

RZ/T2M, RZ/T2ME, RZ/N2L, RZ/T2L Group

Quick Start Guide: lwIP Protocol Stack Sample Program

Introduction

This document describes the setup procedure of the sample program that implements lwIP (lightweight IP) protocol stack on the Renesas RZ/T2M, RZ/T2ME, RZ/N2L, RZ/T2L platform.

Target Device

RZ/T2M, RZ/T2ME, RZ/N2L, RZ/T2L

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1. Overview

This document describes the setup procedure of the sample program for RZ/T2M, RZ/T2ME, RZ/N2L, RZ/T2L of Industrial Network

Please note that since RZ/T2ME can run using RZ/T2M project files, we will omit the specific description for RZ/T2ME.

1.1 Abbreviations / Definitions

Table 1.1. Abbreviations/Definitions

Index	Abbreviations /Definitions	Description
1	IP	Internet Protocol
2	TCP	Transmission Control Protocol
3	USB	Universal Serial Bus
4	PC	Personal Computer
5	SW	Switch
6	EWARM	Embedded Workbench® for ARM
7	lwIP	lightweight IP

1.2 Reference

Technical information about RZ/T2M, RZ/N2L, RZ/T2L is available via Renesas.

Table 1.2 Technical Inputs for RZ/T2M

Document Type	Description	Document Title	Document No.
User's Manual	Describes the technical details of the RSK+RZT2M hardware.	Renesas Starter Kit+ for RZ/T2M,RZ/T2ME User's Manual	r20ut4939ej****
User's Manual	Provides technical details of the RZ/T2M microprocessor.	RZ/T2M Group User's Manual Hardware	r01uh0916ej****

Table 1.3 Technical Inputs for RZ/N2L

Document Type	Description	Document Title	Document No.
User's Manual	Describes the technical details of the RSK+RZN2L hardware.	Renesas Starter Kit+ for RZ/N2L User's Manual	r20ut4984ej****
User's Manual	Provides technical details of the RZ/N2L microprocessor.	RZ/N2L Group User's Manual Hardware	r01uh0955ej****

Table 1.4 Technical Inputs for RZ/T2L

Document Type	Description	Document Title	Document No.
User's Manual	Describes the technical details of the RSK+RZT2L hardware.	Renesas Starter Kit+ for RZ/T2L User's Manual	r20ut5164ej****
User's Manual	Provides technical details of the RZ/T2L microprocessor.	RZ/T2L Group User's Manual Hardware	r01uh0985ej****

1.3 Limitation / Known Issue

None

2. Features

lwIP (lightweight IP) is an open-source embedded TCP/IP protocol stack. lwIP can implement full-scale TCP functionality with few resources and is suitable for use in embedded systems. lwIP was originally developed by Adam Dunkels at the Swedish Institute of Computer Science (SICS). It is now developed and maintained by a worldwide network of developers. For information on licensing lwIP, see "`common\oss\lwip\COPYING`" in the sample program.

2.1 Package folder structure

Here is a folder overview of the main files:

Please refer to the release notes for the folder tree.

Table 2.1. Folder structure

Folder name	Overview
common/oss	lwip+freeRTOS package file
common/renesas/application	Applications
common/renesas/module/ether_netif	Ethernet API
common/renesas/module/lwip_port	lwip API
common/renesas/module/serial_io	Serial API for log output
SRC	Entry functions, etc.

3. Requirements (Software&Hardware)

This project was developed and tested in an environment using the following boards and tools:

3.1 RZ/T2M

Table 3.1. RZ/T2M environment

Category	Name	Version	Description
Board	Renesas Starter Kit+ for RZ/T2M, RZ/T2ME	User's Manual 2.00	Renesas RZ/T2M-RSK - Renesas Starter Kit Plus for RZ/T2M Renesas
IDE	EWARM	9.60.3	IAR Systems IAR Embedded Workbench for Arm IAR
	e ² studio	2025-12	RZ FSP https://github.com/renesas/rz-fsp/releases/tag/v4.0.0
Configurator	FSP Smart Configurator	2025-12	
Flexible Software Package	FSP	4.0.0	
GCC Compiler	GNU ARM Embedded Toolchain	13.3.Rel1	
Emulator	J-Link TM	8.60	SEGGER SEGGER - The Embedded Experts - Downloads - J-Link / J-Trace
	I-jet		IAR Systems IAR debug probes IAR
	Tera Term		Tera Term Tera Term Open Source Project
Software	Wireshark		WIRESHARK Wireshark • Go Deep Download

3.2 RZ/N2L

Table 3.2. RZ/N2L environment

Category	Name	Version	Description
Board	Renesas Starter Kit+ for RZ/N2L	User's Manual 1.04	Renesas RZ/N2L-RSK - Renesas Starter Kit+ for RZ/N2L Renesas
IDE	EWARM	9.60.3	IAR Systems IAR Embedded Workbench for Arm IAR
	e ² studio	2025-12	RZ FSP https://github.com/renesas/rz-fsp/releases/tag/v4.0.0
Configurator	FSP Smart Configurator	2025-12	
Flexible Software Package	FSP	4.0.0	
GCC Compiler	GNU ARM Embedded Toolchain	13.3.Rel1	
Emulator	J-Link TM	8.60	SEGGER SEGGER - The Embedded Experts - Downloads - J-Link / J-Trace
	I-jet		IAR Systems IAR debug probes IAR
	Tera Term		Tera Term Tera Term Open Source Project
Software	Wireshark		WIRESHARK Wireshark • Go Deep Download

3.3 RZ/T2L

Table 3.3. RZ/T2L environment

Category	Name	Version	Description
Board	Renesas Starter Kit+ for RZ/T2L	User's Manual 1.21	Renesas RZ/T2L-RSK - Renesas Starter Kit+ for RZ/T2L Renesas
IDE	EWARM	9.60.3	IAR Systems IAR Embedded Workbench for Arm IAR
	e ² studio	2025-12	RZ FSP https://github.com/renesas/rz-fsp/releases/tag/v4.0.0
Configurator	FSP Smart Configurator	2025-12	
Flexible Software Package	FSP	4.0.0	
GCC Compiler	GNU ARM Embedded Toolchain	13.3.Rel1	
Emulator	J-Link TM	8.60	SEGGER SEGGER - The Embedded Experts - Downloads - J-Link / J-Trace
	I-jet		IAR Systems IAR debug probes IAR
	Tera Term		Tera Term Tera Term Open Source Project
Software	Wireshark		WIRESHARK Wireshark • Go Deep Download

4. Hardware Setup

This section explains the main hardware. For details about the board you are using, please refer to the [user's manual](#).

4.1 RZ/T2M RSK Board

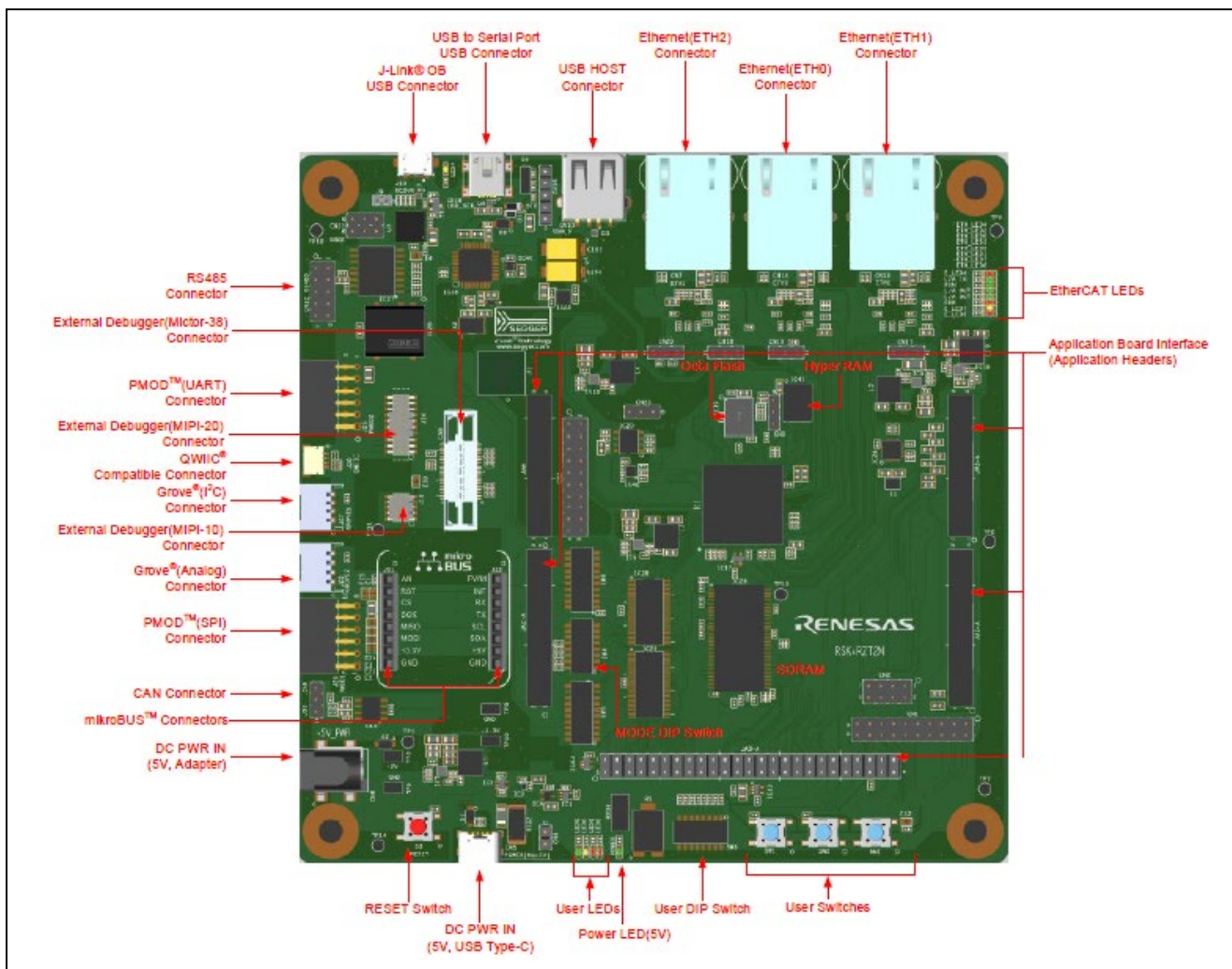


Figure 4.1 RZ/T2M RSK board layout

1. DIP SW and Jumper SW settings

This is the initial setting in "[6. Configuration](#)" of the Renesas Starter Kit+ for RZ/T2M User's Manual.

2. Connect the J-Link to micro USB or J20 with I-jet, switching between them using J9.
3. Use a USB cable (Type-C) or an AC/DC adapter to supply power.
 - When using a USB cable, connect it to CN5.
 - When using an AC/DC adapter, connect it to CN6.
4. You may freely connect the Ethernet cables to ETH0, ETH1, and ETH2—either simultaneously or individually.

4.2 RZ/N2L RSK Board

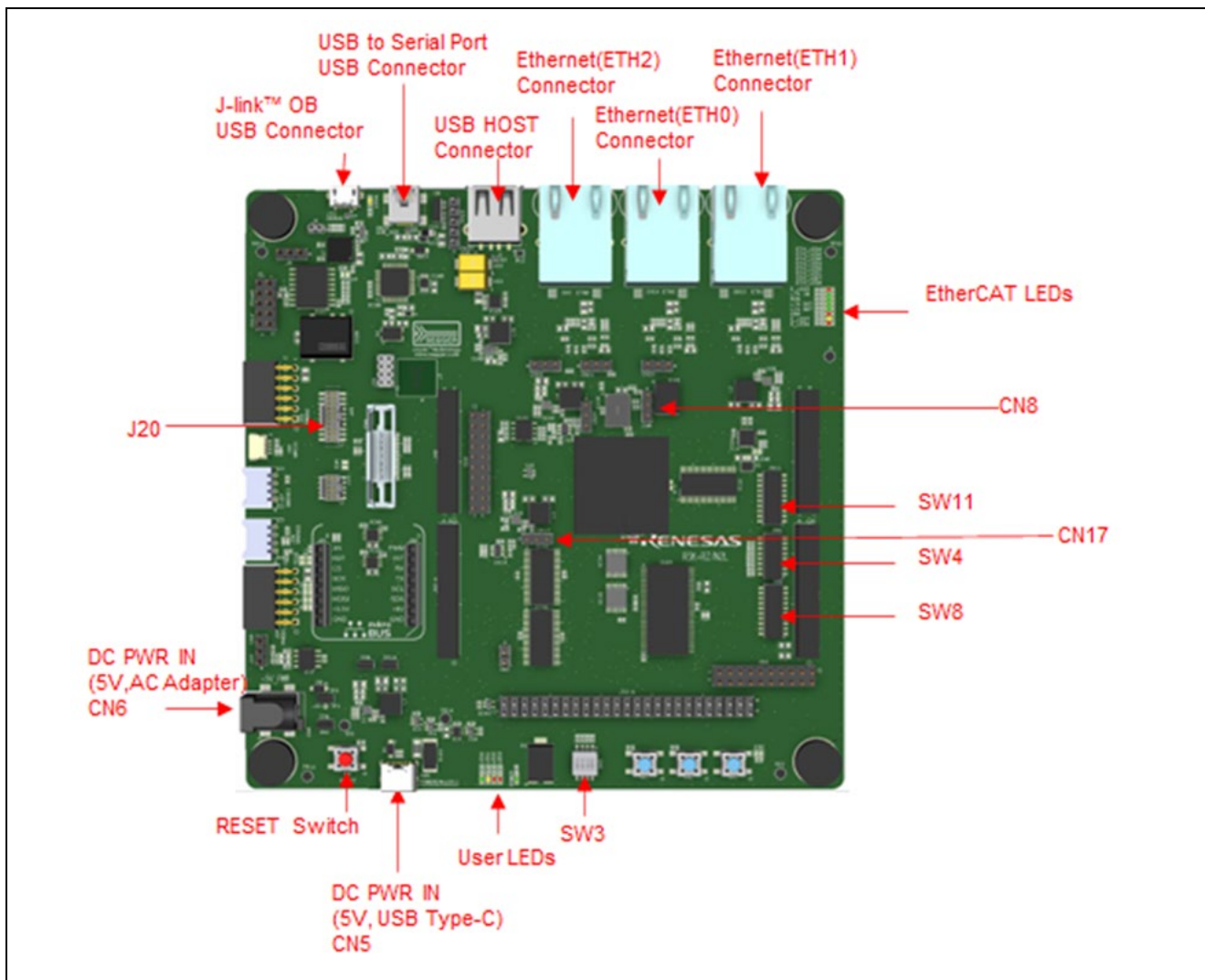


Figure 4.2 RZ/N2L RSK board layout

1. DIP Switch and Jumper Switch Settings

This setting is described in "[6. Configuration](#)" in the Renesas Starter Kit+ for RZ/T2L User's Manual.

2. Connect the J-Link to micro USB or J20 with I-jet, switching between them using J9.
3. Use a USB cable (Type-C) or an AC/DC adapter to supply power.
 - When using a USB cable, connect it to CN5.
 - When using an AC/DC adapter, connect it to CN6.
4. You may freely connect the Ethernet cables to ETH0, ETH1, and ETH2—either simultaneously or individually.

4.3 RZ/T2L RSK Board

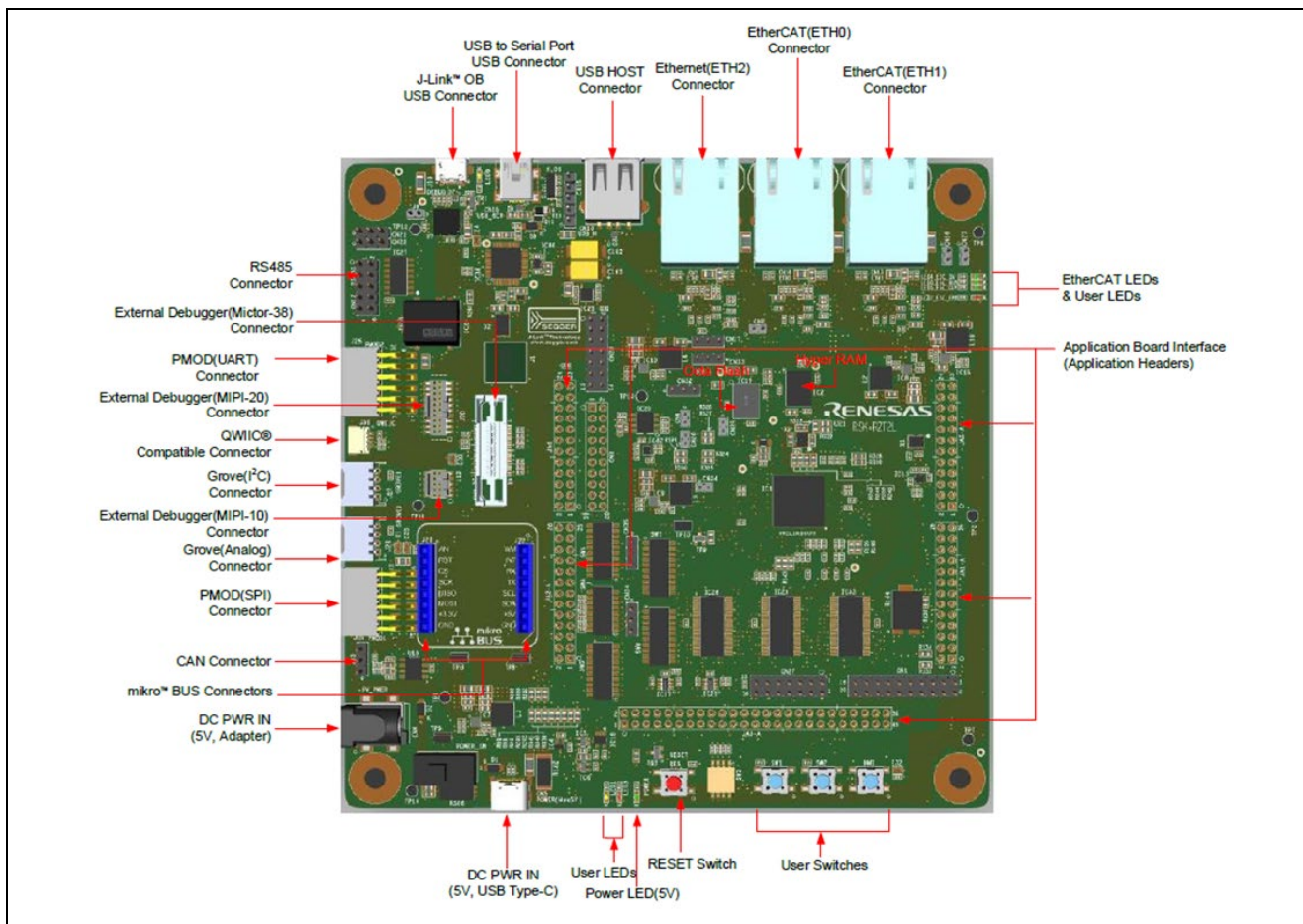


Figure 4.3 RZ/T2L RSK board layout

1. DIP Switch and Jumper Switch Settings

This setting is described in "[6. Configurations](#)" in the Renesas Starter Kit+ for RZ/T2L User's Manual.

