RZ/T2L Group

Quick Start Guide: Modbus RTU/ASCII Software

Introduction

This document is a quick start guide for evaluating Modbus communication with the RZ microcomputer evaluation board.
Modbus protocol is a communication protocol developed by Modicon Inc. (Schneider Electric SA.) for programmable logic controllers (PLCs), and its specifications are open to the public.
For details, refer to the protocol specifications (PI-MBUS-300 Rev.J).

Target Device

RZ/T2L

Contents

1. Overview

This document is for the Modbus protocol stack that operates on the RZ/T2L board, and describes the function overview, application programming interface (API), and application samples for developing and implementing applications using the protocol stack. We will describe examples using Cortex®-R52.
This package supports the RS-485 based Modbus RTU/ASCII protocol.

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	LED	Light Emitting Diode

1.2 Reference

Technical information about RZ/T2L is available via Renesas.

Table 1-2 Technical Inputs for RZ/T2L

Index	Technical Inputs
1	r01an6434ejxxxx-rzt2-rzn2-fsp-getting-started.pdf
2	r01ds0409ejxxxx-rzt2l.pdf
3	r01uh0985ejxxxx-rzt2l.pdf
4	r20ut5164ejxxxx-rskrzt2l.pdf
5	Modicon Modbus Protocol Reference Guide Rev.J
6	Modbus Application Protocol Specification V1.1b3

2. Features

1. The Modbus protocol stack for RZ/T2L allows for quick and easy development of the Modbus RTU/ASCII applications. The following nine codes can be implemented in this stack.

    1. (0x01) - Read coils
    2. (0x02) - Read discrete input
    3. (0x03) - Read holding registers
    4. (0x04) - Read input registers
    5. (0x05) - Write single coil
    6. (0x06) - Write single register
    7. (0x0F) - Write multiple coils
    8. (0x10) - Write multiple registers
    9. (0x17) - Read/Write multiple registers

For more information about Modbus, refer to the following site:
http://www.modbus.org

Note), The version number may differ depending on the update. Refer to the latest manual.

3. Project Setup

3.1 Requirements

This RZ/T2L Modbus protocol stack project has been developed and tested on these environments using the following boards and tools.

Table 3-1 RZ/T2L Requirements

Item	Description
Board	Renesas Electronics RZ/T2L RSK Board
IDE	IAR Systems - IAR Embedded Workbench® for ARM Version 9.60.3 Renesas Electronics - e² studio 2025-12 GCC toolchain GNU ARM Embedded Toolchain (version 13.3.1.arm-13-24 for CR52) - FSP Smart Configurator 2025-12
Emulator	IAR Systems I-jet SEGGER J-Link 8.60
Client demo tool	Renesas Electronics ModbusDemoApplication.exe (Included in this package)

3.2 Hardware

This document describes the major hardware. Refer to Renesas Starter Kit+ for RZ/T2L user's manual and schematic for more board details.

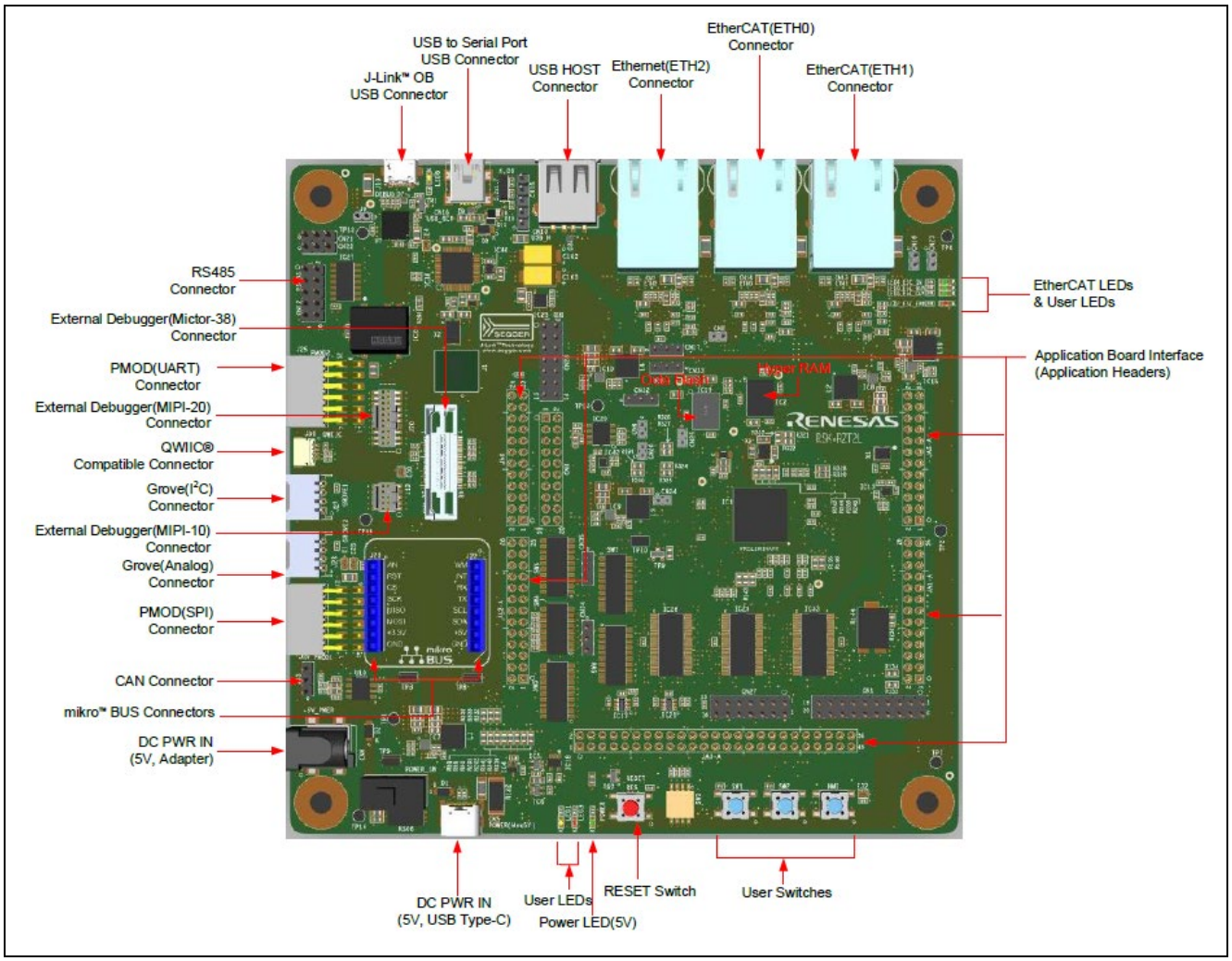

Figure 3.1 RZT2L RSK board layout

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Table 4. Jumper Pin settings

Reference	Jumper Position	Description
CN2	Short	**VCC1833_2 current measurement**
CN4	Short	**VCC1833_3 current measurement**
CN24	Short	**VCC11_RVCORE current measurement**
CN25	Short	**CPU1V8 current measurement**
CN26	Short	**CPU3V3 current measurement**
CN17	Short 1-2	VCC1833_2 Use power supply at 3.3V
	Short 2-3	**VCC1833_2 Use power supply at 1.8V**
CN32	Short 1-2	VCC1833_3 Use power supply at 3.3V
	Short 2-3	**VCC1833_3 Use power supply at 1.8V**
CN21	Short 1-2	Full-duplex communication
	Short 2-3	**Half-duplex communication**
CN22	Short 1-2	Full-duplex communication
	Short 2-3	**Half-duplex communication**
CN34	**Short 1-2**	**Use TXD0_P16_0_JA1 as transmit data signal and RXD0_P16_1_JA1 as receive data signal (use SCI ch0)**
	Short 2-3	Use TXD1_MDAT5 as transmit data signal and RXD1_P24_0_JA1 as receive data signal (use SCI ch1)
CN35	**Short 1-2**	**Use TXD0_P16_0_JA1 as transmit data signal and RXD0_P16_1_JA1 as receive data signal (use SCI ch0)**
	Short 2-3	Use TXD1_MDAT5 as transmit data signal and RXD1_P24_0_JA1 as receive data signal (use SCI ch1)
CN33	**Short 1-2**	**Connect XSPI1_CS0# to CS# of QuadSPI FLASH (IC3)**
	Short 2-3	Connect XSPI1_CS0# to CS# of extended SPI connector (CN28)

Table 5. Switch4 settings

SW4	Setting	Description
SW4-1	ON	**16-bit bus boot mode (NOR flash)** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW4-2	OFF	
SW4-3	ON	
SW4-4	OFF	**ATCM wait cycle = 1 wait**
SW4-5	ON	**JTAG mode = Normal mode**
SW4-6	ON	**VCC1833_2 = 1.8V**
SW4-7	ON	**VCC1833_3 = 3.3V**
SW4-8	OFF	Not used

Note), RAM mode is shared between xSPI0 and x1.
Therefore, if there is data in xSPI0, please delete it as it may cause a problem.

