

RX Family

R20AN0075EJ0106

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Web server using the embedded TCP/IP M3S-T4-Tiny Module Firmware Integration Technology

Introduction

This application note explains Web server using the embedded TCP/IP M3S-T4-Tiny Module (hereafter Web server).

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

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

Web server is used by combining the following middleware products.

Table 1 Middleware products

Function	Middleware Product	Web Page*1
TCP/IP	M3S-T4-Tiny (hereafter T4) (R20AN0051)	http://www.renesas.com/mw/t4
FTP server and Web server Interface	File driver for FTP server and Web server Module (R20AN0333)	http://www.renesas.com/mw/t4
File system	M3S-TFAT- Tiny(R20AN0038)	http://www.renesas.com/mw/tfat
File system Interface	M3S-TFAT-Tiny Memory Driver Interface (R20AN0335)	http://www.renesas.com/mw/tfat
Time management	System Timer Module (R20AN0431)	http://www.renesas.com/mw/t4
MMC driver	SPI mode MultiMediaCard Driver*2	http://www.renesas.com/mw/tfat http://www.renesas.com/mw/tfs
MMC extensions (board)	Middleware Evaluation board*3	http://www.renesas.com/mw/tfat http://www.renesas.com/mw/tfs http://www.renesas.com/mw/s2 http://www.renesas.com/mw/dtmf
USB driver	USB driver	http://www.renesas.com/driver/us b

Notes: 1. The items with multiple page references can be downloaded from the related middleware sites.

There are no differences between the downloadable application notes themselves.

2. The SD(less 2GB size) card that has compatible command for MMC is available on this software.

3. The middleware evaluation board must be produced by the user based on these application notes.

Since each of these middleware packages are independent, they can be combined freely if the user implements interface programs. For example, the file system can be replaced by another file system, or the MMC driver can be replaced with a USB driver.

Furthermore, since the web server program itself contains no program code that depends on the microcontroller, it can be easily ported to another microcontroller simply by replacing the TCP/IP software stack with one for the other microcontroller.

We prepared sample programs for each CPU board included in [the Renesas Starter Kit](#). For more information, see Renesas Starter Kit for sample application notes.

Table 2 Sample application notes

sample application notes	document number	website
Application example using T4 (DHCP/DNS/FTP/HTTP) Firmware Integration Technology	R20AN0314	https://www.renesas.com/mw/t4

Target Device

RX Family

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1. Outline

This web server is an application that operates over TCP/IP, can be accessed from an ordinary web browser, and provides functions for transferring content stored on the web server to web browsers using TCP/IP.

1.1 System Structure

Show System Structure Example.

