RX Family

R01AN2235EJ0142
Rev.1.42
Sep 29, 2023

Sample Program using USB Host Communication Device Class Driver(HCDC) to communicate via USB with CDC device Firmware Integration Technology

Introduction

This document describes the following sample firmware: USB Host Communication Devices Class Driver using Firmware Integration Technology. The sample firmware is referred to below as the HCDC.

When developing an actual software, be sure to use the “USB Basic Host and Peripheral Driver Firmware Integration Technology Application Note” (Document number: R01AN2025) together with the user’s manual for each MCU (Hardware). In addition, also refer to the " USB Host Communication Device Class Driver (HCDC) Firmware Integration Technology Application Note” (Document number:R01AN2027), if necessary. “USB Basic Host and Peripheral Driver Firmware Integration Technology Application Note” (Document number: R01AN2025) 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).

Contents

1. Introduction

1.1 Functions

The HCDC conforms to the Abstract Control Model of the USB communication device class (CDC) specification and implements communication with CDC devices.

The HCDC provides the following functionality:

- Performs communication class data transfer when a CDC device is connected.

1.2 FIT Module Configuration

The HCDC 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 Using Firmware Integration Technology	r_bsp
RX Family USB Basic Host and Peripheral Driver Firmware Integration Technology	r_usb_basic
RX Family USB Host Communication Devices Class Driver (HCDC) Firmware Integration Technology	r_usb_hcdc
RX Family DTC Module Using Firmware Integration Technology	r_dtc_rx
RX Family DMA Controller DMACA Control Module Firmware Integration Technology	r_dmaca_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
CDC	:	Communications Devices Class
HCD	:	Host Control Driver for USB-BASIC-FW
HCDC	:	Host Communication Devices Class
MGR	:	Peripheral Device State Manager for HCD
Non-OS	:	USB Driver for OS-less
RSK	:	Renesas Starter Kits
RTOS	:	USB Driver for the real-time OS
USB-BASIC-FW	:	USB Basic Host and Peripheral Driver

2. Software Configuration

2.1 Module Configuration

The HCDC transfers data to and from a device via the HCD and reports the results to the APL. Also, it reports data transfer requests from the APL to devices via HCDC and HCD.
Figure 2-1 shows the module configuration of the HCDC, and Table 2-1 lists the functions of the modules.

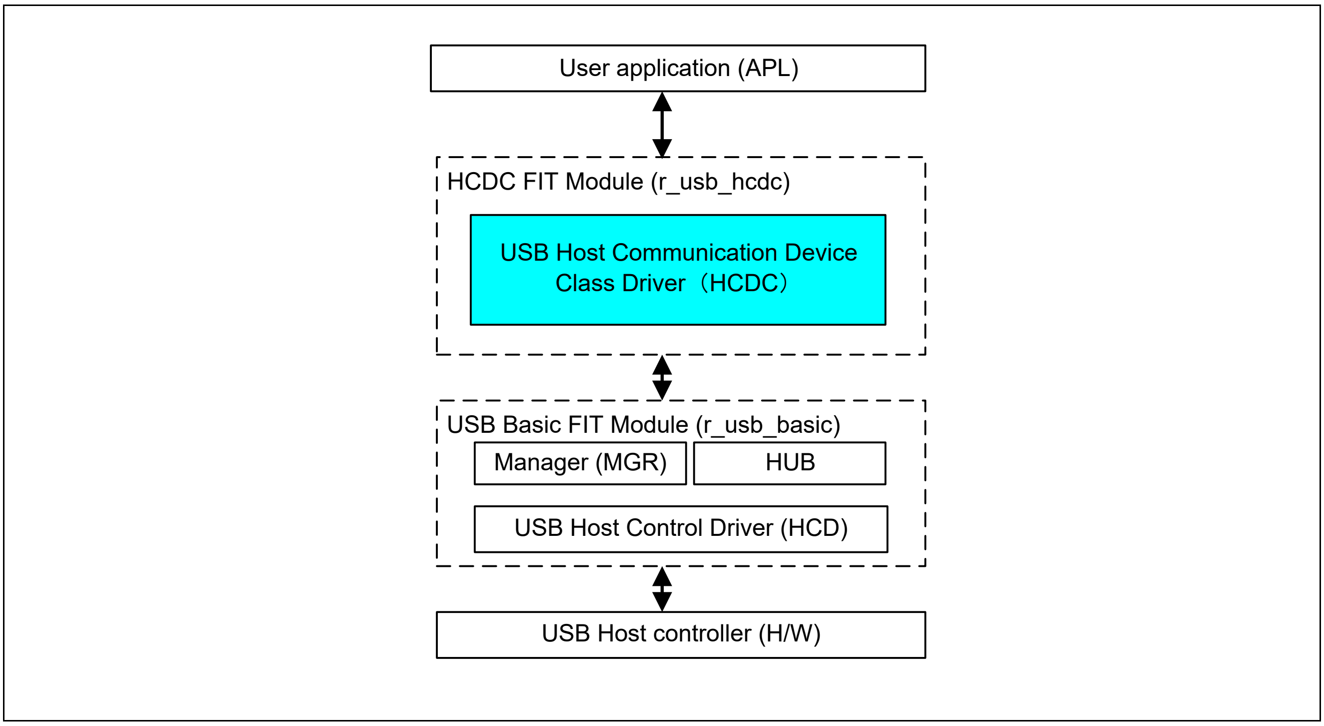


Figure 2-1 Module Configuration

Table 2-1 Functions of Modules

Module Name	Function
APL	Sample application program
HCDC (r_usb_hcdc)	CDC Class Driver ・ Sends CDC-related requests from the APL and data transfer requests to the HCD.
HCD (r_usb_basic)	USB host hardware control driver

