

## RX Family

R20AN0051EJ0200

Rev.2.00

Apr 01, 2014

### TCP/IP for Embedded system M3S-T4-Tiny: Introduction Guide

### Firmware Integration Technology

---

#### Introduction

This document explains TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.00 Release 00 (hereafter referred to as "T4") that depends on MCUs.

T4 is the TCP/IP protocol stack for embedded system. T4 is provided as library format and user can develop own system with this library to use TCP/IP function. The peripherals of the MCU used for communication are two types. Type 1 Ethernet. The peripherals are internal Ethernet controller or external bus. The external bus connects to external Ethernet controller chip. Type 2 PPP. The peripheral is serial I/O (UART). PPP is usually used for the Analog Modem, and for communication using 3G-Line. We recommend RX62N or RX63N or RX64M (has internal Ethernet controller) for Ethernet system, in case user selects RX family.

We prepared sample programs for each CPU board included in [the Renesas Starter Kit](#), [the Gadget Renesas RX63N board](#), the 3<sup>rd</sup> Party board. This sample program shows how to setup CPU board, PC settings, Network connections to confirm correct sample program behavior.

And we prepared "easy T4 application" (Web server, FTP server, DHCP client, DNS client, etc.). Please refer to the URL below.

<http://www.renesas.com/mw/t4>

T4 is provided as Firmware Integration Technology (FIT) Module. Please refer to the URL to know FIT outline.

<http://www.renesas.com/products/mpumcu/rx/rx100/index.jsp#fit>

[Notice about confirm working on MCUs]

This application is only FIT Module about TCP/IP functions. The sample program that can be confirmed working on MCUs is not included. The sample program using T4 FIT module will be uploaded to the URL the above.

[Notice about spec of T4]

T4 is assumed for easy application implementation. T4 does not have the function that "Socket interface" like Linux TCP/IP, next generation IP technology like IPSec and IPv6, router function like ICMP error notifying and routing protocol.

PPP functions are not provided in V.2.00 Release 00. We have the plan to re-provide at next release.

#### Target Device

RX62N, RX63N, RX64M (Ethernet connections)

RX610, RX210 (PPP connections): temporary unavailable

**Contents**

1. Outline.....	3
2. Library Specification.....	4
3. Corresponding MCU.....	4
4. Development Environment .....	5
5. T4 Ethernet Sample Application ROM / RAM / Stack Size .....	6
6. Version information.....	8
7. Notes .....	9
8. Software update information .....	10

## 1. Outline

Package Name(\*): TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.00 Release 00

Part Number: R0MRX60PT0020RRC

(\*)V.x.xx Release yy is package version. Vx.xx is T4 Library version.

Package version indicates all data (document, sample program, library) package's version.

T4 Library version is the Version that indicates Software Library for TCP/IP function provided as binary file.

File/Directory name		Description	
T4 FIT Module (r_t4_rx_v.2.00.zip)			
	T4 config (r_config)		
	r_t4_rx_config.h	T4 Config file (default setting)	
	T4 FIT Module body (r_t4_rx)		
	T4 Library (lib)		
	T4_Library_rx600_ether_big.lib	T4 Library (RX600 series, Big endian, for Ethernet)	
	T4_Library_rx600_ether_little.lib	T4 Library (RX600 series, Little endian, for Ethernet)	
	T4 Document (doc)		
	ja	r20uw0031jj0106_t4tiny.pdf	User's Manual (Japanese)
		r20uw0032jj0105_t4tiny.pdf	Ethernet Driver Interface Specification (Japanese)
		r20an0051jj0200_rx_t4.pdf	Introduction Guide (Japanese)
	en	r20uw0031ej0106_t4tiny.pdf	User's Manual (English)
		r20uw0032ej0105_t4tiny.pdf	Ethernet Driver Interface Specification (English)
		r20an0051ej0200_rx_t4.pdf	Introduction Guide (English)
	T4 Library make environment (make_lib)		
	make_lib.zip	T4 Library make environment (includes source code)	
	T4 config reference (ref)		
	r_t4_rx_config_reference.h	T4 config file (template)	
	readme (readme.txt)	readme	

## 2. Library Specification

Library specification can be seen in user's manual.

User's manual explains how to use this library, and APIs. And Ethernet driver interface specification and PPP driver interface specification explain how to make the user defined functions called from library.

## 3. Corresponding MCU

This product corresponds to RX family.

Library file is built with default compile option.

