RX Family

R01AN2298EJ0130
Rev.1.30
Jul 31, 2024

Sample Program using using USB Peripheral Mass Storage Class Driver (PMSC)
for USB Mini Firmware to communicate via USB with USB Host Firmware Integration Technology

Introduction

This document describes the following sample firmware: USB Peripheral Mass Storage Class Driver using Firmware Integration Technology. The sample firmware is referred to below as the PMSC.

When developing an actual software, be sure to use the “USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note” (Document number: R01AN2166) together with the user’s manual for each MCU (Hardware). In addition, also refer to the " USB Peripheral Mass Storage Class Driver (PMSC) for USB Mini Firmware using Firmware Integration Technology Application Note” (Document number.R01AN2172), if necessary. “USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note” (Document number: R01AN2166) is located in the "reference_documents" folder within the package.

Target Device

RX111 Group
RX113 Group
RX231 Group
RX23W Group
RX261 Group

The operation of this program has been confirmed using the Renesas Starter Kits (RSK), the Renesas Solution Starter Kit (RSSK) or EK.

Contents

1. Specifications

1.1 Functions

The PMSC performs communication with the USB host PC in conformance with the bulk-only transfer (BOT) portion of the USB mass storage class specification (MSC).

The PMSC implements the following functions:

- It is recognized as a mass storage class device when connected to the USB host PC.
- It performs file transfers to and from the USB host PC.

1.2 PMSC Configuration Elements

The PMSC comprises the following FIT modules and a sample application:

Table 1-1 PMSC Configuration Elements

FIT Module	Folder Name
Board Support Package Module Using Firmware Integration Technology	r_bsp
RX Family USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology	r_usb_basic_mini
RX Family USB Peripheral Mass Storage Class Driver (PMSC) for USB Mini Firmware using Firmware Integration Technology	r_usb_pmsc_mini
RX Family DTC Module Using Firmware Integration Technology	r_dtc_rx
RX Family DMA Controller DMACA Control Module Firmware Integration Technology	r_dmaca_rx
RX Family LPC (Low Power Consumption) Module Firmware Integration Technology	r_lpc_rx

Refer to the related documentation for details of each FIT module. Note that the latest versions of the FIT modules used by the sample firmware are available for download from the following website:

Renesas Electronics website: http://www.renesas.com/

1.3 Note

This driver is not guaranteed to provide USB communication operation. The customer should verify operation when utilizing it in a system and confirm the ability to connect to a variety of different types of devices.

1.4 Operating Confirmation Environment

Table 1-2 Operation Confirmation Environment

Item	Contents
C compiler	Renesas Electronics C/C++ compiler for RX Family (The option "-lang=C99" is added to the default setting of IDE)
	GCC for Renesas RX (The option "-std=gnu99" is added to the default setting of IDE)
	IAR C/C++ Compiler for Renesas RX
Real-Time OS	FreeRTOS RI600V4
Endian	Little Endian, Big Endian
USB Driver Revision Number	Rev.1.30
Using Board	Renesas Starter Kit for RX111 Renesas Starter Kit for RX113 Renesas Starter Kit for RX231 Renesas Solution Starter Kit for RX23W
Host Environment	The operation of this USB Driver module connected to the following OSes has been confirmed. 1. Windows® 10

== Storage Media Area ==

The storage media uses a 512K EEPROM or internal RAM. This EEPROM is controlled by SPI.

This EEPROM is not mounted on RSK board. In order to operate this PMSC, prepare the EEPROM and any connection needed.

[Note]

When the following all conditions are satisfied, be sure to do the eject processing by "Safely Remove Hardware and Eject Media" display on Windows® task bar before plugging out MSC device.

(1). The storage media is formatted as FAT12.

(2). MSC Host is Windows® 8.1 or Windows® 10.

2. Software Configuration

2.1 Module Configuration

The Peripheral Device Class Driver (PDCD) comprises a Peripheral Mass Storage Class Driver (PMSCD) and Peripheral Mass Storage Device Driver (PMSDD). The PMSCD comprises a Peripheral Mass Storage Class Function (PMSCF), which performs BOT protocol control and data transmission/reception, as well as functions (DDI) for interfacing with the PMSDD and functions (PCI) for interfacing with the PCD. The PMSCD performs BOT protocol communication with the host via the PCD. The PMSDD analyzes and processes storage commands received from the PMSCD, and accesses media data via the media driver.

Figure 2-1 shows the module configuration of the PMSC, and Table 2-1 lists the functions of the modules.

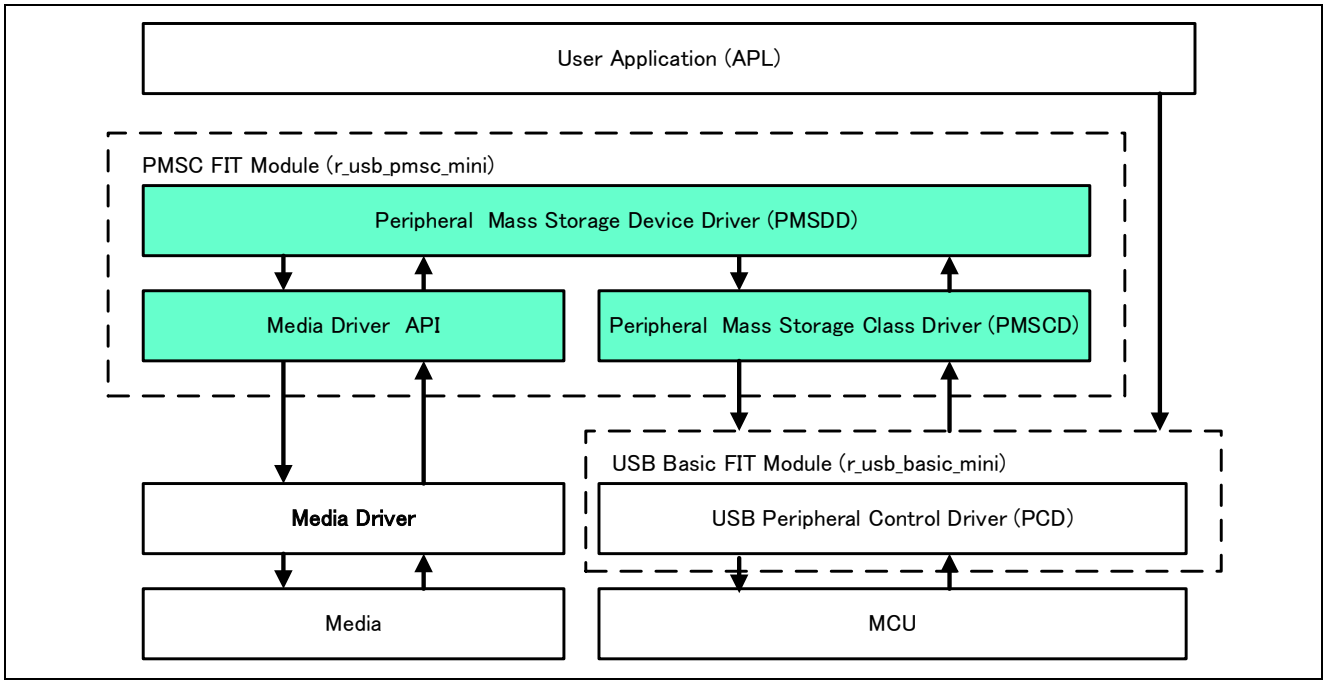


Figure 2-1 Module Configuration

Table 2-1 Functions of Modules

Module Name	Function
PMSDD	Mass storage device driver ・Processes storage commands from the PMSCD. ・Accesses media via the media driver.
PMSCD	Mass storage class driver ・Controls BOT protocol data and responds to class requests. ・Analyses CBWs and performs data transmission/reception. ・Interoperates with the PMSDD and PCD to transmit CSW.
PCD	USB Peripheral Control Driver
Media Driver	Block media storage device control driver

3. Setup

3.1 Hardware

3.1.1 Example Operating Environment

Figure 3-1 shows an example operating environment for the PMSC. Refer to the associated instruction manuals for details on setting up the evaluation board and using the emulator, etc

