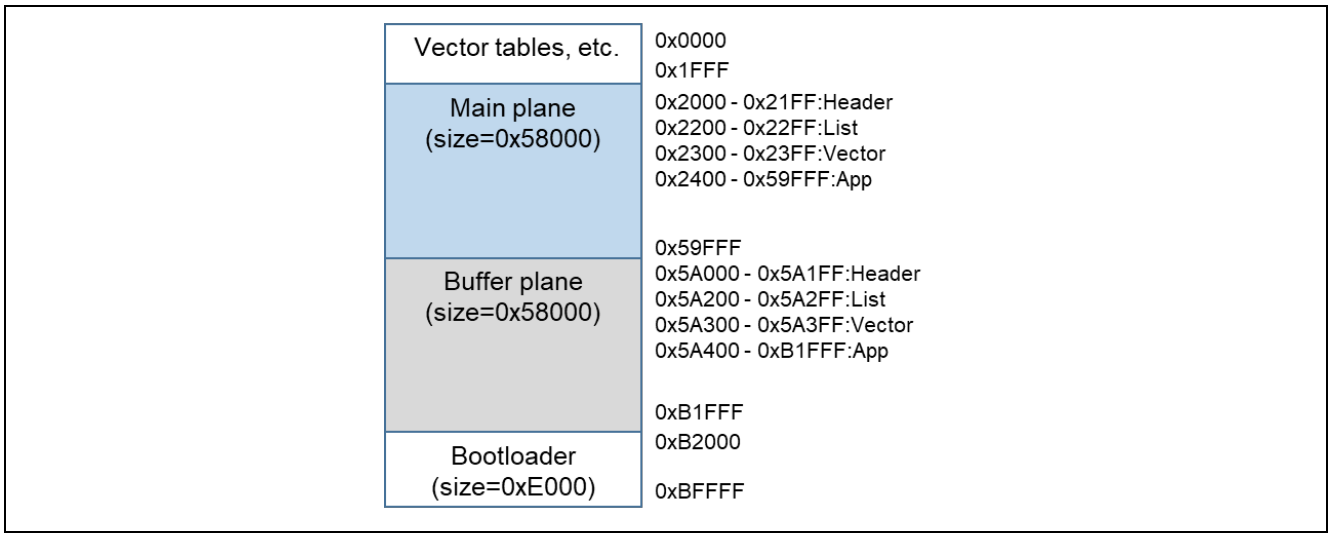


Figure 6.4 RL78/G23 partial update method demo project memory map (For LLVM)

Table 6.5 RL78/G23 partial update method configuration setting (For LLVM)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	1	1
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x5A000	0x5A000
FWUP_CFG_AREA_SIZE	0x58000	0x58000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

6.2.1.2 Information on demo project for full update method

The memory map of the RL78/G23 full update method demo project and the memory map of the configuration settings are shown below.

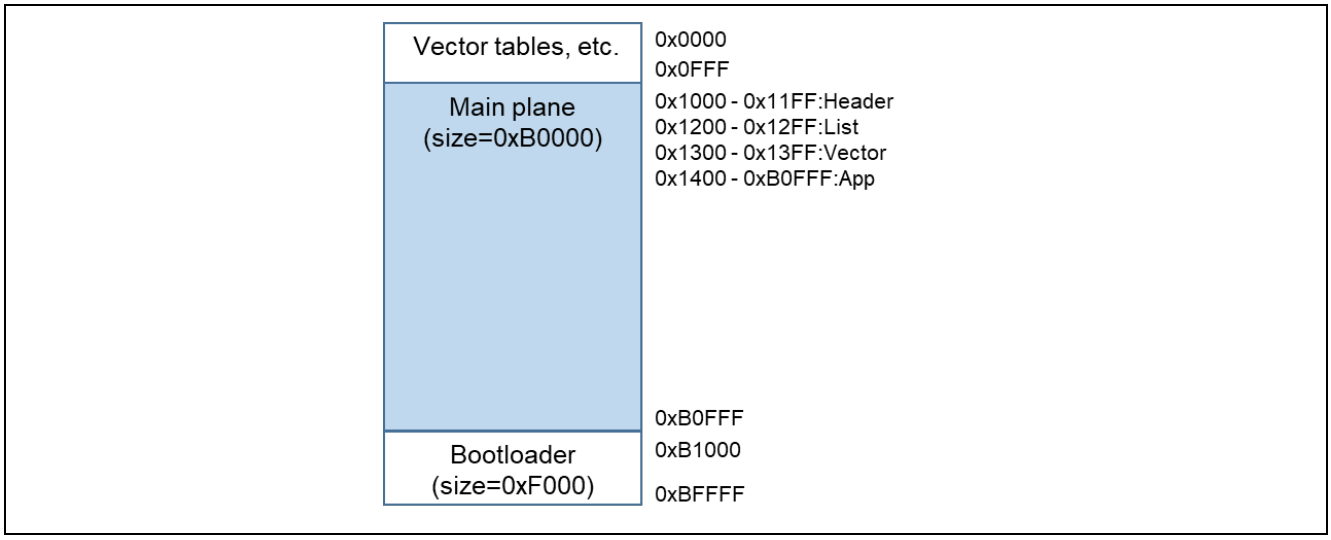


Figure 6.5 RL78/G23 full update method demo project memory map (For CC-RL and IAR)

Table 6.6 RL78/G23 full update method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	2 or 3	3
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_BUF_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_AREA_SIZE	0xB0000	0xB0000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

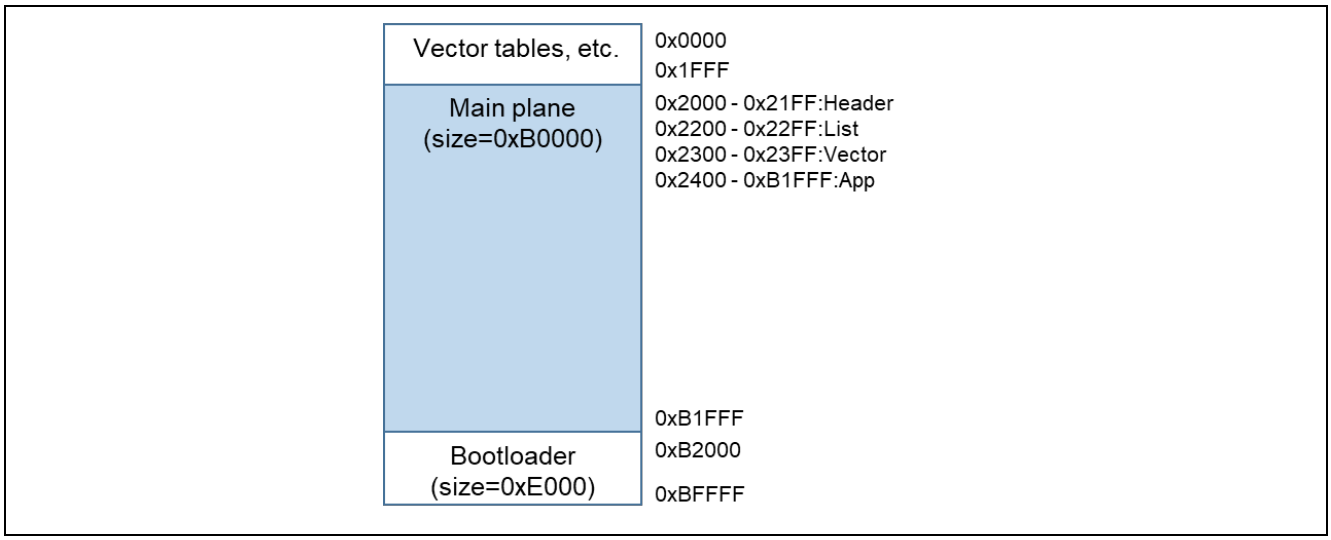


Figure 6.6 RL78/G23 full update method demo project memory map (For LLVM)

Table 6.7 RL78/G23 full update method configuration setting (For LLVM)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	2 or 3	3
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_AREA_SIZE	0xB0000	0xB0000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

6.2.2 Operation Confirmation Environment for RL78/G24

This section shows the connection diagram and pin assignments for the operation verification environment.