- compile option (little endian)

-cpu=rx600 -output=obj="\$ (CONFIGDIR)\\$(FILELEAF).obj" -nologo

or

-cpu=rx200 -output=obj="\$ (CONFIGDIR)\\$(FILELEAF).obj" -nologo

- compile option (big endian)

-cpu=rx600 -output=obj="\$ (CONFIGDIR)\\$(FILELEAF).obj" -nologo -endian=big

or

-cpu=rx200 -output=obj="\$ (CONFIGDIR)\\$(FILELEAF).obj" -nologo -endian=big

## 4. Development Environment

### -Requirement items

When user develops, please choose newer version than below.

### [Software]

#### -Integrated Development Environment

High Performance Embedded Workshop Version 4.09.01.007 (T4 Library make environment)

CubeSuite++ E2.01.00b (Application development environment)

e<sup>2</sup> studio V3.0 (Application development environment)

#### -C compiler

C/C++ compiler package for RX family V.1.02 Release 01 (T4 Library make environment)

CC-RX E2.01.00a (Application development environment)

Device File Updater for RX Family V.1.05

### [Debug tools]

Emulator debugger E1/E20

RX E1/E20 Emulator Debugger V.1.03.00

### [board]

#### Ethernet :

Renesas Starter Kit+ for RX64M (type : [R0K50564MC001BR#WS](#))

Renesas Starter Kit+ for RX63N (type : [R0K50563NS100BE #WS](#))

Renesas Starter Kit+ for RX62N (type : [R0K5562N0S100BE](#))

Hokuto Denshi RX62N,RX621 group MCU board. (type: [HSBRX62N-A](#))

Hokuto Denshi RX63N,RX631 group MCU board. (type: [HSBRX63NB Series](#))

Gadget Renesas RX63N Board (Type: [GR-SAKURA](#), [GR-SAKURA-FULL](#))

#### PPP :

Renesas Starter Kit for RX610 (type : [R0K556100S000BE](#))

Renesas Starter Kit for RX210 (type : [R0K505210S000BE#WS](#))

The sample program for these boards are provided as other application note sample code. Please refer to the URL to download sample program.

<http://www.renesas.com/mw/t4>

The other equipment for confirm running sample program, please refer to the section.7.

## 5. T4 Ethernet Sample Application ROM / RAM / Stack Size

Sample application is made with settings below. Required memory1 - 3 are needed for this sample program.

- \* 3 Reception buffer for application
  - > Required RAM 1500 byte by 1 reception buffer.
- \* 3 Communication endpoints with 1460 bytes reception window.
  - > Required RAM 1460 byte by 1 communication endpoint.
- \* 1 Reception/1 Transmit buffer for Ethernet driver.
  - > Required RAM 1536 byte by 1 Reception/Transmit buffer.

[Required memory1 : ROM/RAM size for Application :: main.c, echo\_srv.c (tcp non blocking call)]

ROM	:	about	0,5	KByte
RAM	:	about	10	KByte

[Required memory2 : ROM/RAM size for T4 :: T4\_Library\_ether\_rx600\_little.lib]

ROM	:	about	14	KByte
RAM	:	about	0.2	KByte

[Required memory3 : ROM/RAM size for Ethernet driver :: t4\_driver.c, phy.c, r\_ether.c]

ROM	:	about	3	KByte
RAM	:	about	3.5	KByte

[stack size]

API	stack size (includes sample driver)	Function called from T4 Library
tcp_acp_cep	148	tcp_api_slp
tcp_con_cep	148	tcp_api_slp
tcp_rcv_dat	148	tcp_api_slp
tcp_snd_dat	148	tcp_api_slp
tcp_sht_cep	132	tcp_api_slp
tcp_cls_cep	140	tcp_api_slp
tcp_can_cep	28	tcp_api_slp
udp_rcv_dat	128	udp_api_slp
udp_snd_dat	124	udp_api_slp
udp_can_cep	24	dis_int ena_int
tcpudp_get_ramsize	28	
tcpudp_open	40	tcpudp_act_cyc
_process_tcpip	312	tcp_api_wup udp_api_wup tcp_api_slp udp_api_slp rcv_buff_release lan_write lan_read lan_reset tcpudp_get_time
tcpudp_close	16	tcpudp_act_cyc

This stack size table is for sample program of T4.

Use the "CallWalker" to check your system stack size. Because the stack size is changed in case "Changed compile option" and "Changed sample driver code", etc.

