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Rev.1.42
Sep 30, 2023

RX Family

Sample Program using USB Host Mass Storage Class Driver (HMSC) to communicate via USB with MSC device Firmware Integration Technology

Introduction

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

When developing an actual software, be sure to use the “USB Basic Host and Peripheral Driver Firmware Integration Technology Application Note” (Document number: R01AN2025EJ) together with the user’s manual for each MCU (Hardware). In addition, also refer to the "USB Host Mass Storage Class Driver (HMSC) Firmware Integration Technology Application Note” (Document number: R01AN2026EJ), if necessary. “USB Basic Host and Peripheral Driver Firmware Integration Technology Application Note” (Document number: R01AN2025EJ) is located in the "reference_documents" folder within the package.

Target Device

RX65N/RX651 Group
RX64M Group
RX71M Group
RX66T Group
RX72T Group
RX72M Group
RX66N Group
RX72N Group
RX671 Group

The operation of this program has been confirmed using the Renesas Starter Kits (RSK).

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1. Introduction

1.1 Functions

The HMSC was built using the USB mass storage class Bulk-Only Transport (BOT) protocol. When used in combination with a file system and storage device driver, it enables communication with USB mass storage devices that support BOT.

The HMSC provides the following functionalities:

- Support for USB mass storage class BOT.
- Support for the SFF-8070i (ATAPI) USB mass storage subclass.
- Use of a single shared pipe for IN and OUT data transfers.

1.2 FIT Module Configuration

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

Table 1-1 FIT Module Configuration

FIT Module	Folder Name
RX Family Board Support Package Module Firmware Integration Technology	r_bsp
RX Family USB Basic Host and Peripheral Driver Firmware Integration Technology	r_usb_basic
RX Family USB Host Mass Storage Class Driver (HMSC) Firmware Integration Technology	r_usb_hmsc
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 Open Source FAT File System [M3S-TFAT-Tiny] Module Firmware Integration Technology	r_tfat_rx
RX Family M3S-TFAT-Tiny Memory Driver Interface Module Firmware Integration Technology	r_tfat_driver_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

The following is the operating confirmation environment of this program.

Table 1-2 Operating Confirmation Environment

Item	Contents
C compiler	Renesas Electronics C/C++ compiler for RX Family V.3.03.00 Compile Option：-lang = c99
Real-Time OS	FreeRTOS V.10.0.0 RI600V4 Azure RTOS (USBX) 6.1.12
Endian	Little Endian, Big Endian
USB Driver Revision Number	Rev.1.42
Using Board	Renesas Starter Kits for RX64M Renesas Starter Kits for RX71M Renesas Starter Kits for RX65N, Renesas Starter Kits for RX65N-2MB Renesas Starter Kits for RX72T Renesas Starter Kits for RX72M Renesas Starter Kits for RX72N Renesas Starter Kits for RX671

1.5 Terms and Abbreviations

APL	:	Application program
BOT	:	Mass Storage Class Bulk Only Transport
FSL	:	FAT File System Library
HCD	:	Host Control Driver for USB-BASIC-FW
HDCD	:	Host Device Class Driver (Device driver and USB class driver)
MGR	:	Peripheral Device State Manager for HCD
MSC	:	Mass Storage Class
Non-OS	:	USB Driver for OS-less
RSK	:	Renesas Starter Kits
RTOS	:	USB Driver for the real-time OS
TFAT	:	Tiny FAT file system software for microcontrollers (M3S-TFAT-Tiny-RX)
USB-BASIC-FW	:	USB Basic Host and Peripheral Driver

2. Software Configuration

2.1 Module Configuration

The term host device class driver (HDCD) refers collectively to the host mass storage device driver (HMSDD) and the USB host mass storage class driver (HMSCD).

