

RX Family

R01AN2167EJ0130

Rev.1.30

Jul 31, 2024

USB Host Communications Device Class Driver for USB Mini Firmware Using Firmware Integration Technology

Introduction

This application note describes USB Host Communication Device Class Driver (HCDC), 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 HCDC 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. USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) using Firmware Integration Technology Application Note (Document number.R01AN2166)
 2. Universal Serial Bus Revision 2.0 specification
<http://www.usb.org/developers/docs/>
 3. USB Class Definitions for Communications Devices Revision 1.2
 4. USB Communications Class Subclass Specification for PSTN Devices Revision 1.2
<http://www.usb.org/developers/docs/>
 5. RX111 Group User's Manual: Hardware (Document number .R01UH0365)
 6. RX113 Group User's Manual: Hardware (Document number.R01UH0448)
 7. RX231 Group User's Manual: Hardware (Document number .R01UH0496)
 8. RX23W Group User's Manual: Hardware (Document number .R01UH0823)
 9. RX261 Group User's Manual: Hardware (Document number .R01UH1045)
- Renesas Electronics Website
<http://www.renesas.com/>
 - USB Devices Page
<http://www.renesas.com/prod/usb/>

Contents

| | | |
|----|---|----|
| 1. | Overview | 3 |
| 2. | Software Configuration | 4 |
| 3. | API Information | 5 |
| 4. | Target Peripheral List (TPL) | 8 |
| 5. | Communication Device Class (CDC), PSTN and ACM | 9 |
| 6. | USB Host Communication Device Class Driver (HCDC) | 14 |
| 7. | API Functions | 17 |
| 8. | Configuration (r_usb_hcdc_mini_config.h)..... | 18 |
| 9. | Creating an Application | 19 |

1. Overview

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

This module supports the following functions.

1. Checking of connected devices
2. Implementation of communication line settings
3. Acquisition of the communication line state
4. Data transfer to and from a CDC peripheral device

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

This driver is subject to the following limitations.

1. Suspend is not supported when data transfer is in progress. Confirm that data transfer has completed before executing suspend.
2. Use of compound USB devices with CDC class support is not supported.

1.4 Terms and Abbreviations

| | |
|--------------|---|
| APL | : Application program |
| CDC | : Communications devices class |
| HCD | : Host control driver of USB-BASIC-FW |
| HCDT | : Host communication devices class |
| HCDT | : Host device class driver (device driver and USB class driver) |
| 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 HCDT 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

Table 2-1 lists the modules, and Figure 2-1 shows a block diagram of HCDC.

