

RX Family

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USB Peripheral Communications Device Class Driver (PCDC) Firmware Integration Technology

Introduction

This application note describes USB Peripheral Communication Device Class Driver(PCDC), which utilizes Firmware Integration Technology (FIT). This module operates in combination with the USB Basic Host and Peripheral Driver (USB-BASIC-F/W FIT module). It is referred to below as the USB PCDC FIT module.

Target Device

RX63N/RX631 Group

RX65N/RX651 Group

RX64M Group

RX71M Group

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

Related Documents

1. Universal Serial Bus Revision 2.0 specification
2. USB Class Definitions for Communications Devices Revision 1.2
3. USB Communications Class Subclass Specification for PSTN Devices Revision 1.2
<http://www.usb.org/developers/docs/>
4. RX63N/RX631 Group User's Manual: Hardware (Document number. R01UH0041EJ)
5. RX64M Group User's Manual: Hardware (Document number. R01UH0377EJ)
6. RX71M Group User's Manual: Hardware (Document number. R01UH0493EJ)
7. RX65N/RX651 Group User's Manual: Hardware (Document number. R01UH0590EJ)
8. RX65N/RX651-2M Group User's Manual: Hardware (Document number. R01UH0659EJ)
9. USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note (Document number. R01AN2025EJ)

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1. Overview

The USB PCDC FIT module, when used in combination with the USB-BASIC-F/W FIT module, operates as a USB peripheral communications device class driver (PCDC). The PCDC conforms to the abstract control model of the USB communication device class specification (CDC) and enables communication with a USB host.

This module supports the following functions.

- Data transfer to and from a USB host
- Response to CDC class requests
- Provision of communication device class notification transmit service

1.1 Please be sure to read

Please refer to the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note* when creating an application program using this driver.

This document is located in the "**reference_documents**" folder within this package.

1.2 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.

1.3 Terms and Abbreviations

Terms and abbreviations used in this document are listed below.

ACM	: Abstract Control Model. This is the USB interface subclass used for virtual COM ports, based in the old V.250 (AT) command standard. See PSTN below.
APL	: Application program
CDC	: Communications Devices Class
CDCC	: Communications Devices Class Communications Interface Class
CDCD	: Communications Devices Class Data Class Interface
CPD	: Serial Communication Port Driver
H/W	: Renesas USB device
PCD	: Peripheral control driver of USB-BASIC-F/W
PCDC	: Communications Devices Class for peripheral
PCDCD	: Peripheral Communications Devices Class Driver
PSTN	: Public Switched Telephone Network, contains the ACM (above) standard.
SCI	: Serial Communication Interface
USB	: Universal Serial Bus
USB-BASIC-FW	: USB Basic Firmware for Renesas USB device

1.4 USB PCDC FIT Module

User needs to integrate this module to the project using `r_usb_basic`. User can control USB H/W by using this module API after integrating to the project.

2. Software Configuration

Figure 2-1 shows the configuration of the modules related to PCDC.

