

## RX Family

### Lightweight IP (lwIP) Module Using Firmware Integration Technology

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#### Introduction

This application note describes the lightweight IP (lwIP) FIT module (r\_lwip\_rx), which is compliant with the firmware integration technology (FIT) concept.

In this application note, software of the lightweight IP (lwIP) FIT module is generally referred to as “the lwIP FIT module” or “this FIT module”. For specific information on the lwIP version used for this FIT module, see section 1.2.

#### Target Devices

RX65N group  
RX72M group  
RX72N group  
RX64M group  
RX71M group  
RX66N group

When applying the material covered in this application note on another microcontroller, modify the descriptions or code to suit the specifications of the target microcontroller and extensively evaluate operation following the modifications.

**Renesas Electronics cannot provide any technical support for the lightweight IP (lwIP) this FIT module includes.** For technical information and contact for the lwIP, refer to the lwIP project page listed as number 6 under the heading “Documents for Reference” on this page.

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#### Documents for Reference

- 1 Firmware Integration Technology User's Manual (R01AN1833)
- 2 RX Family: Board Support Package Module Using Firmware Integration Technology (R01AN1685)
- 3 Adding Firmware Integration Technology Modules to Projects (R01AN1723)
- 4 Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)
- 5 Renesas e<sup>2</sup> studio Smart Configurator User's Guide (R20AN0451)
- 6 lwIP - A Lightweight TCP/IP stack ([link](#))
- 7 Lightweight IP stack ([link](#))
- 8 lwip-tcpip GitHub ([link](#))
- 9 Lightweight IP (lwIP) Driver Using Firmware Integration Technology (R20AN0788)
- 10 FreeRTOS.org ([link](#))

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## Contents

1. Overview.....	3
1.1 What is the “lwIP FIT Module”?.....	3
1.2 Overview of the lwIP FIT Module .....	3
2. API Information.....	4
2.1 Hardware Requirements .....	4
2.2 Software Requirements.....	4
2.3 Supported Toolchains .....	4
2.4 Interrupt Vectors to be Used .....	4
2.5 Header File .....	4
2.6 Integer Types.....	4
2.7 Settings for Compilation .....	5
2.8 Code Size .....	12
2.9 Arguments .....	13
2.10 Return Values.....	13
2.11 Including the FIT Module in Your Project .....	13
3. API Functions .....	14
3.1 API Functions .....	14
4. Appendix.....	14
4.1 Environments for Confirming Operation.....	14
4.2 Troubleshooting.....	15
5. Reference Documents.....	16
Revision History .....	17

## 1. Overview

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### 1.1 What is the “lwIP FIT Module”?

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This FIT module is used by including it as a set of API functions for use in a project. For details on how to include this FIT module, see section 2.11, Including the FIT Module in Your Project.

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### 1.2 Overview of the lwIP FIT Module

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This FIT module is generated from lightweight IP (lwIP), which is released as open-source software, by using the FIT.

The lwIP version used for this FIT module is [v2.2.1](#) (STABLE-2\_2\_1\_RELEASE). Refer to the “[README](#)” section for details.

## 2. API Information

The operation of this FIT module has been confirmed under the conditions listed below.

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### 2.1 Hardware Requirements

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None

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### 2.2 Software Requirements

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This FIT module is dependent on the following FIT modules.

- r\_bsp (Board support package FIT module, see document 2)
- r\_lwip\_driver\_rx (lwIP driver FIT module, see document 9)

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### 2.3 Supported Toolchains

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The operation of this FIT module has been confirmed with the toolchains indicated in section 4.1, Environments for Confirming Operation.

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### 2.4 Interrupt Vectors to be Used

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None

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### 2.5 Header File

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For details on API functions for use with this FIT module, refer to document 7 under the heading “Documents for Reference” on the first page.

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### 2.6 Integer Types

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This FIT module uses ANSI C99 integer types, which are defined in stdint.h.

## 2.7 Settings for Compilation

The configuration options for this FIT module are defined in `r_lwip_rx_config.h`. `r_lwip_rx_config.h` is included from the `lwipopts.h` configuration header file for use with the lwIP FIT module (lwIP).

The option names and settings are described in Table 2.1. Refer to document 7 under the heading “Documents for Reference” on the first page for details.