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

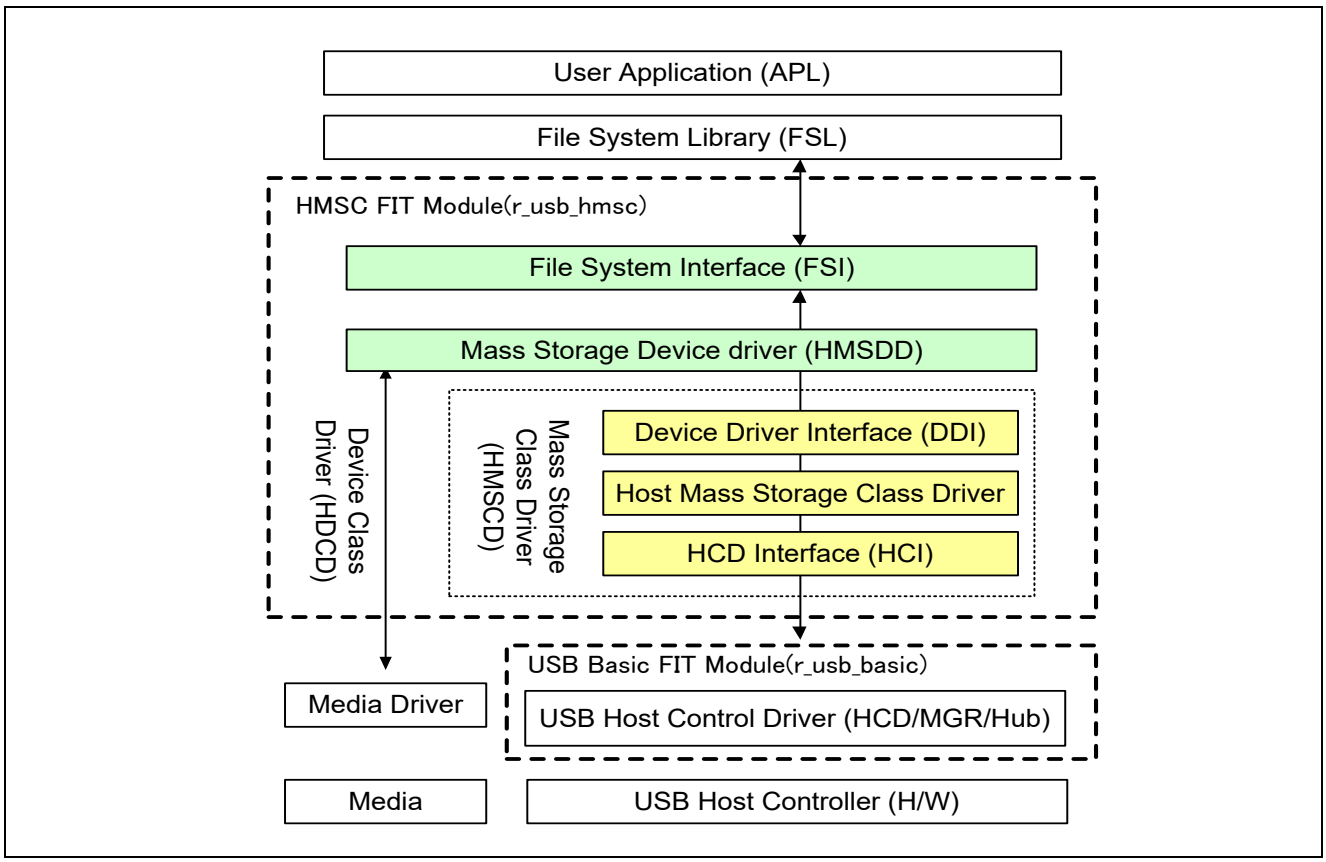


Figure 2-1 Module Configuration

Table 2-1 Function of Modules

Module Name	Function
APL	Sample application program ・ Uses the FSL function to implement storage functionality.
FSL	FAT File System Library
FSI	Interface function between FSL and HMSDD
HMSDD	Mass Storage Device Driver
DDI	Interface function between HMSDD and HMSCD
HMSCD	Mass Storage Class Driver ・ Appends the BOT protocol to storage commands to send requests to the HCD. ・ Performs BOT sequence management.
HCI	Interface function between HMSCD and HCD
HCD/MGR/Hub	USB Basic Host Driver
Media Driver	Storage Driver

3. Setup

3.1 Hardware

3.1.1 Example Operating Environment

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

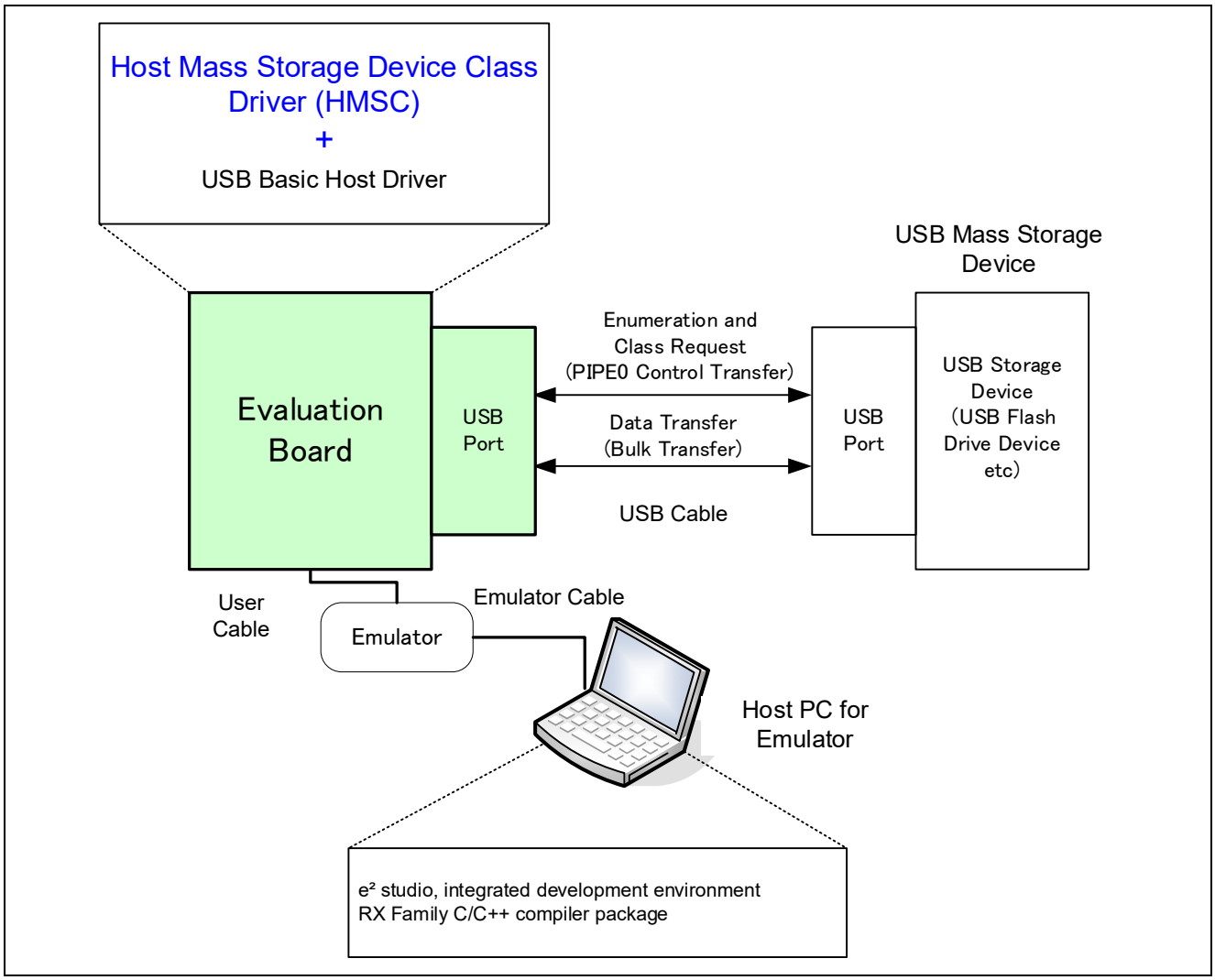


Figure 3-1 Example Operating Environment

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

Table 3-1 Evaluation Board on which HMSC Operation has been verified

MCU	Evaluation Board
RX65N	RSK+RX65N, RSK+RX65N-2MB
RX64M	RSK+RX64M
RX71M	RSK+RX71M
RX72T	RSKRX72T
RX72M	RSK+RX72M
RX72N	RSK+RX72N
RX671	RSK+RX671

3.1.2 RSK Setting

It is necessary to set RSK to operate in the host mode. Please refer to the following.