3. Setup

3.1 Hardware

3.1.1 Example Operating Environment

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

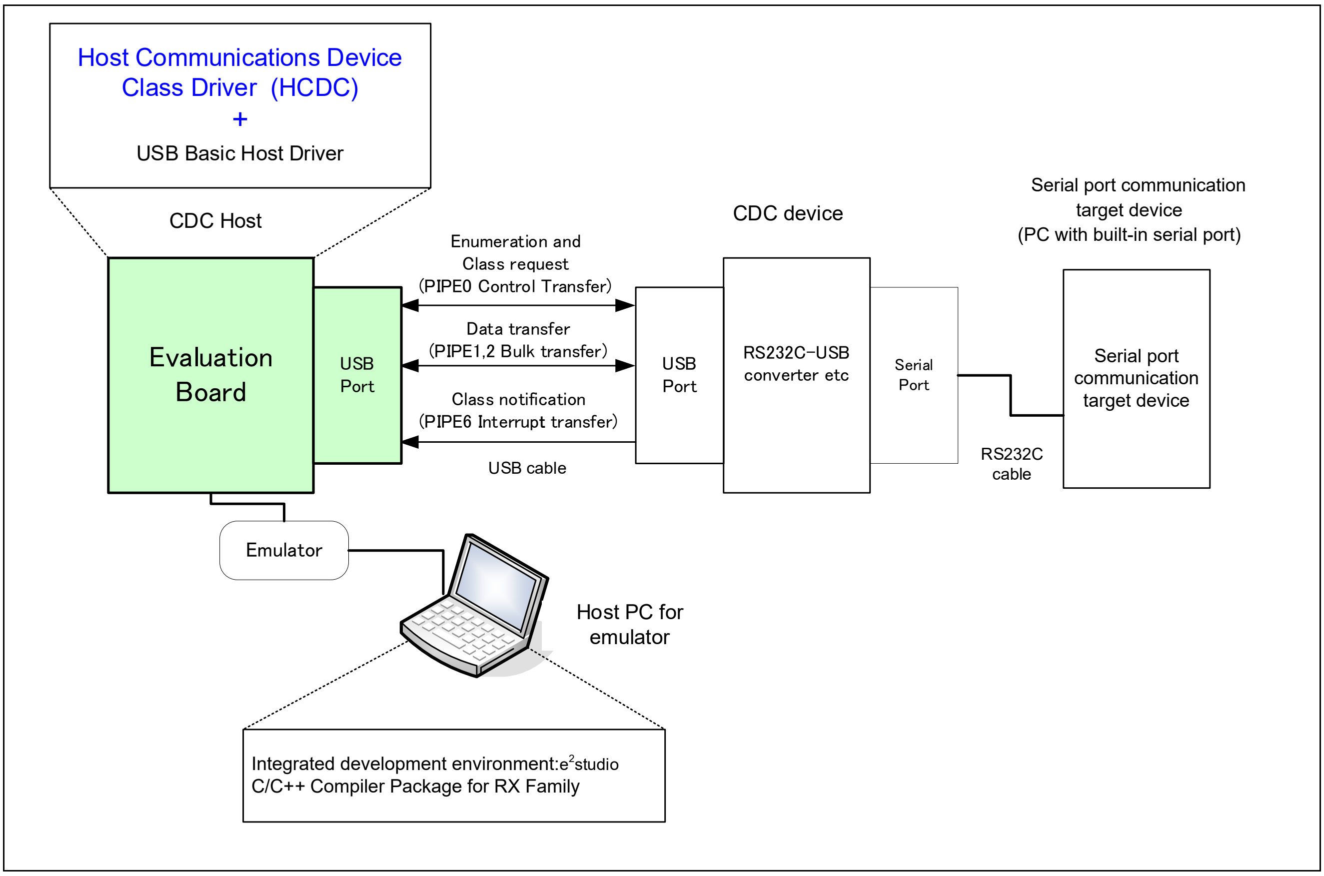


Figure 3-1 Example Operating Environment

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

Table 3-1 Evaluation Board on which HCDC Operation Has Been Verified

MCU	Evalulation Board
RX65N	RSK+RX65N, RSK+RX65N
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:

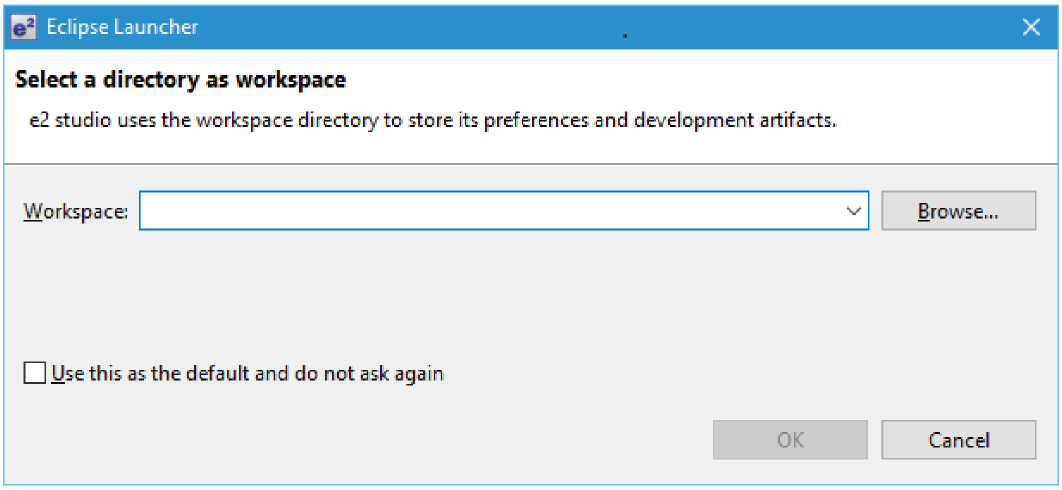
For the detail of RSK setting, refer to the user's manual of RSK.

3.2 Software

1) Setup e^2 studio

a) Start e^2 studio

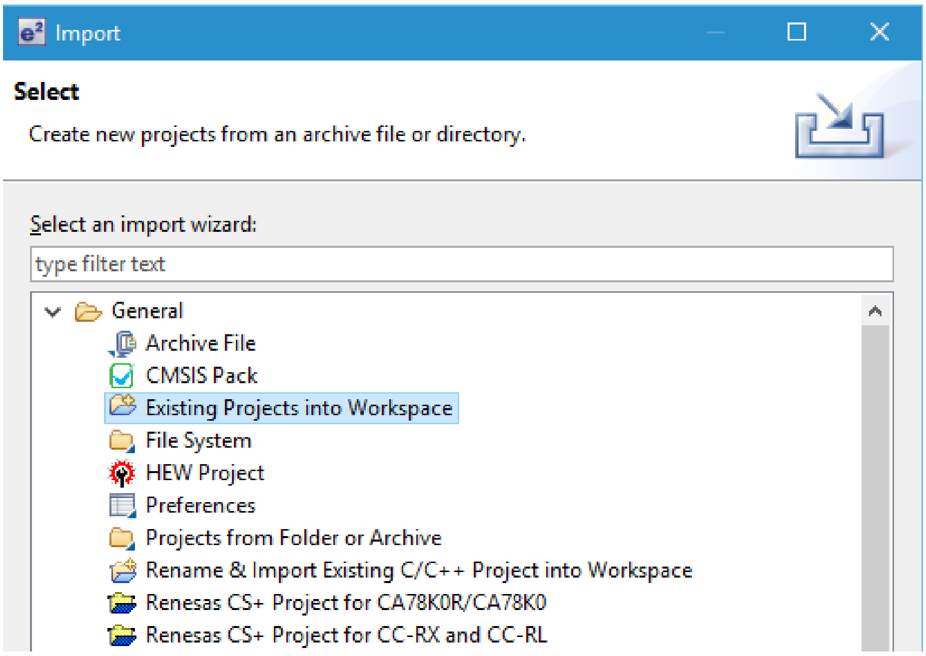
b) If you start up e^2 studio at first, the following dialog is displayed. Specify the folder to store the project in this dialog.