**Table 2.1 Configuration Options (r\_lwip\_rx\_config.h)**

Configuration Options in r_lwip_rx_config.h	
<b>NO_SYS</b> *The default setting is 1.	Selects whether or not an Operating System (OS) is to be used. Sets this option to 0 when using the lwIP with the operating system's functionality. The lwIP driver FIT module used in combination with the lwIP can be used with FreeRTOS. 0: OS used; 1: OS not used
<b>SYS_LIGHTWEIGHT_PROT</b> *The default setting is 0.	Selects whether to enable or disable protection between tasks (and protection against interrupts of tasks) for the specific critical areas during the allocation and release of buffers and the allocation of memory. If the value of this option is 1 (enabled) and that of the NO_SYS option is 1, the I flag of the CPU in the critical section in lwIP is set to 0 (prohibiting interrupts). 0: Disabled; 1: Enabled
<b>MEM_ALIGNMENT</b> *The default setting is 4.	Sets memory alignment for the CPU. A change to the setting is not required. An attempted change to the setting may lead to incorrect operation of this FIT module due to incorrectly aligned access to data in memory.
<b>MEM_SIZE</b> *The default setting is 20*1024.	Sets the size of heap memory.
<b>MEMP_NUM_PBUF</b> *The default setting is 50.	Set the number of pbufs for the memp structure.
<b>MEMP_NUM_UDP_PCB</b> *The default setting is 6.	Sets the number of UDP control blocks.
<b>MEMP_NUM_TCP_PCB</b> *The default setting is 10.	Sets the number of TCP connections.
<b>MEMP_NUM_TCP_PCB_LISTEN</b> *The default setting is 5.	Sets the number of TCP connections in the listening state.
<b>MEMP_NUM_TCP_SEG</b> *The default setting is 16.	Sets the number of TCP segments the queue can hold.
<b>MEMP_NUM_REASSDATA</b> *The default setting is 5.	Sets the number of IP packets simultaneously queued to reassemble IP fragments.
<b>MEMP_NUM_FRAG_PBUF</b> *The default setting is 15.	Sets the number of pbufs the lwIP can allocate to send IP fragments. This option is used if the LWIP_NETIF_TX_SINGLE_PBUF is 0.
<b>MEMP_NUM_ARP_QUEUE</b> *The default setting is 30.	Sets the number of simultaneously queued outgoing packets (pbufs) that are waiting for an ARP request to finish. This option requires using ARP queueing with the ARP_QUEUEING set to 1.
<b>MEMP_NUM_IGMP_GROUP</b> *The default setting is 8.	Sets the number of multicast groups whose network interfaces can be members at the same time. This option requires that the LWIP_IGMP is set to 1.
<b>MEMP_NUM_SYS_TIMEOUT</b> *The default setting is LWIP_NUM_SYS_TIMEOUT_INTERNAL.	Sets the number of simultaneously active timeouts. For details on the LWIP_NUM_SYS_TIMEOUT_INTERNAL option, refer to document 7 under the heading “Documents for Reference” on the first page.

