

## RX Family

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### USB Host Human Interface Device Class Driver for USB Mini Firmware Using Firmware Integration Technology

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#### Introduction

This application note describes USB Host Human Interface Device Class Driver (HHID), 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 HHID 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  
<http://www.usb.org/developers/docs/>
  2. USB Class Definitions for Human Interface Devices Version 1.1
  3. HID Usage Tables Version 1.1  
<http://www.usb.org/developers/docs/>
  4. RX111 Group User's Manual: Hardware (Document number .R01UH0365)
  5. RX113 Group User's Manual: Hardware (Document number.R01UH0448)
  6. RX231 Group User's Manual: Hardware (Document number .R01UH0496)
  7. RX23W Group User's Manual: Hardware (Document number .R01UH0823)
  8. RX261 Group User's Manual: Hardware (Document number .R01UH1045)
  9. USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note (Document number.R01AN2166)
- Renesas Electronics Website  
<http://www.renesas.com/>
  - USB Devices Page  
<http://www.renesas.com/prod/usb/>

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## 1. Overview

The USB HHID FIT module, when used in combination with the USB-BASIC-F/W FIT module, operates as a USB host human interface device class driver (HHID).

This module supports the following functions.

- Data communication with a connected HID device (USB mouse, USB keyboard)
- Issuing of HID class requests to a connected HID device
- Supporting 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 Limitations

The following limitations apply to the HHID.

1. The HID driver must analyze the report descriptor to determine the report format (This HID driver determines the report format from the interface protocol alone.)
2. This driver does not support DMA/DTC transfer.

### 1.4 Terms and Abbreviations

Terms and abbreviations used in this document are listed below.

|              |   |   |
|--------------|---|---|
| APL          | : | Application program   |
| HCD          | : | Host control driver of  |
| HDCD         | : | Host device class driver (device driver and USB class driver) |
| HHID         | : | Host human interface device                                   |
| HID          | : | Human interface device class                                  |
| IDE          | : | Integrated Development Environment                            |
| MGR          | : | Peripheral device state manager of HCD                        |
| RSK          | : | Renesas Starter Kits  |
| RTOS         | : | USB driver for the real-time OS                               |
| USB          | : | Universal Serial Bus  |
| USB-BASIC-FW | : | USB Basic Mini Host and Peripheral Driver                     |

### 1.5 USB HHID FIT

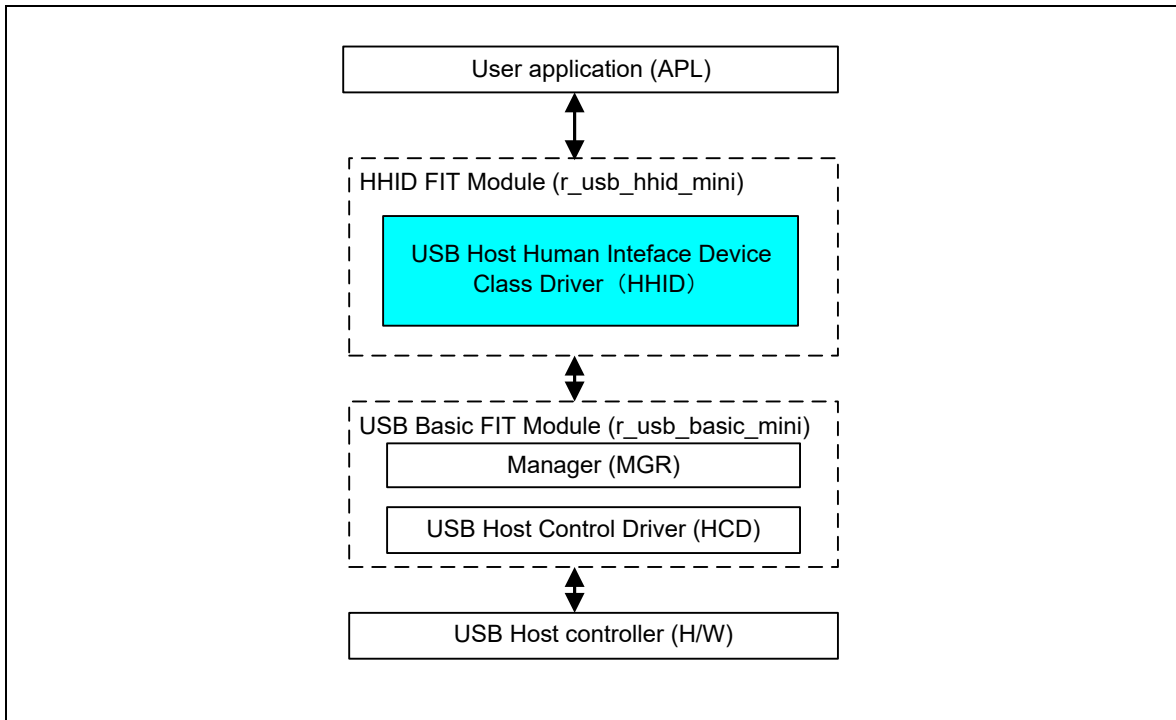
User needs to integrate this module to the project using `r_usb_basic_mini`. User can control USB H/W by using this module API after integrating to the project.