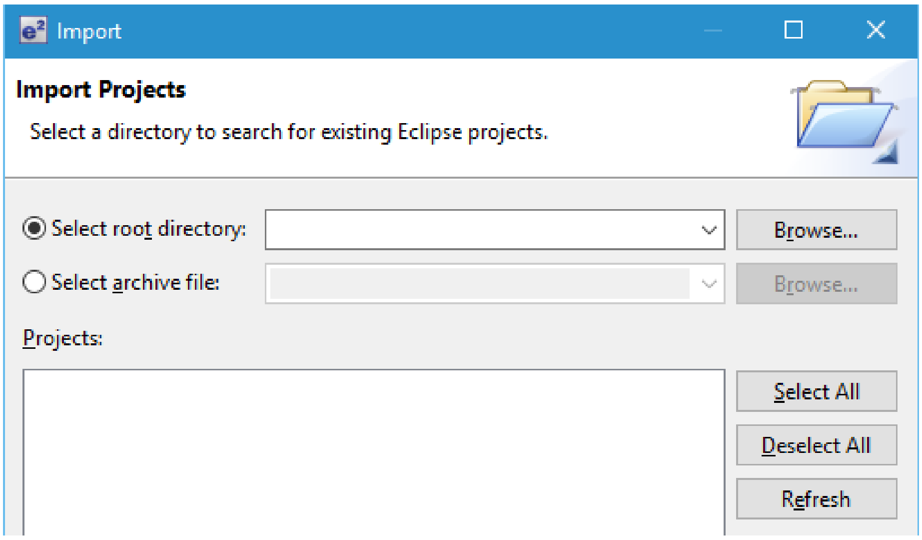
2) Import the project to the workspace

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 main functions of the APL are as follows:

1. Sends receive (Bulk In transfer) requests to the CDC device and receives data.
2. Transfers received data to the CDC device by means of Bulk Out transfers (loopback).
3. The communication speed and other settings are made by transmitting the class request *SET_LINE_CODING* to the CDC device. This class request can be used to set the communication speed, number of data bits, number of stop bits, and the parity bit.

4.1.1 Data Transfer Image

Figure 4-1 shows the data transfer image.

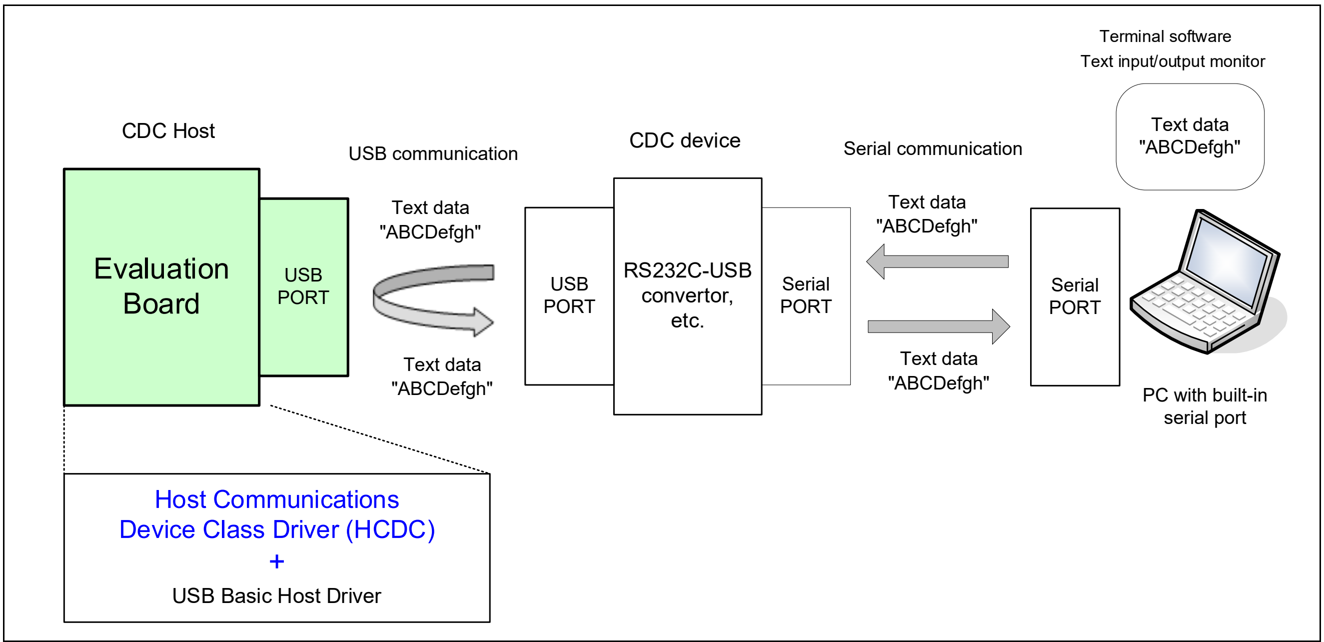


Figure 4-1 Data Transfer (Loopback) Image

4.2 Application Processing

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 (for Non-OS)

The main loop performs loop-back processing in which data received from the CDC device is transmitted unaltered back to the CDC device as part of the main routine. An overview of the processing of the main loop is presented below.

