

RX Family

R20AN0051EJ0207

Rev.2.07

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

Dec 31, 2017

Firmware Integration Technology

Introduction

This document explains TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.07 (hereafter referred to as "T4") that depends on MCUs. This documents name is "Introduction Guide".

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 or RX71M or RX65N (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 3rd Party board. This sample program shows how to setup CPU board, PC settings, Network connections to confirm correct sample program behavior.

Please refer to the following URL to know the latest information about T4.

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

And we prepared "easy T4 application" (Echo Server sample, Application sample (Web server, FTP server, DHCP client, DNS client) etc..) on this site.

echo server sample:R20AN0312

application sample:R20AN0314

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

<https://www.renesas.com/en-us/solutions/rx-applications/fit/about-fit.html>

[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 below.

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

This figure shows 2 cases of T4 software stack.

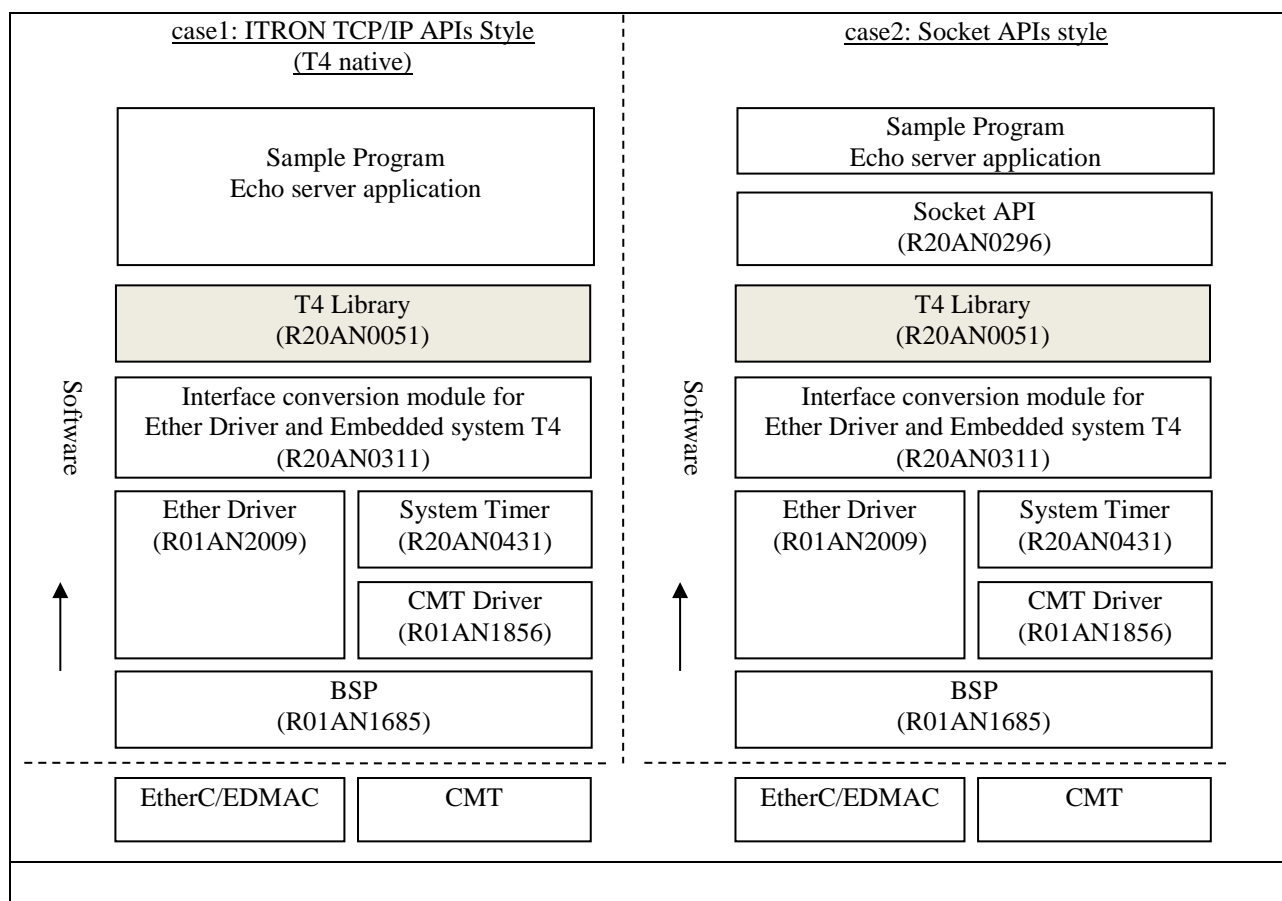


Figure 1 T4 Software Stack

[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.2.07. We have the plan to re-provide at next release.

Target Device

RX family

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1. Overview

1.1 Overview of the T4 FIT Module

Software Name: Embedded TCP/IP M3S-T4-Tiny for RX Family V.2.07

The file structure of the T4 FIT module is as follows.

Table 1 File Structure

File/Directory name		Description	
T4 FIT Module (r_t4_rx_v.2.07.zip)			
	T4 config (r_config)		
	r_t4_rx_config.h	T4 Config header	
	T4 FIT Module body (r_t4_rx)		
	T4 Library (lib)		
