RX Family

Firmware Updating Communications Module Using Firmware Integration Technology

Introduction

This application note describes a firmware updating communications module using the Firmware Integration Technology (FIT).

In a system consisting of a primary MCU and a secondary MCU, this module allows user updating of the firmware of the secondary MCU. This application note explains how to use this module, incorporate its API functions into user applications, and extend its functionality.

The release package associated with this application note includes two demonstration projects. You can confirm the basic operation of the functionality for updating the firmware of the secondary MCU with the use of this module by following the steps described in chapter 5, Demonstration Projects, to build an environment to run the demonstration.

Operation Confirmation Devices

RX140 Group

RX23E-B Group

RX261 Group

RX66T Group

RX660 Group

If you intend to use this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to suit the specifications of the alternative MCU.

Related Application Notes

- Firmware Integration Technology User’s Manual (R01AN1833)
- RX Family Adding Firmware Integration Technology Modules to Projects (R01AN1723)
- RX Family Board Support Package Module Using Firmware Integration Technology (R01AN1685)
- RX Family SCI Module Using Firmware Integration Technology (R01AN1815)
- RX Family Firmware Update Module Using Firmware Integration Technology (R01AN6850)

Target Compilers

- Renesas Electronics C/C++ Compiler Package for RX Family
- GCC for Renesas RX

For details of the environments in which operation has been confirmed, refer to section 6.1, Environments for Confirming Operation.

Contents

1. Overview

1.1 About the Firmware Updating Communications Module

The firmware updating communications module is middleware which controls communications between MCUs in which the secondary MCU receives firmware for use in updating from the primary MCU and applies the firmware to updating in a system of the kind shown in Figure 1-1, consisting of the primary MCU and the secondary MCU. Users can easily update the firmware of the secondary MCU by embedding this module into the primary and secondary MCUs.

1.2 Supported Communications IP and Hardware Configuration

This module supports UART communications through serial communication interface (SCI) as the communications interfaces. Figure 1-1 shows the hardware configuration assumed for this module. The primary and secondary MCUs have one-to-one connections on the same bus via two-wire UART (TXD and RXD).

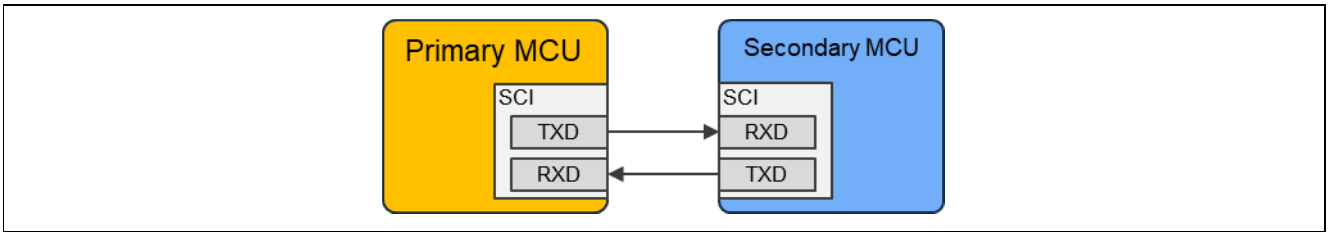

Figure 1-1 Hardware Configuration

1.3 Software Configuration

Figure 1-2 (for the primary MCU) and Figure 1-3 (for the secondary MCU) show the configurations of the software modules. This module is available for bare-metal and FreeRTOS projects.

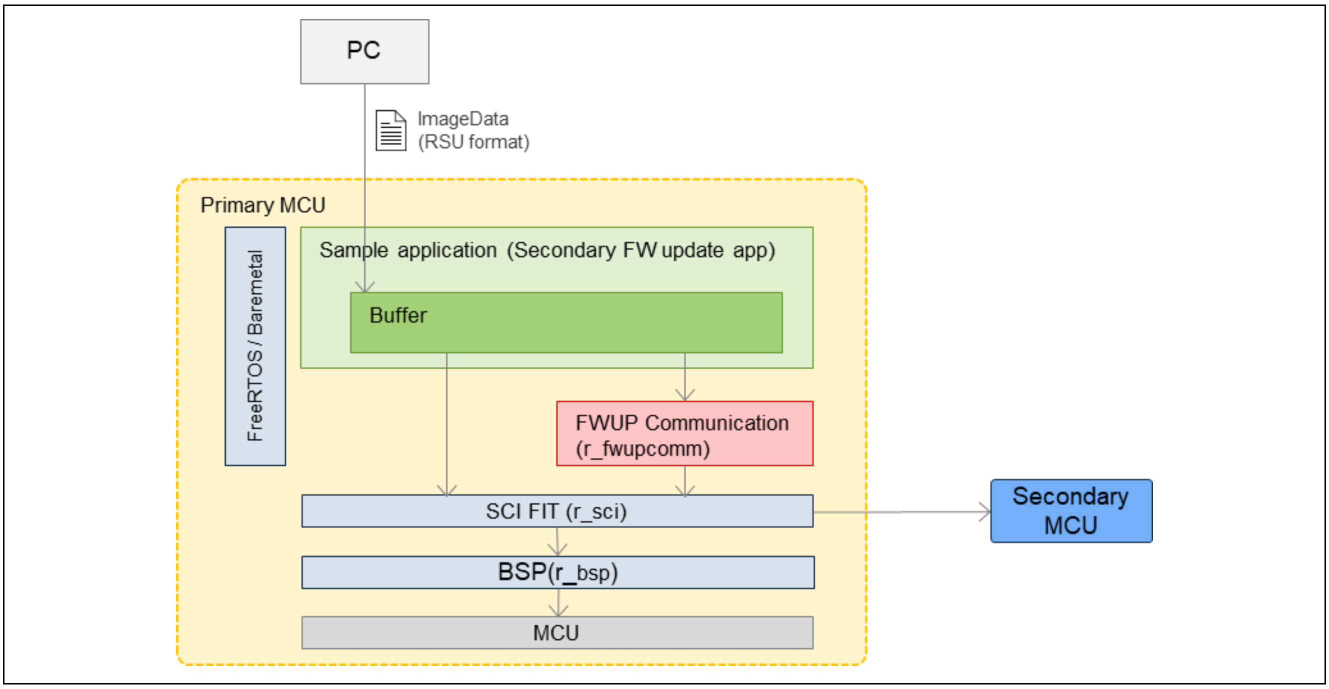

Figure 1-2 Configuration of Software Modules in the Primary MCU

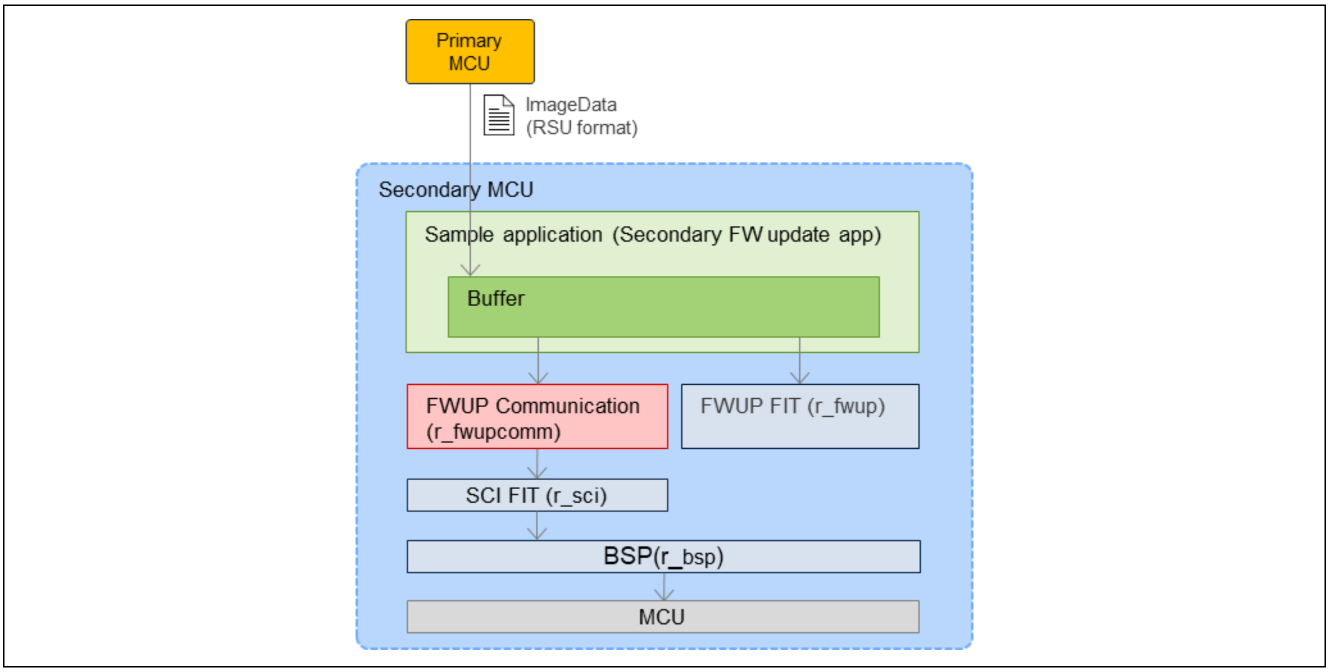

Figure 1-3 Configuration of Software Modules in the Secondary MCU

1.3.1 Setting UART Communications

The operation of this module has been confirmed with the settings for UART communications listed in section 6.2, Settings for UART Communications.

1.4 Packet Communications

Packet communications proceed between primary and secondary MCUs via the communications interface. The primary MCU sends request packets to the secondary MCU. When the secondary MCU receives a request packet, it processes the command and sends the results to the primary MCU as a response packet. Figure 1-4 shows the flow of packet communications.

Primary MCU		Secondary MCU
Sends a request packet.		
	----->	
		Receives the request packet.
		Processes the command.
		Sends a response packet.
	<-----	
Receives the response packet.		

Figure 1-4 Flow of Packet Communications

All commands are classified according to their individual purposes, and the classification is called the command class.

1.5 Data Format

This section describes the specifications for packet communications between the primary and secondary MCUs. The specification of the data format is independent of the method of physical communications between the MCUs.

1.5.1 Data Format of Packets

Figure 1-5 shows the data format of command packets, each of which consists of a command header and command data.