## 2. Module Configuration

The HHID comprises the HID class driver and device drivers for mouse and keyboard.

When data is received from the connected USB device, HCD notifies the application. Conversely, when the application issues a request, HCD notifies the USB device.

Figure 2.1 shows the structure of the HHID-related modules. Table 2-1 lists the modules and an overview of each.



**Figure 2.1 Software Module Structure**

**Table 2-1 Module Function Descriptions**

| Module Name | Description   |
|-------------|---|
| APL         | User application program.<br>Switches initiate communication with HID devices and control suspend/resume.<br>The LCD displays the information received from the HID device. |
| HHID        | The HHID analyzes requests from HID devices.<br>Notifies APL key operation information to the HID host via the HCD.   |
| HCD/MGR     | USB host Hardware 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\_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<br>(The option "-lang=C99" is added to the default setting of IDE)   |
|                            | GCC for Renesas RX 8.3.0.202411<br>(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<br>RI600V4 V.1.06   |
| Endian                     | Little Endian, Big Endian   |
| USB Driver Revision Number | Rev.1.32  |
| Using Board                | Renesas Starter Kit for RX111<br>Renesas Starter Kit for RX113<br>Renesas Starter Kit for RX231<br>Renesas Solution Starter Kit for RX23W<br>Evaluation Kit for RX261 |

#### 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  | USBIO Interrupt (Vector number: 36) / USBR0 Interrupt (Vector number: 90)<br>USB D0FIFO0 Interrupt (Vector number: 36) / USB D1FIFO0 Interrupt (Vector number: 37) |
| RX113  |  |
| RX231  |  |
| RX23W  |  |
| RX261  |  |

#### 3.5 Header Files

All API calls and their supporting interface definitions are located in *r\_usb\_basic\_mini\_if.h* and *r\_usb\_hhid\_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 7, **Configuration (r\_usb\_hhid\_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 | 19.1K bytes (Note 3) | 18.8K bytes (Note 4)     |
| RAM size | 3.7K bytes           | 3.7K bytes               |

##### (2). RI600V4

|          | Checks arguments     | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 36.1K bytes (Note 3) | 35.8K bytes (Note 4)     |
| RAM size | 4.4K bytes           | 4.4K bytes               |

##### (3). FreeRTOS

|          | Checks arguments     | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 32.2K bytes (Note 3) | 31.9K bytes (Note 4)     |
| RAM size | 4.4K bytes           | 4.4K bytes               |

#### 2. GCC (Optimization Level: -O2)

|          | Checks arguments     | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 22.7K bytes (Note 3) | 22.4K bytes (Note 4)     |
| RAM size | 3.3K bytes           | 3.3K bytes               |

#### 3. IAR (Optimization Level: Medium)

|          | Checks arguments     | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 16.1K bytes (Note 3) | 15.9K bytes (Note 4)     |
| RAM size | 2.5K bytes           | 2.5K 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.

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## 3.9 Argument

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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*.

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## 3.10 “for”, “while” and “do while” statements

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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.

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## 3.11 Adding the FIT Module to Your Project

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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<sup>2</sup> studio

By using the Smart Configurator in e<sup>2</sup> studio, the FIT module is automatically added to your project. Refer to “Renesas e<sup>2</sup> studio Smart Configurator User Guide (R20AN0451)” for details.

- (2) Adding the FIT module to your project using the FIT Configurator in e<sup>2</sup> studio

By using the FIT Configurator in e<sup>2</sup> 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<sup>2</sup> 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. Target Peripheral List (TPL)

For the structure used in the argument of API function, refer to chapter "**How to Set the Target Peripheral List (TPL)**" in the document (Document number: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note*.

## 5. Human Interface Device Class (HID)

### 5.1 Basic Functions

This driver complies with the HID class specification. The main functions of this driver are as follows.

- (1) HID device access
- (2) Class request notifications to the HID device
- (3) Data communication with the HID device

### 5.2 Class Requests (Host to Device Requests)

This driver supports the following class requests.