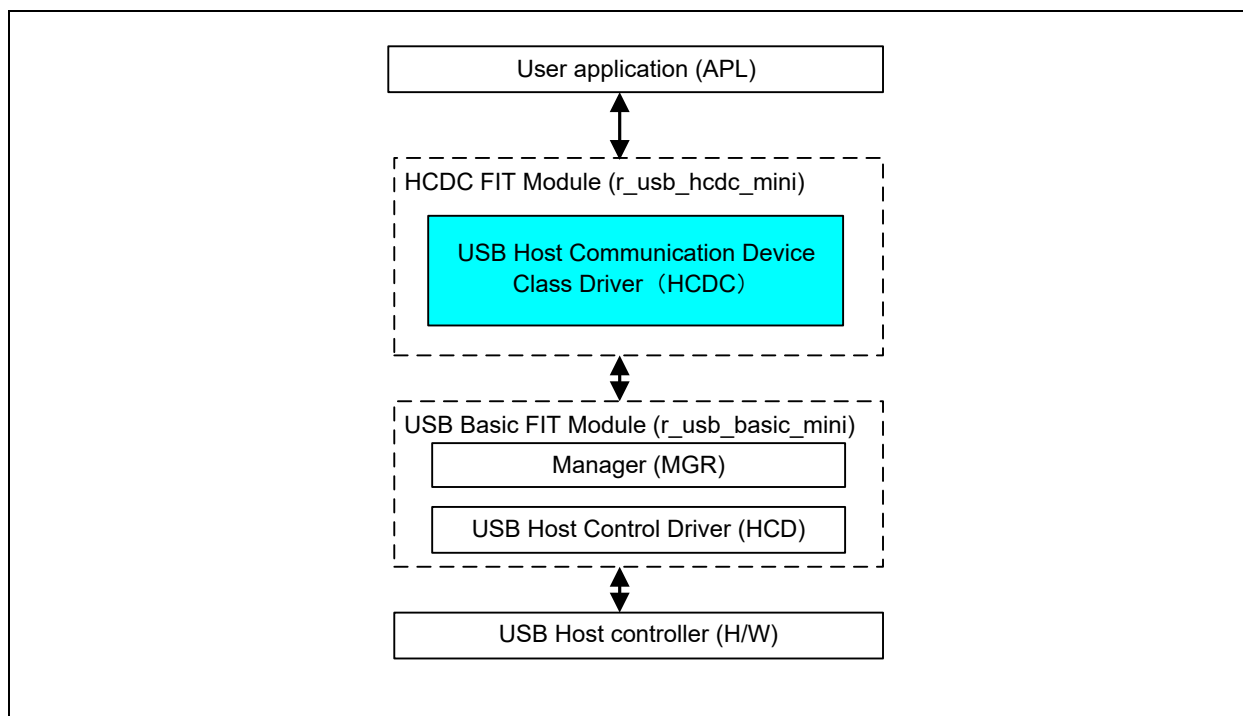


Figure 2-1 Software Module Structure

Table 2-1 Modules

| Module | Description |
|--------|--|
| APL | User application program. Created by customer. |
| HCDC | Requests CDC requests command and the data transfer from APL to HCD . |
| MGR | Enumerates the connected devices and starts HCDC. Also performs device state management. |
| HCD | USB host H/W 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.3.06.00 (The option "-lang=C99" is added to the default setting of IDE) |
| | GCC for Renesas RX 8.3.0.202311 (The option "-std=gnu99" is added to the default setting of IDE) |
| | IAR C/C++ Compiler for Renesas RX version 4.20.3 |
| Real-Time OS | FreeRTOS V.10.4.3 RI600V4 V.1.06 |
| Endian | Little Endian, Big Endian |
| USB Driver Revision Number | Rev.1.30 |
| Using Board | Renesas Starter Kit for RX111 Renesas Starter Kit for RX113 Renesas Starter Kit for RX231 Renesas Solution Starter Kit for RX23W 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) 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_hcdc_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 8, **Configuration** 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 | 19.0K bytes (Note 3) | 18.7K bytes (Note 4) |
| RAM size | 3.7K bytes | 3.7K bytes |

(2). RI600V4

| | Checks arguments | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 36.4K bytes (Note 3) | 36.1K bytes (Note 4) |
| RAM size | 4.4K bytes | 4.4K bytes |

(3). FreeRTOS

| | Checks arguments | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 32.4K bytes (Note 3) | 32.1K bytes (Note 4) |
| RAM size | 14.2K bytes | 4.4K bytes |

2. GCC (Optimization Level: -O2)

| | Checks arguments | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 22.9K bytes (Note 3) | 22.7K bytes (Note 4) |
| RAM size | 3.4K bytes | 3.4K bytes |

3. IAR (Optimization Level: Medium)

| | Checks arguments | Does not check arguments |
|----------|----------------------|--------------------------|
| ROM size | 16.0K bytes (Note 3) | 15.8K 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.

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) or 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 the Smart Configurator in e² studio
By using the Smart Configurator in e² studio, the FIT module is automatically added to your project. Refer to “Renesas e² studio Smart Configurator User Guide (R20AN0451)” for details.
- (2) Adding the FIT module to your project using the FIT Configurator in e² studio
By using the FIT Configurator in e² 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 e² 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. Communication Device Class (CDC), PSTN and ACM

This software conforms to the Abstract Control Model (ACM) subclass of the Communication Device Class specification, as specified in detail in the PSTN Subclass document listed in “Related Documents”.