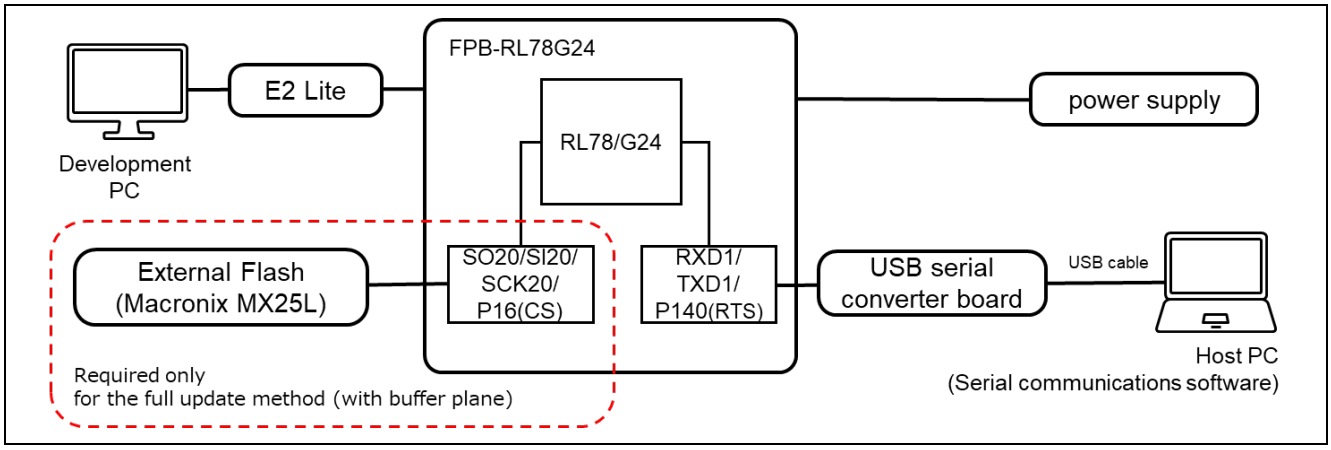


Figure 6.7 FPB−RL78G24 Device Connection Diagram

■ UART(Red)

Arduino J5		USB-UART	Note
1	RXD1	TX	
2	TXD1	RX	
3	P140(RTS)	CTS	

■ External Flash(Green)

Arduino J5,J6		MX25L	Note
J6 3	SO20	SI	1Kohm pull up
J6 2	SI20	SO	1Kohm pull up
J5 7	SCK20	SCLK	1Kohm pull up
J5 6	P16(CS)	CE#	1Kohm pull up

Arduino J3		MX25L	Note
4	3V3	VCC	
6	GND	GND	

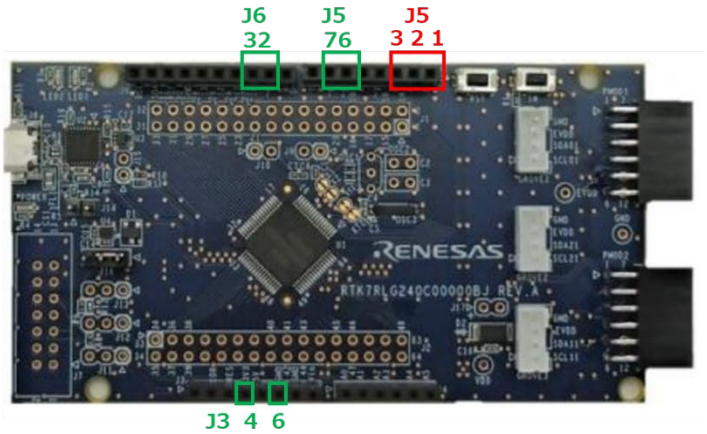


Figure 6.8 FPB−RL78G24 Pin Information

6.2.2.1 Information on demo project for partial update method

Shown below are the memory map of the RL78/G24 partial update method demo project and the memory map of the configuration settings.

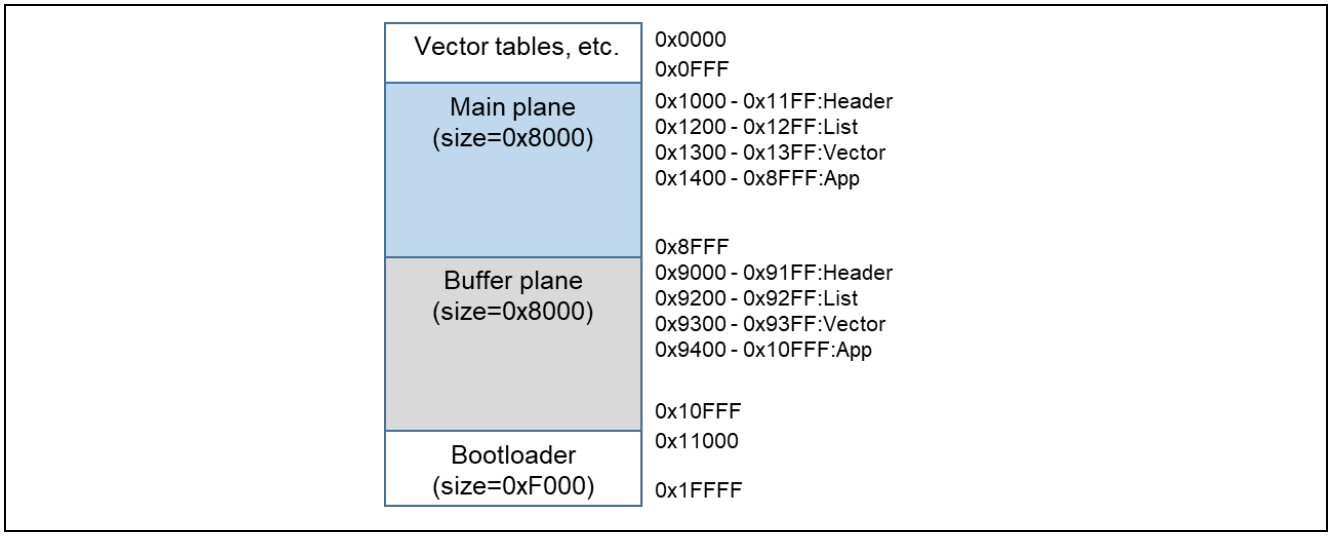


Figure 6.9 RL78/G24 partial update method demo project memory map (For CC-RL and IAR)

Table 6.8 RL78/G24 partial update method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	1	1
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_BUF_AREA_ADDR_L	0x9000	0x9000
FWUP_CFG_AREA_SIZE	0x8000	0x8000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	16	16
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