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 5-1 HID Class Requests**

| Symbol | Request                         | Code     | Description                                    |
|--------|---------------------------------|----------|--|
| a      | USB_GET_REPORT                  | 0x01     | Receives a report from the HID device          |
| b      | USB_SET_REPORT                  | 0x09     | Sends a report to the HID device               |
| c      | USB_GET_IDLE                    | 0x02     | Receives a duration (time) from the HID device |
| d      | USB_SET_IDLE                    | 0x0A     | Sends a duration (time) to the HID device      |
| e      | USB_GET_PROTOCOL                | 0x03     | Reads a protocol from the HID device           |
| f      | USB_SET_PROTOCOL                | 0x0B     | Sends a protocol to the HID device             |
|        | USB_GET_REPORT_DESCRIPTOR<br>OR | Standard | Transmits report descriptor                    |
|        | USB_GET_HID_DESCRIPTOR          | Standard | Transmits an HID descriptor                    |

The class request data formats supported in this driver are described below.

#### a). GetReport Request Format

Table 5-2 shows the GetReport request format.  
Receives a report from the device in a control transfer.

**Table 5-2 GetReport Format**

| bmRequestType | bRequest             | wValue                   | wIndex    | wLength      | Data   |
|---------------|----------------------|--------------------------|-----------|--------------|--------|
| 0xA1          | GET_REPORT<br>(0x01) | ReportType &<br>ReportID | Interface | ReportLength | Report |

#### b). SetReport Request Format

Table 5-3 shows the SetReport request format.  
Sends report data to the device in a control transfer.

**Table 5-3 SetReport Format**

| bmRequestType | bRequest             | wValue                   | wIndex    | wLength      | Data   |
|---------------|----------------------|--------------------------|-----------|--------------|--------|
| 0x21          | SET_REPORT<br>(0x09) | ReportType &<br>ReportID | Interface | ReportLength | Report |

**c). GetIdle Request Format**

Table 5-4 shows the GetIdle request format.

Acquires the interval time of the report notification (interrupt transfer). Idle rate is indicated in 4 ms units.

**Table 5-4 GetIdle Format**

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

**d). SetIdle Request Format**

Table 5-5 shows the SetIdle request format.

Sets the interval time of the report notification (interrupt transfer). Duration time is indicated in 4 ms units.

**Table 5-5 SetIdle Format**

| bmRequestType | bRequest           | wValue              | wIndex    | wLength | Data           |
|---------------|--------------------|---------------------|-----------|---------|----------------|
| 0x21          | SET_IDLE<br>(0x0A) | Duration & ReportID | Interface | 0(zero) | Not applicable |

**e). GetProtocol Request Format**

Table 5-6 shows the GetProtocol request format.

Acquires current protocol (boot protocol or report protocol) settings.

**Table 5-6 GetProtocol Format**

| bmRequestType | bRequest               | wValue  | wIndex    | wLength | Data                                   |
|---------------|------------------------|---------|-----------|---------|--|
| 0xA1          | GET_PROTOCOL<br>(0x03) | 0(Zero) | Interface | 1(one)  | 0(BootProtocol) /<br>1(ReportProtocol) |

**f). SetProtocol Request Format**

Table 5-7 shows the SetProtocol request format.

Sets protocol (boot protocol or report protocol).

**Table 5-7 SetProtocol Format**

| bmRequestType | bRequest               | wValue                                 | wIndex    | wLength | Data           |
|---------------|------------------------|--|-----------|---------|----------------|
| 0x21          | SET_PROTOCOL<br>(0x03) | 0(BootProtocol) /<br>1(ReportProtocol) | Interface | 0(zero) | Not applicable |

## 5.3 HID-Report Format

### 5.3.1 Receive Report Format

Table 5-8 shows the receive report format used for notifications from the HID device. Reports are received in interrupt IN transfers or class request GetReport.

**Table 5-8 Receive Report Format**

| Offset       | Keyboard Mode | Mouse Mode                                     |
|--------------|---------------|--|
| Data length  | 8 Bytes       | 3 Bytes  |
| 0 (Top Byte) | Modifier keys | b0: Button 1<br>b1: Button 2<br>b2-7: Reserved |
| +1           | Reserved      | X displacement                                 |
| +2           | Keycode 1     | Y displacement                                 |
| +3           | Keycode 2     | -  |
| +4           | Keycode 3     | -  |
| +5           | Keycode 4     | -  |
| +6           | Keycode 5     | -  |
| +7           | Keycode 6     | -  |

### 5.3.2 Transmit Report Format

Table 5-9 shows the format of the transmit report sent to the HID device. Reports are sent in the class request SetReport.

**Table 5-9 Transmit Report Format**

| Offset       | Keyboard   | Mouse         |
|--------------|--|---------------|
| Data length  | 1 Byte   | Not supported |
| 0 (Top Byte) | b0: LED 0 (NumLock)<br>b1: LED 1(CapsLock)<br>b2: LED 2(ScrollLock)<br>b3: LED 3(Compose)<br>b4: LED 4(Kana) | -             |
| +1 ~ +16     | -  | -             |

### 5.3.3 Note

The report format used by HID devices for data communication is based on the report descriptor. This HID driver does not acquire or analyze the report descriptor; rather, the report format is determined by the interface protocol code.