MEMP_NUM_NETBUF *The default setting is 2.	Sets the number of struct netbufs.
MEMP_NUM_NETCONN *The default setting is 2.	Sets the number of struct netconns.
MEMP_NUM_TCPIP_MSG_API *The default setting is 8.	Sets the number of struct tcpip_msg, which are used for callback/timeout API communication.
MEMP_NUM_TCPIP_MSG_INPKT *The default setting is 8.	Sets the number of struct tcpip_msg, which are used for incoming packets.
PBUF_POOL_SIZE *The default setting is 16.	Sets the number of buffers in the pbuf pool.
LWIP_ARP *The default setting is 1.	Selects whether to enable or disable the ARP functionality. 0: Disabled; 1: Enabled
ARP_TABLE_SIZE *The default setting is 10.	Sets the number of active MAC-IP address pairs cached.
ARP_QUEUEING *The default setting is 0.	Selects whether to enable the ARP queueing. For details on ARP queueing, refer to document 7 under the heading "Documents for Reference" on the first page.
ETH_PAD_SIZE *The default setting is 2.	Sets the number of bytes added before the ethernet header.
LWIP_IPV4 *The default setting is 1.	Selects whether to enable or disable IPv4. 0: Disabled; 1: Enabled
IP_FRAG *The default setting is 1.	Selects whether to enable or disable the function that fragments outgoing IP packets if their size exceeds MTU. 0: Disabled; 1: Enabled
IP_REASS_MAXAGE *The default setting is 15.	Sets maximum time a fragmented IP packet waits for all fragments to arrive in seconds. This option is used if the IP_REASSEMBLY is 1.
IP_DEFAULT_TTL *The default setting is 255.	Sets default value for Time-To-Live (TTL) used by transport layers.
LWIP_ICMP *The default setting is 1.	Selects whether to enable or disable the ICMP module. 0: Disabled; 1: Enabled
LWIP_RAW *The default setting is 0.	Selects whether to enable or disable to use the raw API. 0: Disabled; 1: Enabled
RAW_TTL *The default setting is IP_DEFAULT_TTL.	Sets the default Time-To-Live (TTL) value for IP packets sent using the raw API.
LWIP_DHCP *The default setting is 0.	Selects whether to enable or disable the DHCP client function. 0: Disabled; 1: Enabled
LWIP_AUTOIP *The default setting is 0.	Selects whether to enable or disable the autoIP module. 0: Disabled; 1: Enabled
LWIP_DHCP_AUTOIP_COOP *The default setting is 0.	Sets whether to enable or disable cooperation between DHCP and AutoIP. If the value of this option is 1 (enabled), this option allows DHCP and AUTOIP to be both enabled on the same interface at the same time. 0: Disabled; 1: Enabled
LWIP_ACD *The default setting is LWIP_AUTOIP    LWIP_DHCP_DOES_ACD_CHECK.	Selects whether to enable or disable the Address Conflict Detection (ACD) module. 0: Disabled; 1: Enabled
LWIP_IGMP *The default setting is 1.	Selects whether to enable or disable the IGMP module. 0: Disabled; 1: Enabled
LWIP_DNS *The default setting is 0.	Selects whether to enable or disable the DNS client function. 0: Disabled; 1: Enabled
LWIP_UDP *The default setting is 1.	Selects whether to enable or disable the UDP. 0: Disabled; 1: Enabled

UDP_TTL *The default setting is IP_DEFAULT_TTL.	Sets the default Time-To-Live (TTL) value for UDP packets.
LWIP_TCP *The default setting is 1.	Selects whether to enable or disable the TCP. 0: Disabled; 1: Enabled
TCP_TTL *The default setting is IP_DEFAULT_TTL.	Sets the default Time-To-Live (TTL) value for TCP segments.
TCP_WND *The default setting is 4 * TCP_MSS.	Sets the size of the TCP window in bytes.
TCP_QUEUE_OOSEQ *The default setting is LWIP_TCP.	Selects whether to enable or disable queuing of TCP segments that arrive out of order when such segments are received. 0: Disabled; 1: Enabled
TCP_MSS *The default setting is 1500 - 40 (= 1460).	Sets the maximum size of a TCP segment in bytes.
TCP_SND_BUF *The default setting is 4 * TCP_MSS.	Sets the TCP sender buffer space in bytes.
TCP_SND_QUEUELEN *The default setting is 2 * TCP_SND_BUF/TCP_MSS.	Sets the TCP sender buffer space with the pbuf size as the unit. This must be at least as much as (2 * TCP_SND_BUF/TCP_MSS) for things to work.
TCP_OOSEQ_MAX_BYTES *The default setting is 0.	Sets the maximum number of bytes that can be queued for out-of-sequence TCP segments per TCP Control Block (PCB). The default is 0 that means no limit. This option is valid if the TCP_QUEUE_OOSEQ is 1.
TCP_OOSEQ_MAX_PBUFS *The default setting is 0.	Sets the default maximum number of pbufs queued on out-of-order per TCP Control Block (PCB). The default is 0 that means no limit. This option is valid if the TCP_QUEUE_OOSEQ is 1.
TCP_LISTEN_BACKLOG *The default setting is 0.	Selects whether to enable or disable the function that limits the number of listening PCBs to be queued. 0: Disabled; 1: Enabled
TCP_DEFAULT_LISTEN_BACKLOG *The default setting is 0xff.	Sets the default maximum number of listening PCBs to be queued.
LWIP_ALTCP *The default setting is 0.	Selects whether to enable or disable Application Layered TCP (ALTCP) API. 0: Disabled; 1: Enabled
LWIP_ALTCP_TLS *The default setting is 0.	Selects whether to enable or disable Transport Layer Security (TLS) support over the Application Layered TCP (ALTCP) interface. 0: Disabled; 1: Enabled
PBUF_POOL_BUFSIZE *The default setting is LWIP_MEM_ALIGN_SIZE( TCP_MSS+PBUF_IP_HLEN+ PBUF_TRANSPORT_HLEN+ PBUF_LINK_ENCAPSULATION_HLEN+ PBUF_LINK_HLEN).	Sets the size of each pbuf in the pbuf pool. The default is designed to accommodate single full size TCP frame in one pbuf, including TCP_MSS, IP header, and link header.
LWIP_NETIF_HOSTNAME *The default setting is 0.	Selects whether to use DHCP_OPTION_HOSTNAME with netif's hostname field. 0: Not used; 1: Used
LWIP_NETIF_API *The default setting is 0.	Selects whether to enable or disable netif API. 0: Disabled; 1: Enabled
LWIP_NETIF_LINK_CALLBACK *The default setting is 0.	Selects whether to enable or disable a callback function for notification of a change to the link state. 0: Disabled; 1: Enabled
LWIP_NETIF_TX_SINGLE_PBUF *The default setting is 0.	Selects whether to enable or disable the function the lwIP tries to put all data to be sent into one single pbuf. 0: Disabled; 1: Enabled