Table 3-2 **RSK Setting**

RSK	Jumper Setting
RSK+RX65N	J8: Shorted Pin1-2
RSK+RX65N_2MB	J7: Shorted Pin1-2 J16: Shorted Pin2-3
RSK+RX64M (USB0)	J2: Shorted Pin1-2 J6: Shorted Pin2-3
RSK+RX64M (USBH)	J7: Shorted Pin1-2 J9: Shorted Pin2-3
RSK+RX71M (USB0)	J1: Shorted Pin1-2 J3: Shorted Pin2-3
RSK+RX71M (USBA)	J4: Shorted Pin1-2 J7: Shorted Pin2-3
RSKRX72T	J13: Shorted Pin1-2
RSK+RX72M	J8: Shorted Pin2-3 J10: Shorted Pin2-3
RSK+RX72N	J7: Shorted Pin2-3 J8: Shorted Pin2-3
RSK+RX671	J8: Shorted Pin2-3 J13: Shorted Pin2-3

Note:

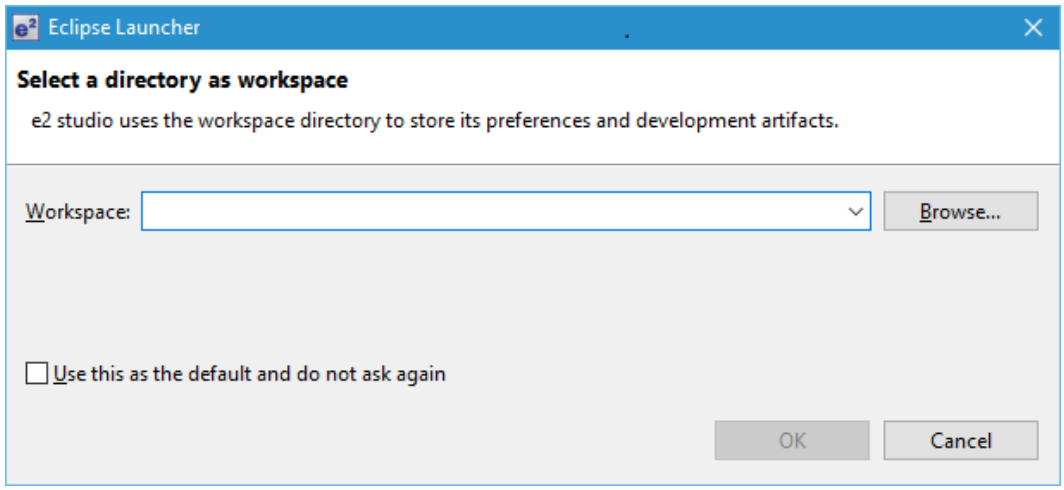
For the detail of RSK setting, refer to the user's manual of RSK.

3.2 Software

1) Setup e² studio

a) Start e² studio

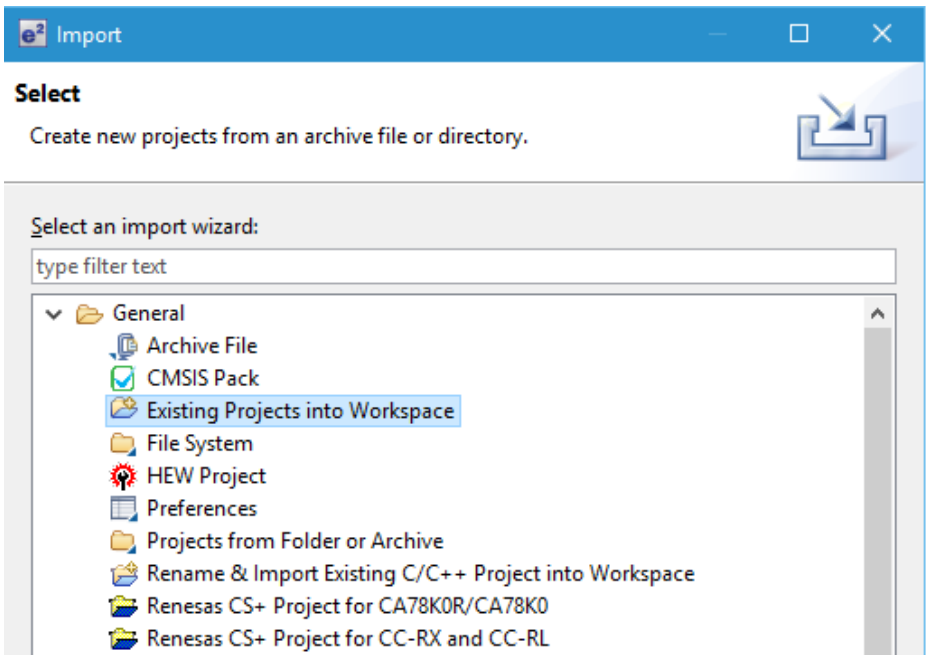
b) If you start up e² studio at first, the following dialog is displayed. Specify the folder to store the project in this dialog.



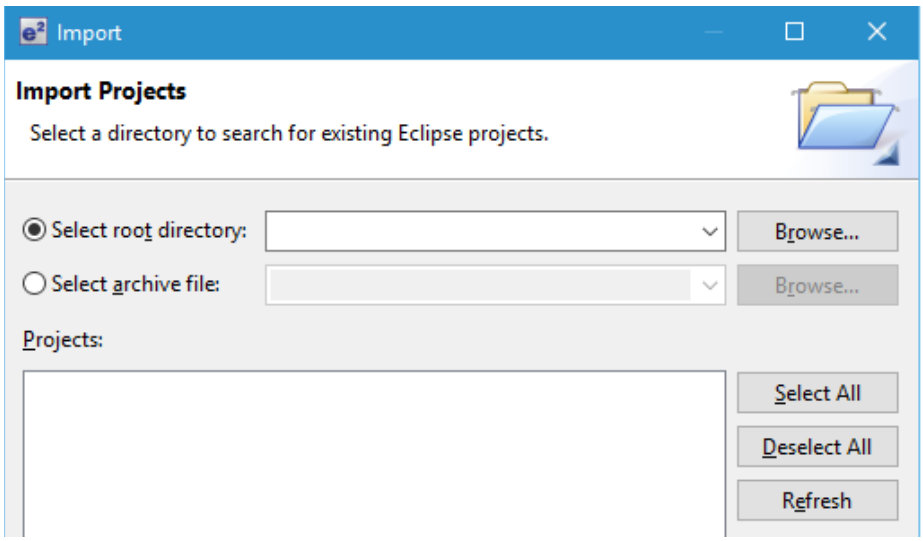
2) Import the project to the workspace

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 main functions of the APL are as follows:

1. Performs enumeration and drive recognition processing on MSC devices.
2. After the above processsing finisihes, the APL writes the file “hmscdemo.txt” to the MSC device once.
3. After writing the above file, the APL repeatedly reads the file “hmscdemo.txt.” It continues to read the file repeatedly until the switch is pressed again.

[Note]

When an MSC device on which on which the file “hmscdemo.txt” is stored is connected to the RSK board and the above steps are performed, “hmscdemo.txt” will be overwritten.

4.2 Application Processing (for Non-OS)

The application comprises two parts: initial settings and main loop. An overview of the processing in these two parts is provided below.

4.2.1 Initial Setting

Initial settings consist of MCU pin settings, USB driver settings, and initial settings to the USB controller.

4.2.2 Main Loop

This main loop controls the program using the return values from the *R_USB_GetEvent* function and state variables. The return values of the *R_USB_GetEvent* function are used for the USB event management such as attach and detach. File write/read is performed on the MSC device based on the state checked with the state variable.