Table 6. Switch5 settings

SW5	Setting	Description
SW5-1	ON	**Use P01_7 as CAN_RX_OB of CAN interface** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW5-2	OFF	
SW5-3	OFF	
SW5-4	OFF	
SW5-5	OFF	
SW5-6	OFF	**Use P02_0 as CAN_TX1_JA5 of JA5-A** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW5-7	OFF	
SW5-8	OFF	
SW5-9	ON	
SW5-10	OFF	Not used

Table 7. Switch6 settings

SW6	Setting	Description
SW6-1	ON	**Use P02_2 as CAN_TX_OB of CAN interface** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW6-2	OFF	
SW6-3	OFF	
SW6-4	OFF	
SW6-5	OFF	
SW6-6	OFF	**Use P02_3 as BSC_A15 of JA3-A** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW6-7	OFF	
SW6-8	ON	
SW6-9	OFF	
SW6-10	OFF	Not used

Table 8. Switch7 settings

SW7	Setting	Description
SW7-1	OFF	**Use P05_5 as HDSL1_LINK of pin header CN1** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW7-2	OFF	
SW7-3	ON	
SW7-4	OFF	**Use P17_6 as LED1 for user LED control** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW7-5	OFF	
SW7-6	ON	
SW7-7	OFF	**Use P18_1 as LED3 for user LED control** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW7-8	OFF	
SW7-9	OFF	
SW7-10	ON	

Table 9. Switch8 settings

SW8	Setting	Description
SW8-1	ON	**Use P22_3 as Ethernet Port GMAC_RESETOUT#** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW8-2	OFF	
SW8-3	OFF	
SW8-4	ON	**Use P22_1 as serial host interface, HSPI_IO7_M2POE_BSC_D08 for JA5-A and JA3-A (When SW8-10=OFF:TRACE_OPTION_SEL=H)** * Refer to" r20ut5164ejxxxx-rskrzt2l.pdf" and set according to the mode to be used.
SW8-5	OFF	
SW8-6	OFF	Not used
SW8-7	ON	**ECAT0_OPTION_SEL = 'L'** **Select ETH0-related signals with bus switch IC33**
SW8-8	ON	**ECAT1_OPTION_SEL = 'L'** **Select ETH1-related signals with bus switch IC41**
SW8-9	OFF	**XSPI1_OPTION_SEL = 'H'** **Select signals other than XSPI1 related signals with bus switch IC37**
SW8-10	OFF	**TRACE_OPTION_SEL = 'H'** **Select signals other than TRACE-related signals with bus switch IC12**

3.3 Setting the Board

3.3.1 Debug connection

Setting the board for running sample program is shown below.
Build and run the sample code on the RZ/T2L RSK board by following the steps below.
Both loading into RAM and flash can be done using IAR Embedded Workbench or e^2 studio.

1. Connect the decoder to the header "J20" on the RZ/T2L RSK board.

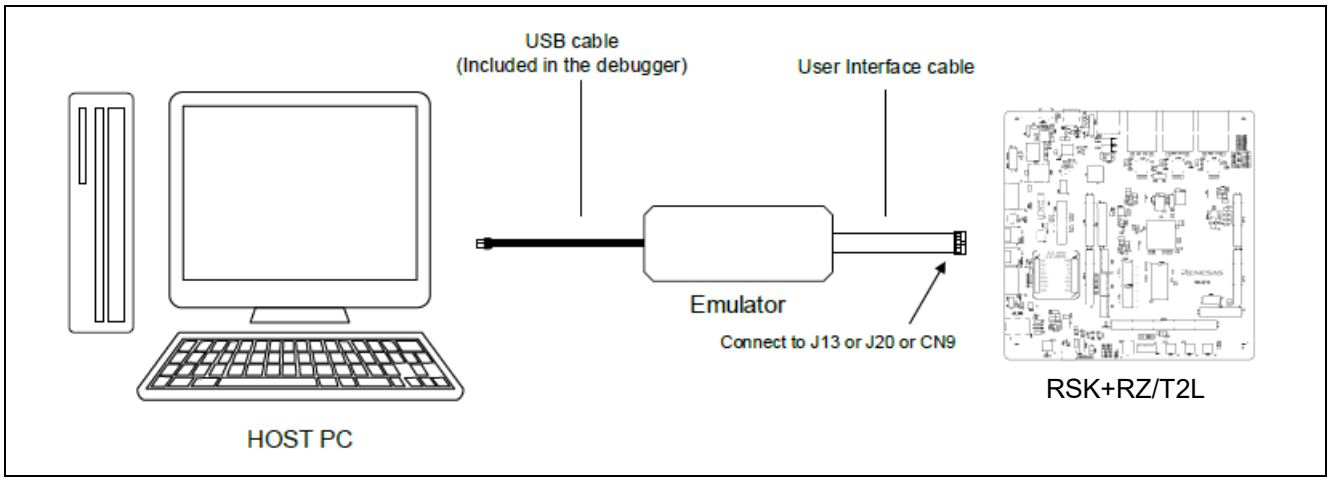


Figure 3.2: RZ/T2L RSK board debug connection diagram

When using J-Link OB, connect the USB cable to the header "J10" and set "J9" to open.

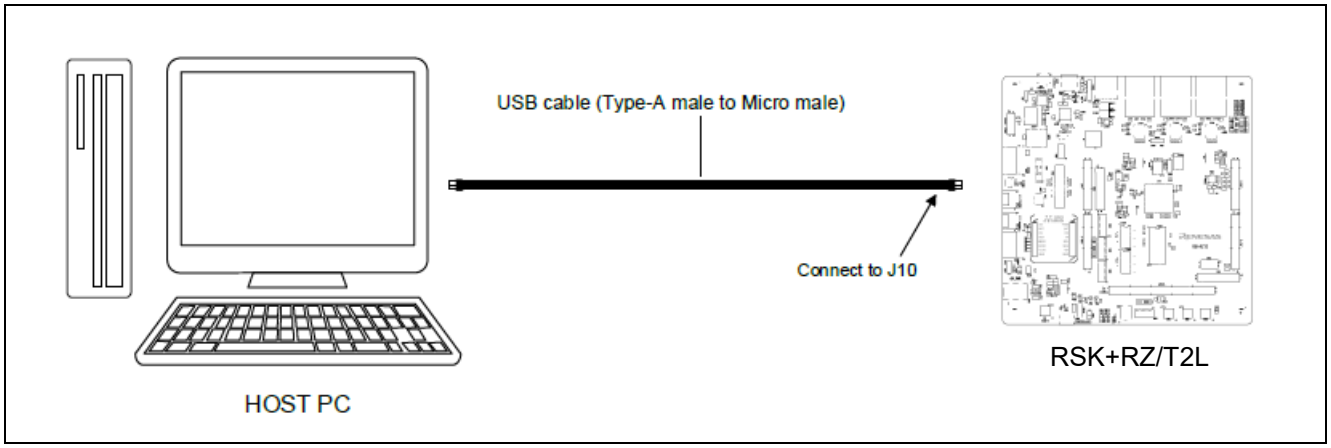


Figure 3.3: RZ/T2L RSK board debug connection diagram (J-Link OB)

2. Power is supplied using a USB cable (Type-C) or an AC / DC adapter. When using a USB cable (Type-C), connect it to the USB connector "CN5" of the RZ/T2L RSK board. When connecting the AC/DC adapter, connect it to the “CN6” connector of the RZ/T2L RSK board.