TCPIP_THREAD_NAME *The default setting is "tcpip_thread".	Sets the name assigned to the main tcpip thread. This option is used if the NO_SYS option is set to 0.
TCPIP_THREAD_STACKSIZE *The default setting is 2048.	Sets the stack size used by the main tcpip thread. This option is used if the NO_SYS option is set to 0.
TCPIP_THREAD_PRIO *The default setting is (configMAX_PRIORITIES - 2).	Sets the priority assigned to the main tcpip thread. This option is used if the NO_SYS option is set to 0.
TCPIP_MBOX_SIZE *The default setting is 6.	Sets the mailbox size for the tcpip thread messages. This option is used if the NO_SYS option is set to 0.
DEFAULT_THREAD_NAME *The default setting is "lwIP".	Sets the name assigned to any other lwIP thread. This option is used if the NO_SYS option is set to 0.
DEFAULT_THREAD_STACKSIZE *The default setting is 2048.	Sets the stack size used by any other lwIP thread. This option is used if the NO_SYS option is set to 0.
DEFAULT_THREAD_PRIO *The default setting is (configMAX_PRIORITIES - 3).	Sets the priority assigned to any other lwIP thread. This option is used if the NO_SYS option is set to 0.
DEFAULT_RAW_RECVMBOX_SIZE *The default setting is 8.	Sets the mailbox size for the incoming packets on a NETCONN_RAW. This option is used if the NO_SYS option is set to 0.
DEFAULT_UDP_RECVMBOX_SIZE *The default setting is 8.	Sets the mailbox size for the incoming packets on a NETCONN_UDP. This option is used if the NO_SYS option is set to 0.
DEFAULT_TCP_RECVMBOX_SIZE *The default setting is 8.	Sets the mailbox size for the incoming packets on a NETCONN_TCP. This option is used if the NO_SYS option is set to 0.
DEFAULT_ACCEPTMBOX_SIZE *The default setting is 8.	Sets the mailbox size for the incoming connections. This option is used if the NO_SYS option is set to 0.
LWIP_NETCONN *The default setting is 0.	Selects whether to enable or disable Netconn API functions. 0: Disabled; 1: Enabled
LWIP_SOCKET *The default setting is 0.	Selects whether to enable or disable socket API functions. 0: Disabled; 1: Enabled
LWIP_SO_SNDTIMEO *The default setting is 0.	Selects whether to enable or disable send timeout for sockets/netconns and SO_SNDTIMEO processing. This option is used if the NO_SYS option is set to 0. 0: Disabled; 1: Enabled
LWIP_SO_RCVTIMEO *The default setting is 0.	Selects whether to enable or disable receive timeout for sockets/netconns and SO_RCVTIMEO processing. This option is used if the NO_SYS option is set to 0. 0: Disabled; 1: Enabled
LWIP_SO_RCVBUF *The default setting is 0.	Selects whether to enable or disable SO_RCVBUF processing. This option is used if the NO_SYS option is set to 0. 0: Disabled; 1: Enabled
LWIP_SO_LINGER *The default setting is 0.	Selects whether to enable or disable SO_LINGER processing. This option is used if the NO_SYS option is set to 0. 0: Disabled; 1: Enabled
LWIP_STATS *The default setting is 0.	Selects whether to enable or disable statistics collection in lwip_stats. 0: Disabled; 1: Enabled
LWIP_STATS_DISPLAY *The default setting is 0.	Selects whether to enable or disable the statistics output functions. 0: Disabled; 1: Enabled
LINK_STATS *The default setting is 0.	Selects whether to enable or disable link stats. 0: Disabled; 1: Enabled
ETHARP_STATS *The default setting is 0.	Selects whether to enable or disable etharp stats. 0: Disabled; 1: Enabled
IP_STATS *The default setting is 0.	Selects whether to enable or disable IP stats. 0: Disabled; 1: Enabled