2. Connect the J-Link to micro USB or J20 with I-jet, switching between them using J9.

3. Use a USB cable (Type-C) or an AC/DC adapter to supply power.

- When using a USB cable, connect it to CN5.
- When using an AC/DC adapter, connect it to CN6.

4. Connect the Ethernet cable to ETH2.

The "three interfaces," "three ports," etc., mentioned in this document are only valid on evaluation boards other than the RZ/T2L.

4.4 Connecting the Debugger

Connect the evaluation board and debugger according to the tool you are using.

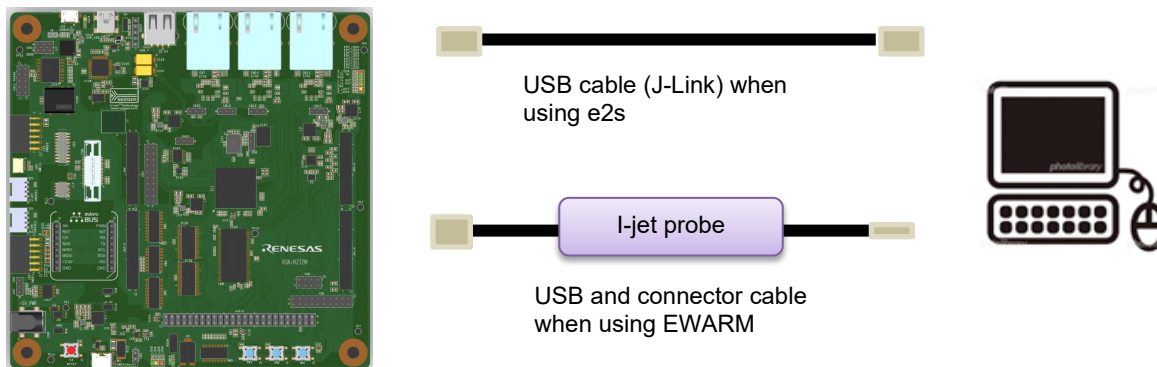


Figure 4. 4 Debugger Connection

5. Host PC Settings

5.1 Interface Property Configuration

Following the following steps, configure the properties of the three interfaces, ensuring that the IP addresses and MAC addresses are unique and match the execution environment.

1. Refer to the source code within the project package to verify the IP address (`ip\_address`), subnet mask (`subnet\_mask`), default gateway (`gateway\_address`), MAC address (`hwaddr`), connected LAN port number (`eth\_port`), and other parameters.
2. Echo server host-side port number
Refer to the source code within the project package to verify the host-side port number for the echo server.

The array data in `g\_lwip\_port\_netif\_cfg` defines the configuration for the LAN ports to be used on each evaluation board.

It is not a problem if a configured LAN port remains unconnected.

Note that the RZ/T2L supports only one LAN-connectable port.

For details, please refer to "[7. Demonstration of the Sample Application](#)"

There are no differences in the contents of the following source files between e² studio and EWARM.

- src/renesas/application/lwip_port_instance.c
- src/renesas/application/lwip_port_main.c

```

94  /* Initial settings data such as IP address and MAC address */
95  static lwip_port_netif_ip_cfg_t g_lwip_port_netif_cfg[LWIP_NIC_MAX] =
96  {
97      {
98          #if LWIP_NIC_MAX > 1
99              .p_next      = &g_lwip_port_netif_cfg[1],
100          #else
101              .p_next      = NULL,
102          #endif
103          .dhcp            = LWIP_PORT_DHCP_DISABLE,
104          .ip_address       = PP_HTONL(LWIP_MAKEU32(192,168, 10,170)),
105          .subnet_mask      = PP_HTONL(LWIP_MAKEU32(255,255,255, 0)),
106          .gateway_address  = PP_HTONL(LWIP_MAKEU32(192,168, 10, 1)),
107          .hwaddr           = {0x00,0x11,0x22,0x33,0x44,0x55},
108          .p_host_name      = gp_lwip_port0_hostname_0,
109          .eth_port         = ETHER_PORT_0,
110      },
111      #if LWIP_NIC_MAX > 1
112      {
113          .p_next      = &g_lwip_port_netif_cfg[2],
114          .dhcp         = LWIP_PORT_DHCP_DISABLE,
115          .ip_address   = PP_HTONL(LWIP_MAKEU32(192,168, 10,171)),
116          .subnet_mask  = PP_HTONL(LWIP_MAKEU32(255,255,255, 0)),
117          .gateway_address = PP_HTONL(LWIP_MAKEU32(192,168, 10, 2)),
118          .hwaddr       = {0x00,0x11,0x22,0x33,0x44,0x77},
119          .p_host_name   = gp_lwip_port0_hostname_1,
120          .eth_port      = ETHER_PORT_1,
121      },
122      #endif
123      #if LWIP_NIC_MAX > 2
124      {
125          .p_next      = NULL,
126          .dhcp         = LWIP_PORT_DHCP_DISABLE,
127          .ip_address   = PP_HTONL(LWIP_MAKEU32(192,168, 10,172)),
128          .subnet_mask  = PP_HTONL(LWIP_MAKEU32(255,255,255, 0)),
129          .gateway_address = PP_HTONL(LWIP_MAKEU32(192,168, 10, 3)),
130          .hwaddr       = {0x00,0x11,0x22,0x33,0x44,0x88},
131          .p_host_name   = gp_lwip_port0_hostname_2,
132          .eth_port      = ETHER_PORT_2,
133      },
134      #endif
135  };
136

```

Figure 5.1 Static IP address

```

41  * Macro definitions
42
43  #define TCP_SERVER_PORT      (65000)
44  #define TCP_SERVER_TASK_PRIORITY (3 + LWIP_TASK_PRIORITY_BASE)
45  #define TCP_SERVER_TASK_STACK_SIZE (1024)
46  #define TCP_SERVER_TASK_NAME "TCP Server task"
47  #define TCP_SERVER_CLIENT_MAX 10
48  #define TCP_SNTP_TASK_PRIORITY (2 + LWIP_TASK_PRIORITY_BASE)

```

Figure 5.2 Port number

5.2 Ethernet Communication Modes

The following communication modes are available between the PC and the evaluation board; please select the appropriate mode or combination based on your specific use case.

1. Routing Mode

In this mode, when communicating with the PC, the evaluation board associates the MAC address of frames received via the internal Ethernet driver with the NETIF and notifies the lwIP stack of the reception.

2. "Management port specific tag"

In the "Stacks" tag of FSP_SC, within "g_ether0 Ethernet(r_ethsw)" of "g_ether0 Ethernet(r_gmac)", the "Management port specific tag" setting will be as follows:

➤ Enable

While this allows for the configuration of the EtherSW and the viewing of settings, data copying occurs for every frame during transmission and reception, resulting in significant overhead.

Additionally, this setting makes it possible to disable the aforementioned routing mode, resulting in the following changes.

Source file: src/renesas/module/lwip_port/um_lwip_port_cfg.h

Macro name: UM_LWIP_PORT_ROUTING_SET

Setting value: 1 (Enabled), 0 (Disabled)

Source file: src/renesas/oss_deps/lwip/lwipopts.h

Macro name: ETH_PAD_SIZE 8

When disabled, the lwIP's NETIF and LAN port will be connected via P2P.

For details, please refer to "[8. Software Specifications.](#)"

➤ Disabled

This setting is the default unless you need to change the configuration, such as forcing port-to-port forwarding on the EtherSW.

Note that if this is set to "Disabled," routing mode is automatically enabled.

Also, please check the number of macros below.

Source file: src/renesas/oss_deps/lwip/lwipopts.h

Macro name: ETH_PAD_SIZE 0

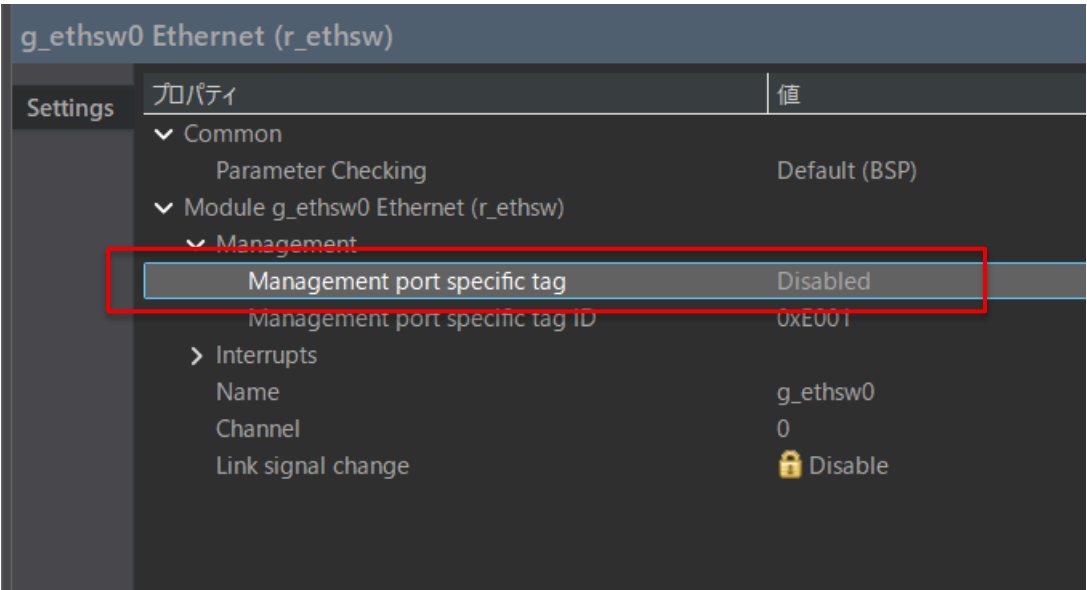


Figure 5.3 Management port specific tag

```
34  /** Routing packets to lwIP based on MAC address. 1 = Enable 0 = Disable */
35  #define UM_LWIP_PORT_ROUTING_SET (1)
36
```

Figure 5.4 Routing mode

```
47  /* If the MAC frame mode containing EtherSW management data is ETHSW_SPECIFIC_TAG_ENABLE, this data will be 8. */
48  #define ETH_PAD_SIZE 0
49
```

Figure 5.5 ETH_PAD_SIZE

6. Running the Sample Application

To run an EWARM project, proceed to [6.2. Setting Up the EWARM Sample Project](#).

6.1 Setting Up the e² studio Sample Project

6.1.1 Starting e² studio

1. Open e² studio and select the workspace directory.
2. Click "Open Projects from File System..." on the File tab.

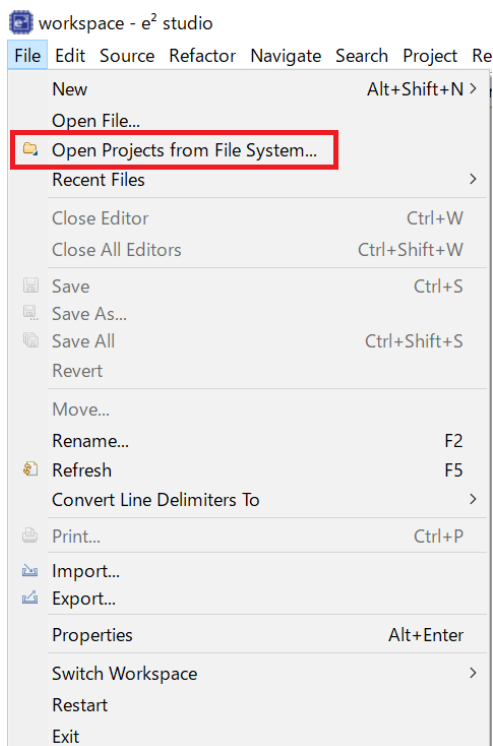


Figure 6.1 e²studio File tab

3. Import the project folder.

➤ RZ/T2M

Import the following two projects.

- The following project has no functionality other than blinking the LED.
Project Name: RZT2M_RSK_lwIP_cpu0 (hereafter referred to as "CPU0")
Folder : project\rzt2m_rsk\e2studio\RZT2M_RSK_lwIP_cpu0
- The following project includes functionality related to "[7. Sample Application Demonstration.](#)"
Project Name: RZT2M_RSK_lwIP_cpu1 (hereafter referred to as "CPU1")
Folder: project\rzt2m_rsk\e2studio\RZT2M_RSK_lwIP_cpu1

➤ RZ/N2L

Project Name: RZN2L_RSK_lwIP_single (hereafter referred to as "CPU0")

Folder : project\rzn2l_rsk\e2studio

➤ RZ/T2L

Project Name: RZT2L_RSK_lwIP_single (hereafter referred to as "CPU0")

Folder : project\rzt2l_rsk\e2studio

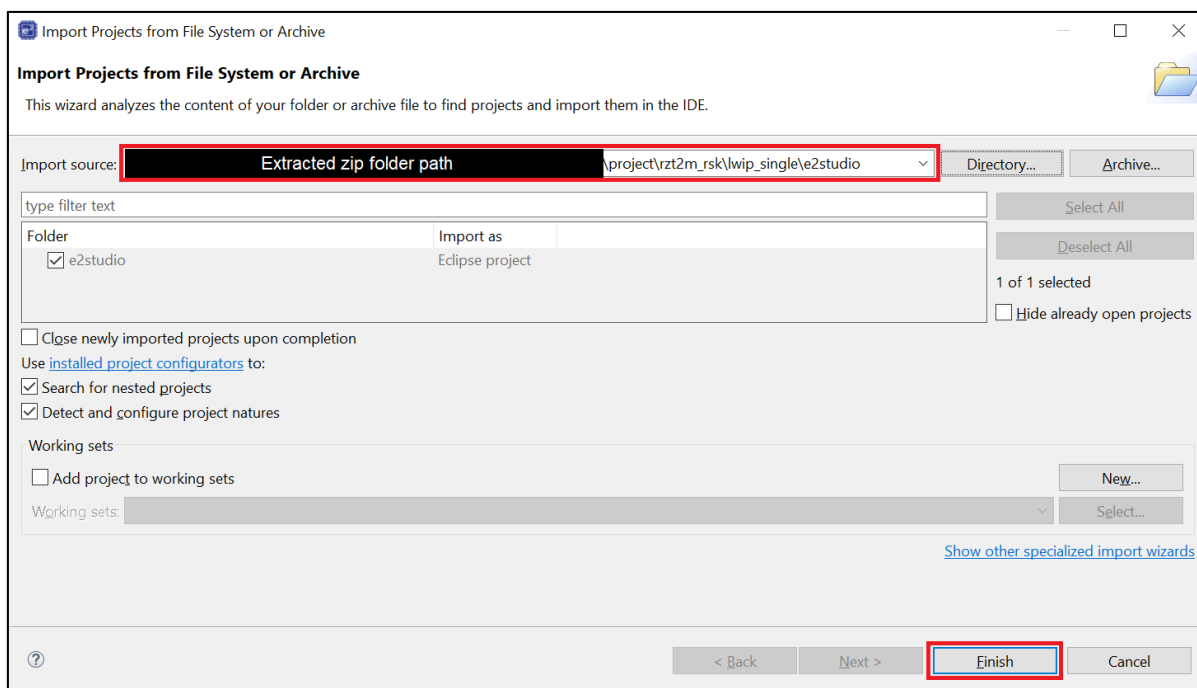


Figure 6.2 Import project on e²studio

6.1.2 How to generate source code and how to build

If there is a script folder in the Project Explorer window before code generation, the following precautions are required.

- If an "ld" file exists in the "script" folder, using a file other than those in that folder may result in unexpected outcomes, such as build errors.
- If you change the boot mode or FSP version, the "ld" file will be overwritten during code generation; therefore, please save it beforehand and restore the saved "ld" file after code generation is complete.

If there is no change, there is no rewriting.

1. Click the "Configuration.xml".

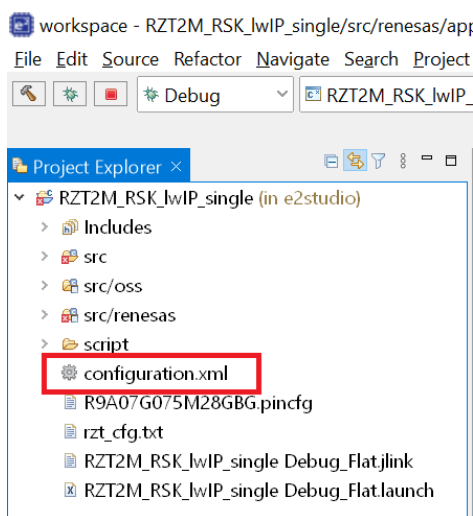


Figure 6.3 Configuration

2. On the "FSP Smart Configurator" screen that appears, check the following settings in the "BSP" tab and click "Generate Project Content". The generated folder will be added to your workspace.

For RZ/T2M, always start with CPU0.