3.3.2 Serial board connection

Connect the PC to the RZ/T2L board as shown below.
Power is supplied by connecting a USB micro-c cable to the board.
For Modbus serial communication, use RS485 connector and connect to PC with RS-485 cable.
Connect the RS485 A cable to CN12-6, the B cable to CN12-3, and the G cable to CN28-1.

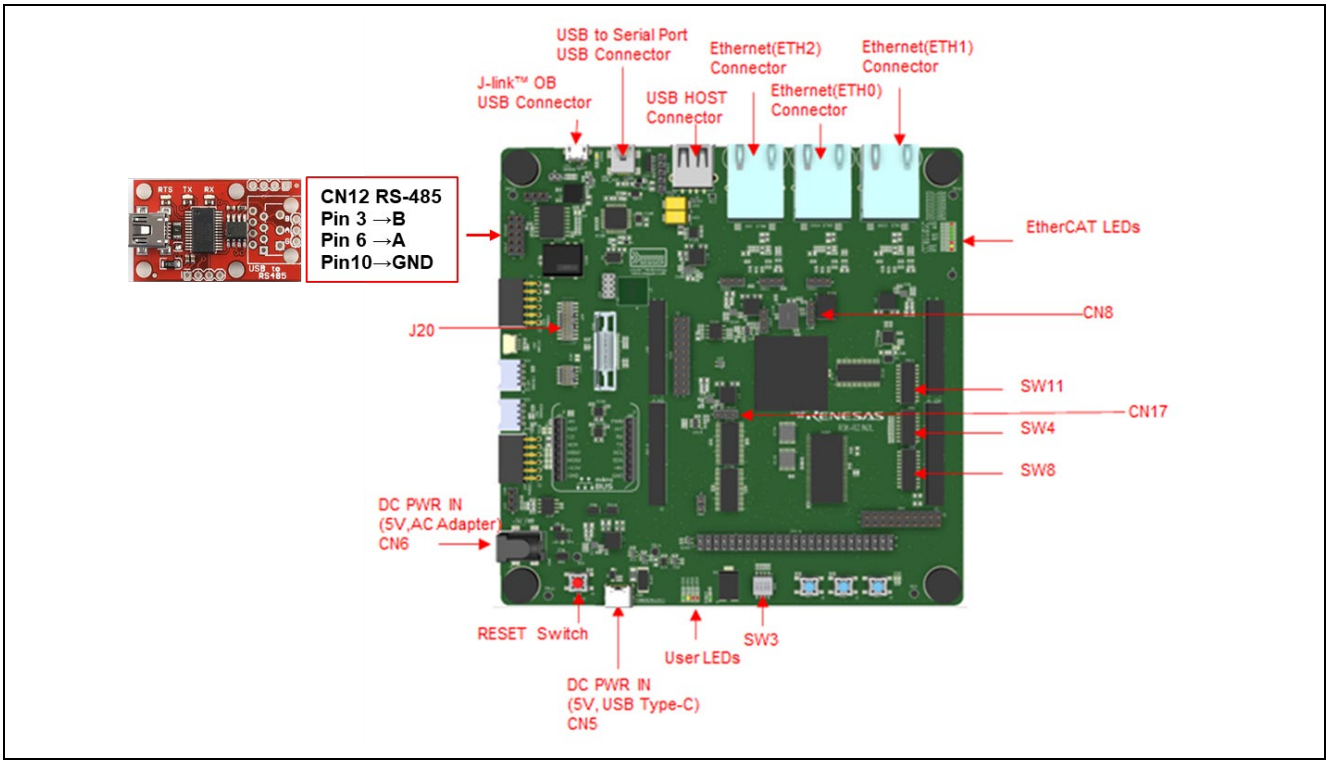


Figure 3.2: RZ/T2L EVALUATION board layout.

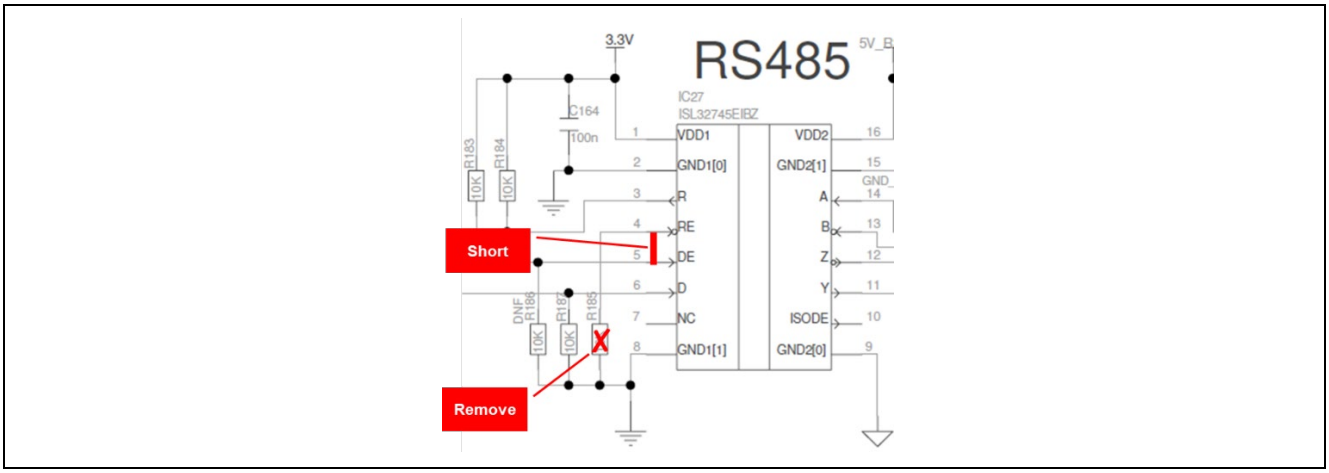
3.3.3 Modification of RSK board for serial communication

This RSK board has a full-duplex RS485 driver, so the following modifications are required to perform Modbus serial communication.

1. Short the header pins "2-3" of CN31 and CN32".

2. Remove the R185 short resistor.

3. Connect "P4_RE" and "P5_DE" of IC27.



4. Set up a demo tool.

1. Open “**ModbusDemoApplication.exe**” which is included in this package.

2. “Connection” is selected to Serial Client or Server, and set serial Port No (for example, “COM3”), Baud Rate (for example, ”115200bps”), Communication mode (for example,” RTU”), Parity (for example,” NONE Parity”), and Stop Bit (for example, ”1 stop bit”).

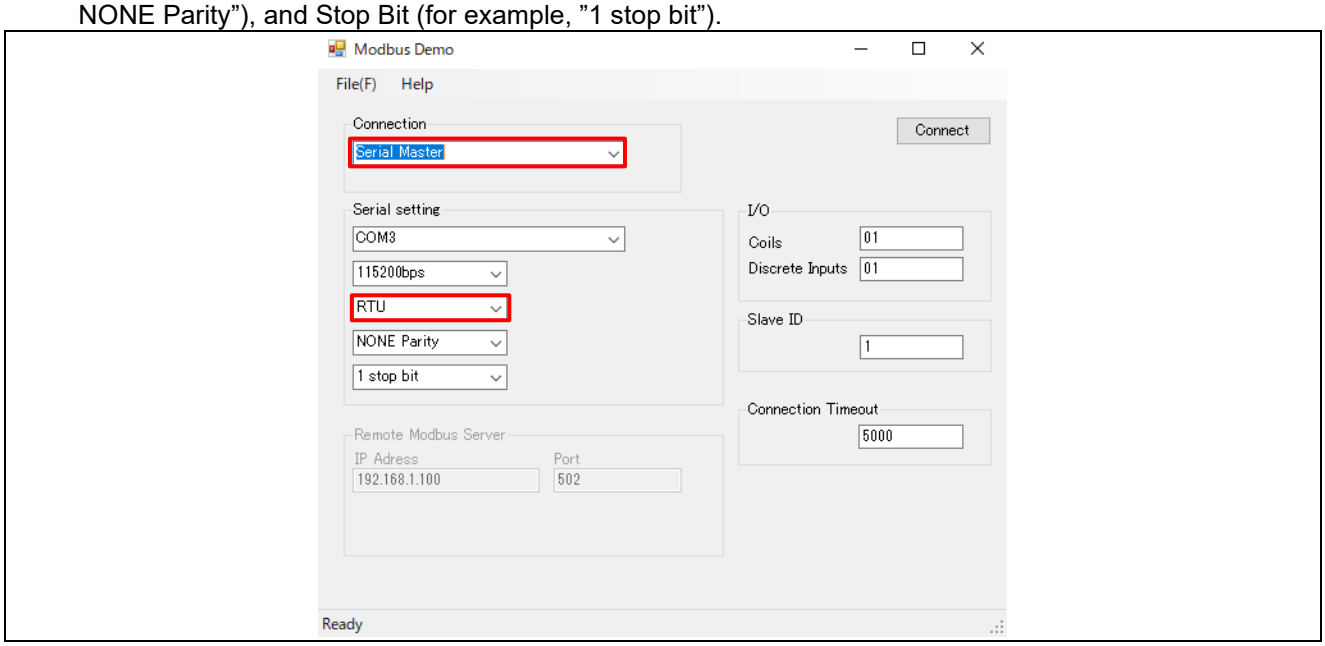


Figure 4.1 ModbusDemoApplication setting for RTU.