IPFRAG_STATS *The default setting is 0.	Selects whether to enable or disable IP fragmentation stats. 0: Disabled; 1: Enabled
ICMP_STATS *The default setting is 0.	Selects whether to enable or disable ICMP stats. 0: Disabled; 1: Enabled
IGMP_STATS *The default setting is 0.	Selects whether to enable or disable IGMP stats. 0: Disabled; 1: Enabled
UDP_STATS *The default setting is 0.	Selects whether to enable or disable UDP stats. 0: Disabled; 1: Enabled
TCP_STATS *The default setting is 0.	Selects whether to enable or disable TCP stats. 0: Disabled; 1: Enabled
MEM_STATS *The default setting is 0.	Selects whether to enable or disable memory manager (mem.c) stats. 0: Disabled; 1: Enabled
MEMP_STATS *The default setting is 0.	Selects whether to enable or disable pool memory manager (memp.c) stats. 0: Disabled; 1: Enabled
SYS_STATS *The default setting is 0.	Selects whether to enable or disable system stats. 0: Disabled; 1: Enabled
IP6_STATS *The default setting is 0.	Selects whether to enable or disable IPv6 stats. 0: Disabled; 1: Enabled
ICMP6_STATS *The default setting is 0.	Selects whether to enable or disable ICMP for IPv6 stats. 0: Disabled; 1: Enabled
IP6_FRAG_STATS *The default setting is 0.	Selects whether to enable or disable IPv6 fragmentation stats. 0: Disabled; 1: Enabled
MLD6_STATS *The default setting is 0.	Selects whether to enable or disable MLD for IPv6 stats. 0: Disabled; 1: Enabled
ND6_STATS *The default setting is 0.	Selects whether to enable or disable ND for IPv6 stats. 0: Disabled; 1: Enabled
MIB2_STATS *The default setting is 0.	Selects whether to enable or disable SNMP MIB-II compliant stats. 0: Disabled; 1: Enabled
LWIP_IPV6 *The default setting is 0.	Selects whether to enable or disable IPv6. 0: Disabled; 1: Enabled
IPV6_REASS_MAXAGE *The default setting is 60.	Sets the maximum time a fragmented IPv6 packet waits for all fragments to arrive.
LWIP_IPV6_SCOPES *The default setting is (LWIP_IPV6 && !LWIP_SINGLE_NETIF).	Selects whether to enable or disable support for IPv6 address scopes. 0: Disabled; 1: Enabled
LWIP_IPV6_NUM_ADDRESSES *The default setting is 3.	Sets the number of IPv6 addresses per netif.
LWIP_IPV6_FRAG *The default setting is 1.	Selects whether the lwIP fragments outgoing IPv6 packets that are too big. 0: Packets not fragmented; 1: Packets fragmented
LWIP_IPV6_DHCP6 *The default setting is 0.	Selects whether to enable or disable DHCPv6 stateful/stateless address autoconfiguration. 0: Disabled; 1: Enabled
LWIP_DBG_MIN_LEVEL *The default setting is LWIP_DBG_LEVEL_ALL.	Sets the minimum level at which debug messages are written. LWIP_DBG_LEVEL_ALL: ALL messages; LWIP_DBG_LEVEL_WARNING: Warnings. bad checksums, dropped packets, ...; LWIP_DBG_LEVEL_SERIOUS: Serious. memory allocation failures, ...; LWIP_DBG_LEVEL_SEVERE: Severe
LWIP_DBG_TYPES_ON *The default setting is LWIP_DBG_ON.	Sets a mask that can be used to globally enable/disable debug messages of certain types. Multiple values can be specified using the bitwise OR operator. LWIP_DBG_ON: Flag for LWIP_DEBUGF to enable debug