- RAM boot (RAM execution without flash memory)
 - RZ/T2M
 - CPU0 and CPU1 have the same settings.
 - Board : RSK+RZT2M (RAM execution without flash memory)
 - RZ/N2L
 - Board : RSK+RZN2L (RAM execution without flash memory)
 - RZ/T2L
 - Board : RSK+RZT2L (RAM execution without flash memory)

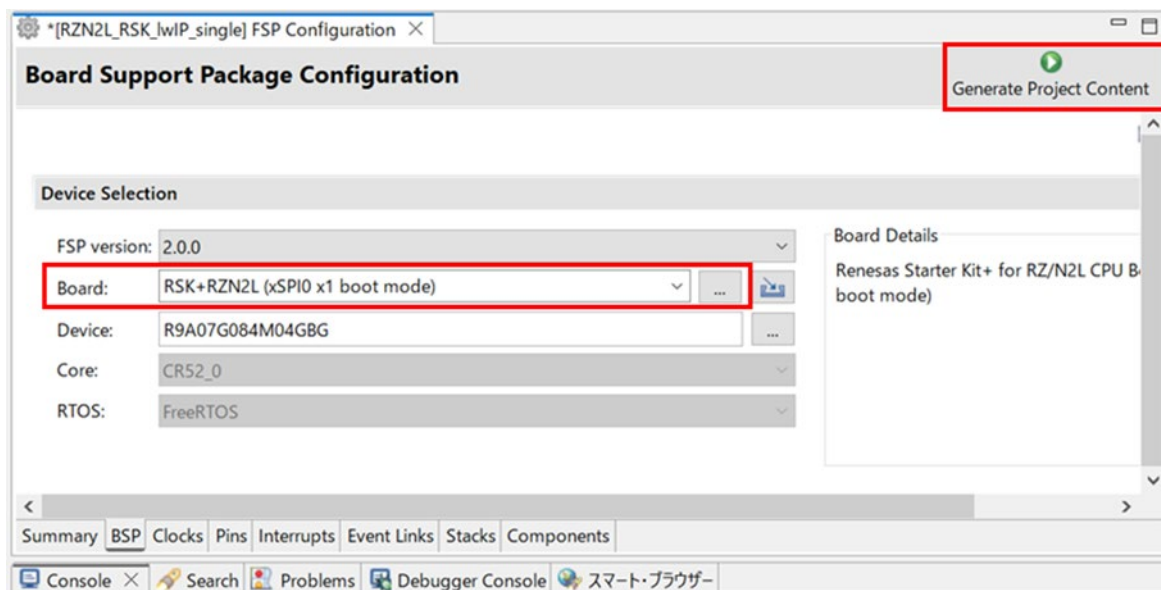


Figure 6.4 Generate Project Content

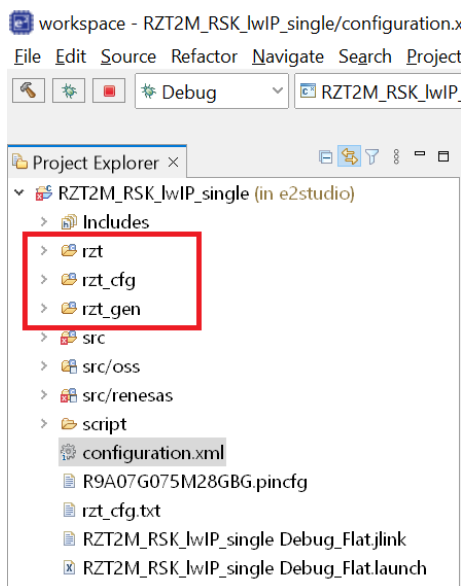


Figure 6.5 Generate project folder

- Click the Build button in tool bar to build the project and confirm that there is no error message in build message log.

For RZ/T2M, always start with CPU0.

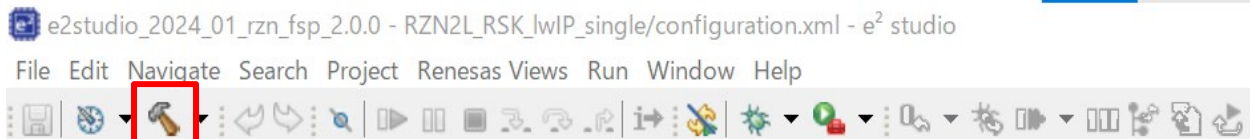
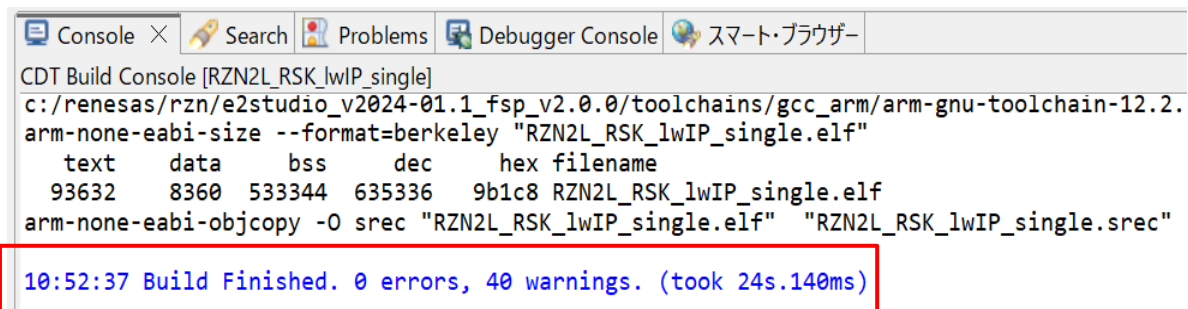


Figure 6.6 Build button



```
CDT Build Console [RZN2L_RSK_lwIP_single]
c:/renesas/rzn/e2studio_v2024-01.1_fsp_v2.0.0/toolchains/gcc_arm/arm-gnu-toolchain-12.2.
arm-none-eabi-size --format=berkeley "RZN2L_RSK_lwIP_single.elf"
  text    data    bss     dec     hex filename
 93632    8360   533344   635336   9b1c8 RZN2L_RSK_lwIP_single.elf
arm-none-eabi-objcopy -O srec "RZN2L_RSK_lwIP_single.elf" "RZN2L_RSK_lwIP_single.srec"

10:52:37 Build Finished. 0 errors, 40 warnings. (took 24s.140ms)
```

Figure 6.7 Build message

6.1.3 Downloading the application and running the debugger

Please follow these steps for each project.

1. Focus on the CPU0 project and click the Debug button on the toolbar to download the CPU0 program and launch the debugger.

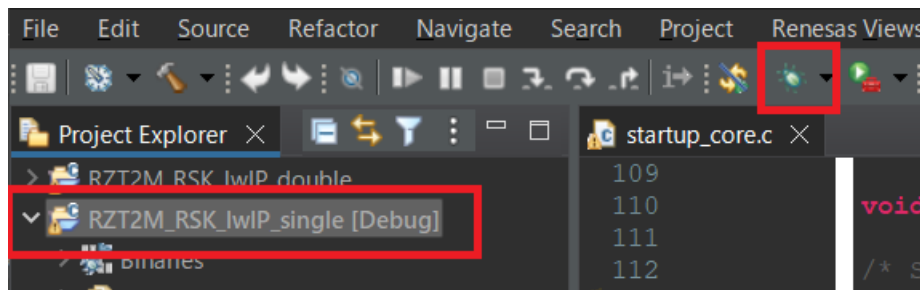


Figure 6.8 CPU0 Debug button

2. Dialog response
When starting the debugger, if a dialog other than an error display appears depending on the usage environment, select "Switch", "Yes", "OK", etc. to close it.
3. The program will stop at the breakpoint set at startup, so simply click the Run button on the toolbar.
For RZ/T2M, continue with CPU1.
Before running, connect your PC as described in "[7. Sample Application Demonstration.](#)"

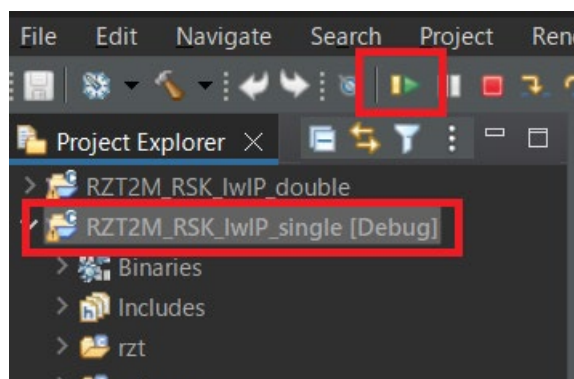


Figure 6.9 CPU0 Run button

4. Next, focus on the CPU1 project and click the Debug button on the toolbar to download the CPU1 program and launch the debugger.
At that time, the following dialog box will appear, so please click "No".

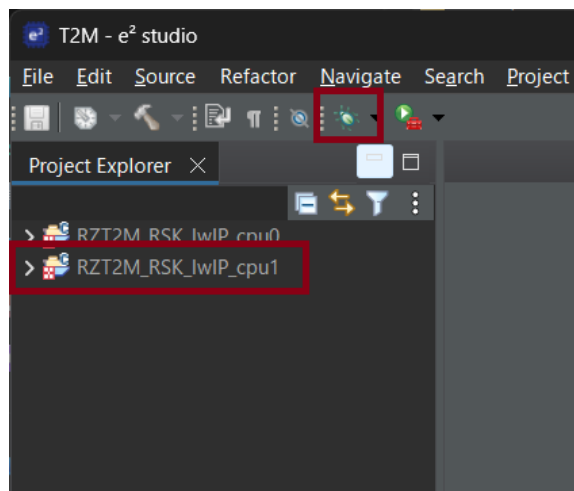


Figure 6.10 CPU1 Debug button

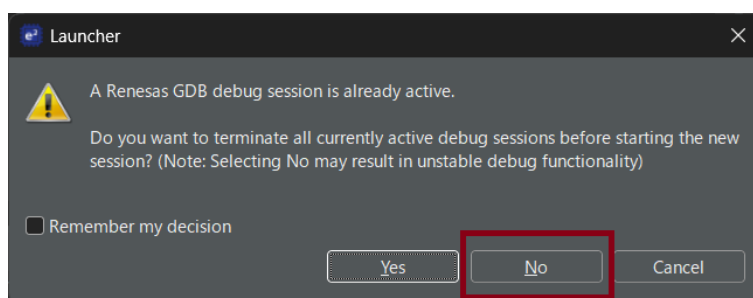


Figure 6.11 CPU1 Duplicate confirmation

5. Other Dialogs
If a dialog other than an error message appears due to your environment or other reasons, close it by selecting "Switch," "Yes," or "OK."
6. The program will stop at the breakpoint set at startup, so simply click the Run button on the toolbar.

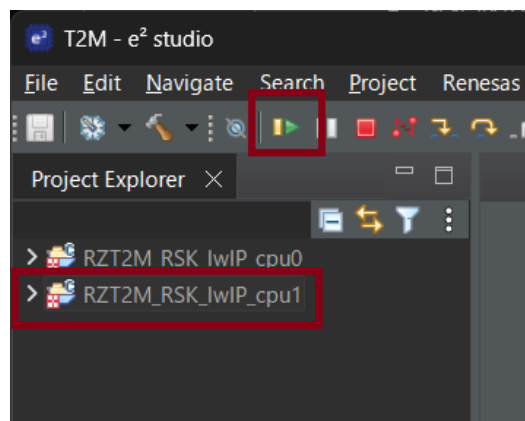


Figure 6.12 CPU1 Run button

6.2 Setting Up the EWARM Sample Project

For each of the project files listed below, please perform steps 1 through 3 below.

6.2.1 Starting EWARM

1. Open the EWARM.
2. Click "Open Workspace..." in File tab.

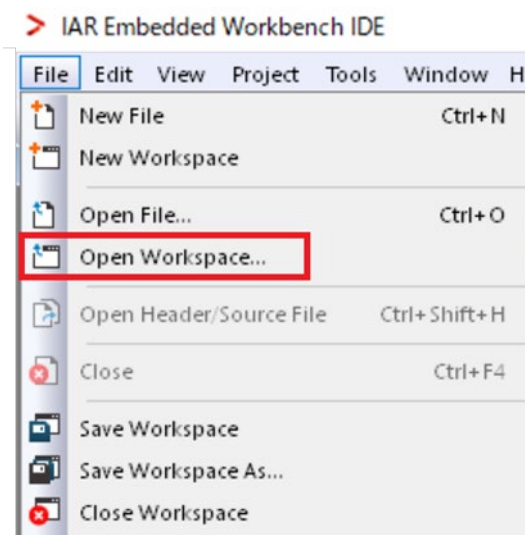


Figure 6.13 EWARM file tab

3. Select the Workspace File(.eww) and click the Open button.
 - RZ/T2M
Open the following two projects in separate EWARMs.
 - The following project has no functionality other than blinking the LED.
Project file: RZT2M_RSK_lwIP_cpu0.eww (hereafter referred to as "CPU0")
Folder: project\rzt2m_rsk\ewarm\RZT2M_RSK_lwIP_cpu0
 - The following project includes functionality related to "[7. Demonstration of the Sample Application](#)"
Project file: RZT2M_RSK_lwIP_cpu1.eww (hereafter referred to as "CPU1")
Folder: project\rzt2m_rsk\ewarm\RZT2M_RSK_lwIP_cpu1
 - RZ/N2L
Project file: RZN2L_RSK_lwIP_single.eww (hereafter referred to as "CPU0")
Import the folder: project\rzn2l_rsk\ewarm.
 - RZ/T2L
Project file: RZT2L_RSK_lwIP_single.eww (hereafter referred to as "CPU0")
Import the folder: project\rzt2l_rsk\ewarm.

6.2.2 How to generate source code and how to build

1. Notes on Code Generation.

- If an "icf" file exists in the "script" folder, using a file other than those in that folder may result in unexpected outcomes, such as build errors.
- If you change the boot mode or FSP version, the "icf" file will be overwritten during code generation; therefore, please save it beforehand and restore the saved "icf" file after code generation is complete.
- For RZ/T2M, build projects for CPU0 and CPU1.
- For RZ/T2M, do not open two "FSP Smart Configurator" projects simultaneously.

2. Launching the FSP Smart Configurator

If you have not set up the Configurator, see "5.4.1 Launch FSP Smart Configurator from IAR EWARM" in "Getting Started with Flexible Software Package."

If you are unable to start FSP_SC when installing it because you specified an installation destination other than the default, please correct it using the following method according to your environment.

- If you want to always use the same version of EWARM and FSP_SC

In "5.4.1 Launch FSP Smart Configurator from IAR EWARM," delete "\$RASC_EXE_PATH\$" from the "Command" field and use "Browse..." to specify the installed "rasc.exe."

- If you want to link and launch FSP_SC for each project

In the workspace's "buildinfo.ipcf," change the environment variables as follows:

```
<group name="RA Smart Configurator">
<argVar>
<name>RASC_EXE_PATH</name>
<value>C:\Renesas\fsp_sc\eclipse\rasc.exe</value>
```

👉 Change this path to your installation location.

how to set it up.

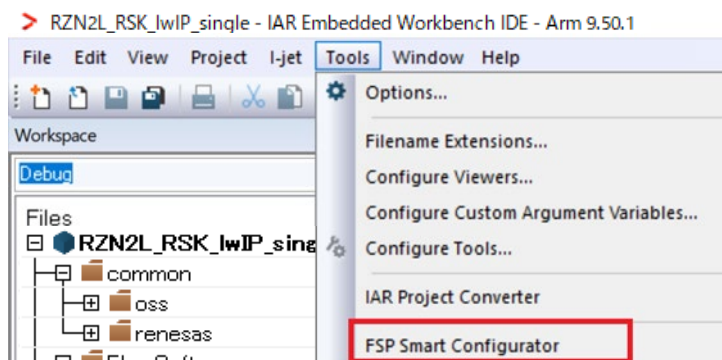


Figure 6.14 Tools tab

3. Code Generation Procedure

After clicking "FSP Smart Configurator," check the following settings under the "BSP" tab on the screen that appears, and then click "Generate Project Content." The generated folder will be added.

➤ RZ/T2M

CPU0 and CPU1 have the same settings.

Board : : RSK+RZT2M (RAM execution without flash memory)

➤ RZ/N2L

Board : : RSK+RZN2L (RAM execution without flash memory)

➤ RZ/T2L

Board : : RSK+RZT2L (RAM execution without flash memory)

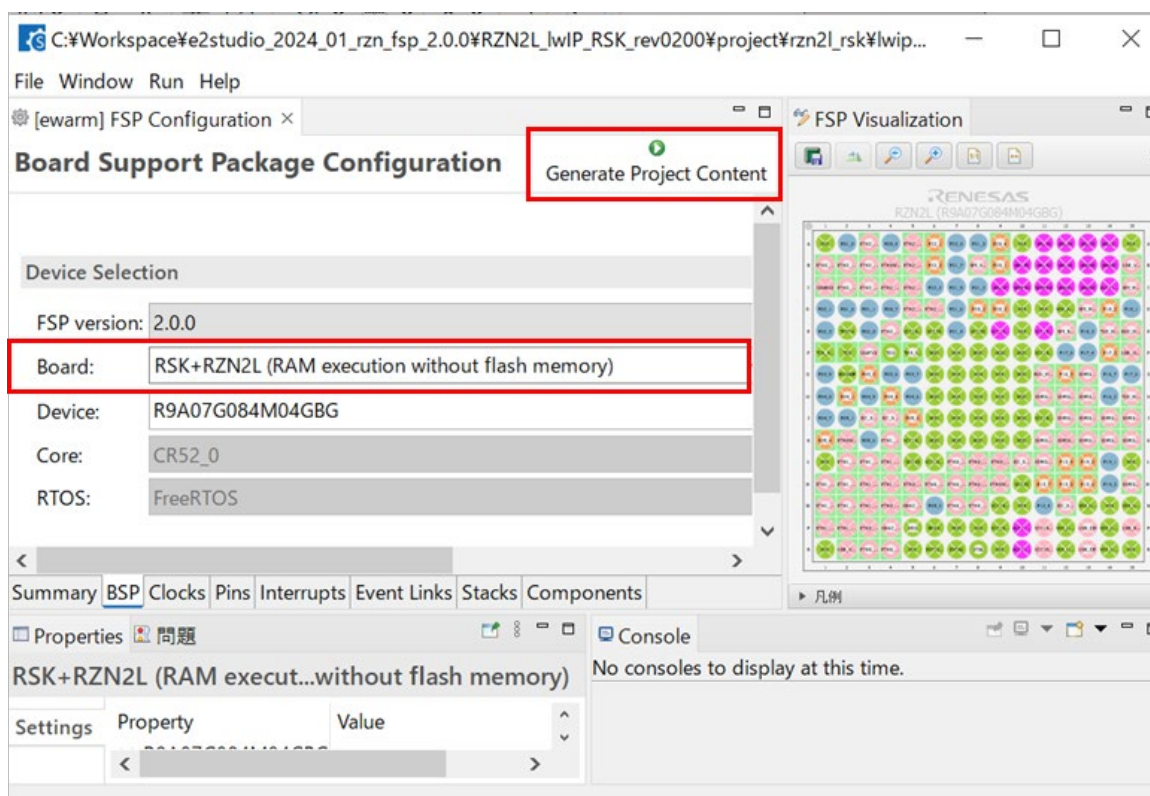


Figure 6.15 FSP SC Smart Configurator

4. Build Procedure

Click "Make" on the Project tab or click the button to build. When the build is complete, build messages will be displayed in the Build Console window, displaying the compilation target files and the number of errors/warnings.

