RZ/N2L Group

Modbus RTU/ASCII Software

Introduction

This document explains the evaluation of Modbus communication using 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/N2L

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1. Overview

This document is for the Modbus protocol stack that operates on the RZ/N2L 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
8	Wireshark	A free packet capture tool for monitoring LAN traffic
9	Client	Modbus TCP Master / Requesting device
10	Server	Modbus TCP Slave / Responding device
11	MAC	Media Access Control Address
12	LAN	Local Area Network
13	DHCP	Dynamic Host Configuration Protocol
14	PHY	Physical Layer
15	LwIP	Lightweight IP
16	RS-485	EIA-485 / Serial communication standard
17	SBOM	Software Bill of Materials

1.2 Reference

1.2.1 About RZ/N2L

Technical information regarding Modbus can be found on the official Modbus Organization website, while details on the RZ/N2L are provided by Renesas.

Table 1.2 Technical Inputs for RZ/N2L

Document Type	Document Title	Description	Document No.
User's Manual	RZ/N2L Group User's Manual Hardware	RZ/N2L Group User's Manual Hardware	r01uh0955ej****
Datasheet	RZ/N2L Group Datasheet	RZ/N2L Group Datasheet	r01ds0397ej****
Getting Started	RZ/T2, RZ/N2 Group FSP Getting Started Guide	RZ/T2, RZ/N2 Group Flexible Software Package Getting Started Guide	r01an6434ej****
User's Manual	Renesas Starter Kit+ for RZ/N2L User's Manual	Renesas Starter Kit+ for RZ/N2L User's Manual	r20ut4984eg****
Reference Guide	Modicon Modbus Protocol Reference Guide Rev.J	Modbus Protocol Reference Guide Rev.J	PI-MBUS-300 Rev. J
Specification	Modbus Application Protocol Specification V1.1b3	Modbus Application Protocol Specification V1.1b3	v1.1b3

2. Features

The Modbus protocol stack for RZ/N2L 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 a 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. Requirements (Software and Hardware)

This project was developed and tested in the environment listed below using the following boards and tools.

3.1 Requirements for this sample package

Table 3.1 Requirements

Category	Name	Version	Description
Board	Renesas Starter Kit+ for RZ/N2L	-	Starter Kit for RZ/N2L Evaluation and Development Renesas Starter Kit+ for RZ/N2L
IDE	Flexible Software Package	V4.1.0	Renesas Flexible Software Package (FSP)
	e^2 studio - GNU ARM Embedded Toolchain	2026-04.1 13.3.1.arm-13-24 for CR52	
	IAR Systems - Embedded Workbench for ARM	 9.60.3	
	GNU ARM Embedded Toolchain	13.3.1.arm-13-24 for CR52	
Emulator	J-Link ™	8.60	SEGGER SEGGER - The Embedded Experts - Downloads - J-Link / J-Trace
Software	ModbusDemoApplication.exe	V1.3	

3.2 Hardware

This document describes the major hardware. Refer to Renesas Starter Kit+ for RZ/N2L user's manual and schematic for more board details.