The Abstract Control Model subclass 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.

5.1 Basic Functions

The main functions of HCDC are as follows.

1. Verify connected devices
2. Make communication line settings
3. Acquire the communication line state
4. Transfer data to and from the CDC peripheral device

5.2 Abstract Control Model Class Requests - Host to Device

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 CDC Class Requests

| Request | Code | Description |
|-------------------------|------|---|
| SendEncapsulatedCommand | 0x00 | Transmits an AT command as defined by the protocol used by the device (normally 0 for USB). |
| GetEncapsulatedResponse | 0x01 | Requests a response to a command transmitted by SendEncapsulatedCommand. |
| SetCommFeature | 0x02 | Enables or disables features such as device-specific 2-byte code and country setting. |
| GetCommFeature | 0x03 | Acquires the enabled/disabled state of features such as device-specific 2-byte code and country setting. |
| ClearCommFeature | 0x04 | Restores the default enabled/disabled settings of features such as device-specific 2-byte code and country setting. |
| 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.

The following describes the class request data formats supported by this class driver software.

5.2.1 SendEncapsulatedCommand

The SendEncapsulatedCommand data format is shown in Table 5-2.

Table 5-2 SendEncapsulatedCommand Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|---------------------------------|--------|--------|-------------|--------------------------|
| 0x21 | SEND_ENCAPSULATED_COMMAND(0x00) | 0x0000 | 0x0000 | Data length | Control protocol command |

Note: Items such as AT commands for modem control are set as Data, and wLength is set to match the length of the data.

5.2.2 GetEncapsulatedResponse

The GetEncapsulatedResponse data format is shown Table 5-3.

Table 5-3 GetEncapsulatedResponse Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|----------------------------------|--------|--------|-------------|-----------------------------------|
| 0x21 | GET_ENCAPSULATED_RESPONSE (0x01) | 0x0000 | 0x0000 | Data length | The data depends on the protocol. |

Note: The response data to SendEncapsulatedCommand is set as Data, and wLength is set to match the length of the data.

5.2.3 SetCommFeature

The SetCommFeature data format is shown Table 5-4.

Table 5-4 SetCommFeature Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|-------------------------|--------------------------|--------|-------------|---|
| 0x21 | SET_COMM_FEATURE (0x02) | Feature Selector Note | 0x0000 | Data length | Status Either the country code or the Abstract Control Model idle setting/multiplexing setting for Feature Selector. |

Note: Shown in Table 4.6 Feature selector Settings.

5.2.4 GetCommFeature Data Format

The GetCommFeature data format is shown below.

Table 5-5 GetCommFeature Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|-------------------------|--------------------------|--------|-------------|---|
| 0x21 | GET_COMM_FEATURE (0x03) | Feature Selector Note | 0x0000 | Data length | Status Either the country code or the Abstract Control Model idle setting/multiplexing setting for Feature Selector. |

Note: Shown in Table 4.6 Feature selector Settings.

A Feature selector setup is shown in Table 5-6. The Status format at the time of ABSTRACT_STATE is shown in Table 5-7.

Table 5-6 Feature Selector Settings

| Feature Selector | Code | Targets | Length of Data | Description |
|------------------|------|-----------|----------------|--|
| RESERVED | 0x00 | None | None | Reserved |
| ABSTRACT_STATE | 0x01 | Interface | 2 | Selects the setting for Abstract Control Model idle state and signal multiplexing. |
| COUNTRY_SETTING | 0x02 | Interface | 2 | Selects the country code in hexadecimal format, as defined by ISO 3166. |

Table 5-7 Status Format when ABSTRACT_STATE Selected

| Bit Position | Description |
|--------------|--|
| D15 to D2 | Reserved |
| D1 | Data multiplexing setting 1: Multiplexing of call management commands is enabled for the Data class. 0: Multiplexing is disabled. |
| D0 | Idle setting 1: No endpoints of the target interface accept data from the host, and data is not supplied to the host. 0: Endpoints continue to accept data and it is supplied to the host. |

5.2.5 ClearCommFeature

The ClearCommFeature data format is shown Table 5-8.

