RX Family

Ethernet Module Using Firmware Integration Technology

Introduction

This application note describes an Ethernet module that uses Firmware Integration Technology (FIT). This module performs Ethernet frame transmission and reception using an Ethernet controller and an Ethernet controller DMA controller. In the remainder of this document, this module is called the Ethernet FIT module.

Pin setting in the Ethernet FIT module has been removed from Rev.1.11. In order to use the Ethernet FIT module, assign input and output signals for Ethernet Controller to I/O Ports. Refer to section 4 Pin Setting in detail.

Target Devices

This API supports the following devices.

- RX64M
- RX71M
- RX65N
- RX72M
- RX72N
- RX66N

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.

Target Compilers

- Renesas Electronics C/C++ Compiler Package for RX Family
- GCC for Renesas RX
- IAR C/C++ Compiler for Renesas RX

For details of the confirmed operation contents of each compiler, refer to “6.2 Confirmed Operation Environment”.

Related Documents

- Board Support Package Module Using Firmware Integration Technology (R01AN1685)
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1. Overview
The Ethernet FIT module uses an Ethernet controller (ETHERC) and an Ethernet controller DMA controller (EDMAC) and a PHY management interface (PMGI)*1 to implement Ethernet frame transmission and reception. The Ethernet FIT module supports the following functions.

- MII (Media Independent Interface) and RMII (Reduced Media Independent Interface)
- An automatic negotiating function is used for the Ethernet PHY-LSI link.
- The link state is detected using the link signals output by the Ethernet PHY-LSI.
- The result of the automatic negotiation is acquired from the Ethernet PHY-LSI and the connection mode (full or half duplex, 10 or 100 Mbps transfer rate) is set in the ETHERC.

Note 1. Use PMGI if ETHER_CFG_NON_BLOCKING is set to 1.

1.1 Ethernet FIT Module
The Ethernet FIT module is implemented in a project and used as the API. Refer to 2.11 Adding the FIT Module for details on implementing the module to the project.

1.2 Outline of the API
Table 1.1 lists the API functions included in the Ethernet FIT module.
### Table 1.1  API Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>R_ETHER_Initial()</td>
<td>Initializes the Ethernet driver.</td>
</tr>
<tr>
<td>R_ETHER_Open_ZC2()</td>
<td>Applies a software reset to the ETHERC, EDMAC, and PHY-LSI, after which it starts PHY-LSI auto-negotiation and enables the link signal change interrupt.</td>
</tr>
<tr>
<td>R_ETHER_Close_ZC2()</td>
<td>Disables transmit and receive functionality on the ETHERC. Does not put the ETHERC and EDMAC into the module stop state.</td>
</tr>
<tr>
<td>R_ETHER_Read()</td>
<td>Receives data in the specified receive buffer.</td>
</tr>
<tr>
<td>R_ETHER_Read_ZC2()</td>
<td>Returns a pointer to the start address of the buffer that holds the receive data.</td>
</tr>
<tr>
<td>R_ETHER_Read_ZC2_BufRelease()</td>
<td>Releases the buffer read with the R_ETHER_Read_ZC2() function.</td>
</tr>
<tr>
<td>R_ETHER_Write()</td>
<td>Transmits data from the specified transmit buffer.</td>
</tr>
<tr>
<td>R_ETHER_Write_ZC2_GetBuf()</td>
<td>Returns a pointer to the start address of the write destination for transmit data.</td>
</tr>
<tr>
<td>R_ETHER_Write_ZC2_SetBuf()</td>
<td>Enables transmission of the transmit buffer data to the EDMAC.</td>
</tr>
<tr>
<td>R_ETHER_CheckLink_ZC()</td>
<td>Checks the link state of a physical Ethernet using the PHY management interface. If the PHY is connected to an appropriately initialized remote device with a cable, the Ethernet link state becomes link-up.</td>
</tr>
<tr>
<td>R_ETHER_LinkProcess()</td>
<td>Performs link signal change detected and magic packet detected interrupt handling.</td>
</tr>
<tr>
<td>R_ETHER_WakeOnLAN()</td>
<td>Switches the ETHERC setting from normal transmission and reception to magic packet detected operation.</td>
</tr>
<tr>
<td>R_ETHER_CheckWrite()</td>
<td>Verifies that data transmission has completed.</td>
</tr>
<tr>
<td>R_ETHER_Control()</td>
<td>Performs the processing that corresponds to a specified control code.</td>
</tr>
<tr>
<td>R_ETHER_WritePHY()</td>
<td>Write access to the registers in the PHY-LSI using the PHY management interface.</td>
</tr>
<tr>
<td>R_ETHER_ReadPHY()</td>
<td>Read access to the registers in the PHY-LSI using the PHY management interface.</td>
</tr>
<tr>
<td>R_ETHER_GetVersion()</td>
<td>Returns the Ethernet FIT module version.</td>
</tr>
</tbody>
</table>
1.3 Use Limit

The Ethernet FIT module has the following limitations.

- When using the Ethernet FIT module with RX64M, RX71M, RX72M, RX72N, RX66N, address 00000000h to 0000001Fh cannot be used.
2. API Information

The API functions of the Ethernet FIT module adhere to the Renesas API naming standards.

2.1 Hardware Requirements

This driver requires your MCU supports the following feature:

- ETHERC
- EDMAC
- PMGI*1

Note 1. Use PMGI if ETHER_CFG_NON_BLOCKING is set to 1.

2.2 Software Requirements

This driver is dependent upon the following packages:

- Renesas Board Support Package (r_bsp) Rev.5.20 or higher

2.3 Supported Toolchains

The operation of the Ethernet FIT module has been confirmed with the toolchain listed as C compiler in 6.2 Confirmed Operation Environment.

2.4 Usage of Interrupt Vector

EINT0 interrupt, or EINT1 interrupt corresponding to the channel number is enabled after specified argument to channel number and calling R_ETHER_Open_ZC2 function. Table 2.1 shows each interrupt vector that Ethernet FIT module uses.

Table 2.1 List of Usage of Interrupt Vectors

<table>
<thead>
<tr>
<th>Device</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX64M</td>
<td>GROUPAL1 interrupt (Vector number. 113)</td>
</tr>
<tr>
<td>RX71M</td>
<td>● EINT0 interrupt [channel number 0] (group interrupt source number. 4)</td>
</tr>
<tr>
<td>RX72M</td>
<td>● EINT1 interrupt [channel number 1] (group interrupt source number. 5)</td>
</tr>
<tr>
<td>RX72N</td>
<td></td>
</tr>
<tr>
<td>RX65N</td>
<td>GROUPAL1 interrupt (Vector number. 113)</td>
</tr>
<tr>
<td>RX66N</td>
<td>● EINT0 interrupt [channel number 0] (group interrupt source number. 4)</td>
</tr>
<tr>
<td>RX72M</td>
<td>● PMGI0 interrupt [channel number 0] (Vector number. 252*1)</td>
</tr>
<tr>
<td>RX72N</td>
<td>● PMGI1 interrupt [channel number 1] (Vector number. 253*1)</td>
</tr>
<tr>
<td>RX66N</td>
<td>● PMGI0 interrupt [channel number 0] (Vector number. 252*1)</td>
</tr>
</tbody>
</table>

Note 1. The interrupt vector numbers for software configurable interrupt A show the default values specified in the board support package FIT module (BSP module).

2.5 Header Files

All API calls and their supporting interface definitions are located in r_ether_rx_if.h.

2.6 Integer Types

This project uses ANSI C99. These types are defined in stdint.h.
## 2.7 Configuration Overview

The configuration options in the Ethernet FIT module are specified in `rEther_rx_config.h`. When using Smart Configurator, the configuration option can be set on software component configuration screen. The setting value is automatically reflected in `rEther_rx_config.h` when adding modules to user project. The option names and setting values are listed in the table below.

<table>
<thead>
<tr>
<th>Configuration options in <code>rEther_rx_config.h</code></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>#define ETHER_CFG_MODE_SEL</code> Note: Default value = 0</td>
<td>Sets the interface between ETHERC and the Ethernet PHY-LSI. If set to 0, MII (Media Independent Interface) is selected. If set to 1, RMII (Reduced Media Independent Interface) is selected.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_CH0_PHY_ADDRESS</code> Note: Default value = 0x6</td>
<td>Specify the PHY-LSI address used by ETHERC channel 0. Specify a value between 0 and 31.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_CH1_PHY_ADDRESS</code> Note: Default value = 1x8</td>
<td>Specify the PHY-LSI address used by ETHERC channel 1. Specify a value between 0 and 31.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_EMAC_RX_DESCRIPTORS</code> Note: Default value = 1</td>
<td>Sets the number of receive descriptors. This must be set to a value 1 or greater</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_EMAC_TX_DESCRIPTORS</code> Note: Default value = 1</td>
<td>Sets the number of transmit descriptors. This must be set to a value 1 or greater</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_BUFSIZE</code> Note: Default value = 1,536</td>
<td>Specify the size of the transmit buffer or receive buffer. The buffer is aligned with 32-byte boundaries, so specify a value that is a multiple of 32 bytes.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_AL1_INT_PRIORTY</code> Note: Default value = 2</td>
<td>Sets the priority level of the group AL1 interrupt. This must be set to a value in the range 1 to 15.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_CH0_PHY_ACCESS</code> Note: Default value = 1x1x7</td>
<td>Specify the PHY access channel used by ETHERC channel 0. When 0 is specified, ETHERC0 is used for PHY register access. When 1 is specified, ETHERC1 is used for PHY register access.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_CH1_PHY_ACCESS</code> Note: Default value = 1x1x7</td>
<td>Specify the PHY access channel used by ETHERC channel 1. When 0 is specified, ETHERC0 is used for PHY register access. When 1 is specified, ETHERC1 is used for PHY register access.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_PHY_MII_WAIT</code> Note: Default value = 8</td>
<td>Specify the loop count of software loop used for read or write in PHY-LSI. Set the number of loops according to the PHY-LSI to be used. Specify a value of 1 or greater.</td>
</tr>
<tr>
<td><code>#define ETHER_CFG_PHY_DELAY_RESET</code> Note: Default value = 0x00020000</td>
<td>Specify the loop count used for timeout processing of PHY-LSI reset completion wait. Set the number of loops according to the PHY-LSI to be used.</td>
</tr>
</tbody>
</table>
#define ETHER_CFG_LINK_PRESENT
Note: Default value = 0

Specify the polarity of the link signal output by the PHY-LSI.
When 0 is specified, link-up and link-down correspond respectively to the fall and rise of the LINKSTA signal.
When 1 is specified, link-up and link-down correspond respectively to the rise and fall of the LINKSTA signal.

#define ETHER_CFG_USE_LINKSTA
Note: Default value = 1

Specify whether or not to use the PHY-LSI status register instead of the LINKSTA signal when a change in the link status is detected.  
When 0 is specified, the PHY-LSI status register is used.
When 1 is specified, the LINKSTA signal is used.

#define ETHER_CFG_USE_PHY_KSZ8041NL
Note: Default value = 0

Specify whether or not the KSZ8041NL PHY-LSI from Micrel is used.
When 0 is specified, the KSZ8041 is not used.
When 1 is specified, the KSZ8041 is used.

#define ETHER_CFG_USE_PHY_ICS1894_32
Note: Default value = 0

Specify whether or not the ICS1894-32 PHY-LSI from Renesas Electronics is used.
When 0 is specified, the ICS1894-32 is not used.
When 1 is specified, the ICS1894-32 is used.

#define ETHER_CFG_NON_BLOCKING
Note: Default value = 0

Specify whether or not to use non blocking for some API functions operation.
When 0 is specified, the non-blocking mode is not used.
When 1 is specified, the non-blocking mode is used.

#define ETHER_CFG_PMGI_CLOCK
Note: Default value = 2500000

Specify the clock of the PHY Management Station.
Specify a value in the range 97657 to 6000000

#define ETHER_CFG_PMGI_ENABLE_PREAMBLE
Note: Default value = 0

PHY Management Station Preamble Control.
When 0 is specified, include Preamble field
When 1 is specified, not include Preamble field

#define ETHER_CFG_PMGI_HOLD_TIME
Note: Default value = 0

Specify the Hold Time Adjustment of the PHY Management Station.
Specify a value in the range 0 to 7

#define ETHER_CFG_PMGI_CAPTURE_TIME
Note: Default value = 0

Define the Capture Time Adjustment of the PHY Management Station.
Specify a value in the range 0 to 7

#define ETHER_CFG_PMGI_INT_PRIORTY
Note: Default value = 2

Sets the priority level of the group PMGI interrupt.
This must be set to a value in the range 1 to 15.

Notes: 1. Refer to Table 2.2 regarding settings for operating the Ethernet FIT module on the Renesas Starter Kit+ for RX64M (product number: R0K50564MSxxxBE). Or refer to Table 2.3 regarding settings for operating the Ethernet FIT module on the Renesas Starter Kit+ for RX71M (product number: R0K50571MSxxxBE)

<table>
<thead>
<tr>
<th>Table 2.2</th>
<th>ETHER_CFG_CH0_PHY_ACCESS/ETHER_CFG_CH1_PHY_ACCESS Settings 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Pin J3</td>
<td>Short Pin J4</td>
</tr>
<tr>
<td>1 and 2 shorted</td>
<td>1 and 2 shorted</td>
</tr>
<tr>
<td>2 and 3 shorted</td>
<td>2 and 3 shorted</td>
</tr>
</tbody>
</table>
Table 2.3  ETHER_CFG_CH0_PHY_ACCESS/ETHER_CFG_CH1_PHY_ACCESS Settings 2

<table>
<thead>
<tr>
<th>Short Pin J13</th>
<th>Short Pin J9</th>
<th>ETHER_CFG_CH0_PHY_ACCESS and ETHER_CFG_CH1_PHY_ACCESS Setting Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2 shorted</td>
<td>1 and 2 shorted</td>
<td>0</td>
</tr>
<tr>
<td>2 and 3 shorted</td>
<td>2 and 3 shorted</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Setting when ETHERC and PHY-LSI are connected as shown below.

RX64M/RX71M

```
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ET0_MDC</td>
<td>ET0_MDIO</td>
</tr>
</tbody>
</table>
```

PHY-LSI

```
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MDC</td>
<td>MDIO</td>
</tr>
</tbody>
</table>
```

3. Setting when ETHERC and PHY-LSI are connected as shown below.

RX64M/RX71M

```
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ET1_MDC</td>
<td>ET1_MDIO</td>
</tr>
</tbody>
</table>
```

PHY-LSI

```
<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MDC</td>
<td>MDIO</td>
</tr>
</tbody>
</table>
```

4. This setting is valid only when the target microcontroller is the RX64M, RX71M, RX65N, RX72M, RX72N or RX66N.

5. This setting is valid for all channels when the target microcontroller is the RX64M, RX71M, RX72M or RX72N.

6. The default value is a numeric value based on the initial setting of Renesas Starter Kit+ for RX64M, Renesas Starter Kit+ for RX71M. When using Renesas Starter Kit+ for RX65N (product number. RTK500565NSxxxxxBE) or Renesas Starter Kit+ for RX65N-2MB (product number. RTK50565N2SxxxxxBE), set the value to 30. When using Renesas Starter Kit+ for RX72M (product number. RTK5572Mxxxxx), set the value to 1.

7. The default value is a numeric value based on the initial setting of Renesas Starter Kit+ for RX64M, Renesas Starter Kit+ for RX71M or Renesas Starter Kit+ for RX72N. When using Renesas Starter Kit+ for RX65N, Renesas Starter Kit+ for RX65N-2MB or Renesas Starter Kit+ for RX72M set the value to 0.

8. The default value is a numeric value based on the initial setting of Renesas Starter Kit+ for RX64M, Renesas Starter Kit+ for RX71M or Renesas Starter Kit+ for RX72N. When using Renesas Starter Kit+ for RX72M (product number. RTK5572Mxxxxx), set the value to 2.

9. These macros are only valid when $\text{ETHER\_CFG\_NON\_BLOCKING} == 1$.

10. The PHY-LSI ICS1894-32 only support full-duplex mode. If you enable this option, prepare a device that support full-duplex mode as the communication partner.

11. This setting can be set to 1 only when the target microcontroller is the RX72M, RX72N, RX66N. Set the value to 0 when the target microcontroller is the RX64M, RX65N, RX71M.
2.8 Code Size

The code size when using the supported toolchain (see section 2.3) is assumed to be that when optimization level 2 and optimization for code size are used. The sizes of ROM (code and constants) and RAM (global data) are set in the configuration header file of the Ethernet FIT module and determined at build time by configuration options.

The values in the table below are confirmed under the following conditions.