3. “Connection” is selected to Serial Client or Server, and set serial Port No (for example, “COM3”), Baud Rate (for example, “115200bps”), Communication mode (for example,”ASCII”), Parity (for example,” NONE Parity”), and Stop Bit (for example, ”1 stop bit”).

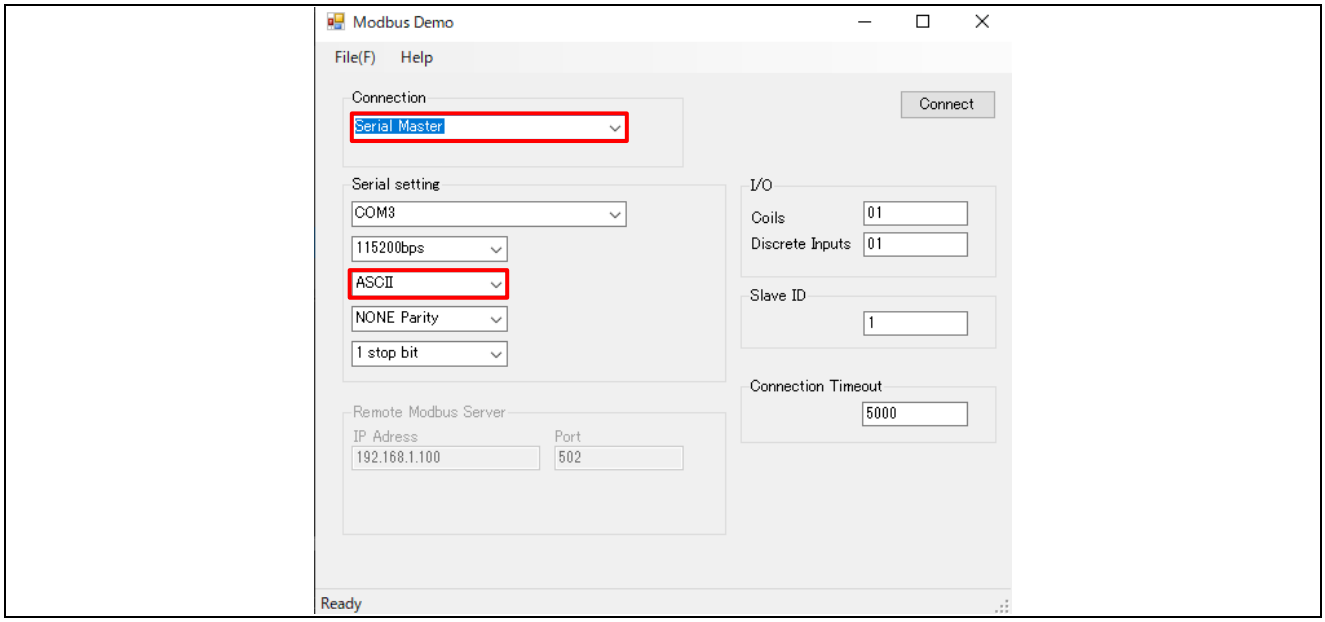


Figure 4.2 ModbusDemoApplication setting for ASCII.

5. Running the sample application

Refer to Section 3.3 Setting the Board for board settings.

The setup differs depending on the IDE.

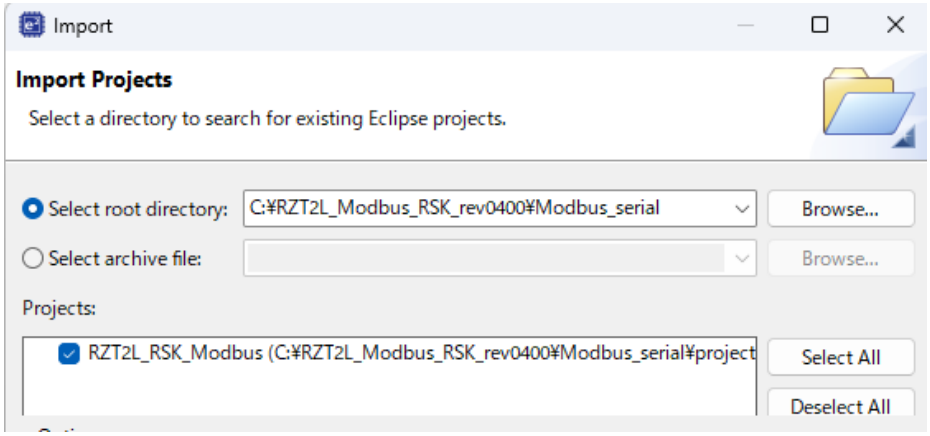
- When using e² studio, refer to section 5.1.
- When using EWARM, refer to section 5.2.

5.1 Setup sample project for e² studio

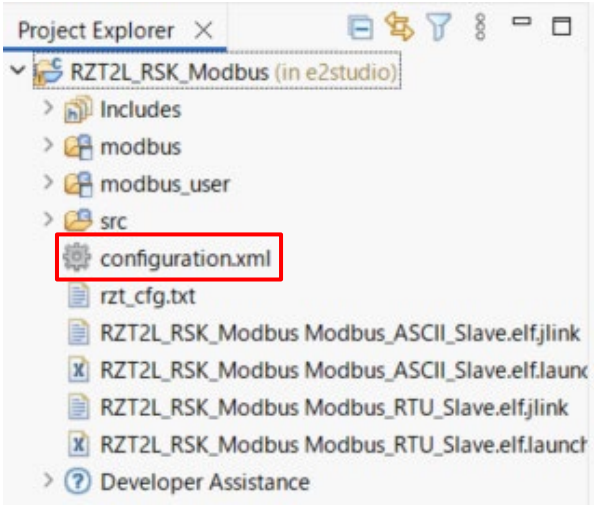
Build the sample code and load it into RAM using Renesas Electronics e² studio.

Note). Please install e² studio and adapt the RZ_FSP_Packs_v4.0.0 in advance.
Refer to the latest getting started guide. (r01an6434ejxxxx-rzt2-rzn2-fsp-getting-started.pdf)

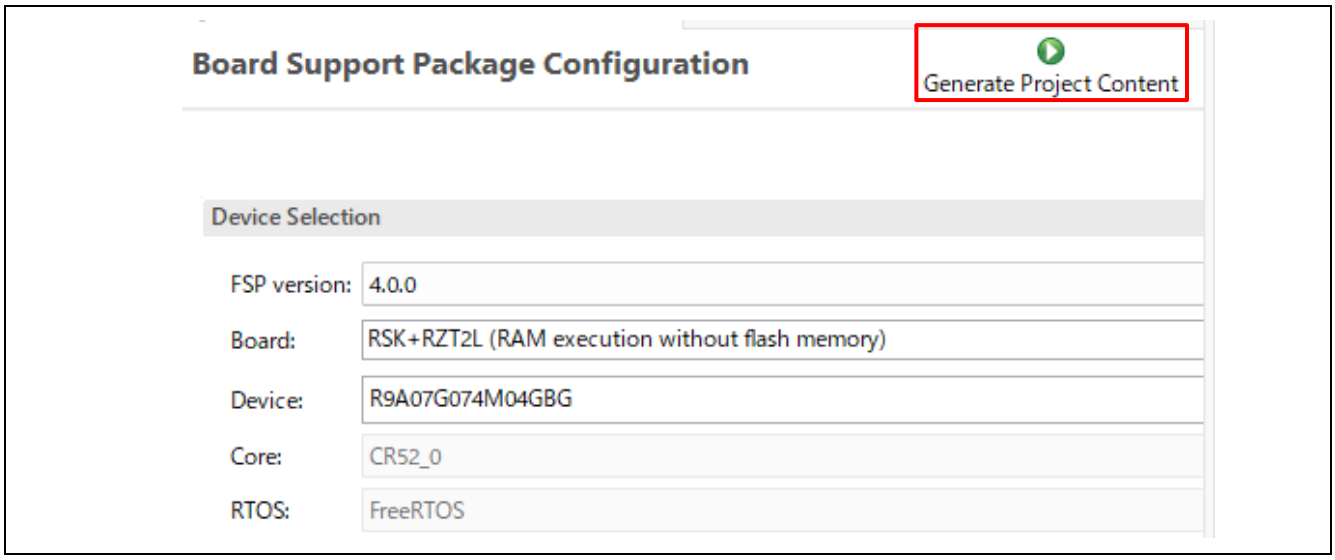
1. Import the sample project. After the program is started, by selecting [File] → [Import] → [Existing Projects into Workspace]. Check the "select root directory" and click “Browse…” button.
→Select “**RZT2L_Modbus_RSK_rev0400\Modbus_serial”** folder → [Finish].