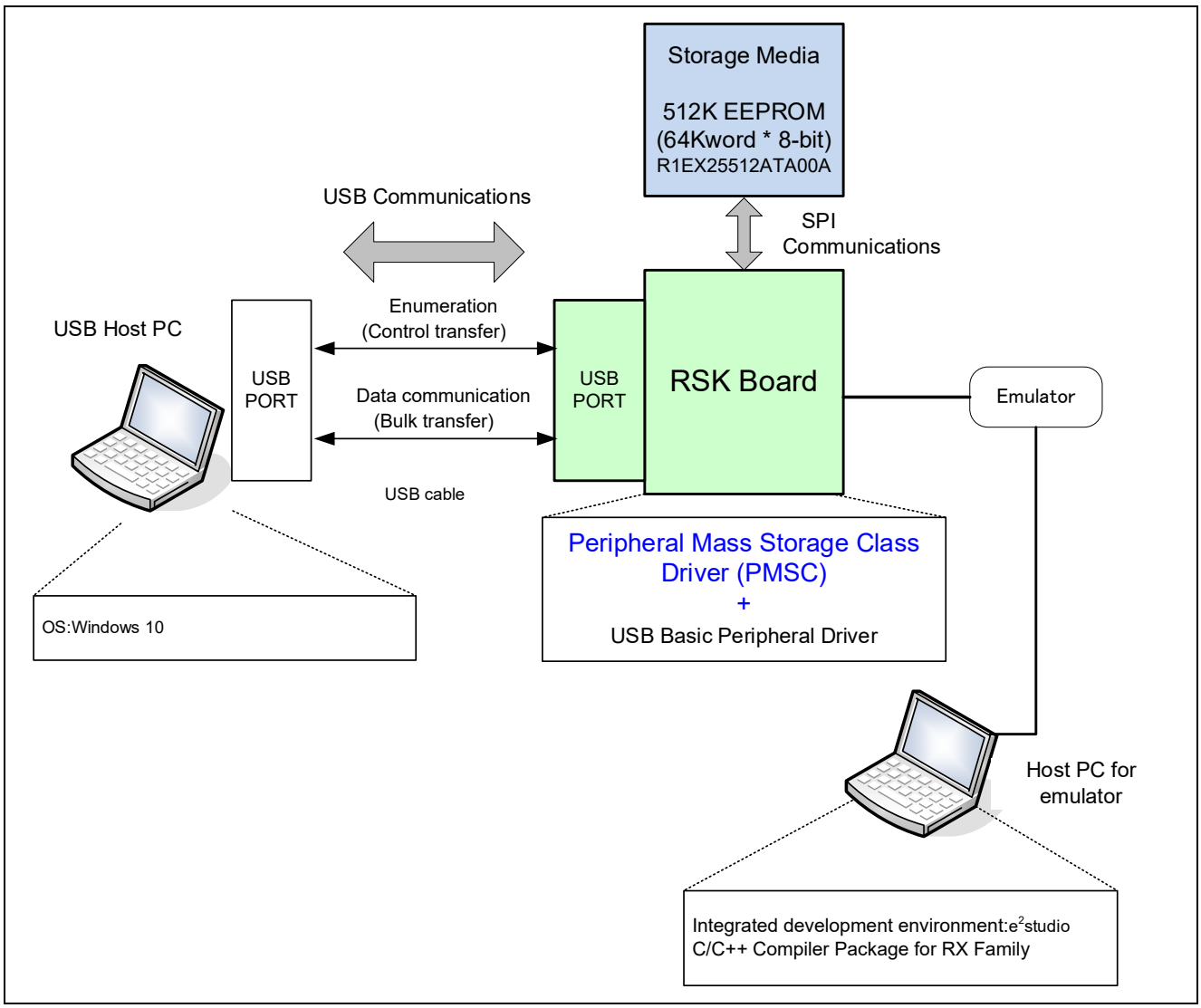


Figure 3-1 Example Operating Environment

Table 3-1 shows the evaluation board on which operation has been confirmed.

Table 3-1 Evaluation Board on Which PMSC Operation Has Been Verified

MCU	Evaluation Board
RX111	RSKRX111
RX113	RSKRX113
RX231	RSKRX231
RX23W	RSSKRX23W
RX261	EK-RX261

3.1.2 RSK / RSSK / EK Setting

It is necessary to set RSK/RSSK/EK to operate in the peripheral mode. Please refer to the following.

Table 3-2 **Jumper Setting**

RSK / RSSK	Jumper Setting
RSKRX111	J12: Shorted Pin2-3
RSKRX113	J12: Shorted Pin2-3
RSKRX231	J15: Shorted Pin2-3
RSSKRX23W	J5: Shorted Pin1-2
EK-RX261	J18: Shorted Pin2-3, J19: Shorted Pin2-3

Note:

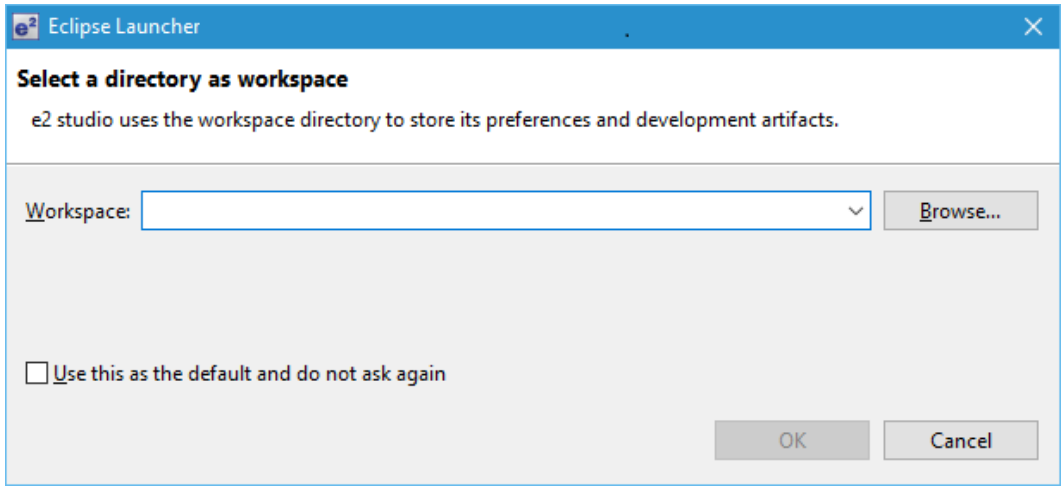
For the detail of RSK/RSSK/EK setting, refer to the user's manual of RSK/RSSK/EK.

3.2 Software

1) Setup e^2 studio

a) Start e^2 studio

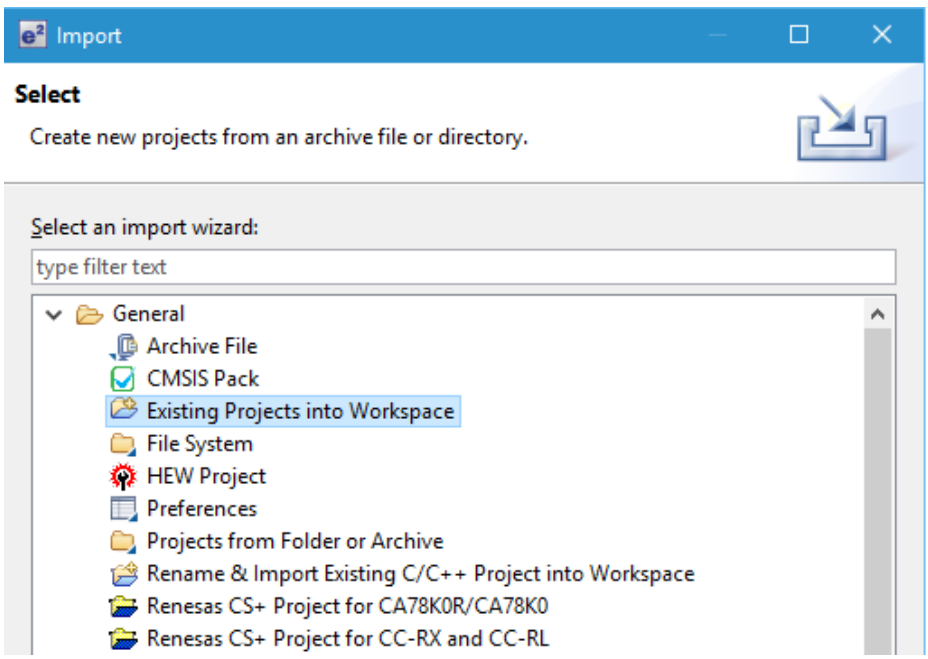
b) If you start up e^2 studio at first, the following dialog is displayed. Specify the folder to store the project in this dialog.