- Module Revision: r_ether_rx rev1.23
- Compiler Version: Renesas Electronics C/C++ Compiler Package for RX Family V3.04.00
  (Compiler option is default setting when using the Smart Configurator.)
  GCC for Renesas RX 8.3.0.202104
  (Compiler option is default setting when using the Smart Configurator.)
  IAR C/C++ Compiler for Renesas RX version 4.20.1
  (Compiler option is default setting of the integrated development environment.)
- Configuration Options: Default settings

<table>
<thead>
<tr>
<th>Device</th>
<th>Category</th>
<th>Memory Used</th>
<th>Renesas Compiler</th>
<th>GCC</th>
<th>IAR Compiler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Blocking(^3)</td>
<td>Non-blocking(^4)</td>
<td>Blocking</td>
</tr>
<tr>
<td>RX72M(^1)</td>
<td>ROM</td>
<td>4,703 bytes</td>
<td>6,703 bytes</td>
<td>9,588 bytes</td>
<td>13,654 bytes</td>
</tr>
<tr>
<td></td>
<td>RAM</td>
<td>6,281 bytes</td>
<td>6,349 bytes</td>
<td>6,272 bytes</td>
<td>6,392 bytes</td>
</tr>
<tr>
<td></td>
<td>STACK(^2)</td>
<td>148 bytes</td>
<td>148 bytes</td>
<td>-</td>
<td>216 bytes</td>
</tr>
<tr>
<td>RX65N(^1)</td>
<td>ROM</td>
<td>4,577 bytes</td>
<td>9,312 bytes</td>
<td>5,674 bytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RAM</td>
<td>3,146 bytes</td>
<td>3,200 bytes</td>
<td>3,146 bytes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>STACK(^2)</td>
<td>148 bytes</td>
<td>-</td>
<td>168 bytes</td>
<td></td>
</tr>
</tbody>
</table>

Note1: With the following settings: ETHER_CFG_EMAC_RX_DESCRIPTORS = 1,
ETHER_CFG_EMAC_TX_DESCRIPTORS = 1, ETHER_CFG_BUFSIZE = 1536
Note2: The sizes of maximum usage stack of Interrupts functions is included.
Note3: The sizes when ETHER_CFG_NON_BLOCKING = 0.
Note4: The sizes when ETHER_CFG_NON_BLOCKING = 1.
2.9 Arguments

This section documents the enumerations, unions, and structures used as arguments to API functions. These are included in the r_ether_rx_if.h header file along with the API function prototype declarations.

typedef enum
{
    CONTROL_SET_CALLBACK,    /* Callback function registration */
    CONTROL_SET_PROMISCUOUS_MODE,  /* Promiscuous mode setting */
    CONTROL_SET_INT_HANDLER,   /* Interrupt handler function registration */
    CONTROL_POWER_ON,        /* Cancel ETHERC/EDMAC module stop */
    CONTROL_POWER_OFF,       /* Transition to ETHERC/EDMAC module stop */
    CONTROL_MULTICASTFRAME_FILTER,  /* Multicast frame filter setting */
    CONTROL_BROADCASTFRAME_FILTER,  /* Broadcast frame filter continuous */
    CONTROL_RECEIVE_DATA_PADDING, /* Insert receive data padding */
    CONTROL_SET_PMGI_CALLBACK /* Set PMGI callback */
} ether_cmd_t;

typedef union
{
    ether_cb_t ether_callback;    /* Callback function pointer */
    ether_promiscuous_t * p_ether_promiscuous;  /* Promiscuous mode setting */
    ether_cb_t ether_int_hnd; /* Interrupt handler function pointer */
    uint32_t channel;      /* ETHERC channel number */
    ether_multicast_t * p_ether_multicast; /* Multicast frame filter setting */
    ether_broadcast_t * p_ether_broadcast; /* Broadcast frame filter setting */
    ether_cb_t pmgi_callback;    /* PMGI callback function pointer */
    ether_recv_padding_t * padding_param; /* Parameters for inserting received data padding */
} ether_param_t;

typedef struct
{
    void (*pcb_func)(void *);   /* Callback function pointer */
    void (*pcb_int_hnd)(void *);  /* Interrupt handler function pointer */
    void (*pcb_pmgi_hnd) (void *); /* PGMI callback function pointer */
} ether_cb_t;

typedef enum
{
    ETHER_PROMISCUOUS_OFF,    /* ETHERC operates in standard mode */
    ETHER_PROMISCUOUS_ON    /* ETHERC operates in promiscuous mode */
} ether_promiscuous_bit_t;

typedef enum
{
    ETHER_MC_FILTER_OFF,    /* Disable multicast frame filter */
    ETHER_MC_FILTER_ON    /* Enable multicast frame filter */
} ether_mc_filter_t;
typedef struct
{
    uint32_t      channel;  /* ETHERC channel */
    ether_promiscuous_bit_t bit;   /* Promiscuous mode */
} ether_promiscuous_t;

typedef struct
{
    uint32_t     channel;  /* ETHERC channel */
    ether_mc_filter_t  flag;   /* Multicast frame filter setting */
} ether_multicast_t;

typedef struct
{
    uint32_t     channel;  /* ETHERC channel */
    uint32_t   counter;    /* Broadcast frame continuous receive count */
} ether_broadcast_t;

typedef enum
{
    ETHER_CB_EVENT_ID_WAKEON_LAN,  /* Magic packet detection */
    ETHER_CB_EVENT_ID_LINK_ON,    /* Link up detection */
    ETHER_CB_EVENT_ID_LINK_OFF    /* Link down detection */
} ether_cb_event_t;

typedef struct
{
    uint32_t    channel;   /* ETHERC channel */
    ether_cb_event_t  event_id;   /* Event code for callback function */
    uint32_t    status_ecsr;    /* ETHERC status register for interrupt handler */
    uint32_t    status_eesr;    /* ETHERC/EDMAC status register for interrupt handler */
} ether_cb_arg_t;

typedef struct
{
    uint32_t   channel;      /* ETHERC channel */
    uint8_t   position;     /* Padding insertion position */
    uint8_t   size;       /* Padding insertion size */
}ether_recvPadding_t;

typedef enum
{
    OPEN_ZC2 = 0,      /* Executing R_ETHER_Open_ZC2 function */
    CHECKLINK_ZC,      /* Executing R_ETHER_CheckLink_ZC function */
    LINKPROCESS,   /* Executing R_ETHER_LinkProcess function */
    WAKEONLAN,    /* Executing R_ETHER_WakeOnLAN function */
    LINKPROCESS_OPEN_ZC2,    /* Executing R_ETHER_LinkProcess function */
    LINKPROCESS_CHECKLINK_ZC0,    /* Executing R_ETHER_LinkProcess function */
    LINKPROCESS_CHECKLINK_ZC1,    /* Executing R_ETHER_LinkProcess function */
    LINKPROCESS_CHECKLINK_ZC2,    /* Executing R_ETHER_LinkProcess function */
    WAKEONLAN_CHECKLINK_ZC,    /* Executing R_ETHER_WakeOnLAN function */
    WRITEPHY,    /* Executing R_ETHER_WritePHY function */
    READPHY,    /* Executing R_ETHER_ReadPHY function */
    PMGI_MODE_NUM    /* PMGI operation mode number */
}pmgi_mode_t;
typedef enum
{
    STEP0 = 0,       /* PMGI operation step 0 */
    STEP1,         /* PMGI operation step 1 */
    STEP2,         /* PMGI operation step 2 */
    STEP3,         /* PMGI operation step 3 */
    STEP4,         /* PMGI operation step 4 */
    STEP5,         /* PMGI operation step 5 */
    STEP6,         /* PMGI operation step 6 */
    PMGI_STEP_NUM, /* PMGI operation step number */
} pmgi_step_t;

typedef enum
{
    PMGI_IDLE = 0,      /* PMGI is idle */
    PMGI_RUNNING = 1,     /* PMGI is running */
    PMGI_COMPLETE = 2,     /* PMGI is complete */
    PMGI_ERROR = -1      /* PMGI is error */
} pmgi_event_t;

typedef struct
{
    ether_return_t (* p_func)(uint32_t ether_channel);
    /* Type of function pointer array */
} st_pmgi_interrupt_func_t;

typedef struct
{
    bool        locked;   /* The flag of PMGI locked status */
    pmgi_event_t event;    /* PMGI current operation status */
    pmgi_mode_t     mode;    /* PMGI operation mode */
    pmgi_step_t     step;    /* PMGI operation step */
    uint16_t        read_data;  /* The read value of PMGI register */
    uint32_t        reset_counter; /* The counter of reading reset register */
    uint32_t        ether_channel; /* ETHERC channel number */
} pmgi_param_t;

typedef struct
{
    uint32_t         channel;   /* ETHERC channel */
    pmgi_event_t     event;    /* Event code for callback function */
    pmgi_mode_t   mode;    /* PMGI operation mode */
    uint16_t        reg_data;  /* PHY register data for interrupt handler */
} pmgi_cb_arg_t;
2.10 Return Values

This section describes return values of API functions. This enumeration is located in rEther_rx_if.h as are the prototype declarations of API functions.

typedef enum /* Error code of Ether API */
{
ETHER_SUCCESS,    /* Processing completed successfully */
ETHER_ERR_INVALID_PTR, /* Value of the pointer is NULL or FIT_NO_PTR */
ETHER_ERR_INVALID_DATA, /* Value of the argument is out of range */
ETHER_ERR_INVALID_CHAN, /* Nonexistent channel number */
ETHER_ERR_INVALID_ARG, /* Invalid argument */
ETHER_ERR_LINK, /* Auto-negotiation is not completed, and */
/*transmission/reception is not enabled. */
ETHER_ERR_MPDE, /* As a Magic Packet is being detected, and */
/* transmission/reception is not enabled. */
ETHER_ERR_TACT, /* Transmit buffer is not empty. */
ETHER_ERR_CHAN_OPEN, /* Indicates the Ethernet cannot be opened because */
/*it is being used by another application*/
ETHER_ERR_MC_FRAME, /* Multicast frame detected when multicast frame */
/*filtering is enabled. */
ETHER_ERR_RECV_ENABLE, /* Could not change setting because receive */
/*function is enabled. */
ETHER_ERR_LOCKED, /* When non-blocking mode is enabled, during PHY */
/*access. */
ETHER_ERR_OTHER /* Other error */
} ether_return_t;
2.11 Callback Function

(1) Callback Function Called by API Function R_ETHER_LinkProcess
In the Ethernet FIT module, a callback function is called when either a magic packet or a link signal change is detected.

To set up the callback function, use the function R_ETHER_Control(), which is described later in this document, and set the control code CONTROL_SET_CALLBACK as the enumeration (the first argument) described in 2.9 Arguments, and set the address of the function to be registered as the callback function in the structure (the second argument).

When the callback function is called, a variable in which the channel number for which the detection occurred and a constant shown in Table 2.4 are stored is passed as an argument. If the value of this argument is to be used outside the callback function, its value should be copied into, for example, a global variable.

Table 2.4 Argument List of the callback Function

<table>
<thead>
<tr>
<th>Constant Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ETHER_CB_EVENT_ID_WAKEON_LAN</td>
<td>Detect magic packet</td>
</tr>
<tr>
<td>ETHER_CB_EVENT_ID_LINK_ON</td>
<td>Detect link signal change (link-up)</td>
</tr>
<tr>
<td>ETHER_CB_EVENT_ID_LINK_OFF</td>
<td>Detect link signal change (link-down)</td>
</tr>
</tbody>
</table>

(2) Callback Function Called by EINT0/EINT1 Status Interrupts
The Ethernet FIT module calls an interrupt handler when an interrupt indicating a condition other than the following occurs.

- Magic Packet detection operation by the Ethernet FIT module
  - Link signal change detection*1
  - Magic packet detection
- Normal operation by the Ethernet FIT module
  - Link signal change detection*1
  - Frame receive detection or frame transmit end detection

To specify the interrupt handler, use the R_ETHER_Control function described below to set the control code “CONTROL_SET_INT_HANDLER” in the enumeration (first argument) shown in 2.9 Arguments, and set the function address of the interrupt handler to be registered in the structure (second argument).

When the interrupt handler function is called, variables in which are stored the number of the channel on which the interrupt occurred, the ETHERC status register value, and the ETHERC/EDMAC status register value are passed as arguments. To use the argument values in functions other than the callback function, copy them to global variables or the like.

Note 1. If the setting of #define ETHER_CFG_USE_LINKSTA is 0, the interrupt handler function is not called when a link signal change is detected.

(3) Callback Function Called by PMGI interrupt
In the Ethernet FIT module, call the callback function when the non-blocking API function processing is completed.

To set up the callback function, use the function R_ETHER_Control(), which is described later in this document, and set the control code CONTROL_SET_PMGI_CALLBACK as the enumeration (the first argument) described in 2.9 Arguments, and set the address of the function to be registered as the callback function in the structure (the second argument).

When the callback function is called, the channel number for which API processing has been completed, the variable storing the constants shown in Table 2.5, the variable storing the constants shown in Table 2.6, and the PHY register read data are passed as arguments. When using the argument value outside the callback function, copy it to a variable such as a global variable.
<table>
<thead>
<tr>
<th>Constant Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OPEN_ZC2</td>
<td>Processing of the R_ETHER_Open_ZC2 function is complete.</td>
</tr>
<tr>
<td>CHECKLINK_ZC</td>
<td>Processing of the R_ETHER_CheckLink_ZC function is complete.</td>
</tr>
<tr>
<td>LINKPROCESS</td>
<td>Processing of the R_ETHER_LinkProcess function is complete.</td>
</tr>
<tr>
<td>WAKEONLAN</td>
<td>Processing of the R_ETHER_WakeOnLAN function is complete.</td>
</tr>
<tr>
<td>WRITEPHY</td>
<td>Processing of the R_ETHER_WritePHY function is complete.</td>
</tr>
<tr>
<td>READPHY</td>
<td>Processing of the R_ETHER_ReadPHY function is complete.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Constant Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMGI_COMPLETE</td>
<td>API function processing completed successfully. In the case of the R_ETHER_CheckLink_ZC function, a link up was detected.</td>
</tr>
<tr>
<td>PMGI_ERROR</td>
<td>API function processing ended abnormally. In the case of the R_ETHER_CheckLink_ZC function, a link down was detected.</td>
</tr>
<tr>
<td>PMGI_IDLE</td>
<td>API function processing completed successfully without PMGI operation. In the case of the R_ETHER_LinkProcess function, no PMGI operations are performed during function execution.</td>
</tr>
</tbody>
</table>
2.12 Adding the FIT Module to Your Project

This module must be added to each project in which it is used. Renesas recommends the method using the Smart Configurator described in (1) or (3) or (5) 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 “RX Smart Configurator User’s Guide: e² studio (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 “RX Family 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 “RX Smart Configurator User’s Guide: CS+ (R20AN0470)” 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 “RX Family Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)” for details.

(5) Adding the FIT module to your project using the Smart Configurator in IAREW
By using the Smart Configurator Standalone version, the FIT module is automatically added to your project. Refer to “RX Smart Configurator User’s Guide: IAREW (R20AN0535)” for details.
2.13 Ethernet Frame Format

The Ethernet FIT module supports the Ethernet II/IEEE 802.3 frame format.

2.13.1 Frame Format for Data Transmission and Reception

Figure 2.1 shows the Ethernet II/IEEE 802.3 frame format.

![Figure 2.1 Ethernet II/IEEE 802.3 Frame Format](image)

The preamble and SFD signal the start of an Ethernet frame. The FCS contains the CRC of the Ethernet frame and is calculated on the transmitting side. When data is received the CRC value of the frame is calculated in hardware, and the Ethernet frame is discarded if the values do not match.

When the hardware determines that the data is normal, the valid range of receive data is: (transmission destination address) + (transmission source address) + (length/type) + (data).

2.13.2 PAUSE Frame Format

Table 2.2 shows the PAUSE frame format.

![Figure 2.2 PAUSE Frame Format](image)

The transmission destination address is specified as 01:80:C2:00:00:01 (a multicast address reserved for PAUSE frames). At the start of the payload the length/type is specified as 0x8808 and the operation code as 0x0001.

The pause duration in the payload is specified by the value of the automatic PAUSE (AP) bits in the automatic PAUSE frame setting register (APR), or the manual PAUSE time setting (MP) bits in the manual PAUSE frame setting register (MPR).

2.13.3 Magic Packet Frame Format

Table 2.3 shows the Magic Packet frame format.

![Figure 2.3 Magic Packet Frame Format](image)

In a Magic Packet, the value FF:FF:FF:FF:FF:FF followed by the transmission destination address repeated 16 times is inserted somewhere in the Ethernet frame data.
2.14 “for”, “while” and “do while” statements

In this module, “for”, “while” and “do while” statements (loop processing) are used in processing to wait for register to be reflected and so on. For these loop processing, comments with “WAIT_LOOP” as a keyword are described. Therefore, if user incorporates fail-safe processing into loop processing, user can search the corresponding processing with “WAIT_LOOP”.

The following shows example of description.

while statement example :
/* WAIT_LOOP */
while(0 == SYSTEM.OSCOVFSR.BIT.PLOVF)
{
    /* The delay period needed is to make sure that the PLL has stabilized. */
}

for statement example :
/* Initialize reference counters to 0. */
/* WAIT_LOOP */
for (i = 0; i < BSP_REG_PROTECT_TOTAL_ITEMS; i++)
{
    g_protect_counters[i] = 0;
}

do while statement example :
/* Reset completion waiting */
do
{
    reg = phy_read(ether_channel, PHY_REG_CONTROL);
    count++;
} while ((reg & PHY_CONTROL_RESET) && (count < ETHER_CFG_PHY_DELAY_RESET)); /* WAIT_LOOP */
3. API Functions

3.1 R_ETHER_Initial()

This function makes initial settings to the Ethernet FIT module.

Format

```c
void R_ETHER_Initial(void);
```

Parameters

None

Return Values

None

Properties

Prototyped in rEtherRx_if.h.

Description

Initializes the memory to be used in order to start Ethernet communication.