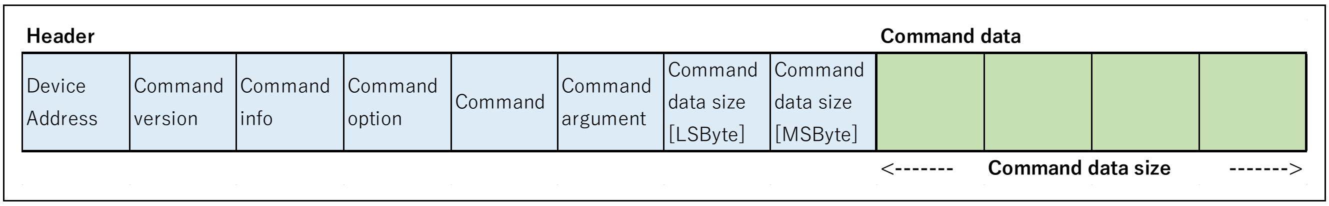

Figure 1-5 Data Format of Command Packets

Figure 1-6 shows the data format of response packets.

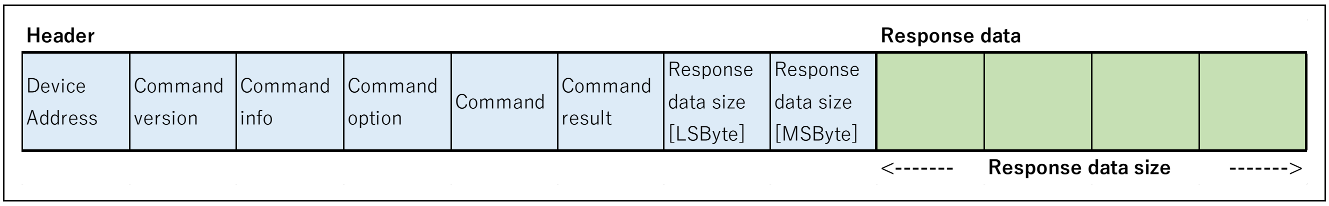

Figure 1-6 Data Format of Response Packets

Table 1-1 lists the specifications of the headers of packets.

Table 1-1 Specifications of the Headers of Packets

Item	Description
Device address	Device address of the secondary MCU to which the command is sent. The secondary MCU only processes a command when it receives the command with its own device address in the header. • 0x00 – 0xFE: Device address of the secondary MCU • 0xFF: Reserved.
Command version	Version of the command. The secondary MCU only processes a command when the version of the command is the same as that of the command on the secondary MCU. 0x00 – 0xFF
Command info	• b7: 0: Command, 1: Response • b4 – b6: Command class. Refer to section 1.6, Specifications of Commands. • b0 – b3: Command ID
Command option	• b7: 0: A response is to be sent. 1: No response is to be sent. • b0 – b6: Reserved.
Command	Indicates the command. Refer to section 1.6, Specifications of Commands.
Command argument/result	Indicates an argument of the command when a command is being sent. Indicates the result of executing the command when a response is being sent. Refer to section 1.6, Specifications of Commands.
Command/Response data size	Size of the command data or response data. The size must be in bytes and a multiple of 4.

1.6 Specifications of Commands

This module has definitions of FWUP commands to control updating of firmware of the secondary MCU and common commands for general data communications.

Table 1-2 List of Command Class

Command class	Description	Value
Common Commands	Commands for general data communications.	0x00
FWUP Commands	Commands for contolling updating of firmware of the secondary MCU.	0x01

1.6.1 Common Commands

The common commands are a set of commands for general purpose use. Table 1-3 lists the commands.

Table 1-3 List of Common Commands

Command	Description	Value
DATA_SEND: Sending data	Sends data with the desired size to the secondary MCU.	0x01
DATA_RECV: Receiving data	Requests sending of data with the desired size for the secondary MCU.	0x02

(1) DATA_SEND: Sending data

This command sends data to the secondary MCU.

Table 1-4 Specifications of the COMMON DATA_SEND Command

Item	Value
Command	0x01
Command argument	0x00
Command result	0x00: Processing succeeded. / 0x02: Processing failed.
Command data size	Desired data length which can be set according to section 2.6, Compiler Settings.
Response data size	0
Command data	Desired data
Response data	None

(2) DATA_RECV: Receiving data

This command requests sending of data for the secondary MCU.

Table 1-5 Specifications of the COMMON DATA_RECV Command

Item	Value
Command	0x02
Command argument	0x00
Command result	0x00: Processing succeeded. / 0x02: Processing failed.
Command data size	0
Response data size	Desired data length which can be set according to section 2.6, Compiler Settings.
Command data	None
Response data	Desired data

1.6.2 FWUP Commands

FWUP commands are a group of commands used in updating of the firmware. Table 1-6 lists the FWUP commands.

Table 1-6 List of FWUP Commands

Command	Description	Value
START: Starting of updating the firmware	Starts updating the firmware.	0x01
WRITE: Writing the updated firmware	Writes the updated firmware.	0x02
INSTALL: Installing the updated firmware	Installs and executes the updated firmware.	0x03
CANCEL: Canceling of updating the firmware	Cancels updating of the firmware.	0x04

(1) START: Starting of updating the firmware

This command requests starting of updating the firmware of the secondary MCU.

The desired data length can be set for the command data. It is used for sending data which are required for initialization processing on the user side when updating of the firmware is started.

On reception of this command, the secondary MCU enables reception of the data for updating the firmware.

When starting of updating the firmware, send this command first.

Table 1-7 Specifications of the FWUP START Command

Item	Value
Command	0x01
Command argument	0x00
Command result	0x00: Processing succeeded. / 0x02: Processing failed.
Command data size	Desired data length which can be set according to section 2.6, Compiler Settings.
Response data size	0
Command data	Desired data
Response data	None

(2) WRITE: Writing the updated firmware

This command sends the data for the updated firmware to the secondary MCU and requests writing of the firmware.

The secondary MCU runs the processing for writing. It also runs signature verification processing when the data for the updated firmware are in the final block.

Table 1-8 Specifications of the FWUP WRITE Command

Item	Value
Command	0x02
Command argument	0x00
Command result	0x00: Processing succeeded. / 0x01: Signature verification succeeded. / 0x02: Processing failed.
Command data size	An integer multiple of the ROM writing unit of the secondary MCU. The data size can be set according to section 2.6, Compiler Settings.
Response data size	0x04
Command data	Data for the updated firmware
Response data	Size of data for the remaining updated firmware

(3) INSTALL: Installing the updated firmware

This command requests installing and executing the updated firmware which has been written to the secondary MCU.

Table 1-9 Specifications of the FWUP INSTALL Command

Item	Value
Command	0x03
Command argument	0x00
Command result	0x00: Processing succeeded. / 0x02: Processing failed.
Command data size	0
Response data size	0
Command data	None
Response data	None

(4) CANCEL: Canceling of updating the firmware

This command requests canceling of updating the firmware for the secondary MCU.

The secondary MCU stops updating the firmware and erases the updated firmware that has been written.

Table 1-10 Specifications of the FWUP CANCEL Command

Item	Value
Command	0x04
Command argument	0x00
Command result	0x00: Processing succeeded. / 0x02: Processing failed.
Command data size	0
Response data size	0
Command data	None
Response data	None

1.6.2.2 Flow of Communications for the FWUP Commands

Figure 1-7 shows the flow of communications for the commands when the firmware of the secondary MCU is to be updated by using the FWUP commands.

Primary MCU		**Secondary MCU**
Sends the FWUP START command.		
	----->	
		Receives the FWUP START command.
		Makes the transition to the state for receiving updated firmware.
		Sends the FWUP START response.
	<-----	
Receives the FWUP START response.		
Sends the FWUP WRITE command.		
	----->	
		Receives the FWUP WRITE command.
		Writes the received data for the updated firmware to the ROM by using the API of FWUP FIT.
		Sends the FWUP WRITE response.
	<-----	
Receives the FWUP WRITE response.		
Repeats the above communications from the FWUP WRITE command until all data for the updated firmware have been received.		
Sends the FWUP INSTALL command.		
	----->	
		Receives the FWUP INSTALL command.
		Installs the updated firmware and prepares for execution of the updated firmware after sending the response.
		Sends the FWUP INSTALL response.
	<-----	
Receives the FWUP INSTALL response.		
		Executes the updated firmware.

Figure 1-7 Flow of Communications for the FWUP Commands

1.7 Handling Errors

If the secondary MCU fails in attempting to analyze the header of a received command packet, it will send the received command header to the primary MCU. However, the command version is overwritten with that set in the secondary MCU. Also, the command data size is overwritten as 0. In this case, no processing for the command proceeds. Analyzing the header of the command packet will fail in the following cases.

- The header of the received command packet differs from the defined specifications.
- The command version of the received command packet differs from that which has been set in the secondary MCU.
- The command class or command has an undefined value.
- The size of command data corresponding to the specified command data size was not received.

The primary MCU side can detect the failure of the header analysis on the secondary MCU side by confirming that the most significant bit of command info in the received packet is “0: Command”.

1.8 Overview of API Functions

Table 1-11 lists the API functions included in this module.

Table 1-11 List of API Functions

Function	Description
R_FWUPCOMM_Open()	Opens a communications channel for use by or within this module.
R_FWUPCOMM_Close()	Closes a communications channel for use by or within this module.
R_FWUPCOMM_CmdSend()	Sends a command for the secondary MCU and receives a corresponding response.
R_FWUPCOMM_ProcessCmdLoop()	Receives a command from the primary MCU, runs the corresponding handler, and sends the result of executing the command.

2. API Information

Operation of this module was confirmed under the following conditions.

2.1 Hardware Requirements

The MCUs in use must support the following function.

- SCI

2.2 Software Requirements

This module depends on the following drivers.

- Board support package (r_bsp)
- Serial communications interface (r_sci)

2.3 Supported Toolchains

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

2.4 Header Files

All API calls and their supporting interface definitions are stated in r_fwupcomm_if.h.

Configuration options which can be set during building are defined in r_fwupcomm_config.h.

2.5 Integer Types

This module uses ANSI C99. The integer types for use are defined in stdint.h.

2.6 Compiler Settings

The file r_fwupcomm_config.h contains the configuration option settings for this module.

The names of the options and descriptions of their settings are listed in Table 2-1.