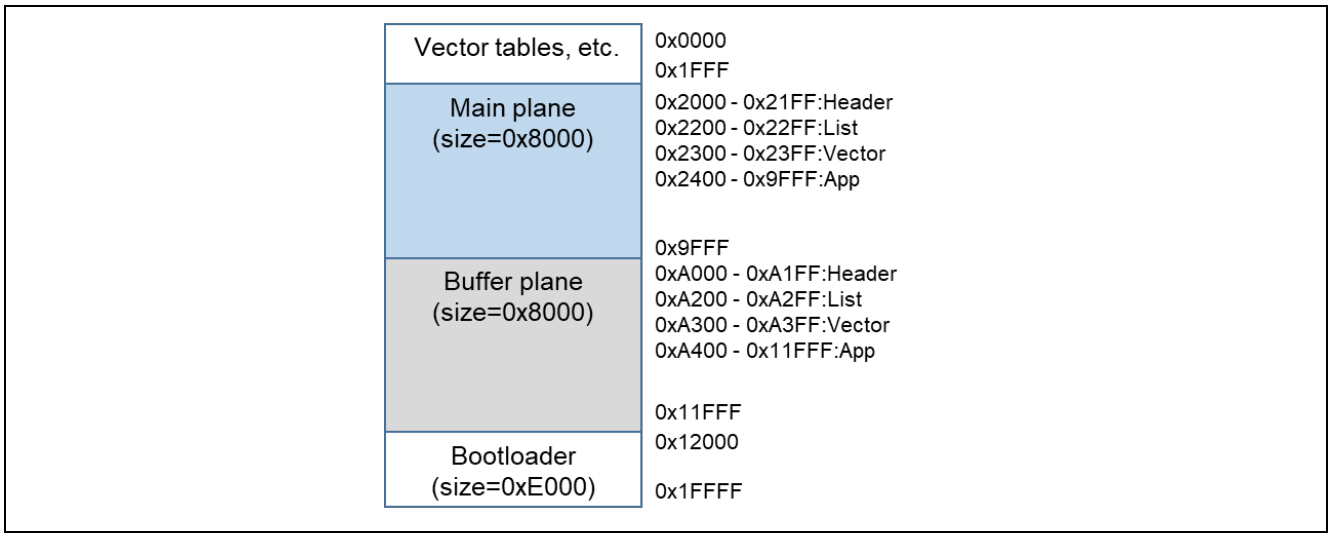


Figure 6.10 RL78/G24 partial update method demo project memory map (For LLVM)

Table 6.9 RL78/G24 partial update method configuration setting (For LLVM)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	1	1
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0xA000	0xA000
FWUP_CFG_AREA_SIZE	0x8000	0x8000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	16	16
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

6.2.2.2 Information on demo project for full update method

The memory map of the RL78/G24 full update method demo project and the memory map of the configuration settings are shown below.

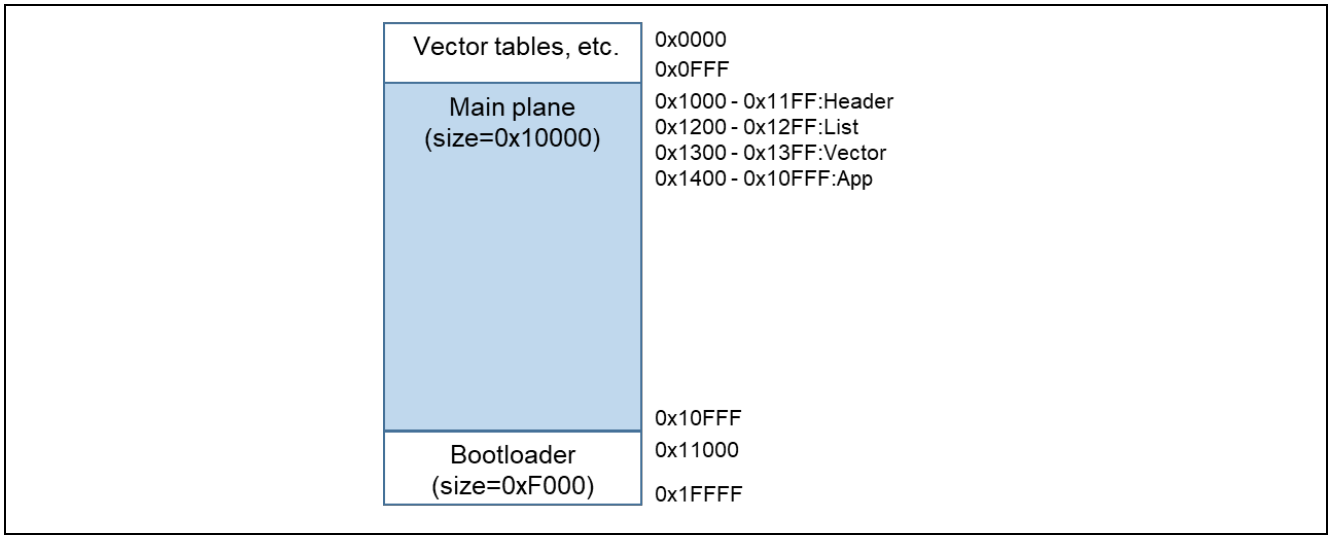


Figure 6.11 RL78/G24 full update method demo project memory map (For CC-RL and IAR)

Table 6.10 RL78/G24 full update method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	2 or 3	3
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_BUF_AREA_ADDR_L	0x9000	0x9000
FWUP_CFG_AREA_SIZE	0x10000	0x10000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	16	16
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

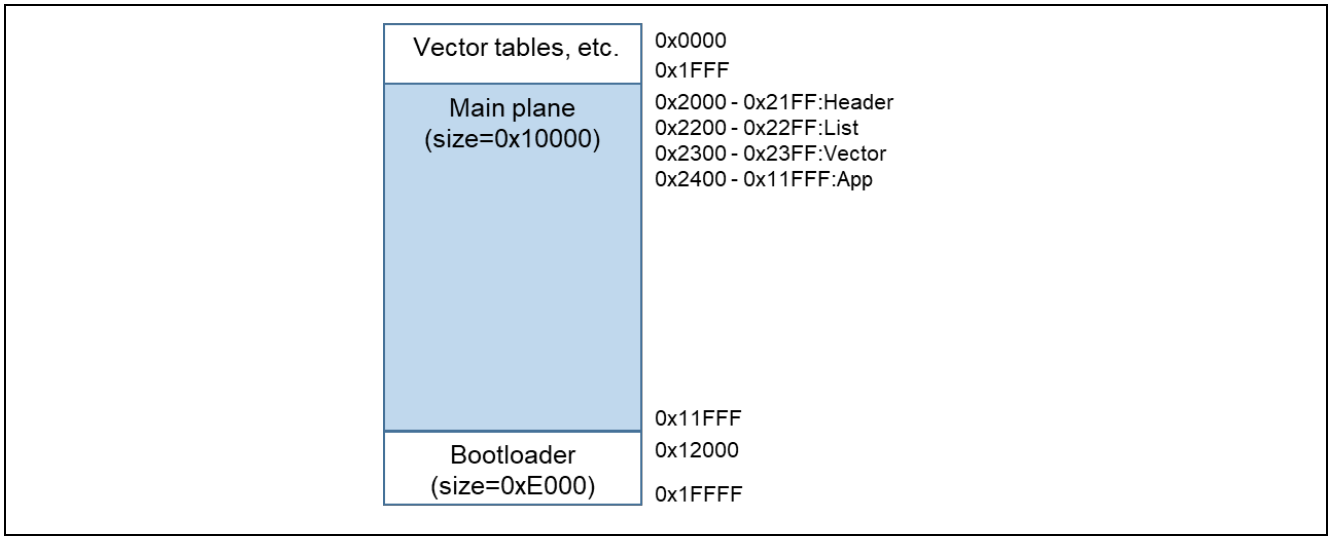


Figure 6.12 RL78/G24 full update method demo project memory map (For LLVM)

Table 6.11 RL78/G24 full update method configuration setting (For LLVM)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	2 or 3	3
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_AREA_SIZE	0x10000	0x10000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	16	16
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

6.2.3 Operation Confirmation Environment for RL78/G22

This section shows the connection diagram and pin assignments for the operation verification environment.