	T4_Library_rxv1_ether_big.lib	T4 Library (RXV1 core, Big endian, for Ethernet)	
	T4_Library_rxv1_ether_little.lib	T4 Library (RXV1 core, Little endian, for Ethernet)	
	T4_Library_rxv1_ether_big_debug.lib	T4 Library includes debug information. (RXV1 core, Big endian, for Ethernet/for QE for TCP/IP)	
	T4_Library_rxv1_ether_little_debug.lib	T4 Library includes debug information. (RXV1 core, Little endian, for Ethernet/for QE for TCP/IP)	
	r_t4_itcpip.h	T4 Library header file.	
	r_stdint.h	Standard data type header file.	
	r_mw_version.h	Middleware version header file.	
	T4 Document (doc)		
	ja	r20uw0031jj0109-t4tiny.pdf	User's Manual (Japanese)
		r20uw0032jj0108-t4tiny.pdf	Ethernet Driver Interface Specification (Japanese)
		r20an0051jj0207-rx-t4.pdf	Introduction Guide (Japanese)
	en	r20uw0031ej0109-t4tiny.pdf	User's Manual (English)
		r20uw0032ej0108-t4tiny.pdf	Ethernet Driver Interface Specification (English)
		r20an0051ej0207-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)		
	config_tcpudp_reference.tpl	T4 Config file (template)	
	r_t4_rx_config_reference.h	T4 Config header(reference)	
	src		
	config_tcpudp.c	T4 Config file	
	readme.txt	readme	

2. API Information

2.1 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.

2.2 Corresponding MCU

This product corresponds to RX family.

Library file is built with default compile option.

- compile option (little endian)

`-isa=rxv1 -nofpu -lang=c99 -output=obj -obj_path=DefaultBuild -nologo`

- compile option (big endian)

`-isa=rxv1 -nofpu -endian=big -lang=c99 -output=obj -obj_path=DefaultBuild -nologo`

- compile option (The case of Little endian with debug information)

`-isa=rxv1 -nofpu -lang=c99 -output=obj -obj_path=Debug -debug -nologo`

- compile option (The case of Big endian with debug information)

`-isa=rxv1 -nofpu -endian=big -lang=c99 -output=obj -obj_path=Debug -debug -nologo`

2.3 ROM / RAM Size

t4 needs the following memory..