Table 2-1 Configuration Settings (r_fwupcomm_config.h)

Configuration Option (r_fwupcomm_config.h)	
FWUPCOMM_CFG_PARAM_CHECKING_ENABLE *The default setting is 0.	0: Checking of parameters in the code at the time of building is omitted. 1: Checking of parameters in the code at the time of building is included. Setting BSP_CFG_PARAM_CHECKING_ENABLE selects use of the default setting for the system.
FWUPCOMM_CFG_DEVICE_PRIMARY *The default setting is 0.	0: Secondary MCU 1: Primary MCU
FWUPCOMM_CFG_SCI_UART_CHANNEL *The default setting is 1.	Sets the SCI channel number to be used for communications.
FWUPCOMM_CFG_SCI_UART_BAUDRATE *The default setting is 115200.	Sets the baud rate for UART communications.
FWUPCOMM_CFG_SCI_UART_INT_PRIORITY *The default setting is 15.	Sets the priority of interrupts from the SCI channel to be used for communications.
FWUPCOMM_CFG_SEND_PACKET_BUFFER_SIZE *The default setting is 1500.	Sets the size of the transmission buffer for commands.
FWUPCOMM_CFG_RECV_PACKET_BUFFER_SIZE *The default setting is 1500.	Sets the size of the reception buffer for commands.
FWUPCOMM_CFG_DEVICE_ADDRESS *The default setting is 0xA0.	Sets a specific address for the device.
FWUPCOMM_CFG_CMD_SEND_TIMEOUT *The default setting is 500.	Sets the timeout time for sending in communications. Unit is milliseconds.
FWUPCOMM_CFG_CMD_RECV_TIMEOUT *The default setting is 500.	Sets the timeout time for receiving in communications. Unit is milliseconds.
FWUPCOMM_CFG_CMD_COMMON_ENABLE *The default setting is 1.	Select whether to enable the Common command.
FWUPCOMM_CFG_CMD_HANDLER_COMMON *The default setting is R_FWUPCOMM_CmdHandler_Common.	Sets the name of the handler function to be called when a Common command is received.
FWUPCOMM_CFG_CMD_HANDLER_FWUP *The default setting is 1.	Select whether to enable the FWUP command.
FWUPCOMM_CFG_CMD_HANDLER_FWUP *The default setting is R_FWUPCOMM_CmdHandler_FWUP.	Sets the name of the handler function to be called when an FWUP command is received.
FWUPCOMM_CFG_CMD_VER *The default setting is 1.	Sets the version number of commands.
FWUPCOMM_CFG_CMD_FWUP_START_DATA_SIZE *The default setting is 0.	Sets the size of data to be included with the FWUP_START command.
FWUPCOMM_CFG_CMD_FWUP_WRITE_FW_BLOCK_SIZE *The default setting is 1024.	Sets the size of the block of firmware to be included with the FWUP_WRITE command.
FWUPCOMM_CFG_CMD_COMMON_MAX_DATA_SIZE *The default setting is 10.	Sets the maximum size of data to be included with a common command.

The configuration option settings for the SCI FIT module used with this module are contained in r_sci_rx_config.h.

Table 2-2 describes the names of options and values of settings for the SCI FIT module. For details on the options, refer to *RX Family SCI Module Using Firmware Integration Technology* (R01AN1815).

Table 2-2 Configuration Settings (r_sci_rx_config.h)

Configuration Option (r_sci_rx_config.h)	
SCI_CFG_CHx_INCLUDED *1. CHx = CH0 to CH12 *2. The default settings for each of the channels are as follows. CH0 = 1, CH1 to CH12 = 0	Includes resources such as the transmission and reception buffers, counters, interrupts, other programs, and areas of RAM for each of the channels. Specify 1 for the same SCI channel number as that specified with FWUPCOMM_CFG_SCI_UART_CHANNEL.
SCI_CFG_CHx_TX_BUFSIZ *1. CHx = CH0 to CH12 *2. The default setting for each channel is 80.	Specifies the buffer size used for the transmission queues of each channel in asynchronous mode. Specify the buffer size which was specified for FWUPCOMM_CFG_SEND_PACKET_BUFFER_SIZE.
SCI_CFG_CHx_RX_BUFSIZ *1. CHx = CH0 to CH12 *2. The default setting for each channel is 80.	Specifies the buffer size used for the reception queues of each channel in asynchronous mode. Specify the buffer size which was specified for FWUPCOMM_CFG_RECV_PACKET_BUFFER_SIZE.
SCI_CFG_TEI_INCLUDED *The default setting is 0.	Enables the transmission complete interrupt for serial transmission. Specify 1 because this FIT module uses the serial transmission complete interrupt.

2.7 Code Size of the Sample Projects

Table 2-3 lists the ROM and RAM sizes for the sample projects included in the package for this application note. The values in the table were confirmed under the following conditions.

Module revision: r_fwupcomm rev.1.00

Compiler versions: Renesas Electronics C/C++ Compiler for RX Family V3.07.00

GCC for Renesas RX 8.3.0.202411

CC-RX

- Optimization level(-optimize): Level 2: Performs whole module optimization
- Optimization type(-speed/-size): Optimizes with emphasis on code size
- Delete variables or functions to which there is no reference (-optimize=symbol_delete)

GCC

- Optimization level: Size (-Os)

Table 2-3 ROM and RAM Sizes for the Sample Projects(Half Update Method)

ROM and RAM Code Sizes				
Device	**Category**	**Memory Used (Byte)**		**Project Name**
		CC-RX	**GCC**	
RX140	ROM	25681	21308	app_rx140_fpb_wo_buffer
		29328	31184	bootloader_rx140_fpb_wo_buffer
	RAM	13380	13308	app_rx140_fpb_wo_buffer
		8869	10108	bootloader_rx140_fpb_wo_buffer
RX23E-B	ROM	25783	21392	app_rx23eb_rssk_wo_buffer
		13823	13820	bootloader_rx23eb_rssk_wo_buffer
	RAM	14629	14629	app_rx23eb_rssk_wo_buffer
		8986	10236	bootloader_rx23eb_rssk_wo_buffer
RX261	ROM	26574	22356	app_rx261_fpb_wo_buffer
		29830	32232	bootloader_rx261_fpb_wo_buffer
	RAM	13777	13692	app_rx261_fpb_wo_buffer
		9107	10492	bootloader_rx261_fpb_wo_buffer
RX66T	ROM	28155	24788	app_rx66t_rsk_wo_buffer
		37654	34804	bootloader_rx66t_rsk_wo_buffer
	RAM	14350	13564	app_rx66t_rsk_wo_buffer
		10641	14460	bootloader_rx66t_rsk_wo_buffer
RX660	ROM	28139	24708	app_rx660_tb_wo_buffer
		38048	34420	bootloader_rx660_tb_wo_buffer
	RAM	13729	14204	app_rx660_tb_wo_buffer
		10496	14588	bootloader_rx660_tb_wo_buffer

Table 2-4 ROM and RAM Sizes for the Sample Projects(Full Update Method)

ROM and RAM Code Sizes				
Device	**Category**	**Memory Used (Byte)**		**Project Name**
		CC-RX	**GCC**	
RX140	ROM	25681	21308	app_rx140_fpb_wo_buffer
		29328	31184	bootloader_rx140_fpb_wo_buffer
	RAM	13380	13308	app_rx140_fpb_wo_buffer
		8869	10108	bootloader_rx140_fpb_wo_buffer
RX23E-B	ROM	25783	21392	app_rx23eb_rssk_wo_buffer
		13823	13820	bootloader_rx23eb_rssk_wo_buffer
	RAM	14629	14629	app_rx23eb_rssk_wo_buffer
		8986	10236	bootloader_rx23eb_rssk_wo_buffer
RX261	ROM	26574	22356	app_rx261_fpb_wo_buffer
		29830	32232	bootloader_rx261_fpb_wo_buffer
	RAM	13777	13692	app_rx261_fpb_wo_buffer
		9107	10492	bootloader_rx261_fpb_wo_buffer
RX660	ROM	28155	24788	app_rx66t_rsk_wo_buffer
		37654	34804	bootloader_rx66t_rsk_wo_buffer
	RAM	14350	13564	app_rx66t_rsk_wo_buffer
		10641	14460	bootloader_rx66t_rsk_wo_buffer

2.8 Arguments

This section shows the definitions of structures and enumerated types that are used as arguments of the API functions. The definitions of these types are described in r_fwupcomm_if.h, along with the prototype declarations of the API functions.

```
/* Structure used for registering a timer interface */
typedef struct r_fwupcomm_timer
{
    r_fwupcomm_start_timer_t start; // Pointer to the function to start counting by a timer
    r_fwupcomm_stop_timer_t stop;   // Pointer to the function to stop counting by a timer
} r_fwupcomm_timer_t;
```

```
/* Structure used as an argument of the Open function during initialization */
typedef struct r_fwupcomm_cfg
{
    r_fwupcomm_timer_t timer; // Timer interface
} r_fwupcomm_cfg_t;
```

```
/* Structure for specifying command information */
struct r_fwupcomm_cmd_info
{
    uint8_t device_address; // Address of the destination device for a command
    uint8_t class;          // Command class
    uint8_t type;           // Command
    uint8_t arg;            // Command argument
    uint16_t data_size;     // Command data size
    const void *data;       // Pointer to command data
    uint8_t id;             // Command ID
};
```

```
/* Structure for storing response information */
struct r_fwupcomm_resp_info
{
    int8_t result;        // Command result
    void *data;           // Pointer to the destination for storing response data
    uint16_t data_size;   // Size of the destination for storing response data
};
```

```
/* Structure used as an argument of the CmdSend function when a command is to be sent */
struct r_fwupcomm_cmd_instr
{
    uint16_t timeout_ms;          // Timeout time from sending the command to receiving the response
    r_fwupcomm_cmd_info_t cmd;    // Command information
    r_fwupcomm_resp_info_t resp;  // Destination for storing response information
};
```

```
/* Enumerated type for defining the command classes */
typedef enum
{
    FWUPCOMM_CMD_CLS_COMMON = 0,    // Common command
    FWUPCOMM_CMD_CLS_FWUP,          // FWUP command
    FWUPCOMM_CMD_NUM_CLS            // Number of defined command classes
} r_fwupcomm_cmd_class_t;
```

```
/* Enumerated type for defining commands of the common command class */
typedef enum
{
    FWUPCOMM_CMD_COMMON_DATA_SEND = 0,    // DATA_SEND command
    FWUPCOMM_CMD_COMMON_DATA_RECV,        // DATA_RECV command
    FWUPCOMM_CMD_COMMON_NUM_COMMANDS      // Number of defined common commands
} r_fwupcomm_cmd_type_common_t;
```

```
/* Enumerated type for defining commands of the FWUP command class */
typedef enum
{
    FWUPCOMM_CMD_FWUP_START = 0,          // START command
    FWUPCOMM_CMD_FWUP_WRITE,              // WRITE command
    FWUPCOMM_CMD_FWUP_INSTALL,            // INSTALL command
    FWUPCOMM_CMD_FWUP_CANCEL,             // CANCEL command
    FWUPCOMM_CMD_FWUP_NUM_COMMANDS        // Number of defined FWUP commands
} r_fwupcomm_cmd_type_fwup_t;
```

2.9 Return Values

This section describes the return values of the API functions. The enumerated type is defined in r_fwupcomm_if.h, along with the prototype declarations of the API functions.

```
typedef enum
{
    FWUPCOMM_SUCCESS = 0,
    FWUPCOMM_ERR_INVALID_PTR,        // The pointer passed as an argument was NULL.
    FWUPCOMM_ERR_INVALID_ARG,        // The parameter passed as an argument was invalid.
    FWUPCOMM_ERR_NOT_OPEN,           // The module has not been opened.
    FWUPCOMM_ERR_ALREADY_OPEN,       // The module has already been initialized.
    FWUPCOMM_ERR_INVALID_CMD,        // An invalid command was received.
    FWUPCOMM_ERR_INVALID_RESP,       // The received response was invalid.
    FWUPCOMM_ERR_RECV_RESP_TIMEOUT,  // A timeout occurred before a response was received.
    FWUPCOMM_ERR_NO_CMD,             // No command was received.
    FWUPCOMM_ERR_CH_ALREADY_OPEN,    // The communications channel has already been opened.
    FWUPCOMM_ERR_CH_SEND,            // Sending of data in the communications channel failed.
    FWUPCOMM_ERR_CH_SEND_BUSY,       // The communications channel was busy so sending of data failed.
    FWUPCOMM_ERR_CH_RECV,            // Receiving of data from the communications channel failed.
    FWUPCOMM_ERR_CH_RECV_NO_DATA,    // The communications channel does not have enough received data.
} fwupcomm_err_t;
```

2.10 Adding the FIT Module to Your Project

The module must be added to each project in which it is used.