For RZ/T2M models, please start execution from CPU0.

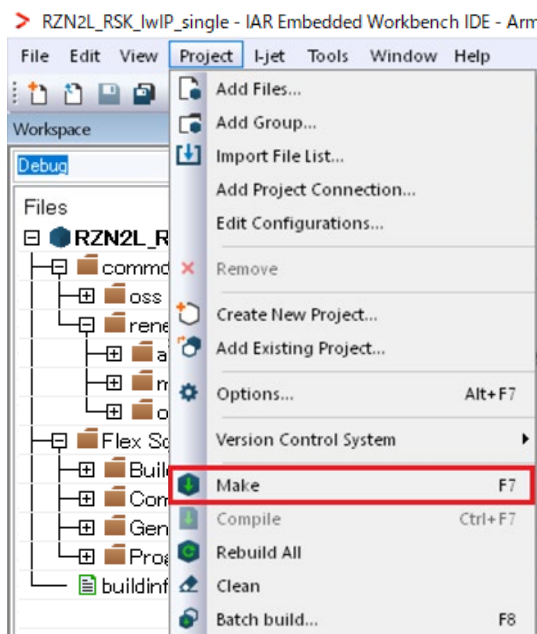


Figure 6.16 Make button 1

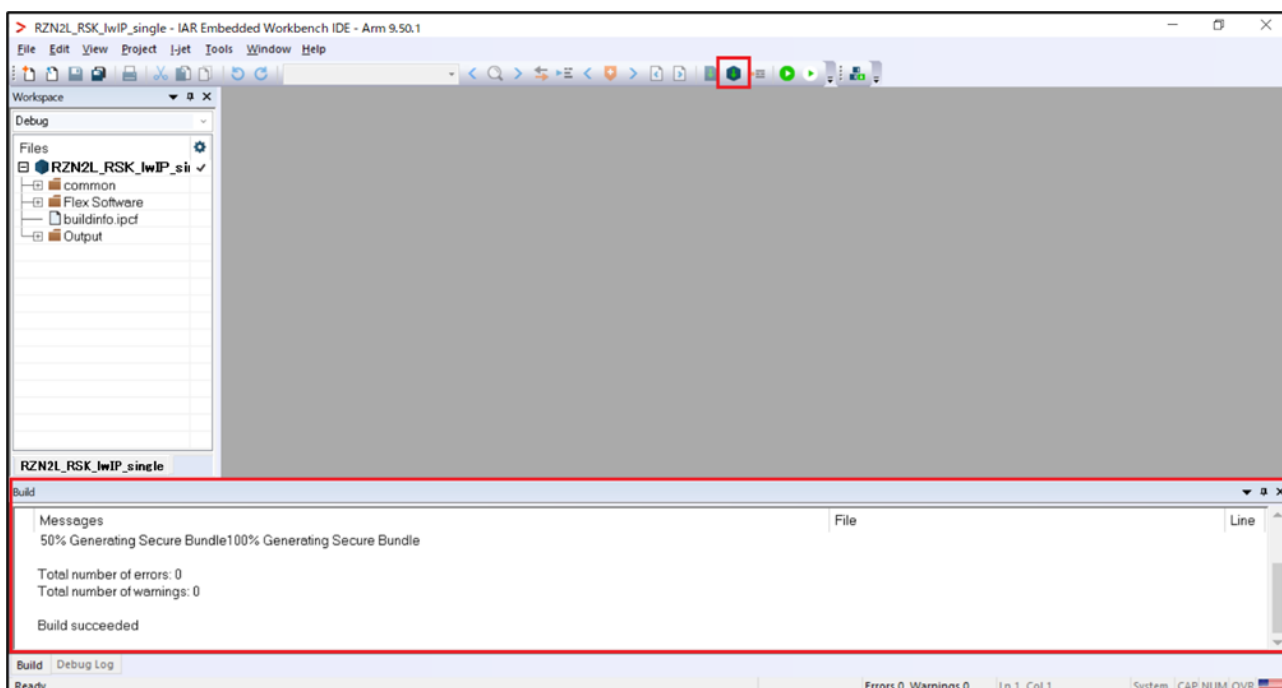


Figure 6.17 Make button 2 and Build console

6.2.3 Downloading the application and running the debugger (single-core version)

1. Click "Download and Debug" under "Project" on the menu bar, or click the Debug button to download the application program. After the debugger starts, the program will stop at the set breakpoint.

For RZ/T2M, skip this section and proceed to "[6.2.4. Downloading the Application and Running the Debugger \(Dual-Core Version\)](#)"

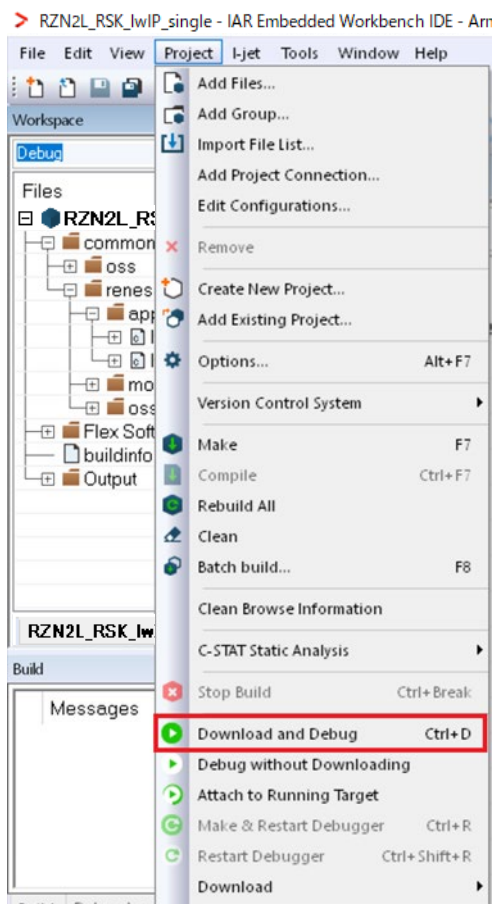


Figure 6.18 Download and Debug button

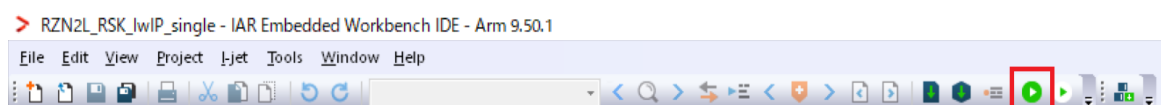


Figure 6.19 Debug button

- Click the Go button. If the program is running correctly, it will wait for a TCP/IP connection request.
Before running, please connect your PC as described in "[7. Sample Application Demonstration.](#)"

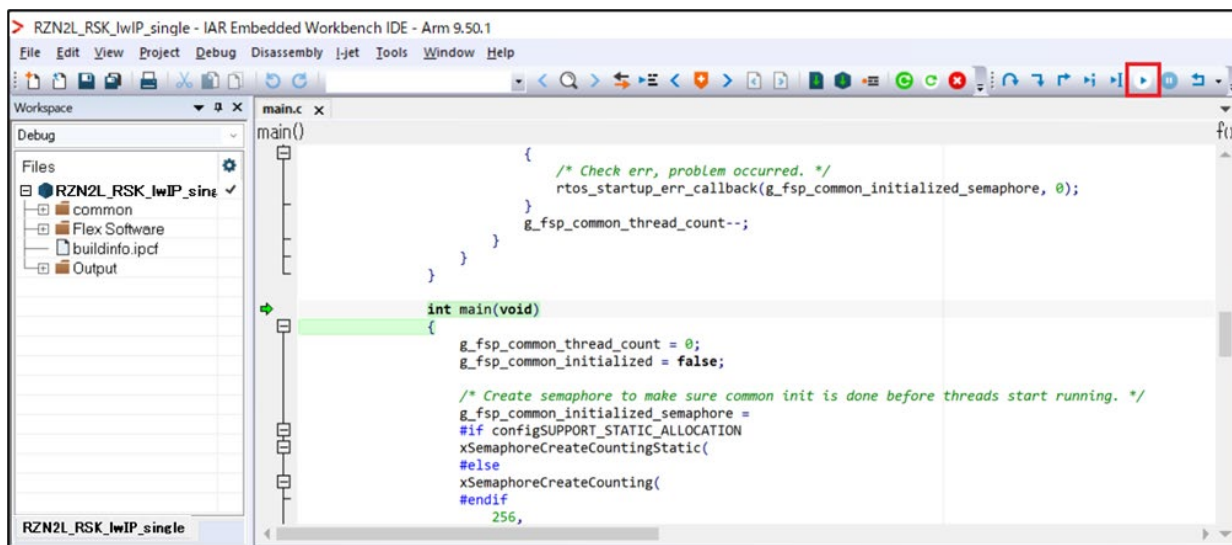


Figure 6.20 Break point and Go button

6.2.4 Downloading the application and running the debugger (Dual-Core Version))

Please perform the following steps.

1. Close EWARM for the CPU1 project.
2. Click "Download and Debug" in the "Project" menu bar, or click the Debug button to download the application program. After the debugger starts, the program will stop at the set breakpoint.

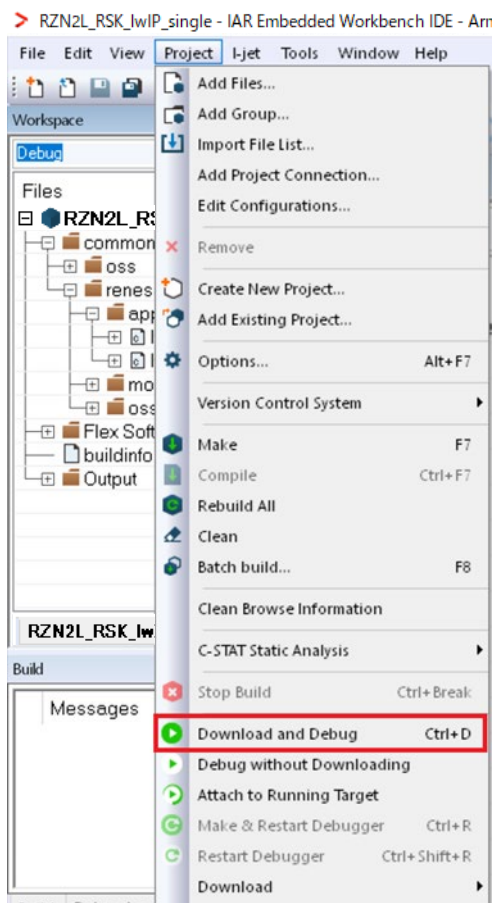


Figure 6.21 Download and Debug button

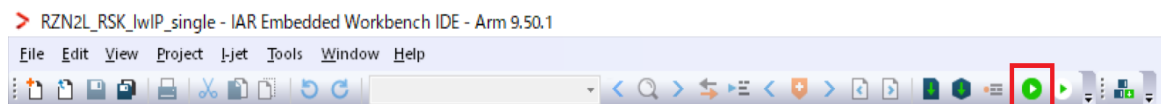


Figure 6.22 Debug button

- As CPU0 downloads, CPU0 will become the master and the CPU1 project will automatically start as the slave, and both projects will stop at the set breakpoints.
- Click the Run button in the CPU0 project, then run the CPU1 project in the same way.

Before running, connect via UART to a PC running terminal software.

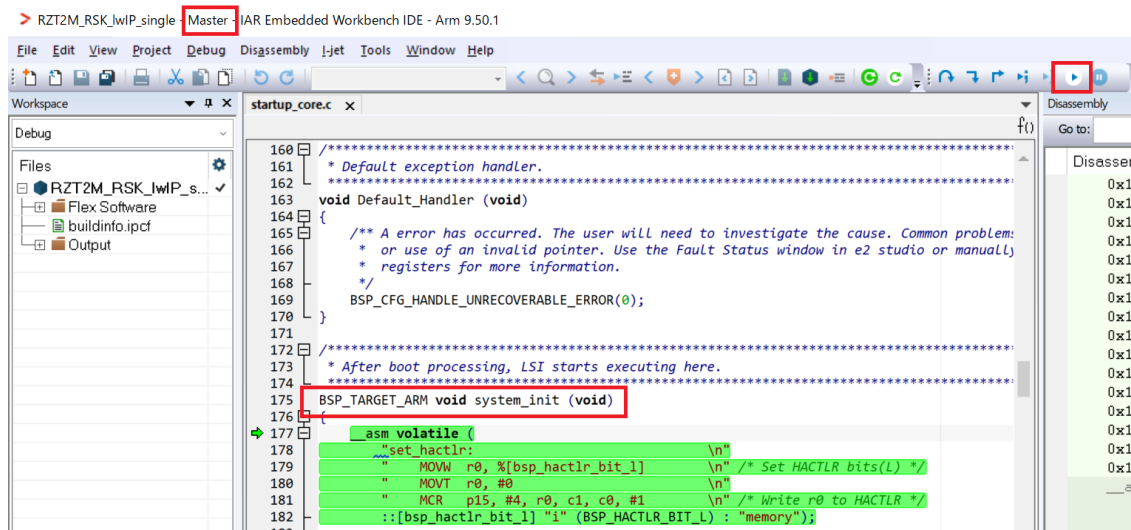


Figure 6.23 CPU0 Go button

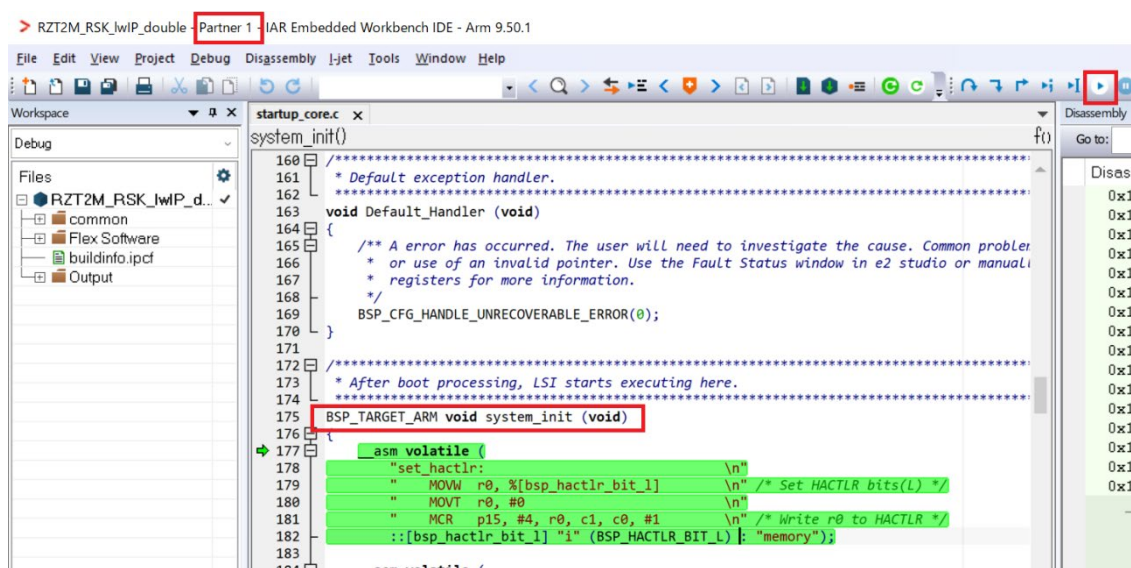


Figure 6.24 CPU1 Go button

7. Demonstration of the Sample Application

The sample program demonstrates the echo server function and the lwIP add-on, "iperf" and "SNTP," which are located in the "apps" folder and can be executed.

7.1 Connecting to a PC

Follow the steps below to connect the evaluation board to the communication PC.

1. Connect the "USB to Serial Port" port shown in [4. Hardware Settings](#) to your PC using a USB cable.
2. To display log data from the evaluation board, launch terminal software such as "Tera Term" using the following protocol.

We will use "Tera Term" here.