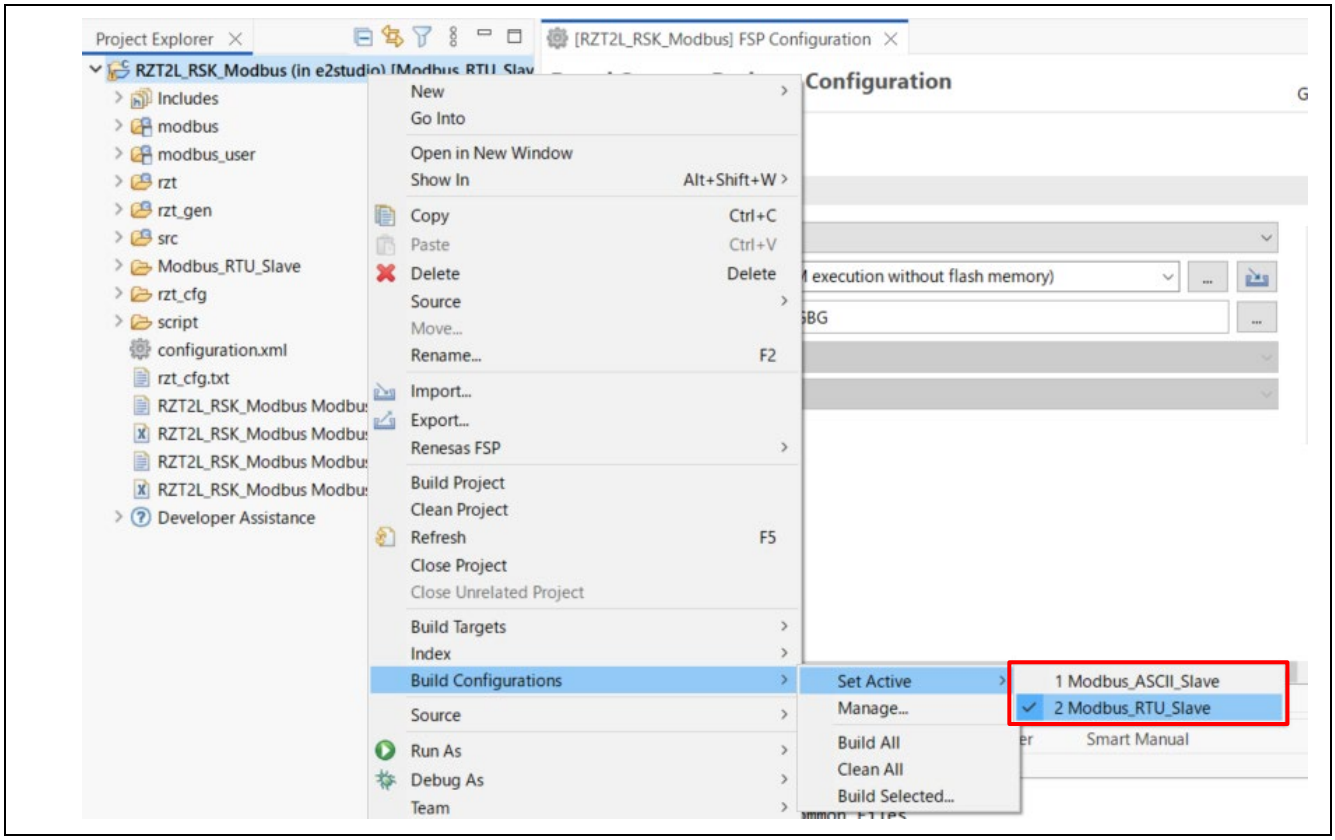
2. Open "configuration.xml".



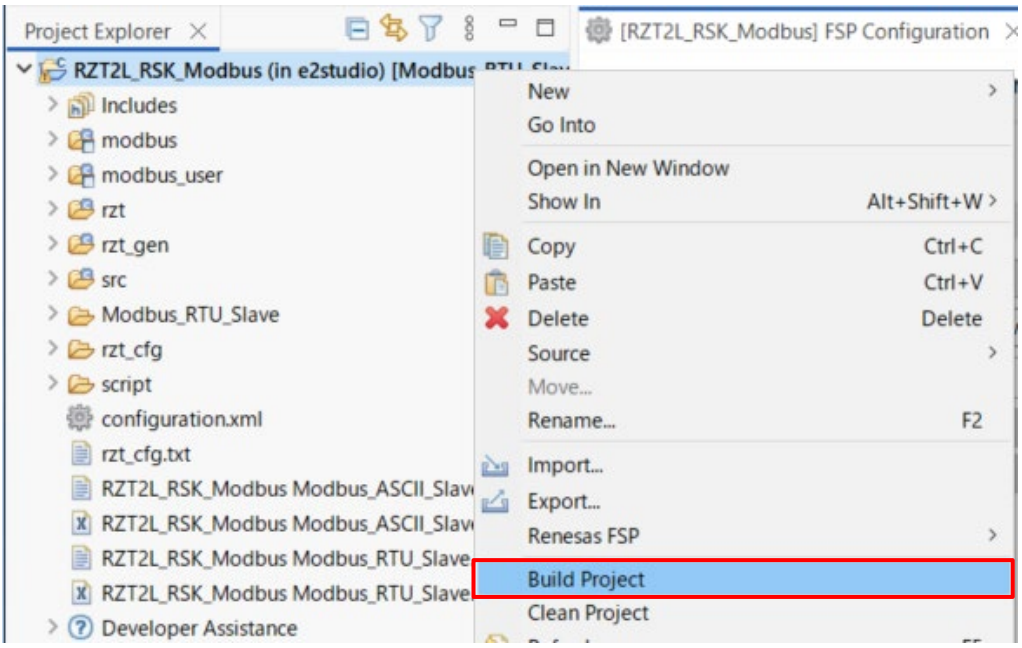
3. Check the boot mode project from BSP tab (following is RAM boot mode). And generate the code with "Generate Project Content".