Renesas recommends the method using the Smart Configurator described in (1) below. However, the Smart Configurator only supports some RX devices. Use the method under (2) for RX devices that are not supported by the Smart Configurator.

(1) Adding the FIT module to your project by using the Smart Configurator in the e^2 studio

By using the Smart Configurator in the e^2 studio, the FIT module is automatically added to your project. Refer to “RX Smart Configurator User’s Guide: e^2 studio (R20AN0451)” for details.

(2) Adding the FIT module to your project by using the FIT Configurator in the e^2 studio

By using the FIT Configurator in the e^2 studio, the FIT module is automatically added to your project. Refer to “RX Family Adding Firmware Integration Technology Modules to Projects (R01AN1723)” for details.

2.11 “for”, “while” and “do while” Statements

In this module, “for”, “while”, and “do while” statements (loop processing) are used in processing to wait for registers to reflect written values and so on. For such loop processing, the comment “WAIT_LOOP” is written as a keyword. Therefore, if the user wishes to incorporate fail-safe processing into the loop processing, the user can search for the corresponding processing by using “WAIT_LOOP”.

The following listings are examples of such loop processing.

```
while statement example:
/* WAIT_LOOP */
while(0 == SYSTEM.OSCOVFSR.BIT.PLOVF)
{
    /* The delay period needed is to make sure that the PLL has stabilized. */
}
```

```
for statement example:
/* Initialize reference counters to 0. */
/* WAIT_LOOP */
for (i = 0; i < BSP_REG_PROTECT_TOTAL_ITEMS; i++)
{
    g_protect_counters[i] = 0;
}
```

```
do while statement example:
/* Reset completion waiting */
do
{
    reg = phy_read(ether_channel, PHY_REG_CONTROL);
    count++;
} while ((reg & PHY_CONTROL_RESET) && (count < ETHER_CFG_PHY_DELAY_RESET));
/* WAIT_LOOP */
```

3. API Functions

3.1 R_FWUPCOMM_Open Function

Table 3-1 Specifications of the R_FWUPCOMM_Open Function

Format	fwupcomm_err_t R_FWUPCOMM_Open(r_fwupcomm_hdl_t *hdl, void *cfg)	
Description	Opens a communications channel for use by or within this module. This function must be executed before other API functions are used.	
Parameters	hdl: Handler of the module cfg: Structure variable with information required for initializing modules	
Return Values	FWUPCOMM_SUCCESS	The channel was successfully initialized.
	FWUPCOMM_ERR_INVALID_PTR	The pointer passed as an argument was NULL.
	FWUPCOMM_ERR_ALREADY_OPEN	Opening has already proceeded.
	FWUPCOMM_ERR_CH_ALREADY_OPEN	The communications channel has already been opened.
	FWUPCOMM_ERR_NOT_OPEN	Initializing the communications channel failed.
Special Notes	—	

Example:

```
fwupcomm_err_t fwupcomm_err;
r_fwupcomm_hdl_t fwupcomm_hdl = {0};
r_fwupcomm_cfg_t fwupcomm_cfg;
fwupcomm_cfg.timer.start = demo_start_timer;
fwupcomm_cfg.timer.stop = demo_stop_timer;

fwupcomm_err = R_FWUPCOMM_Open(&fwupcomm_hdl, &fwupcomm_cfg);
```

3.2 R_FWUPCOMM_Close Function

Table 3-2 Specifications of the R_FWUPCOMM_Close Function

Format	fwupcomm_err_t R_FWUPCOMM_Close(r_fwupcomm_hdl_t *hdl)	
Description	Closes a communications channel for use by or within this module.	
Parameters	hdl: Handler of the module	
Return Values	FWUPCOMM_SUCCESS	Closing was successful.
	FWUPCOMM_ERR_NOT_OPEN	The module has not been opened.
	FWUPCOMM_ERR_INVALID_PTR	The pointer passed as an argument is NULL.
Special Notes	—	

Example:

```
fwupcomm_err = R_FWUPCOMM_Close(&fwupcomm_hdl);
```

3.3 R_FWUPCOMM_CmdSend Function

Table 3-3 Specifications of the R_FWUPCOMM_CmdSend Function

Format	fwupcomm_err_t R_FWUPCOMM_CmdSend(r_fwupcomm_hdl_t *hdl, r_fwupcomm_cmd_instr_t *cmd_instr)	
Description	Sends a command for the secondary MCU and receives a corresponding response.	
Parameters	hdl: Handler of the module cmd_instr: Structure variable with information on the command to be sent and the destination for storing the response	
Return Values	FWUPCOMM_SUCCESS	The command was successfully completed.
	FWUPCOMM_ERR_NOT_OPEN	The module has not been opened.
	FWUPCOMM_ERR_INVALID_PTR	The pointer passed as an argument was NULL.
	FWUPCOMM_ERR_INVALID_ARG	The parameter passed as an argument was invalid.
	FWUPCOMM_ERR_CH_SEND	Sending of data in the communications channel failed.
	FWUPCOMM_ERR_CH_RECV	Receiving of data from the communications channel failed.
	FWUPCOMM_ERR_RECV_RESP_TIMEOUT	A timeout occurred before a response was received.
Special Notes	—	

Example:

```
r_fwupcomm_cmd_info_t cmd = {0};
r_fwupcomm_resp_info_t resp = {0};
uint8_t resp_data[4] = {0};


cmd.device_address = 0xA0;
cmd.class = FWUPCOMM_CMD_CLS_FWUP;
cmd.type = FWUPCOMM_CMD_FWUP_START;
cmd.arg = 0;
cmd.data = NULL;
cmd.data_size = 0;

resp.data = resp_data;

r_fwupcomm_cmd_instr_t cmd_instruction =
{
    .timeout_ms = 500U,
    .cmd = cmd,
    .resp = resp
};

fwupcomm_err = R_FWUPCOMM_CmdSend(&fwupcomm_hdl, &cmd_instruction);
```

3.4 R_FWUPCOMM_ProcessCmdLoop Function

Table 3-4 Specifications of the R_FWUPCOMM_ProcessCmdLoop Function

Format	fwupcomm_err_t R_FWUPCOMM_ProcessCmdLoop(r_fwupcomm_hdl_t *hdl)	
Description	Receives a command from the primary MCU, runs the corresponding handler, and sends the result of executing the command. Periodically execute this function in the secondary MCU while it is waiting for commands.	
Parameters	hdl: Handler of the module	
Return Values	FWUPCOMM_SUCCESS	The channel was successfully initialized.
	FWUPCOMM_ERR_NOT_OPEN	The module has not been opened.
	FWUPCOMM_ERR_INVALID_PTR	The pointer passed as an argument was NULL.
	FWUPCOMM_ERR_INVALID_ARG	The parameter passed as an argument was invalid.
	FWUPCOMM_ERR_NO_CMD	No command was received.
	FWUPCOMM_ERR_INVALID_CMD	An invalid command was received.
	FWUPCOMM_ERR_CH_SEND	Sending of data in the communications channel failed.
	FWUPCOMM_ERR_CH_RECV	Receiving of data from the communications channel failed.
Special Notes	—	

Example:

```
do
{
    fwupcomm_err = R_FWUPCOMM_ProcessCmdLoop(&fwupcomm_hdl);
}while((FWUPCOMM_SUCCESS == fwupcomm_err)||(FWUPCOMM_ERR_NO_CMD == fwupcomm_err));
```

4. Extending the Functionality of This Module

This chapter describes how to add commands to this module and change the method of communications.

4.1 Adding Commands

This section describes how to define desired commands in addition to the FWUP and common commands which have already been defined for this module. Here, ADDITIONAL1 and ADDITIONAL2 commands having the UserDefined command class name are added as an example.

(1) Create a source file such as r_fwupcomm_cmd_user_defined.c and a header file such as r_fwupcomm_cmd_user_defined.h.
Include the r_fwupcomm_if.h header file and also include the header file of the created UserDefined commands in the source file.