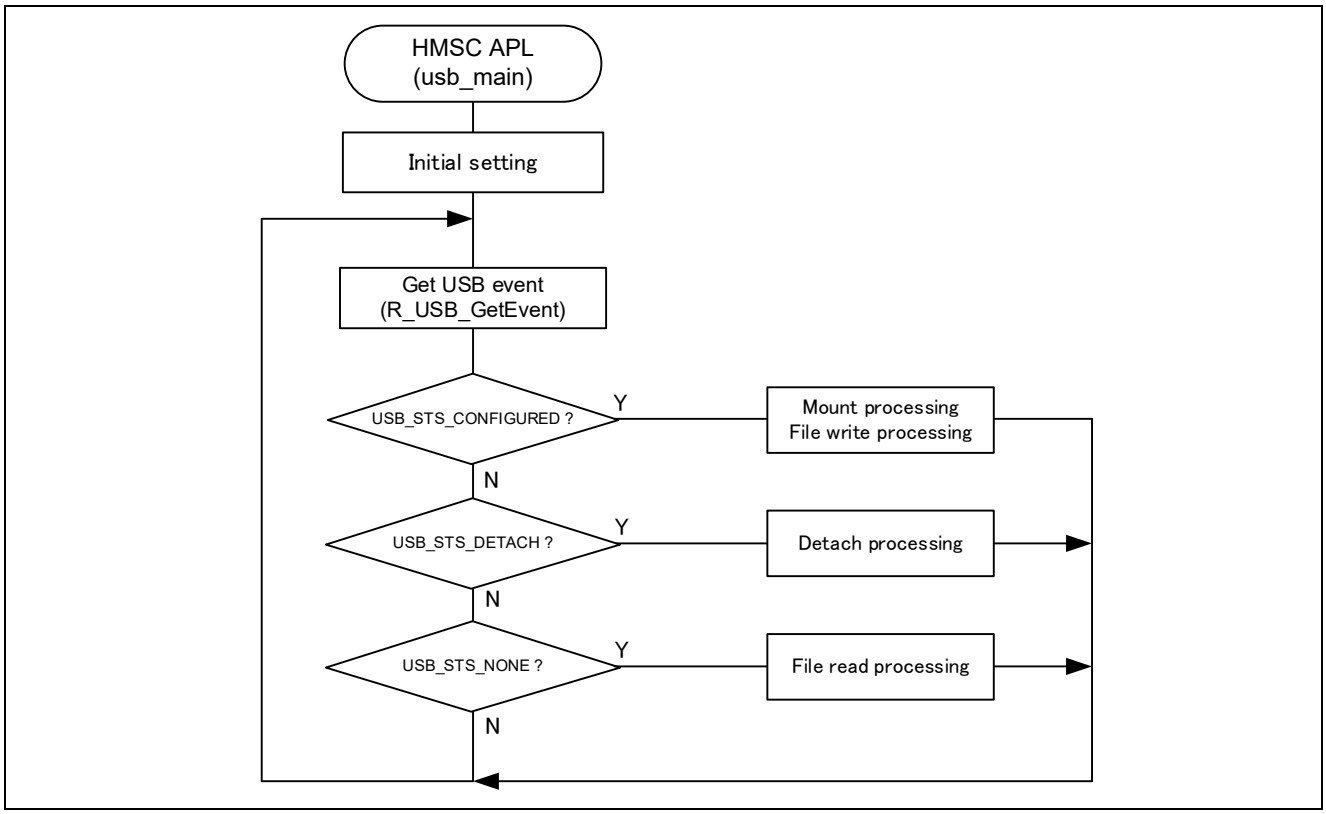


Figure 4-1 Main Loop

1. Mount processing and File write processing (USB_STS_CONFIGURED)

When the *R_USB_GetEvent* function is called after the MSC device is attached to the RSK and the enumeration and drive recognition processing is completed, *USB_STS_CONFIGURED* is set for the return value. After the application program checks that *USB_STS_CONFIGURED* has been set for the return value and performs the Mount processing and the file write processing, then it assigns *STATE_FILE_READ* to the state management variable to perform the file write/read processing.

2. File read processing (USB_STS_NONE)

When the *R_USB_GetEvent* function is called with no USB-related event, *USB_STS_NONE* is set for the return value. The application program checks that *USB_STS_NONE* has been set for the return value and then performs the following file read processing.

(1). File read processing

Performs the file read processing on an MSC device using the FAT API. After completion of the file read, the file read processing is continued until the MSC is detached.

3. Detach processing (USB_STS_DETACH)

If the *R_USB_GetEvent* is called after the MSC device has been detached from the RSK, then *USB_STS_DETACH* will be the return value. After the application program checks that *USB_STS_DETACH* has been set for the return value, then it assigns *STATE_DETACH* to the state variable.

4.3 Application Processing (for FreeRTOS)

This application has two tasks. An overview of the processing in these two tasks is provided below.

4.3.1 usb_apl_task

1. After the RSK starts up, MCU pin setting, USB controller initialization, and application program initialization are performed.
2. The MSC device is attached to the RSK, and when enumeration and drive recognition processing have completed, the USB driver calls the callback function (*usb_apl_callback*). In the callback function (*usb_apl_callback*), the application task is notified of the USB completion event using the FreeRTOS functionality.
3. In the application task, information regarding the USB completion event about which notification was received from the callback function is retrieved using the real-time OS functionality.
4. If the USB completion event (the *event* member of the *usb_ctrl_t* structure) retrieved in step 2 above is *USB_STS_CONFIGURED* then, based on the USB completion event, mounting of the MSC device and file writing to the MSC device are performed.
5. If the USB completion event (the *event* member of the *usb_ctrl_t* structure) retrieved in step 2 above is *USB_STS_DETACH*, the application initializes the variables for state management.