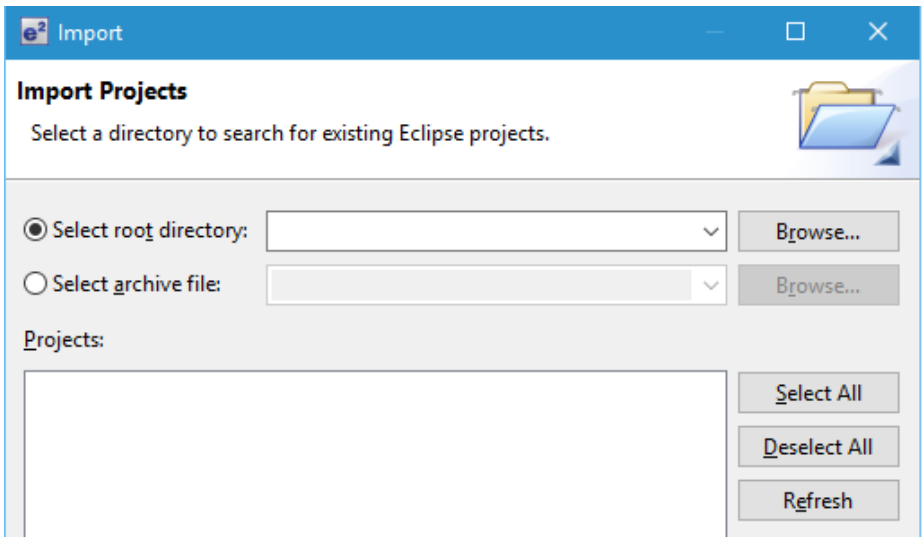
2) Import the project to the workspace

a) Select [File] > [Import]

b) Select [General] => [Existing Projects into Workspace]



c) Select the root directory of the project, that is, the folder containing the ".cproject" file.



d) Click "Finish".

You have now imported the project into the workspace. Note that you can import other projects into the same workspace.

3) Generate the binary target program by clicking the "Build" button.

4) Connect the target board to the debug tool and download the executable. The target is run by clicking the "Run" button.

4. Sample Application

4.1 Application Specifications

The PMSC sample application (APL) runs on the RSK. When the RSK/RSSK is connected to the host PC it is recognized as a removable disk, and data transfers, such as reading and writing files, can be performed.

Figure 4-1 shows an example PMSC operating environment, and Figure 4-2 shows a PMSC operation example.

4.1.1 Operating Environment

Figure 4-1 shows an example PMSC operating environment, Figure 4-2 shows a PMSC operation example and Table 4-1 shows EEPROM connection specification.

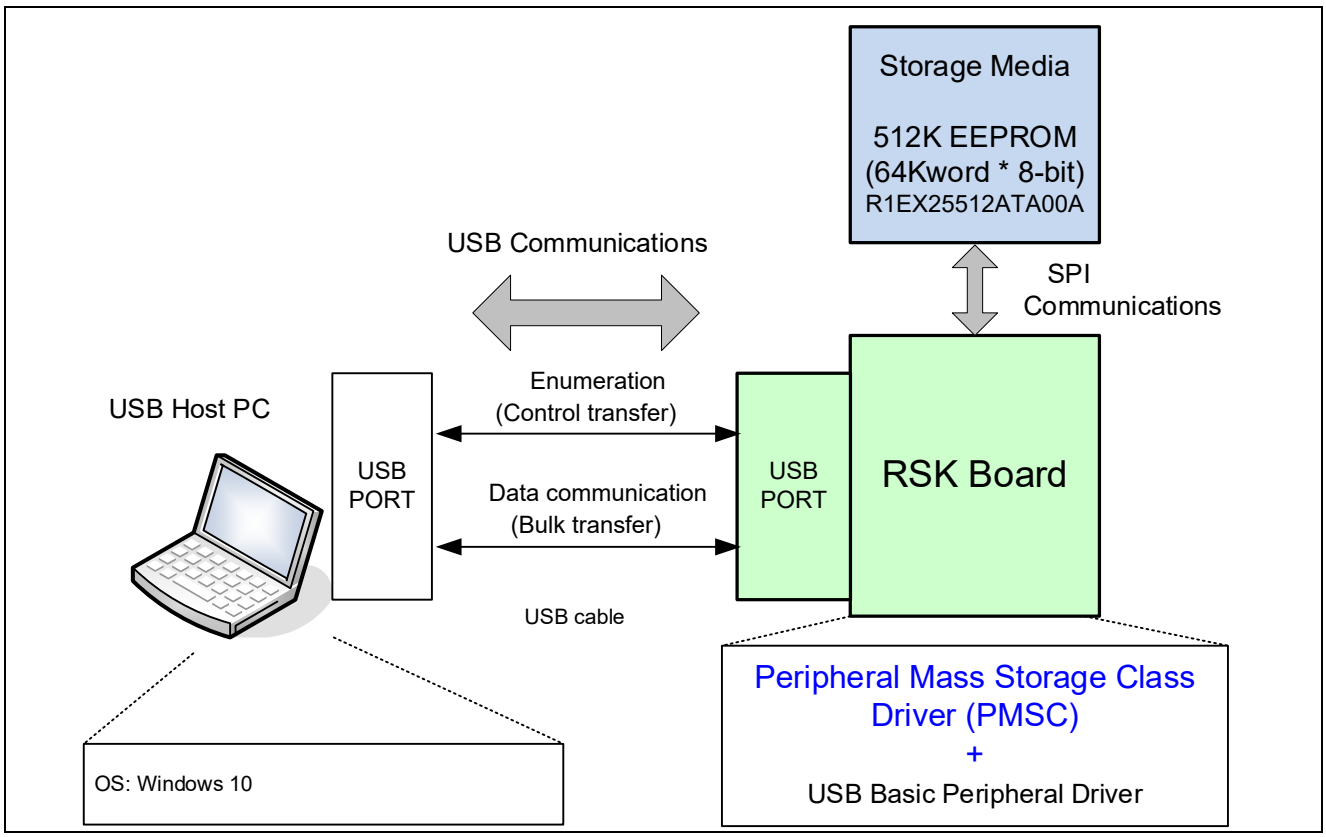


Figure 4-1 PMSC Operation Environment

Note:

1. A 512K EEPROM is used as the storage media in RX111. This EEPROM is controlled by SPI. This EEPROM is not mounted on RSK board. In order to operate this PMSC, prepare the EEPROM and any connection needed.
2. The internal RAM is used as the storage media in RX113, RX231,RX23W or RX261.

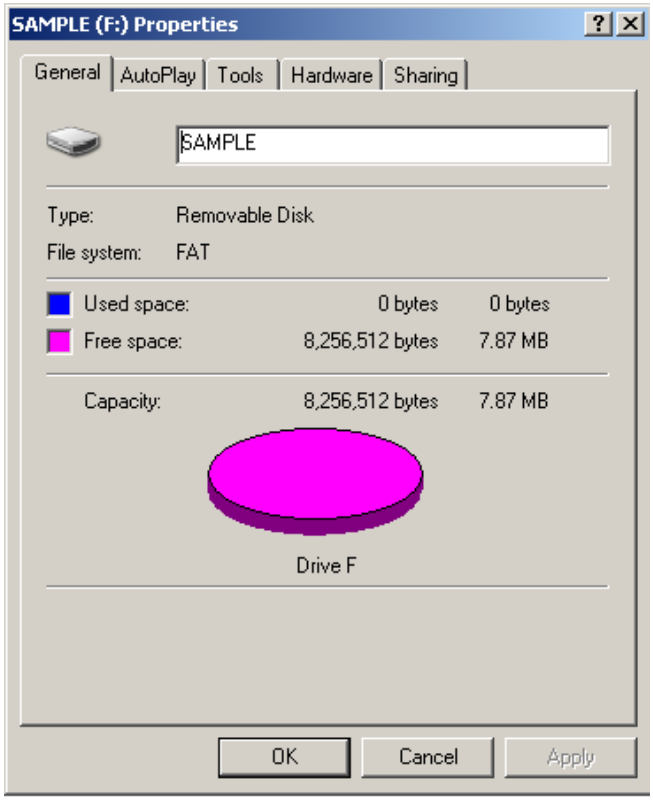


Figure 4-2 PMSC Operation Example

Table 4-1 EEPROM connection specification

RX111			
Connection Signal	**SPI0 Signal**	**RSK Port/Junction Pin**	**EEPROM Pin/Number**
Clock	RSPCKA	PE3/J3-16	C/6
Data Transfer(RX111->EEPROM)	MOSIA	PC6/J2-12	D/5
Data Transfer(RX111<-EEPROM)	MISOA	P17/J2-1	Q/2
Chip Select	--	PE5/J3-14	S/1

4.2 Application Processing (for Non-OS)

The application comprises two parts: initial settings and main loop.