(2) Create an enumerated type for defining the UserDefined commands, such as r_fwupcomm_cmd_class_user_defined_t shown below, in the header file and define enumerators to indicate the ADDITIONAL1 and ADDITIONAL2 commands. Define an enumerator to indicate the number of elements as the last enumerator of the enumerated type.

```
typedef enum
{
    FWUPCOMM_CMD_USERDEFINED_ADDITIONAL1,
    FWUPCOMM_CMD_USERDEFINED_ADDITIONAL2,
    FWUPCOMM_CMD_USERDEFINED_NUM_COMMANDS
} r_fwupcomm_cmd_class_user_defined_t;
```

(3) Define an array of the r_fwupcomm_cmd_table_t type in the source file and place information on the ADDITIONAL1 and ADDITIONAL2 commands as the two elements of the array.

```
const r_fwupcomm_cmd_table_t
r_fwupcomm_user_defined_cmd_table[FWUPCOMM_CMD_USERDEFINED_NUM_COMMANDS] =
{
  { FWUPCOMM_CMD_USERDEFINED_ADDITIONAL1, 0x01, 0U, 0U },
  { FWUPCOMM_CMD_USERDEFINED_ADDITIONAL2, 0x02, 0U, 0U }
};
```

The r_fwupcomm_cmd_table_t type is a structure defined in r_fwupcomm_if.h. Each of the members is defined as follows.

```
typedef struct r_fwupcomm_cmd_table
{
    uint8_t type;                  // Value indicating this command (enumerator)
    uint8_t value;                 // Actual value used for communications by this command
    uint16_t cmd_data_max_size;    // Maximum size of the command data of this command
    uint16_t resp_data_max_size;   // Maximum size of the response data of this command
} r_fwupcomm_cmd_table_t;
```

(4) Define the handler function which describes the processing to be executed when the secondary MCU receives the UserDefined command in the source file.
The pointer variable of the r_fwupcomm_cmd_info_t type contains the information on the received command such as pointers to the command arguments or command data. Refer to such command information to run the processing within the handler function. After that, store the information on responses to be sent to the primary MCU (command results, pointer to the response data, and response data size) in a pointer variable of the r_fwupcomm_resp_info_t type as the argument.

```
void R_FWUPCOMM_CmdHandler_UserDefined(r_fwupcomm_cmd_info_t *cmd,
                                       r_fwupcomm_resp_info_t *resp)
{
    if((NULL == cmd)||(NULL == resp))
    {
        return;
    }

    if(cmd->type >= FWUPCOMM_CMD_USERDEFINED_NUM_COMMANDS)
    {
        return;
    }

    switch(cmd->type)
    {
        case FWUPCOMM_CMD_USERDEFINED_ADDITIONAL1:
            /* Describe the processing to be executed upon receiving the ADDITIONAL1 command. */
            break;
        case FWUPCOMM_CMD_USERDEFINED_ADDITIONAL2:
            /* Describe the processing to be executed upon receiving the ADDITIONAL2 command. */
            break;
}
```

(5) Declare an array of the r_fwupcomm_cmd_table_t type for the UserDefined command, which was previously defined in the source file, in the header file as extern. Similarly, write a prototype declaration for the handler function of the UserDefined command.

```
extern const r_fwupcomm_cmd_table_t r_fwupcomm_user_defined_cmd_table
[FWUPCOMM_CMD_COMMON_NUM_COMMANDS];

#if FWUPCOMM_CFG_DEVICE_PRIMARY == (0)  // Macro which enables only the secondary MCU
void R_FWUPCOMM_CmdHandler_UserDefined (r_fwupcomm_cmd_info_t *cmd,
r_fwupcomm_resp_info_t *resp);
#endif
```

(6) Include the header file for the UserDefined command in the r_fwupcomm¥src¥commands¥r_fwupcomm_cmd.h file.

```
#include "r_fwupcomm_cmd_common.h"
#include "r_fwupcomm_cmd_fwup.h"
#include " r_fwupcomm_cmd_user_defined.h"
```

(7) Add an enumerator indicating the UserDefined command to the r_fwupcomm_cmd_class_t enumerated type which is defined in the r_fwupcomm_cmd.h file.

```
typedef enum
{
    FWUPCOMM_CMD_CLS_COMMON = 0,
    FWUPCOMM_CMD_CLS_FWUP,
    FWUPCOMM_CMD_CLS_USERDEFINED,
    FWUPCOMM_CMD_NUM_CLS
} r_fwupcomm_cmd_class_t;
```

(8) Add the UserDefined command to the array of the r_fwupcomm_cmd_def_table_t type which is defined in the r_fwupcomm_cmd.c file.

```
const r_fwupcomm_cmd_def_table_t r_fwupcomm_cmd_def_table_list[] =
{
  [FWUPCOMM_CMD_CLS_COMMON] = {r_fwupcomm_common_cmd_table, FWUPCOMM_CMD_COMMON_NUM_COMMANDS},
  [FWUPCOMM_CMD_CLS_FWUP] = {r_fwupcomm_fwup_cmd_table, FWUPCOMM_CMD_FWUP_NUM_COMMANDS},
  [FWUPCOMM_CMD_CLS_USERDEFINED] = {r_fwupcomm_user_defined_cmd_table,
                                    FWUPCOMM_CMD_USERDEFINED_NUM_COMMANDS}
};
```

As stated, the r_fwupcomm_cmd_def_table_t type is defined in r_fwupcomm_cmd.h. Specify the array of the r_fwupcomm_cmd_table_t type defined in the source file as the table member. Specify the number of commands in that command class as the num_cmd member.

```
typedef struct
{
    const r_fwupcomm_cmd_table_t *table;
    uint8_t num_cmd;
} r_fwupcomm_cmd_def_table_t;
```

(9) Add the handler functions of the UserDefined command defined in the source file to the array of the R_FWUPCOMM_CmdHandler_t type which is defined in the r_fwupcomm_cmd.c file.

```
#if FWUPCOMM_CFG_DEVICE_PRIMARY == (0)    // Macro which enables only the secondary MCU
const R_FWUPCOMM_CmdHandler_t r_fwupcomm_cmd_handler_list[FWUPCOMM_CMD_NUM_CLS] =
{
     [FWUPCOMM_CMD_CLS_COMMON] = FWUPCOMM_CFG_CMD_HANDLER_COMMON,
     [FWUPCOMM_CMD_CLS_FWUP] = FWUPCOMM_CFG_CMD_HANDLER_FWUP,
     [FWUPCOMM_CMD_CLS_USERDEFINED] = R_FWUPCOMM_CmdHandler_UserDefined
};
#endif
```

The steps described above are used for adding commands. For further information, refer to the definition files for the FWUP commands (r_fwupcomm_cmd_fwup.c and r_fwupcomm_cmd_fwup.h) and for the common commands (r_fwupcomm_cmd_common.c and r_fwupcomm_cmd_common.h) in the r_fwupcomm¥src¥commands folder.

4.2 Changing the Method of Communications

This module only supports UART communications via the SCI. This section describes how to change to another method of communications.

4.2.1 Communications Interface

This module specifies the communications interface for packet communications. It is defined in r_fwupcomm¥src¥connectivity¥r_fwupcomm_ch.h as follows.

```
typedef struct r_fwupcomm_ch_api
{
    fwupcomm_err_t (*open)(void);
    void (*close)(void);
    fwupcomm_err_t (*send)(uint8_t *src, uint16_t size);
    fwupcomm_err_t (*recv)(uint8_t *dest, uint16_t size);
    void (*rx_flush)(void);
} r_fwupcomm_ch_api_t;
```

4.2.1.1 fwupcomm_err_t (*open)(void)

Table 4-1 Specifications of the open Function

Format	fwupcomm_err_t (*open)(void)	
Description	Opens a communications channel.	
Parameters	—	
Return Values	FWUPCOMM_SUCCESS	The channel was successfully initialized.
	FWUPCOMM_ERR_CH_ALREADY_OPEN	The communications channel has already been opened.
	FWUPCOMM_ERR_NOT_OPEN	Initializing the communications channel failed.
Special Notes	—	

4.2.1.2 void (*close)(void)

Table 4-2 Specifications of the close Function

Format	void (*close)(void)
Description	Closes a communications channel.
Parameters	—
Return Values	—
Special Notes	—

4.2.1.3 fwupcomm_err_t (*send)(uint8_t *src, uint16_t size)

Table 4-3 Specifications of the send Function

Format	fwupcomm_err_t (*send)(uint8_t *src, uint16_t size)	
Description	Sends data by using a communications channel.	
Parameters	src: Pointer to the destination for storing data to be sent size: Size of data to be sent	
Return Values	FWUPCOMM_SUCCESS	The channel was successfully initialized.
	FWUPCOMM_ERR_INVALID_PTR	The src pointer is NULL.
	FWUPCOMM_ERR_INVALID_ARG	size is 0.
	FWUPCOMM_ERR_NOT_OPEN	The communications channel has not been opened.
	FWUPCOMM_ERR_CH_SEND_BUSY	The communications channel was busy so sending of data failed.
	FWUPCOMM_ERR_CH_SEND	Sending of data in the communications channel failed.
Special Notes	—	

4.2.1.4 fwupcomm_err_t (*recv)(uint8_t *dest, uint16_t size)

Table 4-4 Specifications of the recv Function

Format	fwupcomm_err_t (*recv)(uint8_t *dest, uint16_t size)	
Description	Receives data by using a communications channel.	
Parameters	dest: Pointer to the buffer for storing received data size: Required size of received data	
Return Values	FWUPCOMM_SUCCESS	The channel was successfully initialized.
	FWUPCOMM_ERR_INVALID_PTR	The dest pointer is NULL.
	FWUPCOMM_ERR_INVALID_ARG	size is 0.
	FWUPCOMM_ERR_NOT_OPEN	The communications channel has not been opened.
	FWUPCOMM_ERR_CH_RECV_NO_DATA	The communications channel does not have enough received data.
Special Notes	—	

4.2.1.5 void (*rx_flush)(void)

Table 4-5 Specifications of the rx_flush Function

Format	void (*rx_flush)(void)
Description	Empties the reception buffer of the communications channel.
Parameters	—
Return Values	—
Special Notes	—

4.2.2 How to Change the Method of Communications

(1) Implement the functions for communications interfaces described in section 4.2.1 by using the method of communications you wish to use.

(2) Define the r_fwupcomm_ch_api variable of the const r_fwupcomm_ch_api_t type, and initialize the functions which have been created for the communications interface as shown below.

```
const r_fwupcomm_ch_api_t r_fwupcomm_ch_api =
{ .open = r_fwupcomm_rx_sci_uart_open,          // open
  .close = r_fwupcomm_rx_sci_uart_close,        // close
  .send = r_fwupcomm_rx_sci_uart_send,          // send
  .recv = r_fwupcomm_rx_sci_uart_recv,          // recv
  .rx_flush = r_fwupcomm_rx_sci_uart_rx_flush   // rx_flush
};
```

(3) Create a header file with a name such as r_fwupcomm_ch_user_defined.h to declare the r_fwupcomm_ch_api variable as extern.

```
extern r_fwupcomm_ch_api_t const r_fwupcomm_ch_api;
```

(4) Add the definition of the communications interface to the r_fwupcomm¥src¥r_fwupcomm_private.h file in such a way that the newly created header file is included instead of the one that has been previously created.

```
#define FWUPCOMM_CH_RX_SCI_UART             (1)
#define FWUPCOMM_CH_USERDEFINED             (2)

#define FWUPCOMM_USE_CH                     (FWUPCOMM_CH_USERDEFINED)

#if (FWUPCOMM_USE_CH == FWUPCOMM_CH_RX_SCI_UART)
  #include "r_fwupcomm_rx_sci_uart.h"
#elif (FWUPCOMM_USE_CH == FWUPCOMM_CH_USERDEFINED)
  #include "r_fwupcomm_ch_user_defined.h"
#endif
```

That ends the description of how to change the method of communications.