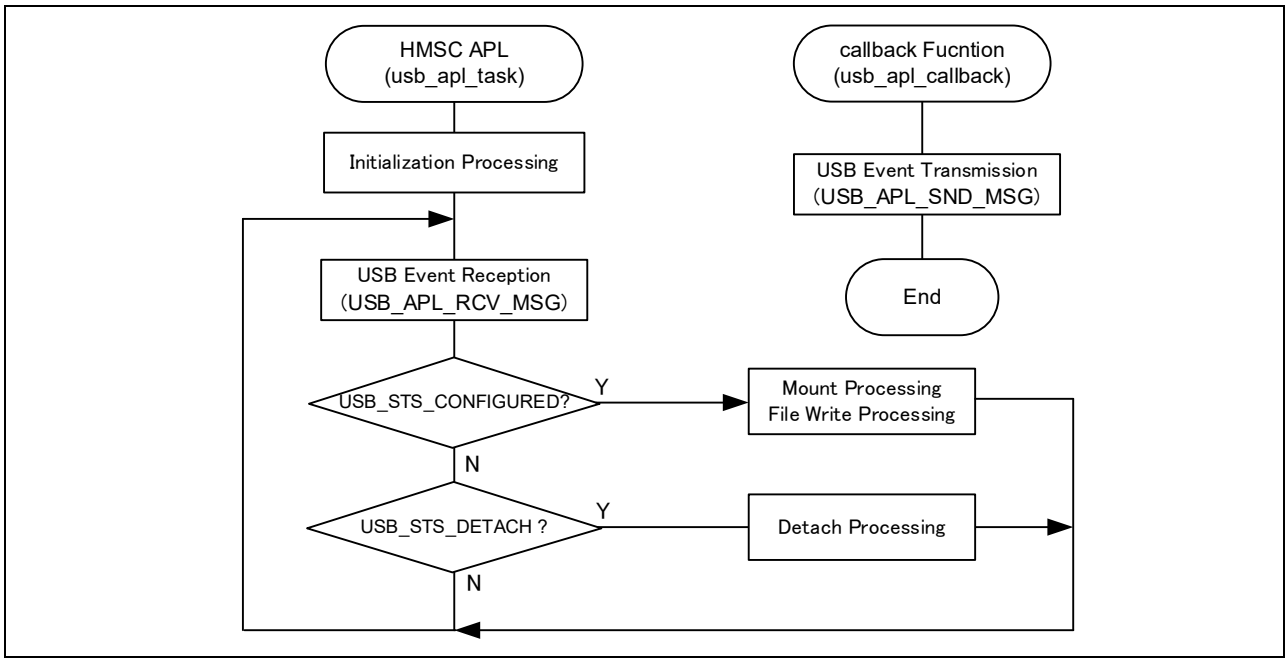


Figure 4-2 usb_apl_task

4.3.2 file_read_task

Of the application tasks (*usb_apl_task* and *file_read_task*), *file_read_task* is processed while *usb_apl_task* is in the wait state. This task performs file read processing on the file that was written to the MSC device (hmscdemo.txt).

4.4 Configuration File for the application program (r_usb_hmsc_apl_config.h)

Make settings for the definitions listed below.This file is not used when using Azure RTOS.

1. USE_USBIP Definition

Specify the module number of the USB module you are using.

```
#define  USE_USBIP  USE_USBIP0              // Specify USB_IP0.
#define  USE_USBIP  USE_USBIP1              // Specify USB_IP1.
#define  USE_USBIP  (USE_USBIP1|USE_USBIP0) // Specify USB_IP1 and USB_IP0
```

[Note]

You can specify *USE_USBIP1* when using RX64M or RX71M. Specify *USE_USBIP0* when using the MCU other than RX64M and RX71M.

2. USB_SUPPORT_MULTI Definition

Please specify *USB_APL_ENABLE* to *USB_SUPPORT_MULTI* definition when connecting the multiple MSC devices at the same time by using USB Hub etc.

```
#define  USB_SUPPORT_MULTI  USB_APL_DISABLE  // No conntecting the multiple MSC devices
#define  USB_SUPPORT_MULTI  USB_APL_ENABLE   // Conntecting the multiple MSC devices
```