Initial setting	:	Makes MCU pin settings, initializes the USB controller, and initializes the USB driver.
Main loop	:	Calls *R_USB_GetEvent* function in the loop. If a Suspend request is received from the USB host or the USB host is detached while the loop is being processed, the APL transitions the MSC device (RSK/RSSK) to low-power mode. For details of low-power mode, see 4.5, MCU Low power consumption processing

PMSC controls processing by a mass storage class driver (MSCD) and mass storage device driver (MSDD) in response to requests from the USB host (PC). Therefore, the PMSC APL does not perform any processing on data transferred from the host. Aside from initialization processing, the only thing performed within the loop is calling the *R_USB_GetEvent* function. The APL does not write files to or read files from the PMSC storage area; this processing is all performed by the PMSC USB driver.

[Note]

1. For a list of the storage commands supported by the PMSC, see 5.2,Storage Commands.
2. Make sure to call the *R_USB_GetEvent* function from within the application program loop processing.

An overview of the processing performed by the APL is shown below:

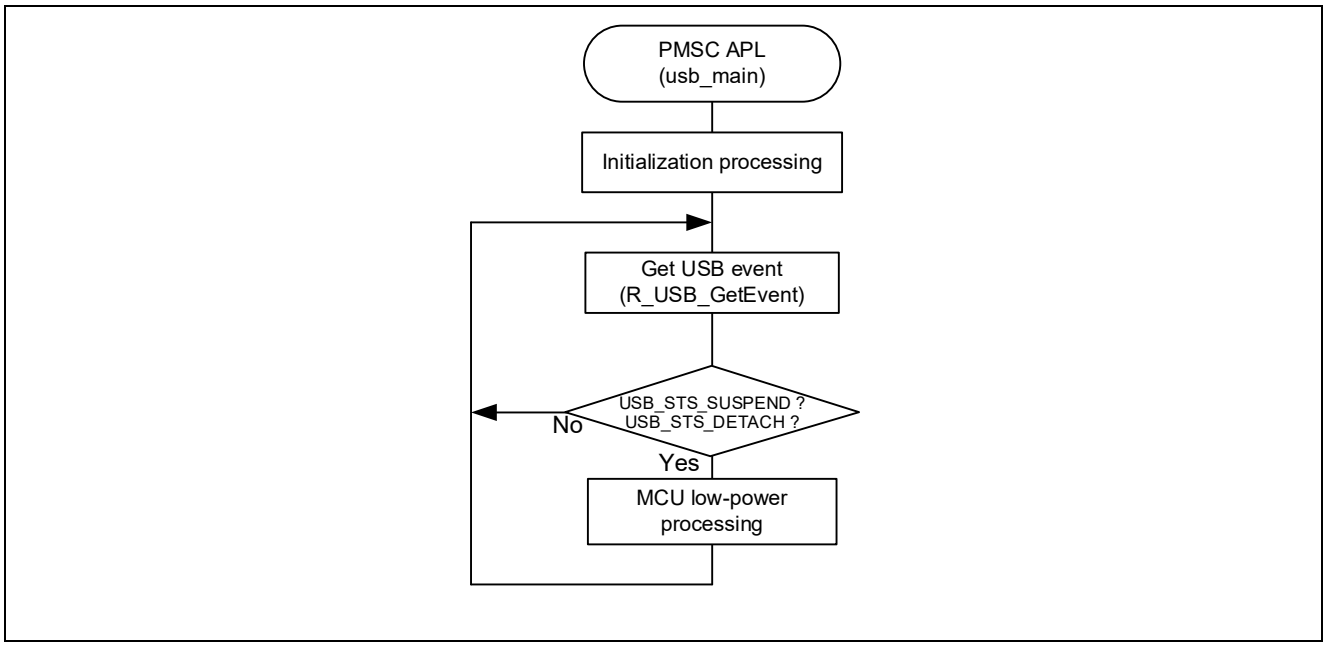


Figure 4-3 APL Processing Overview

4.3 Application Processing (for RTOS)

The application comprises two parts: initial settings and main loop.

Initial setting	:	Makes MCU pin settings, initializes the USB controller, and initializes the USB driver.
Main loop	:	The reception processing of USB completion event is performed in the loop. If a Suspend request is received from the USB host or the USB host is detached while the loop is being processed, the APL transitions the MSC device (RSK) to low-power mode. For details of low-power mode, see 4.5, MCU Low power consumption processing

PMSC controls processing by a mass storage class driver (MSCD) and mass storage device driver (MSDD) in response to requests from the USB host (PC). Therefore, the PMSC APL does not perform any processing on data transferred from the host. Aside from initialization processing, only the reception processing of USB completion event is performed within the loop. The APL does not write files to or read files from the PMSC storage area; this processing is all performed by the PMSC USB driver.

[Note]

For a list of the storage commands supported by the PMSC, see chapter **5.2,Storage Commands**.

An overview of the processing performed by the APL is shown below:

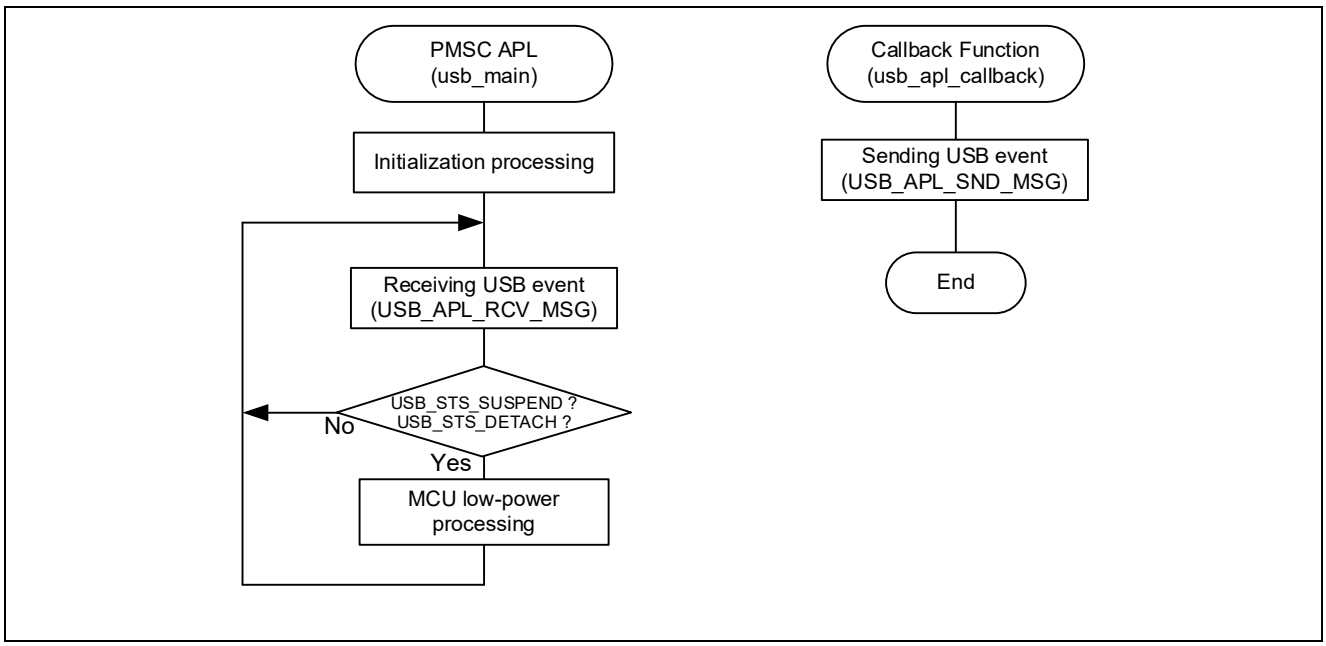


Figure 4-4 APL Processing Overview

4.4 Descriptor

The PMSC's descriptor information is contained in *r_usb_pmsc_descriptor.c*. Also, please be sure to use your vendor ID.