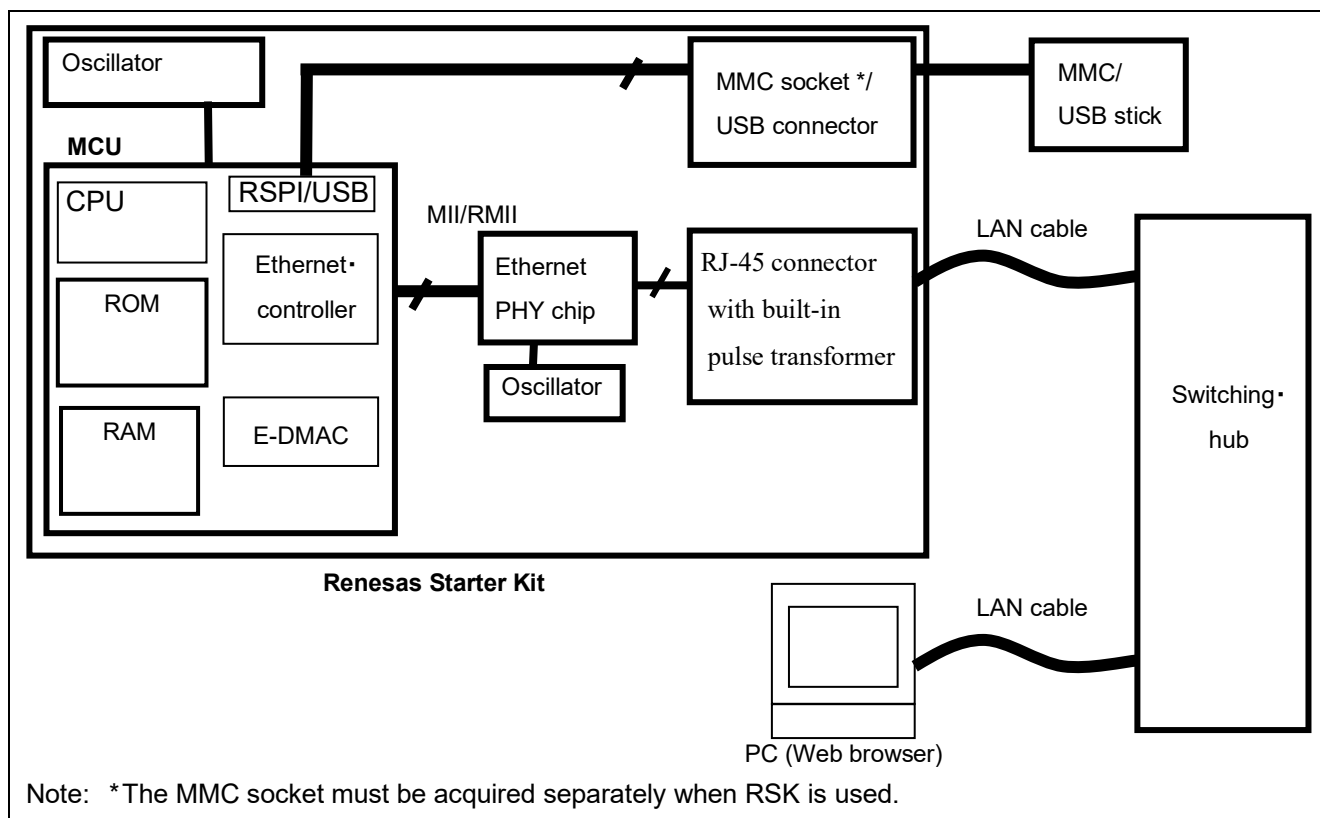


Figure 1 System Structure Example

1.2 Software Structure

1.2.1 In case MMC driver or in case USB driver

Show Software Structure Example in case MMC driver or in case USB driver.