5. Demonstration Projects

This demonstration projects are sample programs for updating the firmware of the secondary MCU, as shown in Figure 5-1. The primary MCU is connected to a PC and receives the firmware for use in updating that of the secondary MCU via serial communications from the PC. The primary MCU then transfers that firmware to the secondary MCU by using the FWUP Comm module.

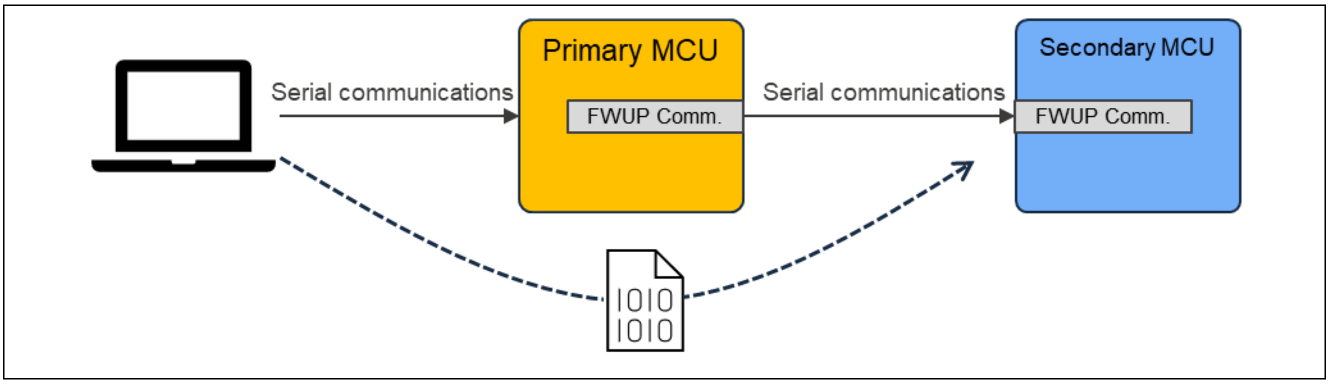

Figure 5-1 Configuration of the Demonstrations

5.1 Configuration for the Demonstration Projects

5.1.1 Primary MCU

Only the RX65N device is used for the demonstration project in the primary MCU side.

- FreeRTOS environment: FITDemos¥rx65n-ck¥(compiler name)¥app_rx65n_ck_primary_frtos
- Bare-metal environment: FITDemos¥rx65n-ck¥(compiler name)¥app_rx65n_ck_primary

5.1.2 Secondary MCU

Demonstration projects in the secondary MCU are classified into folders for each of the supported device groups.

- Partial update method in linear mode: FITDemos¥(board name)¥w_buffer¥(compiler name)¥(project name)
- Full update method in linear mode: FITDemos¥(board name)¥wo_buffer¥(compiler name)¥(project name)

Boot loader projects:

- Partial update method in linear mode: bootloader_(board name)_w_buffer
- Full update method in linear mode: bootloader_(board name)_wo_buffer

Application projects:

- Partial update method in linear mode: app_(board name)_w_buffer
- Full update method in linear mode: app_(board name)_wo_buffer:

5.2 Preparing an Operating Environment

To update the firmware of the secondary MCU, use the firmware updating module. To run the demonstration projects, you need to install certain tools on your Windows PC.

5.2.1 Installing TeraTerm

TeraTerm is used to transfer the firmware updating image via serial communications from a Windows PC to the primary MCU. For the demonstration project, the operation was confirmed with TeraTerm 4.106.

After installation, make the serial port communications settings listed in Table 5-1.

Table 5-1 Specifications for Communications

Item	Description
Communications system	Asynchronous
Bit rate	115200 bps
Data length	8 bits
Parity	None
Stop bit	1 bit
Flow control	RTS/CTS

5.2.2 Installing the Python Execution Environment

The Python execution environment is used by Renesas Image Generator (image-gen.py) to create the initial and updating images.

Renesas Image Generator uses ECDSA to generate signature data. For the demonstration project, the operation was confirmed with Python 3.10.4.

The Python encryption library (pycryptodome) is also used. Accordingly, after installing Python, execute the following pip command from the command prompt to install the library.

```
pip install pycryptodome
```

5.2.3 Installing the Flash Writer

A flash writer is required to write the initial image.

Renesas Flash Programmer V3.18.00 is used with the demonstration projects.

Renesas Flash Programmer (Programming GUI) | Renesas

5.3 Procedure for Executing a Demonstration Project

This section describes an example of the procedure for executing a demonstration project with the use of an RX140 device. The procedure for executing the demonstration project is common to other MCU products; however, only the environment for confirming the operation differs with the MCU. Confirm the environment (section 6.1, Environments for Confirming Operation) for the MCU product you intend to use. The procedure for executing the demo project is also common for the CC-RX compiler and GCC compiler environments.

5.3.1 Execution Environment

Prepare the environment for confirming the operation with an RX140 (6.3.1). For MCU products other than RX140 devices, refer to the environment for confirming the operation of the applicable product.

5.3.2 Building the Demonstration Projects

Follow the steps below to build the projects for the primary and secondary MCUs.

5.3.2.1 Primary MCU

(1) Import the app_rx65n_ck_primary project into the e^2 studio and build the project. For the full update method, change the "`FWUP_FULL_UPDATE`" macro definition to (1) in app_rx65n_ck_primary¥src¥app_rx65n_ck_primary.h before the build.

```
#define FWUP_FULL_UPDATE            (1)
```

(2) Confirm that the following MOT file has been generated in the HardwareDebug folder for the project.
- app_rx65n_ck_primary.mot

5.3.2.2 Creating Initial and Updating Images for the Secondary MCU

The procedure for creating the initial and updating images, using initial_firm.mot as the name of the initial image and update_firm.mot as the name of the updating image, is described below. This is the procedure for the partial update method, but the procedure is the same for the full update method, so please replace projects used with those for the full update method.

(1) Import the bootloader_rx140_fpb_w_buffer and app_rx140_fpb_w_buffer projects into the e^2 studio and build the projects.

(2) Confirm that the following MOT files have been generated in the HardwareDebug folder for each project.
- bootloader_rx140_fpb_w_buffer.mot
- app_rx140_fpb_w_buffer.mot

(3) Store the MOT files created by building the demonstration project in the bootloader_rx140_fpb_w_buffer¥src¥smc_gen¥r_fwup¥tool folder. Also store the FITDemos¥keys¥secp256r1.privatekey file there as well.

image-gen.py
RX140_Linear_Full_ImageGenerator_PRM.csv
RX140_Linear_Half_ImageGenerator_PRM.csv
secp256r1.privatekey
bootloader_rx140_fpb_w_buffer.mot
app_rx140_fpb_w_buffer.mot

(4) Execute the following command in the bootloader_rx140_fpb_w_buffer¥src¥smc_gen¥r_fwup¥tool folder to create the initial image. For the full update method, use RX140_Linear_Full_ImageGenerator_PRM.csv instead of RX140_Linear_Half_ImageGenerator_PRM.csv.

```
python .¥image-gen.py -iup ".¥app_rx140_fpb_w_buffer.mot" -
ip .¥RX140_Linear_Half_ImageGenerator_PRM.csv -o initial_firm -ibp
".¥bootloader_rx140_fpb_w_buffer.mot" -vt ecdsa -key ".¥secp256r1.privatekey"
```

(5) Open the app_rx140_fpb_w_buffer¥src¥fwupcomm_demo_main.h file. Change the definition of DEMO_VER_MAJOR from (1) to (2) and rebuild the app_rx140_fpb_w_buffer project. After that, store the MOT files created by building the project in the tool folder.

```
#define DEMO_VER_MAJOR          (2)
#define DEMO_VER_MINOR          (0)
#define DEMO_VER_BUILD          (0)
```

(6) Execute the following command to create the updating image. For the full update method, use RX140_Linear_Full_ImageGenerator_PRM.csv instead of RX140_Linear_Half_ImageGenerator_PRM.csv.

```
python .¥image-gen.py -iup ".¥app_rx140_fpb_w_buffer.mot" -
ip .¥RX140_Linear_Half_ImageGenerator_PRM.csv -o update_firm -vt ecdsa -key
".¥secp256r1.privatekey"
```

Confirm that the initial and updating images have been generated in the tool folder.

```
Image-gen.py
RX140_Linear_Full_ImageGenerator_PRM.csv
RX140_Linear_Half_ImageGenerator_PRM.csv
secp256r1.privatekey
bootloader_rx140_fpb_w_buffer.mot
app_rx140_fpb_w_buffer.mot
initial_firm.mot
update_firm.rsu
```

5.3.3 Programming the Initial Image

Use the flash writer to program app_rx65n_ck_primary.mot to the MCU on the CK-RX65Nv2 board.

Similarly, use the flash writer to program the initial image (initial_firm.mot) to the MCU on the FPB-RX140 board. After programming is finished, turn off the power to the board and disconnect the debugger (E2 Lite).

5.3.4 Executing a Firmware Update

Once the initial image firmware has been activated, it waits for the transfer of the updating image through the primary MCU. The received updating image is programmed to the flash memory, and after the transfer is completed, the signature of the updating image is verified and the firmware is activated.

Follow the steps below to execute a firmware update.

(1) Launch two TeraTerm windows on the PC, select the serial COM ports for the primary MCU (CK-RX65Nv2) and the secondary MCU (FPB-RX140) in the respective windows, and configure the connection settings.

(2) Turn on the board. The following messages will be output to the TeraTerm windows.

Primary MCU side:

```
==== RX65N : FWUPCOMM DEMO [Primary] ====
Send image(*.rsu) via UART.
```

Secondary MCU side:

```
==== RX140 : BootLoader [with buffer] ====
verify install area main [sig-sha256-ecdsa]...OK
execute image ..
==== RX140 : FWUPCOMM DEMO [Secondary][with buffer]  ver. 1.0.0 ====
```

(3) Send the updating image via TeraTerm.
Click on [Send file] from the [File] menu of TeraTerm for the primary MCU side. Select update_firm.rsu then [Binary] as the option and click on [Open].
The following messages are output during the transfer of the updating image, a software reset is applied after installation and signature verification are completed, and the firmware from the updating image is executed.
The version number output in the last message from the secondary MCU having been incremented indicates that the update was successful.