- Port: Port added by connecting to the evaluation board
- Speed: 115200
- Other: DATA8 / NONE / 1 bit / Local Echo OFF

3. Connect the Ethernet port shown in [4. Hardware Settings](#) to your PC's NIC using a LAN cable.

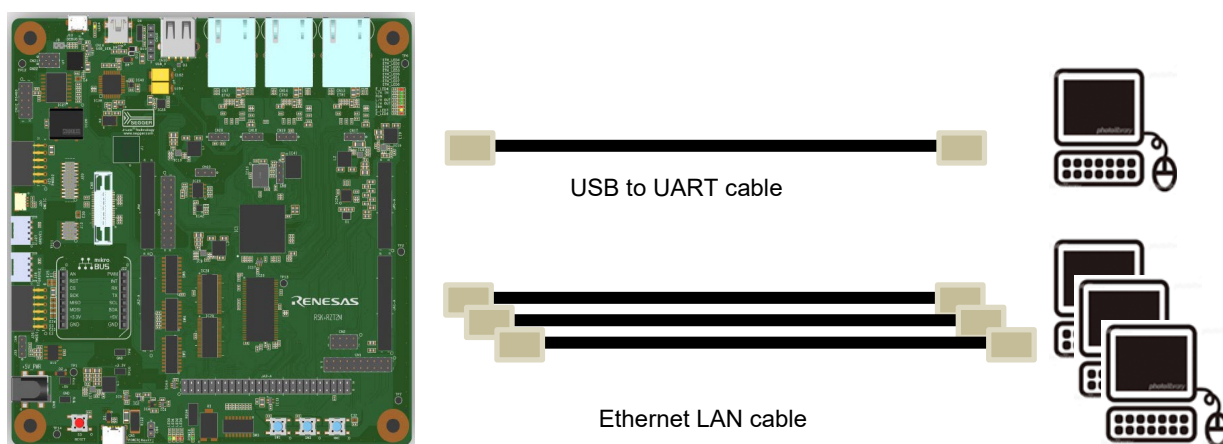


Figure 7.1 Communication terminal connection

4. Startup Screen

As shown in the figure above, when you connect the UART to the PC and start up the evaluation board, the following screen appears in the PC's terminal software.

```
>>Info : Started Serial I/O interface.
>>Info : lwIP initialization successful
>>Info : Initialized Ethernet network interface.
>>Info : Successfully registered lwIP as a callback to Ethernet.
>>Info : Started Ethernet network interface.
>>Info : <<< Started sample application (v2.0) for lwIP Port. >>>
>>Info : =====
>>Info : lwIP API routing mode ENABLED
>>Info : lwIP ETH_PAD_SIZE = 0
>>Info : ETHSW_SPECIFIC_TAG_DISABLE
>>Info : =====
>>Info : Please connect the IPERF LAN cable to the port.
>>Info : link-up port( NIC_0 )
>>Info : link-up port( NIC_1 )
>>Info : link-up port( NIC_2 )
>>Info : << Start the SNTP client for 15 seconds. >>
>>Info : << SNTP client application completed [ 25.07.2026 07:08:18 ] >>
>>Info : << IPERF2 server application start >>
>>Info : << The echo server will be start. >>
```

Figure 7.2 Startup screen

7.2 SNTP Client

When this sample program is launched, if it can connect to an NTP server, it will acquire and display time data for 15 seconds. If data cannot be retrieved within 15 seconds, a log message indicating this is displayed, and the program proceeds to the next process.

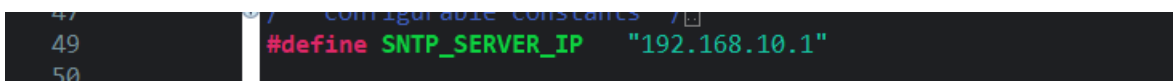
1. SNTP Configuration

- Verifying the NTP server IP address

Please modify the NTP server IP address to match your operating environment, referring to the settings in the source file below.

Source file: src/renesas/application/lwip_add_on_main.c

Note: There is no difference between e² studio and EWARM.



```
47 // Configurable constants
49 #define SNTP_SERVER_IP "192.168.10.1"
50
```

Figure 7.3 NTP server IP address

2. NTP Server Configuration

For this sample program, operation was verified using the Windows NTP server function. The NTP server is disabled by default but can be enabled by modifying the registry.

Please note that NTP servers are not supported, so please check the web or other resources for setup instructions.

7.3 iperf Client/Server

This sample program uses iperf to measure the Ethernet baud rate.

- PC-side application: iperf2-1-9win (freeware)
- Evaluation board: Add-on located in the lwIP "apps" folder

7.3.1 Procedure for measuring communication speed

Perform the measurement according to the following steps:

- Start the lwIP sample program.
The following message appears on the startup screen:
`"<< IPERF2 server application start >>"`
- Start the server from the PC's terminal software using the following command:
`"iperf-2-1-9-win.exe -s"`
- From the PC, verify the destination IP address and transmit data for 10 seconds using the following command:
`"iperf-2-1-9-win.exe -c 192.168.10.170"`
- Once communication from the PC completes, the evaluation board automatically transmits data back to the source (PC) address for 10 seconds.

Transmission and reception communication speeds are not displayed on the evaluation board's terminal; please check them on the PC's terminal.

The iperf parameters are as follows:

- PC
 - Client: `iperf-2-1-9-win.exe -c 192.168.10.170`
 - Server: `iperf-2-1-9-win.exe -s`
- Evaluation Board
 - Client: Uses the source address from the received data; other settings are default.
 - Server: IP address set to ANY; other settings are default.

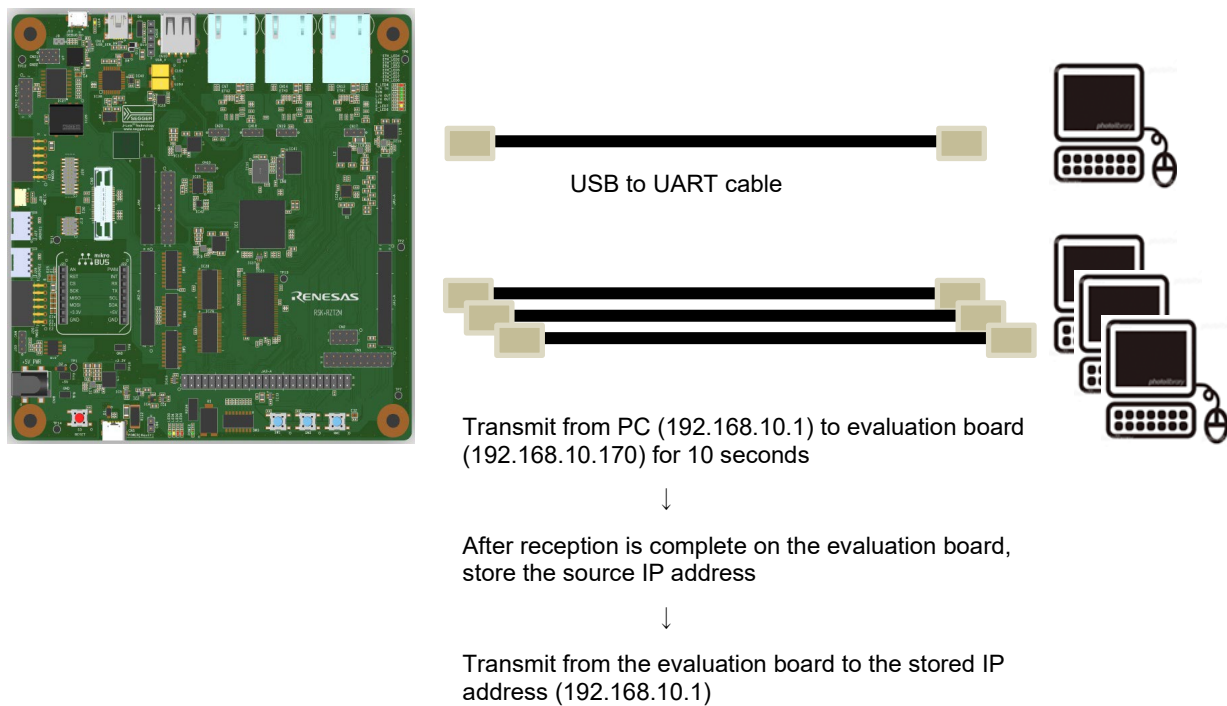


Figure 7.4 Communication sequence

7.4 Echo Server

In this sample program, the echo server is always running, so after startup, you can communicate via TELNET from your PC's terminal software.

- TELNET port number: As configured in "[5.1. Ethernet Property Settings](#)"
- P address: One of the IP addresses configured in "[5.1. Ethernet Property Settings](#)"
- Maximum number of connections: 10

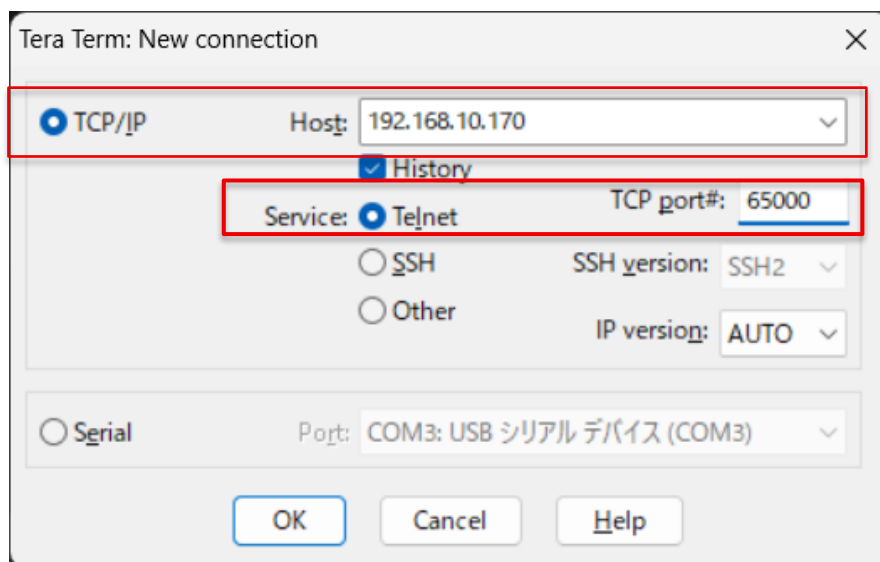


Figure 7.5 Tera Term Configuration

8. Software Specifications

8.1 Software Structure

An overview of the software is shown below.

Legend in the figure: () Destination of the corresponding source file

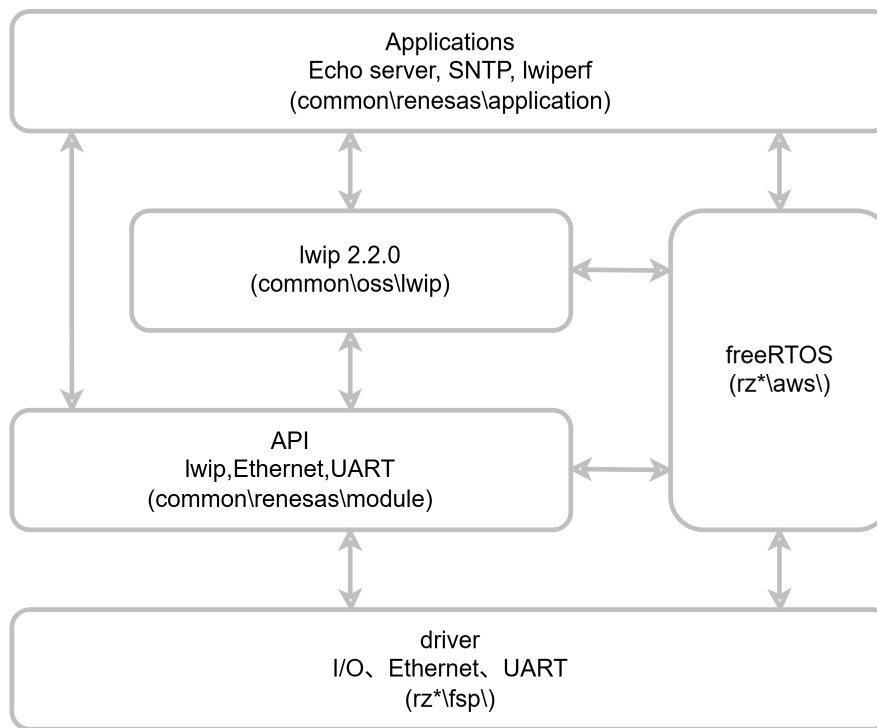


Figure 8.1. Software Architecture Diagram

8.1.1 Components Overview

Functionality overview in the overview diagram

Table 8.1. Overview of Each Component

Group	Folder name	Overview
Applications	common/renesas/application	Demonstration App
	SRC	Entry functions etc.
API	common/renesas/module/ether_netif	Ethernet API
	common/renesas/module/lwip_port	lwip API
	common/renesas/module/serial_io	UART API
OS	Rz*/aws/	freeRTOS
driver	rz*/fsp/	Ethernet driver
	rz*/fsp/	UART driver

8.1.2 Drivers Used

The stacks used in FSP are shown below.

Table 8.2. Sample Software Support Status

Stack Name	function
g_ioport I/O Port Driver	Pin Settings, Control
g_ether0 Ethernet	Ethernet communication
g_uart0 UART	Serial communication
Heap 4	Allocating heap for FreeRTOS

8.2 Task

The task properties used in the sample program are shown below.

Table 8.3. Task List

Module	Task name	Priority	Stack size [bytes]	Synchronous mode	Overview
Main	Main thread	5	1024	Pause after initialization	Main task
Ethernet Port	Ethernet Monitor Task	3	1024	Wake up every 1 second	Ethernet link status monitoring
	Ethernet Reader Task	4	2048	Received events	Waiting for received Ethernet data
lwIP Port	iperf_client_task	4	1024	Waiting for lperf send event	lperf send event
lwIP Port	lwIP	4	2048	Queue notification events	LINK status notification processing
lwIP	TCP Server task	3	1024	Received events	Reception processing within lwIP
	TCP Server task(No.)*	3	1024	Waiting for reception	Reception and transmission

* This is a client connection task; it can connect up to 10 lines, and the (No.) indicated will be a number from 1 to 10. the "(No.)" in the name corresponds to a number from 1 to 10. Note that the specifications for all tasks (1 through 10) are identical.

Table 8.4. RTOS Max Priority

Item	Value
Max Priority	10

8.2.1 Resources

The resources used are shown below.

Table 8.5. Used Resource

Resources used	Format	Module	Use
Heap4	Heap memory	All modules	Ethernet transmission and reception data
queue	Queue	Ethernet port	Link status notification

8.2.2 Task Operations

The following diagram shows the relationships between tasks.

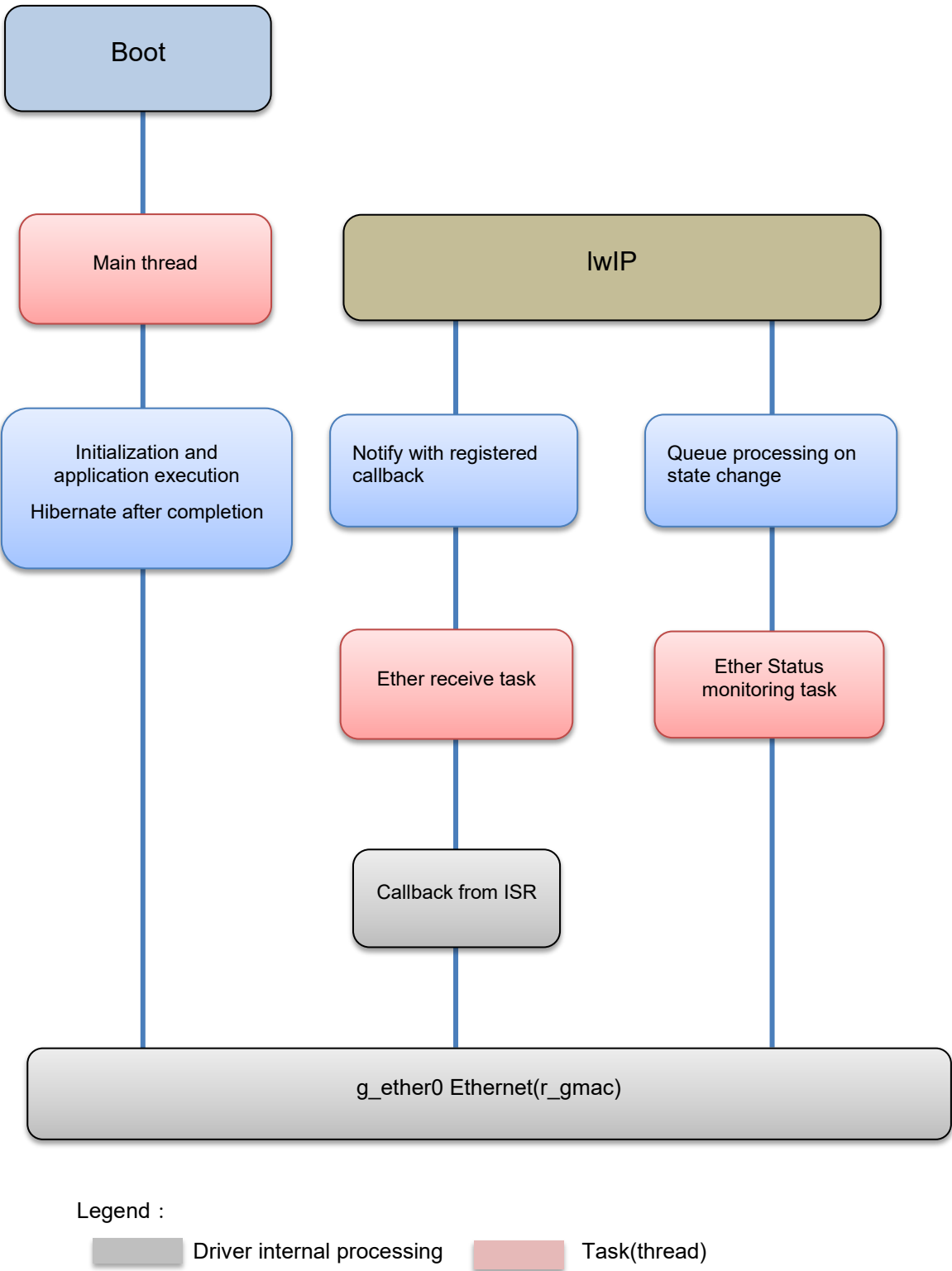


Figure 8.2. sequence

8.3 Received Packet Mirroring and Transmission Functions

Please refer to the following documentation when directly capturing received data from the driver or performing direct transmission without going through lwIP..