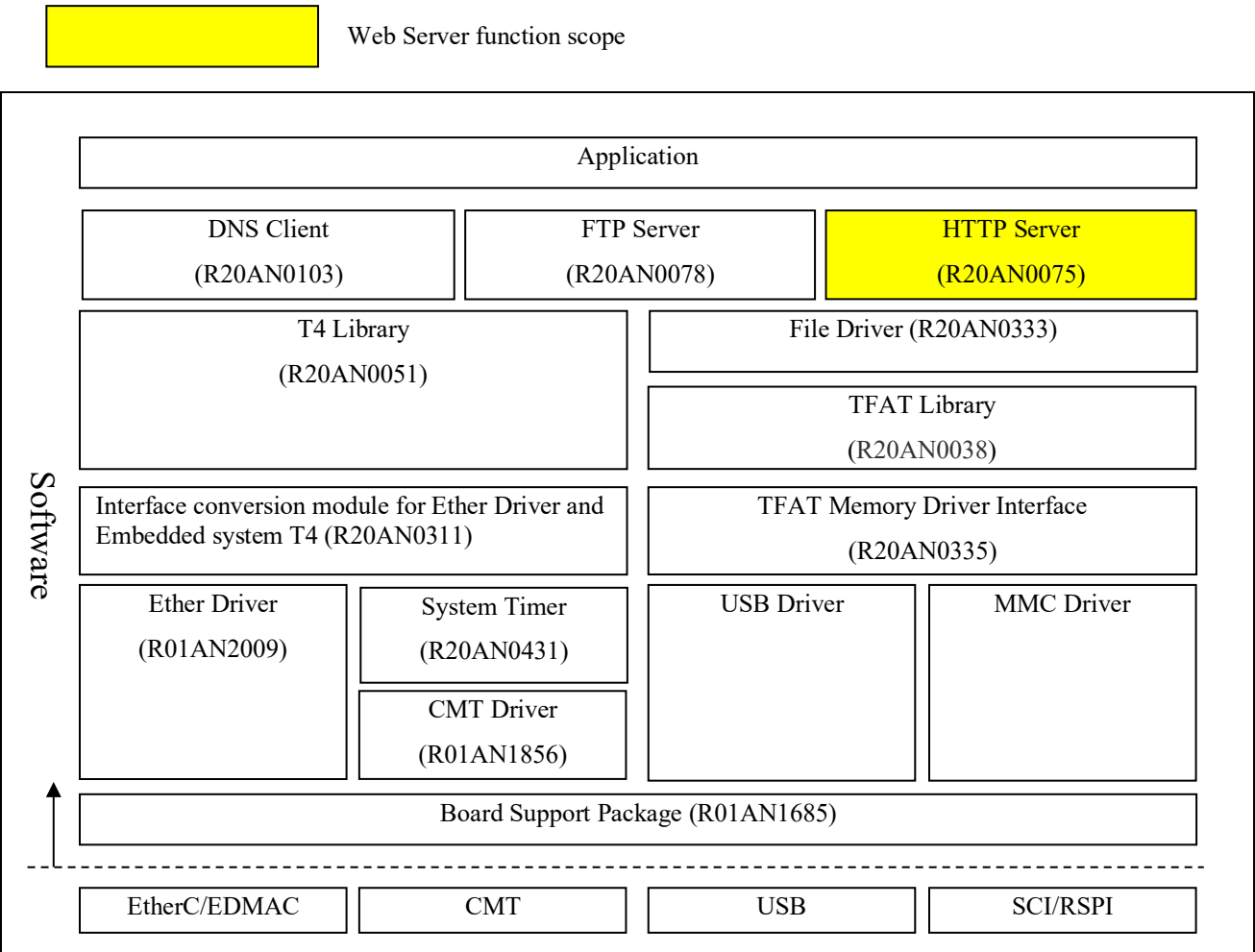


Figure 2 Software Structure Example (in case, store the web contents to MMC/USB memory)

1.2.2 In case internal ROM

Show Software Structure Example in case internal ROM.