Example

```c
#include "platform.h"
#include "rEtherRx_if.h"

void callback_sample(void*);
void int_handler_sample(void*);

ether_return ret;
ether_param_t param;
ether_cb_t cb_func;

/* Ethernet channel number
   * ETHER_CHANNEL_0 = Ethernet channel number is 0
   * ETHER_CHANNEL_1 = Ethernet channel number is 1
   */
uint32_t channel;

/* Initialize memory which ETHERC/EDMAC is used */
R_ETHER_Initial();

channel = ETHER_CHANNEL_0
param.channel = channel;

/* Set the callback function */
cb_func.pcb_func = &callback_sample;
param.ether_callback = cb_func;
ret = R_ETHER_Control(CONTROL_SET_CALLBACK, param);

/* Set the interrupt handler */
cb_func.pcb_int_hnd = &int_handler_sample;
```
param.ether_int_hnd = cb_func;
ret = R_ETHER_Control(CONTROL_SET_INT_HANDLER, param);

/* Release ETHERC and EDMAC module stop, port settings using ETHERC */
ret = R_ETHER_Control(CONTROL_POWER_ON, param);
if(ETHER_SUCCESS == ret)
{
    /* Initialized successfully completed without ETHERC, EDMAC */
}

**Special Notes:**

This function must be called before calling the `R_ETHER_Open_ZC2()` function.
3.2 R_ETHER_Open_ZC2()

When using the ETHER API, this function is used first.

Format

```c
ether_return_t R_ETHER_Open_ZC2(
    uint32_t   channel  /* ETHERC channel number */
    const uint8_t mac_addr[] /* The MAC address of ETHERC */
    uint8_t   pause  /* Specifies whether flow control */
    /* functionality is enabled or disabled. */
);```

Parameters

- **channel**
  Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

- **mac_addr**
  Specifies the MAC address of ETHERC.

- **pause**
  Specifies the value set in bit 10 (Pause) in register 4 (auto-negotiation advertisement) of the PHY-LSI. The setting ETHER_FLAG_ON is possible only when the user’s PHY-LSI supports the pause function. This value is passed to the other PHY-LSI during auto-negotiation. Flow control is enabled if the auto-negotiation result indicates that both the local PHY-LSI and the other PHY-LSI support the pause function. Specify ETHER_FLAG_ON to convey that the pause function is supported to the other PHY-LSI during auto-negotiation, and specify ETHER_FLAG_OFF if the pause function is not supported or will not be used even though it is supported.

Return Values

- **ETHER_SUCCESS** /* Processing completed successfully or the PMGI operation start */
- **ETHER_ERR_INVALID_CHAN** /* Nonexistent channel number */
- **ETHER_ERR_INVALID_PTR** /* Value of the pointer is NULL or FIT_NO_PTR */
- **ETHER_ERR_INVALID_DATA** /* Value of the argument is out of range */
- **ETHER_ERR_OTHER** /* PHY-LSI initialization failed */
  /* when the non-blocking mode is enabled */
  /* and PMGI callback function is not registered */
- **ETHER_ERR_LOCKED** /* When PHY access is in progress when non-blocking mode is enabled */

Properties

Prototyped in r Ether rx_if.h.

Description

The R_ETHER_Open_ZC2() function resets the ETHERC, EDMAC and PHY-LSI by software, and starts PHY-LSI auto-negotiation to enable the link signal change interrupt.

The MAC address is used to initialize the ETHERC MAC address register.

When non-blocking mode is enabled, the processing result of the function is passed as an argument of the PMGI callback function.
Example
The MAC address used in the sample code is assigned based on the vendor ID of Renesas Electronics Corporation. Customers developing products must use a MAC address obtained by submitting an application to the IEEE.

```c
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return ret;

/* Source MAC Address */
static uint8_t mac_addr_src[6] = {0x74,0x90,0x50,0x00,0x79,0x01};

/* Flow control function
 * ETHER_FLAG_ON = Use flow control function
 * ETHER_FLAG_OFF = No use flow control function
 */
static volatile uint8_t pause_enable = ETHER_FLAG_OFF;

/* Ethernet channel number
 * ETHER_CHANNEL_0 = Ethernet channel number is 0
 * ETHER_CHANNEL_1 = Ethernet channel number is 1
 */
uint32_t channel;

channel = ETHER_CHANNEL_0;

/* Initialize ETHERC, EDMAC */
ret = R_ETHER_Open_ZC2(channel, mac_addr_src, pause_enable);
if(ETHER_SUCCESS == ret)
{
    while(1)
    {
        /* Check Link status when Initialized successfully completed */
        R_ETHER_LinkProcess(channel);
    }
}

Special Notes:
Either after the R_ETHER_initial() function is called immediately following a power-on reset, or after the R_ETHER_Close_ZC2() function was called, applications should only use the other API functions after first calling this function and verifying that the return value is ETHER_SUCCESS.
3.3 R_ETHER_Close_ZC2()

The R_ETHER_Close_ZC2() function disables transmit and receive functionality on the ETHERC. This function does not put the ETHERC and EDMAC into the module stop state.

Format

```c
ether_return_t R_ETHER_Close_ZC2(
    uint32_t channel   /* ETHERC channel number */
);
```

Parameters

`channel`

Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

Return Values

- `ETHER_SUCCESS` /* Processing completed successfully */
- `ETHER_ERR_INVALID_CHAN` /* Nonexistent channel number */

Properties

Prototyped in `r_ether_rx_if.h`.

Description

The R_ETHER_Close_ZC2() function disables transmit and receive functionality on the ETHERC and disables Ethernet interrupts. It does not put the ETHERC and EDMAC into the module stop state.

Execute this function to end the Ethernet communication.

Example

```c
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return   ret;

/* Ethernet channel number
* ETHER_CHANNEL_0 = Ethernet channel number is 0
* ETHER_CHANNEL_1 = Ethernet channel number is 1
*/
uint32_t    channel;

channel = ETHER_CHANNEL_0;

/* Disable transmission and receive function */
ret = R_ETHER_Close_ZC2(channel);
if(ETHER_SUCCESS == ret)
{
    goto end;
}
```

Special Notes:

None
3.4 R_ETHER_Read_ZC2()

The R_ETHER_Read_ZC2() function returns a pointer to the starting address of the buffer storing the receive data.

Format

```c
int32_t R_ETHER_Read_ZC2(
    uint32_t  channel /* ETHERC channel number */
    void  ** pbuf  /* Pointer to buffer that holds the receive data */
);
```

Parameters

** channel

Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

** pbuf

Returns a pointer to the starting address of the buffer storing the receive data.

Return Values

- A value of 1 or greater /* Returns the number of bytes received. */
- ETHER_NO_DATA /* A zero value indicates no data is received. */
- ETHER_ERR_INVALID_CHAN /* Nonexistent channel number */
- ETHER_ERR_INVALID_PTR /* Value of the pointer is NULL or FIT_NO_PTR */
- ETHER_ERR_LINK /* Auto-negotiation is not completed, and reception is not enabled. */
- ETHER_ERR_MPDE /* As a Magic Packet is being detected, transmission and reception is not enabled. */
- ETHER_ERR_MC_FRAME /* Multicast frame detected when multicast frame filtering is enabled. */

Properties

Prototyped in r_ether_rx_if.h.

Description

The driver’s buffer pointer to the starting address of the buffer storing the receive data is returned in the parameter pbuf. Returning the pointer allows the operation to be performed with zero-copy. Return value shows the number of received bytes. If there is no data available at the time of the call, ETHER_NO_DATA is returned. When auto-negotiation is not completed, and reception is not enabled, ETHER_ERR_LINK is returned. ETHER_ERR_MPDE is returned when a Magic Packet is being detected.

The EDMAC hardware operates independent of the R_ETHER_Read_ZC2() function and reads data into a buffer pointed by the EDMAC receive descriptor. The buffer pointed by the EDMAC receive descriptor is statically allocated by the driver.

When multicast frame filtering on the specified channel is enabled by the R_ETHER_Control function, the buffer is released immediately when a multicast frame is detected. Also, the value ETHER_ERR_MC_FRAME is returned. Note that when hardware-based multicast frame filtering is enabled on the RX64M, RX71M, RX72M, RX72N or RX66N, multicast frames are discarded by the hardware and detection is not possible. For details, see section 6.1 EPTPC Light FIT Module.

Frames that generate a receive FIFO overflow, residual-bit frame receive error, long frame receive error, short frame receive error, PHY-LSI receive error, or receive frame CRC error are treated as receive frame errors. When a receive frame error occurs, the descriptor data is discarded, the status is cleared, and reading of data continues.
Example

```c
#include <string.h>
#include "platform.h"
#include "r Ether_rx_if.h"

ether_return ret;
uint8_t * pread_buffer_address;
uint8_t * pbuf;

/* Ethernet channel number
 * ETHER_CHANNEL_0 = Ethernet channel number is 0
 * ETHER_CHANNEL_1 = Ethernet channel number is 1
 */
uint32_t channel;

channel = ETHER_CHANNEL_0;

ret = R_ETHER_Read_ZC2(channel, (void **)&pread_buffer_address);
/* When there is data to receive */
if(ETHER_NO_DATA < ret)
{
    memcpy(pbuf, pread_buffer_address, (uint32_t)ret);
    /* Release the receive buffer after reading the receive data. */
    R_ETHER_Read_ZC2_BufRelease(channel);
}
```

Special Notes:

This function is used in combination with the R_ETHER_Read_ZC2_BufRelease function. Always call the R_ETHER_Read_ZC2 function and then the R_ETHER_Read_ZC2_BufRelease function in sequence. If the value ETHER_ERR_LINK is returned when this function is called, initialize the Ethernet FIT module.
3.5 R_ETHER_Read_ZC2_BufRelease()

The R_ETHER_Read_ZC2_BufRelease() function releases the buffer read by the R_ETHER_Read_ZC2() function.

Format

```c
int32_t R_ETHER_Read_ZC2_BufRelease(
    uint32_t channel   /* Specifies the ETHERC channel number. */
);
```

Parameters

channel

Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

Return Values

- **ETHER_SUCCESS** /* Processing completed successfully */
- **ETHER_ERR_INVALID_CHAN** /* Nonexistent channel number */
- **ETHER_ERR_LINK** /* Auto-negotiation is not completed, and reception is not enabled. */
- **ETHER_ERR_MPDE** /* As a Magic Packet is being detected, transmission and reception */
  /* is not enabled. */

Properties

Prototyped in r_ether_rx_if.h.

Description

The R_ETHER_Read_ZC2_BufRelease() function releases the buffer read by the R_ETHER_Read_ZC2() function.

Example

```c
#include <string.h>
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return    ret;
uint8_t   * pread_buffer_address;
uint8_t   * pbuf;

/* Ethernet channel number
 * ETHER_CHANNEL_0 = Ethernet channel number is 0
 * ETHER_CHANNEL_1 = Ethernet channel number is 1
 */
uint32_t    channel;

channel = ETHER_CHANNEL_0;

ret = R_ETHER_Read_ZC2(channel, (void **)&pread_buffer_address);
/* When there is data to receive */
if(ETHER_NO_DATA < ret)
    {
        memcpy(pbuf, pread_buffer_address, (uint32_t)ret);
    }
```
/* Release the receive buffer after reading the receive data. */
R_ETHER_Read_ZC2_BufRelease(channel);
}

**Special Notes:**

Before calling this function, use the R_ETHER_Read_ZC2 function to read data. Call this function after a value of 1 or greater is returned.

This function is used in combination with the R_ETHER_Read_ZC2_BufRelease function. Always call the R_ETHER_Read_ZC2 function and then the R_ETHER_Read_ZC2_BufRelease function in sequence. If the value ETHER_ERR_LINK is returned when this function is called, initialize the Ethernet FIT module.
3.6 R_ETHER_Write_ZC2_GetBuf()

The R_ETHER_Write_ZC2_GetBuf() function returns a pointer to the starting address of the transmit data destination.

Format

```c
ether_return_t R_ETHER_Write_ZC2_GetBuf(
     uint32_t  channel    /* ETHERC channel number */
     void **  pbuf        /* Pointer to the starting address of the */
                      /* transmit data destination */
     uint16_t * pbuf_size  /* The Maximum size to write to the buffer */
);
```

Parameters

- **channel**
  Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

- **pbuf**
  Returns a pointer to the starting address of the transmit data destination.

- *pbuf_size*
  Returns the maximum size to write to the buffer.

Return Values

- **ETHER_SUCCESS** /* Processing completed successfully */
- **ETHER_ERR_INVALID_CHAN** /* Nonexistent channel number */
- **ETHER_ERR_INVALID_PTR** /* Value of the pointer is NULL or FIT_NO_PTR */
- **ETHER_ERR_LINK** /* Auto-negotiation is not completed, and reception is not enabled. */
- **ETHER_ERR_MPDE** /* As a Magic Packet is being detected, transmission and reception */
                      /* is not enabled. */
- **ETHER_ERR_TACT** /* Transmit buffer is not empty. */

Properties

Prototyped in r_ether_rx_if.h.

Description

The R_ETHER_Write_ZC2_GetBuf() function returns the parameter pbuf containing a pointer to the starting address of the transmit data destination. The function also returns the maximum size to write to the buffer to the parameter pbuf_size. Returning the pointer allows the operation to be performed with zero-copy.

Return values indicate if the transmit buffer (pbuf) is writable or not. ETHER_SUCCESS is returned when the buffer is writable at the time of the call. When auto-negotiation is not completed, and transmission is not enabled, ETHER_ERR_LINK is returned. ETHER_ERR_MPDE is returned when a Magic Packet is being detected. ETHER_ERR_TACT is returned when the transmit buffer is not empty.

The EDMAC hardware operates independent of the R_ETHER_Write_ZC2_GetBuf() function and writes data stored in a buffer pointed by the EDMAC transmit descriptor. The buffer pointed by the EDMAC transmit descriptor is statically allocated by the driver.
Example

The MAC address used in the sample code is assigned based on the vendor ID of Renesas Electronics Corporation. Customers developing products must use a MAC address obtained by submitting an application to the IEEE.

```c
#include <string.h>
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return ret;
uint8_t * pwrite_buffer_address;
uint8_t * pbuf;
uint16_t buf_size;

/* Transmit data */
static uint8_t send_data[60] =
{  
    0x74,0x90,0x50,0x00,0x79,0x02,        /* Destination MAC address */
    0x74,0x90,0x50,0x00,0x79,0x01,        /* Source MAC address       */
    0x00,0x00,                            /* The type field is not used */
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
};

/* Ethernet channel number */
* ETHER_CHANNEL_0 = Ethernet channel number is 0
* ETHER_CHANNEL_1 = Ethernet channel number is 1
*/
uint32_t channel;

channel = ETHER_CHANNEL_0;

ret = R_ETHER_Write_ZC2_GetBuf(channel, (void **)&pwrite_buffer_address, &buf_size);
/* When transmission buffer is empty */
if(ETHER_SUCCESS == ret)
{
    /* Write the transmit data to the transmission buffer. */
    memcpy(pwrite_buffer_address, send_data, sizeof(send_data));

    R_ETHER_Write_ZC2_SetBuf(channel, sizeof(send_data));

    /* Verifying that the transmission is completed */
    ret = R_ETHER_CheckWrite(channel);
    if(ETHER_SUCCESS == ret)
    {
        /* Transmission is completed */
    }
}
```

Special Notes:

This function is used in combination with the R_ETHER_Write_ZC2_SetBuf function. Always call the R_ETHER_Write_ZC2_GetBuf function and then the R_ETHER_Write_ZC2_SetBuf function in sequence. If the value ETHER_ERR_LINK is returned when this function is called, initialize the Ethernet FIT module.
3.7 **R_ETHER_Write_ZC2_SetBuf()**

The R_ETHER_Write_ZC2_SetBuf() function enables the EDMAC to transmit the data in the transmit buffer.

**Format**

```c
ether_return_t R_ETHER_Write_ZC2_SetBuf(
    uint32_t channel   /* ETHERC channel number */
    const uint32_t len   /* The size (60 to 1,514 bytes) which is the */
                        /* Ethernet frame length minus 4 bytes of CRC */
);
```

**Parameters**

- **channel**
  Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

- **len**
  Specifies the size (60 to 1,514 bytes) which is the Ethernet frame length minus 4 bytes of CRC.

**Return Values**

- **ETHER_SUCCESS** /* Processing completed successfully */
- **ETHER_ERR_INVALID_CHAN** /* Nonexistent channel number */
- **ETHER_ERR_INVALID_DATA** /* Value of the argument is out of range */
- **ETHER_ERR_LINK** /* Auto-negotiation is not completed, and reception is not enabled. */
- **ETHER_ERR_MPDE** /* As a Magic Packet is being detected, transmission and reception */
  /* is not enabled. */

**Properties**

Prototyped in r_ether_rx_if.h.

**Description**

Call this function after writing one frame of transmit data is completed.

Set the buffer length to be not less than 60 bytes (64 bytes of the minimum Ethernet frame minus 4 bytes of CRC) and not more than 1,514 bytes (1,518 bytes of the maximum Ethernet frame minus 4 bytes of CRC).

To transmit data less than 60 bytes, make sure to pad the data with zero to be 60 bytes.

Return values indicate that the data written in the transmit buffer is enabled to be transmitted. ETHER_SUCCESS is returned when the data in the transmit buffer is enabled to be transmitted at the time of the call. When auto-negotiation is not completed, and transmission is not enabled, ETHER_ERR_LINK is returned. ETHER_ERR_MPDE is returned when a Magic Packet is being detected.