Table 5-8 ClearCommFeature Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|---------------------------|--------------------------|--------|---------|------|
| 0x21 | CLEAR_COMM_FEATURE (0x04) | Feature Selector Note | 0x0000 | 0x0000 | None |

Note: Shown in Table 4.6 Feature selector Settings.

5.2.6 SetLineCoding

The SetLineCoding data format is shown Table 5-9.

Table 5-9 SetLineCoding Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|------------------------|--------|--------|---------|---|
| 0x21 | SET_LINE_CODING (0x20) | 0x0000 | 0x0000 | 0x0000 | Line Coding Structure See Table 5-10, Line Coding Structure Format |

Line Coding Structure Format is shown Table 5-10.

Table 5-10 Line Coding Structure 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 3 - Mask 4 - Space |
| 6 | bDataBits | 1 | Number | Data bits (5, 6, 7, 8) |

5.2.7 GetLineCoding

The GetLineCoding data format is shown Table 5-11.

Table 5-11 GetLineCoding Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|---------------------------|--------|--------|---------|--|
| 0xA1 | GET_LINE_CODING (0x21) | 0x0000 | 0x0000 | 0x0007 | Line Coding Structure See Table 5-10 , Line Coding Structure Format |

5.2.8 SetControlLineState

The SetControlLineState data format is shown below.

Table 5-12 SetControlLineState Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|-------------------------------|---|--------|---------|------|
| 0x21 | SET_CONTROL_LINE_STATE (0x22) | Control Signal Bitmap See Table 5-13, Control Signal Bitmap Format | 0x0000 | 0x0000 | None |

Table 5-13 Control Signal Bitmap

| Bit Position | Description |
|--------------|---|
| D15 to D2 | Reserved |
| D1 | DCE transmit function control 0 - RTS OFF 1 - RTS ON |
| D0 | Notification of DTE ready state 0 - DTR OFF 1 - DTR ON |

5.2.9 SendBreak

The SendBreak data format is shown below.

Table 5-14 SendBreak Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|----------------------|---------------------------------------|--------|---------|------|
| 0x21 | SEND_BREAK (0x23) | Break signal output duration | 0x0000 | 0x0000 | None |

5.3 ACM Notifications from Device to Host

The class notifications supported and not supported by the software are shown Table 5-15.

Table 5-15 CDC Class Notifications

| Notification | Code | Description | Supported |
|--------------------|------|--|-----------|
| NETWORK_CONNECTION | 0x00 | Notification of network connection state | No |
| RESPONSE_AVAILABLE | 0x01 | Response to GET_ENCAPSLATED_RESPONSE | Yes |
| SERIAL_STATE | 0x20 | Notification of serial line state | Yes |

5.3.1 SerialState

The SerialState data format is shown below.

Table 5-16 SerialState Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|------------------------|--------|--------|---------|---|
| 0xA1 | SERIAL_STATE (0x20) | 0x0000 | 0x0000 | 0x0000 | UART State bitmap See Table 5-17, UART State bitmap Format |

UART State bitmap format is shown Table 5-17.

Table 5-17 UART State bitmap Format

| Bits | Field | Description |
|-----------|-------------|--|
| D15 to D7 | | Reserved |
| D6 | bOverRun | Overflow error detected |
| D5 | bParity | Parity error detected |
| D4 | bFraming | Framing error detected |
| D3 | bRingSignal | INCOMING signal (ring signal) detected |
| D2 | bBreak | Break signal detected |
| D1 | bTxCarrrier | Data Set Ready: Line connected and ready for communication |
| D0 | bRxCarrrier | Data Carrier Detect: Carrier detected on line |

5.3.2 ResponseAvailable

The ResponseAvailable data format is shown below.