4.5 MCU Low power consumption processing

MCU low-power processing occurs when the conditions in Table 4-2 or Table 4-3 are met, causing a transition to low-power mode. To enable this processing, specify *USB_APL_ENABLE* to *USB_SUPPORT_LPW* definition in the *r_usb_pmsc_apl_config.h file*.

1. Non-OS

Table 4-2 Conditions for Transition to Low-Power Mode

Transition Condition		Transition Status
VBUS	USB State	
OFF	—	Software standby mode
ON	Suspend Configured	Sleep mode
ON	Other than Suspend Configured	Normal mode (program running)

(1). When the MSC device (RSK/RSSK) detaches from the USB host (VBUS OFF), the APL performs processing to transition the MCU to software standby mode. Recovery from software standby mode occurs when the MSC device (RSK/RSSK) attaches to the USB host.

(2). When a suspend signal sent by the USB host is received while the MSC device (RSK/RSSK) is connected to the USB host, the APL performs processing to transition the MCU to sleep mode. Note that recovery from sleep mode occurs when a resume signal is received from the USB host.

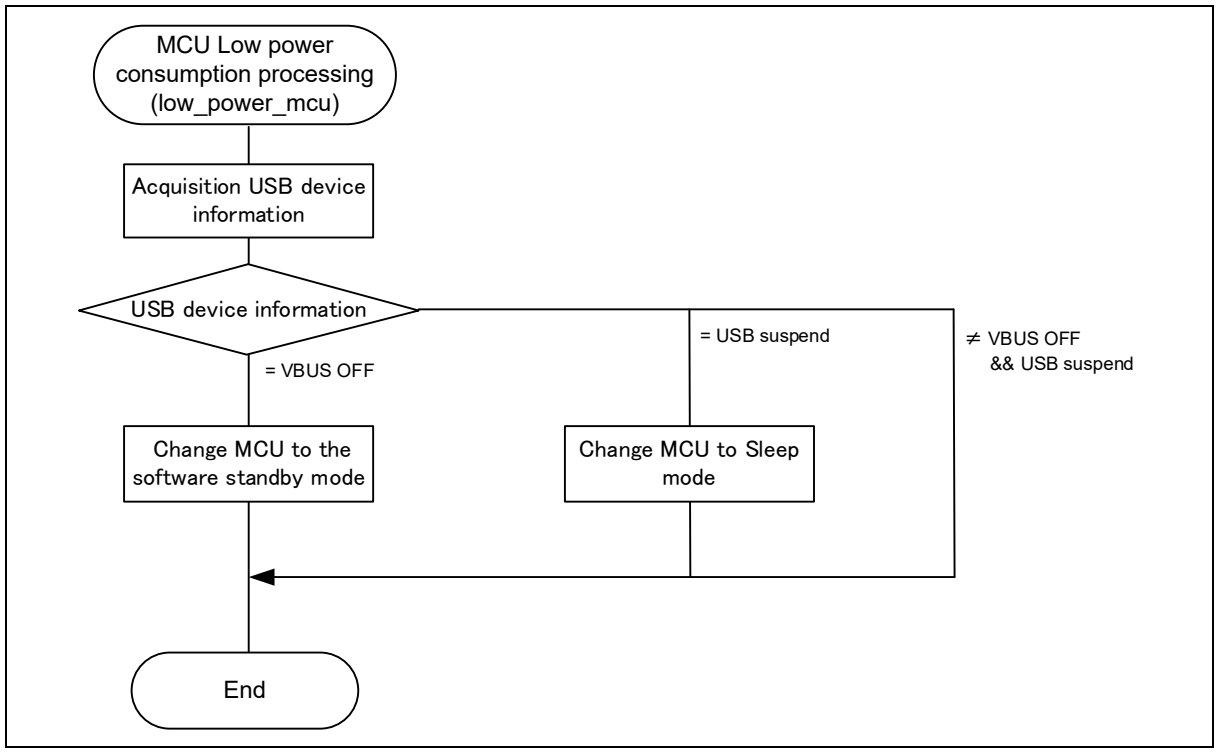


Figure 4-5 Flowchart of MCU Low Power Consumption Processsing

2. RTOS (FreeRTOS only)

Table 4-3 Conditions for Transition to Low-Power Mode

Transition Condition		Transition Status
VBUS	USB State	
OFF	–	Software standby mode
ON	Suspend Configured	Software standby mode
ON	Other than Suspend Configured	Normal mode (program running)

(1). When the MSC device (RSK) detaches from the USB host (VBUS OFF), the APL performs processing to transition the MCU to software standby mode. Recovery from software standby mode occurs when the MSC device (RSK) attaches to the USB host.

(2). When a suspend signal sent by the USB host is received while the MSC device (RSK) is connected to the USB host, the APL performs processing to transition the MCU to software standby mode. Note that recovery from softwre standby mode occurs when a resume signal is received from the USB host.

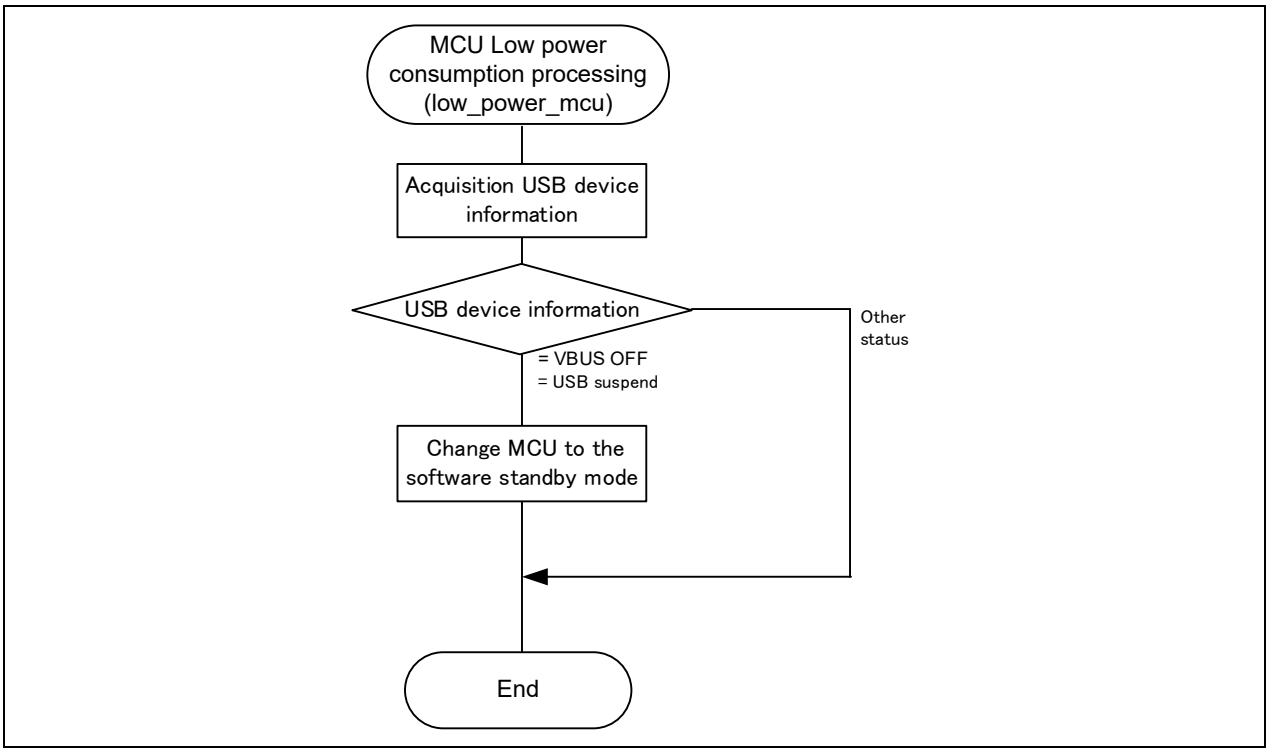


Figure 4-6 Flowchart of MCU Low Power Consumption Processsing

4.6 Configuration File for the application program (r_usb_pcdc_apl_config.h)

Make settings for the definitions listed below.