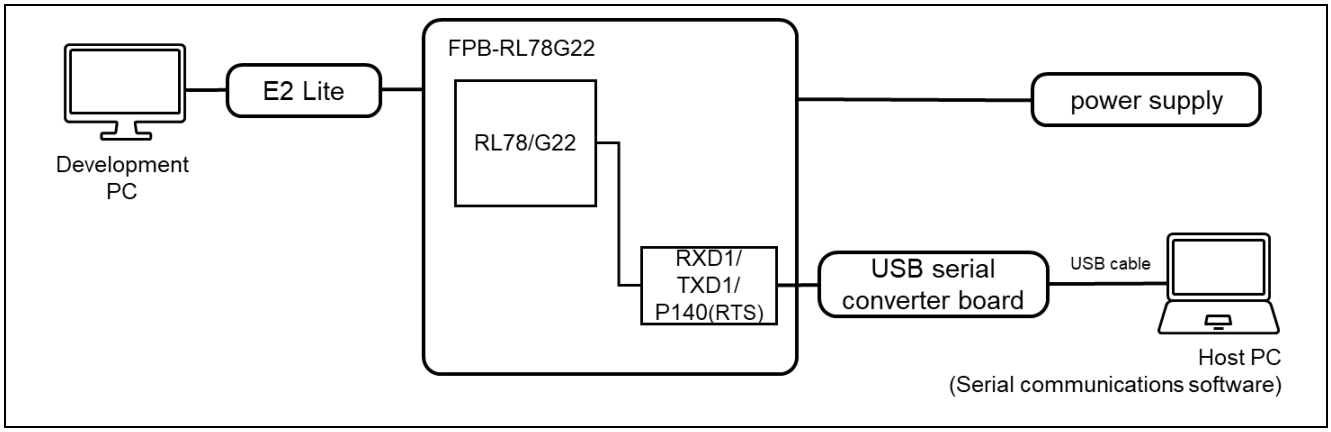


Figure 6.13 FPB–RL78G22 Device Connection Diagram

■ UART(Red)

Arduino J7		USB-UART	Note
1	RXD1	TX	
2	TXD1	RX	
3	P140(RTS)	CTS	

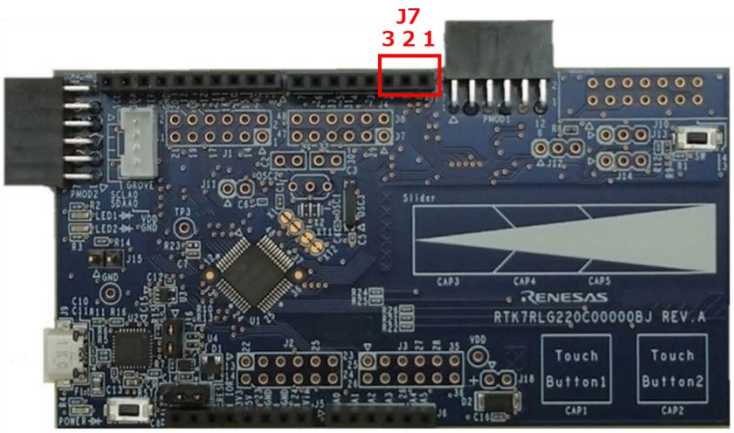


Figure 6.14 FPB–RL78G22 Pin Information

6.2.3.1 Information on demo project for full update method

The memory map of the RL78/G22 full update method demo project and the memory map of the configuration settings are shown below.

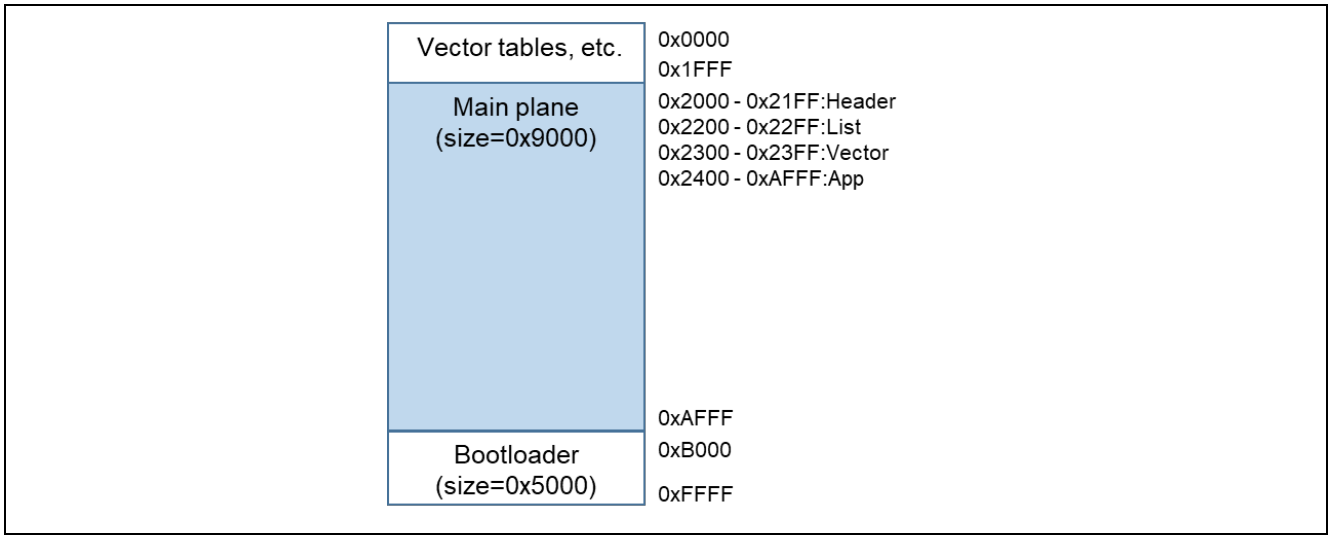


Figure 6.15 RL78/G22 full update method demo project memory map (For CC-RL and IAR)

Table 6.12 RL78/G22 full update method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h	
parameter name	**boot_loader**
FWUP_CFG_UPDATE_MODE	2
FWUP_CFG_FUNCTION_MODE	0
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x2000
FWUP_CFG_AREA_SIZE	0x9000
FWUP_CFG_CF_BLK_SIZE	2048
FWUP_CFG_CF_W_UNIT_SIZE	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096
FWUP_CFG_DF_ADDR_L	0xF1000
FWUP_CFG_DF_BLK_SIZE	256
FWUP_CFG_DF_NUM_BLKS	8
FWUP_CFG_FWUPV1_COMPATIBLE	0
FWUP_CFG_SIGNATURE_VERIFICATION	1
FWUP_CFG_PRINTF_DISABLE	1