Table 5-18 ResponseAvailable Data Format

| bmRequestType | bRequest | wValue | wIndex | wLength | Data |
|---------------|------------------------------|--------|--------|---------|------|
| 0xA1 | RESPONSE_AVAILABLE (0x01) | 0x0000 | 0x0000 | 0x0000 | None |

6. USB Host Communication Device Class Driver (HCD) (HCDC)

6.1 Basic Functions

This software conforms to the Abstract Control Model subclass of the communication device class specification.

The main functions of HCDC are to:

1. Send class requests to the CDC peripheral
2. Transfer data to and from the CDC peripheral
3. Receive communication error information from the CDC peripheral

6.2 Structure / Union

The following structure or union is defined in *r_usb_hcdc_mini_if.h*.

6.2.1 HCDC Request Structure

Table 6-1 describes the “UART settings” parameter structure used for the CDC requests *SetLineCoding* and *GetLineCoding*.

Table 6-1 usb_hcdc_linecoding_t Structure

| Type | Member | Description | Remarks |
|----------|--------------|-------------------|-----------|
| uint32_t | dwdte_rate | Line speed | Unit: bps |
| uint8_t | bchar_ormat | Stop bits setting | |
| uint8_t | bparity_type | Parity setting | |
| uint8_t | bdata_bits | Data bit length | |

Table 6-2 describes the “UART settings” parameter structure used for the CDC requests *SetControlLineState*.

Table 6-2 usb_hcdc_controllinestate_t Structure

| Type | Member | Description | Remarks |
|---------------|--------|--|---------|
| uint16_t (D1) | brts:1 | Carrier control for half duplex modems 0 - Deactivate carrier, 1 - Activate carrier | |
| uint16_t (D0) | bdtr:1 | Indicates to DCE if DTE is present or not 0 - Not Present, 1 - Present | |

Table 6-3 describes the “AT command” parameter structure used for the CDC requests *SendEncapsulatedCommand* and *GetEncapsulatedResponse*.

Table 6-3 usb_hcdc_encapsulated_t Structure

| Type | Member | Description | Remarks |
|----------|---------|--------------------------------------|------------|
| uint8_t | *p_data | Area where AT command data is stored | |
| uint16_t | wlength | Size of AT command data | Unit: byte |

Table 6-4 describes the “Break signal” parameter structure used for the CDC requests *SendBreak*.

Table 6-4 usb_hcdc_breakduation_t Structure

| Type | Member | Description | Remarks |
|----------|----------|-------------------|----------|
| uint16_t | wtime_ms | Duration of Break | Unit: ms |

6.2.2 CommFeature Function Selection Union

Table 6-5 and Table 6-6 describe the “Feature Selector” parameter structure used for the CDC requests *SetCommFeature* and *GetCommFeature*, and Table 6-7 describes the parameter union.

Table 6-5 usb_hcdc_abstractstate_t Structure

| Type | Member | Description | Remarks |
|----------|---------|------------------------|---------|
| uint16_t | rsv1:14 | Reserved | |
| uint16_t | bdms:1 | Data Multiplexed State | |
| iomt16_t | bis:1 | Idle Setting | |

Table 6-6 usb_hcdc_countrysetting_t Structure

| Type | Member | Description | Remarks |
|----------|--------------|---|---------|
| uint16_t | country_code | Country code in hexadecimal format as defined in [ISO3166], | |

Table 6-7 usb_hcdc_commfeature_t Union

| Type | Member | Description | Remarks |
|---------------------------|-----------------|---|---------|
| usb_hcdc_abstractstate_t | abstract_state | Parameter when selecting Abstract Control Model | |
| usb_hcdc_countrysetting_t | country_setting | Parameter when selecting Country Setting | |

6.2.3 CDC Notification Format

Table 6-8 and Table 6-9 describe the data format of the CDC notification.