1. Overview

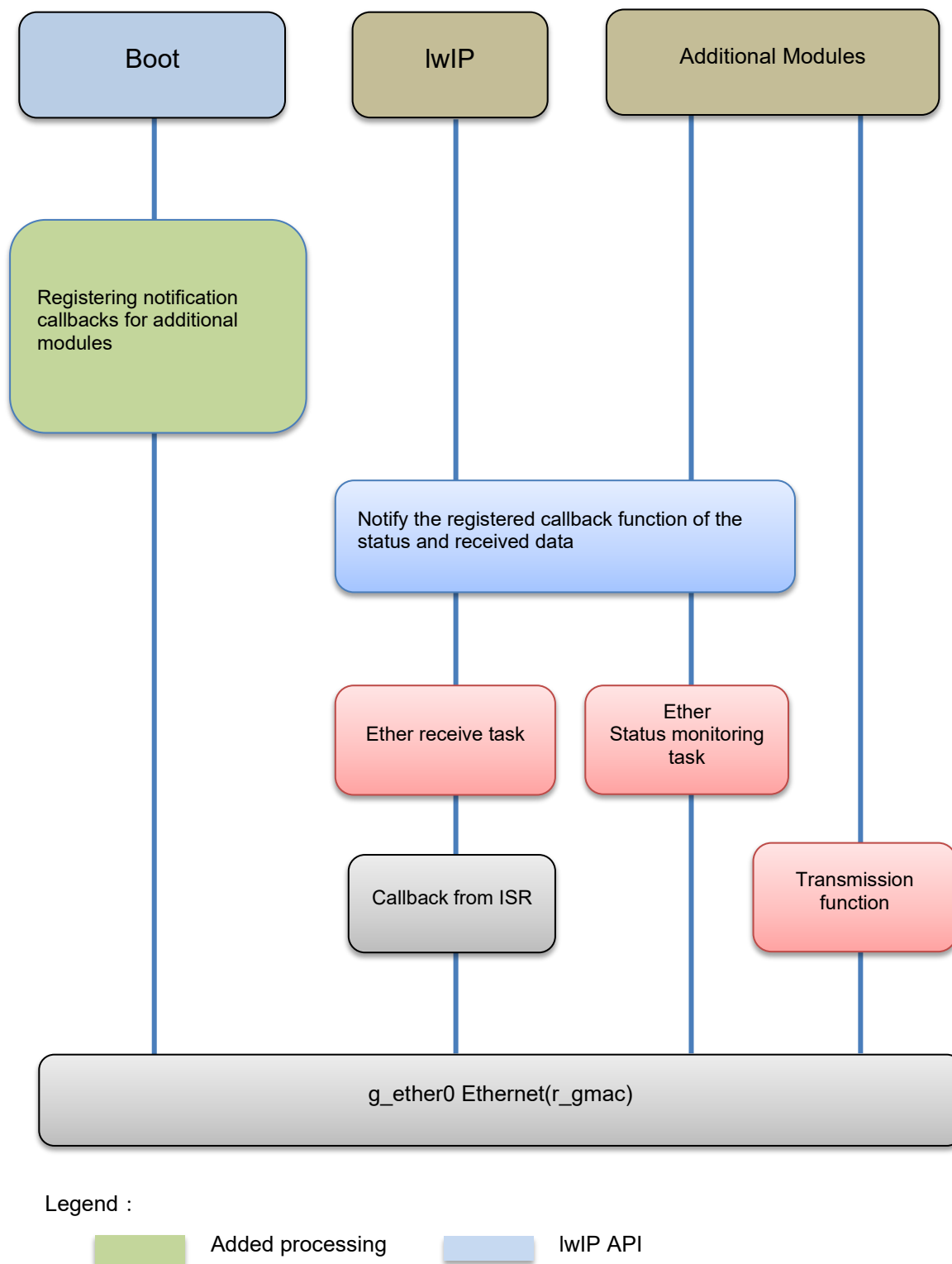


Figure 8.3. sequence

2. Mirroring

To enable the mirroring function, register a callback function using the Ethernet API to receive the LINK status and received data (MAC frames).

➤ Parameters when registering a callback function

Please create it as follows, referring to the existing process.

Table 8.6. Callback function parameters

データの形	概要
struct st_ether_netif_callback_link_node * p_next;	Initial value: NULL; writing is prohibited except for the initial value.
void (* p_func) (ether_netif_callback_args_t *);	Callback function (function that receives notifications).
ether_netif_callback_args_t * p_memory;	Data (ether_netif_callback_args_t) set when the callback notification occurs.
request_port_t Request_port;	Specifies the target port(s) for the callback notification. To specify multiple ports, combine the values for each port using a bitwise OR operation. 1: ETH0, 2: ETH1, 4: ETH2
void const * p_context;	Data to be added to the callback parameters.

➤ Callback registration function

```
usr_err = gp_ether_netif0->p_api->callbackAddstart(gp_ether_netif0->p_ctrl,
ether_netif_callback_link_node_t *);
```

➤ Parameters for the callback function

Table 8.7. Callback parameters

ether_netif_callback_args_t	Data is set during the callback.
ether_netif_callback_event_t event	Callback type
ether_netif_frame_t * p_frame_packet	Received data
ether_netif_monitor_queue_t * p_port_status	Port status at the time of the event
void const * p_context;	Data specified during callback registration

3. Transmission Function

To transmit a MAC frame without going through lwIP, use the function as follows:

➤ Transmission function parameters

Create a new `static ether\_netif\_frame\_t` and initialize it to zero.

- buffer[] : Copy the data to be transmitted here.
- length : Transmission length
- port : Destination port number (1: ETH0, 2: ETH1, 4: ETH2)

➤ Transmission function

```
usr_err = gp_ether_netif0->p_api->send(gp_ether_netif0->p_ctrl, ether_netif_frame_t *);
```

8.4 Multi-interface

8.4.1 Interface Property Table

```

124 125 126 127 128 129 130 131 132 133 134 135 136
94  /** Initial settings data such as IP address and MAC address */
95  static lwip_port_netif_ip_cfg_t g_lwip_port_netif_cfg[LWIP_NIC_MAX] =
96  {
97  {
98  #if LWIP_NIC_MAX > 1
99      .p_next      = &g_lwip_port_netif_cfg[1],
100  #else
101      .p_next      = NULL,
102  #endif
103      .dhcp        = LWIP_PORT_DHCP_DISABLE,
104      .ip_address   = PP_HTONL(LWIP_MAKEU32(192,168, 10,170)),
105      .subnet_mask  = PP_HTONL(LWIP_MAKEU32(255,255,255, 0)),
106      .gateway_address = PP_HTONL(LWIP_MAKEU32(192,168, 10, 1)),
107      .hwaddr       = {0x00,0x11,0x22,0x33,0x44,0x55},
108      .p_host_name  = gp_lwip_port0_hostname_0,
109      .eth_port     = ETHER_PORT_0,
110  },
111  #if LWIP_NIC_MAX > 1
112  {
113      .p_next      = &g_lwip_port_netif_cfg[2],
114      .dhcp        = LWIP_PORT_DHCP_DISABLE,
115      .ip_address   = PP_HTONL(LWIP_MAKEU32(192,168, 10,171)),
116      .subnet_mask  = PP_HTONL(LWIP_MAKEU32(255,255,255, 0)),
117      .gateway_address = PP_HTONL(LWIP_MAKEU32(192,168, 10, 2)),
118      .hwaddr       = {0x00,0x11,0x22,0x33,0x44,0x77},
119      .p_host_name  = gp_lwip_port0_hostname_1,
120      .eth_port     = ETHER_PORT_1,
121  },
122  #endif
123  #if LWIP_NIC_MAX > 2
124  {
125      .p_next      = NULL,
126      .dhcp        = LWIP_PORT_DHCP_DISABLE,
127      .ip_address   = PP_HTONL(LWIP_MAKEU32(192,168, 10,172)),
128      .subnet_mask  = PP_HTONL(LWIP_MAKEU32(255,255,255, 0)),
129      .gateway_address = PP_HTONL(LWIP_MAKEU32(192,168, 10, 3)),
130      .hwaddr       = {0x00,0x11,0x22,0x33,0x44,0x88},
131      .p_host_name  = gp_lwip_port0_hostname_2,
132      .eth_port     = ETHER_PORT_2,
133  }
134  #endif
135  };

```

Figure 8.4. sequence

1. Property Details

Details of the property items are provided below.

Table 8.8. Interface properties

Variables	overview
.p_next	Pointer to an array of interface structures Set this data to "NULL" to limit the number of property data entries; any subsequent data will be ignored.
.dhcp	IP address
.ip_address	Subnet mask
.subnet_mask	Default gateway (connected host PC)
.gateway_address	MAC address
.hwaddr	Network name
.p_host_name	IP address
.eth_port	LAN port(s) used: 1: ETH0, 2: ETH1, 4: ETH2 (use a logical OR for multiple ports) This enables callbacks for received data and LINK status for the LAN ports specified by the bitmask.

2. Notes on Properties

- IP addresses and MAC addresses cannot duplicate those of other interface properties.
- If multiple LAN ports are specified in the LAN port settings with the intention of allowing cable swapping, connect the LAN cable to only one of the specified ports.

If different IP and MAC addresses are required, do not simply swap the LAN cable; instead, configure two interfaces and use routing to direct traffic intended for a single IP address.

8.4.2 Routing

With multi-interface configuration, the Ethernet driver and lwIP associate received frames with the corresponding NETIF based on their MAC addresses and pass them to lwIP.

1. Overview Diagram

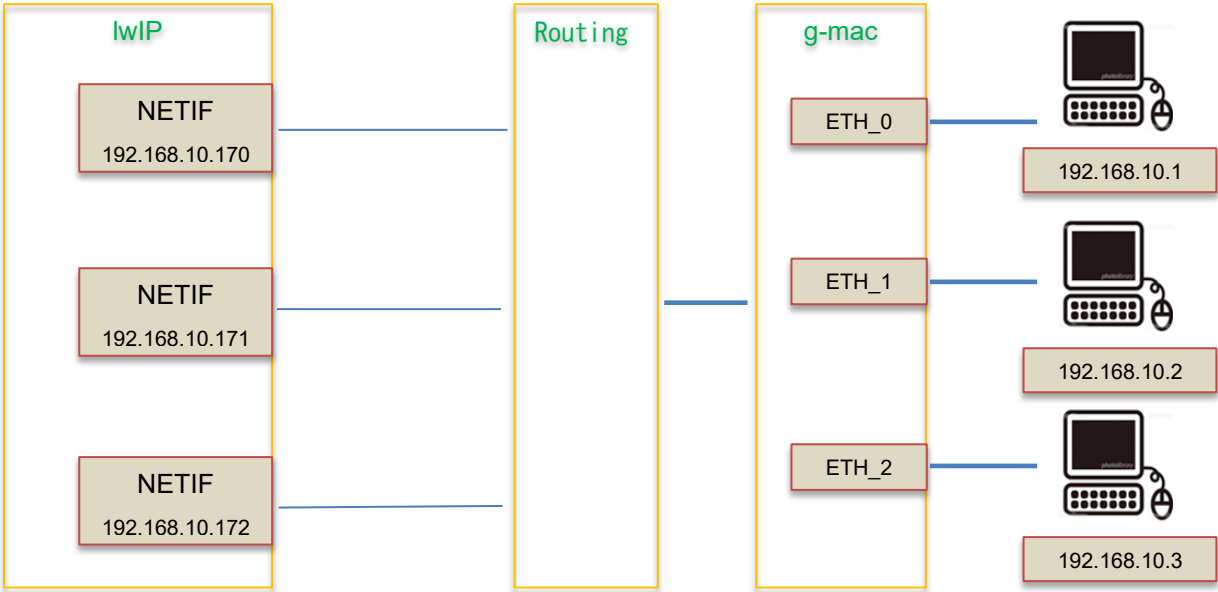


Figure 8.5. Routing Overview Diagram

2. Examples of IP address combinations that allow communication via routing

Table 8.9. IP address combinations

PC 192.168.10.1 → 192.168.10.170 → 192.168.10.171 → 192.168.10.172	lwIP 192.168.10.170 → 192.168.10.1 → 192.168.10.2 → 192.168.10.3
PC 192.168.10.2 → 192.168.10.170 → 192.168.10.171 → 192.168.10.172	lwIP 192.168.10.171 → 192.168.10.1 → 192.168.10.2 → 192.168.10.3
PC 192.168.10.3 → 192.168.10.170 → 192.168.10.171 → 192.168.10.172	lwIP 192.168.10.172 → 192.168.10.1 → 192.168.10.2 → 192.168.10.3

8.4.3 Management port specific tag + Non-routing mode

When "Management port specific tag" is set to "Enable" and routing is disabled, communication proceeds as follows.

1. Overview Diagram

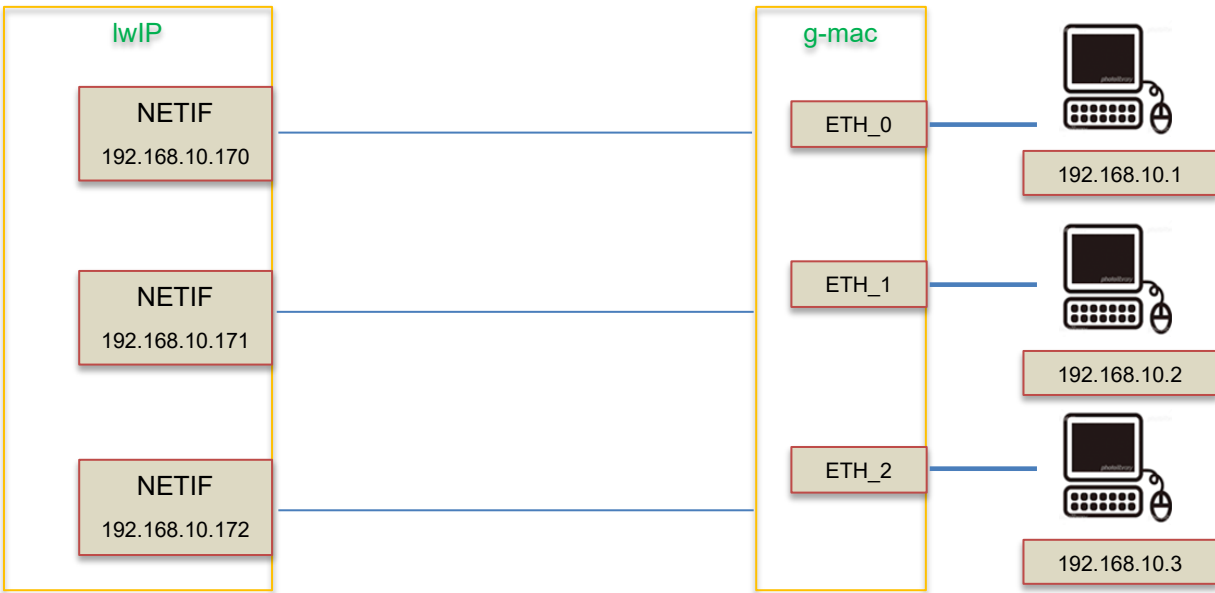


Figure 8.6. Non-routing overview diagram

2. Examples of communicable IP address combinations

Table 8.10. IP address combinations

PC 192.168.10.1 → 192.168.10.170	lwIP 192.168.10.170 → 192.168.10.1
PC 192.168.10.2 → 192.168.10.171	lwIP 192.168.10.171 → 192.168.10.2
PC 192.168.10.3 → 192.168.10.172	lwIP 192.168.10.172 → 192.168.10.3

8.5 Memory Allocation

The following three groups are placed in a project.

- Loader Program
Startup processing and initialization of the clock, interrupts, IO, etc. are placed in the BTCM.
- User Program
Processing other than the loader program, such as the RTOS, interrupt vectors, drivers, and applications, is placed in the ATCM or system RAM.
- Shared Non-Cache
Used as a storage location for Ethernet transmission and reception data, etc., this is placed in the mirror area of system RAM.

8.5.1 e² studio project

These definition files are located in the "script" folder.

➤ xxxxxxxx.ld

This is a link script file; the file name changes depending on the boot mode, etc.

➤ xxxxxxxx.h

This is a physical memory definition file, and defines the address of the implemented device, etc.

1. RZ/T2M

The memory usage by group is shown below.

➤ CPU0(CR52_0)

The only application that runs on CPU0 is the LED blinking function.

RZT2M Memory Map

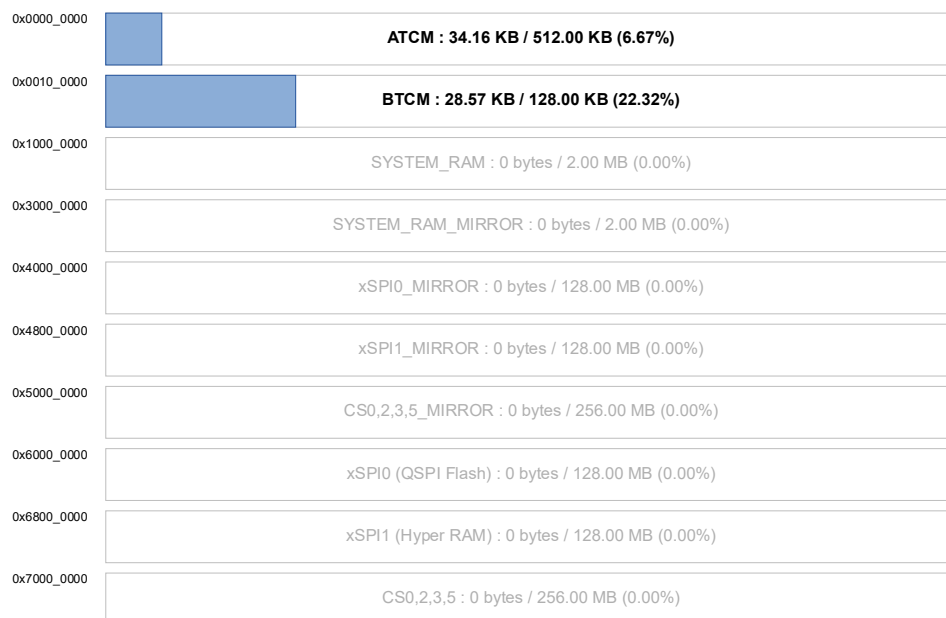


Figure 8.7. Memory footprint of the CPU0 project (e² studio)

ATCM

Total Usage : 34.16 KB

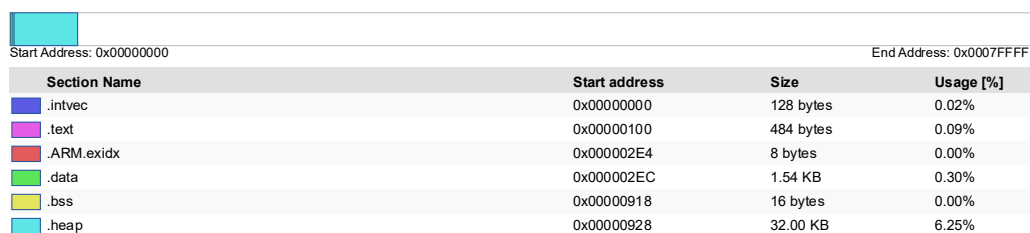


Figure 8.8. ATCM footprint of the CPU0 project (e² studio)

BTCM

Total Usage : 28.57 KB

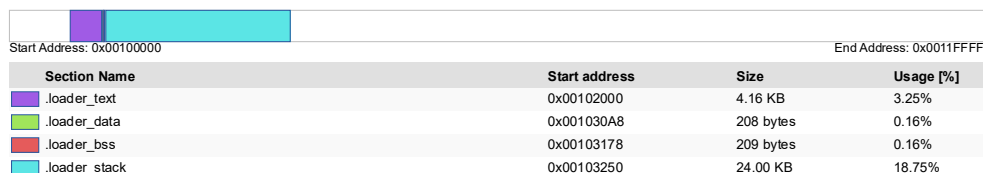


Figure 8.9. BTCM footprint of the CPU0 project (e² studio)

➤ CPU1(CR52_1)

The application running on CPU1 will perform functions other than blinking the LED.