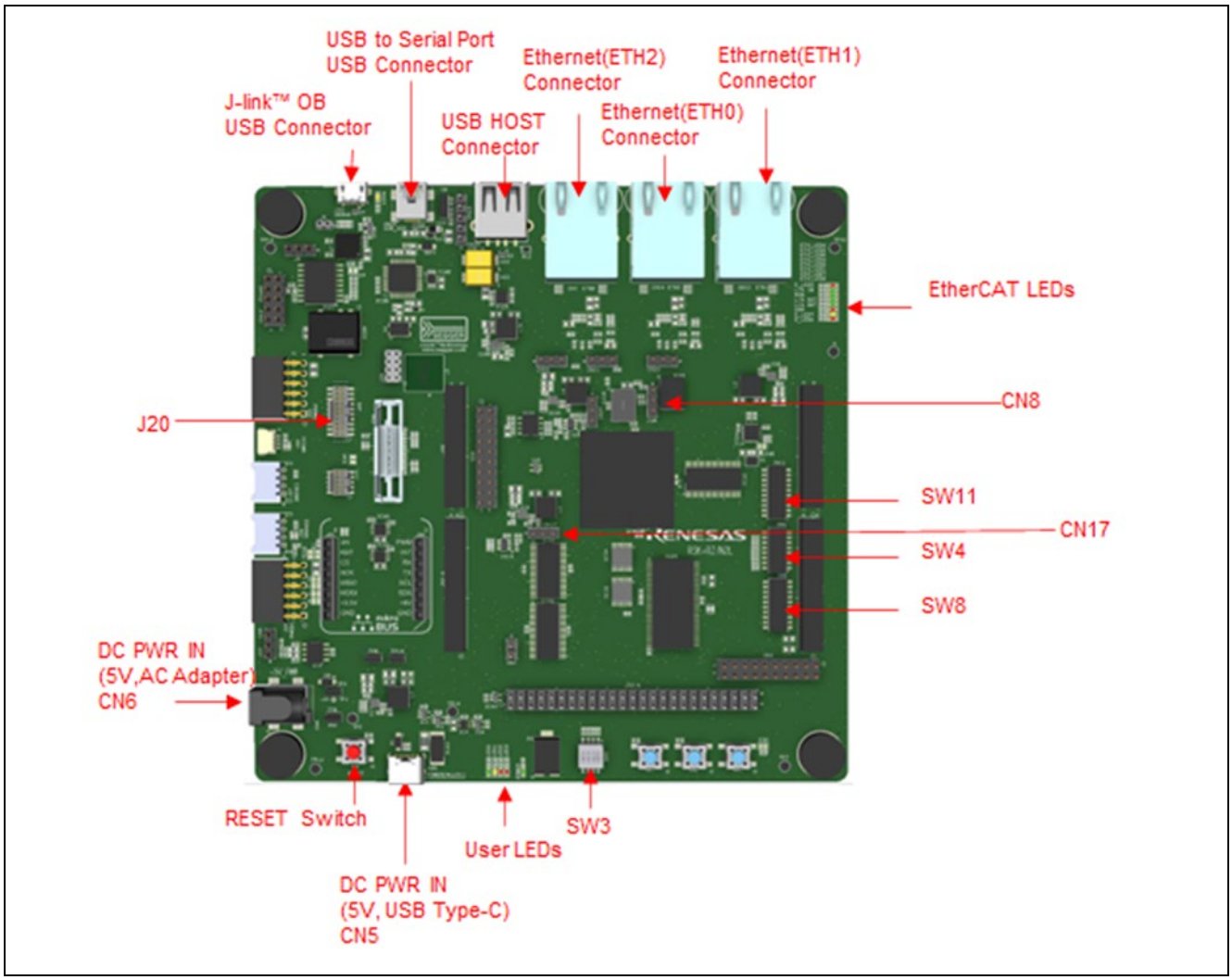


Figure 3.1 RZ/N2L Evaluation board layout.

Table 3.2 Jumper pin settings

Reference	Jumper Position	Description
CN8	Short 1-2	Use Octa Flash
	Short 2-3	**Use QSPI Serial Flash**
CN17	Short 1-2	VCC1833_2 Use power supply at 3.3V
	Short 2-3	**VCC1833_2 Use power supply at 1.8V**
CN20	**Short 1-2**	**Use 3 ports in the same PHY mode**
	Short 2-3	Use ports 0, 1 in the same PHY mode, use port 2 in different PHY modes
CN21	**Short 1-2**	**Use 3 ports in the same PHY mode**
	Short 2-3	Use ports 0, 1 in the same PHY mode, use port 2 in different PHY modes
CN22	**Short 1-2**	**Use 3 ports in the same PHY mode**
	Short 2-3	Use ports 0, 1 in the same PHY mode, use port 2 in different PHY modes
CN24	Short 1-2	VCC1833_2 Use power supply at 3.3V
	Short 2-3	**VCC1833_2 Use power supply at 1.8V**

Table 3.3 SW4 Settings

SW4	Setting	Description
SW4-1	ON	16bit bus boot mode * Refer to" r20ut4984egxxxx-rskplus-rzn2l-v1-um.pdf" and set according to the mode to be used.
SW4-2	OFF	
SW4-3	ON	
SW4-4	ON	MDD=0, JTAG Authentication by Hash is disabled.
SW4-5	OFF	MDW=1, ACTM 1 wait, should be set when TCM is used with CPU operating frequencies above 400MHz
SW4-6	OFF	Valid signals other than trace signals
SW4-7	ON	Signals other than the external bus is valid
SW4-8	OFF	SW3 is valid

Table 3.4 SW8 Setting.