	<p>messages;</p> <p>LWIP_DBG_TRACE: Flag for LWIP_DEBUGF indicating a tracing message to follow program flow;</p> <p>LWIP_DBG_STATE: Flag for LWIP_DEBUGF indicating a state debug message to follow module states;</p> <p>LWIP_DBG_HALT: Flag for LWIP_DEBUGF to halt after printing this debug message</p>
<p>ETHARP_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in etharp.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>NETIF_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in netif.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>PBUF_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in pbuf.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>API_LIB_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in api_lib.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>API_MSG_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in api_msg.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>SOCKETS_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in sockets.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>ICMP_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in icmp.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>IGMP_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in igmp.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>INET_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in inet.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>IP_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging for IP.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>IP_REASS_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in ip_frag.c for both frag &amp; reass.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>RAW_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in raw.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>MEM_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in mem.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>MEMP_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in memp.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>SYS_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in sys.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>TIMERS_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in timers.c.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>TCP_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging for TCP.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>TCP_INPUT_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in tcp_in.c for incoming debug.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>TCP_FR_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in tcp_in.c for fast retransmit.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>TCP_RTO_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging in TCP for retransmit timeout.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>
<p>TCP_CWND_DEBUG</p> <p>*The default setting is LWIP_DBG_OFF.</p>	<p>Selects whether to enable or disable debugging for TCP congestion window.</p> <p>LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled</p>

TCP_WND_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in tcp_in.c for window updating. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
TCP_OUTPUT_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in tcp_out.c output functions. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
TCP_RST_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging for TCP with the RST message. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
TCP_QLEN_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging for TCP queue lengths. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
UDP_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in UDP. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
TCPIP_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in tcpip.c. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
SLIP_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in slipif.c. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
DHCP_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in dhcp.c. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
AUTOIP_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in autoip.c. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
ACD_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in acd.c. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
DNS_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging for DNS. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
IP6_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging for IPv6. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
DHCP6_DEBUG *The default setting is LWIP_DBG_OFF.	Selects whether to enable or disable debugging in dhcp6.c. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled
LWIP_PERF *The default setting is 0.	Selects whether to enable or disable performance testing for lwIP. LWIP_DBG_OFF: Disabled; LWIP_DBG_ON: Enabled

## 2.8 Code Size

Table 2.2 lists the ROM and RAM sizes and the maximum stack usage for this FIT module.

The configuration options listed in section 2.7, Settings for Compilation, during the build process determine the actual ROM (code and constants) and RAM (global data) sizes.

The values listed in Table 2.2 have been confirmed under the following conditions.

FIT module revision: r\_lwip\_rx rev1.11

Compiler version: Renesas Electronics C/C++ Compiler Package for RX Family V3.07.00

(The “-lang = c99” option was added to the default settings of the integrated development environment.)

Compilation options: Default settings

**Table 2.2 Code Size**

Code Sizes of ROM, RAM, and Stack			
Device	Category	Memory Used	Remarks
RX65N	ROM	Approximately 51k bytes	-
	RAM	Approximately 50k bytes	-
	Maximum stack usage	Approximately 700 bytes	This is a value measured using the sample project included with the package for the lwIP driver FIT module (see document 9). This value includes the stack usage of other FIT modules including the lwIP driver FIT module that this FIT module calls.

## 2.9 Arguments

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For details on the arguments for the API functions of this FIT module, refer to document 7 under the heading “Documents for Reference” on the first page.