1. Low-Power Function Definition

Specify whether or not the low-power function will be used. If the low-power function will be used, speify *USB_APL_ENABLE* to *USB_SUPPORT_LPW* definition.

```
#define     USE_SUPPORT_LPW     USB_APL_DISABLE     // No use the low-power function
#define     USB_SUPPORT_LPW     USB_APL_ENABLE      // Use the low-power function
```

2. USB_SUPPORT_RTOS Definition

Please specify *USB_APL_ENABLE* to *USB_SUPPORT_RTOS* definition when using the real-time OS.

```
#define     USB_SUPPORT_RTOS    USB_APL_DISABLE     // No use the real-time OS
#define     USB_SUPPORT_RTOS    USB_APL_ENABLE      // Use the real-time OS
```

3. Note

The above configuration settings apply to the application program. USB driver configuration settings are required in addition to the above settings. For information on USB driver configuration settings, refer to the application note *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology* (Document number. R01AN2166).

5. Class Driver Overview

5.1 Class Request

Table 5-1 lists the class requests supported by the PMSC.

Table 5-1 Supported MSC Class Requests

Request	Code	Description
Bulk-Only Mass Storage Reset	0xFF	Resets the connection interface to the mass storage device.
Get Max Lun	0xFE	Reports the logical numbers supported by the device.

5.2 Storage Commands

The PMSC supports storage commands necessary to access an USB mass storage device as well as sample storage commands. The MSDD of the PMSC supports the SFF-8070i USB mass storage subclass.

Table 5-2 lists the storage commands supported by the PMSC.

Table 5-2 Supported Storage Commands

Command	Code	Description	Supported
TEST_UNIT_READY	0x00	Checks the state of the peripheral device.	○
REQUEST_SENSE	0x03	Gets the state of the peripheral device.	○
FORMAT_UNIT	0x04	Formats the logical unit.	×
INQUIRY	0x12	Gets the parameter information of the logical unit.	○
MODE_SELECT6	0x15	Specifies parameters.	×
MODE_SENSE6	0x1A	Gets the parameters of the logical unit.	×
START_STOP_UNIT	0x1B	Enables/disabled logical unit access.	×
PREVENT_ALLOW	0x1E	Enables/disabled media removal.	×
READ_FORMAT_CAPACITY	0x23	Gets the formattable capacity.	○
READ_CAPACITY	0x25	Gets the capacity information of the logical unit.	○
READ10	0x28	Reads data.	○
WRITE10	0x2A	Writes data.	○
SEEK	0x2B	Moves to a logical block address.	×
WRITE_AND_VERIFY	0x2E	Writes data with verification.	×
VERIFY10	0x2F	Verifies data.	×
MODE_SELECT10	0x55	Specifies parameters.	×
MODE_SENSE10	0x5A	Gets the parameters of the logical unit.	○

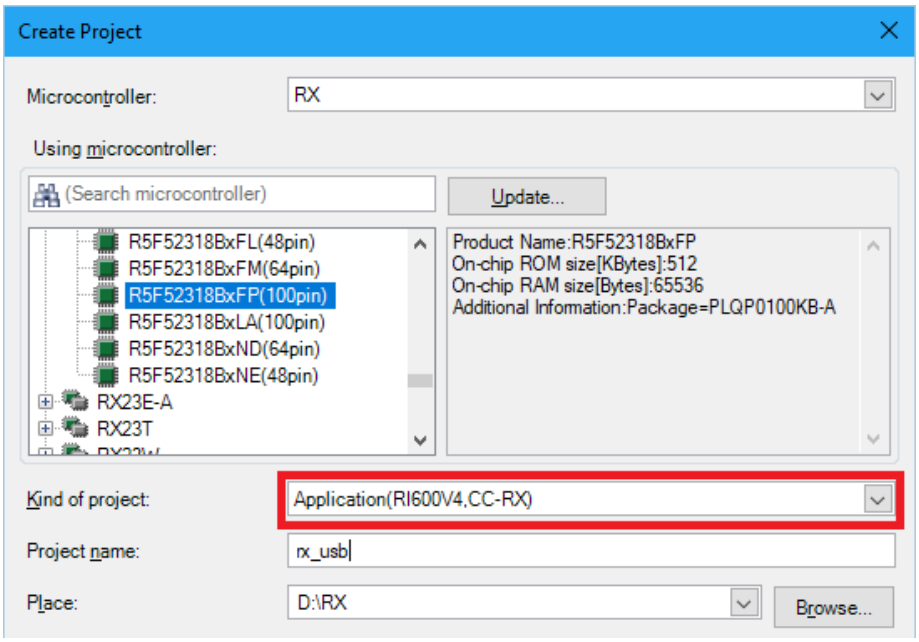
○ : Implemented × : Not implemented(Stall response)

6. Using RI600V4 project with CS+

The RI600V4 project in the package does not support CS+. The user needs to create a project for CS+ according to the following procedure when using RI600V4 project on CS+.

6.1 New Project Creation

Select "Application(RI600V4, CC-RX) for the Kind of project.

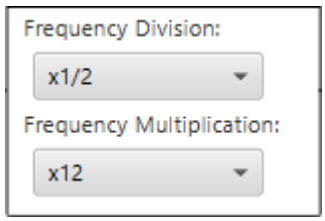


6.2 Launch Smart Configurator

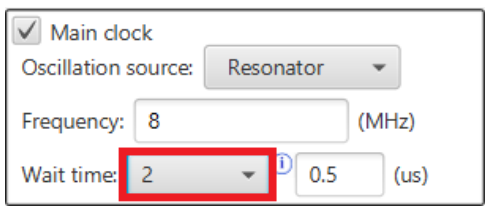
1. Clock Setting (Select "Clocks" tab)

(1). Set the related clock so that "48MHz" is set to UCLK (USB clock).

The following is a setting example when using the oscillator(8MHz).



(2). Set the minimum value to the wait time for the main clock.



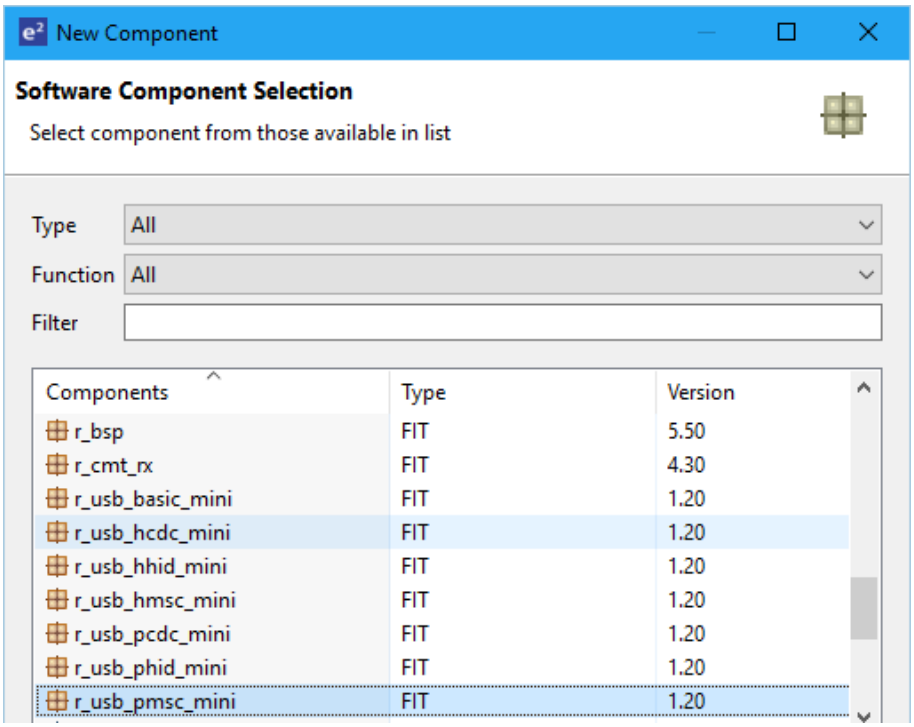
2. Component Setting (Select "Components" tab)

(1). Import the USB FIT module

Select the *r_usb_pmsc_mini* module and press the "Finish" button. The *r_usb_basic_mini* module is imported at the same time.

