R01AN2663EJ0127
Rev.1.27
Jul 31, 2019

RX Family

USB Peripheral Human Interface Device Class Driver 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 performs hardware control of USB communication. It is referred to below as the USB-BASIC-FW FIT module.

Target Device

RX65N/RX651 Group
RX64M Group
RX71M Group
RX66T Group
RX72T Group
RX72M 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. RX64M Group User's Manual: Hardware (Document number. R01UH0377)
3. RX71M Group User's Manual: Hardware (Document number. R01UH0493)
4. RX65N/RX651 Group User's Manual: Hardware (Document number. R01UH0590)
5. RX65N/RX651-2M Group User's Manual: Hardware (Document number. R01UH0659)
6. RX66T User's Manual: Hardware (Document number. R01UH0749)
7. RX72T User's Manual: Hardware (Document number. R01UH0803)
8. RX72M User's Manual: Hardware (Document number. R01UH0804)
9. USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note (Document number. R01AN2025)

Renesas Electronics Website
http://www.renesas.com

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-FW 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: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note* when creating an application program using this driver.

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

1.2 Note

This driver is not guaranteed to provide USB communication operation. The customer should verify operation when utilizing it in a system and confirm the ability to connect to a variety of different types of devices.

1.3 Terms and Abbreviations

Terms and abbreviations used in this document are listed below.

API	:	Application Program Interface
APL	:	Application program
HID	:	Human Interface Device class
IDE	:	Integrated Development Environment
Non-OS	:	USB Driver for OS-less
PCD	:	Peripheral Control Driver for USB-BASIC-FW
PDCD	:	Peripheral Device Class Driver (Device driver and USB class driver)
PHID	:	Peripheral Human Interface Devices
RSK	:	Renesas Starter Kits
RTOS	:	USB Driver for the real-time OS
USB-BASIC-FW	:	USB Basic Host and Peripheral Driver