## 2.10 Return Values

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For details on the return values for the API functions of this FIT module, refer to document 7 under the heading “Documents for Reference” on the first page.

## 2.11 Including the FIT Module in Your Project

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This FIT module must be included in each project where it is to be used. Renesas recommends using the Smart Configurator in the way described in (1), (3), or (5) below. However, the Smart Configurator only supports this for some RX devices. If the RX device in use is not supported, use the method described in either (2) or (4).

- (1) Including the FIT module in your project by using the Smart Configurator in the e<sup>2</sup> studio  
Using the Smart Configurator in the e<sup>2</sup> studio allows the automatic inclusion of the FIT module in your project. Refer to the application note *RX Smart Configurator User's Guide: e<sup>2</sup> studio* (R20AN0451) for details.
- (2) Including the FIT module in your project by using the FIT Configurator in the e<sup>2</sup> studio  
Using the FIT Configurator in the e<sup>2</sup> studio allows the automatic inclusion of the FIT module in your project. Refer to the application note *RX Family: Adding Firmware Integration Technology Modules to Projects* (R01AN1723) for details.
- (3) Including the FIT module in your project by using the Smart Configurator in CS+  
Using the standalone version of the Smart Configurator in CS+ allows the automatic inclusion of the FIT module in your project. Refer to the application note *RX Smart Configurator User's Guide: CS+* (R20AN0470) for details.
- (4) Including the FIT module in your project in CS+  
Manually include the FIT module in your project in CS+. Refer to the application note *RX Family: Adding Firmware Integration Technology Modules to CS+ Projects* (R01AN1826) for details.
- (5) Including the FIT module in your project by using the Smart Configurator with the IAR Embedded Workbench (IAREW)  
Using the standalone version of the Smart Configurator allows the automatic inclusion of the FIT module in your project. Refer to the application note *RX Smart Configurator User's Guide: IAREW* (R20AN0535) for details.

### 3. API Functions

#### 3.1 API Functions

This FIT module is generated from lwIP, which is released on the associated [Web page](#) as open-source software, by using the FIT. For details on the specifications of the lwIP API functions, refer to the document 7 under the heading “Documents for Reference” on the first page.

### 4. Appendix

#### 4.1 Environments for Confirming Operation

Table 4.1 lists the environments used in confirming operation of this FIT module.

**Table 4.1 Environments for Confirming Operation**

Item		Description
Integrated development environment		e <sup>2</sup> studio Ver.2025-12 from Renesas Electronics
Compiler	CC-RX	C/C++ Compiler for RX Family V3.07.00 from Renesas Electronics Compilation options: The following option was added to the default settings of the integrated development environment. -lang = c99
	GCC	GCC for Renesas RX 14.2.0.202505
Endian for operation		Little or Big* <sup>1</sup>
Revision number of this FIT module		Rev. 1.11
Board used		Renesas CK-RX65N v2 (part number: RTK5CK65N0S08xxxBE) Renesas RX72N Envision Kit (part number: RTK5RX72N0C00000BJ) Renesas Starter Kit+ for RX72M (part number: RTK5572MNxSx00000BE)
RTOS	FreeRTOS	10.4.3-rx-1.0.10
FIT	BSP FIT	Ver. 7.60
	Ethernet FIT	Ver. 1.24
	CMT FIT	Ver. 5.71
	LWIP driver FIT	Ver. 1.11

\*1: Big endian is supported on bare metal only.

## 4.2 Troubleshooting

(1) Q: I added this FIT module to my project, but when I attempted to build it, an error message, "Could not open source file 'platform.h'," appeared.