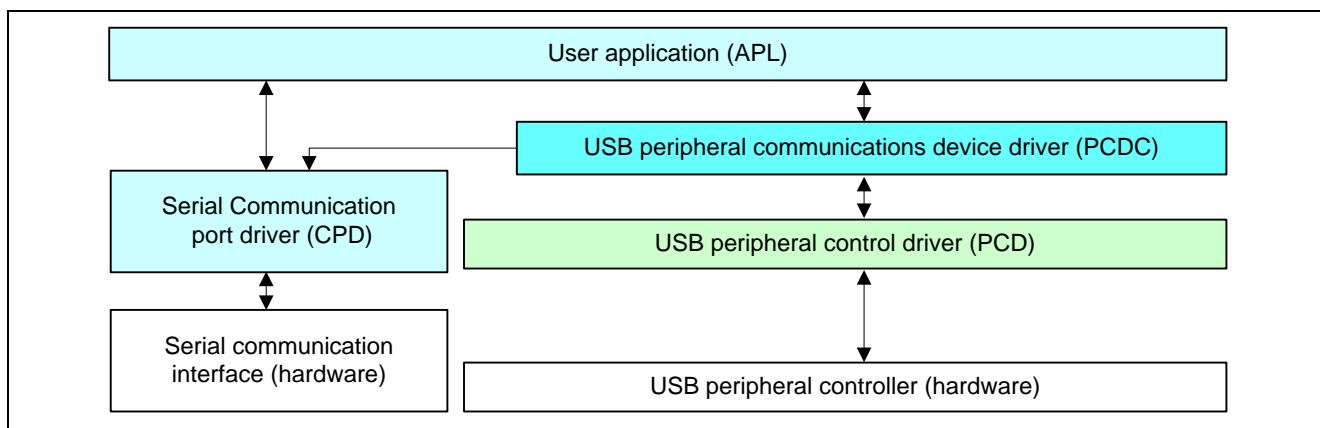


Figure 2-1 Source Code Block Diagram

Table 2-1 Modules

Module	Description
APL	User application program.
PCDC	Sends requests from the APL for requests and data communication involving the CDC to the PCD.
PCD	USB peripheral hardware control driver. (Basic USB FW.)
CPD	Serial port control driver

3. API Information

This Driver API follows the Renesas API naming standards.

3.1 Hardware Requirements

This driver requires your MCU support the following features:

- USB

3.2 Software Requirements

This driver is dependent upon the following packages:

- r_bsp
- r_usb_basic

3.3 Operating Confirmation Environment

Table 3-1 shows the operating confirmation environment of this driver.

Table 3-1 Operation Confirmation Environment

Item	Contents
Integrated Development Environment	Renesas Electronics e ² studio V.6.0.0
C compiler	Renesas Electronics C/C++ compiler for RX Family V.2.07.00 Compile Option : -lang = c99
Endian	Little Endian, Big Endian
USB Driver Revision Number	Rev.1.22
Using Board	Renesas Starter Kit for RX63N Renesas Starter Kit for RX64M Renesas Starter Kit for RX71M Renesas Starter Kit for RX65N, Renesas Starter Kit for RX65N-2MB
Host Environment	The operation of this USB Driver module connected to the following OSes has been confirmed. 1. Windows® 7 2. Windows® 8.1 3. Windows® 10

3.4 Usage of Interrupt Vector

Table 3-2 shows the interrupt vector which this driver uses.

Table 3-2 List of Usage Interrupt Vectors

Device	Contents
RX63N RX631	USBIO Interrupt (Vector number: 35) / USBR0 Interrupt (Vector number: 90)
	USB D0FIFO0 Interrupt (Vector number: 33) / USB D1FIFO0 Interrupt (Vector number: 34)
	USB11 Interrupt (Vector number: 38) / USBR1 Interrupt (Vector number: 91)
	USB D0FIFO1 Interrupt (Vector number: 36) / USB D1FIFO1 Interrupt (Vector number: 37)
RX64M RX71M	USBIO(GROUPB) Interrupt (Vector number: 189, Group interrupt source number : 62)
	USB D0FIFO0 Interrupt (Vector number: 34) / USB D1FIFO0 Interrupt (Vector number: 35)
	USBR0 Interrupt (Vector number: 90)
	USBAR Interrupt (Vector number: 94)
RX65N RX651	USB D0FIFO2 Interrupt (Vector number: 32) / USB D1FIFO2 Interrupt (Vector number: 33)
	USBIO(GROUPB) Interrupt (Vector number: 185, Group interrupt source number : 62)
	USB D0FIFO0 Interrupt (Vector number: 34) / USB D1FIFO0 Interrupt (Vector number: 35)
	USBR0 Interrupt (Vector number: 90)

3.5 Header Files

All API calls and their supporting interface definitions are located in `r_usb_basic_if.h` and `r_usb_pcdc_if.h`.

3.6 Integer Types

This project uses ANSI C99 "Exact width integer types" in order to make the code clearer and more portable. These types are defined in `stdint.h`.

3.7 Compile Setting

For compile settings, refer to chapter 6, **Configuration (r_usb_pcdc_config.h)** in this document and chapter "Configuration" in the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

3.8 ROM / RAM Size

The follows shows ROM/RAM size of this driver.