1.4 USB PHID FIT Module

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

2. Software Configuration

Figure 2-1 shows the configuration of the modules related to PHID

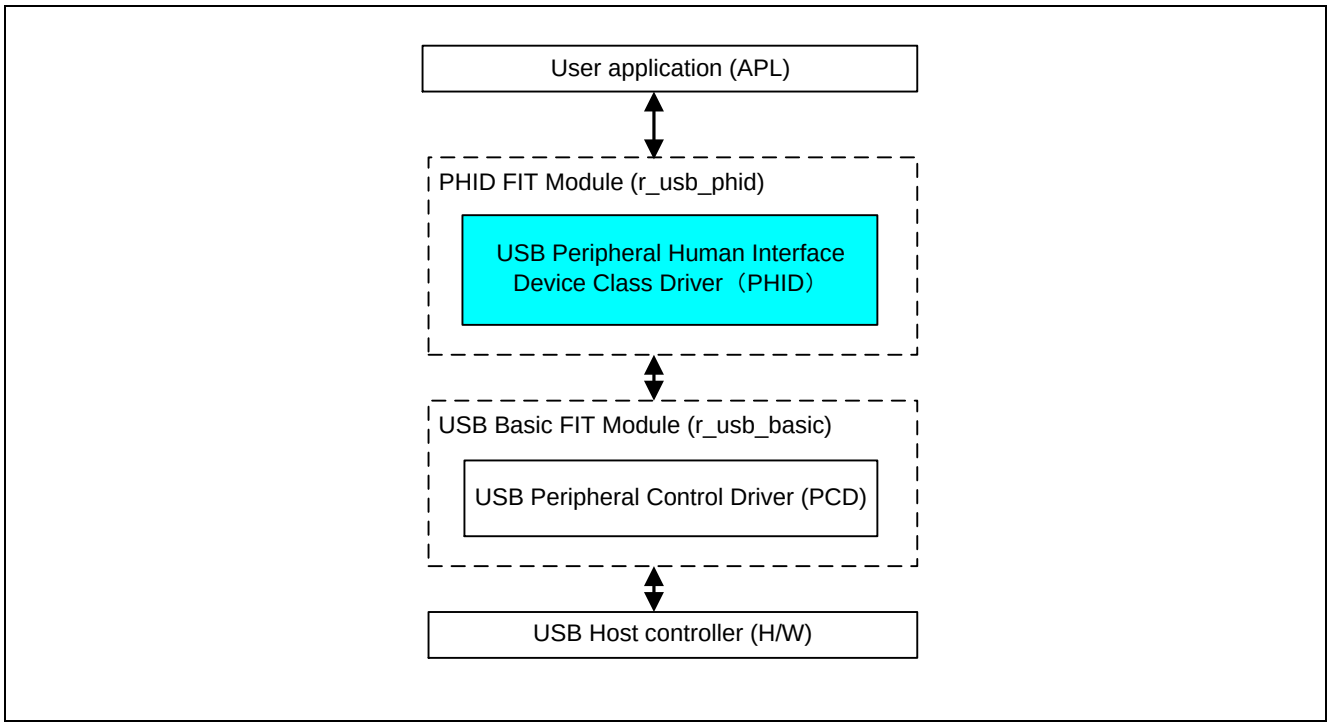

Figure 2-1 Software Module Structure

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 Host and Peripheral Driver (Peripheral Hardware Control)

3. API Information

This Driver API follows the Renesas API naming standards.

3.1 Hardware Requirements

This driver requires your MCU support the following features:

- USB

3.2 Software Requirements

This driver is dependent upon the following packages:

- r_bsp
- r_usb_basic

3.3 Operating Confirmation Environment

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

Table 3-1 Operating Confirmation Environment

Item	Contents
C compiler	Renesas Electronics C/C++ compiler for RX Family V.3.01.00 (The option "-lang=C99" is added to the default setting of IDE)
	GCC for Renesas RX 4.08.04.201902 (The option "-std=gnu99" is added to the default setting of IDE)
	IAR C/C++ Compiler for Renesas RX version 4.12.01
Real-Time OS	FreeRTOS V.10.0.0
Endian	Little Endian, Big Endian
USB Driver Revision Number	Rev.1.27
Using Board	Renesas Starter Kits for RX64M Renesas Starter Kits for RX71M Renesas Starter Kits for RX65N, Renesas Starter Kits for RX65N-2MB Renesas Starter Kits for RX72T Renesas Starter Kits for RX72M
Host Environment	The operation of this USB Driver module connected to the following OSes has been confirmed. 1. Windows® 7 2. Windows® 8.1 3. Windows® 10

3.4 Usage of Interrupt Vector

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

Table 3-2 List of Usage Interrupt Vectors

Device	Contents
RX64M RX71M	USBI0 Interrupt (Vector number: 189, Interrupt source number：62, Software Configurable Interrupt B) USB D0FIFO0 Interrupt (Vector number: 34) / USB D1FIFO0 Interrupt (Vector number: 35) USBR0 Interrupt (Vector number:90)
	USBAR Interrupt (Vector number: 94) USB D0FIFO2 Interrupt (Vector number: 32) / USB D1FIFO2 Interrupt (Vector number: 33)
RX65N RX651	USBI0 Interrupt (Vector number: 185, Interrupt source number：62, Software Configurable Interrupt B) USB D0FIFO0 Interrupt (Vector number: 34) / USB D1FIFO0 Interrupt (Vector number: 35) USBR0 Interrupt (Vector number:90)
RX66T RX72T	USBI0 Interrupt (Vector number: 174) / USBR0 Interrupt (Vector number: 90) USB D0FIFO0 Interrupt (Vector number: 34) / USB D1FIFO0 Interrupt (Vector number: 35)

3.5 Header Files

All API calls and their supporting interface definitions are located in r_usb_basic_if.h and r_usb_phid_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_config.h)** in this document and chapter "Configuration" in the document (Document number: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note.*

3.8 ROM / RAM Size

The follows show ROM/RAM size of this driver.