4. Select the following functions from “Build Configurations”.
   “Modbus_RTU_Slave”
   “Modbus_ASCII_Slave”

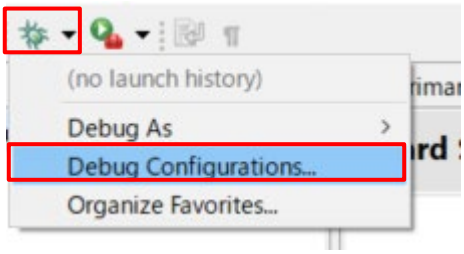


5. Execute the build.



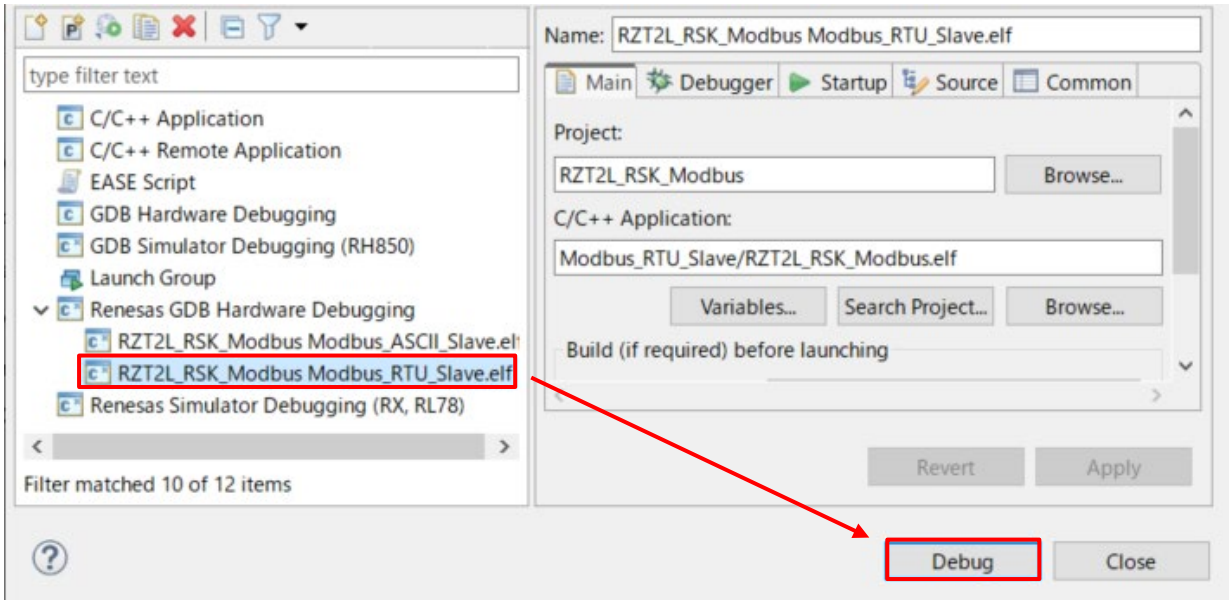
6. Restart the device by turning the power on/off.

7. Select the drop-down menu next to the bug icon and selecting “Debugger Configurations ...”.

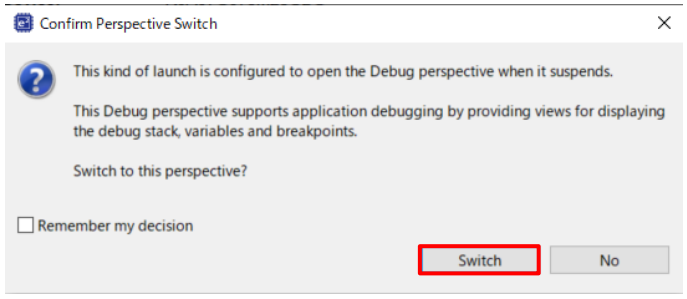


[Renesas GDB Hardware Debugging] → [**RZ/T2L_RSK_Modbus Modbus_xxx_Slave.elf**] item, then press [Debug].

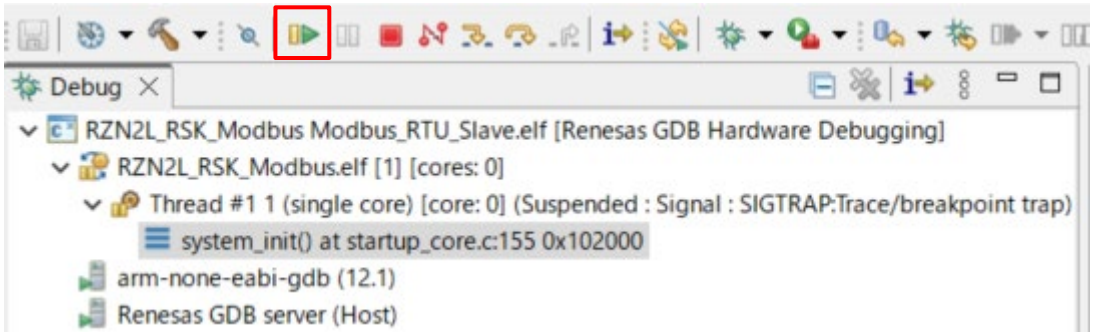
Note), xxx is RTU or ASCII



Following dialog will appear, so switch to the debug screen.



8. Press the "Resume" button. xxx_Slave debug will start, and the program will be suspended in main.c. Press the "Resume" button again. Program will run.

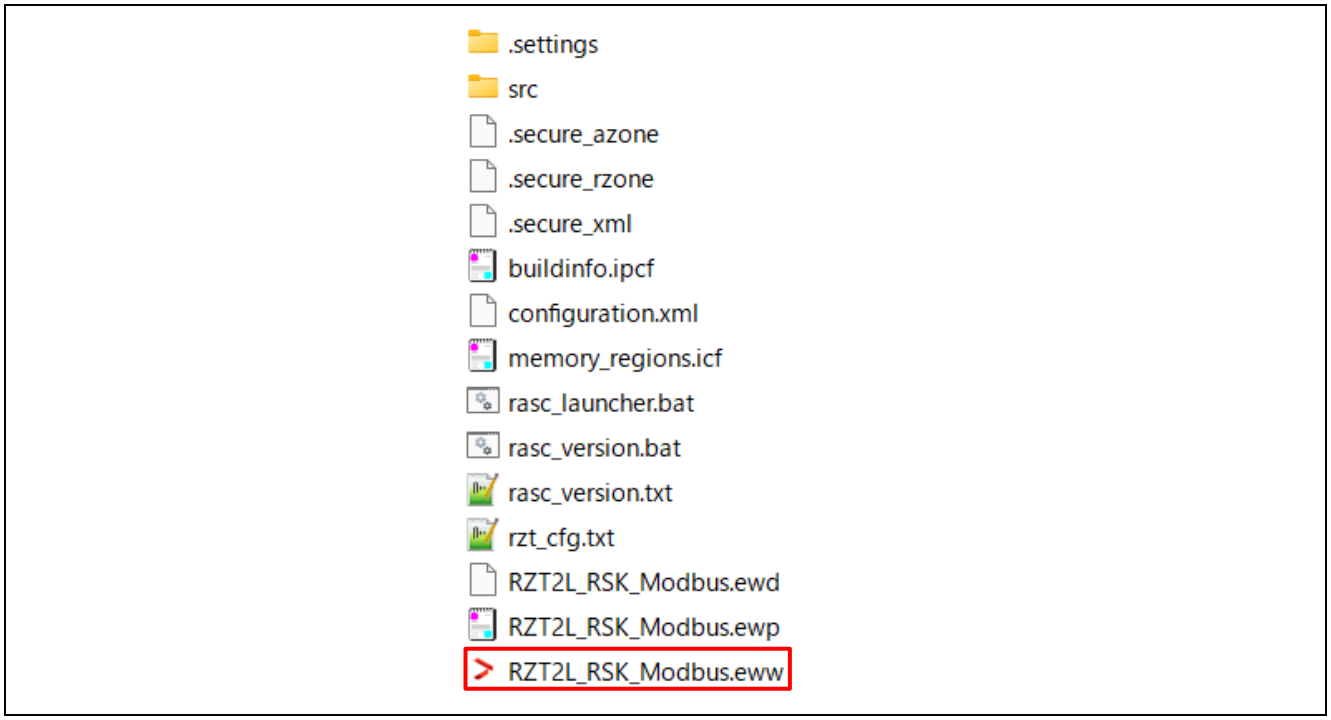


5.2 Setup sample project for EWARM

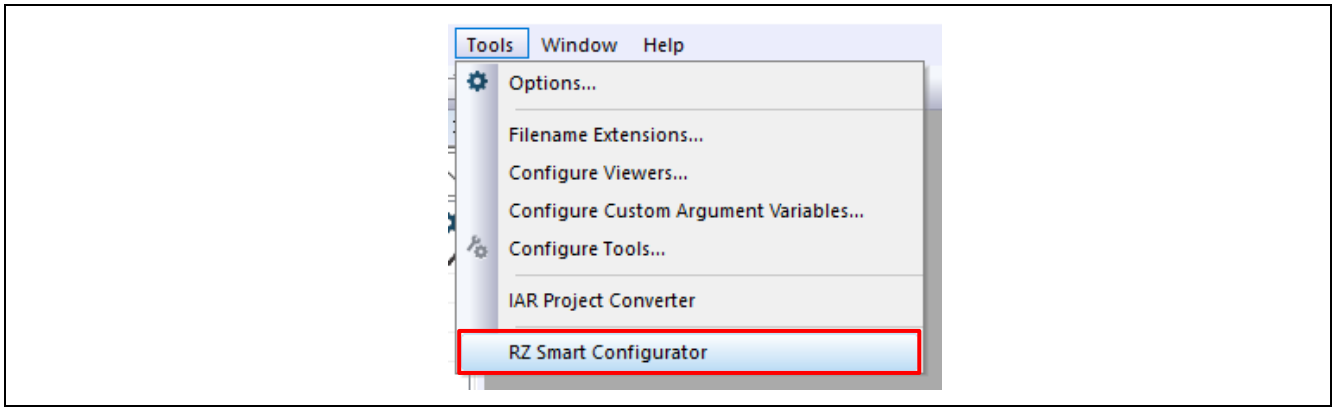
Build the sample code and load it into RAM using IAR Systems EWARM.