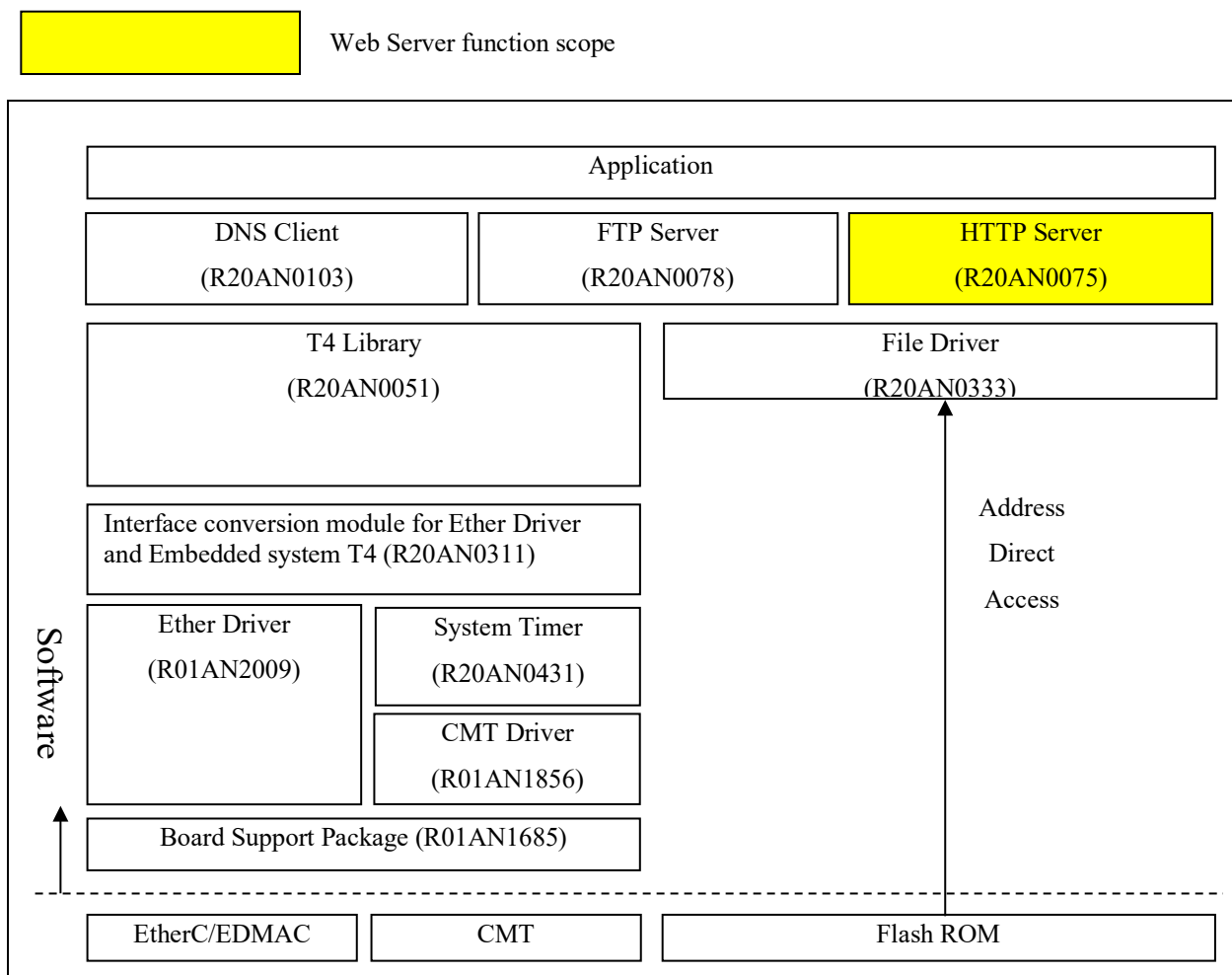


Figure 3 Software Structure Example (in case internal ROM)

1.3 CGI function

This Web server has easily implementation CGI (Common Gateway Interface) function. CGI is way to execute user program on Web server under the Web browser request. This Web server can call the CGI functions that corresponds to the URL. The CGI functions can be set in config file.

2. API Information

2.1 Hardware Requirements

None

2.2 Software Requirements

This module is dependent upon the following packages:

`r_t4_rx`

`r_t4_file_driver_rx`

`r_sys_time_rx`

2.3 Supported Toolchains

This library is tested and working with following toolchains:

Renesas RX Toolchain v.2.05.00

2.4 Limitations

This program uses `stdio.h`, `stdlib.h`, `string.h`, and `ctype.h`. Specify `stdio`, `stdlib`, `string`, and `ctype` as compiler options when compiling user programs.

2.5 Header Files

All API calls are accessed by including a single file "`r_t4_http_server_rx_if.h`" which is supplied with this software's project code.

2.6 Configuration Overview

All configurable options that can be set at build time are located in the file “r_t4_http_server_rx_config.h”. A summary of these settings are provided in the following table:

Table 3 Configuration options

Configuration options in <i>r_t4_http_server_rx_config.h</i>	
#define HTTPD_VERSION_CODE ※Default value is ” ”Renesas Embedded Web Server/1.06”” .	Server header field. The data stored in the server header field transmitted to the web browser during communication with the web browser can be specified.
#define ROOT_DIR ※Default value is ” ””(NULL literal) ”” .	Root directory. Which directory in external memory is seen as the root directory can be specified. Example : #define ROOT_DIR “” #define ROOT_DIR “user” #define ROOT_DIR “user/root_dir”
#define INDEXES ※Default value is ” 1” .	Displaying or not displaying an index page. The behavior when a directory is specified from the web browser can be specified. When set to 1, the directory contents are returned as the response. When set to 0, the file specified as the DEFAULT_FILE_NAME is returned as the response.
#define DEFAULT_FILE_NAME ※Default value is ” ”index.htm”” .	File returned as response when do not display index page is specified This file is the response when INDEXES is set to 0. A "404 Not Found" response is returned if the specified file cannot be found.
#define MAX_EXTENSION ※Default value is ” 15” .	The number of corresponding content-type. This is the max number of a list of the file extensions stored in external memory.

