RX Family

R01AN2171EJ0131
Rev.1.31
Mar 01, 2025

USB Peripheral Human Interface Devices Class Driver for USB Mini Firmware Using Firmware Integration Technology

Introduction

This application note describes USB Peripheral Human Interface Devices Class Driver (PHID), which utilizes Firmware Integration Technology (FIT). This module operates in combination with the USB Basic Mini Host and Peripheral Driver. It is referred to below as the USB PHID FIT module.

Target Device

RX111 Group
RX113 Group
RX231 Group
RX23W Group
RX261 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. RX111 Group User's Manual: Hardware (Document number .R01UH0365)
3. RX113 Group User's Manual: Hardware (Document number.R01UH0448)
4. RX231 Group User's Manual: Hardware (Document number .R01UH0496)
5. RX23W Group User's Manual: Hardware (Document number .R01UH0823)
6. RX261 Group User's Manual: Hardware (Document number .R01UH1045)
7. USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note (Document number.R01AN2166)

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USB Devices Page
http://www.renesas.com/prod/usb/

Contents

1. Overview

The USB PHID FIT module, when used in combination with the USB-BASIC-F/W FIT module, operates as a USB peripheral human interface device class driver (PHID). The PHID conforms to the USB Human Interface Device class specifications (referred to here as HID) and implements communication with a HID host.

This module supports the following functions.

- Data transfer to and from a USB host
- Response to HID class requests
- Response to function references from the HID host
- Interrupt OUT transfer

1.1 Please be sure to read

Please refer to the document (Document number: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) 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.

API	:	Application Program Interface
APL	:	Application program
HID	:	Human Interface Device class
IDE	:	Integrated Development Environment
PCD	:	Peripheral control driver of USB-BASIC-F/W
PDCD	:	Peripheral device class driver (device driver and USB class driver)
PHID	:	Peripheral Human Interface Devices
RTOS	:	USB Driver for the real-time OS
USB	:	Universal Serial Bus
USB-BASIC-FW	:	USB Basic Mini Host and Peripheral Driver

1.4 USB PHID FIT Module

User needs to integrate this module to the project using r_usb_basic_mini. 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 PHID