Primary MCU side:

```
Send FWUP_START command... OK.
Send FWUP_WRITE command... OK. (1024 bytes sent, remaining 38912 bytes.)
Send FWUP_WRITE command... OK. (1024 bytes sent, remaining 37888 bytes.)
...
Send FWUP_WRITE command... OK. (1024 bytes sent, remaining 2048 bytes.)
Send FWUP_WRITE command... OK. (1024 bytes sent, remaining 1024 bytes.)
Send FWUP_INSTALL command... OK.
Firmware update for the device(0xA0) is successful.
```

Secondary MCU side:

```
Received FWUPCOMM_CMD_FWUP_START command.
Received FWUPCOMM_CMD_FWUP_WRITE command. size=1024
W 0xFFF78000, 512 ... OK
W 0xFFF78200, 256 ... OK
W 0xFFF78300, 256 ... OK
Received FWUPCOMM_CMD_FWUP_WRITE command. size=1024
W 0xFFF78400, 1024 ... OK
...
Received FWUPCOMM_CMD_FWUP_WRITE command. size=1024
W 0xFFF81400, 1024 ... OK
Received FWUPCOMM_CMD_FWUP_WRITE command. size=1024
W 0xFFF81800, 768 ... OK
W 0xFFFEFF00, 256 ... OK
verify install area buffer [sig-sha256-ecdsa]...OK
Received FWUPCOMM_CMD_FWUP_INSTALL command.
software reset...

==== RX140 : BootLoader [with buffer] ====
verify install area buffer [sig-sha256-ecdsa]...OK
activating image ... OK
software reset...
==== RX140 : BootLoader [with buffer] ====
verify install area main [sig-sha256-ecdsa]...OK
execute image ...
==== RX140 : FWUPCOMM DEMO [Secondary][with buffer]  ver. 2.0.0 ====
```

6. Appendices

6.1 Environments for Confirming Operation

This section describes environments in which the operation of this module has been confirmed.

Table 6-1 Environment for Confirming Operation (CC-RX)

Item	Description
Integrated development environment	e^2 studio 2025-04 from Renesas Electronics
C compiler	C/C++ Compiler for RX Family V3.07.00 from Renesas Electronics Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian	Little endian
Revision of the module	Rev. 1.00
Board used	Fast Prototyping Board for RX140 MCU Group (product No.: RTK5FP1400S00001BE) Renesas Solution Starter Kit for RX23E-B (product No.: RTK0ES1001C00001BJ) Fast Prototyping Board for RX261 MCU Group (product No.: RTK5FP2610S00001BE) Target Board for RX660 (product No.: RTK5RX6600C00000BJ) Renesas Starter Kit for RX66T (product No.: RTK50566T0S00000BE) Cloud Kit for RX65N Microcontroller Group (product No.: RTK5CK65N0S08001BE)
USB-to-serial conversion board	Pmod USBUART (from DIGILENT) https://digilent.com/reference/pmod/pmodusbuart/start

Table 6-2 Environment for Confirming Operation (GCC)

Item	Description
Integrated development environment	e^2 studio 2025-04 from Renesas Electronics
C compiler	GCC for Renesas RX 8.3.0.202411 Compiler option: The following option is added to the default settings of the integrated development environment. -std=gnu99
Endian	Little endian
Revision of the module	Rev. 1.00
Board used	Fast Prototyping Board for RX140 MCU Group (product No.: RTK5FP1400S00001BE) Renesas Solution Starter Kit for RX23E-B (product No.: RTK0ES1001C00001BJ) Fast Prototyping Board for RX261 MCU Group (product No.: RTK5FP2610S00001BE) Target Board for RX660 (product No.: RTK5RX6600C00000BJ) Renesas Starter Kit for RX66T (product No.: RTK50566T0S00000BE) Cloud Kit for RX65N Microcontroller Group (product No.: RTK5CK65N0S08001BE)
USB-to-serial conversion board	Pmod USBUART (from DIGILENT) https://digilent.com/reference/pmod/pmodusbuart/start

6.2 Settings for UART Communications

Table 6-3 lists the settings for UART communications by this module.

Table 6-3 Settings for UART Communications

Item	Description
Data length	8 bits
Parity	None
Stop bit	1 bit
Flow control	None
Bit rate	1 Mbps

6.3 Operating Environment for the Demonstration Projects

This section shows the configurations of connections of each device for the demonstration projects.

For the PMOD pins of the evaluation board and the USB-to-serial conversion board in the figure, pins 1 to 6 of the PMOD interface are connected to pins 1 to 6 of the USB-to-serial conversion board (Pmod USBUART).

6.3.1 Environment for Confirming Operation with an RX140

The configuration of connections is shown below.

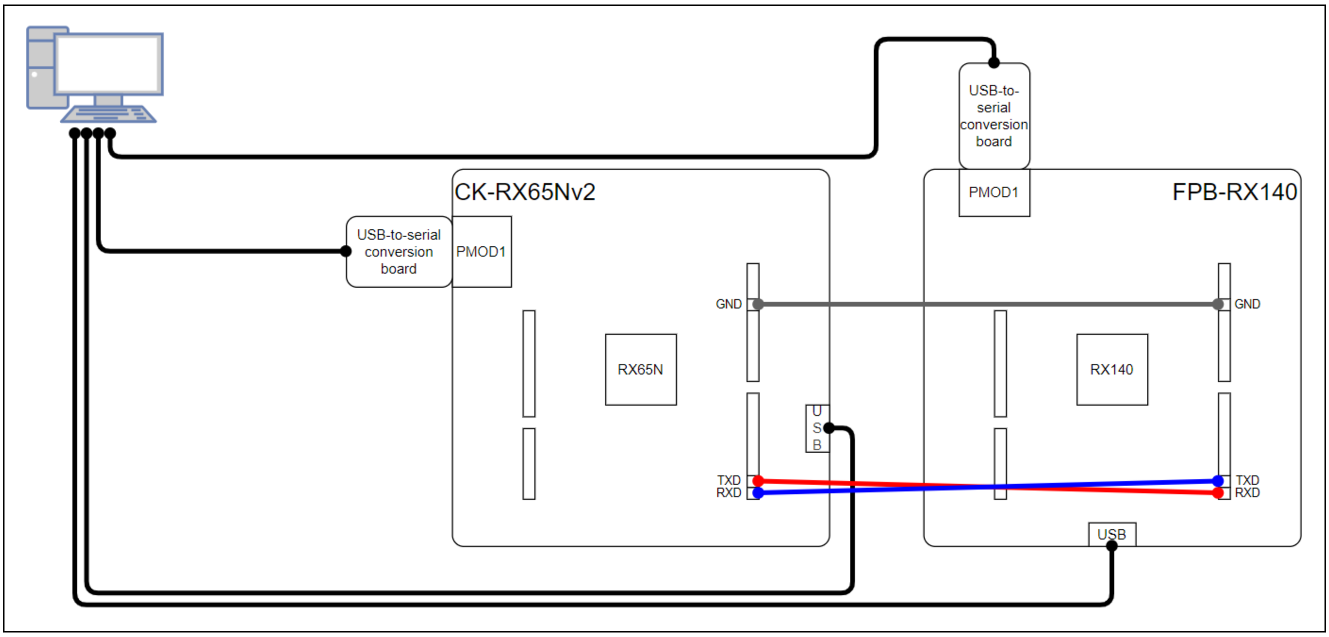

Figure 6-1 Configuration of Connections on the FPB-RX140

Table 6-4 Correspondence of Connected Pins for UART Communications between the CK-RX65Nv2 and FPB-RX140

CK-RX65Nv2		FPB-RX140
J24 pin 7: GND	⇔	J10 pin 7
J23 pin 2: D1/TXD	⇔	J12 pin 1: D0/RX
J23 pin 1: D0/RXD	⇔	J12 pin 2: D1/TX

6.3.2 Environment for Confirming Operation with an RX23E-B

The configuration of connections is shown below.

Please make the following settings to supply power to the RSSK-RX23E-B from the USB-to-serial conversion board.

— Short-circuit “Pins 1-2” of jumper JP1 on the RSSK-RX23E-B.
— Short-circuit “Pins 1-2” of jumper JP3 on the RSSK-RX23E-B.
— Short-circuit “Pins VCC-SYS” of jumper JP1 on the USB-to-serial conversion board (Pmod USBUART).

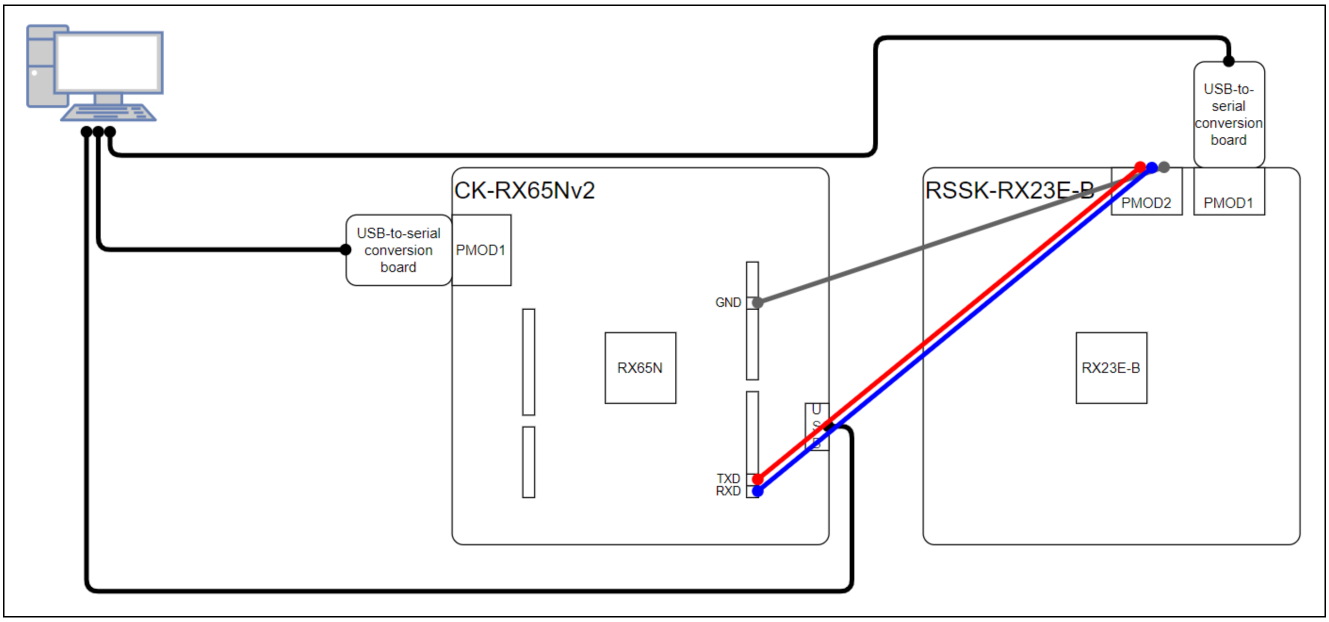

Figure 6-2 Configuration of Connections on the RSSK-RX23E-B

Table 6-5 Correspondence of Connected Pins for UART Communications between the CK-RX65Nv2 and RSSK-RX23E-B

CK-RX65Nv2		RSSK-RX23E-B
J24 pin 7: GND	⇔	PMOD2 pin 5
J23 pin 2: D1/TXD	⇔	PMOD2 pin 3
J23 pin 1: D0/RXD	⇔	PMOD2 pin 2

6.3.3 Environment for Confirming Operation with an RX261

The configuration of connections is shown below.