1. CC-RX (Optimization Level: Default)

(1). Non-OS

	Checks arguments	Does not check arguments
ROM size	20.1K bytes (Note 3)	19.7K bytes (Note 4)
RAM size	5.2K bytes	5.2K bytes

(2). RTOS

	Checks arguments	Does not check arguments
ROM size	34.7K bytes (Note 3)	34.3K bytes (Note 4)
RAM size	24.2K bytes	24.2K bytes

2. GCC (Optimization Level: -O2)

	Checks arguments	Does not check arguments
ROM size	24.9K bytes (Note 3)	24.5K bytes (Note 4)
RAM size	5.0K bytes	5.0K bytes

3. IAR (Optimization Level: Medium)

	Checks arguments	Does not check arguments
ROM size	18.7K bytes (Note 3)	18.4K bytes (Note 4)
RAM size	3.8K bytes	3.8K 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_config.h* file.
4. The ROM size of "Does not check arguments" is the value when *USB_CFG_DISABLE* is specified to *USB_CFG_PARAM_CHECKING* definition in *r_usb_basic_config.h* file.
5. The result of RTOS includes the ROM/RAM size of the real-time OS.

3.9 Argument

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

3.10 Adding the FIT Module to Your Project

This module must be added to each project in which it is used. Renesas recommends 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: R01AN2025) for *USB Basic Host and Peripheral Driver 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: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

6. Configuration (r_usb_phid_config.h)

Please set the following according to your system.

Note:

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

1. Setting pipe to be used

Set the pipe number (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: R01AN2025) for *USB Basic Host and Peripheral Driver using Firmware Integration Technology Application Note*.

Website and Support

Renesas Electronics Website

http://www.renesas.com/

Inquiries

http://www.renesas.com/inquiry

Revision Record

Rev.	Date	Description	
		Page	Summary
1.11	Sep 30, 2015	—	First edition issued
1.20	Sep 30, 2016	—	1. RX65N and RX651 are added in Target Device. 2. Supporting USB Host and Peripheral Interface Driver application note(Document No.R01AN3293EJ)
1.21	Mar 31, 2017	—	1. When the return value of *R_USB_GetEvent* function is USB_STS_READ_COMPLETE or USB_STS_WRITE_COMPLETE, the USB driver has been changed so that USB_PHID is set for the member *type* of usb_ctrl_t structure. 2. The chapter *API Functions* is moved to the document (Document number: R01AN2025) of *USB Basic Host and Peripheral Driver Firmware Integration Technology*.
1.22	Sep 30, 2017	—	Supporting RX65N/RX651-2M
1.23	Mar 31, 2018	—	Supporting the Smart Configurator.
1.24	Dec 28, 2018	—	Supporting RTOS.
1.25	Apr 16, 2019	—	Added RX66T/RX72T in Target Device.
1.26	May 31, 2019	—	1. Support GCC compiler and IAR compiler. 2. Remove RX63N from Target Device.
1.27	Jul 31, 2019		RX72M is added in 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. Handling of Unused Pins

   Handle unused pins in accordance with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

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

4. Clock Signals

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

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the 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 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.
5. 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.
6. 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.
7. 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.
8. 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.
9. 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.
10. 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.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note 1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note 2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)

RENESAS

SALES OFFICES

Renesas Electronics Corporation

http://www.renesas.com

Refer to "http://www.renesas.com/" for the latest and detailed information.

Renesas Electronics Corporation
TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

Renesas Electronics America Inc.
1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.
Tel: +1-408-432-8888, Fax: +1-408-434-5351

Renesas Electronics Canada Limited
9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3
Tel: +1-905-237-2004

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
Room 101-T01, Floor 1, Building 7, Yard No. 7, 8th Street, Shangdi, Haidian District, Beijing 100085, China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai 200333, China
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

Renesas Electronics Hong Kong Limited
Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2265-6688, Fax: +852 2886-9022

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit No 3A-1 Level 3A Tower 8 UOA Business Park, No 1 Jalan Pengaturcara U1/51A, Seksyen U1, 40150 Shah Alam, Selangor, Malaysia
Tel: +60-3-5022-1288, Fax: +60-3-5022-1290

Renesas Electronics India Pvt. Ltd.
No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India
Tel: +91-80-67208700

Renesas Electronics Korea Co., Ltd.
17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5338

Colophon 8.0