**Example**

The MAC address used in the sample code is assigned based on the vendor ID of Renesas Electronics Corporation. Customers developing products must use a MAC address obtained by submitting an application to the IEEE.

```c
#include <string.h>
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return ret;
uint8_t * pwrite_buffer_address;
```
uint8_t * pbuf;
uint16_t buf_size;

/* Transmit data */
static uint8_t send_data[60] = {
    0x74,0x90,0x50,0x00,0x79,0x02,        /* Destination MAC address */
    0x74,0x90,0x50,0x00,0x79,0x01,        /* Source MAC address */
    0x00,0x00,                            /* The type field is not used */
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,

    0x00,0x00,0x00,0x00,0x00,0x00,
};

/* Ethernet channel number */
* ETHER_CHANNEL_0 = Ethernet channel number is 0
* ETHER_CHANNEL_1 = Ethernet channel number is 1
*/
uint32_t channel;

channel = ETHER_CHANNEL_0;

ret = R_ETHER_Write_ZC2_GetBuf(channel, (void **)&pwrite_buffer_address, &buf_size);
/* When transmission buffer is empty */
if(ETHER_SUCCESS == ret)
{
    /* Write the transmit data to the transmission buffer. */
    memcpy(pwrite_buffer_address, send_data, sizeof(send_data));

    R_ETHER_Write_ZC2_SetBuf(channel, sizeof(send_data));

    /* Verifying that the transmission is completed */
    ret = R_ETHER_CheckWrite(channel);
    if(ETHER_SUCCESS == ret)
    {
        /* Transmission is completed */
    }
}

Special Notes:

- Call this function after writing one frame of transmit data is completed.
- To transmit data less than 60 bytes, make sure to pad the data with zero to be 60 bytes.
- Before calling this function, use the R_ETHER_Write_ZC2_GetBuf function to read data. Call this function after ETHER_SUCCESS is returned.
- This function is used in combination with the R_ETHER_Write_ZC2_GetBuf function. Always call the R_ETHER_Write_ZC2_GetBuf function and then the R_ETHER_Write_ZC2_SetBuf function in sequence. If the value ETHER_ERR_LINK is returned when this function is called, initialize the Ethernet FIT module.
### 3.8 R_ETHER_CheckLink_ZC()

The R_ETHER_CheckLink_ZC() function checks the status of the physical Ethernet link using PHY management interface. Ethernet link is up when the cable is connected to a peer device whose PHY is properly initialized.

#### Format

```c
ether_return_t  R_ETHER_CheckLink_ZC(
    uint32_t channel   /* ETHERC channel number */
);
```

#### Parameters

- **channel**: Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

#### Return Values

- **ETHER_SUCCESS**: /* the link status is link up or the operation starts normally when */ /* the non-blocking mode is enabled*/
- **ETHER_ERR_OTHER**: /* the link status is link-down or the non-blocking mode is */ /* enabled and the interrupt handler function is not registered*/
- **ETHER_ERR_INVALID_CHAN**: /* Nonexistent channel number */
- **ETHER_ERR_LOCKED**: /* When PHY access is in progress when non-blocking mode is */ /* enabled */

#### Properties

Prototyped in r_ether_rx_if.h.

#### Description

The R_ETHER_CheckLink_ZC() function checks the status of the physical Ethernet link using PHY management interface. This information (status of Ethernet link) is read from the basic status register (register 1) of the PHY-LSI device. If non-blocking mode is disabled, ETHER_SUCCESS is returned when the link is up, and ETHER_ERR_OTHER when the link is down.

When non-blocking mode is enabled, the check result is passed as an argument of the interrupt handler function after the link status check is completed.

#### Example

```c
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return   ret;

/* Ethernet channel number
 * ETHER_CHANNEL_0 = Ethernet channel number is 0
 * ETHER_CHANNEL_1 = Ethernet channel number is 1
 */
uint32_t    channel;

channel = ETHER_CHANNEL_0;

ret = R_ETHER_CheckLink_ZC(channel);
```
if(ETHER_SUCCESS == ret) {
    /* Link is up */
    LED1 = LED_ON;
} else {
    /* Link is down */
    LED1 = LED_OFF;
}

**Special Notes:**
None
3.9 R_ETHER_LinkProcess()

The R_ETHER_LinkProcess() function performs link signal change interrupt processing and Magic Packet detection interrupt processing.

Format

```c
void R_ETHER_LinkProcess(
    uint32_t channel  /* ETHERC channel number */
);
```

Parameters

- **channel**
  - Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

Return Values

None

Properties

Prototyped in r Ether rx_if.h.

Description

The R_ETHER_LinkProcess() function performs link signal change interrupt processing and Magic Packet detection interrupt processing. Note that link status change detection processing takes place but link signal change interrupt processing does not occur when ETHER_CFG_USE_LINKSTA is set to a value of 0. When non-blocking mode is enabled, the processing result of the function is passed as an argument of the PMGI callback function.

- When a Magic Packet detection interrupt occurs:
  - The callback function registered by the function R_ETHER_Control() reports that a magic packet was detected.

- When a link signal change (link is up) interrupt occurs:
  - The descriptors and the contents of the transmit and receive buffers are erased.
  - After ETHERC and EDMAC are initialized, decide the appropriate configuration to support full-duplex/half-duplex, link speed, and flow control based on the auto-negotiation result, and then enable transmission and reception functionality.
  - EDMAC descriptor is set up to its initial status.
  - The callback function registered by the function R_ETHER_Control() reports that a link signal change (link is up) was detected.

- When a link signal change (link is down) interrupt occurs:
  - After the transmission and reception functions are disabled, the callback function registered by the function R_ETHER_Control() reports that a link signal change (link is down) was detected.

- When ETHER_CFG_USE_LINKSTA is set to a value of 0:
  - The PHY-LSI basic status register (register 1) is read to confirm the Ethernet link status. If a change in the link status is detected, the processing described below occurs.
    - If the link status has changed (link status is link up):
      - The descriptors and the contents of the transmit and receive buffers are erased.
      - After the ETHERC and EDMAC are initialized, the appropriate configuration of full-duplex/half-duplex, link speed, and flow control are determined based on the auto-negotiation result, and transmission and reception functionality are enabled.
      - The EDMAC descriptors are set to their initial status.
• The callback function registered by the R_ETHER_Control function reports that a link status change (link up) was detected.
  — If the link status has changed (link status is link down):
• After the transmission and reception functions are disabled, the callback function registered by the R_ETHER_Control function reports that a link status change (link down) was detected.

Example

```c
#include "platform.h"
#include "r_ether_rx_if.h"

/* Ethernet channel number
* ETHER_CHANNEL_0 = Ethernet channel number is 0
* ETHER_CHANNEL_1 = Ethernet channel number is 1
*/
uint32_t channel;

channel = ETHER_CHANNEL_0;

while(1)
{
    /* Perform link signal change interrupt processing and
    * Magic Packet detection interrupt processing
    */
    R_ETHER_LinkProcess(channel);
}
```

Special Notes:

• If ETHER_CFG_USE_LINKSTA is set to a value of 1, either call this function periodically within the normal processing routine. Note that Ethernet transmission and reception may not operate correctly, and the Ethernet driver may not enter Magic Packet detection mode correctly, if this function is not called.
• If ETHER_CFG_USE_LINKSTA is set to a value of 0, either call this function periodically within the normal processing routine, or call it from an interrupt function that is processed when a periodically occurring interrupt source occurs. Note that Ethernet transmission and reception may not operate correctly, and the Ethernet driver may not enter Magic Packet detection mode correctly, if this function is not called.
• If no callback function was registered with the function R_ETHER_Control(), there will be no notification by a callback function.
3.10  R_ETHER_WakeOnLAN()

The R_ETHER_WakeOnLAN() function switches the ETHERC setting from normal transmission/reception to Magic Packet detection.

Format

```c
ether_return_t  R_ETHER_WakeOnLAN(
    uint32_t channel  /* ETHERC channel number */
);
```

Parameters

`channel`

Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

Return Values

- `ETHER_SUCCESS` /* Processing completed successfully or the operation starts*/
  /* normally when the non-blocking mode is enable */
- `ETHER_ERR_INVALID_CHAN` /* Nonexistent channel number */
- `ETHER_ERR_LINK` /* Auto-negotiation is not completed, and reception is not enabled. */
- `ETHER_ERR_OTHER` /* A switch to magic packet detection was performed when the */
  /* link state was link is down. Or the non-blocking mode is */
  /* enabled and the interrupt handler function is not registered */
- `ETHER_ERR_LOCKED` /* When PHY access is in progress when non-blocking mode is */
  /* enabled */

Properties

Prototyped in r_ether_rx_if.h.

Description

The R_ETHER_WakeOnLAN() function initializes the ETHERC and EDMAC, and then switches the ETHERC to Magic Packet detection.

If non-blocking call is disabled, return values indicate whether the ETHERC has been switched to Magic Packet detection or not. When auto-negotiation is not completed, and transmission/reception is not enabled, `ETHER_ERR_LINK` is returned. `ETHER_ERR_OTHER` is returned if the link is down after ETHERC is set to Magic Packet detection.

When non-blocking mode is enabled, the processing result of the function is passed as an argument of the PMGI callback function.

Example

```c
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return       ret;

/* Ethernet channel number
 * ETHER_CHANNEL_0 = Ethernet channel number is 0
 * ETHER_CHANNEL_1 = Ethernet channel number is 1
 */
uint32_t           channel;
```
channel = ETHER_CHANNEL_0;

while(1)
{
    /* Perform link signal change interrupt processing and
     * Magic Packet detection interrupt processing
     */
    R_ETHER_LinkProcess(channel);

    /* Enter Magic Packet detection mode. */
    ret = R_ETHER_WakeOnLAN(channel);
    if(ETHER_SUCCESS == ret)
    {
        R_BSP_RegisterProtectDisable(BSP_REG_PROTECT_LPC_CGC_SWR);
        /* Set the MCU in sleep mode as low power consumption mode when the MCU is
        * awaiting a Magic Packet detection.
        */
        SYSTEM.SBYCR.BIT.SSBY = 0;
        R_BSP_RegisterProtectEnable(BSP_REG_PROTECT_LPC_CGC_SWR);

        wait();
    }
}

**Special Notes:**
None
3.11  R_ETHER_CheckWrite()

The R_ETHER_CheckWrite() function verifies that data transmission has completed.

Format

```c
ether_return_t  R_ETHER_CheckWrite(
    uint32_t channel  /* ETHERC channel number */
);
```

Parameters

`channel`

Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

Return Values

- `ETHER_SUCCESS` /* Processing completed successfully */
- `ETHER_ERR_INVALID_CHAN` /* Nonexistent channel number */

Properties

Prototyped in `r Ether_rx_if.h`.

Description

The R_ETHER_CheckWrite() function verifies that data was transmitted.

If the transmission completed, `ETHER_SUCCESS` is returned.

Example

The MAC address used in the sample code is assigned based on the vendor ID of Renesas Electronics Corporation. Customers developing products must use a MAC address obtained by submitting an application to the IEEE.

```c
#include <string.h>
#include "platform.h"
#include "r Ether_rx_if.h"

ether_return ret;
uint8_t * pwrite_buffer_address;
uint8_t * pbuf;
uint16_t buf_size;

/* Transmit data */
static uint8_t send_data[60] =
{
    0x74,0x90,0x50,0x00,0x79,0x02,        /* Destination MAC address       */
    0x74,0x90,0x50,0x00,0x79,0x01,        /* Source MAC address           */
    0x00,0x00,                            /* The type field is not used     */
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00
```
/* Ethernet channel number
 * ETHER_CHANNEL_0 = Ethernet channel number is 0
 * ETHER_CHANNEL_1 = Ethernet channel number is 1
 */
uint32_t channel = ETHER_CHANNEL_0;

ret = R_ETHER_Write_ZC2_GetBuf(channel, (void **)&pwrite_buffer_address, &buf_size);
/* When transmission buffer is empty */
if(ETHER_SUCCESS == ret)
{
    /* Write the transmit data to the transmission buffer. */
    memcpy(pwrite_buffer_address, send_data, sizeof(send_data));

    R_ETHER_Write_ZC2_SetBuf(channel, sizeof(send_data));

    /* Verifying that the transmission is completed */
    ret = R_ETHER_CheckWrite(channel);
    if(ETHER_SUCCESS == ret)
    {
        /* Transmission is completed */
    }
}

Special Notes:
- This function should be called after transmit data has been written with the R_ETHER_Write_ZC2_Setbuf() function.
- Note that it takes several tens of microseconds for data transmission to actually complete after the R_ETHER_Write_ZC2_Setbuf() function is called. Therefore, when using the R_ETHER_Close_ZC2() function to shut down the Ethernet module following data transmission, call the R_ETHER_CheckWrite() function after calling the R_ETHER_Write_ZC2_Setbuf() function and, after waiting for data transmission to finish, call the R_ETHER_Close_ZC2() function. Calling the R_ETHER_Close_ZC2() function without calling the R_ETHER_CheckWrite() function can cause data transmission to be cut off before it completes.
3.12 **R_ETHER_Read()**

The `R_ETHER_Read()` function receives data into the specified receive buffer.

**Format**

```c
int32_t R_ETHER_Read(
    uint32_t channel /* ETHERC channel number */
    void * pbuf /* The receive buffer (to store the receive data) */
);
```

**Parameters**

- `channel`
  - Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

- `pbuf`
  - Specifies the receive buffer (to store the receive data).
  - The maximum write size is 1,514 bytes. When calling this function, specify the start address of an array with a capacity of 1,514 bytes.

**Return Values**

- *A value of 1 or greater* /* Returns the number of bytes received. */
- `ETHER_NO_DATA` /* A zero value indicates no data is received. */
- `ETHER_ERR_INVALID_CHAN` /* Nonexistent channel number */
- `ETHER_ERR_INVALID_PTR` /* Value of the pointer is NULL or FIT_NO_PTR */
- `ETHER_ERR_LINK` /* Auto-negotiation is not completed, and reception is not enabled. */
- `ETHER_ERR_MPDE` /* As a Magic Packet is being detected, transmission and reception is */ /* not enabled. */
- `ETHER_ERR_MC_FRAME` /* Multicast frame detected when multicast frame filtering is enabled. */

**Properties**

Prototyped in `r_ether_rx_if.h`.

**Description**

This function stores the receive data in the specified receive buffer.

Return values indicate the number of bytes received. If there is no data available at the time of the call, `ETHER_NO_DATA` is returned. When auto-negotiation is not completed, and reception is not enabled, `ETHER_ERR_LINK` is returned. `ETHER_ERR_MPDE` is returned when a Magic Packet is being detected.

When multicast frame filtering on the specified channel is enabled by the `R_ETHER_Control` function, the buffer is released immediately when a multicast frame is detected. Also, the value `ETHER_ERR_MC_FRAME` is returned. Note that when hardware-based multicast frame filtering is enabled on the RX64M, RX71M, RX72M, RX72N or RX66N, multicast frames are discarded by the hardware and detection is not possible. For details, see section 6.1 EPTPC Light FIT Module.

Frames that generate a receive FIFO overflow, residual-bit frame receive error, long frame receive error, short frame receive error, PHY-LSI receive error, or receive frame CRC error are treated as receive frame errors. When a receive frame error occurs, the descriptor data is discarded, the status is cleared, and reading of data continues.
Example

```c
#include "platform.h"
#include "r_ether_rx_if.h"
#include "r_ether_rx_config.h"

ether_return ret;
uint8_t read_buffer[ETHER_BUFSIZE];

/* Ethernet channel number */
* ETHER_CHANNEL_0 = Ethernet channel number is 0
* ETHER_CHANNEL_1 = Ethernet channel number is 1
*/
uint32_t channel;

channel = ETHER_CHANNEL_0;

ret = R_ETHER_Read(channel, (void *)read_buffer);
if(ETHER_NO_DATA < ret)
{
    /* Reading the receive data is completed */
}
```

Special Notes:

- As this function calls the R_ETHER_Read_ZC2() function and the R_ETHER_Read_ZC2_BufRelease() function internally, data is copied between the buffer pointed by the EDMAC receive descriptor and the receive buffer specified by the R_ETHER_Read() function. (The maximum write size is 1,514 bytes, so set aside a space of 1,514 bytes for the specified receive buffer.)
- Make sure not to use the R_ETHER_Read_ZC2() function and R_ETHER_Read_ZC2_BufRelease() function when using the R_ETHER_Read() function.
- This function uses the standard function memcpy, so string.h is included.
- If the value ETHER_ERR_LINK is returned when this function is called, initialize the Ethernet FIT module.
The R_ETHER_Write() function transmits the data from the specified transmit buffer.

Format

```c
ether_return_t  R_ETHER_Write(
    uint32_t   channel /* ETHERC channel number */
    void    *  pbuf  /* Transmit buffer pointer */
    const uint32_t len   /* The size (60 to 1,514 bytes) which is the */
    /* Ethernet frame length minus 4 bytes of CRC */
);
```

Parameters

channel

Specifies the ETHERC and EDMAC channel number (0 or 1). This value must be specified as 0 on products with only one ETHERC and EDMAC channel.

*pbuf

Specifies the transmit data (the destination for the transmit data to be written).

len

Specifies the size (60 to 1,514 bytes) which is the Ethernet frame length minus 4 bytes of CRC.