1. When the *R_USB_GetEvent* function is called after the CDC device attaches to the RSK and enumeration completes, *USB_STS_CONFIGURED* is set as the return value. When the APL confirms *USB_STS_CONFIGURED*, it sends class request *SET_LINECODING* to the CDC device.
2. When it confirms that the class request processing has completed, the APL calls the *R_USB_Read* function to make a data receive request for data sent from the CDC device. Note that in addition to the data receive request a receive request is also sent for a class notification from the CDC device.
3. When the *R_USB_GetEvent* function is called after reception of data from the CDC device has completed, *USB_STS_READ_COMPLETE* is set as the return value. The received data is stored in external variable *g_data*. The receive data size can be confirmed by means of the size member of the usb_ctrl_t structure. The APL determines that a null packet has been received if the value of the size member is 0 (zero) and performs another data receive request. If the value of the size member is other than 0 (zero), the APL determines that data has been received from the CDC device. It then makes a transmit request to send the received data to the CDC device.
4. When the *R_USB_GetEvent* function is called after transmission of data to the CDC device completes, *USB_STS_WRITE_COMPLETE* is set as the return value. When the APL confirms *USB_STS_WRITE_COMPLETE*, it calls the R_USB_Read function to make a data receive request for data sent by the CDC device.
5. The processing in steps 3 and 4, above, is repeated.

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

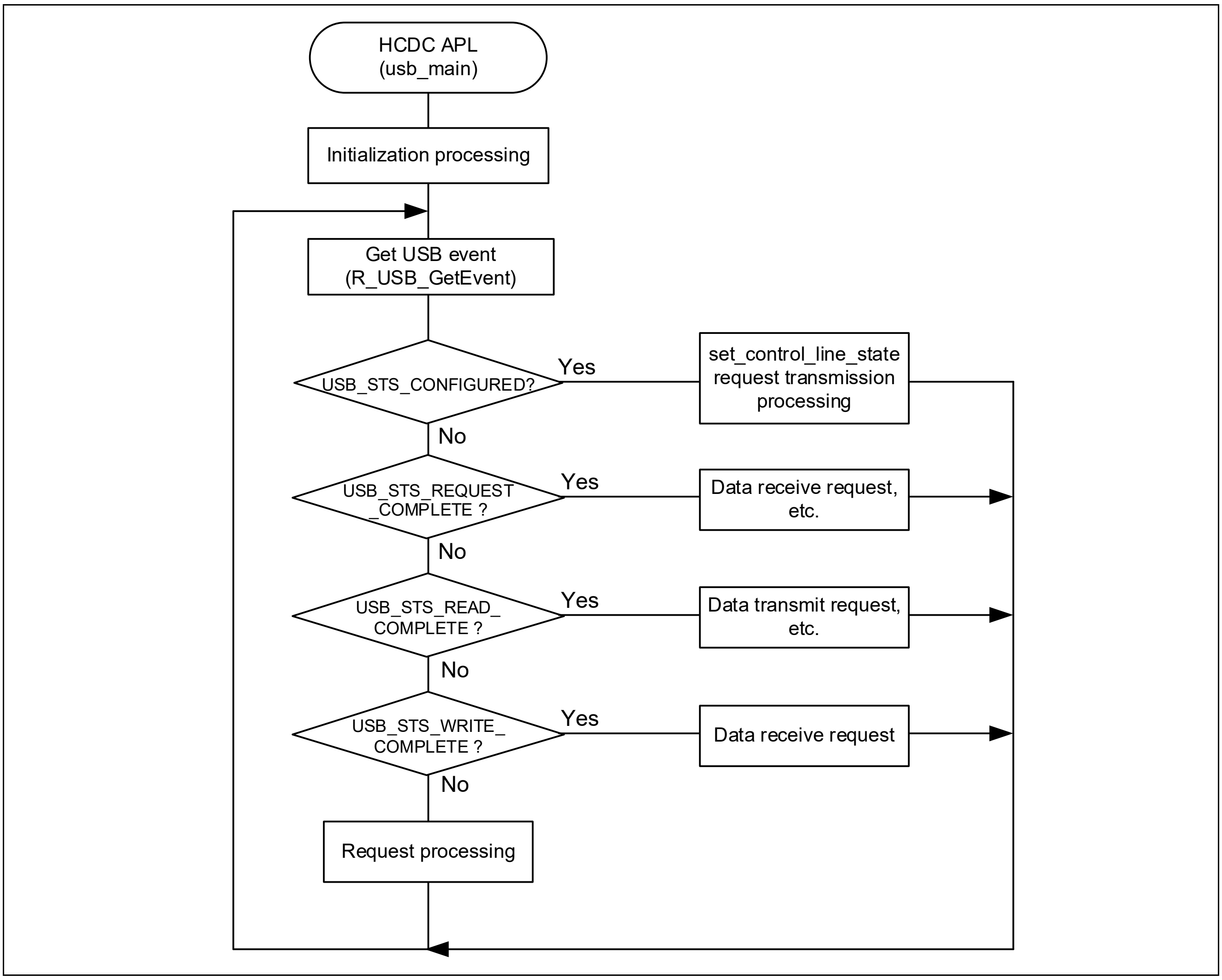


Figure 4-2 Main Loop processing (for Non-OS)

4.2.3 Main Loop (for RTOS)

The loop performs loop-back processing in which data received from the CDC device is transmitted unaltered back to the CDC device as part of the main routine. An overview of the processing performed by the loop is shown below. The following process is for FreeRTOS version and uITRON.

1. When a USB-related event has completed, the USB driver calls the callback function (*usb_apl_callback*). In the callback function (*usb_apl_callback*), the application task (APL) is notified of the USB completion event using the real-time OS functionality.
2. In APL, information regarding the USB completion event was notified from the callback function is retrieved using the real-time OS functionality.
3. If the USB completion event (the *event* member of the *usb_ctrl_t* structure) retrieved in step 2 above is *USB_STS_CONFIGURED*, APL sends the class request (*SET_LINECODING*) to the CDC device.
4. If the USB completion event (the *event* member of the *usb_ctrl_t* structure) retrieved in step 2 above is *USB_STS_REQUEST_COMPLETE*, APL performs a data reception request to receive data transmitted from the CDC device by calling the *R_USB_Read* function and also performs a class notification reception request from CDC device.
5. If the USB completion event (the *event* member of the *usb_ctrl_t* structure) retrieved in step 2 above is *USB_STS_READ_COMPLETE*, APL performs a data transmission request to send the reception data by calling the *R_USB_Write* function. The reception data is stored in the gloval variable (*g_data*). The reception data size

is set in the member (*size*) of the *usb_ctrl_t* structure. If this member (*size*) is zero, the USB driver judges that the *NULL* packet is received and performs a data reception request to the CDC device again.