1. RX64M, RX71M, RX65N/RX651

	Checks arguments	Does not check arguments
ROM size	19.7K bytes (Note 3)	19.3K bytes (Note 4)
RAM size	9.4K bytes	9.4K bytes

2. RX63N/RX631

	Checks arguments	Does not check arguments
ROM size	16.1K bytes (Note 3)	15.6K bytes (Note 4)
RAM size	9K bytes	9K bytes

Note:

1. ROM/RAM size for BSP and USB Basic Driver is included in the above size.
2. The default option is specified in the compiler optimization option.

3. The ROM size of “Checks arguments” is the value when `USB_CFG_ENABLE` is specified to `USB_CFG_PARAM_CHECKING` definition in `r_usb_basic_config.h` file.
4. The ROM size of “Does not check arguments” is the value when `USB_CFG_DISABLE` is specified to `USB_CFG_PARAM_CHECKING` definition in `r_usb_basic_config.h` file.

3.9 Argument

For the structure used in the argument of API function, refer to chapter "**Structures**" in the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

3.10 Adding the FIT Module to Your Project

This module must be added to each project in which it is used. Renesas recommends using “Smart Configurator” described at (1) or (3). However, “Smart Configurator” supports some RX devices. Please use the methods of (2) or (4) for unsupported RX devices.

- (1) Adding the FIT module to your project using “Smart Configurator” on e² studio

By using the “Smart Configurator” in e² studio, FIT module is automatically added to your project. Refer to “Renesas e² studio Smart Configurator User Guide (R20AN0451)”.

- (2) Adding the FIT module to your project using “FIT Configurator” on e² studio

By using the “FIT Configurator” in e² studio, FIT module is automatically added to your project. Refer to “Adding Firmware Integration Technology Modules to Projects (R01AN1723)”.

- (3) Adding the FIT module to your project using “Smart Configurator” on CS+

By using the “Smart Configurator Standalone version” on CS+, FIT module is automatically added to your project. Refer to “Renesas e² studio Smart Configurator User Guide (R20AN0451)”.

- (4) Adding the FIT module to your project on CS+

In CS+, please manually add FIT module to your project. Refer to “Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)”

4. CDC, PSTN, and ACM (Abstract Control Model)

4.1 Basic Functions

This software conforms to the Abstract Control of the CDC PSTN Subclass. See 4.2 below.

4.2 Abstract Control Model Overview

The Abstract Control Model subclass of CDC is a technology that bridges the gap between USB devices and earlier modems (employing RS-232C connections), enabling use of application programs designed for older modems. The class requests and class notifications supported are listed below.

4.2.1 Class Requests (Host to Peripheral)

This driver notifies to the application program when receiving the following class request.

For the class request processing, refer to chapter "USB Class Requests" in the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

Table 4-1 CDC class requests

Request	Code	Description
SetLineCoding	0x20	Makes communication line settings (communication speed, data length, parity bit, and stop bit length).
GetLineCoding	0x21	Acquires the communication line setting state.
SetControlLineState	0x22	Makes communication line control signal (RTS, DTR) settings.
SendBreak	0x23	Transmits a break signal.

For details concerning the Abstract Control Model requests, refer to Table 11, "Requests - Abstract Control Model" in "USB Communications Class Subclass Specification for PSTN Devices", Revision 1.2.

4.2.2 Data Format of Class Requests

The data format of the class requests supported by the class driver software is described below.

1. SetLineCoding

This is the class request the host transmits to perform the UART line setting.

The SetLineCoding data format is shown below.

Table 4-2 SetLineCoding Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0x21	SET_LINE_CODING (0x20)	0x00	0x00	0x07	Line Coding Structure See Table 4-3, Line Coding Format

Table 4-3 Line Coding Format

Offset	Field	Size	Value	Description
0	DwDTERate	4	Number	Data terminal speed (bps)
4	BcharFormat	1	Number	Stop bits 0 - 1 stop bit 1 - 1.5 stop bits 2 - 2 stop bits
5	BparityType	1	Number	Parity 0 - None 1 - Odd 2 - Even
6	BdataBits	1	Number	Data bits (5, 6, 7, 8)

The following shows the setting that this S/W supports.

DwDTERate: 1200bps/2400bps/4800bps/9600bps/14400bps/19200bps/38400bps/57600bps/115200bps
 BcharFormat: 1 Stop bit/2 Stop bit
 BparityType: None/Odd/Even
 BdataBits: 7bit/8bit

2. GetLineCoding

This is the class request the host transmits to request the UART line state.