Return Values

ETHER_SUCCESS    /* Processing completed successfully */
ETHER_ERR_INVALID_CHAN  /* Nonexistent channel number */
ETHER_ERR_INVALID_DATA    /* Value of the argument is out of range */
ETHER_ERR_INVALID_PTR     /* Value of the pointer is NULL or FIT_NO_PTR */
ETHER_ERR_LINK    /* Auto-negotiation is not completed, and reception is not enabled. */
ETHER_ERR_MPDE    /* As a Magic Packet is being detected, transmission and reception */
                    /* is not enabled. */
ETHER_ERR_TACT    /* Transmit buffer is not empty. */

Properties

Prototyped in r_ether_rx_if.h.

Description

This function transmits data from the specified transmit buffer.

Set the buffer length to be not less than 60 bytes (64 bytes of the minimum Ethernet frame minus 4 bytes of CRC) and not more than 1,514 bytes (1,518 bytes of the maximum Ethernet frame minus 4 bytes of CRC).

To transmit data less than 60 bytes, make sure to pad the data with zero to be 60 bytes.

Return values indicate that the data written in the transmit buffer is enabled to be transmitted. ETHER_SUCCESS is returned when the data in the transmit buffer is enabled to transmit at the time of the call. When auto-negotiation is not completed, and transmission is not enabled, ETHER_ERR_LINK is returned. ETHER_ERR_MPDE is returned when a Magic Packet is being detected. The value ETHER_ERR_TACT is returned if there is no free space in the transmit buffer.
Example

The MAC address used in the sample code is assigned based on the vendor ID of Renesas Electronics Corporation. Customers developing products must use a MAC address obtained by submitting an application to the IEEE.

```c
#include "platform.h"
#include "r_ether_rx_if.h"

ether_return ret;

/* Transmit data */
static uint8_t send_data[60] =
{
    0x74,0x90,0x50,0x00,0x79,0x02,        /* Destination MAC address       */
    0x74,0x90,0x50,0x00,0x79,0x01,        /* Source MAC address           */
    0x00,0x00,                            /* The type field is not used */
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00, /* Data field    */
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,
    0x00,0x00,0x00,0x00,0x00,0x00
};

/* Ethernet channel number */
* ETHER_CHANNEL_0 = Ethernet channel number is 0
* ETHER_CHANNEL_1 = Ethernet channel number is 1
*/
uint32_t channel;

channel = ETHER_CHANNEL_0;

ret = R_ETHER_Write(channel, (void *)send_data, sizeof(send_data));
if (ETHER_SUCCESS == ret)
{
    /* Transmission is completed */
}
```

Special Notes:

- To transmit data less than 60 bytes, make sure to pad the data with zero to be 60 bytes.
- As this function calls the R_ETHER_Write_ZC2_GetBuf() function and the R_ETHER_Write_ZC2_SetBuf() function internally, data is copied between the buffer pointed by the EDMAC transmit descriptor and the transmit buffer specified by the R_ETHER_Write() function.
- Make sure not to use the R_ETHER_Write_ZC2_GetBuf() function and R_ETHER_Write_ZC2_SetBuf() function when using the R_ETHER_Write() function.
- This function uses the standard functions memset and memcpy, so string.h is included.
- If the value ETHER_ERR_LINK is returned when this function is called, initialize the Ethernet FIT module.
### 3.14 R_ETHER_Control()

The R_ETHER_Control() function performs the processing that corresponds to the control code.

#### Format

```c
ether_return_t R_ETHER_Control(
    ether_cmd_t const    cmd   /* Control code */
    ether_param_t const  control /* Parameters according to the control */
    /* code */
);```

#### Parameters

- **cmd**
  - Specifies the control code.

- **control**
  - Specify the parameters according to the control code.

#### Return Values

- ETHER_SUCCESS /* Processing completed successfully */
- ETHER_ERR_INVALID_CHAN /* Nonexistent channel number */
- ETHER_ERR_CHAN_OPEN /* Indicates the Ethernet cannot be opened because it is being used by another application */
- ETHER_ERR_INVALID_ARG /* Invalid argument */
- ETHER_ERR_RECV_ENABLE /* ETHERC receive function enabled */

#### Properties

Prototyped in rEther_rx_if.h.

#### Description

Performs the processing that corresponds to the control code. The value ETHER_ERR_INVALID_ARG is returned if the control code is not supported.

The table below lists the corresponding control codes.
<table>
<thead>
<tr>
<th>Control Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTROL_SET_CALLBACK</td>
<td>Registers a function to be called by callback when a link signal change interrupt occurs or a magic packet is detected. Registers the function specified with the second argument.</td>
</tr>
<tr>
<td>CONTROL_SET_PROMISCUOUS_MODE</td>
<td>Set the promiscuous mode bit (PRM) in the ETHERC mode register (ECMR). The second argument specifies the ETHERC channel number of the side on which PRM is to be set and the address of the variable storing the PRM value.</td>
</tr>
<tr>
<td>CONTROL_SET_INT_HANDLER</td>
<td>Registers the function that is called when an EINT0 or EINT1 status interrupt occurs. Registers the function specified with the second argument.</td>
</tr>
<tr>
<td>CONTROL_POWER_ON</td>
<td>Cancels module stop for the ETHERC and EDMAC. The second argument specifies the ETHERC channel for the cancel module stop.</td>
</tr>
<tr>
<td>CONTROL_POWER_OFF</td>
<td>Transitions the ETHERC and EDMAC to the module stop state. The second argument specifies the ETHERC channel for the transition to module stop.</td>
</tr>
<tr>
<td>CONTROL_MULTICASTFRAME_FILTER</td>
<td>Enables functionality that reads descriptor information, detects multicast frames, and discards those frames (multicast frame filtering). Specify the setting value for multicast frame filtering functionality with the second argument.</td>
</tr>
<tr>
<td>CONTROL_BROADCASTFRAME_FILTER</td>
<td>Specifies the number of broadcast frames that can be received continuously by the ETHERC. When more than the specified number of broadcast frames are received by the ETHERC, the additional broadcast frames are discarded. Specify the ETHERC channel number and the number of broadcast frames that can be received continuously by the ETHERC with the second argument. This function is disabled when the number of broadcast frames is specified as 0.</td>
</tr>
<tr>
<td>CONTROL_RECEIVE_DATA_PADDING</td>
<td>Specifies the parameters of receive data padding insert register (PRadir). The second argument specifies the ETHERC channel, padding insert position and padding insert size.</td>
</tr>
<tr>
<td>CONTROL_SET_PMGI_CALLBACK</td>
<td>If non-blocking call is enabled, register a function to be called back after API function processing is completed. Registers the function specified with the second argument.</td>
</tr>
</tbody>
</table>

**Example**

To register a callback function.

```c
void callback(void*);

ether_return_t ret;
ether_param_t param;
ether_cb_t cb_func;

cb_func.pcb_func = &callback;
param.ether_callback = cb_func;

ret = R_ETHER_Contorl(CONTROL_SET_CALBACK, param);
```
To set up promiscuous mode)

```c
ether_return ret;
ether_param_t param;
ether_promiscuous_t promiscuous;

promiscuous.channel = ETHER_CHANNEL_0;
promiscuous.bit = ETHER_PROMISCUOUS_ON;
param.p_ether_promiscuous = &promiscuous;

ret = R_ETHER_Control(CONTROL_SET_PROMISCUOUS_MODE, param);
```

Registering an interrupt handler function)

```c
void int_handler(void*);
ether_return_t ret;
ether_param_t param;
ether_cb_t cb_func;

cb_func.pcb_int_hnd = &int_handler;
param.ether_callback = cb_func;

ret = R_ETHER_Contorl(CONTROL_SET_INT_HANDLER, param);
```

Interrupt handler function)

```c
static uint32_t status_ecsr[2];
static uint32_t status_eesr[2];

void int_handler(void *p_param)
{
    ether_cb_arg_t *p_arg;

    p_arg = (ether_cb_arg_t *)p_param;

    if (ETHER_CANNEL_MAX > p_arg->channel)
    {
        status_ecsr[p_arg->channel] = p_arg->status_ecsr;
        status_eesr[p_arg->channel] = p_arg->status_eesr;
    }
}
```

Canceling ETHERC/EDMAC module stop)

```c
ether_return_t ret;
ether_param_t param;

param.channel = channel;
ret = R_ETHER_Control(CONTROL_POWER_ON, param);
```

Transitioning ETHERC/EDMAC to module stop)

```c
ether_return_t ret;
ether_param_t param;

param.channel = channel;
ret = R_ETHER_Control(CONTROL_POWER_OFF, param);
```
To enable or disable multicast frame filtering)

```c
ether_return_t   ret;
ether_param_t     param;
ether_multicast_t  multicast;

multicast.channel        = channel;
multicast.flag           = ETHER_MC_FILTER_ON;
param.p_ether_multicast = &multicast;

ret = R_ETHER_Contorl(CONTROL_MULTICASTFRAME_FILTER, param);
```

To set the continuous receive count for broadcast frame filtering)

```c
ether_return_t   ret;
ether_param_t   param;
ether_broadcast_t  broadcast;

broadcast.channel        = channel;
broadcast.counter        = 10;
param.p_ether_broadcast = &broadcast;

ret = R_ETHER_Contorl(CONTROL_BROADCASTFRAME_FILTER, param);
```

To set the receive data insert padding)

```c
ether_return_t    ret;
ether_param_t    param;
ether_recv_padding_t  pad_param;

pad_param.channel        = channel;
pad_param.position       = 0x3f;
pad_param.size        = 0x3;
param.padding_param   = &pad_param;

ret = R_ETHER_Contorl(CONTROL_RECEIVE_DATA_PADDING, param);
```

Registering an PMGI callback function)

```c
void int_handler(void*);

ether_return_t  ret;
ether_param_t   param;
ether_cb_t      cb_func;

cb_func. pcb_pmgi_hnd = &int_handler;
param.ether_callback = cb_func;

ret = R_ETHER_Contorl(CONTROL_SET_PMGI_CALLBACK, param);
```
PMGI callback function)

```c
static pmgi_event_t   pmgi_event;
static pmgi_mode_t   pmgi_mode;
static uint16_t     phy_reg_data;

void int_handler(void * p_param)
{
    pmgi_cb_arg_t *p_arg;

    p_arg = (pmgi_cb_arg_t *)p_param;

    if (ETHER_CANNEL_MAX > p_arg->channel)
    {
        pmgi_event   = p_arg->event;
        pmgi_mode    = p_arg->mode;
        pmgi_reg_data = p_arg->reg_data;
    }
}
```

**Special Notes:**

Register callback functions and interrupt handlers before calling the `R_ETHER_Open_ZC2()` function. It may not be possible to detect the first interrupt if the preceding are registered after the `R_ETHER_Open_ZC2()` function is called.

Specify promiscuous mode after setting the control code to `CONTROL_POWER_ON` and calling this function. The intended value will not be stored in the ETHERC mode register if the promiscuous mode setting is specified without first setting the control code to `CONTROL_POWER_ON` and calling this function.

Multicast frame filtering and broadcast frame filtering settings cannot be made while the receive functionality of the ETHERC is enabled. Make these settings before calling the `R_ETHER_LinkProcess` function. After the `R_ETHER_LinkProcess` function is called, the receive functionality is enabled when the Ethernet FIT module enters link up status, so calling this function with `CONTROL_MULTICASTFRAME_FILTER` or `CONTROL_BROADCASTFRAME_FILTER` set as the control code causes `ETHER_ERR_RECV_ENABLE` to be returned, and the settings have no effect.
3.15 R_ETHER_WritePHY()

The R_ETHER_WritePHY function uses the PHY management interface to write to registers in the PHY-LSI.

Format

```c
ether_return_t R_ETHER_WritePHY(
    uint32_t channel,    /* ETHERC channel number */
    uint16_t address,    /* Register address of PHY-LSI to access */
    uint16_t data       /* Data to be written to PHY-LSI registers */
);
```

Parameters

channel
- Specify the ETHERC / EDMAC channel number (0, 1). Be sure to specify channel number 0 for products with only 1 channel of ETHERC / EDMAC.

address
- Specify the address of the PHY-LSI register to be accessed. For details, check the data sheet of the PHY-LSI to be used.

data
- Specify the data to be written to the PHY-LSI register. For details, check the data sheet of the PHY-LSI to be used.

Return Values

ETHER_SUCCESS  /* When access is completed normally or when the operation start normally when*/ /* non-blocking mode is enabled */
ETHER_ERR_OTHER  /* When non-blocking mode is enabled and no interrupt handler function is*/ /* registered */
ETHER_ERR_INVALID_CHAN  /* For a nonexistent channel */
ETHER_ERR_LOCKED  /* When non-blocking mode is enabled and PHY is being accessed */

Properties
- Prototyped in r_ether_rx_if.h.

Description
The R_ETHER_WritePHY function uses the PHY management interface to write access to registers in the PHY-LSI. If non-blocking mode is disabled, ETHER_SUCCESS is returned when write access is successfully completed.

When non-blocking mode is enabled, the callback function is executed after the write access is completed.

Example

```c
#include "platform.h"
#include "r_ether_rx_if.h"
ether_return_t ret;
uint32_t channel;
uint16_t address;
uint16_t data;

channel = ETHER_CHANNEL_0;
address = PHY_REG_CONTROL;
data = PHY_CONTROL_RESET;
ret = R_ETHER_WritePHY(channel, address, data);
```

Special Notes:

None.
3.16 R_ETHER_ReadPHY()

The R_ETHER_ReadPHY function uses the PHY management interface to access to the registers in the PHY-LSI.

Format

```c
ether_return_t R_ETHER_ReadPHY(
    uint32_t channel,  /* ETHERC channel number */
    uint16_t address,  /* Register address of PHY-LSI to access */
    uint16_t *p_data   /* Pointer to the variable that stores the value */
                     /* of the read register*/
);
```

Parameters

channel

Specify the ETHERC / EDMAC channel number (0, 1). Be sure to specify channel number 0 for products with only 1 channel of ETHERC / EDMAC.

address

Specify the address of the PHY-LSI register to be accessed. For details, check the data sheet of the PHY-LSI to be used.

*p_data

Specify the pointer of the variable to store the register value read from PHY-LSI. For details, check the data sheet of the PHY-LSI to be used.

Return Values

ETHER_SUCCESS  /* When access is completed normally or when the operation starts */
               /* normally when non-blocking mode is enabled */
ETHER_ERR_OTHER /* When non-blocking mode is enabled and no interrupt handler function */
                /* is registered */
ETHER_ERR_INVALID_CHAN /* For a nonexistent channel */
ETHER_ERR_LOCKED  /* When non-blocking mode is enabled and PHY is being accessed */

Properties

Prototyped in r_ether_rx_if.h.

Description

The R_ETHER_ReadPHY function uses the PHY management interface to read access to the registers in the PHY-LSI. When non-blocking mode is disabled, the register value read from the PHY-LSI is stored in the argument p_data. Also, ETHER_SUCCESS is returned when the read access is successfully completed.

When non-blocking mode is enabled, the read value is transferred as an argument of the callback function.

Example