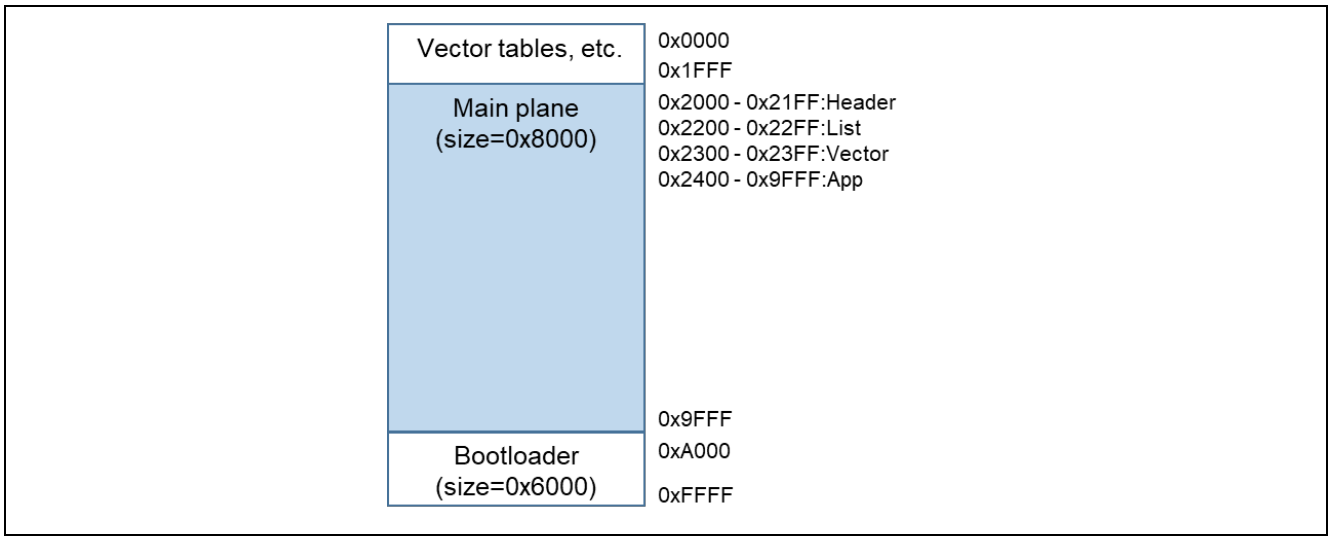


Figure 6.16 RL78/G22 full update method demo project memory map (For LLVM)

Table 6.13 RL78/G22 full update method configuration setting (For LLVM)

Configuration options in r_fwup _config.h	
parameter name	**boot_loader**
FWUP_CFG_UPDATE_MODE	2
FWUP_CFG_FUNCTION_MODE	0
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x2000
FWUP_CFG_AREA_SIZE	0x8000
FWUP_CFG_CF_BLK_SIZE	2048
FWUP_CFG_CF_W_UNIT_SIZE	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096
FWUP_CFG_DF_ADDR_L	0xF1000
FWUP_CFG_DF_BLK_SIZE	256
FWUP_CFG_DF_NUM_BLKS	8
FWUP_CFG_FWUPV1_COMPATIBLE	0
FWUP_CFG_SIGNATURE_VERIFICATION	1
FWUP_CFG_PRINTF_DISABLE	1

6.2.4 Operation Confirmation Environment for RL78/L23

This section shows the connection diagram and pin assignments for the operation verification environment.

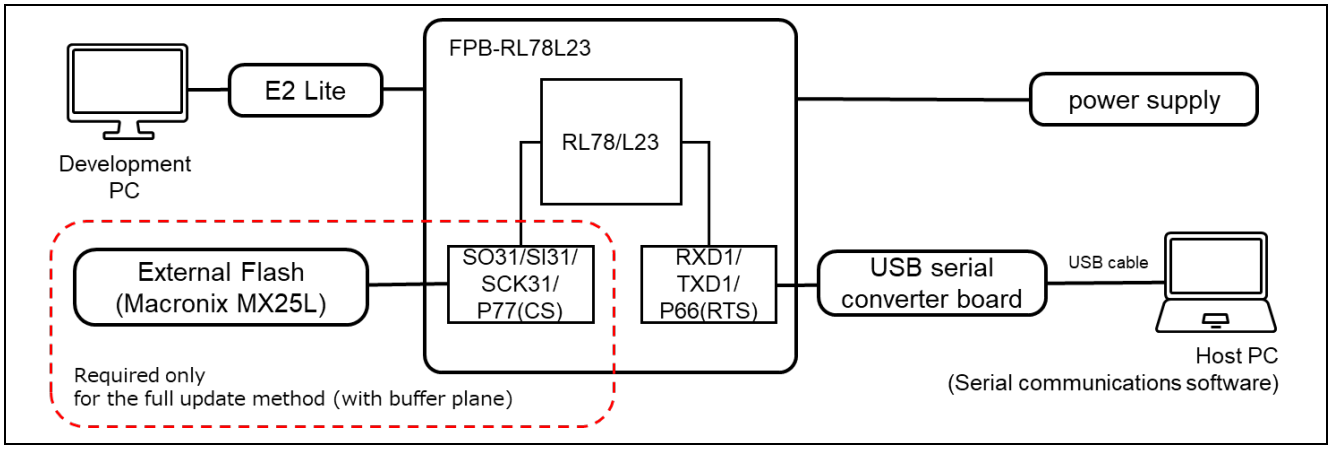


Figure 6.17 FPB−RL78L23 Device Connection Diagram

■ UART(Red)

PMOD1		USB-UART	Note
2	RXD1	TX	
3	TXD1	RX	
4	P66(RTS)	CTS	

■ External Flash(Green)

Arduino J10		MX25L	Note
2	P77(CS)	CE#	1Kohm pull up
4	SO31	SI	1Kohm pull up
5	SI31	SO	1Kohm pull up
6	SCK31	SCLK	1Kohm pull up

Arduino J7		MX25L	Note
4	3V3	VCC	
6	GND	GND	

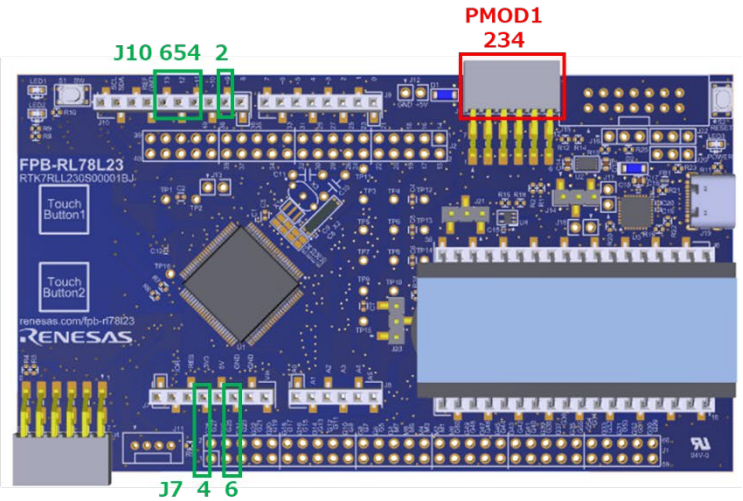


Figure 6.18 FPB−RL78L23 Device Connection Pin Information

6.2.4.1 Information on demo project for dual-bank(2-bank) method

Shown below are the memory map of the RL78/L23 dual-bank(2-bank) method demo project and the memory map of the configuration settings.