Table 6-8 Response_Available notification format

| Type | Member | Description | Remarks |
|----------|---------------|--------------------------|---------|
| uint8_t | bmRequestType | 0xA1 | |
| uint8_t | bRequest | RESPONSE_AVAILABLE(0x01) | |
| uint16_t | wValue | 0x0000 | |
| uint16_t | wIndex | Interface | |
| uint16_t | wLength | 0x0000 | |
| uint8_t | Data | none | |

Table 6-9 Serial_State notification format

| Type | Member | Description | Remarks |
|----------|---------------|--------------------|---------------------|
| uint8_t | bmRequestType | 0xA1 | |
| uint8_t | bRequest | SERIAL_STATE(0x20) | |
| uint16_t | wValue | 0x0000 | |
| uint16_t | wIndex | Interface | |
| uint16_t | wLength | 0x0002 | |
| uint16_t | Data | UART State bitmap | Refer to Table 6-10 |

The host is notified of the “*SerialState*” when a change in the UART port state is detected. Table 6-10 describes the structure of the UART State bitmap.

Table 6-10 usb_hcdc_serialstate_t Structure

| Type | Member | Description | Remarks |
|-------------------|----------------|--|---------------------|
| uint16_t (D15-D7) | rsv1:9 | Reserved | |
| uint16_t (D6) | bover_run:1 | Overrun error detected | |
| uint16_t (D5) | bparity:1 | Parity error detected | |
| uint16_t (D4) | bframing:1 | Framing error detected | |
| uint16_t (D3) | bring_signal:1 | Incoming signal (Ring signal) detected | |
| uint16_t (D2) | bbreak:1 | Break signal detected | |
| uint16_t (D1) | btx_carrier:1 | Line connected and ready for communication | Data Set Ready |
| uint16_t (D0) | brx_carrier:1 | Carrier detected on line | Data Carrier Detect |

7. 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*.

8. Configuration (r_usb_hcdc_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 CDC class

Specify the device class ID of the CDC device to be connected.

```
#define      USB_CFG_HCDC_IFCLS      USB_CFG_CDC          // CDC class supported device
#define      USB_CFG_HCDC_IFCLS      USB_CFG_VEN          // Vendor class device
```

Note:

With regard to the USB serial conversion device in the marketplace, the device class ID may be the Vendor class. Check the CDC device specifications before use. If the device class is Vendor class, then set *USB_CFG_VEN*.

2. 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.

```
#define      USB_CFG_HCDC_BULK_IN      Pipe number (USB_PIPE1 to USB_PIPE5)
#define      USB_CFG_HCDC_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. Do not set the same pipe number. If the USB Hub is being used, then PIPE9 cannot be set as the following definitions.

```
#define      USB_CFG_HCDC_INT_IN       Pipe number (USB_PIPE6 to USB_PIPE9)
```

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

Renesas Electronics Website

<http://www.renesas.com/>

Inquiries

<http://www.renesas.com/inquiry>

All trademarks and registered trademarks are the property of their respective owners.

Revision Record

| Rev. | Date | Description | |
|------|--------------|-------------|---|
| | | Page | Summary |
| 1.00 | Dec 1, 2015 | — | First edition issued |
| 1.01 | Jun 1, 2015 | — | RX231 is added in the target device. |
| 1.02 | Dec 28, 2015 | — | Upgrading of this USB driver by upgrading of "USB Basic Mini Firmware (R01AN2166)". |
| 1.10 | Nov 30, 2018 | — | <ol style="list-style-type: none">1. Supporting Smart Configurator.2. The following chapter is added.<ol style="list-style-type: none">(1). 8. Configuration (r_usb_hcdc_mini_config.h)3. The following chapters are changed.<ol style="list-style-type: none">(1). 3. API Information(2). 7. API Functions(3). 9. Creating an Application4. The following chapters are deleted. "How to Register Class Driver", "System Resources", "Task ID and Priority Setting". |
| 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. |
| | | | |
| | | | |

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

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.

"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.

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

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.

"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.

"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.

Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.

7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,
Koto-ku, Tokyo 135-0061, Japan
www.renesas.com

Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:
www.renesas.com/contact/.