3. 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
```

4. 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 Host and Peripheral Driver Firmware Integration Technology* (Document number. R01AN2025EJ).

4.5 Connecting Multiple MSC Devices

Refer to the following sample programs for reference when developing application programs that connect with multiple MSC devices using a USB hub, etc.

Note: It is impossible to connect the multiple MSC devices when using Azure RTOS.

a. r_usb_hmsc_apl_multi.c

5. Class Driver

5.1 Class Request

Table 5-1 shows the class requests supported by HMSC.

Table 5-1 Class Request

Request	Description
GetMaxLun	Gets the maximum number of units that are supported.
MassStrageReset	Cancels a protocol error.

5.2 Storage Command

The HMSC supports storage commands necessary to access USB mass storage devices as well as sample storage commands.
The HMSC supports the SFF-8070i (ATAPI) USB mass storage class.

Table 5-2 Storage Command

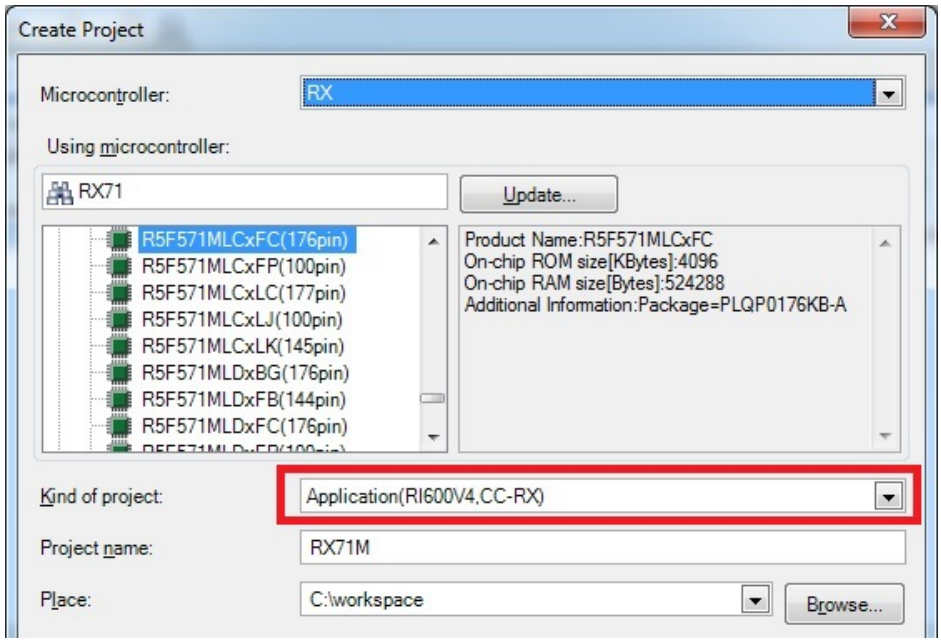
Command	Code	Description	Supported
TEST_UNIT_READY	0x00	Verify state of peripheral device	YES
REQUEST_SENSE	0x03	Obtain peripheral device state	YES
FORMAT_UNIT	0x04	Format logic unit	NO
INQUIRY	0x12	Obtain logic unit parameter information	YES
MODE_SELECT6	0x15	Set parameters	NO
MODE_SENSE6	0x1A	Obtain logic unit parameters	NO
START_STOP_UNIT	0x1B	Enable/disable logic unit access	NO
PREVENT_ALLOW	0x1E	Enable/disable media removal	YES
READ_FORMAT_CAPACITY	0x23	Obtain format capacity	YES
READ_CAPACITY	0x25	Obtain logic unit capacity information	YES
READ10	0x28	Read data	YES
WRITE10	0x2A	Write data	YES
SEEK	0x2B	Move to logic block address	NO
WRITE_AND_VERIFY	0x2E	Write and verify data	NO
VERIFY10	0x2F	Verify data	NO
MODE_SELECT10	0x55	Set parameters	YES
MODE_SENSE10	0x5A	Obtain logic unit parameters	YES