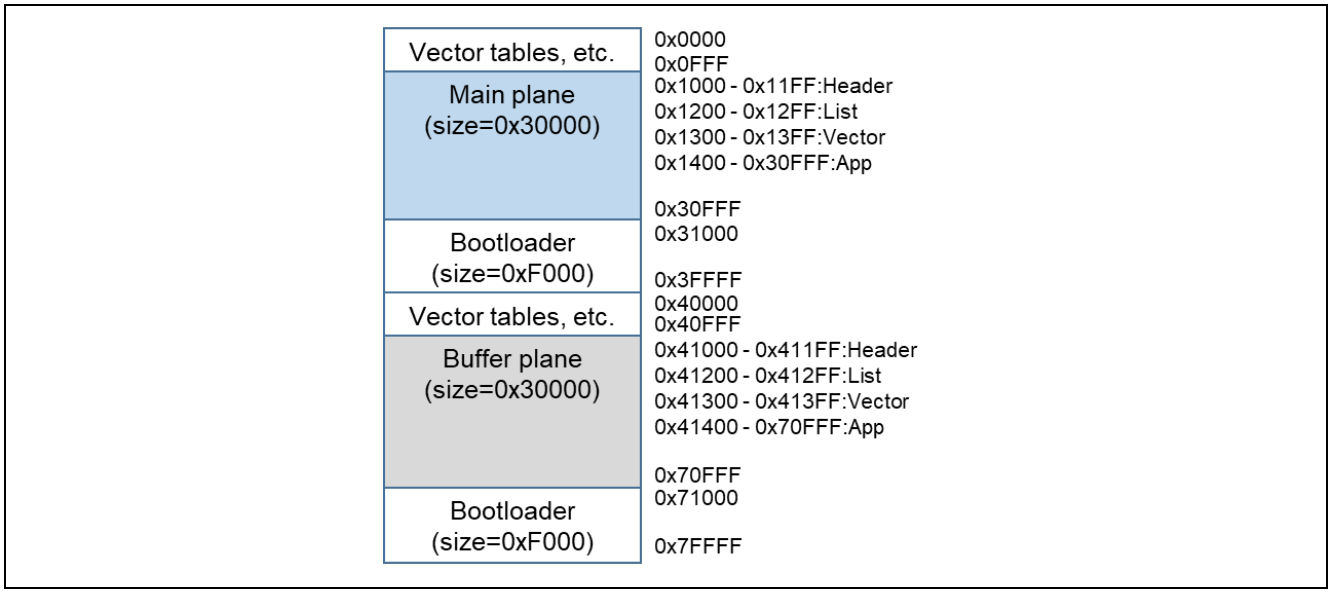


Figure 6.19 RL78/L23 dual-bank(2-bank) method demo project memory map (For CC-RL and IAR)

Table 6.14 RL78/L23 dual-bank(2-bank) method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	0	0
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_BUF_AREA_ADDR_L	0x41000	0x41000
FWUP_CFG_AREA_SIZE	0x30000	0x30000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

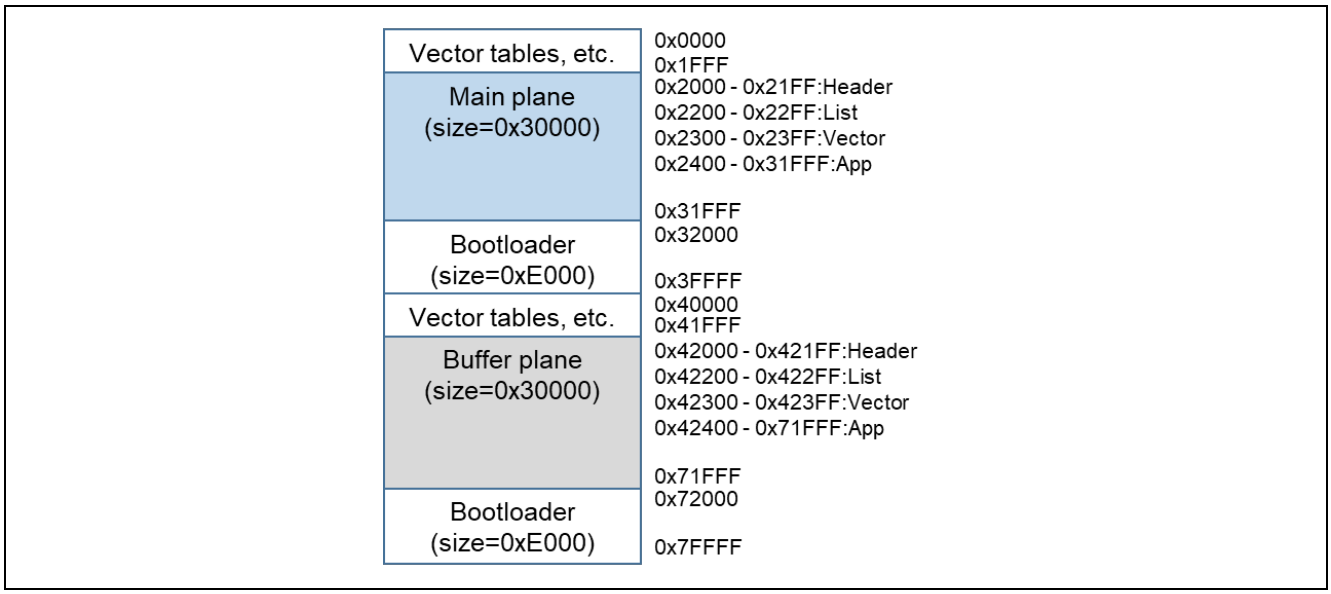


Figure 6.20 RL78/L23 dual-bank(2-bank) method demo project memory map (For LLVM)

Table 6.15 RL78/L23 dual-bank(2-bank) method configuration setting (For LLVM)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	0	0
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x42000	0x42000
FWUP_CFG_AREA_SIZE	0x30000	0x30000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

6.2.4.2 Information on demo project for partial update method

Shown below are the memory map of the RL78/L23 partial update method demo project and the memory map of the configuration settings.

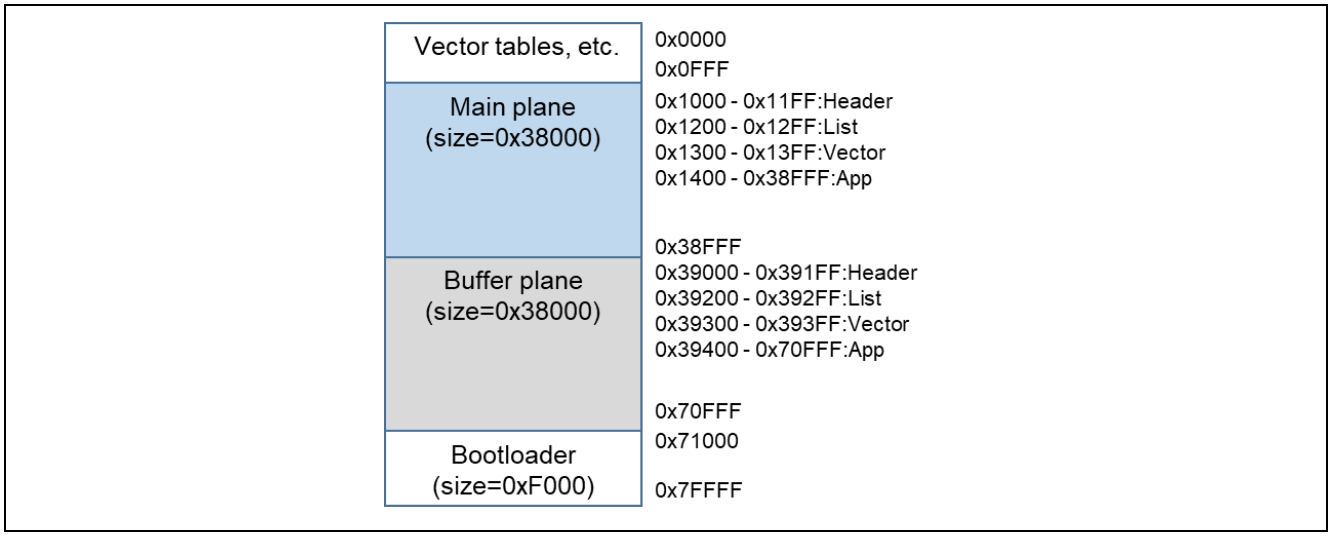


Figure 6.21 RL78/L23 partial update method demo project memory map (For CC-RL and IAR)