```c
#include "platform.h"
#include "r_ether_rx_if.h"
ether_return_t  ret;
uint32_t    channel;
uint16_t    address;
uint16_t    data;
channel = ETHER_CHANNEL_0;
address = PHY_REG_CONTROL;
ret = R_ETHER_ReadPHY(channel, address, &data);
```

Special Notes:

None.
3.17 R_ETHER_GetVersion()

This function returns the API version.

Format

    uint32_t R_ETHER_GetVersion(void);

Parameters

None

Return Values

Version number

Properties

Prototyped in r_ether_rx_if.h.

Description

Returns the API version number.

Example

    #include "platform.h"
    #include "rEther_rx_if.h"

    uint32_t    version;

    version = R_ETHER_GetVersion();

Special Notes:

None.
4. Pin Setting

To use the Ethernet FIT module, input/output signals of the peripheral function have to be allocated to pins with the multi-function pin controller (MPC). This pin allocation is referred to as “pin setting” in this document. Please perform the pin setting before calling the R_ETHER_Open_ZC2 function.

When performing the pin setting in the e² studio, the pin setting feature of the FIT configurator or the Smart Configurator can be used. When using the pin setting feature, a source file is generated according to the option selected in the Pin Setting window in the FIT configurator or the Smart Configurator. Pins are configured by calling the function defined in the source file. Refer to Table 4.1 for details.

### Table 4.1 Function Output by the FIT Configurator

<table>
<thead>
<tr>
<th>MCU Used</th>
<th>Option Selected</th>
<th>Function to be Output</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>RX64M, RX71M, RX65N, RX72M, RX72N, RX66N</td>
<td>Channel 0 MII mode</td>
<td>R_ETHER_PinSet_ETHERC0_MII()</td>
<td>When Channel 0 is used in MII mode.</td>
</tr>
<tr>
<td></td>
<td>Channel 0 RMII mode</td>
<td>R_ETHER_PinSet_ETHERC0_RMII()</td>
<td>When Channel 0 is used in RMII mode.</td>
</tr>
<tr>
<td></td>
<td>Channel 1 MII mode</td>
<td>R_ETHER_PinSet_ETHERC1_MII()</td>
<td>When Channel 1 is used in MII mode.</td>
</tr>
<tr>
<td></td>
<td>Channel 1 RMII mode</td>
<td>R_ETHER_PinSet_ETHERC1_RMII()</td>
<td>When Channel 1 is used in RMII mode.</td>
</tr>
</tbody>
</table>

4.1 Pin setting example for using RSK+RX64M/RSK+RX71M/RSK+RX72M

Table 4.3 and Table 4.4 shows pin setting example using RSK+RX64M or RSK+RX71M, Table 4.5 and shows pin setting example using RSK+RX72M. Note that channel number in need of pin setting are determined by use channel and configuration option specified in Table 4.2. Don’t set the parameters other than Table 4.2. Table 4.3, Table 4.4, Table 4.5 and Table 4.6 show the details of each channel's Pins.

### Table 4.2 Channel number in need of pin setting by use channel and configuration option

<table>
<thead>
<tr>
<th>Use Channel</th>
<th>Setting of Configuration Option</th>
<th>Channel Number in Need of Pin Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel 0</td>
<td>ETHER_CFG_CH0_PHY_ACCESS (0) ETHER_CFG_CH1_PHY_ACCESS (0)</td>
<td>Channel 0</td>
</tr>
<tr>
<td></td>
<td>ETHER_CFG_CH0_PHY_ACCESS (1) ETHER_CFG_CH1_PHY_ACCESS (1)</td>
<td>Channel 0</td>
</tr>
<tr>
<td>Channel 1</td>
<td>ETHER_CFG_CH0_PHY_ACCESS (0) ETHER_CFG_CH1_PHY_ACCESS (0)</td>
<td>Channel 0</td>
</tr>
<tr>
<td></td>
<td>ETHER_CFG_CH0_PHY_ACCESS (1) ETHER_CFG_CH1_PHY_ACCESS (1)</td>
<td>Channel 1</td>
</tr>
<tr>
<td>Channel 0</td>
<td>ETHER_CFG_CH0_PHY_ACCESS (0) ETHER_CFG_CH1_PHY_ACCESS (0)</td>
<td>Channel 0</td>
</tr>
<tr>
<td>Channel 1</td>
<td>ETHER_CFG_CH0_PHY_ACCESS (1) ETHER_CFG_CH1_PHY_ACCESS (1)</td>
<td>Channel 0</td>
</tr>
</tbody>
</table>
### Table 4.3  Pin setting example for channel 0 of RSK+RX64M and RSK+RX71M

<table>
<thead>
<tr>
<th>Case of Using MII Mode</th>
<th>Case of Using RMII Mode</th>
<th>I/O Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET0_TX_CLK</td>
<td>PC4</td>
<td></td>
</tr>
<tr>
<td>ET0_RX_CLK</td>
<td>REF50CK0</td>
<td>P76</td>
</tr>
<tr>
<td>ET0_TX_EN</td>
<td>RMII0_TXD_EN</td>
<td>P80</td>
</tr>
<tr>
<td>ET0_ETXD3</td>
<td>PC6</td>
<td></td>
</tr>
<tr>
<td>ET0_ETXD2</td>
<td>PC5</td>
<td></td>
</tr>
<tr>
<td>ET0_ETXD1</td>
<td>RMII0_TXD1</td>
<td>P82</td>
</tr>
<tr>
<td>ET0_ETXD0</td>
<td>RMII0_TXD0</td>
<td>P81</td>
</tr>
<tr>
<td>ET0_TX_ER</td>
<td>PC3</td>
<td></td>
</tr>
<tr>
<td>ET0_RX_DV</td>
<td>PC2</td>
<td></td>
</tr>
<tr>
<td>ET0_ERXD3</td>
<td>PC0</td>
<td></td>
</tr>
<tr>
<td>ET0_ERXD2</td>
<td>PC1</td>
<td></td>
</tr>
<tr>
<td>ET0_ERXD1</td>
<td>RMII0_RXD1</td>
<td>P74</td>
</tr>
<tr>
<td>ET0_ERXDO</td>
<td>RMII0_RXD0</td>
<td>P75</td>
</tr>
<tr>
<td>ET0_RX_ER</td>
<td>RMII0_RX_ER</td>
<td>P77</td>
</tr>
<tr>
<td>ET0_CRS</td>
<td>RMII0_CRS_DV</td>
<td>P83</td>
</tr>
<tr>
<td>ET0_COL</td>
<td>PC7</td>
<td></td>
</tr>
<tr>
<td>ET0_MDC</td>
<td>P72</td>
<td></td>
</tr>
<tr>
<td>ET0_MDIO</td>
<td>P71</td>
<td></td>
</tr>
<tr>
<td>ET0_LINKSTA</td>
<td>P34 *1</td>
<td></td>
</tr>
<tr>
<td>ET0_EXOUT</td>
<td>- *2</td>
<td></td>
</tr>
<tr>
<td>ET1_WOL</td>
<td>- *2</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. Setting is not required if the setting of #define ETHER_CFG_USE_LINKSTA is 0.
Notes: 2. Setting is not required because these pin are not used in Ethernet FIT module.

### Table 4.4  Pin setting example for channel 1 of RSK+RX64M and RSK+RX71M

<table>
<thead>
<tr>
<th>Case of Using MII Mode</th>
<th>Case of Using RMII Mode</th>
<th>I/O Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET1_TX_CLK</td>
<td>PG2</td>
<td></td>
</tr>
<tr>
<td>ET1_RX_CLK</td>
<td>REF50CK1</td>
<td>PG0</td>
</tr>
<tr>
<td>ET1_TX_EN</td>
<td>RMII1_TXD_EN</td>
<td>P60</td>
</tr>
<tr>
<td>ET1_ETXD3</td>
<td>PG6</td>
<td></td>
</tr>
<tr>
<td>ET1_ETXD2</td>
<td>PG5</td>
<td></td>
</tr>
<tr>
<td>ET1_ETXD1</td>
<td>RMII1_TXD1</td>
<td>PG4</td>
</tr>
<tr>
<td>ET1_ETXD0</td>
<td>RMII1_TXD0</td>
<td>PG3</td>
</tr>
<tr>
<td>ET1_TX_ER</td>
<td>PG7</td>
<td></td>
</tr>
<tr>
<td>ET1_RX_DV</td>
<td>P90</td>
<td></td>
</tr>
<tr>
<td>ET1_ERXD3</td>
<td>P97</td>
<td></td>
</tr>
<tr>
<td>ET1_ERXD2</td>
<td>P96</td>
<td></td>
</tr>
<tr>
<td>ET1_ERXD1</td>
<td>RMII1_RXD1</td>
<td>P95</td>
</tr>
<tr>
<td>ET1_ERXDO</td>
<td>RMII1_RXD0</td>
<td>P94</td>
</tr>
<tr>
<td>ET1_RX_ER</td>
<td>RMII1_RX_ER</td>
<td>PG1</td>
</tr>
<tr>
<td>ET1_CRS</td>
<td>RMII1_CRS_DV</td>
<td>P92</td>
</tr>
<tr>
<td>ET1_COL</td>
<td>P91</td>
<td></td>
</tr>
<tr>
<td>ET1_MDC</td>
<td>P31</td>
<td></td>
</tr>
<tr>
<td>ET1_MDIO</td>
<td>P30</td>
<td></td>
</tr>
<tr>
<td>ET1_LINKSTA</td>
<td>P93 *1</td>
<td></td>
</tr>
<tr>
<td>ET1_EXOUT</td>
<td>- *2</td>
<td></td>
</tr>
<tr>
<td>ET1_WOL</td>
<td>- *2</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. Setting is not required if the setting of #define ETHER_CFG_USE_LINKSTA is 0.
Notes: 2. Setting is not required because these pin are not used in Ethernet FIT module.
Table 4.5  Pin setting example for channel 0 of RSK+RX72M

<table>
<thead>
<tr>
<th>Case of Using MII Mode</th>
<th>Case of Using RMII Mode</th>
<th>I/O Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLKOUT25M</td>
<td></td>
<td>PH7</td>
</tr>
<tr>
<td>ET0_TX_CLK</td>
<td></td>
<td>PM6</td>
</tr>
<tr>
<td>ET0_RX_CLK</td>
<td>REF50CK0</td>
<td>PL3</td>
</tr>
<tr>
<td>ET0_TX_EN</td>
<td>RMII0_TXD_EN</td>
<td>PL6</td>
</tr>
<tr>
<td>ET0_ETXD3</td>
<td></td>
<td>PM5</td>
</tr>
<tr>
<td>ET0_ETXD2</td>
<td></td>
<td>PM4</td>
</tr>
<tr>
<td>ET0_ETXD1</td>
<td>RMII0_TXD1</td>
<td>PL5</td>
</tr>
<tr>
<td>ET0_ETXD0</td>
<td>RMII0_TXD0</td>
<td>PL4</td>
</tr>
<tr>
<td>ET0_TX_ER</td>
<td></td>
<td>*2</td>
</tr>
<tr>
<td>ET0_RX_DV</td>
<td></td>
<td>PK2</td>
</tr>
<tr>
<td>ET0_ERXD3</td>
<td></td>
<td>PK5</td>
</tr>
<tr>
<td>ET0_ERXD2</td>
<td></td>
<td>PK4</td>
</tr>
<tr>
<td>ET0_ERXD1</td>
<td>RMII0_RXD1</td>
<td>P74</td>
</tr>
<tr>
<td>ET0_ERXD0</td>
<td>RMII0_RXD0</td>
<td>P75</td>
</tr>
<tr>
<td>ET0_RX_ER</td>
<td>RMII0_RX_ER</td>
<td>PL2</td>
</tr>
<tr>
<td>ET0_CRS</td>
<td>RMII0_CRS_DV</td>
<td>PM7</td>
</tr>
<tr>
<td>ET0_COL</td>
<td></td>
<td>PK1</td>
</tr>
<tr>
<td>PMGI0_MDC *3</td>
<td></td>
<td>PK0</td>
</tr>
<tr>
<td>PMGI0_MDIO *3</td>
<td></td>
<td>PL7</td>
</tr>
<tr>
<td>ET0_MDC *4</td>
<td></td>
<td>PK0</td>
</tr>
<tr>
<td>ET0_MDIO *4</td>
<td></td>
<td>PL7</td>
</tr>
<tr>
<td>ET0_LINKSTA</td>
<td></td>
<td>P34 *1</td>
</tr>
<tr>
<td>ET0_EXOUT</td>
<td></td>
<td>*2</td>
</tr>
<tr>
<td>ET0_WOL</td>
<td></td>
<td>*2</td>
</tr>
</tbody>
</table>

Notes:
1. Setting is not required if the setting of #define ETHER_CFG_USE_LINKSTA is 0.
2. Setting is not required because these pin are not used in Ethernet FIT module.
3. Setting is not required if the setting of #define ETHER_CFG_NON_BLOCKING is 0.
4. Setting is not required if the setting of #define ETHER_CFG_NON_BLOCKING is 1.
Table 4.6 Pin setting example for channel 1 of RSK+RX72M

<table>
<thead>
<tr>
<th>Case of Using MII Mode</th>
<th>Case of Using RMII Mode</th>
<th>I/O Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLKOUT25M</td>
<td>PH7</td>
<td></td>
</tr>
<tr>
<td>ET1_TX_CLK</td>
<td>PN2</td>
<td></td>
</tr>
<tr>
<td>ET1_RX_CLK</td>
<td>REF50CK1</td>
<td>PQ4</td>
</tr>
<tr>
<td>ET1_TX_EN</td>
<td>RMII1_TXD_EN</td>
<td>PQ7</td>
</tr>
<tr>
<td>ET1_ETXD3</td>
<td>PN1</td>
<td></td>
</tr>
<tr>
<td>ET1_ETXD2</td>
<td>PN0</td>
<td></td>
</tr>
<tr>
<td>ET1_ETXD1</td>
<td>RMII1_TXD1</td>
<td>PQ6</td>
</tr>
<tr>
<td>ET1_ETXD0</td>
<td>RMII1_TXD0</td>
<td>PQ5</td>
</tr>
<tr>
<td>ET1_TX_ER</td>
<td>- *2</td>
<td></td>
</tr>
<tr>
<td>ET1_RX_DV</td>
<td>PQ2</td>
<td></td>
</tr>
<tr>
<td>ET1_ERXD3</td>
<td>PM3</td>
<td></td>
</tr>
<tr>
<td>ET1_ERXD2</td>
<td>PM2</td>
<td></td>
</tr>
<tr>
<td>ET1_ERXD1</td>
<td>RMII1_RXD1</td>
<td>PM1</td>
</tr>
<tr>
<td>ET1_ERXD0</td>
<td>RMII1_RXD0</td>
<td>PM0</td>
</tr>
<tr>
<td>ET1_RX_ER</td>
<td>RMII1_RX_ER</td>
<td>PN3</td>
</tr>
<tr>
<td>ET1_CRS</td>
<td>RMII1_CRS_DV</td>
<td>PQ0</td>
</tr>
<tr>
<td>ET1_COL</td>
<td>PQ1</td>
<td></td>
</tr>
<tr>
<td>PMGI0_MDC *3</td>
<td>PK0</td>
<td></td>
</tr>
<tr>
<td>PMGI0_MDIO *3</td>
<td>PL7</td>
<td></td>
</tr>
<tr>
<td>ET0_MDC *4</td>
<td>PK0</td>
<td></td>
</tr>
<tr>
<td>ET0_MDIO *4</td>
<td>PL7</td>
<td></td>
</tr>
<tr>
<td>ET1_LINKSTA</td>
<td>P84 *1</td>
<td></td>
</tr>
<tr>
<td>ET1_EXOUT</td>
<td>- *2</td>
<td></td>
</tr>
<tr>
<td>ET1_WOL</td>
<td>- *2</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. Setting is not required if the setting of #define ETHER_CFG_USE_LINKSTA is 0.
Notes: 2. Setting is not required because these pin are not used in Ethernet FIT module.
Notes: 3. Setting is not required if the setting of #define ETHER_CFG_NON_BLOCKING is 0.
Notes: 4. Setting is not required if the setting of #define ETHER_CFG_NON_BLOCKING is 1.
### 4.2 Pin setting example for using RSK+RX65N/RSK+RX65N-2M

Table 4.7 shows pin setting example for using RSK+RX65N or RSK+RX65N-2M.

#### Table 4.7 Pin setting example for using RSK+RX65N or RSK+RX65N-2M

<table>
<thead>
<tr>
<th>Case of Using MII Mode</th>
<th>Case of Using RMII Mode</th>
<th>I/O Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>ET0_TX_CLK</td>
<td>PC4</td>
<td></td>
</tr>
<tr>
<td>ET0_RX_CLK</td>
<td>REF50CK0</td>
<td>P76</td>
</tr>
<tr>
<td>ET0_TX_EN</td>
<td>RMII0_TXD_EN</td>
<td>P80</td>
</tr>
<tr>
<td>ET0_ETXD3</td>
<td>PC6</td>
<td></td>
</tr>
<tr>
<td>ET0_ETXD2</td>
<td>PC5</td>
<td></td>
</tr>
<tr>
<td>ET0_ETXD1</td>
<td>RMII0_TXD1</td>
<td>P82</td>
</tr>
<tr>
<td>ET0_ETXD0</td>
<td>RMII0_TXD0</td>
<td>P81</td>
</tr>
<tr>
<td>ET0_TX_ER</td>
<td>PC3</td>
<td></td>
</tr>
<tr>
<td>ET0_RX_DV</td>
<td>PC2</td>
<td></td>
</tr>
<tr>
<td>ET0_ERXD3</td>
<td>PC0</td>
<td></td>
</tr>
<tr>
<td>ET0_ERXD2</td>
<td>PC1</td>
<td></td>
</tr>
<tr>
<td>ET0_ERXD1</td>
<td>RMII0_RXD1</td>
<td>P74</td>
</tr>
<tr>
<td>ET0_RXD0</td>
<td>RMII0_RXD0</td>
<td>P75</td>
</tr>
<tr>
<td>ET0_RX_ER</td>
<td>RMII0_RX_ER</td>
<td>P77</td>
</tr>
<tr>
<td>ET0_CRS</td>
<td>RMII0_CRS_DV</td>
<td>P83</td>
</tr>
<tr>
<td>ET0_COL</td>
<td>PC7</td>
<td></td>
</tr>
<tr>
<td>ET0_MDC</td>
<td>P72</td>
<td></td>
</tr>
<tr>
<td>ET0_MDI0</td>
<td>P71</td>
<td></td>
</tr>
<tr>
<td>ET0_LINKSTA *1</td>
<td>P54 (RSK+RX65N) *1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>P34 (RSK+RX65N-2M) *1</td>
<td></td>
</tr>
<tr>
<td>ET0_EXOUT</td>
<td>- *2</td>
<td></td>
</tr>
<tr>
<td>ET0_WOL</td>
<td>- *2</td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. Setting is not required if the setting of `#define ETHER_CFG_USE_LINKSTA` is 0.

Notes: 2. Setting is not required because these pin are not used in Ethernet FIT module.
## 4.3 Pin setting example for using RSK+RX72N

Table 4.8 shows pin setting example for using RSK+RX72N.

### Table 4.8 Pin setting example for using RSK+RX72N

<table>
<thead>
<tr>
<th>Case of Using MII Mode</th>
<th>Case of Using RMII Mode</th>
<th>I/O Port</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLKOUT25M</td>
<td></td>
<td>PH7</td>
</tr>
<tr>
<td>ET1_TX_CLK</td>
<td></td>
<td>PN2</td>
</tr>
<tr>
<td>ET1_RX_CLK</td>
<td>REF50CK1</td>
<td>PQ4</td>
</tr>
<tr>
<td>ET1_TX_EN</td>
<td>RMII1_TXD_EN</td>
<td>PQ7</td>
</tr>
<tr>
<td>ET1_ETXD3</td>
<td></td>
<td>P01</td>
</tr>
<tr>
<td>ET1_ETXD2</td>
<td></td>
<td>P00</td>
</tr>
<tr>
<td>ET1_ETXD1</td>
<td>RMII1_TXD1</td>
<td>PQ6</td>
</tr>
<tr>
<td>ET1_ETXD0</td>
<td>RMII1_TXD0</td>
<td>PQ5</td>
</tr>
<tr>
<td>ET1_TX_ER</td>
<td>- *2</td>
<td></td>
</tr>
<tr>
<td>ET1_RX_DV</td>
<td></td>
<td>P09</td>
</tr>
<tr>
<td>ET1_ERXD3</td>
<td></td>
<td>P07</td>
</tr>
<tr>
<td>ET1_ERXD2</td>
<td></td>
<td>P06</td>
</tr>
<tr>
<td>ET1_ERXD1</td>
<td>RMII1_RXD1</td>
<td>P05</td>
</tr>
<tr>
<td>ET1_ERXD0</td>
<td>RMII1_RXD0</td>
<td>P04</td>
</tr>
<tr>
<td>ET1_RX_ER</td>
<td>RMII1_RX_ER</td>
<td>PN3</td>
</tr>
<tr>
<td>ET1_CRS</td>
<td>RMII1_CRS_DV</td>
<td>P00</td>
</tr>
<tr>
<td>ET1_COL</td>
<td></td>
<td>P01</td>
</tr>
<tr>
<td>PMGI1_MDC *3</td>
<td></td>
<td>P31</td>
</tr>
<tr>
<td>PMGI1_MDIO *3</td>
<td></td>
<td>P30</td>
</tr>
<tr>
<td>ET1_MDC *4</td>
<td></td>
<td>P31</td>
</tr>
<tr>
<td>ET1_MDIO *4</td>
<td></td>
<td>P30</td>
</tr>
<tr>
<td>ET1_LINKSTA *1</td>
<td></td>
<td>P93*1</td>
</tr>
<tr>
<td>ET1_EXOUT</td>
<td></td>
<td>- *2</td>
</tr>
<tr>
<td>ET1_WOL</td>
<td></td>
<td>- *2</td>
</tr>
</tbody>
</table>

Notes: 1. Setting is not required if the setting of `#define ETHER_CFG_USE_LINKSTA` is 0.
Notes: 2. Setting is not required because these pins are not used in Ethernet FIT module.
Notes: 3. Setting is not required if the setting of `#define ETHER_CFG_NON_BLOCKING` is 0.
Notes: 4. Setting is not required if the setting of `#define ETHER_CFG_NON_BLOCKING` is 1.
### 5. How to use

#### 5.1 Section Allocation

Table 5.1 shows a sample section allocation for the Ethernet FIT module.

<table>
<thead>
<tr>
<th>Address</th>
<th>Device</th>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00000020</td>
<td>Internal RAM</td>
<td>SI</td>
<td>Interrupt stack area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SU</td>
<td>User stack area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B_1</td>
<td>Uninitialized data area of 1byte boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R_1</td>
<td>Initialized data area of 1byte boundary (variable)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B_2</td>
<td>Uninitialized data area of 2byte boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R_2</td>
<td>Initialized data area of 2byte boundary (variable)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>Uninitialized data area of 4byte boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>R</td>
<td>Initialized data area of 4byte boundary (variable)</td>
</tr>
<tr>
<td>0x00010000</td>
<td></td>
<td>B_ETHHERNET_BUFFERS*</td>
<td>Transmit buffer and receive buffer area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B_RX_DESC*</td>
<td>Receive descriptor area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B_TX_DESC*</td>
<td>Transmit descriptor area</td>
</tr>
<tr>
<td>0xFFFF8000</td>
<td>Internal ROM</td>
<td>C_1</td>
<td>Constant area of 1byte boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C_2</td>
<td>Constant area of 2byte boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>Constant area of 4byte boundary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C$*</td>
<td>Constant region (C$DEC, C$BSEC, C$VECT) of C$ section</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D*</td>
<td>Initialization data area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P*</td>
<td>Program area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W*</td>
<td>Branch table area for switch statements</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L</td>
<td>String literal area</td>
</tr>
<tr>
<td>0xFFFFFFF80</td>
<td></td>
<td>EXCEPTVECT</td>
<td>Interrupt vector area</td>
</tr>
<tr>
<td>0xFFFFFFFCC</td>
<td></td>
<td>RESETVECT</td>
<td>Reset vector area</td>
</tr>
</tbody>
</table>
5.1.1 GCC for Renesas RX section setting example

Edit the linker_script.ld file and add sections and symbols.

**Add Sections and Symbols**

Add the following code.