[Required ROM/RAM size for T4 : T4_Library_rxv1_ether_little.lib]

ROM	:	about	23.3	KByte
RAM	:	about	0.2	KByte

Table 2 Stack Size

API	stack size (includes sample driver)	Function called from T4 Library
tcp_acp_cep	232	tcp_api_slp
tcp_con_cep	232	tcp_api_slp
tcp_rcv_dat	236	tcp_api_slp
tcp_snd_dat	232	tcp_api_slp
tcp_sht_cep	212	tcp_api_slp
tcp_cls_cep	224	tcp_api_slp
tcp_can_cep	24	tcp_api_slp
udp_rcv_dat	220	udp_api_slp
udp_snd_dat	224	udp_api_slp
udp_can_cep	28	dis_int ena_int
tcpudp_get_ramsize	36	-
tcpudp_open	92	tcpudp_act_cyc lan_check_link
_process_tcpip	348	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	44	tcpudp_act_cyc
tcpudp_reset	76	dis_int ena_int
igmp_join_group	132	lan_write
igmp_leave_group	136	lan_write

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.

2.4 Version information

T4 has version information as string data in R_t4_version variable library member. R_t4_version variable is defined in the r_t4_itcpip.h. T4 Library information is as below.

```
extern const mw_version_t R_t4_version;
```

RXV1 core(little endian) Library file (For the Ethernet):

```
compiler = 0x02070000
```

```
library = "M3S-T4-Tiny(Ethernet) version 2.07 for RXV1 LITTLE endian.(Dec 20  
2017, 12:55:29)"
```

RXV1 core(big endian) Library file (For the Ethernet):

```
compiler = 0x02070000
```

```
library = "M3S-T4-Tiny(Ethernet) version 2.07 for RXV1 BIG endian.(Dec 20  
2017, 13:02:42)"
```

RXV1 core (little endian) with debug information Library file (For the Ethernet):

```
compiler = 0x02070000
```

```
library = "M3S-T4-Tiny(Ethernet) version 2.07 for RXV1 LITTLE endian.(Dec 20  
2017, 12:56:29)"
```

RXV1 core (big endian) with debug information Library file (For the Ethernet):

```
compiler = 0x02070000
```

```
library = "M3S-T4-Tiny(Ethernet) version 2.07 for RXV1 BIG endian.(Dec 20  
2017, 13:03:41)"
```

2.5 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 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 in 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.

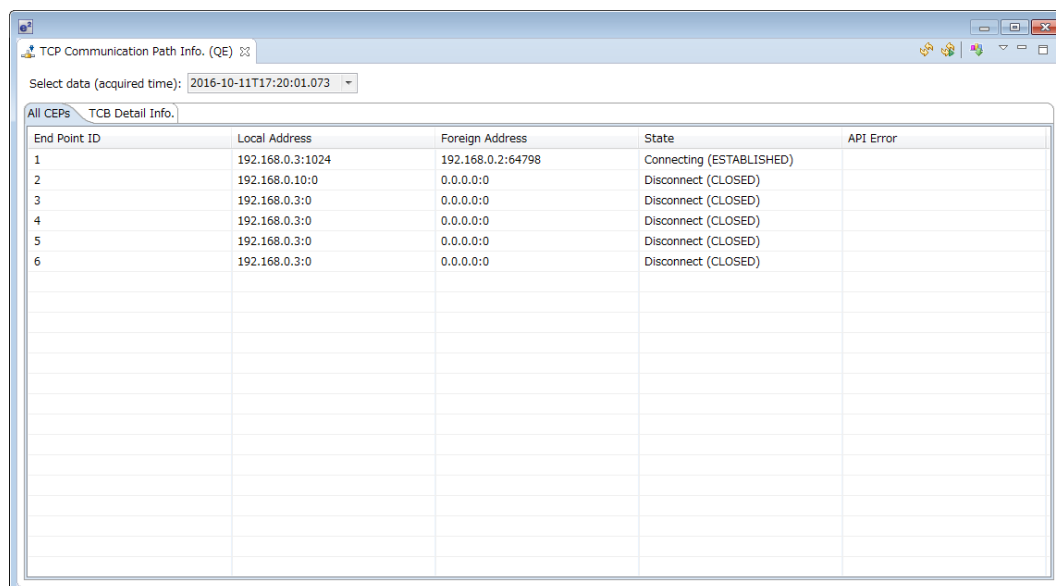
3. QE for TCP/IP

QE for TCP/IP provides the T4 debug information as e2 studio plug-in. This tool can display following information at realtime. This means debug efficiency will be improved.