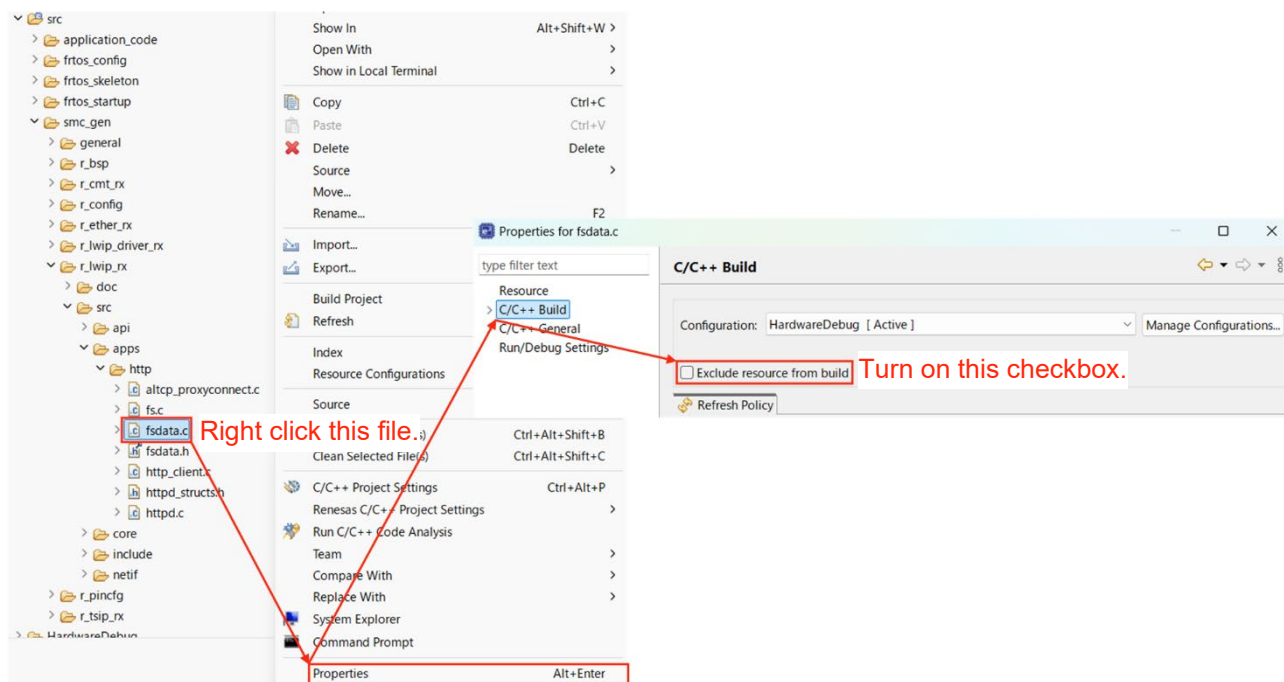
A: The FIT module may not have been correctly added to your project. Refer to the appropriate document of the two listed below to confirm how to add the FIT module to a project.

- When CS+ is in use  
Application note *RX Family: Adding Firmware Integration Technology Modules to CS+ Projects* (R01AN1826)
- When the e<sup>2</sup> studio is in use  
Application note *RX Family: Adding Firmware Integration Technology Modules to Projects* (R01AN1723)

When this FIT module is to be used, the board support package FIT module (BSP module) must also be added to the project. For details on how to add the BSP module, refer to the application note *RX Family: Board Support Package Module Using Firmware Integration Technology* (R01AN1685).

(2) Q: I have added this FIT module to the project and built it. Then I got the following error:  
E0562300:Duplicate symbol "\_file\_\_img\_sics\_gif" in ".\src\smc\_gen\r\_lwip\_rx\src\apps\http\fs.obj".

A: Exclude the file ".\src\smc\_gen\r\_lwip\_rx\src\apps\http\fsdata.c" from build.



## 5. Reference Documents

### User's Manual: Hardware

(The latest version can be downloaded from the Renesas Electronics Web site.)

### Technical Updates/Technical News

(The latest information can be downloaded from the Renesas Electronics Web site.)

### User's Manual: Development Environment

#### RX Family CC-RX Compiler User's Manual (R20UT3248)

(The latest version can be downloaded from the Renesas Electronics Web site.)

### GNU-RX Compiler Manual

(The latest version can be downloaded from the following Web site.)

<https://llvm-gcc-renesas.com/ja/gnu-tools-manuals/gnu-compiler/>

## Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Jun.20.25	-	First edition issued.
1.10	Dec.19.25	5-11	Added configuration options in section 2.7 Settings for Compilation
		14	Updated the Table 4.1 in section 4.1 Environments for Confirming Operation.
1.11	Mar.19.26	-	Included spdx file in the package.

# 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.

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