## 6. Version information

User can access T4 Library information with valuable below.

```
extern const mw_version_t R_t4_version;
```

RX600(big endian) Library file (For the Ethernet) :

Compiler = 0x01020100

library = "M3S-T4-Tiny(Ethernet) version 2.00 for RX600 BIG endian.(May 9 2014, 14:55:27)"

RX600(little endian) Library file (For the Ethernet) :

Compiler = 0x01020100

library = "M3S-T4-Tiny(Ethernet) version 2.00 for RX600 LITTLE endian.(May 9 2014, 14:55:30)"



## 7. Notes

- (1) Specify the size of 15bit or less for the third argument "INT len" of tcp\_rcv\_dat() and tcp\_snd\_dat().
- (2) Specify the size of 15bit or less for argument "TMO tmout" of tcp\_acp\_cep(), tcp\_con\_cep(), tcp\_cls\_cep(), tcp\_rcv\_dat(), tcp\_snd\_dat(), udp\_snd\_dat() and udp\_rcv\_dat().
- (3) This library can be used with Microcontroller Options fint\_register=0 (Fast interrupt vectorregister [None]). The default for this option is fint\_register=0.

## 8. Software update information

Package version	change	release date
V.2.00 Release 00	Add Function: <ul style="list-style-type: none"> <li>- Support Several LAN ports. Each LAN ports can have the MAC address and IP address.</li> <li>- Opened source code.</li> <li>- Supported FIT(Firmware Integration Technology).</li> <li>- Supported Hokuto-Denshi RX63N board.</li> </ul> Bug Fix: <ul style="list-style-type: none"> <li>- Fixed error code fitting to ITRON V.4</li> <li>- Fixed behavior when LAN cable is disconnected, cannot cancel tcp_cls_cep().</li> <li>- Fixed behavior when UDP transmitting and not resolve the ARP sequence, cannot complete UDP transmitting.</li> <li>- Fixed tcp_sht_cep() can be canceled with specifying TFN_TCP_ALL .</li> </ul>	Apr,01,14
V.1.06 Release 00	Add Function: <ul style="list-style-type: none"> <li>- UDP broadcast receive function (destination IP address 255.255.255.255)</li> <li>- UDP directed-broadcast receive function (destination IP address example: network address = 192.168.0.0/24 -&gt; broadcast address 192.168.0.255)</li> <li>- UDP broadcast send function (destination IP address 255.255.255.255)</li> <li>- UDP directed-broadcast send function (destination IP address example: network address = 192.168.0.0/24 -&gt; broadcast address 192.168.0.255)</li> </ul> Bug Fix: <ul style="list-style-type: none"> <li>- When user use RI600/4(Renesas uITRON) with T4, conflict r_t4_itcpip.h and itron.h.</li> <li>- Receiving TCP window size is 0 packet, incorrect ACK would be sent from T4</li> <li>- Incorrect return value from tcp_acp_cep() that is in state of accepting.</li> <li>- There is incorrect combination about IP address and subnet mask. This combination makes the packets not to transmit.</li> <li>- Failure to re-allocate IP address from PPP server when PPP re-connection</li> <li>- Incorrect setting for SCI channel 1 for RX210 PPP driver.</li> </ul>	Jun,21,13
1.05	Add Function: <ul style="list-style-type: none"> <li>- Add T4 Library for PPP</li> <li>- Divide APIs api_wup() to tcp_api_wup() and udp_api_wup()</li> <li>- Divide APIs api_slp() to tcp_api_slp() and udp_api_slp()</li> </ul> Improve Performance: <ul style="list-style-type: none"> <li>- Optimize checksum calculation.</li> <li>- Enable Ethernet transmit interrupt</li> </ul> Bug Fix: <ul style="list-style-type: none"> <li>- In case, result of calculating UDP checksum is ZERO, T4 stores temporary value to received UDP checksum area.</li> <li>- In case, receiving broadcast packet before sending ARP response, T4 sends illegal packet.</li> </ul>	Apr,01,12
1.04	Add Function: <ul style="list-style-type: none"> <li>- Add Ethernet driver function "report_error".</li> <li>- Add variable "_udp_enable_zerochecksum" for behavior of UDP sum check.</li> </ul> Bug Fix:	Aug.30.11