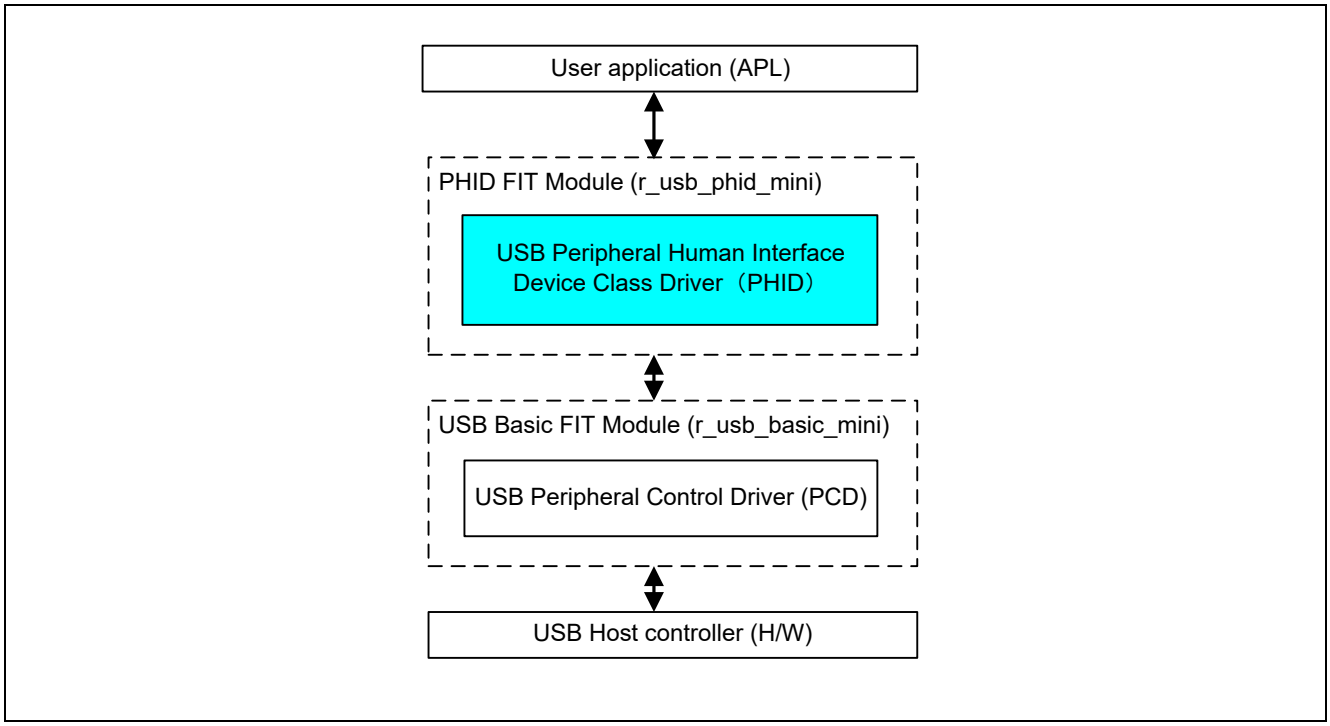

Figure 2-1 Software Module Structure

Table 2.1 Modules

Module	Description
PHID	User switch operation on the RSK board is converted into HID reports. The transfer result is notified to APL by the callback function. In addition, communicate the output report of HID host to APL.
USB-BASIC-FW	USB Basic Mini Host and Peripheral 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_mini

3.3 Operating Confirmation Environment

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

Table 3-1 Operation Confirmation Environment

Item	Contents
C compiler	Renesas Electronics C/C++ compiler for RX Family V.3.07.00 (The option "-lang=C99" is added to the default setting of IDE)
	GCC for Renesas RX 8.3.0.202411 (The option "-std=gnu99" is added to the default setting of IDE)
	IAR C/C++ Compiler for Renesas RX version 5.10.1
Real-Time OS	FreeRTOS V.10.4.3 RI600V4 V.1.06
Endian	Little Endian, Big Endian
USB Driver Revision Number	Rev.1.31
Using Board	Renesas Starter Kit for RX111 Renesas Starter Kit for RX113 Renesas Starter Kit for RX231 Renesas Solution Starter Kit for RX231, Evaluation Kit for RX261
Host Environment	The operation of this USB Driver module connected to the following OSes has been confirmed. 1. 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
RX111 RX113 RX231 RX23W RX261	USBI0 Interrupt (Vector number: 36) / USBR0 Interrupt (Vector number: 90) USB D0FIFO0 Interrupt (Vector number: 36) / USB D1FIFO0 Interrupt (Vector number: 37)

3.5 Header Files

All API calls and their supporting interface definitions are located in *r_usb_basic_mini_if.h* and *r_usb_phid_mini_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_phid_mini_config.h)** in this document and chapter "Configuration" in the document (Document number: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note.*

3.8 ROM / RAM Size

The follows show ROM/RAM size of this driver.

1. CC-RX (Optimization Level: Default)

(1). Non-OS

	Checks arguments	Does not check arguments
ROM size	17.5K bytes (Note 3)	17.2K bytes (Note 4)
RAM size	3.3K bytes	3.3K bytes

(2). RI600V4

	Checks arguments	Does not check arguments
ROM size	34.1K bytes (Note 3)	33.8K bytes (Note 4)
RAM size	4.4K bytes	4.4K bytes

(3). FreeRTOS

	Checks arguments	Does not check arguments
ROM size	30.0K bytes (Note 3)	29.7K bytes (Note 4)
RAM size	14.7K bytes	14.7K bytes

2. GCC (Optimization Level: -O2)

	Checks arguments	Does not check arguments
ROM size	19.0K bytes (Note 3)	18.7K bytes (Note 4)
RAM size	3.2K bytes	3.2K bytes

3. IAR (Optimization Level: Medium)

	Checks arguments	Does not check arguments
ROM size	11.6K bytes (Note 3)	11.4K bytes (Note 4)
RAM size	2.6K bytes	2.6K bytes

[Note]

1. ROM/RAM size for BSP and USB Basic Driver is included in the above size.
2. The above is the size when specifying RX V2 core 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_mini_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_mini_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: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note*.

3.10 "for", "while" and "do while" statements

In FIT module, when using "for", "while" and "do while" statements (loop processing) in register reflection waiting processing, etc., write comments with "WAIT_LOOP" as a keyword for these loop processing. Also, write in the FIT documentation that "WAIT_LOOP" is written as a comment in these loop processes.

3.11 Adding the FIT Module to Your Project

This module must be added to each project in which it is used. Renesas recommends the method using the Smart Configurator described in (1) or (3) below. However, the Smart Configurator only supports some RX devices. Please use the methods of (2) or (4) for RX devices that are not supported by the Smart Configurator.

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

By using the Smart Configurator in e^2 studio, the FIT module is automatically added to your project. Refer to "Renesas e^2 studio Smart Configurator User Guide (R20AN0451)" for details.