Note:

Select the *r_dtc_rx / r_dmaca_rx* module when using the DTC/DMA.

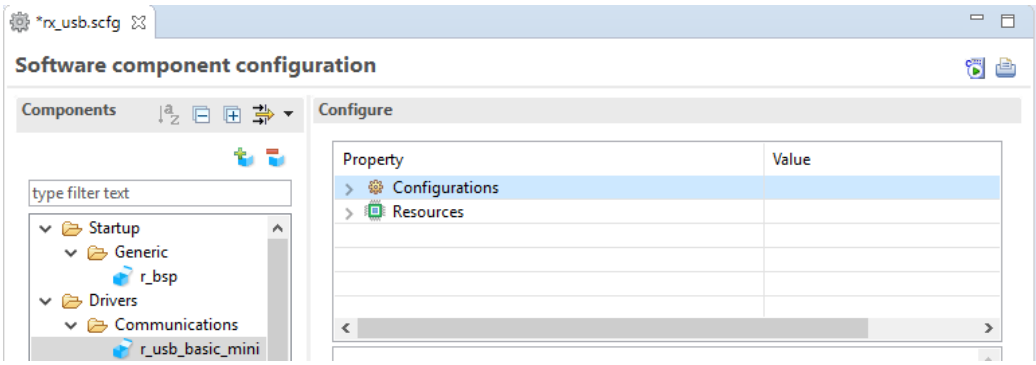


(2). Configuration Setting

a. r_bsp

Change the heap size when using DTC transfer. For the setting value, refer to the documentation for DTC FIT module.

b. r_usb_basic_mini



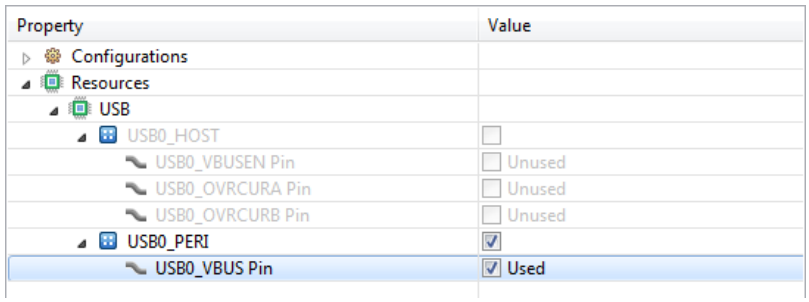
(a). Configurations

Set each item according to the user system.

For the detail of each item, refer to chapter "Configuration" in *USB Basic Mini Host and Peripheral Driver Firmware Integration Technology* application note (Document number: R01AN2166).

(b). Resources

Check the check box for USBx_VBUS pin.

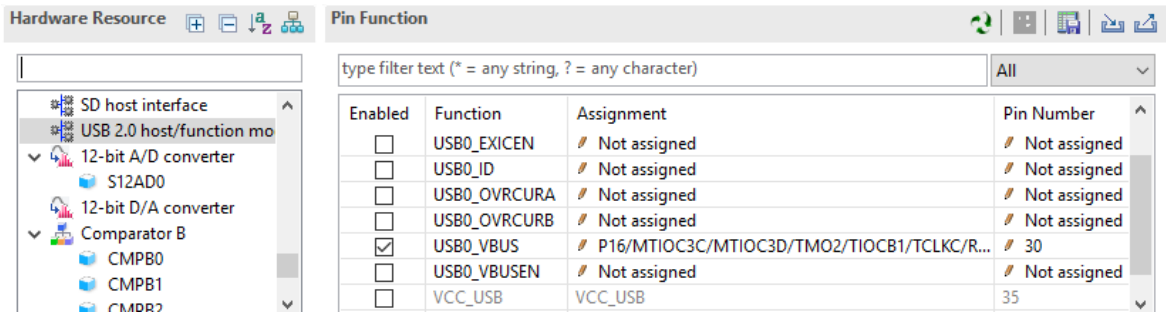


c. r_usb_pmsc_mini

Refer to chapter "Configuration" in *USB Peripheral Mass Storage Class Driver (PMSC) for USBMini Firmware Firmware Integration Technology* application note (Document number: R01AN2172).

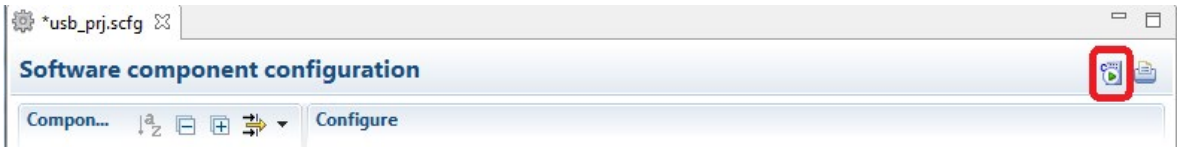
3. Pin Setting (Select "Pins" tab)

Select the port for USB pin match the user system.



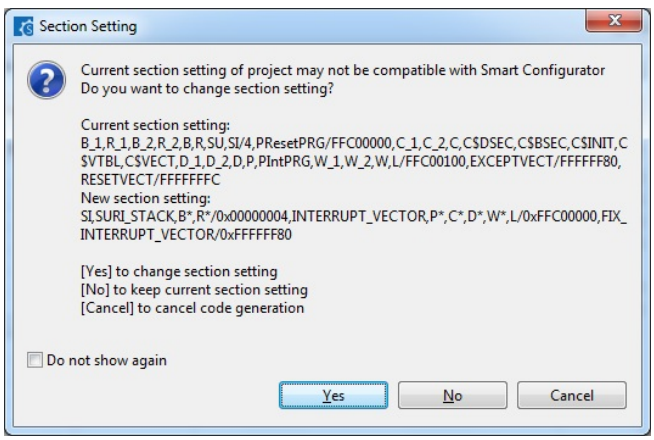
4. Generate Code

The Smart Configurator genrates source codes for USB FIT module and USB pin setting in "*<ProjectDir>¥src¥smc_gen*" folder by by clicking on the [(Generate Code)] button.



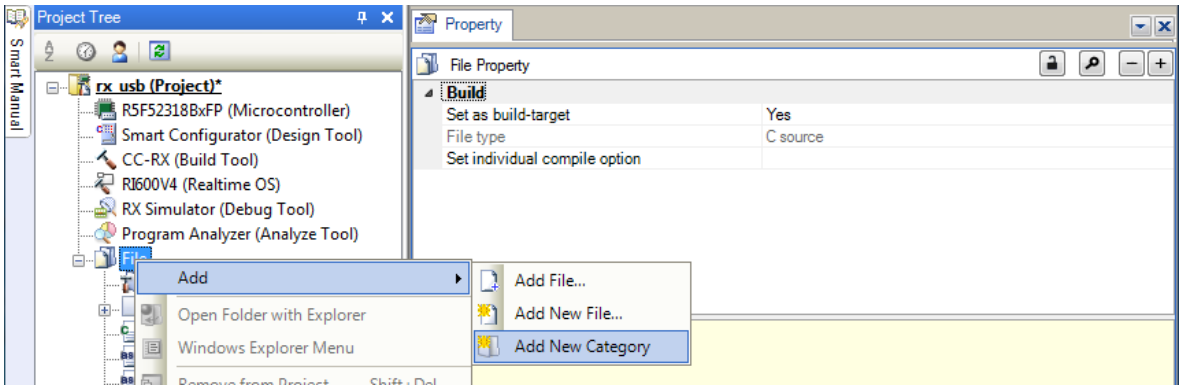
Note:

Select "Yes" if the following dialog box is displayed.