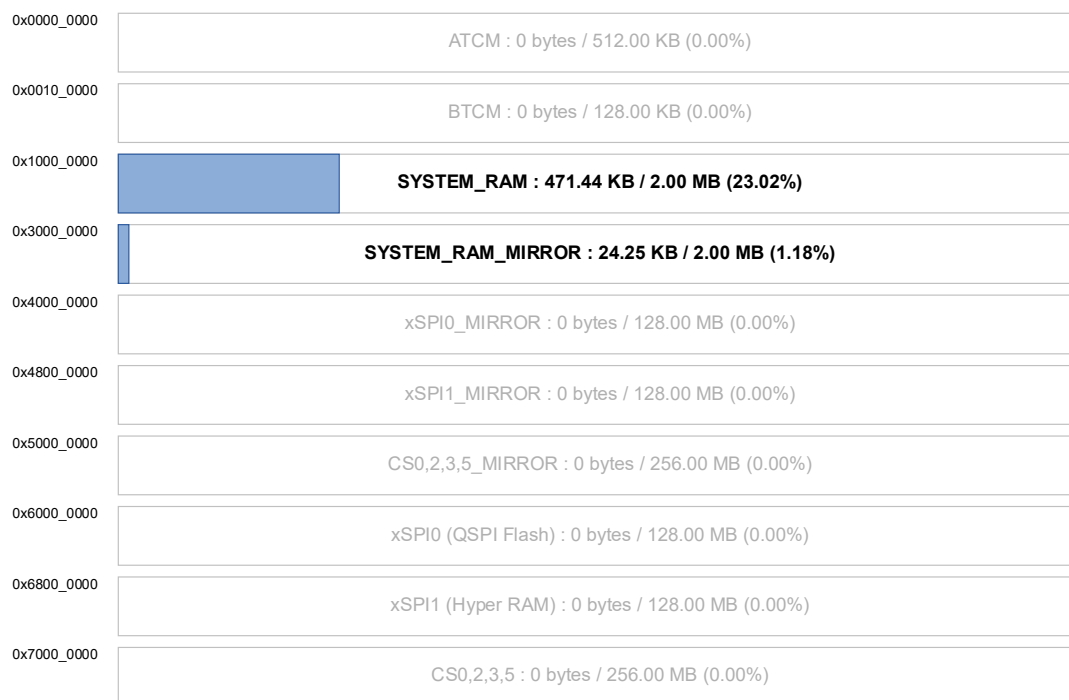
RZT2M Memory Map

Figure 8.10. Memory footprint of the CPU1 project (e² studio)

SYSTEM_RAM

Total Usage : 471.44 KB

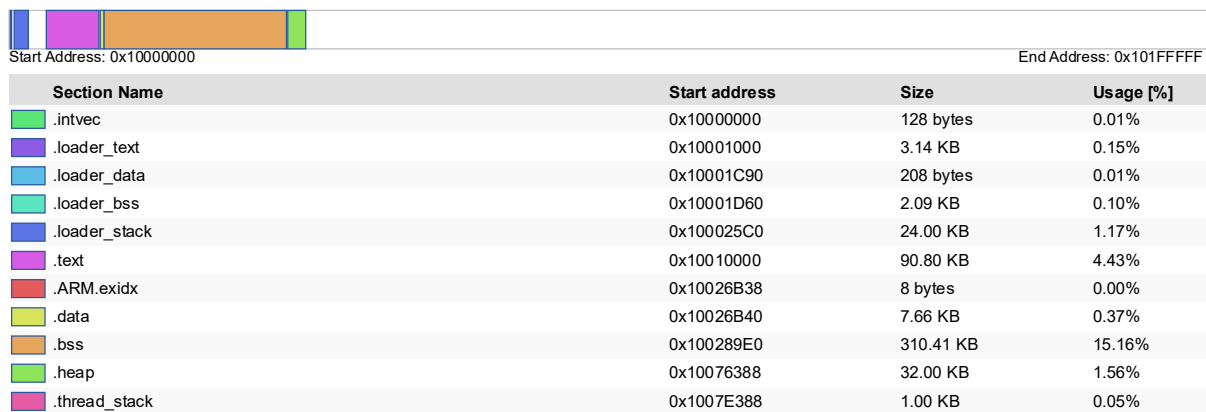


Figure 8.11. SYSTM_RAM footprint of the CPU1 project (e² studio)

SYSTEM_RAM_MIRROR

Total Usage : 24.25 KB



Figure 8.12. SYSTM_RAM (MIRROR) footprint of the CPU1 project (e² studio)

2. RZ/N2L

In the case of RZ/N2L, the size of the ATCM is small, so the user program is placed in SYSTEM_RAM.

RZN2L Memory Map

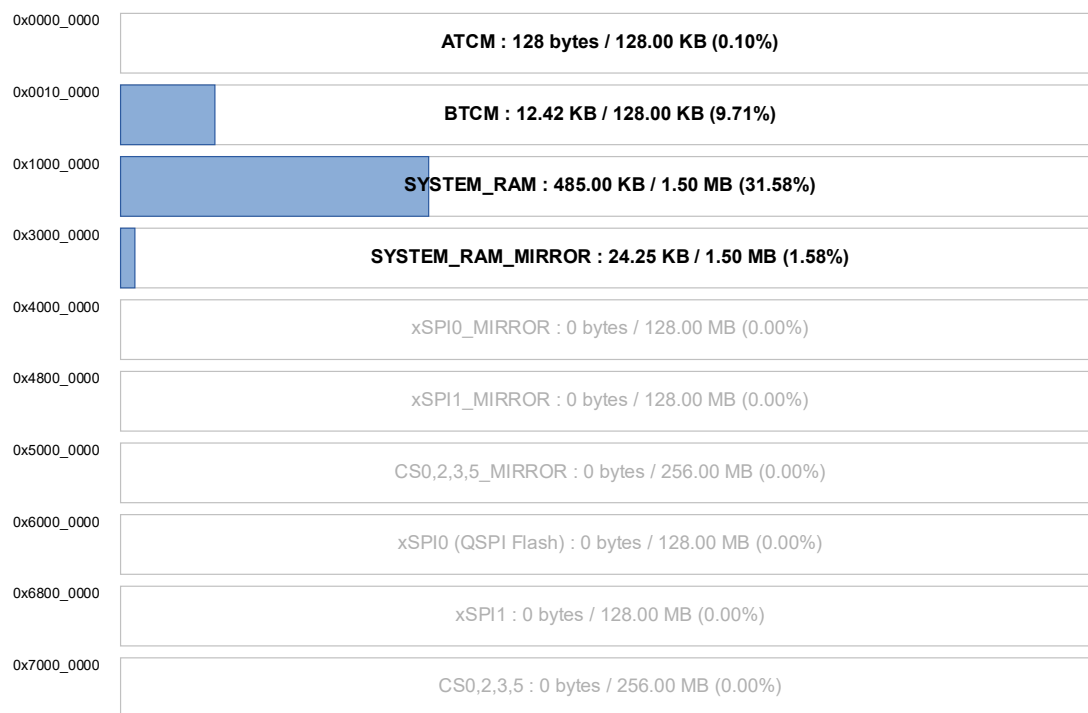


Figure 8.13. Memory footprint of the CPU0 project (e² studio)

ATCM

Total Usage : 128 bytes

Start Address: 0x00000000				End Address: 0x0001FFFF			
Section Name		Start address	Size	Usage [%]			
.intvec		0x00000000	128 bytes	0.10%			

Figure 8.14. ATCM footprint of the CPU0 project (e² studio)

BTCM

Total Usage : 12.42 KB

Start Address: 0x00100000				End Address: 0x0011FFFF			
Section Name		Start address	Size	Usage [%]			
.loader_text		0x00102000	4.13 KB	3.23%			
.loader_data		0x00103088	208 bytes	0.16%			
.loader_bss		0x00103158	2.09 KB	1.63%			
.loader_stack		0x001039B8	6.00 KB	4.69%			

Figure 8.15. BTCM footprint of the CPU0 project (e² studio)

SYSTEM_RAM

Total Usage : 485.00 KB

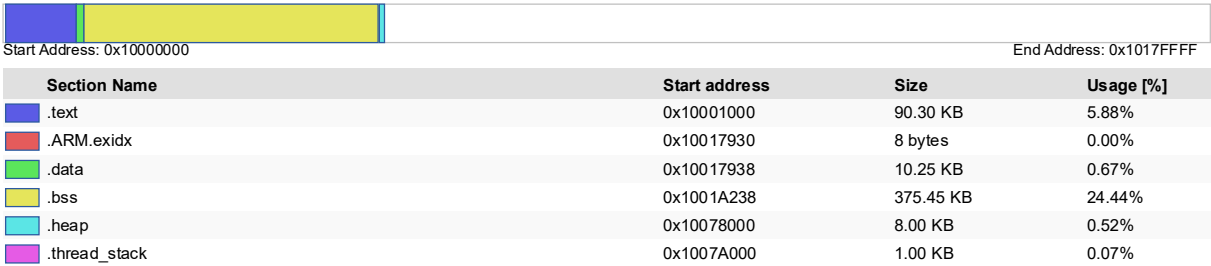


Figure 8.16. SYSTEM_RAM footprint of the CPU0 project (e² studio)

SYSTEM_RAM_MIRROR

Total Usage : 24.25 KB



Figure 8.17. SYSTEM_RAM (MIRROR) footprint of the CPU0 project (e² studio)

3. RZ/T2L

The memory usage by group is shown below.

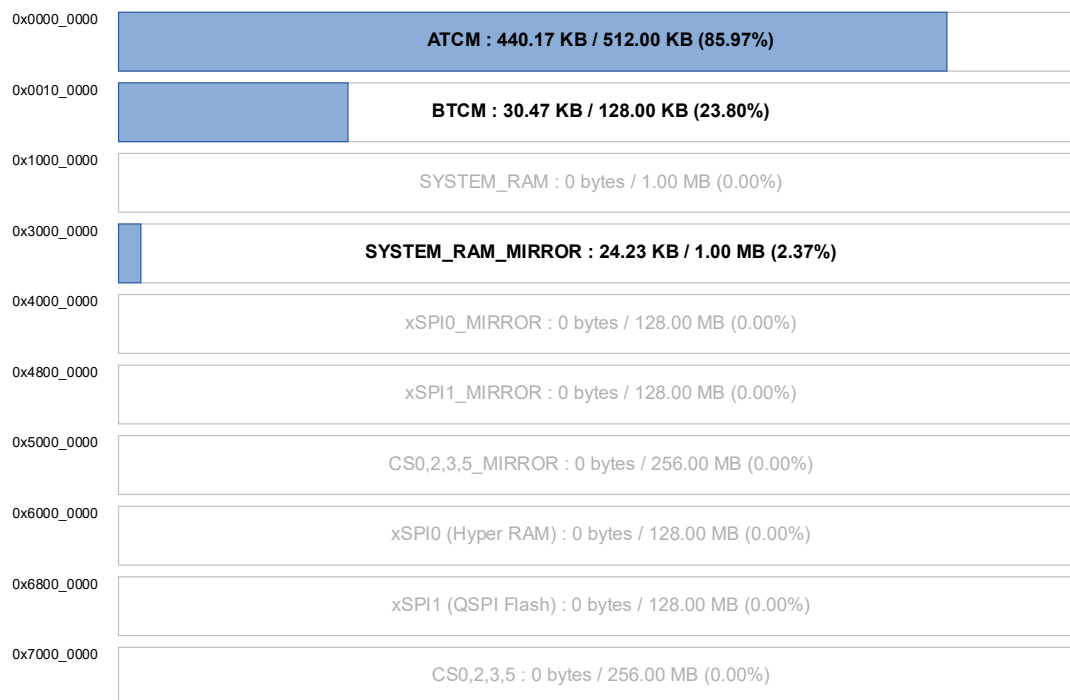
RZT2L Memory Map

Figure 8.18. Memory footprint of the CPU0 project (e² studio)

ATCM

Total Usage : 440.17 KB

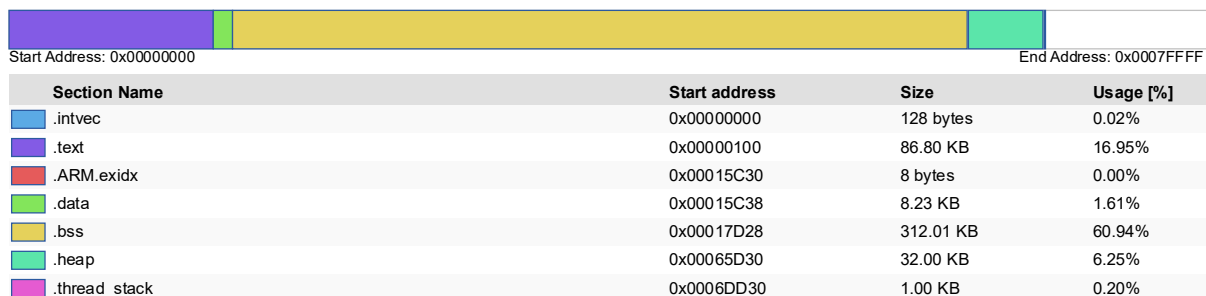


Figure 8.19. ATCM footprint of the CPU0 project (e² studio)

BTCM

Total Usage : 30.47 KB



Figure 8.20. BTCM footprint of the CPU0 project (e² studio)

SYSTEM_RAM_MIRROR

Total Usage : 24.23 KB

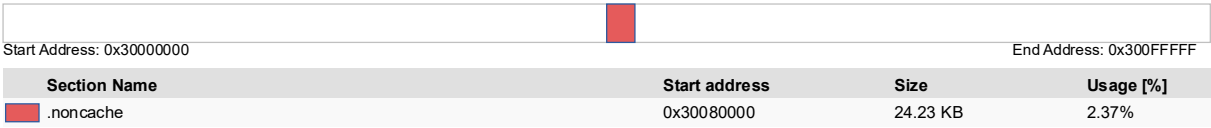


Figure 8.21. SYSTEM_RAM (MIRROR) footprint of the CPU0 project (e² studio)

8.5.2 EWARM project

It is placed in the definition file below in the "script" folder.

- xxxxxxxx.icf

This is a link script file. The file name changes depending on the boot mode, etc.

- xxxxxxxxxx.h

This is the physical memory definition file, and defines the addresses of the implemented devices.

1. RZ/T2M

The memory usage by group is shown below.

➤ CPU0(CR52_0)

The only application running on CPU0 is the LED blinking function.

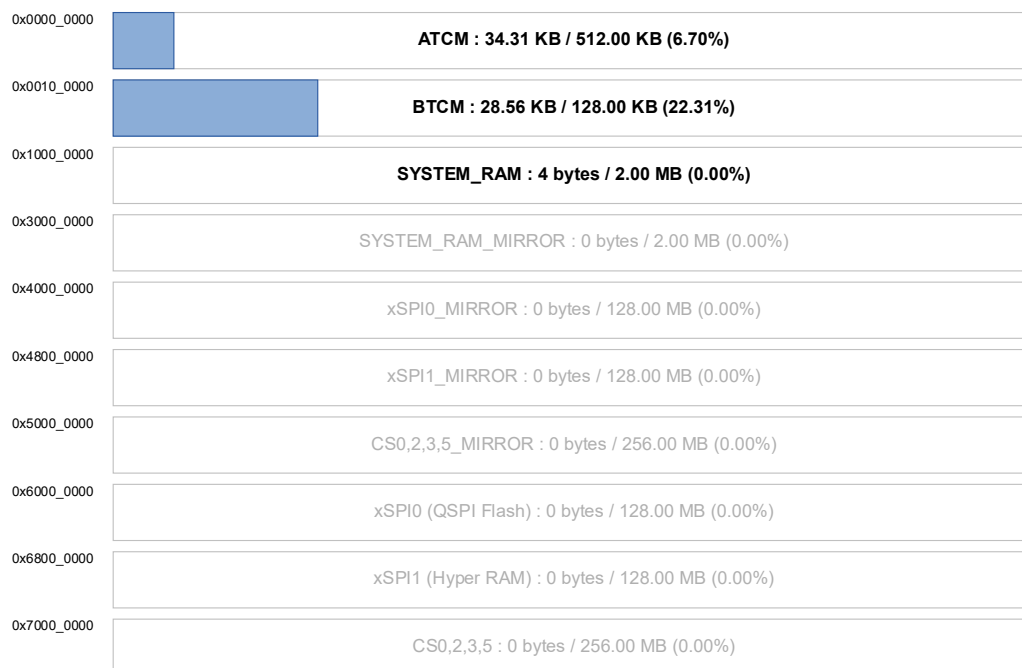
RZT2M Memory Map

Figure 8.22. Memory footprint of the CPU0 project (EWARM)

ATCM

Total Usage : 34.31 KB



Figure 8.23. ATCM footprint of the CPU0 project (EWARM)

SYSTEM_RAM

Total Usage : 4 bytes



Figure 8.24. BTCM footprint of the CPU0 project (EWARM)

SYSTEM_RAM

Total Usage : 4 bytes

Start Address: 0x10000000				End Address: 0x101FFFFF			
Section Name		Start address		Size		Usage [%]	
 NONCACHE_END_block		0x10180000		4 bytes		0.00%	

Figure 8.25. SYSTM_RAM footprint of the CPU0 project (EWARM)

➤ CPU1(CR52_1)

The application running on CPU1 will perform functions other than blinking the LED.