Table 6.16 RL78/L23 partial update method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	1	1
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_BUF_AREA_ADDR_L	0x39000	0x39000
FWUP_CFG_AREA_SIZE	0x38000	0x38000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

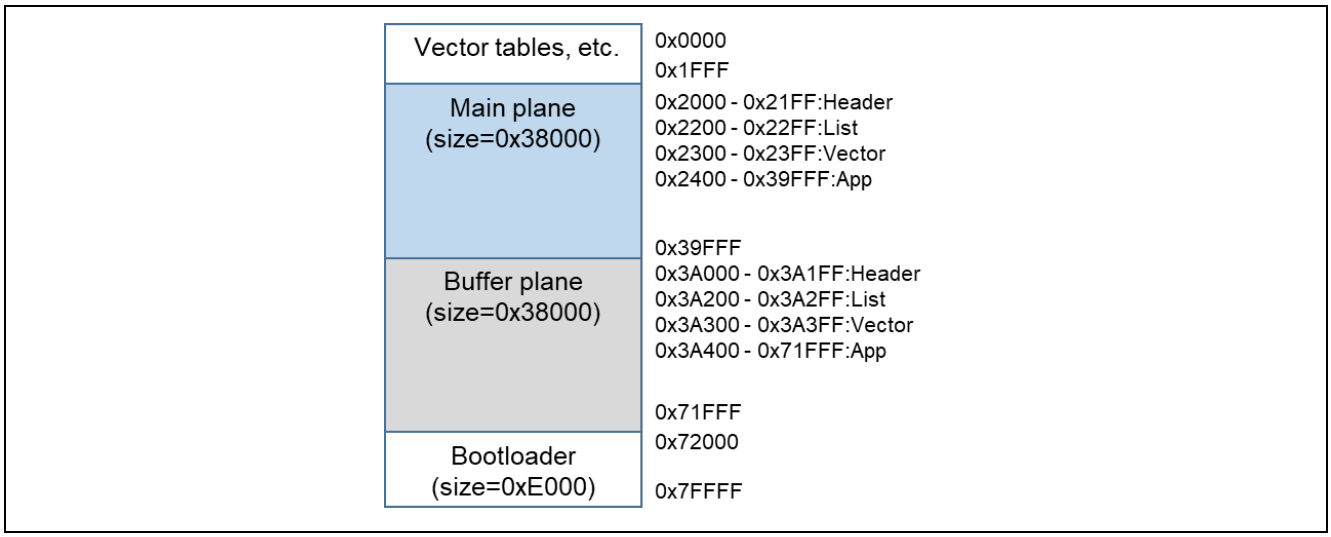


Figure 6.22 RL78/L23 partial update method demo project memory map (For LLVM)

Table 6.17 RL78/L23 partial update method configuration setting (For LLVM)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	1	1
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x3A000	0x3A000
FWUP_CFG_AREA_SIZE	0x38000	0x38000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

6.2.4.3 Information on demo project for full update method

The memory map of the RL78/L23 full update method demo project and the memory map of the configuration settings are shown below.

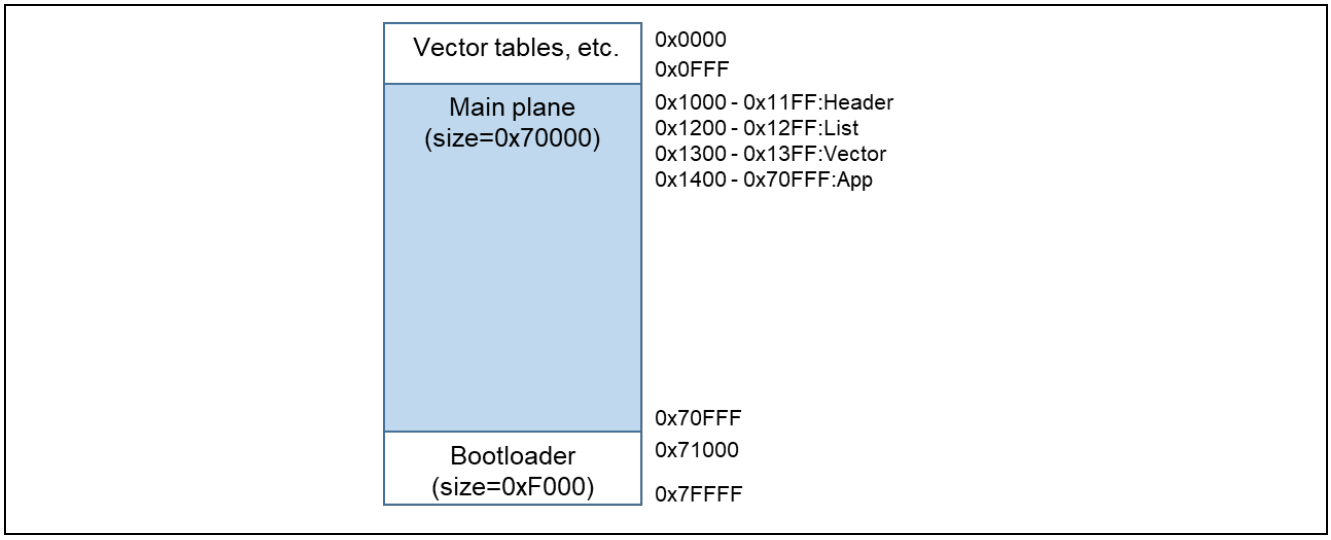


Figure 6.23 RL78/L23 full update method demo project memory map (For CC-RL and IAR)

Table 6.18 RL78/L23 full update method configuration setting (For CC-RL and IAR)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	2 or 3	3
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_BUF_AREA_ADDR_L	0x1000	0x1000
FWUP_CFG_AREA_SIZE	0x70000	0x70000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

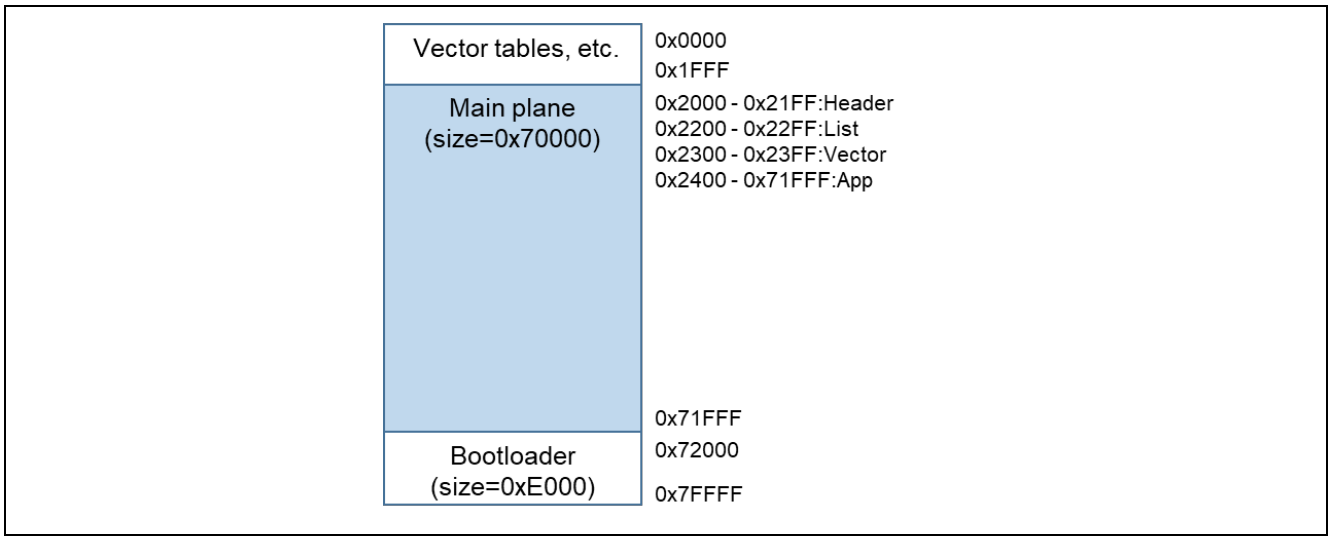


Figure 6.24 RL78/L23 full update method demo project memory map (For LLVM)