The GetLineCoding data format is shown below.

Table 4-4 SetLineCoding Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0xA1	GET_LINE_CODING (0x21)	0x00	0x00	0x07	Line Coding Structure See Table 4-2, SetLineCoding Format

Table 4-9 UART state bitmap format

Bits	Field	Description	Supported
D15~D7		Reserved	-
D6	b_over_run	Overrun error detected	Yes
D5	b_parity	Parity error detected	Yes
D4	b_framing	Framing error detected	Yes
D3	b_ring_signal	INCOMING signal (ring signal) detected	No
D2	b_break	Break signal detected	No
D1	btx_arrier	Data Set Ready: Line connected and ready for communication	No
D0	brx_carrier	Data Carrier Detect: Carrier detected on line	No

4.3 PC Virtual COM-port Usage

The CDC device can be used as a virtual COM port when operating in Windows OS.

Use a PC running Windows OS, and connect an RSK board. After USB enumeration, the CDC class requests *GetLineCoding* and *SetControlLineState* are executed by the target, and the CDC device is registered in Windows Device Manager as a virtual COM device.

Registering the CDC device as a virtual COM-port in Windows Device Manager enables data communication with the CDC device via a terminal app such as “HyperTerminal” which comes standard with Windows OS. When changing settings of the serial port in the Windows terminal application, the UART setting is propagated to the firmware via the class *request SetLineCoding*.

Data input (or file transmission) from the terminal app window is transmitted to the RSK board using endpoint 2 (EP2); data from the RSK board side is transmitted to the PC using EP1.

When the last packet of data received is the maximum packet size, and the terminal determines that there is continuous data, the received data may not be displayed in the terminal. If the received data is smaller than the maximum packet size, the data received up to that point is displayed in the terminal.

The received data is outputted on the terminal when the data less than Maximum packet size is received.

5. API Functions

For API used in the application program, refer to chapter "**API Functions**" in the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

6. Configuration (r_usb_pcdc_config.h)

Please set the following according to your system.

Note:

Be sure to set *r_usb_basic_config.h* file as well. For *r_usb_basic_config.h* file, refer to chapter "**Configuration**" in the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

1. Setting pipe to be used

Set the pipe number to use for data transfer.

(1). Bulk IN/OUT transfer

Set the pipe number (PIPE1 to PIPE5) to use for Bulk IN/OUT transfer. Do not set the same pipe number for the definitions of *USB_CFG_PCDC_BULK_IN* and *USB_CFG_PCDC_BULK_OUT*.

#define	USB_CFG_PCDC_BULK_IN	Pipe number (USB_PIPE1 to USB_PIPE5)
#define	USB_CFG_PCDC_BULK_OUT	Pipe number (USB_PIPE1 to USB_PIPE5)

(2). Interrupt IN transfer

Set the pipe number (PIPE6 to PIPE9) to use for Interrupt IN transfer.

#define	USB_CFG_PCDC_INT_IN	Pipe number (USB_PIPE6 to USB_PIPE9)
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7. Creating an Application

Refer to the chapter “**Creating an Application Program**” in the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Aug 1, 2014	—	First edition issued
1.10	Dec 26, 2014	—	RX71M is supported newly.
1.11	Sep 30, 2015	—	RX63N and RX631 are added in Target Device.
1.20	Sep 30, 2016	—	<ol style="list-style-type: none"> 1. RX65N and RX651 are added in Target Device. 2. Supporting DMA transfer. 3. Supporting USB Host and Peripheral Interface Driver application note(Document No.R01AN3293EJ)
1.21	Mar 31, 2017	—	<ol style="list-style-type: none"> 1. Supported Technical Update (Document number. TN-RX*-A172A/E) 2. The chapter <i>API Functions</i> is moved to the document (Document number: R01AN2025) of <i>USB Basic Host and Peripheral Driver Firmware Integration Technology</i>.
1.22	Sep 30, 2017	—	Supporting RX65N/RX651-2M

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1. 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 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. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

The state of the product is undefined at the moment 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 moment 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 moment 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 moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has 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. Moreover, 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.

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