- Which state is in TCP state machine.
- Which API is executed.
- Which error is occurred. etc.

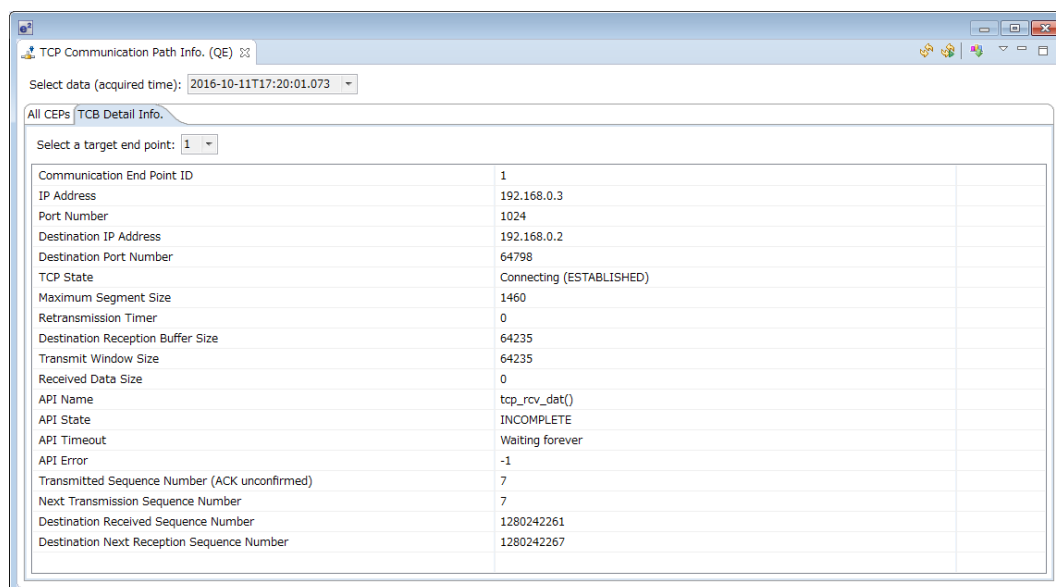
QE for TCP/IP can be downloaded from following URL. It is possible to use to plug-in this tool to e2 studio.

<https://www.renesas.com/en-us/products/software-tools/tools/solution-toolkit/qe-qe-for-tcp-ip.html>



End Point ID	Local Address	Foreign Address	State	API Error
1	192.168.0.3:1024	192.168.0.2:64798	Connecting (ESTABLISHED)	
2	192.168.0.10:0	0.0.0.0:0	Disconnect (CLOSED)	
3	192.168.0.3:0	0.0.0.0:0	Disconnect (CLOSED)	
4	192.168.0.3:0	0.0.0.0:0	Disconnect (CLOSED)	
5	192.168.0.3:0	0.0.0.0:0	Disconnect (CLOSED)	
6	192.168.0.3:0	0.0.0.0:0	Disconnect (CLOSED)	

Figure 2 Example of All TCP Endpoint List



Communication End Point ID	
1	
IP Address	192.168.0.3
Port Number	1024
Destination IP Address	192.168.0.2
Destination Port Number	64798
TCP State	Connecting (ESTABLISHED)
Maximum Segment Size	1460
Retransmission Timer	0
Destination Reception Buffer Size	64235
Transmit Window Size	64235
Received Data Size	0
API Name	tcp_rcv_dat()
API State	INCOMPLETE
API Timeout	Waiting forever
API Error	-1
Transmitted Sequence Number (ACK unconfirmed)	7
Next Transmission Sequence Number	7
Destination Received Sequence Number	1280242261
Destination Next Reception Sequence Number	1280242267

Figure 3 Example of Detail Information about a TCP Endpoint

4. Notes

4.1 T4 Libraly

- (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.

4.2 Smart Configurator

You can customize 6 endpoints on the T4 software component setting screen.

To change the number of endpoints themselves, you need to edit r_t4_rx_config.h and config_tcpudp.c.