Note). Please install EWARM and adapt the RZ_FSP_Packs_v4.0.0 in advance.
Refer to the latest getting started guide. (r01an6434ejxxxx-rzt2-rzn2-fsp-getting-started.pdf)

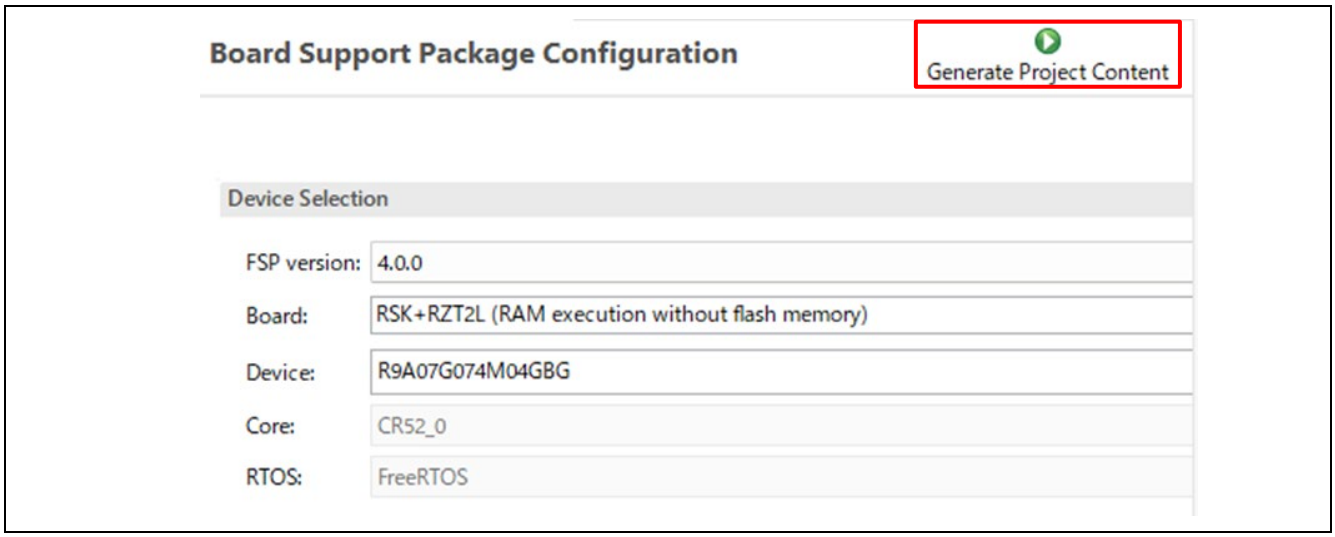
1. Open the sample project.
“**RZT2L_Modbus_RSK_rev0400\Modbus_serial\project\ewarm\Primary_0\RZT2L_RSK_Modbus.eww**”



2. Open the “RZ Smart Configurator”

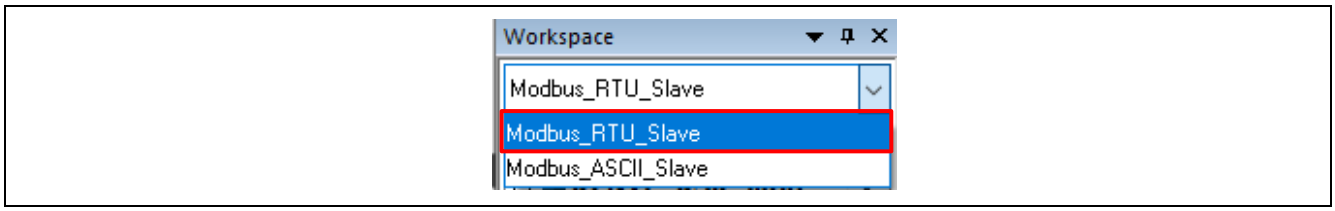


3. Check the boot mode project from BSP tab (following is RAM boot mode). And generate the code with "Generate Project Content".

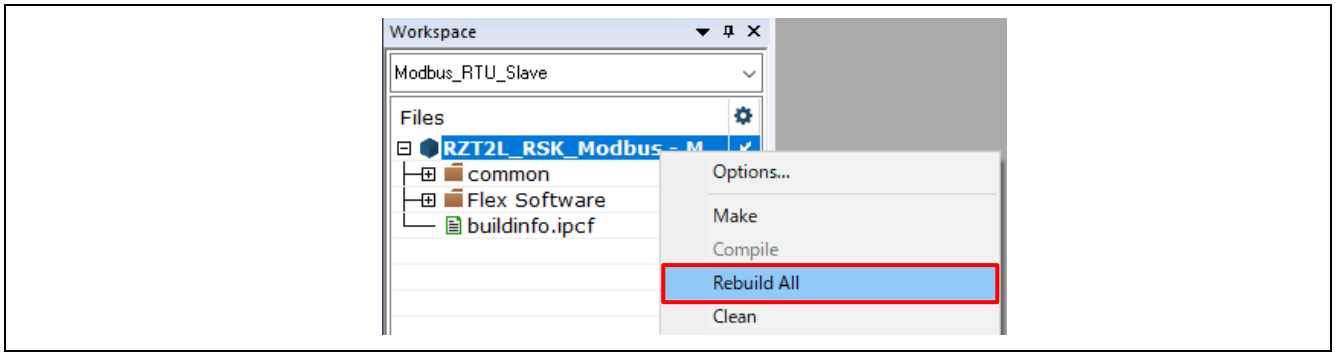


4. Select the following functions from the drop-down menu.

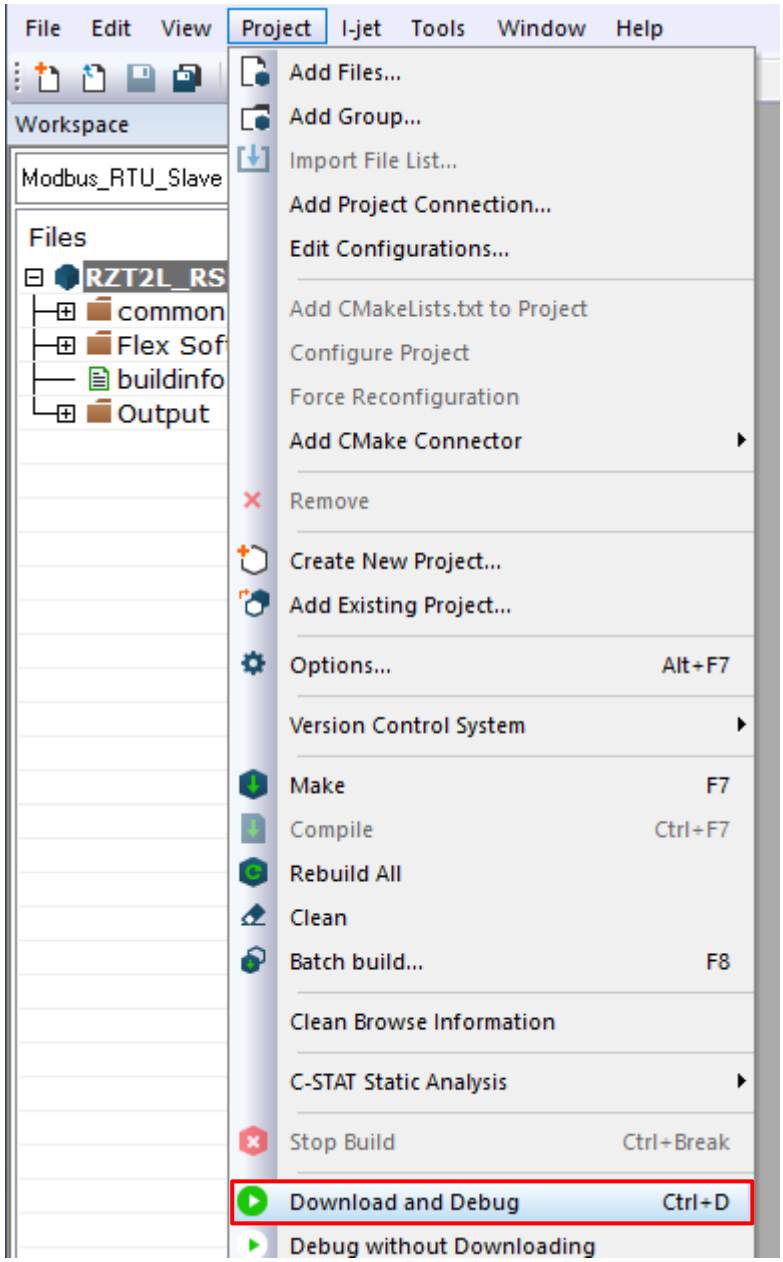
“Modbus RTU Slave”
“Modbus ASCII Slave”