<pre>#define EXTENSION_TYPE_TABLE_LIST ※Default value is " {"def", "application/octet-stream"},\ {"htm", "text/html"},\ {"txt", "text/plain"},\ {"exe", "application/octet-stream"},\ {"com", "application/octet-stream"},\ {"jpg", "image/jpeg"},\ {"gif", "image/gif"},\ {"png", "image/png"},\ {"zip", "application/octet-stream"},\ {"mp3", "audio/mpeg"},\ {"wav", "Naudio/x-wav"},\ {"dat", "application/octet-stream"},\ {"xls", "application/vnd.ms-excel"},\ {"doc", "application/msword"},\ {"cgi", "text/html"},\}" .</pre>	<p>Corresponding content-type</p> <p>This is a list of the file extensions stored in external memory.</p> <p>If a file with an extension not defined here is transferred, the system will respond to that file with the settings for the extension defined at the head of the list.</p>
<pre>#define MAX_CGI_FILE ※Default value is " 1" .</pre>	The number of registered CGI file
<pre>#define CGI_FILE_NAME_TABLE_LIST Default value is " {"cgi_smpl.cgi", NULL}, " .</pre>	The table includes CGI file name and corresponding internal functionCGI
<pre>#define HTTP_POST_CALLBACK_FUNCTION ※Default value is NULL</pre>	Callback function for receiving POST command.
<pre>#define LF_CODE ※Default value is " "\n" .</pre>	New line code used for index page generation.
<pre>#define HTTP_TCP_CEP_NUM ※Default value is " 4" .</pre>	<p>Maximum number of clients that can be accepted at the same time</p> <p>This value must be set to match the number of sockets defined in config_tcpudp.c</p>
<pre>#define HTTP_START_TCP_CEP ※Default value is "0" .</pre>	The offset value of starting position of the communication endpoint in "config_tcpudp.c".
<pre>#define HTTP_MAX_FILE_LIST ※Default value is " 16" .</pre>	<p>Maximum number of files that can be displayed on the index page</p> <p>Set this value so that BODY_BUF_SIZE is not exceeded.</p>
<pre>#define RCV_BUF_SIZE ※Default value is " 1024" .</pre>	Reception buffer size
<pre>#define HDR_BUF_SIZE ※Default value is " 1460" .</pre>	Header file transmission buffer size
<pre>#define BODY_BUF_SIZE ※Default value is " 2048" .</pre>	Body field transmission buffer size
<pre>#define NO_COMMUNICATION_TIMEOUT_TIMER ※Default value is " 10" .</pre>	Timeout timer for no communication, unit is second.

2.7 Adding Library to Your Project

2.7.1 Adding FIT Module for Your Project

Please refer to the Adding Firmware Integration Technology Modules to Projects (r01an1723eu0111_rx.pdf, for e² studio) or the Adding Firmware Integration Technology Modules to CS+ Projects (r01an1826ej0102_rx.pdf).

2.7.2 Combination with TCP/IP(T4 Library)

Please add the config_tcpudp.c that is included into TCP/IP (T4) as the following.

This example set the macro HTTP_TCP_CEP_NUM = 4, HTTP_START_TCP_CEP=0.

1. Please add the 4 reception points (tcp_crep[] array) settings from HTTP_START_TCP_CEP (=0) to HTTP_TCP_CEP_NUM(=4). And change last member to 80.

```
T_TCP_CREP tcp_crep[] =
{
    { 0x0000, { 0, 80 }}, /* =HTTP_START_TCP_CEP */
    { 0x0000, { 0, 80 }},
    { 0x0000, { 0, 80 }},
    { 0x0000, { 0, 80 }},
};
```

2. Please add the 4 communication endpoints (tcp_ccep[] array) settings from HTTP_START_TCP_CEP (=0) to HTTP_TCP_CEP_NUM(=4). And change last member to R_TCPIP_HttpServerCallback.

```
T_TCP_CCEP tcp_ccep[] =
{
    /* { attribute of TCP communication end point,
        top address of transmit window buffer, size of transmit window
buffer,
        top address of receive window buffer, size of receive window buffer,
address of callback routine }
    */
    { 0, 0, 0, 0, 1460, R_TCPIP_HttpServerCallback }, /* =HTTP_START_TCP_CEP */
    { 0, 0, 0, 0, 1460, R_TCPIP_HttpServerCallback },
    { 0, 0, 0, 0, 1460, R_TCPIP_HttpServerCallback },
    { 0, 0, 0, 0, 1460, R_TCPIP_HttpServerCallback },
};
```