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

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

(3) Adding the FIT module to your project using the Smart Configurator in CS+

By using the Smart Configurator Standalone version in CS+, the FIT module is automatically added to your project. Refer to "Renesas e^2 studio Smart Configurator User Guide (R20AN0451)" for details.

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

In CS+, please manually add the FIT module to your project. Refer to "Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)" for details.

4. USB Peripheral Human Interface Devices Class Driver (PHID)

4.1 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: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note*.

Table 4.1 HID class requests

Request	Code	Description
Get_Report	0x01	Receives a report from the HID host
Set_Report	0x09	Sends a report to the HID host
Get_Idle	0x02	Receives a duration (time) from the HID host
Set_Idle	0x0A	Sends a duration (time) to the HID host
Get_Protocol	0x03	Reads a protocol from the HID host
Set_Protocol	0x0B	Sends a protocol to the HID host
Get_Descriptor Descriptor Type : Class Class Descriptor Type : Report	0x06 (Standard)	Transmits a report descriptor
Get_Descriptor Descriptor Type : Class Class Descriptor Type : HID	0x06 (Standard)	Transmits an HID descriptor

4.2 Class Request Data Format

1. GetReport

Table 4-1 GetReport Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0xA1	GET_REPORT (0x01)	ReportType & ReportID	Interface	ReportLength	Report

2. SetReport

Table 4-2 SetReport Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0x21	SET_REPORT (0x09)	ReportType & ReportID	Interface	ReportLength	Report

3. GetIdle

Table 4-3 GetIdle Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0xA1	GET_IDLE (0x02)	0(Zero) & ReportID	Interface	1(one)	Idle rate

4. SetIdle

Table 4-4 SetIdle Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0x21	SET_IDLE (0x0A)	Duration & ReportID	Interface	0(zero)	Not applicable

5. GetProtocol

Table 4-5 GetProtocol Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0xA1	GET_PROTOCOL (0x03)	0(zero)	Interface	0(zero)	0 (Boot Protocol) / 1 (Report Protocol)

6. SetProtocol

Table 4-6 SetProtocol Format

bmRequestType	bRequest	wValue	wIndex	wLength	Data
0x21	SET_PROTOCOL (0x0B)	0 (Boot Protocol) / 1 (Report Protocol)	Interface	0(zero)	Not applicable

5. API Functions

For API used in the application program, refer to chapter "**API Functions**" in the document (Document number: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note*.

6. Configuration (r_usb_phid_mini_config.h)

Please set the following according to your system.

Note:

Be sure to set *r_usb_basic_mini_config.h* file as well. For *r_usb_basic_mini_config.h* file, refer to chapter "**Configuration**" in the document (Document number: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note*.

1. Setting pipe to be used

Set the pipe number (PIPE6 to PIPE9) to use for Interrupt IN/OUT transfer. Do not set the same pipe number for the definitions of USB_CFG_PHID_INT_IN and USB_CFG_PHID_INT_OUT.

#define	USB_CFG_PHID_INT_IN	Pipe number (USB_PIPE6 to USB_PIPE9)
#define	USB_CFG_PHID_INT_OUT	Pipe number (USB_PIPE6 to USB_PIPE9)

Note:

For a system that does not support the OUT transfer, set *USB_NULL* as the definition of *USB_CFG_PHID_INT_OUT*.

7. Creating an Application

Refer to the chapter "**Creating an Application Program**" in the document (Document number: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note*.

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Dec 1, 2014	—	First edition issued
1.01	Jun 1, 2015	—	RX231 is added in the target device.
1.02	Dec 28, 2015	—	1. API (R_usb_phid_receive_data) for OUT transfer is added. 2. Checked the operation with Windows® 10.
1.10	Nov 30, 2018	—	1. Supporting Smart Configurator. 2. The following chapter is added. (1). 5. API Functions 3. The following chapters are changed. (1). 3. API Information (2). 6. Configuration (r_usb_phid_mini_config.h) (3). 7. Creating an Application 4. The following chapters are deleted. "How to Register Class Driver", "System Resources", "Task ID and Priority Setting", "USB Peripheral Communication Device Class Driver".
1.11	May 31, 2019	—	Support GCC compiler and IAR compiler.
1.12	Jun 30, 2019	—	RX23W is added in the target device.
1.20	Jun 1, 2020	—	Support the real time OS.
1.30	Jul 31, 2024	—	RX261 is added in the target device.
1.31	Mar 01, 2025	—	Change Disclaimer.

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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.
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   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.).
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(Rev.5.0-1 October 2020)

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