Table 6.19 RL78/L23 full update method configuration setting (For LLVM)

Configuration options in r_fwup _config.h		
parameter name	**boot_loader**	**fwup_main**
FWUP_CFG_UPDATE_MODE	2 or 3	3
FWUP_CFG_FUNCTION_MODE	0	1
FWUP_CFG_MAIN_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_BUF_AREA_ADDR_L	0x2000	0x2000
FWUP_CFG_AREA_SIZE	0x70000	0x70000
FWUP_CFG_CF_BLK_SIZE	2048	2048
FWUP_CFG_CF_W_UNIT_SIZE	128	128
FWUP_CFG_EXT_BUF_AREA_ADDR_L	0x0000	0x0000
FWUP_CFG_EXT_BUF_AREA_BLK_SIZE	4096	4096
FWUP_CFG_DF_ADDR_L	0xF1000	0xF1000
FWUP_CFG_DF_BLK_SIZE	256	256
FWUP_CFG_DF_NUM_BLKS	32	32
FWUP_CFG_FWUPV1_COMPATIBLE	0	0
FWUP_CFG_SIGNATURE_VERIFICATION	0	0
FWUP_CFG_PRINTF_DISABLE	1	1

6.3 Open source license information used in the demo project

The demo project for this product uses the open source TinyCrypt. If you use TinyCrypto for your cryptographic library, you must comply with the terms of use set forth in TinyCrypt's license terms.

Check out the TinyCrypt license terms below.

URL：https://github.com/intel/tinycrypt

license：https://github.com/intel/tinycrypt/blob/master/LICENSE

7. Notes

7.1 Notes on Transition from Bootloader to Application.

When transitioning from the sample bootloader program to the application, the settings of the bootloader's peripheral functions will be taken over by the application.

For the peripheral functions used in the sample bootloader, the API functions of each module are closed at the end of the bootloader. Other settings are default values when the smart configurator is used.

If the customer modifies the bootloader sample program for use, the settings of the peripheral functions set in the bootloader will be inherited by the application side. Therefore, it is recommended to initialize the settings of the peripheral functions before moving from the bootloader to the application, or to share the settings of the peripheral functions with the application.

When creating an application, please take the implementation of the bootloader into consideration.

Table 7.1 Notes on peripheral functions used in the bootloader

Peripheral Functions	Settings and Notes on the Boot Loader
Board Functions	These are the default values when the module is embedded in the Smart Configurator. The settings are not changed in the bootloader.
Functions of Flash Memory	The Flash API performs Close for peripheral functions related to flash memory and transitions to the application.
Serial Communication Functions	For peripheral functions related to serial communication, Close is performed by the SCI API and the transition is made to the application. For the SCI channels used in the bootloader, refer to the device connection diagram for each product in 6.2 Operating Environment for Demo Project.
Option Setting Memory	For the option setting memory, set the same value in the bootloader and the application program.
Other Functions	As for the settings of other functions, these are the default values when using the Smart Configurator. The interrupt enable flag is set to interrupt disabled to transition to the application.

7.2 Security measures for the bootloader area

When the firmware update module is commercialized by the customer, it is recommended to protect the area of the code flash where the bootloader (boot_loader) is deployed.

Revision History

Rev.	Date	Description	
		Page	Summary
2.00	Jul. 20, 2023	—	First edition issued
2.01	Nov. 22, 2023	1	Added RL78/G24 to Target Devices
		13-14	Added device to folder structure
		18	Added FWUP_CFG_CF_W_UNIT_SIZE and FWUP_CFG_FWUPV1_COMPATIBLE to configuration settings
		20	Added device in ROM/RAM/Stack
		23	Added parameter to R_FWUP_EraseArea function
		23	Added description to R_FWUP_GetImageSize function
		23	Added description to R_FWUP_GetImageSize function
		24	Added parameter to R_FWUP_WriteImageProgram function
		24	Added return value to R_FWUP_WriteImage function
		25	Added return value to R_FWUP_VerifyImage function
		58	Added board used for operation check environment
		59-67	Added device to Operation check environment
		69	Added note
2.02	Dec.13.2024	12-13	Modified chapter 1.4.
		22-23	Moved figures from chapter 1.6 to chapter 2.10.
		28	Moved the R_FWUP_WriteImageHeader function to chapter 3.13.
		28	Moved the R_FWUP_WriteImageProgram function to chapter 3.14.
		-	Replaced chapters 4 and 5.
		37-52	Modified the description of 4.demo project.
		53-61	Added chapter 4.6 Debugging demo projects.
		62-70	Modified chapter 5 Renesas Image Generator.
		83	Added chapter 7.2 Security measures for the bootloader area
2.03	Apr.18.2025	1	Executive summary LLVM is added to the target compiler.
		14,15	1.5 LLVM content added to the package configuration table.
		18	2.6 Default log display setting changed to Disable.
		19	2.7 Added LLVM to the code size of the demo project.
		22,23	2.10 Changed the flow of the example bootloader implementation.
		41	4.4 Added LLVM contents.
		74	6.1 Added LLVM testing environment.
		77,78	6.2.1.1 LLVM figures and tables added.
		79,80	6.2.1.2 LLVM figures and tables added.

Rev.	Date	Description	
		Page	Summary
2.04	Aug.27.2025	1	Added RL78/G24 to Target Devices
		1	Added Flash Driver RL78 Type11 to related application notes.
		6,9,13,14	Added description related to dual-bank method in Section 1.1, 1.3.1, 1.4.1, 1.4.4
		16,17	Added the RL78/L23 FPB folder to Table 1-2.
		19	Added Flash Driver RL78 Type11 to the software requirements in Section 2.2.
		20	Added dual-bank method to update method in Table 2-1.
		23	Added code size for RL78/L23 in Section 2.7.4.
		25,26	Added an example of dual-bank method implementation to Section 2.10.1.
		38	Added details of bank swap processing to Section 3.15.2.6.
		47-51	Added dual bank method demo project execution procedure to Section 4.4.
		78,79	Added initial image files for the dual bank method to Section 5.2.2.
		96-100	Added RL78/L23 operation verification environment to Section 6.2.4.
2.05	May.22.2026	6	Renaming of update methods in Section 1.1.
		8	Added Supported Update Methods for Each Product to Table 1-2.
		16,17	Changed the Package Folder Structure in Table 1-3.
		50,54,58, 61	Unified the Compiler-Specific Log Output Descriptions in Sections 4.4.5, 4.5.5, 4.6.5, and 4.7.
		71-73	Added How to Change the Update Image Retrieval Path for the Demo Project in Section 4.9
		74-77	Added How to Add Interrupts Handling to the Demo Project in Section 4.10
		78-81	Added How to Use a Memory Layout Different from That of the Demo Project in Section 4.11
		92	Added LLVM to the operation verification environment in Section 6.1.
		93-112	Added LLVM to the operation verification environment for the demo project in Section 6.2.

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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(Rev.5.0-1 October 2020)

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