3. Please add the R_TCPIP_HttpServerCallback() extern declaration.

```
#include "r_t4_itcpip.h"
extern ER R_TCPIP_HttpServerCallback(ID cepid, FN fncd , VP p_parblk);
```

3. API Functions

3.1 R_TCPIP_HttpServerOpen

This function starts Web server process.

Format

```
int32_t R_TCPIP_HttpServerOpen(void)
```

Parameters

None

Return Value

- 0 : Normal termination
- excluding 0 : Illegal termination (No register the TCP/IP process to system timer)
-

Properties

Prototyped in file "r_t4_http_server_rx_if.h".

Description

This function communicates itself is performed automatically as driven by interrupts.

Reentrant

No

Special Notes

None

3.2 R_TCPIP_HttpServerClose

This function starts Web server process.

Format

```
int32_t R_TCPIP_HttpServerClose(void)
```

Parameters

None

Return Value

- 0 : Normal termination

Properties

Prototyped in file “r_t4_http_server_rx_if.h”.

Description

This function terminates the Web server.

Reentrant

No

Special Notes

None

3.3 R_TCPIP_HttpServerPendingReleaseRequest

The function that is called when application would like to release the CGI pending

Format

```
void R_TCPIP_HttpServerPendingReleaseRequest (ID cepid)
```

Parameters

cepid	input	communication endpoint ID
-------	-------	---------------------------

Return Value

None

Properties

Prototyped in file “r_t4_http_server_rx_if.h”.

Description

Application calls this function when release the CGI pending

Please refer to the section 5.1.http_server_cgi_callback.

Reentrant

No

Special Notes

None

3.4 R_TCPIP_HttpServerGetVersion

This function returns the version number of Web server.

Format

```
uint32_t R_TCPIP_HttpServerGetVersion(void)
```

Parameters

None

Return Value

Version number of Web server

Properties

Prototyped in file “r_t4_http_server_rx_if.h”.

Description

Returns the version of this module. The version number is encoded such that the top two bytes are the major version number and the bottom two bytes are the minor version number.

For example, version ‘4.25’, the return value is ‘0x00040019’.

Reentrant

Yes

Special Notes

This function is inlined using the “#pragma inline” directive in “r_http_server.c”.

3.5 R_TCPIP_HttpServerReset

Initialize memory for Web server.

Format

```
void R_TCPIP_HttpServerReset(uint8_t channel)
```

Parameters

channel	input	RJ45 port
---------	-------	-----------

Return Value

None

Properties

Prototyped in file “r_t4_http_server_rx_if.h”.

Description

This function initializes the memory for web server communication endpoints running on channel that is specified by argument.

Reentrant

No

Special Notes

Please do not call this function in interrupt function.

4. File driver for FTP server and Web server Module

The web server calls these functions. The user must code the processing performed by these functions appropriately for the file system used. Also, the web server can use this data structure to acquire information from external memory.

Please refer the application note for each function details.

Document Title : RX Family File driver for FTP server and Web server Module Firmware Integration Technology

Document No. : R20AN0333

Table 4 API

Name	Function
change_dir()	Change current directory
file_close()	Close file
file_delete()	Delete file
file_open()	Open file
file_read()	Read file
file_rename()	Rename file
file_exist()	Confirm exit file
file_write()	Write file
get_file_info()	Get file information
get_file_list_info()	Get file list information
get_file_size()	Get file size
make_dir()	Make directory
remove_dir()	Remove directory

The gray out function is not used this sample program.

5. Callback Function

5.1 http_server_cgi_callback

Description

This callback function that is defined into CGI_FILE_NAME_TABLE_LIST in "r_t4_http_server_config.h". User can name this function in originally. In case, user uses CGI function, please register the function pointer to the CGI_FILE_NAME_TABLE_LIST and implement callback function.