6.3 Add the application program and the configuration file

1. Copy the *demo_src* folder in this package to the *"<ProjectDir>¥src"* folder.
2. Copy the RI600V4 configuration file (.cfg file) to *"<ProjectDir>"* folder.
3. Select "File" in the "Project Tree" and click the right button. Select [Add] → [Add New Category] and create the category to store the application program. Then select [Add File] and register the application program and the configuration file which are copied at the above 2.



Note:

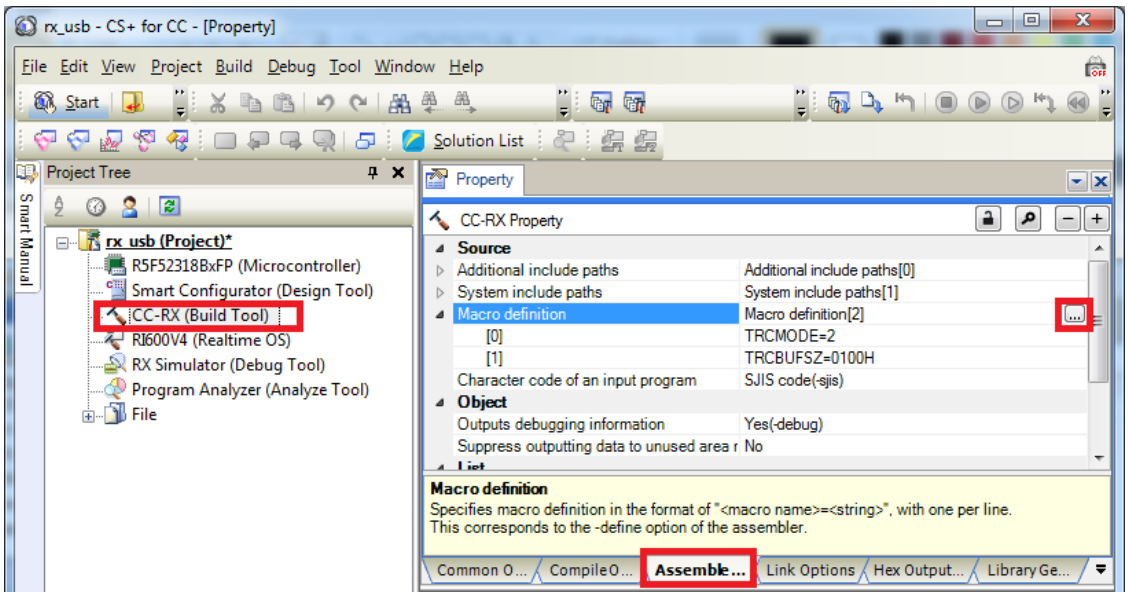
Remove the "task.c" file and "sample.cfg" created in "*<ProjectDir>*" folder by CS+.

6.4 Remote Macro Definition

Remove these macros since the following macros is defined in the new created project.

Select [CC-RX(Build Tool)] → [Assemble Options] tab, remove the following macros.

1. TRCMODE = 2
2. TRCBUFSZ = 0100H



6.5 Build Execution

Excecute the build and generate the binary target program.

7. Using the e² studio project with CS+

The PMSC contains a project only for e² studio. When you use the PMSC with CS+, import the project to CS+ by following procedures.

[Note]

1. Uncheck the checkbox Backup the project composition files after conversion in Project Convert Settings window.
2. The following method is not supported when using RI600V4. Refer to chapter **6, Using RI600V4 project with CS+**.

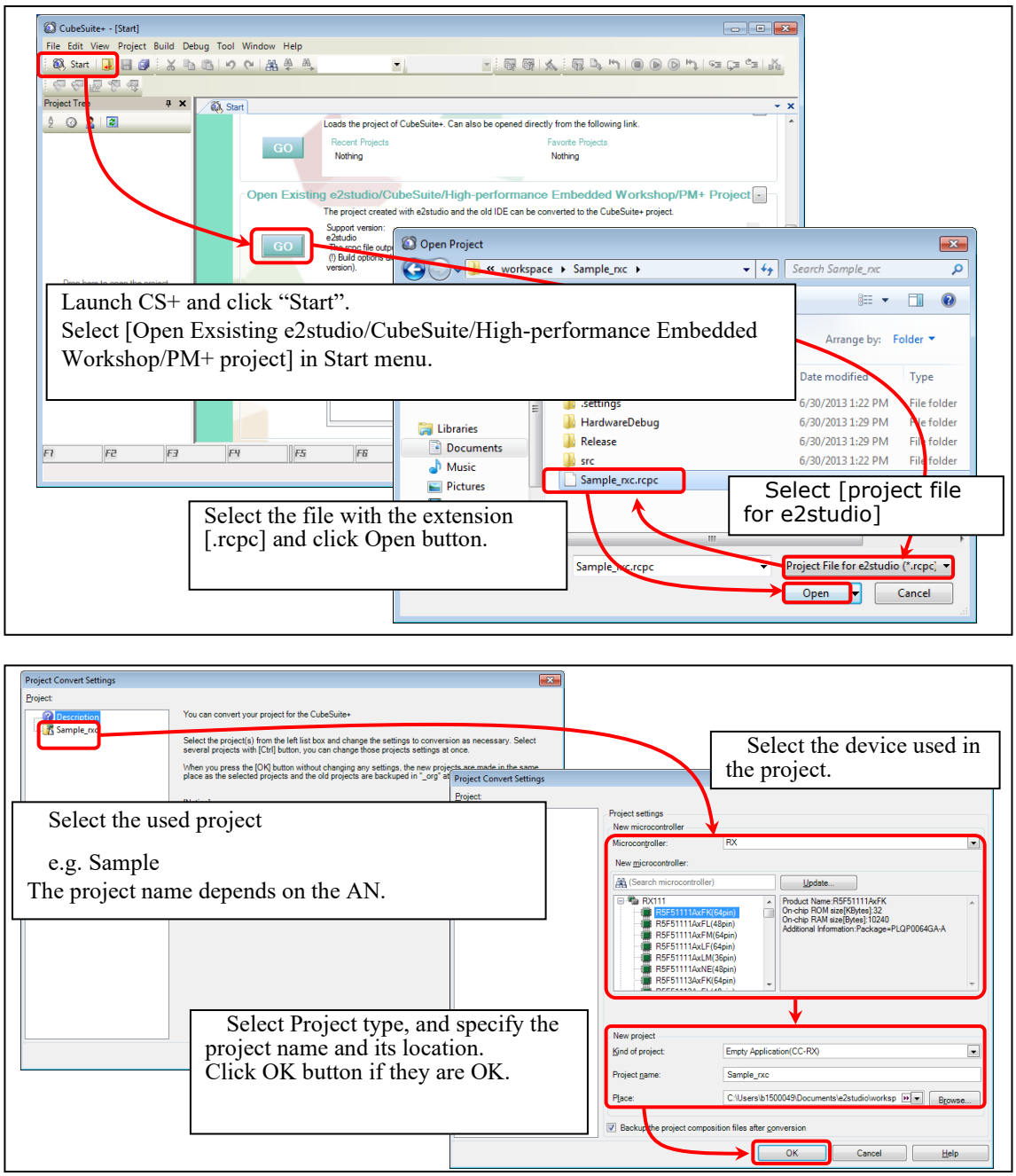


Figure 7-1 Using the e² studio project with CS+

Website and Support

Renesas Electronics Website
http://www.renesas.com/

Inquiries
http://www.renesas.com/inquiry/

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Dec 1, 2014	—	First Edition Issued.
1.01	Jun 1, 2015	—	RX231 is added in Target Device.
1.02	Dec 28, 2015	—	Checked the operation with Windows® 10.
1.10	Nov 30, 2018	—	1. The following chapter has beed added. (1). 3.1.2 RSK/RSSK Setting 2. The following chapter has beed changed. (1). 4. Sample Application
1.12	Jun 30, 2019	—	RX23W is added in Target Device.
1.20	Jun 1, 2020	—	Supported the real-time OS.
1.30	Jul 31, 2024	—	RX261 is added in Target Device.

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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