6. If the USB completion event (the *event* member of the *usb_ctrl_t* structure) retrieved in step 2 above is *USB_STS_WRITE_COMPLETE*, APL performs a data reception request to receive the data sent from CDC device.

7. The avove processing is repeated.

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

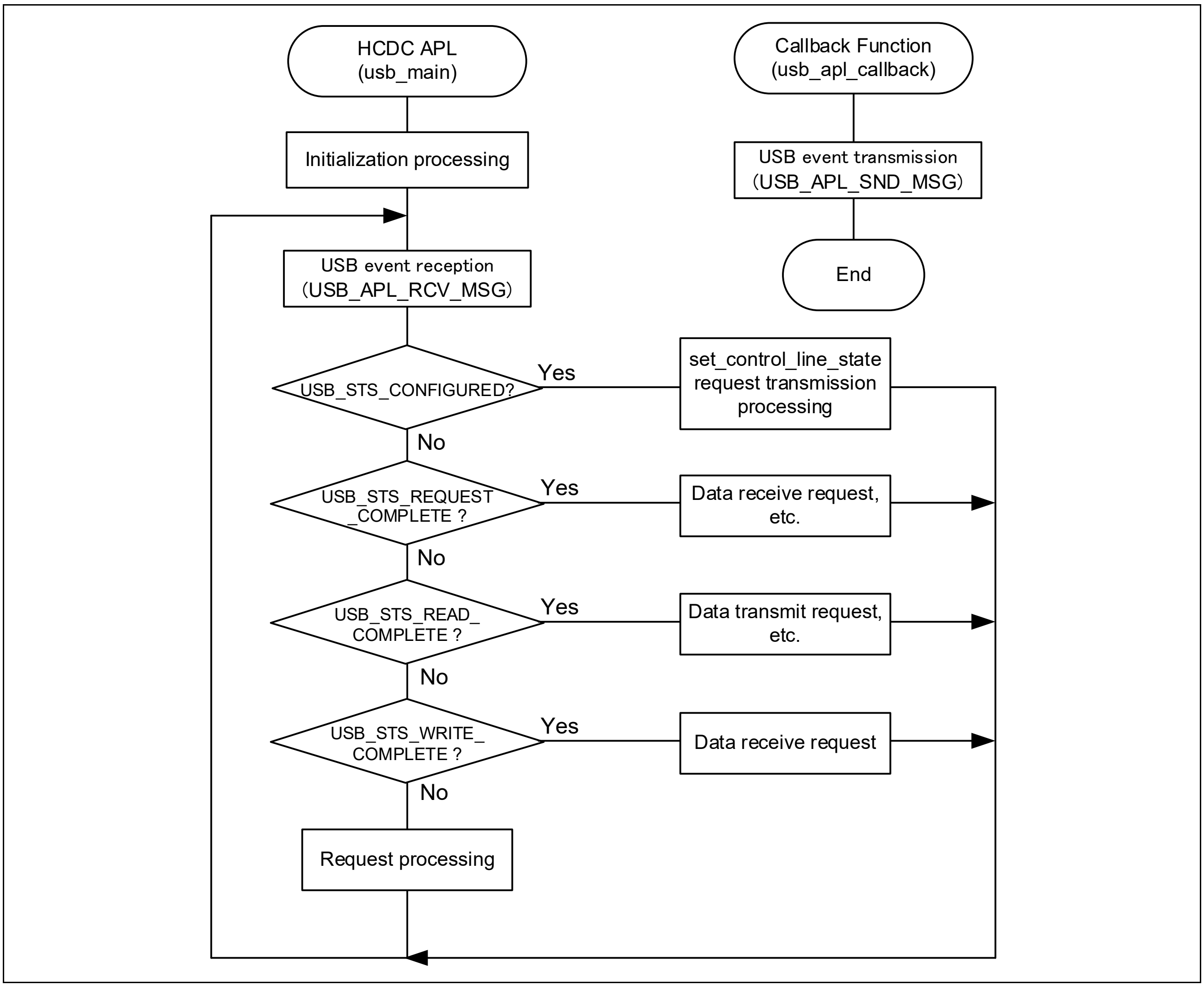


Figure 4-3 Main Loop processing (for RTOS)

4.3 Configuration File for the application program (r_usb_hcdc_apl_config.h)

Make settings for the definitions listed below.

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|USB_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. COM_SPEED Definition

Please specify the baud rate value. This baud rate value is set to the CDC device by the class request (SET_LINE_CODING). Specify a setting of *BPS_9600 / BPS_14400 / BPS_19200 / BPS_38400 / BPS_57600 / BPS_115200* to *COM_SPEED* defintion.

```
#define   COM_SPEED        BPS_57600        // Baud rate value
```

3. COM_PARITY_BIT Definition

Please specify the parity bit. This parity bit is set to the CDC device by the class request (SET_LINE_CODING). Specify a setting of *PARITY_EVEN / PARITY_ODD / PARITY_NONE* to *COM_PARITY_BIT* definition.

```
#define   COM_PARITY_BIT   PARITY_NONE      // Parity bit
```

4. COM_STOP_BIT Definition

Please specify the stop bit. This stop bit is set to the CDC device by the class request (SET_LINE_CODING). Specify a setting of *STOP_BIT1*(1 bit) / *STOP_BIT15*(1.5 bit) / *STOP_BIT2*(2 bit) to *COM_STOP_BIT* definition.

```
#define   COM_STOP_BIT     STOP_BIT1        // Stop bit
```

5. COM_DATA_BIT Definition

Please specify the data bit. This data bit is set to the CDC device by the class request (SET_LINE_CODING). Specify a setting of *DATA_BIT7*(7 bit) / *DATA_BIT8*(8 bit) to *COM_DATA_BIT* definition.

```
#define   COM_DATA_BIT     DATA_BIT8        // Data bit
```

6. USB_SUPPORT_MULTI Definition

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

```
#define   USB_SUPPORT_MULTI   USB_APL_DISABLE   // Do not connect the multiple CDC devices
#define   USB_SUPPORT_MULTI   USB_APL_ENABLE    // Connect the multiple CDC devices
```