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)

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



2. Component Setting (Select "Components" tab)

(1). Import the FIT module

Select the following FIT modules and press the "Finish" button.

a. *r_usb_hmsc*

b. *r_tfat_rx*

c. *r_tfat_driver_rx*

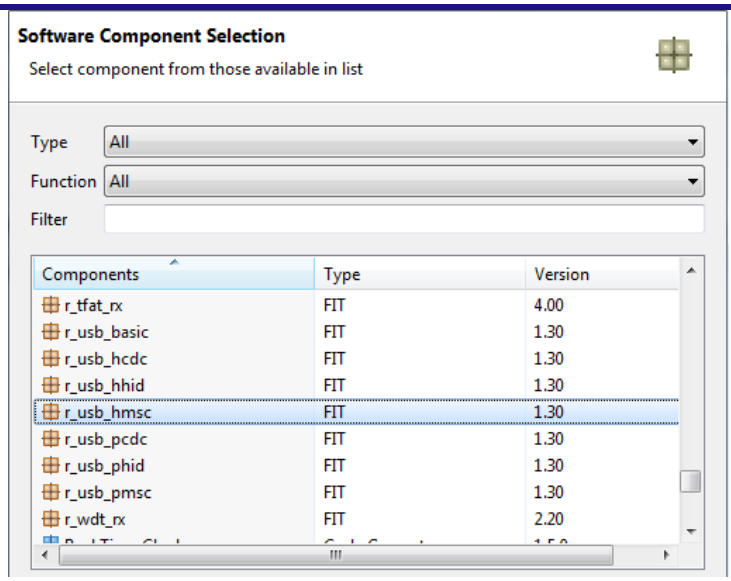
d. *r_sys_timer_rx*

e. *r_cmt_rx*

Note:

a. The *r_usb_basic* module is also imported at the same time.

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

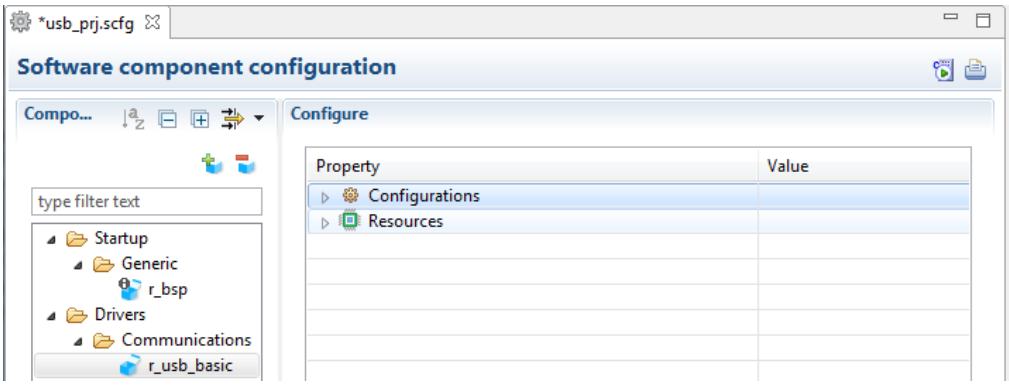


(2). Configuration Setting

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



(a). Configurations

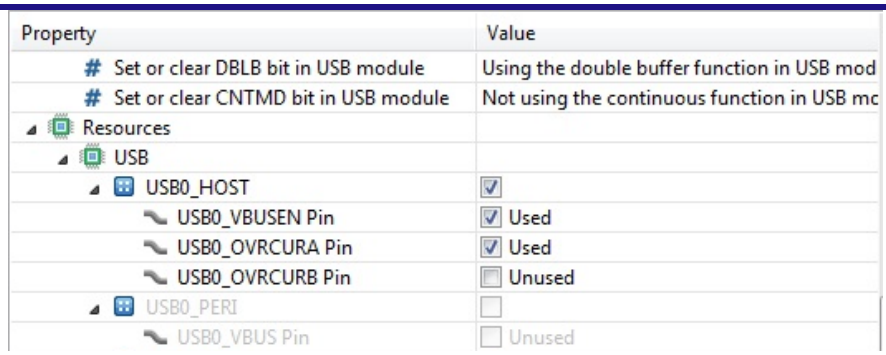
Set each item according to the user system.
For the detail of each item, refer to chapter "Configuration" in *USB Basic Host and Peripheral Driver Firmware Integration Technology* application note (Document number: R01AN2025).

(b). Resources

Check the following check box.

i. *USBx_VBUSEN* pin

ii. *USBx_OVRCURA* pin or *USBx_OVRCURB* pin



c. r_usb_tfat_driver_rx

(a). Number of USB drives

Set the number of MSC devices connected at the same.

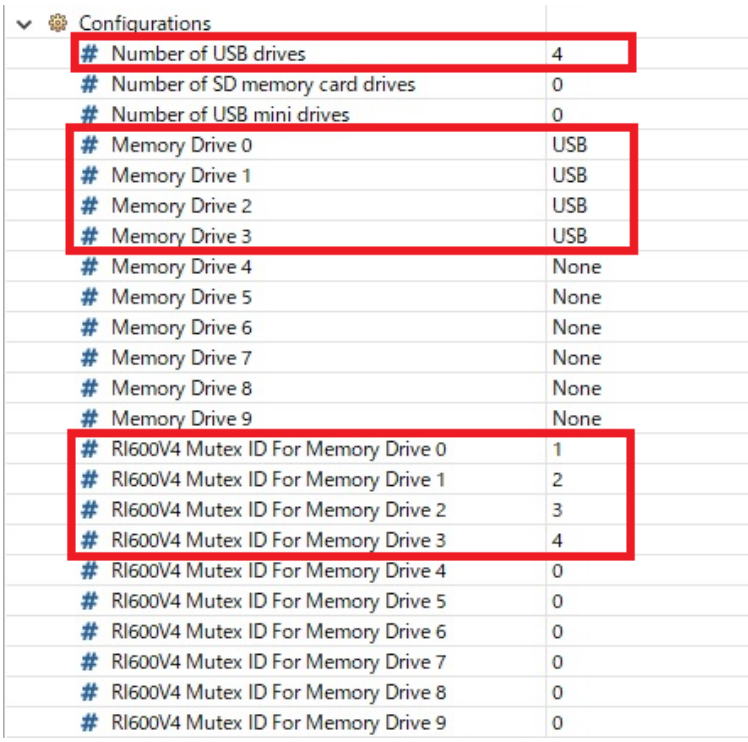
(b). Memory Drive

Set "USB" in order from "Memory Driver 0". The number to set "USB" must match the number set in (a) above.

(c). RI600V4 Mutex ID For Memory Drive

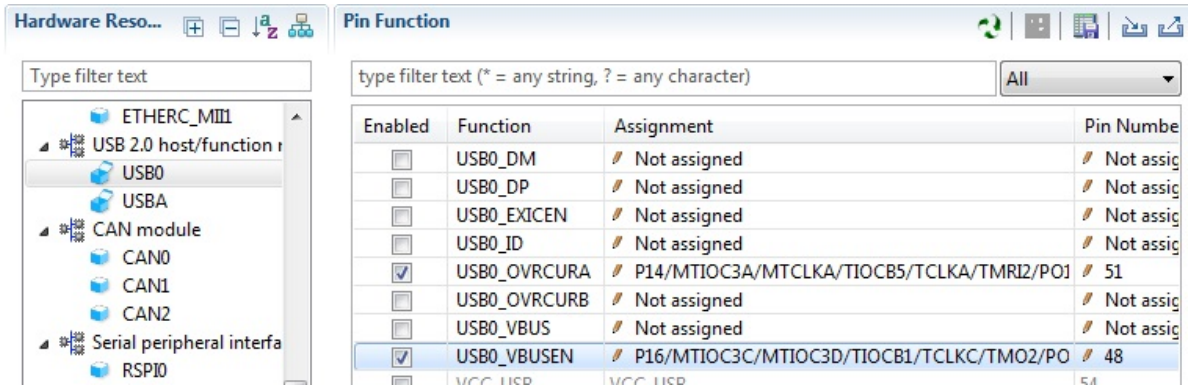
Set the Mutex ID number defined in the RI600V4 configuration file (.cfg file).

The following is an example when the number of MSC devices connected at the same time is 4.



3. Pin Setting (Select "Pins" tab)

Select the port for USB pin match the user system.



4. Other Setting

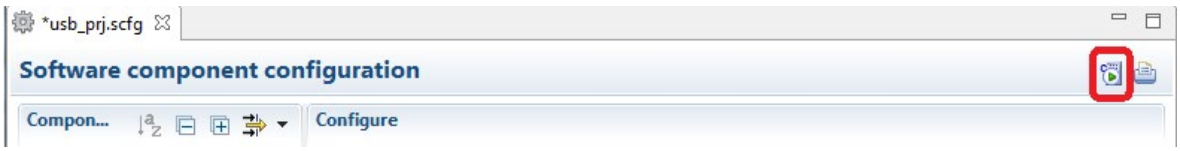
Set the number of drives (1 to 4) that can be supported at the same time to the *FF_VOLUMES* definition in the *"r_tfat_rx¥src¥ffconf.h"* file.

Example)