	<ul style="list-style-type: none"> <li>- Correct "t4_driver.c" to fix FR flag clear timing.</li> <li>- This fixes wrong operation that EDMAC stops incorrectly.</li> </ul>	
1.03	Bug Fix: <ul style="list-style-type: none"> <li>- When user use RI600/4(Renesas uITRON) with T4, User definition function "api_wup()" has no way to know which communication endpoint is ended.</li> <li>- Change "api_wup()" argument. To know which communication endpoint is ended.</li> </ul>	Feb.02.11
1.02	Bug Fix: <ul style="list-style-type: none"> <li>- When user use RI600/4(Renesas uITRON) with T4, conflict r_t4_itcpip and itron.h.</li> <li>- Fixed r_t4_itcpip.h</li> </ul>	internal use
1.01	Bug Fix: <ul style="list-style-type: none"> <li>- When T4 uses API "tcp_snd_dat" with condition that other endpoint becomes zerowindow, and other endpoint returns ACK with enough window size. T4 (sender) continues zerowindow probe, and other endpoint returns ACK with enough window size.</li> <li>- This condition makes T4 not to be able to update remote window size and hung-up.</li> <li>- When T4 judges "other endpoint is zerowindow", and other endpoint returns ACK with enough window size, T4 retransfers previous data. ( not zerowindow probe)</li> </ul>	Nov.10.10
1.00	first release	Oct.09.10

## Website and Support

Renesas Electronics Website

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

Inquiries

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

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

## Revision History

Rev.	Date	Description	
		Page	Summary
2.00	Apr.01.14	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.00 Release 00 - Added Hokuto Denshi RX63N board for environment - Changed stack size table. - Changed stack size table. - Changed stack size value.
1.06	Jun.21.13	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.1.06 Release 00E - Changed form "Library version information" to "Software update information". ->Changed from "Ver" to "Package version"
		p6	- Added Hokuto Denshi RX62N board for environment - Added Gadget Renesas RX63n board for environment
		p10	- Changed stack size table.
		p12	- Changed stack size table.
		p13	- Changed stack size value.
		p14	- Added section for Ethernet sample driver patch program
		p15	- Added How to confirm sample program sections
1.05	Nov.09.12		Release with M3S-T4-Tiny for the RX Family V.1.05 Release01
		p1	Added RX63N to introduction
		p4	Added RX63N to Development Environment
1.04	Sep.30.12	all	Release for internal use. Added RX63N sample program. Updated RX62N sample program. Updated RX62N Ether driver Applied Zero-copy API, and Improve performance. Added function, LAN cable hotswap. Added function, wake on LAN.
1.03	Apr.01.12	all	Release with M3S-T4-Tiny for the RX Family V.1.05 Release00E
		all	Add information about T4 PPP.
		p2	Add description for word that "HEW".
		p6	Add notes for sample program. Add notes for multicast
1.02	Aug.30.11	all	Release with T4 library ver 1.04
1.01	Feb.02.11	all	Release with T4 library ver 1.03
1.00	Nov.10.10	-	First edition issued

## General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU 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 an MPU or MCU 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 of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.
  2. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.
  3. Renesas Electronics does not assume any liability for infringement of 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. 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 should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.
  5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The recommended 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; and industrial robots etc.  
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; and safety equipment etc.  
Renesas Electronics products are neither intended nor 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 damages (nuclear reactor control systems, military equipment etc.). You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application for which it is not intended. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for which the product is not intended by Renesas Electronics.
  6. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.
  7. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, 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, please evaluate 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. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
  9. Renesas Electronics products and technology may 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 should not use Renesas Electronics products or technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. When exporting the Renesas Electronics products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations.
  10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.
  11. This document may not be 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, or if you have any other inquiries.
- (Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.
- (Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.



### SALES OFFICES

### Renesas Electronics Corporation

<http://www.renesas.com>

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

#### **Renesas Electronics America Inc.**

2801 Scott Boulevard Santa Clara, CA 95050-2549, U.S.A.  
Tel: +1-408-588-6000, Fax: +1-408-588-6130

#### **Renesas Electronics Canada Limited**

1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada  
Tel: +1-905-898-5441, Fax: +1-905-898-3220

#### **Renesas Electronics Europe Limited**

Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K.  
Tel: +44-1628-585-100, Fax: +44-1628-585-900

#### **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 1709, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100191, P.R.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, P. R. China 200333  
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

#### **Renesas Electronics Hong Kong Limited**

Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
Tel: +852-2265-6688, Fax: +852 2886-9022/9044

#### **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 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

#### **Renesas Electronics Korea Co., Ltd.**

12F., 234 Teheran-ro, Gangnam-Ku, Seoul, 135-920, Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5141