SW8	Setting	Description
SW8-1	OFF	Enable the "LED_GREEN" signal.
SW8-2	ON	
SW8-3	OFF	
SW8-4	ON	Enable the "LED5" signal.
SW8-5	OFF	
SW8-6	OFF	RS485_DE & M2_VN Configuration Switch Setting
SW8-7	ON	
SW8-8	OFF	CAN_TX & IRQ4 & P02_2 Configuration Switch Setting
SW8-9	OFF	
SW8-10	ON	

Table 3.5 SW11 Setting

SW11	Setting	Description
SW11-1	ON	Enable the "LED_RED2" signal.
SW11-2	OFF	
SW11-3	OFF	
SW11-4	OFF	RS485_RX & M2_UP Configuration Switch Setting
SW11-5	ON	
SW11-6	OFF	P21_5 & M2_VP Configuration Switch Setting
SW11-7	ON	
SW11-8	OFF	CAN_RX & ADTRG & P01_7 Configuration Switch Setting
SW11-9	OFF	
SW11-10	ON	

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/N2L 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/N2L RSK board.

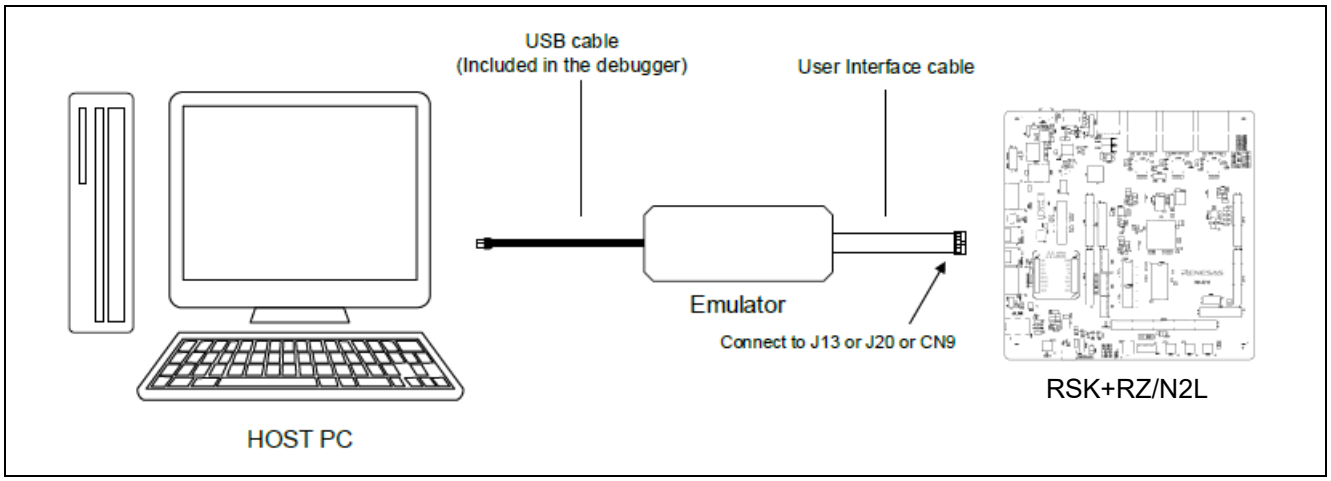


Figure 3.2 RZ/N2L RSK board debug connection diagram

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