## 6. API Functions

The following is Host Human Interface Device Class specific API function.

| API                 | Description                                     |
|---------------------|---|
| R_USB_HhidGetType() | Obtains type information for the HID device.    |
| R_USB_HhidGetMxps() | Obtains the max packet size for the HID device. |

**Note:**

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

## 6.1 R\_USB\_HhidGetType

Obtains type information for the HID device.

### Format

```
usb_err_t      R_USB_HhidGetType(uint8_t *p_type)
```

### Arguments

p\_drive            Pointer to the area to store the type information

### Return Value

USB\_SUCCESS    Successfully completed  
 USB\_ERR\_PARA   Parameter error  
 USB\_ERR\_NG     Other error

### Description

This API obtains type information (mouse, keyboard, etc.) for the connected HID device. The type information is set to the area indicated by the argument (*p\_type*). For the type information to be set, see Table 6-1.

**Table 6-1 Type Information**

| Type Information | Description                              |
|------------------|--|
| USB_HID_KEYBOARD | Keyboard                                 |
| USB_HID_MOUSE    | Mouse                                    |
| USB_HID_OTHER    | HID device other than keyboard and mouse |

### Note

1. If *USB\_NULL* is assigned to the argument (*p\_type*), then *USB\_ERR\_PARA* will be the return value.
2. This function can be called when the USB device is in the configured state. When the API is called in any other state, *USB\_ERR\_NG* is returned.

**Example**

```
void usb_application( void )
{
    uint8_t type;
    :
    while (1)
    {
        switch (R_USB_GetEvent(&ctrl))
        {
            :
            case USB_STS_CONFIGURED:
                :
                R_USB_HhidGetType( &type );
                if( USB_HID_KEYBOARD == type )
                {
                    :
                }
                :
                break;
                :
            }
        }
    }
}
```

## 6.2 R\_USB\_HhidGetMxps

Obtains the max packet size of the HID device.

### Format

```
usb_err_t      R_USB_HhidGetMxps(uint16_t *p_mxps, uint8_t dir)
```

### Arguments

|        |   |
|--------|---|
| p_mxps | Pointer to the area to store the max packe size |
| dir    | Transfer direction                              |

### Return Value

|              |                        |
|--------------|------------------------|
| USB_SUCCESS  | Successfully completed |
| USB_ERR_PARA | Parameter error        |
| USB_ERR_NG   | Other error            |

### Description

This API obtains max packet size for the connected HID device. The max packet size is set to the area indicated by the 1st argument (*p\_mxps*).

Set the direction (USB\_IN / USB\_OUT) of the max packet size which the user want to obtain to the 2nd argument.

### Note

1. If *USB\_NULL* is assigned to the argument (*p\_mxps*), then *USB\_ERR\_PARA* will be the return value.
2. This function returns *USB\_ERR\_PARA* when the connected HID device does not support the transfer direction set the 2nd argument (*dir*).
3. This function can be called when the USB device is in the configured state. When the API is called in any other state, *USB\_ERR\_NG* is returned.

### Example

```
void usb_application( void )
{
    uint16_t mxps;
    usb_ctrl_t ctrl;
    :
    while (1)
    {
        switch (R_USB_GetEvent(&ctrl))
        {
            :
            case USB_STS_CONFIGURED:
                :
                R_USB_HhidGetMxps(&mxps, USB_IN);
                :
                break;
            :
        }
    }
}
```

## 7. Configuration (r\_usb\_hhid\_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 transfer and Interrupt OUT. Do not set the same pipe number.

|         |                      |                                      |
|---------|----------------------|--------------------------------------|
| #define | USB_CFG_HHID_INT_IN  | Pipe number (USB_PIPE6 to USB_PIPE9) |
| #define | USB_CFG_HHID_INT_OUT | Pipe number (USB_PIPE6 to USB_PIPE9) |

## 8. Configuration File (When using RI600V4)

It is necessary to register the OS resource used by HHID USB driver to RI600V4 when using RI600V4. Please add the following definition in the configuration file. For how to create the configuration file, refer to the chapter, "**RI600V4(Configuration File Creation)**" in the document (Document number: R01AN2166) for *USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note*.

### 5.4 Mailbox Definition

|               |   |                      |
|---------------|---|----------------------|
| name          | : | ID_USB_RTOS_HHID_MBX |
| wait_queue    | : | TA_FIFO              |
| message_queue | : | TA_MFIFO             |

## 9. 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*.

## Website and Support

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## 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.

## Notice

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## Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan  
[www.renesas.com](http://www.renesas.com)

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