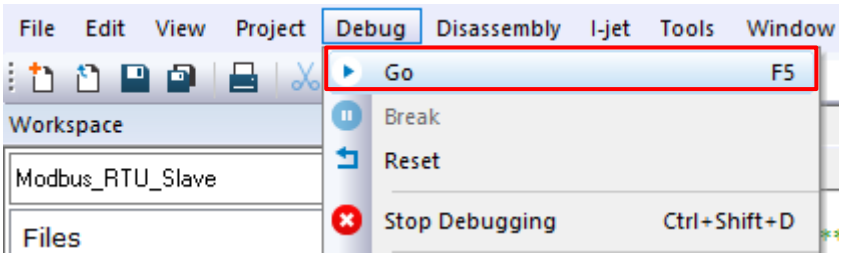
5. Select the “Rebuild All” item from the “Project” menu to rebuild the project.



6. After connecting the board and I-jet, click the “Download and Debug button” on the Project toolbar.

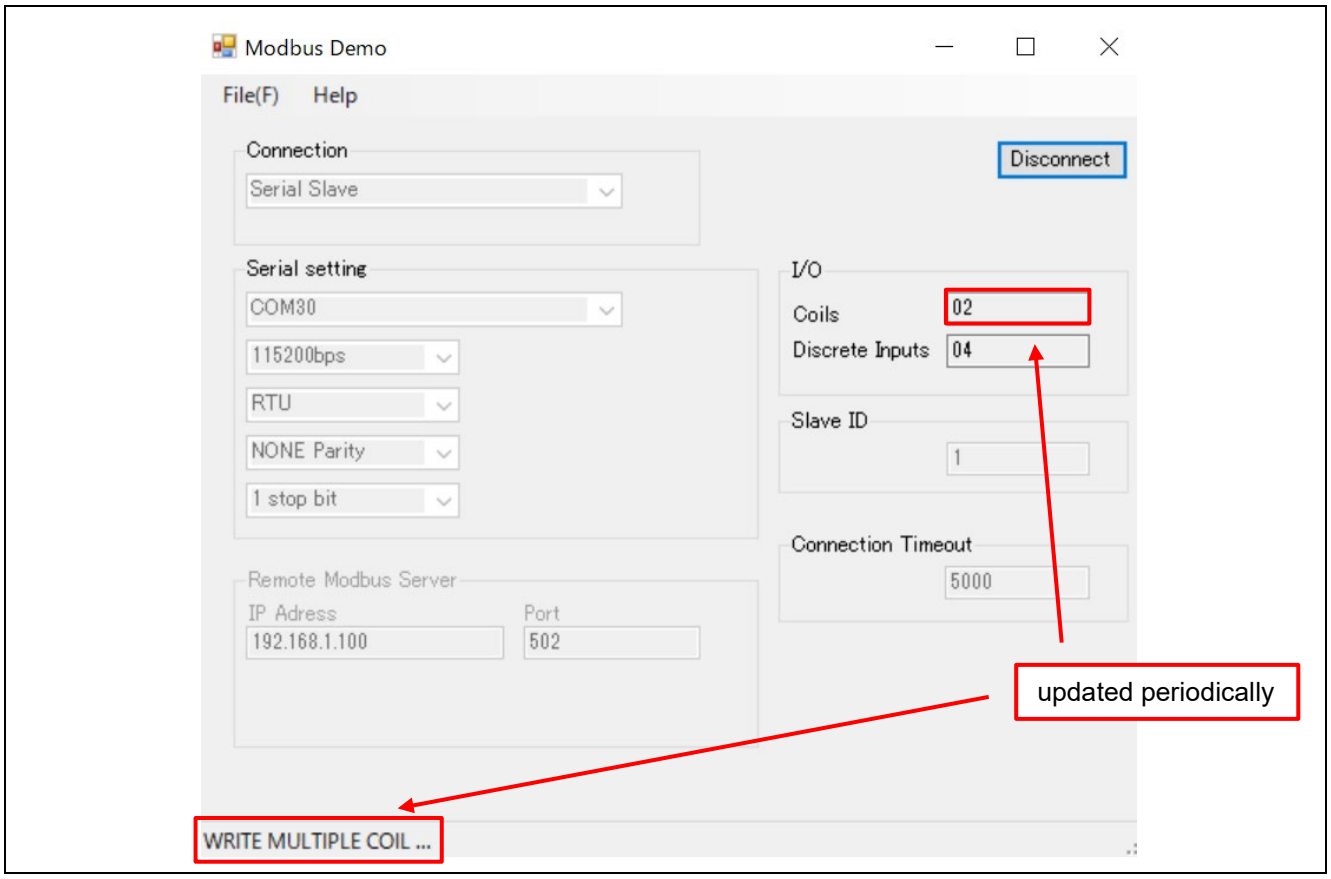


7. First, press the "Resume" button. Program will run.



5.3 Demonstration

Users can see the simple demonstration using this Modbus protocol stack in this sample project.
By communicating with PC through the Modbus RTU / ASCII protocol, LED blinking speed is controlled dynamically.
For this control, "Read_Discrete_Inputs" and "Write_Single_Coil" function codes are used. Specifically, the following sequence is executed.
PC application checks the state of the switch (SW3), by using Modbus "Read_Discrete_Inputs" function code. The [SW setting value] is the 8-bits of data calculated by the state of SW3.
According to the state of the switch, the states of the output ports, which are connected to LED, are updated periodically.



6. Appendix

6.1 Appendix A. Setting the baud rate

1. Open
   "RZT2L_Modbus_RSK_rev0400\Modbus_serial\common\renesas\modbus_user\modbus_init.c"

2. Change the following variables.

```
/* serial connection setting */
    st_init_info.u32_baud_rate = UART_BAUD_115200;
/* Baud rate for serial port configuration, supported baud rate values are 9600 to 115200 bps */
```

The values that can be set are 115200, 76800, 38400, 31250, 19200 or 9600.

The timeout period is calculated based on the baud rate setting above.

6.2 Appendix B. Setting Server ID

1. When changing the Server ID, please change the following settings. (range : 1 to 247)
   "**RZT2L_Modbus_RSK_rev0400\Modbus_serial\common\renesas\modbus_user\modbus_init.c**"

2. Build and debug.

```
#ifdef MODBUS_ASCII /* ASCII Slave mode */
                                    MODBUS_ASCII_SLAVE_MODE,
#else               /* RTU Slave mode */
                                    MODBUS_RTU_SLAVE_MODE,
#endif
                                    1);                                 /* Slave ID */
#endif
#endif
```

7. Limitations

There is no limitation.

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Feb 29, 2024	-	First Edition issued
2.20	Apr 4, 2025	-	Modbus serial updated to FSP2.2.0
3.00	Nov 7, 2025	-	Supports RZ/T2 FSP3.0.0
4.00	Apr 3, 2026	-	Supports RZ FSP4.0.0

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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