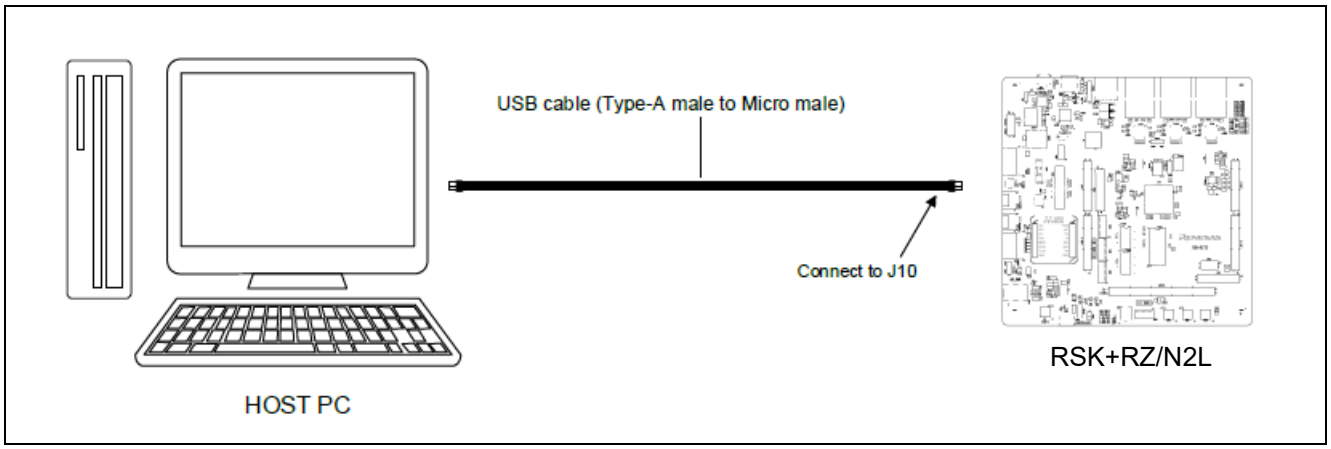


Figure 3.3 RZ/N2L RSK board debug connection diagram (J-Link OB)

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/N2L RSK board. When connecting the AC/DC adapter, connect it to the “CN6” connector of the RZ/N2L RSK board.

3.3.2 Serial board connection

Connect the PC to the RZ/N2L 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 GND.

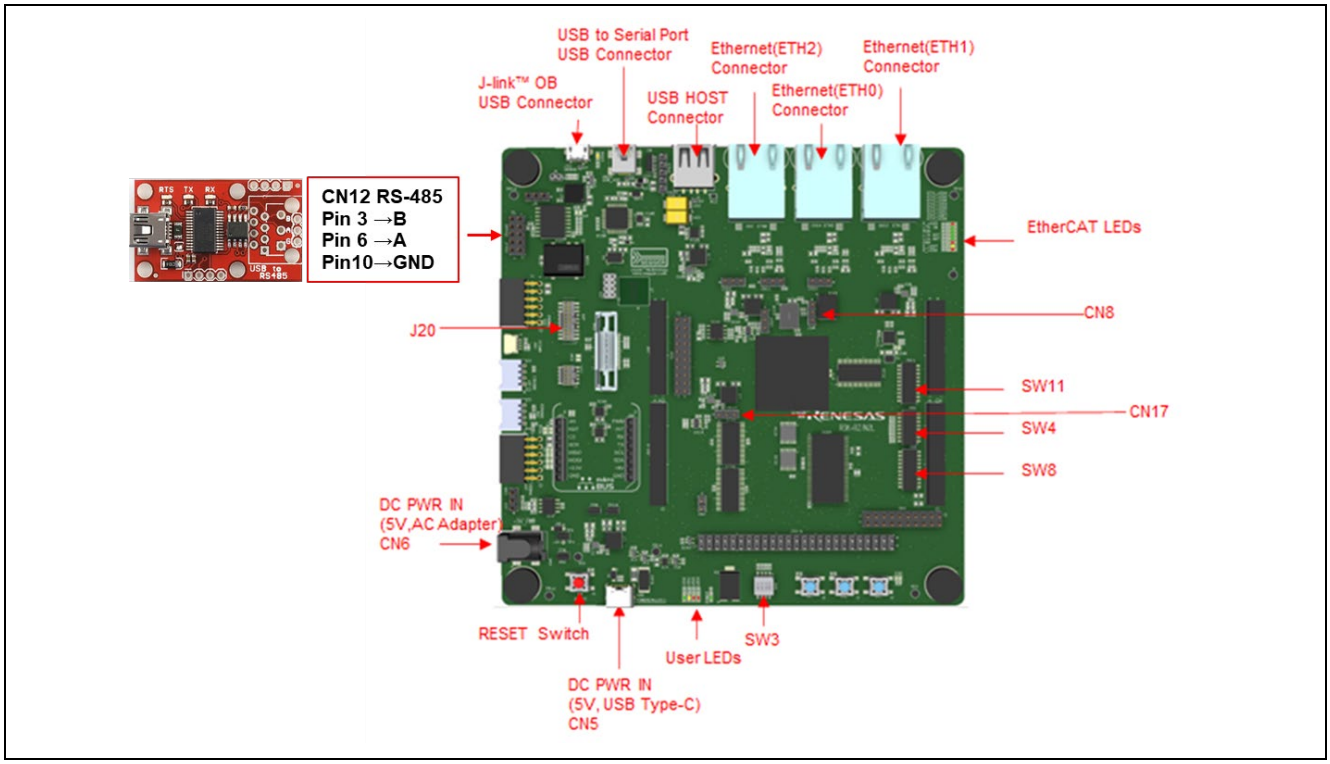
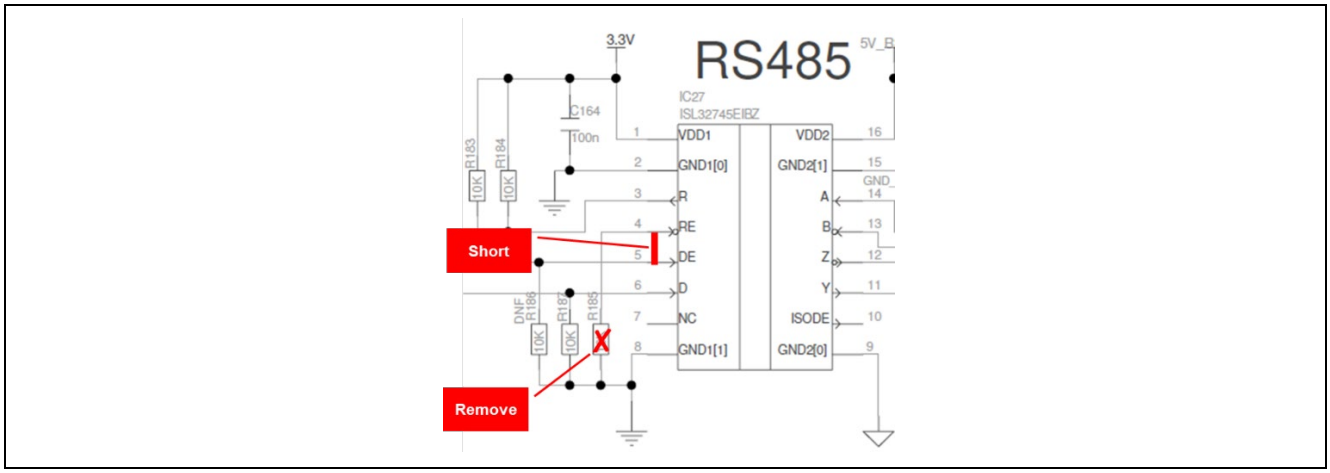