5. Appendices

5.1 Development Environment

Requirement items

When user develops, please choose newer version than below.

Table 5.1 Operating Environment

Item	Contents
Integrated development environment	Rnesas Electronics CS+ V6.00.00 (T4 Library make environment and Application development environment) Rnesas Electronics e2 studio V6.2.0 (Application development environment)
C compiler	Renesas Electronics CC-RX V2.07.00 (T4 Library make environment and Application development environment) Compiler options: The integrated development environment default settings are used, with the following option added. -lang = c99
Endian order	Big-endian/Little-endian
Revision of the module	Ver.2.07
Software Tools(option)	QE for TCP/IP V1.0.1 (link)
Board used	Renesas Starter Kit+ for RX65N-2MB (RTK50565N2SxxxxxBE) (link) Renesas Starter Kit+ for RX65N (RTK500565NSxxxxxBE) (link) Renesas Starter Kit+ for RX71M (R0K50571MSxxxBE) (link) Renesas Starter Kit+ for RX64M (R0K50564MSxxxBE) (link) Renesas Starter Kit+ for RX63N (R0K50563NSxxxBE) (link) Renesas Starter Kit+ for RX62N (R0K5562N0SxxxBE) (link) Hokuto Denshi RX62N,RX621 group MCU board (HSBRX62N-A series) (link) Hokuto Denshi RX63N,RX631 group MCU board (HSBRX63NB series) (link) Gadget Renesas RX63N GR-SAKURA (link)

5.2 Software update information

Software version	change	release date
V.2.07	Bug Fix: <ul style="list-style-type: none"> - Fixed a problem that T4 Tiny sent an illegal Ping reply packet. - Fixed the problem that UDP transmission / reception processing can't be performed when UDP transmission / reception processing is canceled. 	Dec,31,17
V.2.06 Release 00	Add function: <ul style="list-style-type: none"> - Added DHCP function. Bug Fix: <ul style="list-style-type: none"> - Receive API cancel will not be accepted when TCP receive window data is remaining. - SYN/ACK will not return when several SYNs come from by peer in same time. - Discard the received packet when re-transmitted data includes additional payload. - Illegal transmit data will be generated when T4 re-transmit and receive are occurred in same time. 	Dec,15,16
V.2.05 Release 00	Add Function: <ul style="list-style-type: none"> - Add IGMP functions Add igmp_join_group() function and igmp_leave_group() function. Join to the Multicast group using igmp_join_group() function. Leave from the Multicast group using igmp_leave_group() function. 	Dec,01,15
V.2.03 Release 00	Bug Fix: Fixed wrong 2 behavior of FIN packet crossing between T4 and peer. <ul style="list-style-type: none"> - Fixed code for peer that is not sending ACK - Fixed code for internal state that detect wrong zero-window status after closing, the next connection will fail. 	Aug,07,15
V.2.02 Release 00	- Changed library make Integrated Development Environment for RX Family	Jan,05,15
V.2.01 Release 00	- Applied the T4 source code to Renesas coding rule	Jul,01,14
V.2.00 Release 00	Add Function: <ul style="list-style-type: none"> - Support Several LAN ports. Each LAN ports can have the MAC address and IP address. - Opened source code. - Supported FIT(Firmware Integration Technology). - Supported Hokuto-Denshi RX63N board. Bug Fix: <ul style="list-style-type: none"> - Fixed error code fitting to ITRON V.4 - Fixed behavior when LAN cable is disconnected, cannot cancel tcp_cls_cep(). - Fixed behavior when UDP transmitting and not resolve the ARP sequence, cannot complete UDP transmitting. - Fixed tcp_sht_cep() can be canceled with specifying TFN_TCP_ALL . 	Apr,01,14
V.1.06 Release 00	Add Function: <ul style="list-style-type: none"> - UDP broadcast receive function (destination IP address 255.255.255.255) - UDP directed-broadcast receive function (destination IP address example: network address = 192.168.0.0/24 -> broadcast address 192.168.0.255) 	Jun,21,13