7. 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
```

8. 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).

4.4 Connecting Multiple CDC Devices

Refer to the following sample programs for reference when developing application programs that connect with multiple CDC devices using a USB hub, etc. Note that the following file is not supported in Azure RTOS version.

1. r_usb_hcdc_apl_multi.c

5. Class Driver Overview

5.1 Class Request

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

Table 5-1 Supported Basic Requests and CDC Class Requests

Request	Code	Description	Suppoted
SendEncapsulatedCommand	0x00	Sends protocol-defined commands such as AT.	YES
GetEncapsulatedResponse	0x01	Requests response to command sent in SendEncapsulatedCommand.	YES
SetCommFeature	0x02	Sets enable/disable for device-specific 2-byte code and country code.	YES
GetCommFeature	0x03	Sets enable/disable for device-specific 2-byte code and country code.	YES
ClearCommFeature	0x04	Returns enable/disable status for device-specific 2-byte code and country code to default settings.	YES
SetLineCoding	0x20	Sets transmission line coding (transmission speed, data length, parity bit, stop bit length)	YES
GetLineCoding	0x21	Obtains transmission line coding status.	YES
SetControlLineState	0x22	Sets control signals RTS and DTR for transmission line.	YES
SendBreak	0x23	Sends break signal.	YES

5.2 Class Notification（Notification from CDC device to USB Host）

Table 5-2 shows class notifications supported by the HCDC.

Table 5-2 CDC Class Specific Notification

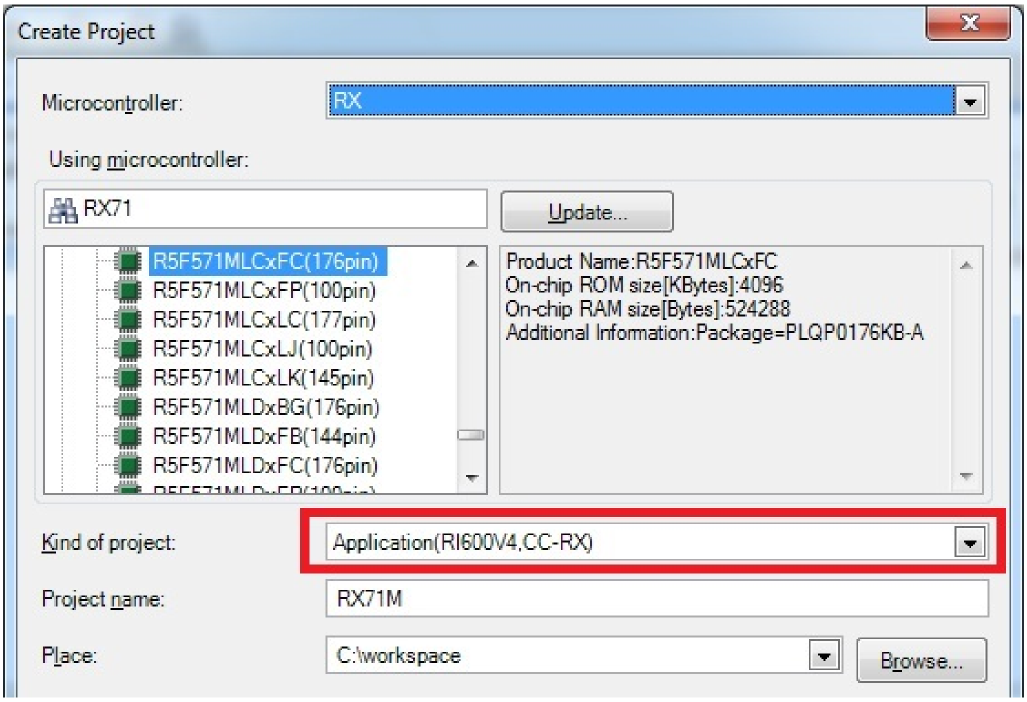
Notification	Code	Description	Supported
NETWORK_CONNECTION	0x00	Notifies network connection state.	NO
RESPONSE_AVAILABLE	0x01	Response to GET_ENCAPSLATED_RESPONSE.	NO
SERIAL_STATE	0x20	Notifies serial line status.	YES

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).

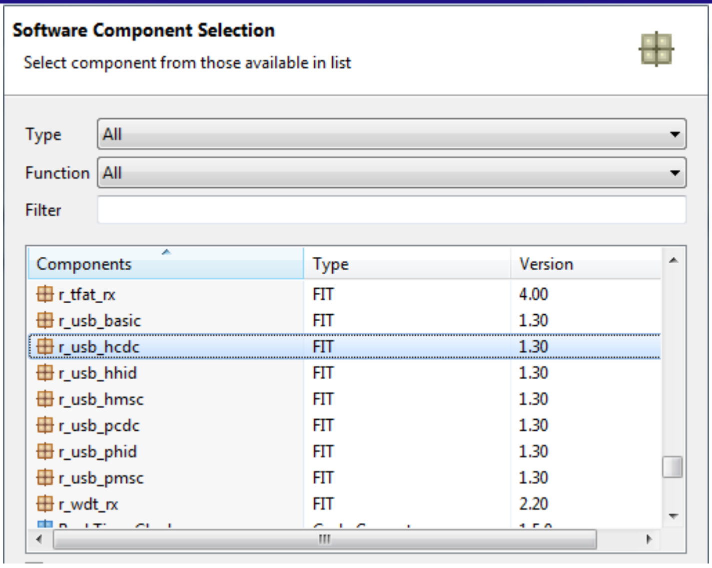
2. Component Setting (Select "Components" tab)

(1). Import the USB FIT module

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

Note:

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

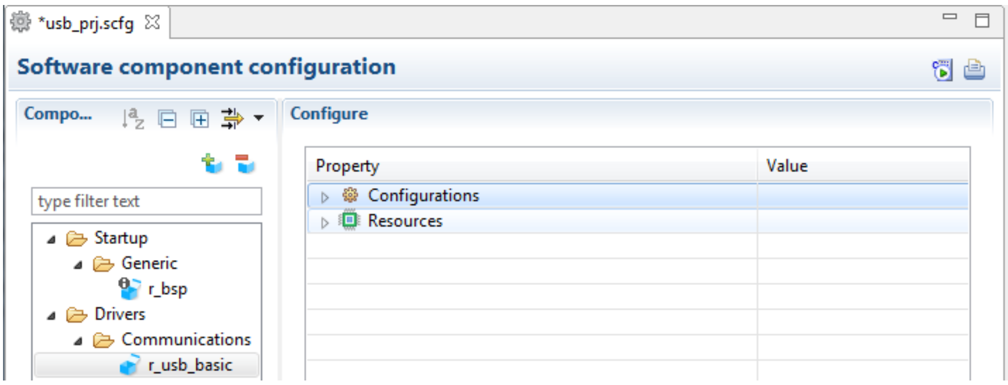


(2). Configuration Setting

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



(a). Configurations

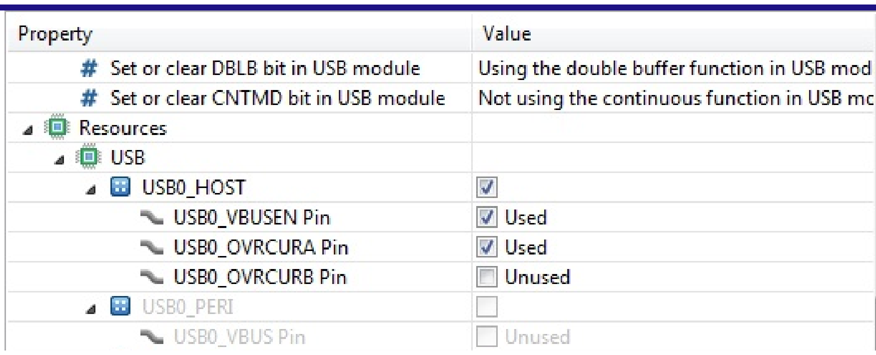
Set each item according to the user system.
For the detail of each item, refer to chapter "Configuration" in *USB Basic Host and Peripheral Driver Firmware Integration Technology* application note (Document number: R01AN2025).

(b). Resources

Check the following check box.