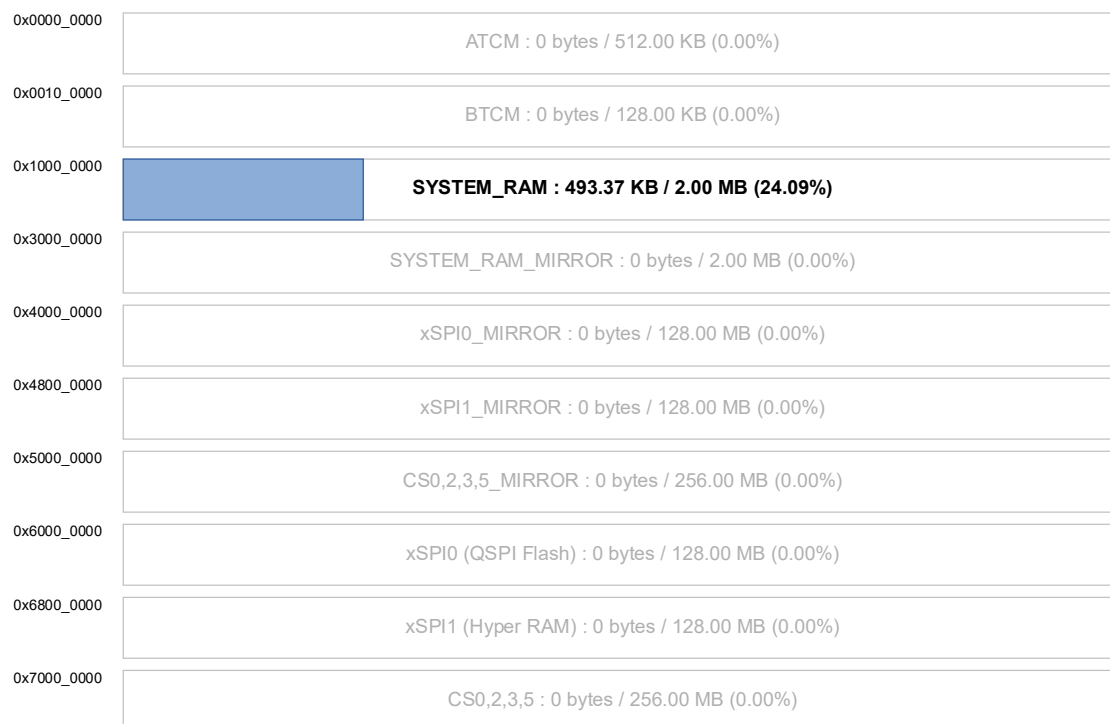
RZT2M Memory Map

Figure 8.26. Memory footprint of the CPU1 project (EWARM)

SYSTEM_RAM

Total Usage : 493.37 KB

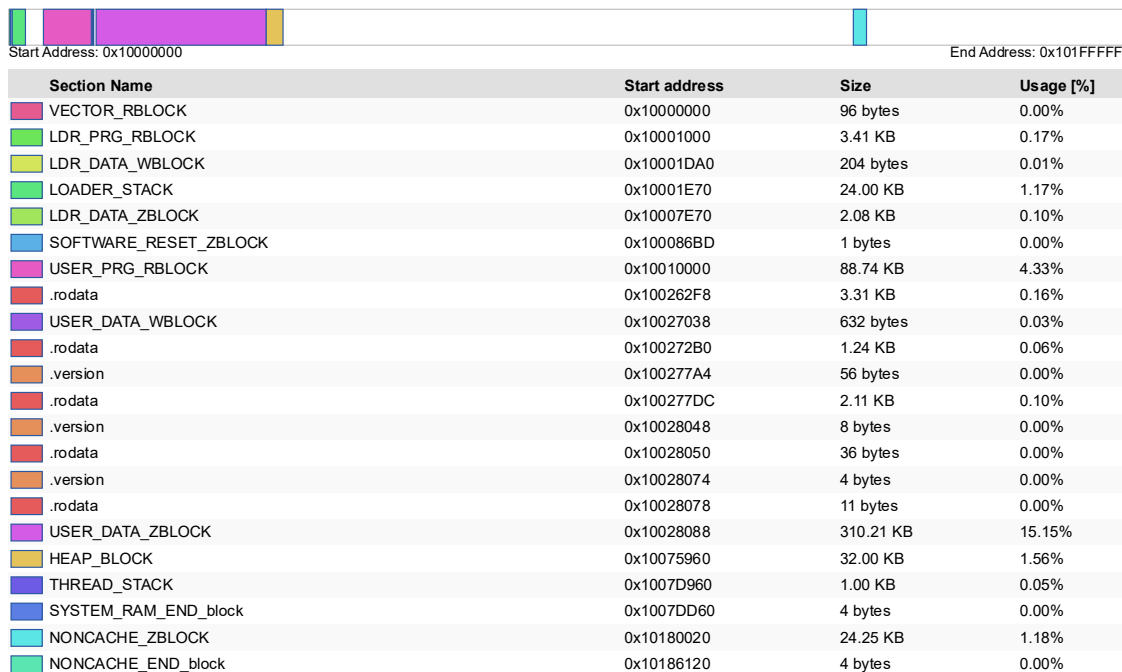


Figure 8.27. SYSTM_RAM footprint of the CPU1 project (EWARM)

2. RZ/N2L

In the case of RZ/N2L, the size of the ATCM is small, so the user program is placed in SYSTEM_RAM.

RZN2L Memory Map

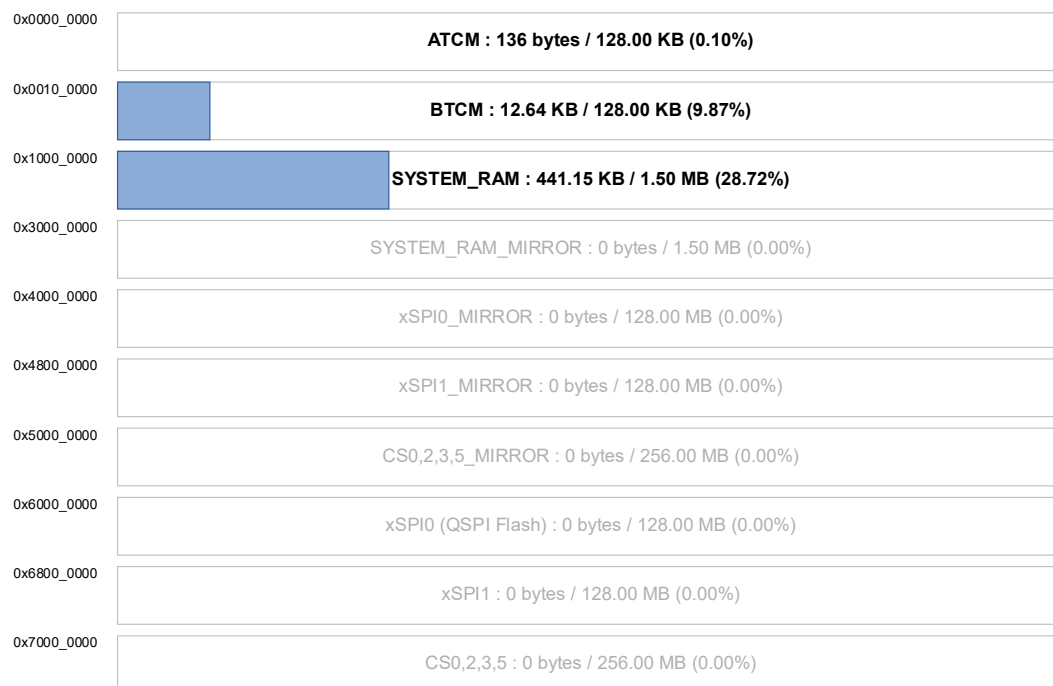


Figure 8.28. Memory footprint of the CPU0 project (EWARM)

BTCM

Total Usage : 12.64 KB

Start Address: 0x00100000				End Address: 0x0011FFFF			
Section Name	Start address	Size	Usage [%]				
LDR_PRG_RBLOCK	0x00102000	4.36 KB	3.41%				
LDR_DATA_WBLOCK	0x00103178	204 bytes	0.16%				
LOADER_STACK	0x00103248	6.00 KB	4.69%				
LDR_DATA_ZBLOCK	0x00104A48	2.08 KB	1.62%				
SOFTWARE_RESET_ZBLOCK	0x00105295	1 bytes	0.00%				

Figure 8.29. ATCM footprint of the CPU0 project (EWARM)

ATCM

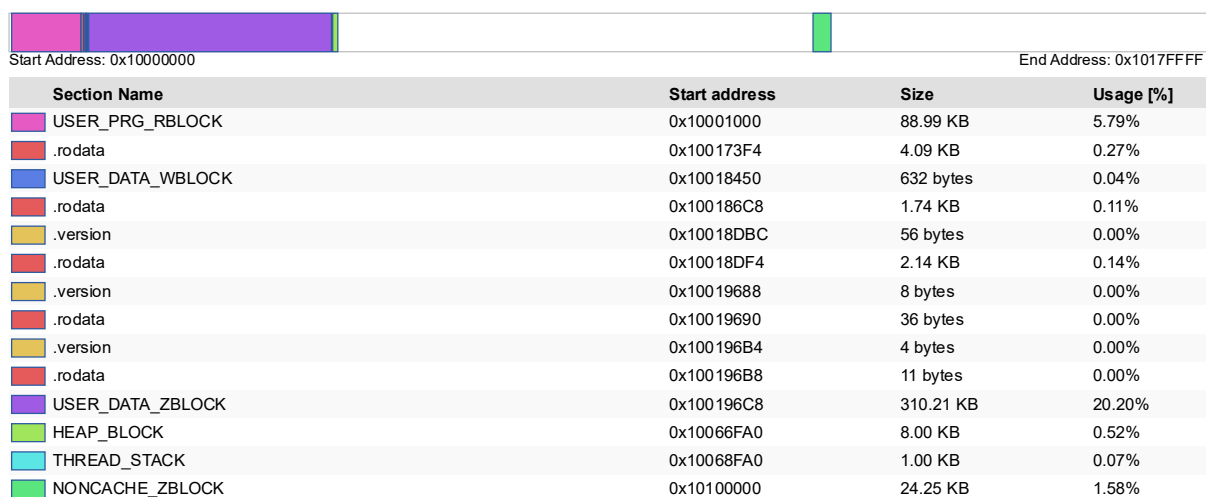
Total Usage : 136 bytes

Start Address: 0x00000000				End Address: 0x0001FFFF			
Section Name	Start address	Size	Usage [%]				
VECTOR_RBLOCK	0x00000000	136 bytes	0.10%				

Figure 8.30. BTCM footprint of the CPU0 project (EWARM)

SYSTEM_RAM

Total Usage : 441.15 KB

**Figure 8.31. SYSTM_RAM footprint of the CPU0 project (EWARM)**

3. RZ/T2L

The memory usage by group is shown below.

RZT2L Memory Map

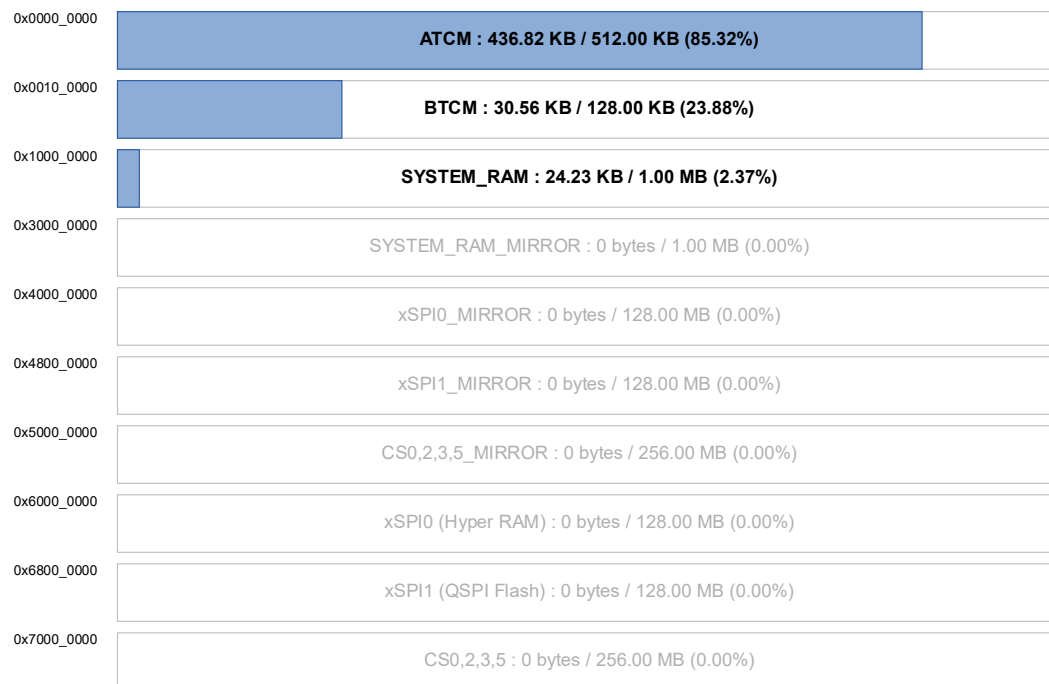


Figure 8.32. Memory footprint of the CPU0 project (EWARM)

ATCM

Total Usage : 436.82 KB

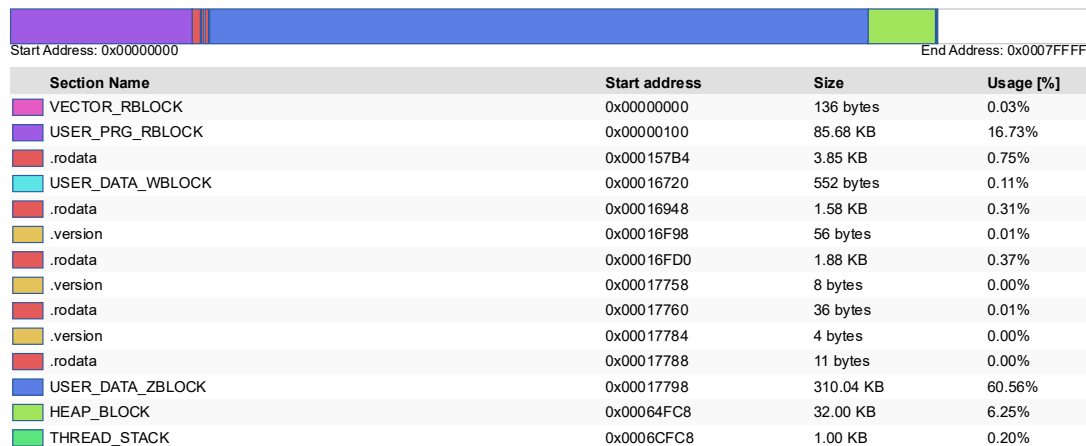


Figure 8.33. ATCM footprint of the CPU0 project (EWARM)

BTCM

Total Usage : 30.56 KB

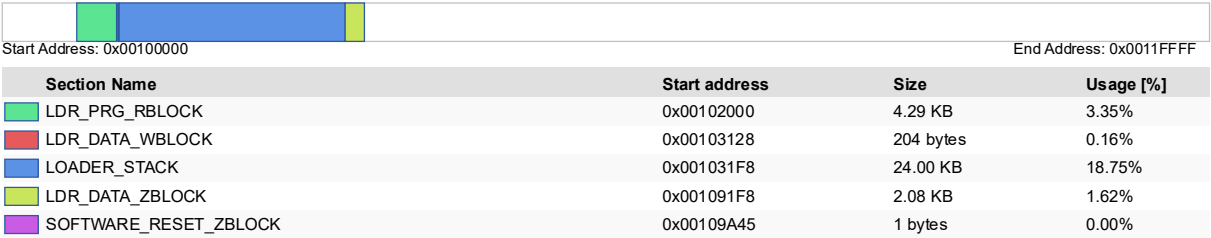


Figure 8.34. BTCM footprint of the CPU0 project (EWARM)

SYSTEM_RAM

Total Usage : 24.23 KB

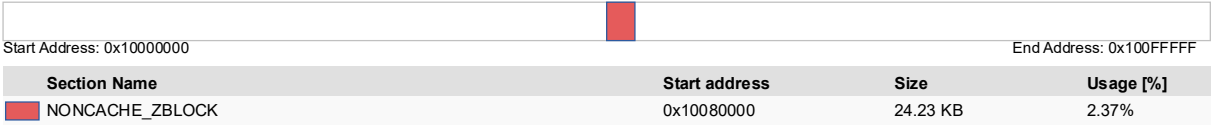


Figure 8.35. SYSTM_RAM footprint of the CPU0 project (EWARM)

8.6 CPU Utilization

Please note that the measurements were obtained using a single LAN port and e² studio based on a simplified calculation utilizing FreeRTOS APIs; therefore, the results should be treated as reference values.

Additionally, the communication mode was set to "Management port specific tag: Disabled," and the measurements include latency caused by communication conditions during the test.

1. **RZ/T2M**
 - iperf communication in progress
CPU Utilization 69%
 - When the echo server is waiting for a client
CPU Utilization 18%
2. **RZ/N2L**
 - iperf communication in progress
CPU Utilization 71%
 - When the echo server is waiting for a client
CPU Utilization 35%
3. **RZ/T2L**
 - iperf communication in progress
CPU Utilization 62%
 - When the echo server is waiting for a client
CPU Utilization 26%

Revision History

Rev.	Date	Description	
		Page	Summary
1.60	Jul 31, 2026	-	Standardization of fonts and other improvements
		-	Improvements such as standardizing table formatting
		-	Corrections of typos and other errors
		P8,P9,P10, P12,P13,P14 P15, P31-,P36 P39, P40-P45	Multi-interface support
1.50	Mar, 20 2026	-	Revised New Edition

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

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

1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity.

Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

2. Processing at power-on

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

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

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

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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