	<ul style="list-style-type: none"> - UDP broadcast send function (destination IP address 255.255.255.255) - UDP directed-broadcast send function (destination IP address example: network address = 192.168.0.0/24 -> broadcast address 192.168.0.255) <p>Bug Fix:</p> <ul style="list-style-type: none"> - When user use RI600/4(Renesas uITRON) with T4, conflict r_t4_itcpip.h and itron.h. - Receiving TCP window size is 0 packet, incorrect ACK would be sent from T4 - Incorrect return value from tcp_acp_cep() that is in state of accepting. - There is incorrect combination about IP address and subnet mask. This combination makes the packets not to transmit. - Failure to re-allocate IP address from PPP server when PPP re-connection - Incorrect setting for SCI channel 1 for RX210 PPP driver. 	
1.05	<p>Add Function:</p> <ul style="list-style-type: none"> - Add T4 Library for PPP - Divide APIs api_wup() to tcp_api_wup() and udp_api_wup() - Divide APIs api_slp() to tcp_api_slp() and udp_api_slp() <p>Improve Performance:</p> <ul style="list-style-type: none"> - Optimize checksum calculation. - Enable Ethernet transmit interrupt <p>Bug Fix:</p> <ul style="list-style-type: none"> - In case, result of calculating UDP checksum is ZERO, T4 stores temporary value to received UDP checksum area. - In case, receiving broadcast packet before sending ARP response, T4 sends illegal packet. 	Apr,01,12
1.04	<p>Add Function:</p> <ul style="list-style-type: none"> - Add Ethernet driver function "report_error". - Add variable "_udp_enable_zerochecksum" for behavior of UDP sum check. <p>Bug Fix:</p> <ul style="list-style-type: none"> - Correct "t4_driver.c" to fix FR flag clear timing. - This fixes wrong operation that EDMAC stops incorrectly. 	Aug.30.11
1.03	<p>Bug Fix:</p> <ul style="list-style-type: none"> - When user use RI600/4(Renesas uITRON) with T4, User definition function "api_wup()" has no way to know which communication endpoint is ended. - Change "api_wup()" argument. To know which communication endpoint is ended. 	Feb.02.11
1.02	<p>Bug Fix:</p> <ul style="list-style-type: none"> - When user use RI600/4(Renesas uITRON) with T4, conflict r_t4_itcpip and itron.h. - Fixed r_t4_itcpip.h 	internal use
1.01	<p>Bug Fix:</p> <ul style="list-style-type: none"> - 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. - This condition makes T4 not to be able to update remote window size and hung-up. - When T4 judges "other endpoint is zerowindow", and other endpoint returns ACK with enough window size, T4 retransfers previous data. (not zerowindow probe) 	Nov.10.10

1.00	first release	Oct.09.10
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Website and Support

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Revision History

Rev.	Date	Description	
		Page	Summary
2.07	Dec.31.17	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.07 ->Changed from "Package version" to "Ver". Update following things. 1. Overview 2.3 T4 Ethernet Sample Application ROM / RAM / Stack Size 2.4 Version information 4. Notes 5. Appendices Adding following thing. 2.5 Adding the FIT Module to Your Project 5.1 Development Environment
2.06	Dec.15.16	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.06 Release 00 Added Support RX65N group. Added Chapter7. Added library with debug information. Changed library Compiler option. Changed library make Integrated Development Environment
2.05	Dec.01.15	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.05 Release 00 Update following things. Outline Remove rxv2 core library from the file structure. 4. Development Environment compiler version 5. T4 Ethernet sample Application ROM / RAM / Stack Size 6. Version information
2.03	Aug.07.15	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.03 Release 00
2.02	Jan.05.15	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.02 Release 00 Added Support RX71M group.
		p4,p5 p6	- Changed library file name and Compiler option. - Changed library make Integrated Development Environment
2.01	Jul.01.14	-	Release with TCP/IP for Embedded system M3S-T4-Tiny for the RX Family V.2.01 Release 00 - Changed FIT Module URL. - Figure 1 T4 Software Stack
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 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

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