i. *USBx_VBUSEN* pin

ii. *USBx_OVRCURA* pin or *USBx_OVRCURB* pin

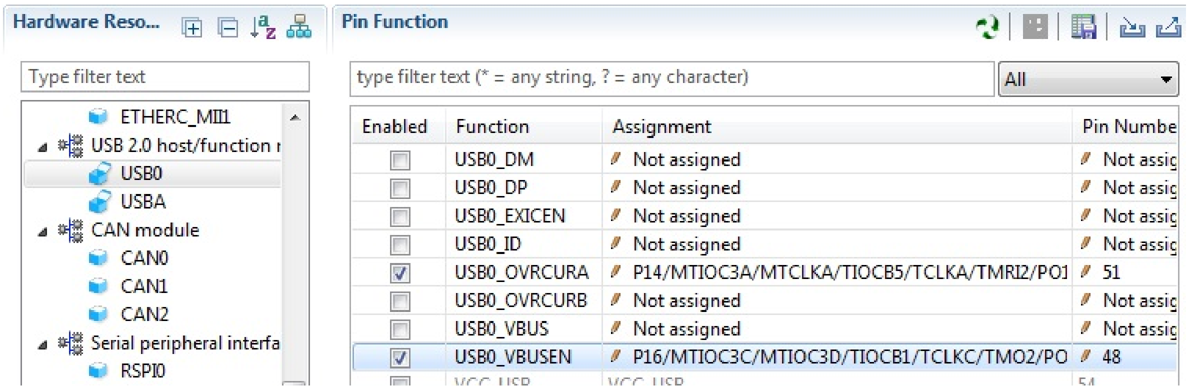


c. r_usb_hcdc

Refer to chapter "Configuration" in *USB Host Communications Devices Class Driver (HCDC) Firmware Integration Technology* application note (Document number: R01AN2027).

3. Pin Setting (Select "Pins" tab)

Select the port for USB pin match the user system.

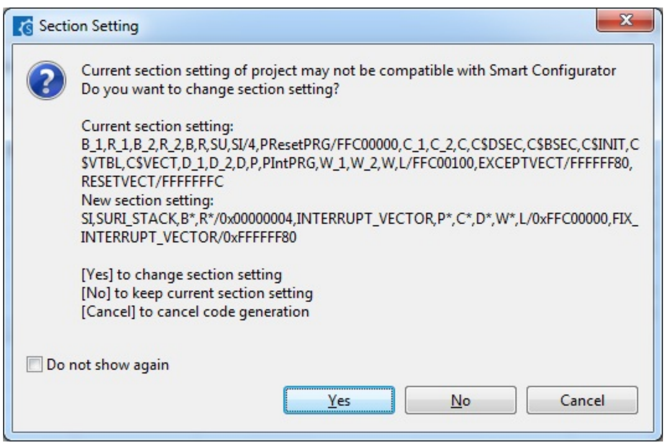


4. Generate Code

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.

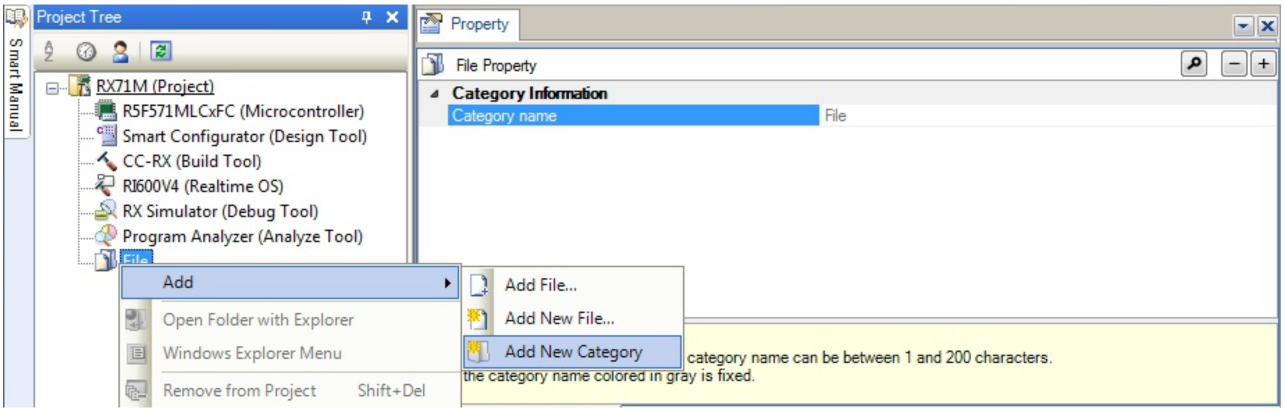
Note:

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:

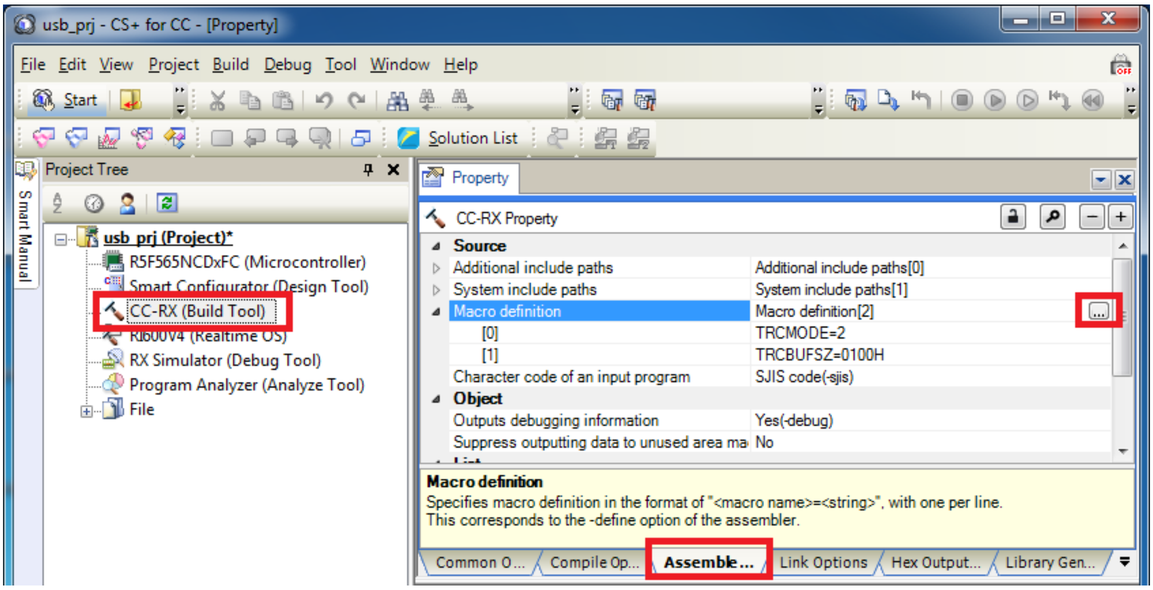
Remove the "task.c" file and "sample.cfg" created in "*<ProjectDir>*" folder by CS+.

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+ (Except RI600V4)

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

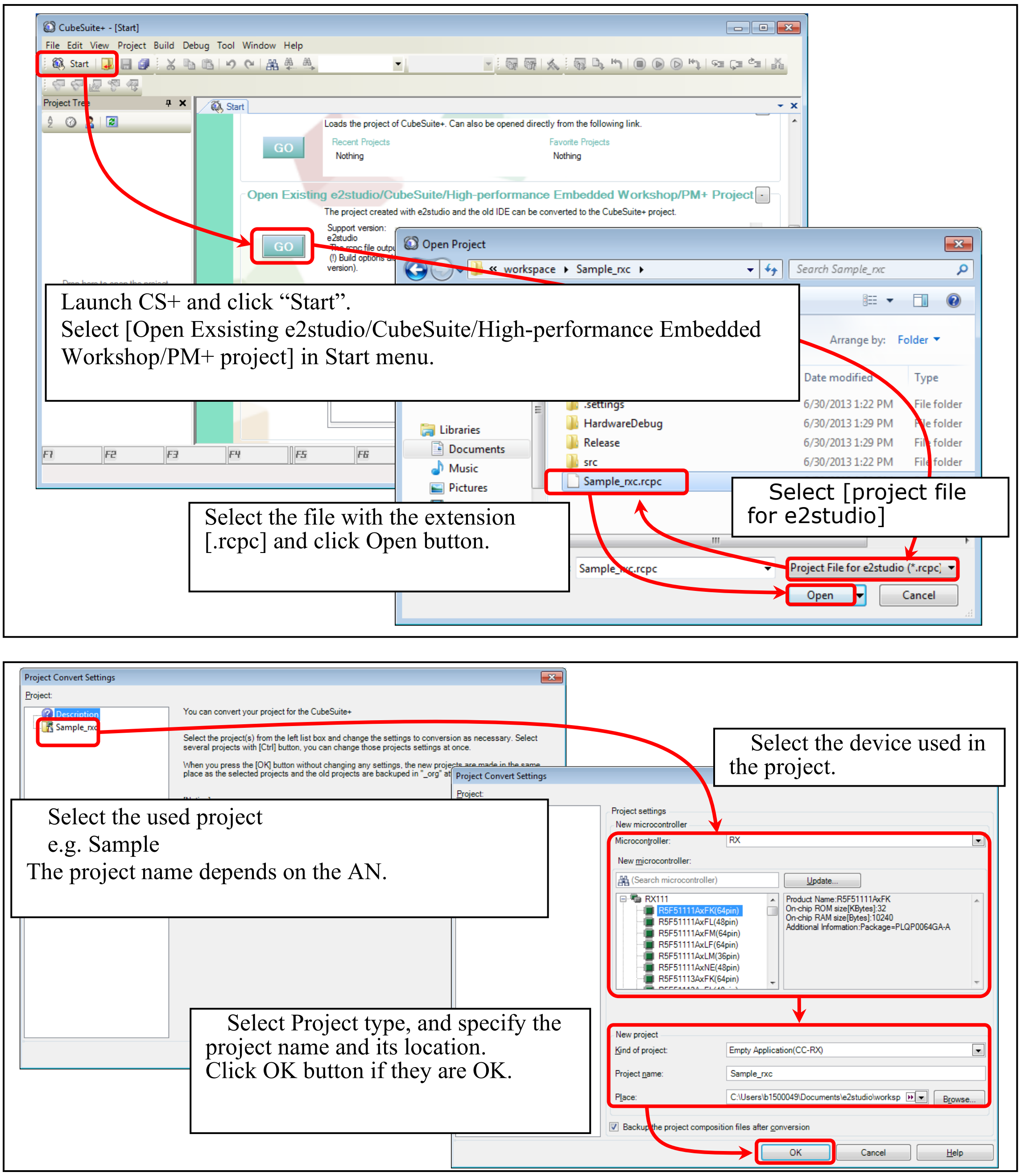


Figure 7-1 Using the e² studio project with CS+

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	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, 2018	—	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	Mar 1, 2021	—	Added RX671 in Target Device.
1.42	Sep 29, 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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