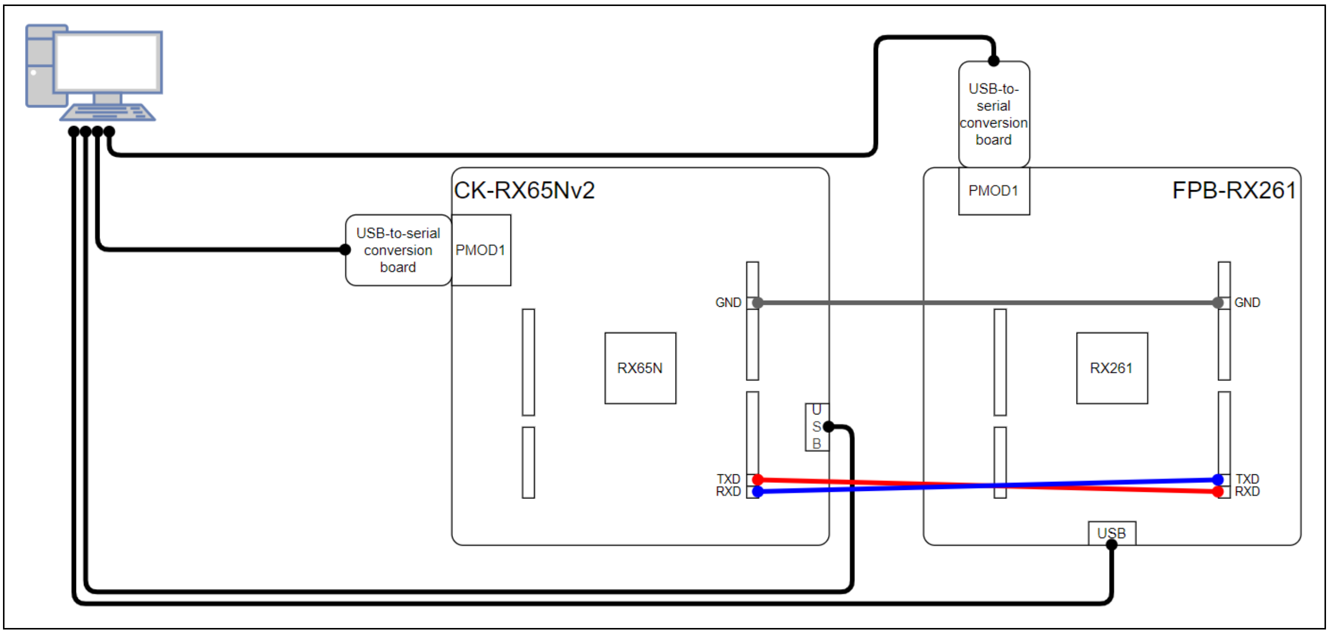

Figure 6-3 Configuration of Connections on the FPB-RX261

Table 6-6 Correspondence of Connected Pins for UART Communications between the CK-RX65Nv2 and FPB-RX261

CK-RX65Nv2		FPB-RX261
J24 pin 7: GND	⇔	J10 pin 7
J23 pin 2: D1/TXD	⇔	J12 pin 1: D0/RX
J23 pin 1: D0/RXD	⇔	J12 pin 2: D1/TX

6.3.4 Environment for Confirming Operation with an RX66T

The configuration of connections is shown below.

Please make the following settings to supply power to the RSK-RX66T from the DC power connector (5V).

— Short-circuit jumper J7 on the RSK-RX66T.

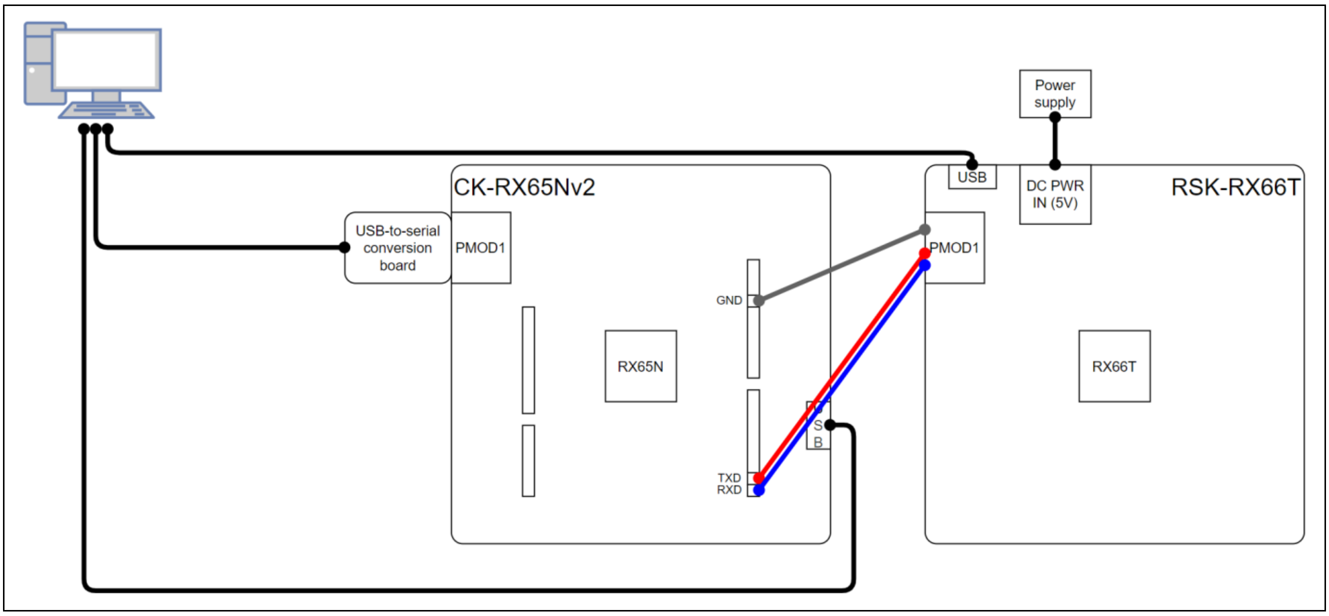

Figure 6-4 Configuration of Connections on the RSK-RX66T

Table 6-7 Correspondence of Connected Pins for UART Communications between the CK-RX65Nv2 and RSK-RX66T

CK-RX65Nv2		RSK-RX66T
J24 pin 7: GND	⇔	PMOD1 pin 5
J23 pin 2: D1/TXD	⇔	PMOD1 pin 3
J23 pin 1: D0/RXD	⇔	PMOD1 pin 2

6.3.5 Environment for Confirming Operation with an RX660

The configuration of connections is shown below.

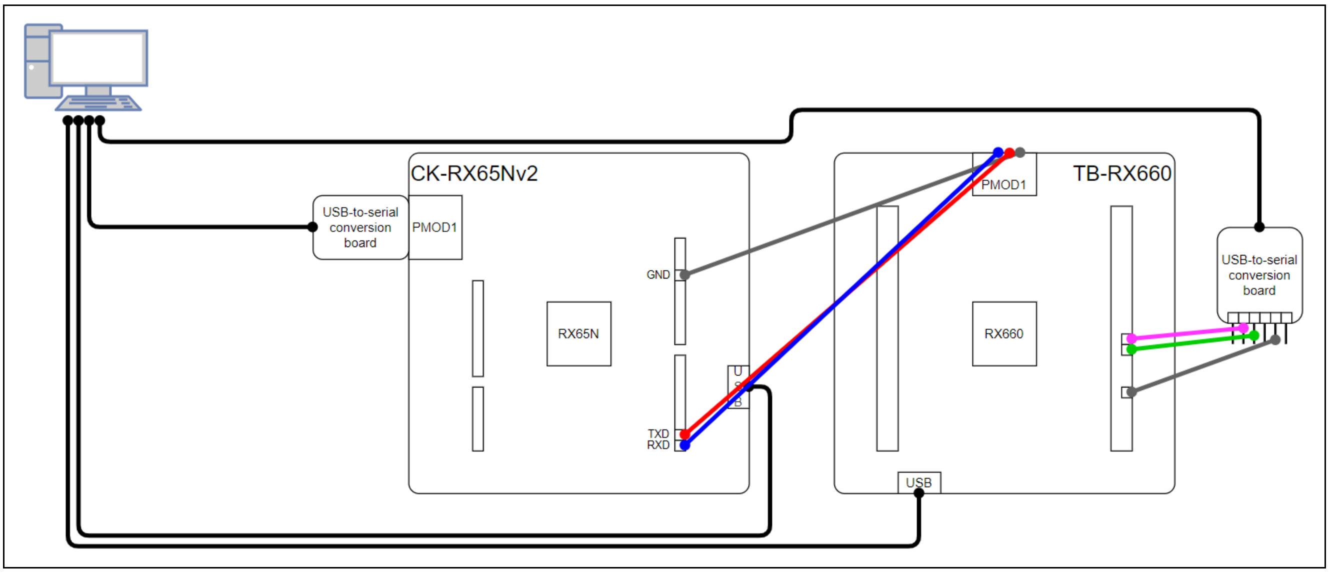

Figure 6-5 Configuration of Connections on the TB-RX660

Table 6-8 Correspondence of Connected Pins for UART Communications between the CK-RX65Nv2 and TB-RX660

CK-RX65Nv2		TB-RX660
J24 pin 7: GND	⇔	PMOD1 pin 11
J23 pin 2: D1/TXD	⇔	PMOD1 pin 10
J23 pin 1: D0/RXD	⇔	PMOD1 pin 9

Table 6-9 Correspondence of Connected Pins for UART Communications between the TB-RX660 and USB-to-serial Conversion Board (Pmod USBUART)

TB-RX660		Pmod USBUART
MCU header CN2 pin 22	⇔	Pin 2
MCU header CN2 pin 20	⇔	Pin 3
MCU header CN2 pin 12	⇔	Pin 5

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	May.20.25	—	First edition issued

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

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

1. Precaution against Electrostatic Discharge (ESD)

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

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