The second element (cgi function pointer) of CGI_FILE_NAME_TABLE_LIST will be called when web browser requests the defined cgi file URL. And next, R_TCPIP_HttpServerProcess() will call cgi function.

HTTPd behavior will be changed by the return value.

case: Normal termination

CGI process finishes in this function.

case: Internal error

CGI process errors occur in this function.

case: CGI pending

CGI process does not finish in this function. The third element (cgi function pointer) of CGI_FILE_NAME_TABLE_LIST will be called when user will call R_TCPIP_HttpServerPendingReleaseRequest() in finishing CGI process.

Usage

```
#include "r_t4_itcpip.h"
#include "r_http_server_config.h"
#include "r_t4_http_server_rx_if.h"
ER http_server_cgi_callback (ID cepid, void *res_info);
```

Parameters

cepid	input	The Communication Endpoint ID that is requested CGI function execution.
res_info	input	(HTTPD_RESOURCE_INFO*)res_info->param
		The parameter from Web browser request.
	output	(HTTPD_RESOURCE_INFO*)res_info->res.body
		HTML strings as response
	output	(HTTPD_RESOURCE_INFO*)res_info->res.body_size
		HTML strings length as response

Return Value

-1	Internal Error
-2	CGI pending
0	Normal completion

Remark

None

5.2 http_server_post_callback

Description

This callback function that is defined into HTTP_POST_CALLBACK_FUNCTION in "r_t4_http_server_config.h". User can name this function in originally. In case, user uses POST function, please register the function pointer to the HTTP_POST_CALLBACK_FUNCTION and implement callback function.

This function is the Web server (received POST command) callback function that passes the received data to the user. POST command is often specified several MB as huge file size for embedded system. This function will be called when Web server received the data size reaching each RCV_BUF_SIZE after the POST command. This function specifies the following 4 kinds of event code to the 2nd argument. Please execute fitting process for each event code.

HTTP_POST_CALLBACK_EVENT_INITIALIZE

This event code will be specified when starting upload. This means passes the head of file.

HTTP_POST_CALLBACK_EVENT_PROCEEDING

This event code will be specified when uploading. This means passes the body of file.

HTTP_POST_CALLBACK_EVENT_FINALIZE

This event code will be specified when finishing upload. This means passes the tail of file.

HTTP_POST_CALLBACK_EVENT_ABORT

This event code will be specified when aborted.

Usage

```
#include "r_t4_itcpip.h"
#include "r_http_server_config.h"
#include "r_t4_http_server_rx_if.h"
void http_server_post_callback(ID id, uint8_t event, uint8_t *file_name, uint8_t *receive_data,
                             uint32_t receive_data_size, uint32_t uploaded_file_size);
```

Parameters

id	input	Communication endpoint ID received POST command
event	input	Current processing event code
file_name	input	The file name that specified by POST command
receive_data	input	Receive data pointer
receive_data_size	input	Receive data size
uploaded_file_size	input	File size for current uploading

Return Value

None

Remark

None

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Revision History

Rev.	Date	Description	
		Page	Summary
1.06	Nov 30, 16	—	Corresponded to POST command.
		1	Fixed Table 1
		4	Fixed Figure 2
		5	Fixed Figure 3
		7	Fixed Section 2.2.
		10	Added explanation for combine with T4 in Section 2.7.2.
		11-13	Changed API names in Section 3.1-3.3.
		15	Added Section 3.4 R_TCPIP_HttpServerReset
		16	Fixed Section 4
		—	Delete section “User-Defined Function Reference”
1.05	Oct 01.16	—	Updated the xml file for FIT.
1.04	Jan 05.15	1	Fixed FIT Module URL Added Support MCUs.
		4	Fixed Figure 2
		5	Fixed Figure 3
1.03	May 09.14	—	Corresponded to FIT Modules.
1.02	Apr 28.14	—	Corresponded to RX63N MCU.
		—	Corresponded to simple CGI function.
		—	Add web server runs by only internal ROM.
1.01	Sep 27.12	3	Add information about USB stick
1.00	Apr 12.11	—	First edition issued

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

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

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

2. Processing at Power-on

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

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

3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

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

4. Clock Signals

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

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

5. Differences between Products

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

- The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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