```
#define    FF_VOLUMES     4
```

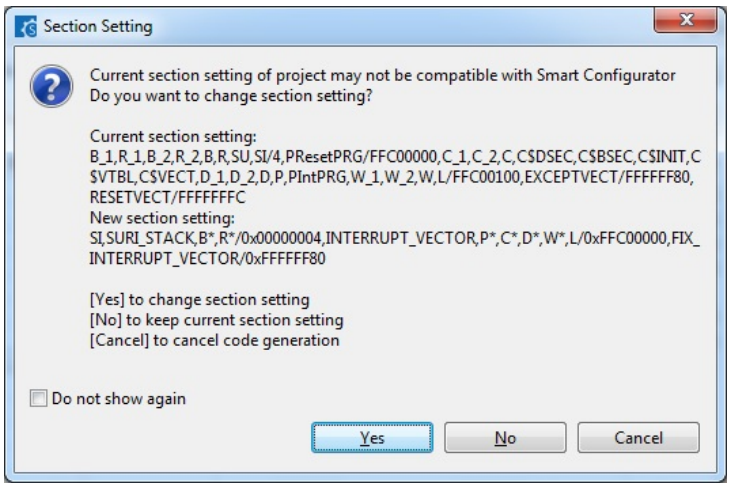
5. Generate Code

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.



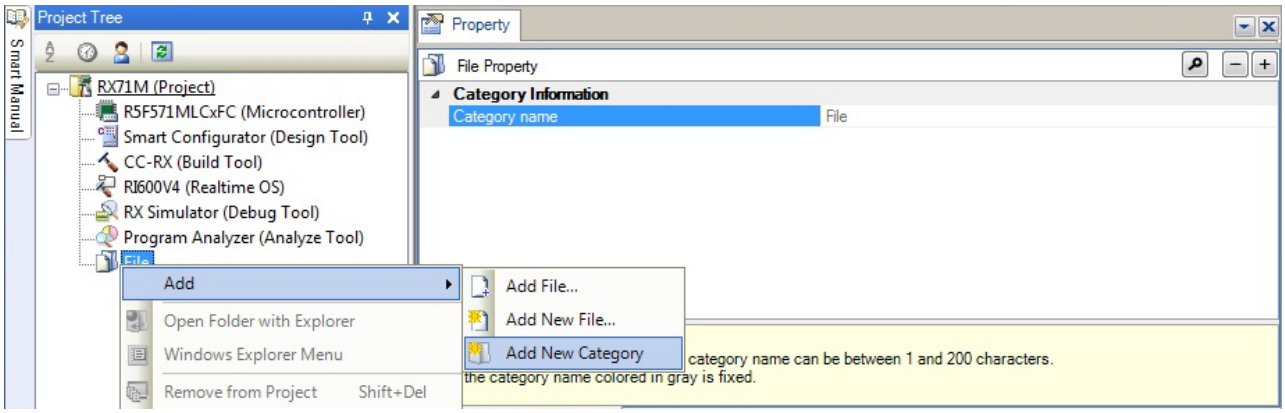
Note:

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:

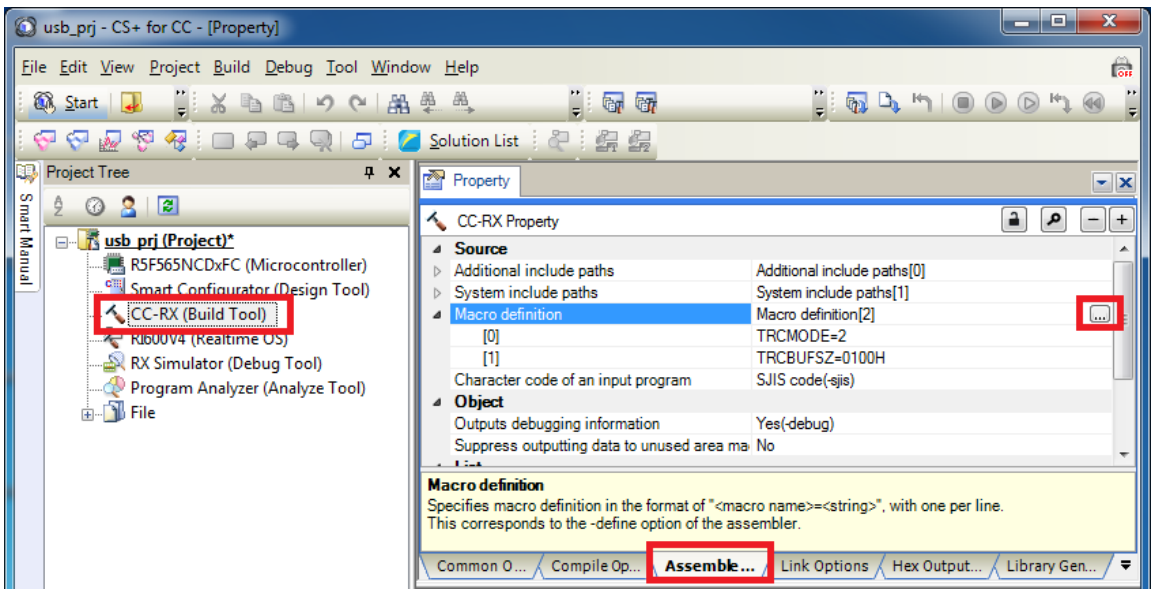
Remove the "task.c" file and "sample.cfg" created in "<*ProjectDir*>" folder by CS+.

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 HMSC contains a project only for e² studio. When you use the HMSC 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+**.

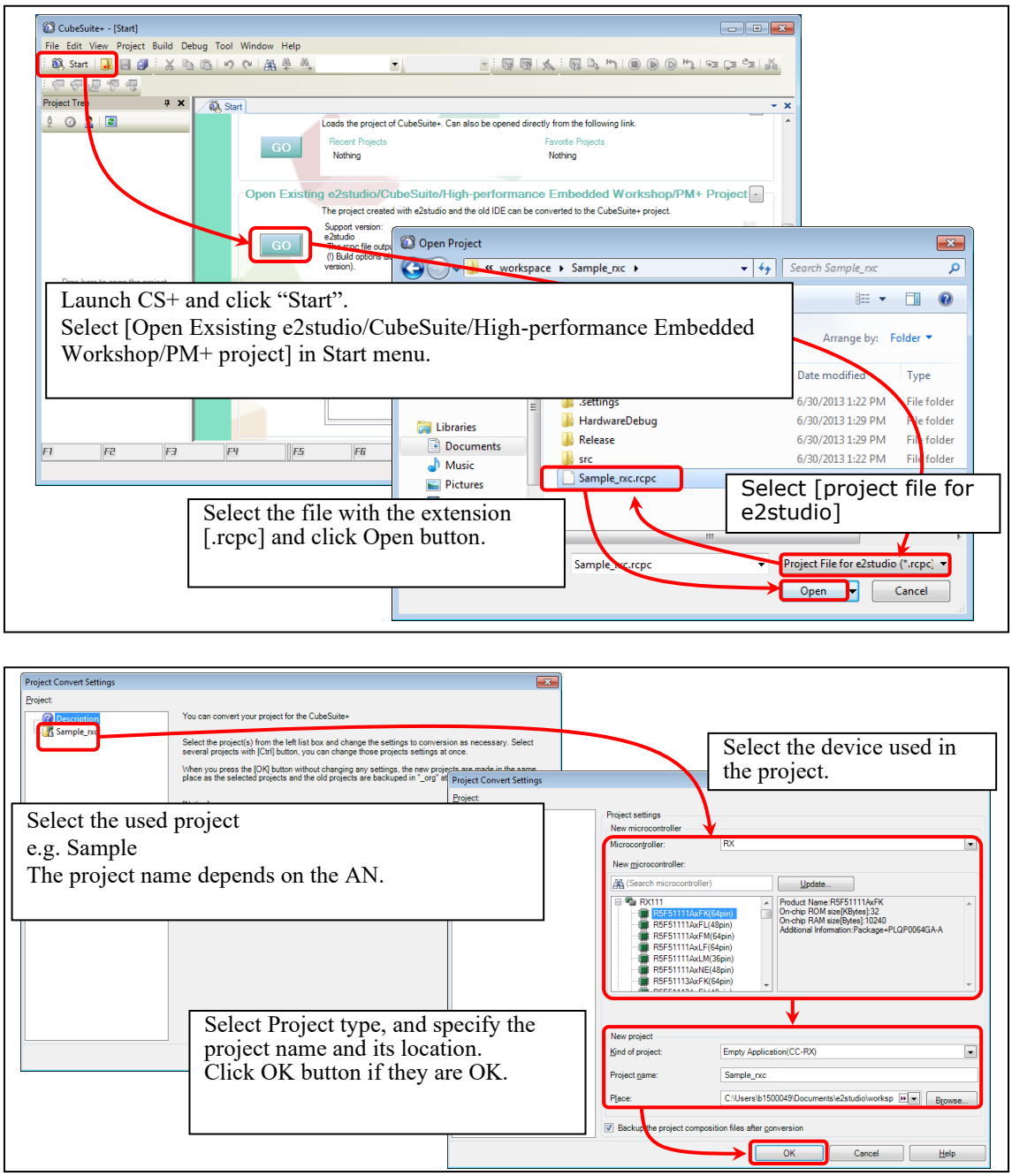


Figure 7-1 Using the e² studio project with CS+

Website and Support

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

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

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Oct 16, 2014	—	First edition issued
1.10	Dec 26, 2014	—	RX71M is added in Target Device.
1.11	Sep 30, 2015	—	RX63N and RX631 are added in Target Device.
1.20	Sep 30, 2016	—	1. RX65N and RX651 are added in Target Device. 2. Supporting DMA transfer. 3. Supporting USB Host and Peripheral Interface Driver application note.
1.21	Mar 31, 2017	—	The revision of USB Basic driver has been updated.
1.22	Sep 30, 2017	—	Supporting RX65N/RX651-2M
1.23	Mar 31, 2018	—	The revision of USB Basic driver has been updated.
1.24	Dec 28, 2018	—	Supported the real-time OS.
1.25	Apr 16, 2019	—	Added RX66T/RX72T in Target Device.
1.27	Jul 31, 2019	—	1. RX72M is added in Target Device. 2. RX63N is removed from Target Device.
1.30	Mar 1, 2020	—	1. Supported the real time OS (uITRON:RI600V4). 2. Added RX72N/RX66N in Target Device.
1.31	Oct 30, 2022	—	Added RX671 in Target Device.
1.42	Sep 30, 2023	—	Support Azure RTOS (USBX).

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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