```assembly
B ETHERNET BUFFERS_1 0x00010000 (NOLOAD) : AT(0x00010000)
{
    _B ETHERNET BUFFERS_1_start = .;
    *(B ETHERNET BUFFERS_1)
    _B ETHERNET BUFFERS_1_end = .;
} >RAM

B RX DESC_1 (NOLOAD) :
{
    _B RX DESC_1_start = .;
    *(B RX DESC_1)
    _B RX DESC_1_end = .;
} >RAM

B TX DESC_1 (NOLOAD) :
{
    _B TX DESC_1_start = .;
    *(B TX DESC_1)
    _B TX DESC_1_end = .;
} >RAM
```

(1) Open "linker_script.ld" from Project Explorer.

- Binaries
- Archives
- Includes
- src
  - smc_gen
  - main.c
  - linker_script.ld
- HardwareDebug
(2) Click linker_script.ld.

(3) Enter code.

```c

#include <stdio.h>

int main() {
    printf("Hello, World!\n");
    return 0;
}
```

(2) Click linker_script.ld

(3) Enter code
5.1.2 IAR C/C++ Compiler for Renesas RX section setting example

Edit the icf file and add section settings.

The icf file to be edited depends on the target device of the project, so please confirm and edit the upper 8 digits of the model name of the device to be used.

As an example, edit "lnkr5f565ne.icf" with RX65N (R5F565NEDDFC).

The following is an example of editing on the RX65N (R5F565NEDDFC).

Add section settings.

(1) Create "config" folder in project folder.

(2) Copy "lnkr5f565ne.icf" from "rx\config" where IAR C/C++ Compiler for Renesas RX ("EWRX") is installed to the "config" folder in the project folder.

The installation default is "C: \Program Files (x86)\IAR Systems\Embedded Workbench 8.1".

(3) Open the copied "lnkr5f565ne.icf" file and add the following code.

```c
place at address mem:0x00010000 { rw section BETHERNET_BUFFERS*, rw section B_RX_DESC*, rw section B_TX_DESC* };

place at address mem:0x00010000 { ro section option_mem: ;
place at address mem:0x00010000 { ro section resitvext: ;
place at address mem:0x00010000 { ro section excptext: ;
place at address mem:0x00010000 { rw section BETHERNET_BUFFERS*, rw section B_RX_DESC*, rw section B_TX_DESC* ;
"ROM16":place in ROM_region16
section .code16*
"RAM16":place in RAM_region16
rw section __DLIB_PERTHREAD :;
```

(4) Add the following code.
(4) Open the project from EWRX, right-click the project in the workspace and open options.

(5) Select “Category: Linker” and click “Config”.

(6) Check “Override default”.

(7) Set the file edited in step (3) as a reference destination.

(8) Click “OK”.

Options for node “project”
5.1.3 Notes on Section Allocation

- Since the EDMAC mode register (EDMR) transmit/receive descriptor length bits (DL) are set to specify 16 bytes, sections must be allocated on 16-byte boundaries.
- Transmit buffer and receive buffer areas must be allocated on 32-byte boundaries.
- If Ethernet FIT module is installed in the user project by FIT configurator of e2 studio, section allocation is will be set automatically. Please change the setting according the user program.
- When using the Ethernet FIT module with RX64M, RX71M, RX72M, RX72N and RX66N, do not use addresses 0000 0000h to 0000 001Fh.
5.2 **Ethernet FIT Module Initial Settings**

Figure 5.1 is a flowchart of the routine for making initial settings to the Ethernet FIT module.

```
main

Memory initialization
R_ETHER_Initial()

Callback function registration
R_ETHER_Control(CONTROL_SET_CALLBACK)

Interrupt handler function registration
R_ETHER_Control(CONTROL_SET_INT_HANDLER)

PHY mode settings, module stop cancellation
R_ETHER_Control(CONTROL_POWER_ON)

Pin setting
R_ETHER_PinSet_ETHERCn_xxx()

ETHERC and EDMAC initialization
R_ETHER_Open_ZC2()

Link up
R_ETHER_LinkProcess()

User defined processing

Figure 5.1 Flowchart of Ethernet FIT Module Initial Settings
```

5.2.1 **Notes on Ethernet FIT Module Initial Settings**

Calling the R_ETHER_Initial function clears the memory contents for all channels.
5.3 Magic Packet Detection Operation

Figure 5.2 is a flowchart showing the processing whereby the ETHERC and EDMAC are initialized when a Magic Packet is detected, following the transition to Magic Packet detection operation mode.

![Flowchart of Magic Packet Detection Operation](image)

5.3.1 Notes on Magic Packet Detection Operation

- Do not transition the ETHERC or EDMAC to the module stop state after switching to Magic Packet detection operation. Doing so will make it impossible to the CPU to recover from sleep mode following a WAIT instruction, because the ETHERC will be unable to detect Magic Packets.

- When a Magic Packet is detected, there will be data from the previously received broadcast frame, etc., in the receive FIFO, and the ETHERC will receive notifications of receive status, etc. Therefore, call the R_ETHER_LinkProcess function to initialize the ETHERC and EDMAC.

- When the value of #define ETHER_CFG_USE_LINKSTA is set to 1, the interrupt handler function is called when a change in the link signal is detected. Therefore, if the CPU was in sleep mode when the link signal change was detected, it will return to normal operation regardless of whether or not a Magic Packet is detected.
5.4 Notes on Accessing MII/RMII Registers

When ETHER_CFG_NON_BLOCKING is set to 0, the MII/RMII register in PHY-LSI is accessed using PIR register. Serial data according to the MII/RMII management frame format is transmitted and received by controlling the ETn_MDC and ETn_MDIO pins with software.

Figure 5.3 shows the MII/RMII register access timing when accessing the MII/RMII registers in the PHY-LSI under the conditions shown in Table 5.2.

Table 5.2 Conditions for Accessing MII/RMII Registers in PHY-LSI

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcomputer used</td>
<td>R5F565N9ADFB</td>
</tr>
<tr>
<td>C compiler</td>
<td>CC-RX V3.02</td>
</tr>
<tr>
<td>ICLK frequency</td>
<td>120MHz</td>
</tr>
<tr>
<td>PCLKA frequency</td>
<td>120MHz</td>
</tr>
<tr>
<td>Ether FIT Version</td>
<td>1.21</td>
</tr>
<tr>
<td>ETHER_CFG_PHY_MII_WAIT setting value</td>
<td>4</td>
</tr>
<tr>
<td>PHY implemented in RSK</td>
<td>DP83620</td>
</tr>
</tbody>
</table>

Table 5.3 shows the AC specifications of the input/output timing of MDC/MDIO in the PHY mounted on RSK and the measured values (reference) when the MII/RMII register is accessed under the conditions of Table 5.2.

Table 5.3 AC specifications and measurement values (reference) of MDC/MDIO input/output timing in PHY implemented in RSK

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Measured Value (ref.)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDC to MDIO (Output) Delay Time</td>
<td>T1</td>
<td>10</td>
<td>20</td>
<td>800</td>
<td>ns</td>
</tr>
<tr>
<td>MDIO (Input) to MDC Setup Time</td>
<td>T2</td>
<td>10</td>
<td>20</td>
<td>500</td>
<td>ns</td>
</tr>
<tr>
<td>MDIO (Input) to MDC Hold Time</td>
<td>T3</td>
<td>10</td>
<td>20</td>
<td>2300</td>
<td>ns</td>
</tr>
<tr>
<td>MDC Frequency</td>
<td>T4</td>
<td>10</td>
<td>40</td>
<td>2840</td>
<td>ns</td>
</tr>
</tbody>
</table>

When ETHER_CFG_NON_BLOCKING is set to the value 1, PMGI is used to access the MII/RMII register in the PHY-LSI. Serial data according to the MII/RMII management frame format is sent and received from the PMGIn_MDC and PMGIn_MDIO pins. Figure 5.4 shows the MII/RMII register access timing when accessing the MII/RMII register in the PHY-LSI under the conditions shown in Table 5.4.
Table 5.4 Conditions for Accessing MII/RMII Registers in PHY-LSI

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microcomputer used</td>
<td>R5F572NNDBD</td>
</tr>
<tr>
<td>C compiler</td>
<td>CC-RX V3.02</td>
</tr>
<tr>
<td>ICLK frequency</td>
<td>240MHz</td>
</tr>
<tr>
<td>PCLKA frequency</td>
<td>120MHz</td>
</tr>
<tr>
<td>ETHER_CFG_PMGI_CLOCK</td>
<td>2500000</td>
</tr>
<tr>
<td>ETHER_CFG_PMGI_HOLD_TIME</td>
<td>7</td>
</tr>
<tr>
<td>ETHER_CFG_PMGI_CAPTURE_TIME</td>
<td>0</td>
</tr>
<tr>
<td>Ether FIT Version</td>
<td>1.21</td>
</tr>
<tr>
<td>PHY implemented in RSK</td>
<td>KSZ8041NL</td>
</tr>
</tbody>
</table>

Figure 5.4 MII/RMII Register Access Timing

Table 5.5 shows the AC specifications of the input/output timing of MDC/MDIO in the PHY mounted on RSK and the measured values (reference) when the MII/RMII register is accessed under the conditions of Table 5.4.

Table 5.5 AC specifications and measurement values (reference) of MDC/MDIO input/output timing in PHY implemented in RSK

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Measured Value (ref.)</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDC to MDIO (Output) Delay Time</td>
<td>T1</td>
<td>-</td>
<td>-</td>
<td>64</td>
<td>ns</td>
</tr>
<tr>
<td>MDIO (Input) to MDC Setup Time</td>
<td>T2</td>
<td>10</td>
<td>-</td>
<td>332</td>
<td>ns</td>
</tr>
<tr>
<td>MDIO (Input) to MDC Hold Time</td>
<td>T3</td>
<td>4</td>
<td>-</td>
<td>60</td>
<td>ns</td>
</tr>
<tr>
<td>MDC Frequency</td>
<td>T4</td>
<td>-</td>
<td>-</td>
<td>399</td>
<td>ns</td>
</tr>
</tbody>
</table>

If you cannot meet the AC specifications of the PHY to be used under the set conditions, change the configuration option settings shown in Section 2.7 so that the MII/RMII register access timing can meet the AC specifications of the PHY.
5.5 How to Use API Function Called in Non-Blocking

Setting ETHER_CFG_NON_BLOCKING to a value of 1 makes R_ETHER_Open_ZC2, R_ETHER_CheckLink_ZC, R_ETHER_LinkProcess, R_ETHER_WakeOnLAN, R_ETHER_WritePHY, and R_ETHER_ReadPHY function calls non-blocking-call. The callback function is called when the processing of the API function called by the non-blocking-call is completed. Figures 5.5 to 5.6 show flowcharts of usage examples of API functions called by non-blocking-call.

![Flowchart of usage example of API function called by non-blocking-call](image)

- **Figure 5.5 Usage Example of API Function Called by Non-Blocking-Call (1) - Main Routine**

  Main:
  - Global variable initialization
    - link_stat = false;
    - link_up = false;
    - pgmi_busy = true;
    - ...
  - Memory initialization
    - Callback function registration
    - Interrupt handler function registration
    - Pin setting
  - Callback function registration called from PMGI interrupt
    - R_ETHER_Control(CONTROL_SET_PMGI_CALLBACK)
  - ETHERC, EDAMC initialization
    - R_ETHER_Open_ZC2()
  - pgmi_busy == false?
    - No
    - Yes
  - Link status check
    - R_ETHER_CheckLink_ZC()
  - link_stat == true?
    - No
    - Yes
  - Link up
    - R_ETHER_LinkProcess()
  - link_up == true?
    - No
    - Yes
  - Next user-defined process

  Initialize the global variables needed for non-blocking.

  Please refer to the description of Figure 5.1.

  Calls the callback function when the non-blocking API function processing is completed.

  Run R_ETHER_Open_ZC2 in non-blocking mode. Upon completion of initialization, the callback function sets pgmi_busy = false.

  Run R_ETHER_CheckLink_ZC in non-blocking mode. When the check is complete, the callback function sets link_stat = true.

  Run R_ETHER_LinkProcess in non-blocking mode. When the linkup is completed, the callback function sets link_up = true.

  Execute next user-defined processing including the API function that called other non-blocking.
Figure 5.6 Usage Example of API Function Called by Non-Blocking-Call (2) - PMGI Interrupt Callback Function

Note: For PMGI callback functions, refer to 2.11 Callback Function.
6. Appendices

6.1 EPTPC Light FIT Module

Simple switching functionality and multicast frame filtering functionality can be implemented on the RX64M, RX71M, RX72M, and RX72N by combining the Ethernet FIT module with the EPTPC Light FIT module.

1) Simple Switching

When using a two-channel ETHERC, frame transfers between channels take place in hardware.

Channel 0 to channel 1, channel 1 to channel 0, or bidirectional can be selected as the transfer direction. Store and forward or cut through can be selected as the transfer method.

2) Multicast Frame Filtering

Processing to receive or discard multicast frames received by the ETHERC is performed in hardware.

It is possible to receive all multicast frames, to receive no multicast frames, or to receive only multicast frames with a designated destination address (up to two addresses can be registered).

For details, refer to the EPTPC Light FIT module application note “RX Family: EPTPC Light Module Using Firmware Integration Technology Modules,” document No. R01AN3035

6.1.1 Usage Notes

When using the Ethernet FIT module and EPTPC Light FIT module together in combination, it is not possible at the same time to use the EPTPC FIT module (full version),*1 which provides time synchronization based on the IEEE 1588 specification.

When using simple switching or multicast frame filtering on the RX64M, RX71M, RX72M, or RX72N select one of the following:

- When not using the IEEE 1588 time synchronization functionality:
  Select the EPTPC Light FIT module (module name: r_ptp_light_rx).
- When using the IEEE 1588 time synchronization functionality:
  Select EPTPC FIT module (full version) (module name: r_ptp_rx).

Note 1. RX Family: EPTPC Module Using Firmware Integration Technology, document No. R01AN1943
### 6.2 Confirmed Operation Environment

This section describes confirmed operation environment for the Ethernet FIT module.

#### Table 6.1 confirmed operation environment (Rev1.13)

<table>
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<th>Item</th>
<th>Contents</th>
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<tbody>
<tr>
<td>Integrated development environment</td>
<td>Renesas Electronics e² studio Version 6.00.000</td>
</tr>
<tr>
<td>C compiler</td>
<td>Renesas Electronics C/C++ Compiler Package for RX Family V2.07.00</td>
</tr>
<tr>
<td></td>
<td>Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99</td>
</tr>
<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
</tr>
<tr>
<td>Board used</td>
<td>Renesas Starter Kit+ for RX64M (product number.ROK50564MSxxxxBE)</td>
</tr>
<tr>
<td></td>
<td>Renesas Starter Kit+ for RX65N (product number.RTK50565NSxxxxxxBE)</td>
</tr>
<tr>
<td></td>
<td>Renesas Starter Kit+ for RX65N-2MB (product number.RTK50565N2SxxxxxBE)</td>
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</table>

#### Table 6.2 confirmed operation environment (Rev1.15)

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<td>Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99</td>
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<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
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<tr>
<td>Board used</td>
<td>Renesas Starter Kit+ for RX64M (product number.ROK50564MSxxxxBE)</td>
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<tr>
<td></td>
<td>Renesas Starter Kit+ for RX71M (product number.ROK50571MCxxxxBE)</td>
</tr>
<tr>
<td></td>
<td>Renesas Starter Kit+ for RX65N (product number.RTK50565NSxxxxxxBE)</td>
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</table>

#### Table 6.3 confirmed operation environment (Rev1.16)

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<tbody>
<tr>
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<td>Renesas Electronics e² studio Version 7.3.0</td>
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<tr>
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<td>IAR Embedded Workbench for Renesas RX 4.10.01</td>
</tr>
<tr>
<td>C compiler</td>
<td>Renesas Electronics C/C++ Compiler Package for RX Family V.3.01.00</td>
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<td>Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99</td>
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<td></td>
<td>GCC for Renesas RX 4.08.04.201803</td>
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<td></td>
<td>Compiler option: The following option is added to the default settings of the integrated development environment. -std=gnu99</td>
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<tr>
<td></td>
<td>IAR C/C++ Compiler for Renesas RX version 4.10.01</td>
</tr>
<tr>
<td></td>
<td>Compiler option: The default settings of the integrated development environment.</td>
</tr>
<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
</tr>
<tr>
<td>Board used</td>
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### Table 6.4  confirmed operation environment (Rev1.17)

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<td>IAR Embedded Workbench for Renesas RX 4.12.01</td>
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<tr>
<td>C compiler</td>
<td>Renesas Electronics C/C++ Compiler Package for RX Family V.3.01.00</td>
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<td></td>
<td>Compiler option: The following option is added to the default settings of the integrated development environment.</td>
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<td></td>
<td>-lang = c99</td>
</tr>
<tr>
<td></td>
<td>GCC for Renesas RX 4.08.04.201902</td>
</tr>
<tr>
<td></td>
<td>Compiler option: The following option is added to the default settings of the integrated development environment.</td>
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<td></td>
<td>-std=gnu99</td>
</tr>
<tr>
<td></td>
<td>IAR C/C++ Compiler for Renesas RX version 4.12.01</td>
</tr>
<tr>
<td></td>
<td>Compiler option: The default settings of the integrated development environment.</td>
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<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
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<tr>
<td>Board used</td>
<td>Renesas Starter Kit+ for RX72M (product number.RTK5572Mxxxxxxxxxx)</td>
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### Table 6.5  confirmed operation environment (Rev1.20)

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<td>IAR Embedded Workbench for Renesas RX 4.12.01</td>
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<td>C compiler</td>
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<td>-lang = c99</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>Compiler option: The following option is added to the default settings of the integrated development environment.</td>
</tr>
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<td>-std=gnu99</td>
</tr>
<tr>
<td></td>
<td>IAR C/C++ Compiler for Renesas RX version 4.12.01</td>
</tr>
<tr>
<td></td>
<td>Compiler option: The default settings of the integrated development environment.</td>
</tr>
<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
</tr>
<tr>
<td>Board used</td>
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</tr>
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</table>
**Table 6.6 confirmed operation environment (Rev1.21)**

<table>
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<th>Contents</th>
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<tbody>
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<td>environment</td>
<td>IAR Embedded Workbench for Renesas RX 4.14.01</td>
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<td>C compiler</td>
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<td>-lang = c99</td>
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<td>Compiler option: The following option is added to the default settings of the integrated development environment.</td>
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<td>IAR C/C++ Compiler for Renesas RX version 4.14.01</td>
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<td></td>
<td>Compiler option: The default settings of the integrated development environment.</td>
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<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
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<tr>
<td>Board used</td>
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</table>

**Table 6.7 confirmed operation environment (Rev1.22)**

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<tbody>
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<tr>
<td>environment</td>
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<td>C compiler</td>
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</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>Compiler option: The following option is added to the default settings of the integrated development environment.</td>
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<td></td>
<td>-std=gnu99</td>
</tr>
<tr>
<td></td>
<td>IAR C/C++ Compiler for Renesas RX version 4.20.1</td>
</tr>
<tr>
<td></td>
<td>Compiler option: The default settings of the integrated development environment.</td>
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<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
</tr>
<tr>
<td>Board used</td>
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### Table 6.8  confirmed operation environment (Rev1.23)

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<td>environment</td>
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<td>Renesas Electronics C/C++ Compiler Package for RX Family V.3.04.00</td>
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<td>Compiler option: Default setting when using the Smart Configurator.</td>
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<td>GCC for Renesas RX 8.3.0.202104</td>
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<td>Compiler option: Default setting when using the Smart Configurator.</td>
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<td>IAR C/C++ Compiler for Renesas RX version 4.20.1</td>
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<td></td>
<td>Compiler option: The default settings of the integrated development</td>
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<td></td>
<td>environment.</td>
</tr>
<tr>
<td>Endian order</td>
<td>Big-endian/Little-endian</td>
</tr>
<tr>
<td>Board used</td>
<td>Renesas Starter Kit+ for RX65N (product number.RTK500565Nxxxxxx)</td>
</tr>
</tbody>
</table>
6.3 Troubleshooting

(1) Q: I have added the FIT module to the project and built it. Then I got the error: Could not open source file “platform.h”.

A: The FIT module may not be added to the project properly. Check if the method for adding FIT modules is correct with the following documents:

- Using CS+:
  Application note “Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)”

- Using e² studio:
  Application note “Adding Firmware Integration Technology Modules to Projects (R01AN1723)”

When using a FIT module, the board support package FIT module (BSP module) must also be added to the project. For this, refer to the application note “Board Support Package Module Using Firmware Integration Technology (R01AN1685)”.

(2) Q: I have added the FIT module to the project and built it. Then I got the error: This MCU is not supported by the current r Ether_RX module.

A: The FIT module you added may not support the target device chosen in the user project. Check the supported devices of added FIT modules.

(3) Q: I have added the FIT module to the project and built it. Then I got an error for when the configuration setting is wrong.

A: The setting in the file “r Ether_RX_config.h” may be wrong. Check the file “r Ether_RX_config.h”. If there is a wrong setting, set the correct value for that. Refer to 2.7 Configuration Overview for details.

(4) Q: Data transmission and reception is not started.

A: The pin setting may not be performed correctly. When using this FIT module, the pin setting must be performed. Refer to 4 Pin Setting for details.
7. **Provided Modules**

The module provided can be downloaded from the Renesas Electronics website.

8. **Ethernet FIT Module Usage Notes**

Keep the following points in mind when using the Ethernet FIT module.

- If broken frames or noise on an external line cause detection of a frame error during reception by the ETHERC and EPTPC on the RX64M, RX71M, RX72M, RX72N or RX66N, proper reception may no not be possible even if subsequent received frames are normal. For details, refer to the technical updates and application notes listed below.
- Notes on Using Ethernet Controller (Technical Notification No. TN-RX*-A125A/E)
- RX Family Retrieve Recommend Operation of INFABT Occurrence in The Ethernet Controller (Doc No. R01AN2604)
- If the EDMR.SWR bit is set to 1 while data transfer is being performed by EDMAC0, EDMAC1, or PTPEDMAC in RX64M / RX71M / RX72M/ RX72N/ RX66N, data at address 0000 0000h to 0000 001Fh may be destroyed. Please refer to the following technical update for details.
- Notes on software reset of the DMA controller (EDMAC) for the RX64M group and RX71M group Ethernet controller (Technical Update No. TN-RX * -A0212A / J)

9. **Reference Documents**

User’s Manual: Hardware
- RX64M Group User’s Manual: Hardware (Doc No. R01UH0377)
- RX65N Group, RX651 Group User’s Manual: Hardware (Doc No. R01UH0590)
- RX72M Group User’s Manual: Hardware (Doc No. R01UH0804)

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

Technical Update/Technical News

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

User’s Manual: Development Tools

RX Family C/C++ Compiler, Assembler, Optimizing Linkage Editor Compiler Package (R20UT0570)

(The latest version can be downloaded from the Renesas Electronics website.)
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<td>The module is updated to fix the software issue.</td>
<td>When R_ETHER_LinkProcess function is called, there are cases when link up/link down are not processed successfully.</td>
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<td>1.15</td>
<td>May 07, 2018</td>
<td>Program</td>
<td>The module is updated to fix the software issue.</td>
<td>When R_ETHER_Read_ZC2 function or R_ETHER_Read function is called, there is case when the Ethernet frame cannot be received normally.</td>
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<td>Program</td>
<td>The module is updated to fix the software issue.</td>
<td>When R_ETHER_LinkProcess function is called, there is case when link up processing is not completed normally.</td>
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### Program

**Description:**

When `R_ETHER_Read_ZC2` function or `R_ETHER_Read` function is called, there is case when execution of function is not completed.

**Conditions:**

- `R_ETHER_LinkProcess` function is called in the interrupt function.

**Corrective action:**

Please use the Ethernet FIT module Rev1.15.

The following function is changed by this correction.

- `R_ETHER_Read_ZC2` function

### Corresponding Tool News number: R20TS0307

- **9** 2.8 Code Size, amended
- **54** 6.2 Confirmed Operation Environment, amended

**1.16** May 20, 2019

- Update the following compilers:
  - GCC for Renesas RX
  - IAR C/C++ Compiler for Renesas RX

- **1** Added Target Compilers.

- **1** Deleted R01AN1723, R01AN1826, R20AN0451 from Related Documents.

- **5** Added revision of dependent `r_bsp` module in 2.2 Software Requirements.

- **8** 2.8 Code Size, amended.

- **47** `R_ETHER_GetVersion` function, deleted special notes.

- **53-56** 5.1.1 and 5.1.2, added.

- **61** Added Table 6.3 Operation Confirmation Environment (Ver. 1.16).

**1.17** Jul 30, 2019

- Supported RX72M version.

- **5** 1.3 Use Limit, added.

- **6** Table 2.1 List of Usage of Interrupt Vectors, amended.

- **9** Note 5, Note6, Note 7, Note 8, amended.
  - Note 9, added.
  - 2.8 Code Size, amended.

- **16** 2.14 “for”, “while” and “do while” statements, added.

- **17-46** Delete “Reentrant” item on the API description page.

- **47-50** Table 4.5 Pin setting example for channel 0 of RX72M and Table 4.6 Pin setting example for channel 1 of RX72M, added.

- **53** 5.1 Section Allocation, amended.

- **58** 5.1.3 Notes on Section Allocation, amended.

- **60** 6.1 EPTPC Light FIT Module add RX72M.

- **62** 6.2 Confirmed Operation Environment, amended.

- **65** 8 Ethernet FIT Module Usage Notes, amended.
  - 9 Reference Documents, amended.

### Program

**Description:**

If an Ethernet frame is received after buffer open processing in the `R_ETHER_Read_ZC2_BufRelease` function or `R_ETHER_Read` function, the following phenomenon may
(1) There are cases where the received Ethernet frame cannot be read.
(2) The received error frame may be read as a normal Ethernet frame.

**Conditions:**
An Ethernet frame is received after buffer open processing in the R_ETHER_Read_ZC2_BufRelease function or R_ETHER_Read function.

**Corrective action:**
Please use Ethernet FIT module Rev1.17.
The following functions have been changed by this correction.

**R_ETHER_Read_ZC2_BufRelease Function**

**Correspondence tool news number:** R20TS0447

| 1.20 | Nov 22, 2019 | Supported RX72N and RX66N version. | 5 |
| 1.20 | 2.8 Code Size, amended. | Table 1.1 API Functions, amended. | 6 |
| 1.20 | 3.2 R_ETHER_Open_ZC2(), amended. | Table 2.1 List of Usage of Interrupt Vectors, amended. | 8 |
| 1.20 | 3.8 R_ETHER_CheckLink_ZC(), amended. | Configuration options in rEther_rx_config.h, amended. | 10 |
| 1.20 | 3.14 R_ETHER_Control(), amended. | Note 4, Note 5, Note6, Note 7, Note 8, amended. Note 9, added. | 11 |
| 1.20 | 3.16 R_ETHER_ReadPHY(), added. | 2.11 Callback Function, amended. | 16-17 |
| 1.20 | 4.1.2 Pin setting example for using RSK+RX63N, deleted. | 3.9 R_ETHER_LinkProcess(), amended. | 23 |
| 1.20 | 4.1.3 Pin setting example for using RSK+RX72N, added. | 3.10 R_ETHER_WakeOnLAN(), amended. | 34 |
| 1.20 | 4.1.5 confirmed operation environment (Rev 1.20), added. | 3.14 R_ETHER_Control(), amended. | 36 |
| 1.20 | 8 Ethernet FIT Module Usage Notes, amended. | 3.15 R_ETHER_WritePHY(), added. | 46-49 |
| 1.20 | 9 Reference Documents, amended. | 3.16 R_ETHER_ReadPHY(), added. | 51 |

**Program**
Ethernet FIT module fixed due to software failure

**Description:**
When one receive descriptor is set, Ethernet frames may not be received after the buffer release processing in the “R_ETHER_Read_ZC2_BufRelease” function or “R_ETHER_Read” function.

**Conditions:**
Use the R_ETHER_Read_ZC2_BufRelease function or R_ETHER_Read function to receive an Ethernet frame.

**Corrective action:**
Please use Ethernet FIT module Rev1.20.
The following functions are changed by this modification.

**R_ETHER_Read_ZC2**

**R_ETHER_Read_ZC2_BufRelease function**

**Correspondence tool news number:** R20TS0481
## Program

**Ethernet FIT module fixed due to software failure**

**Description:**
When one transmission descriptor is set, the Ethernet frame may not be transmitted after the transmission start processing in the "R_ETHER_Write_ZC2_SetBuf" function or the "R_ETHER_Write" function.

**Conditions:**
Use the R_ETHER_Read_ZC2_SetBuf function or R_ETHER_Write function to transmit an Ethernet frame.

**Corrective action:**
Please use Ethernet FIT module Rev1.20.
The following functions are changed by this modification.

| R_ETHER_Write_ZC2_GetBuf function |

**Corresponding tool news number:** R20TS0481

### Note

- **1.21**
  - Sep 10, 2020
  - 10: Note 10 amended
  - 18: 2.12 Adding the FIT Module to Your Project, amended.
  - 56-57: Table 4.5 and 4.6, amended.
  - 59: Table 4.8, amended.
  - 68: 5.4 Notes on Accessing MII/RMII Registers, added.
  - 70: 5.5 How to Use API Function Called in Non-Blocking, added.
  - 75: Table 6.6 confirmed operation environment (Rev1.21), added.

- **1.22**
  - Nov 21, 2021
  - 9, 10: 2.7 Compile Time Settings, amended.

- **1.23**
  - Mar 01, 2022
  - 62-66: 5.1 Section Allocation, amended.
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   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.

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   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.

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