Figure 3.4 RZ/N2L EVALUATION board layout.

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. Setup a demo tool.

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

2. “Connection” is selected to Serial Client (“Serial Master”) or Serial Server (“Serial Slave”), 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”).

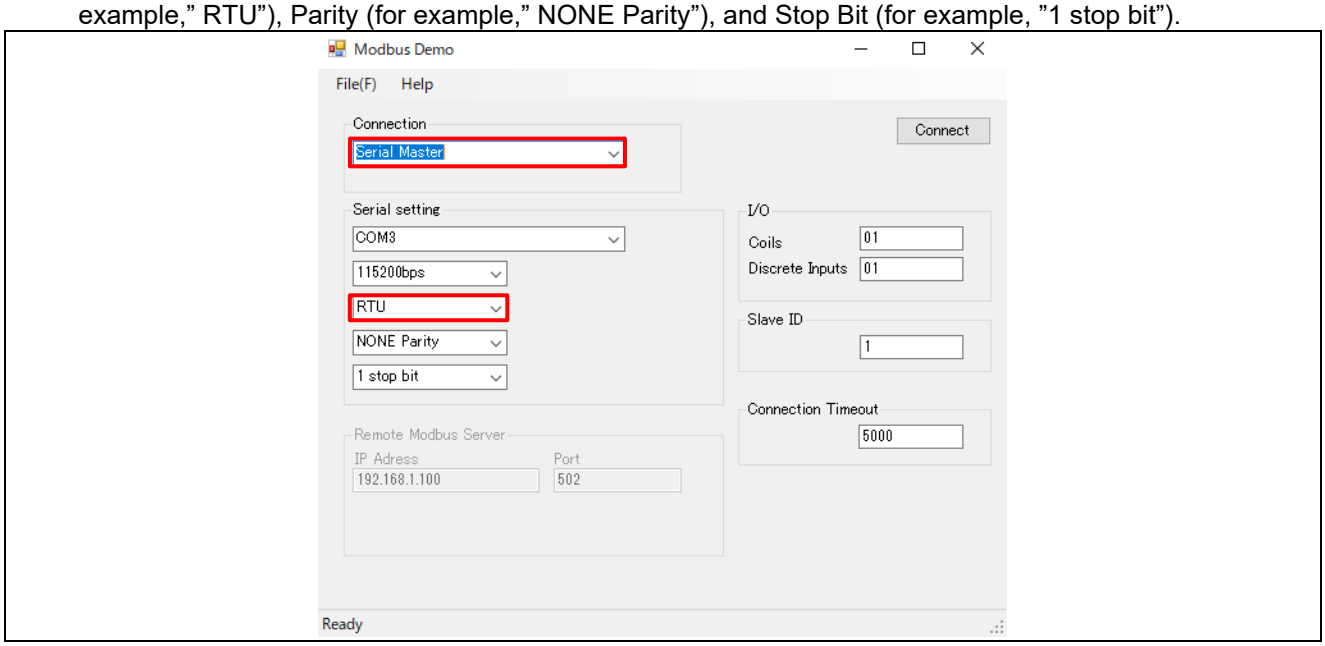


Figure 4.1 ModbusDemoApplication setting for RTU.

3. “Connection” is selected to Serial Client (“Serial Master”) or Serial Server (“Serial Slave”), 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”).

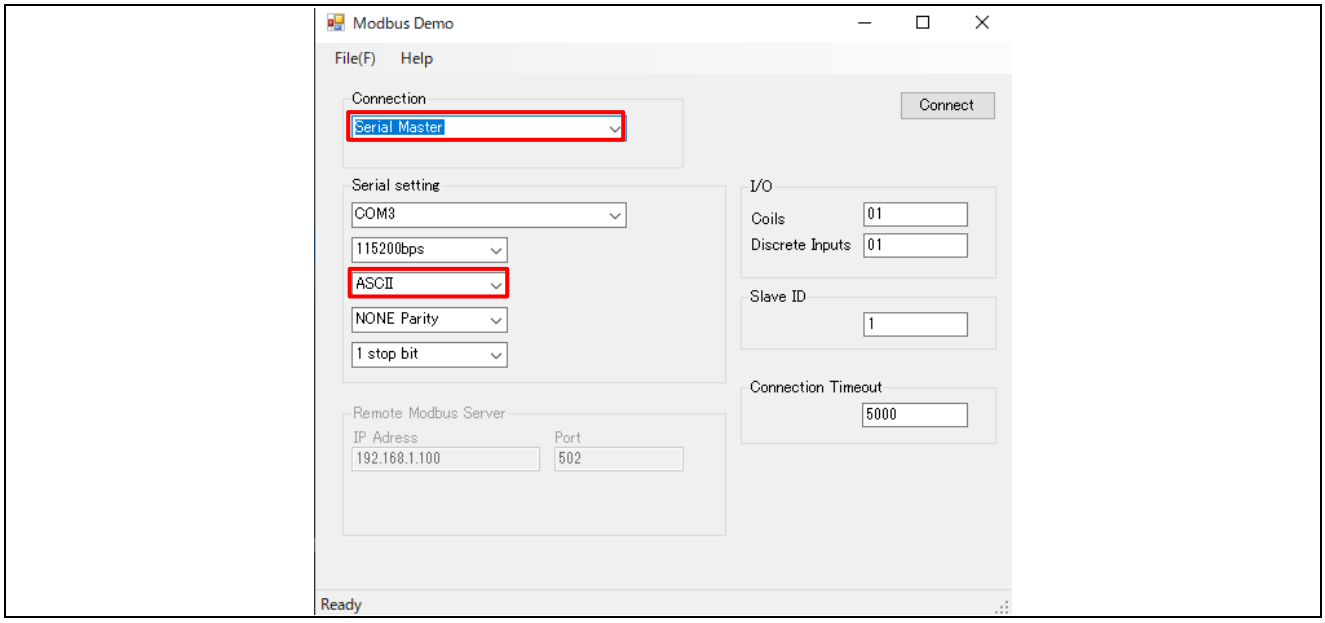


Figure 4.2 ModbusDemoApplication setting for ASCII.

5. Running the sample application

Refer to Section 3.3 Setting the Board for board settings.

The setup differs depending on the IDE.

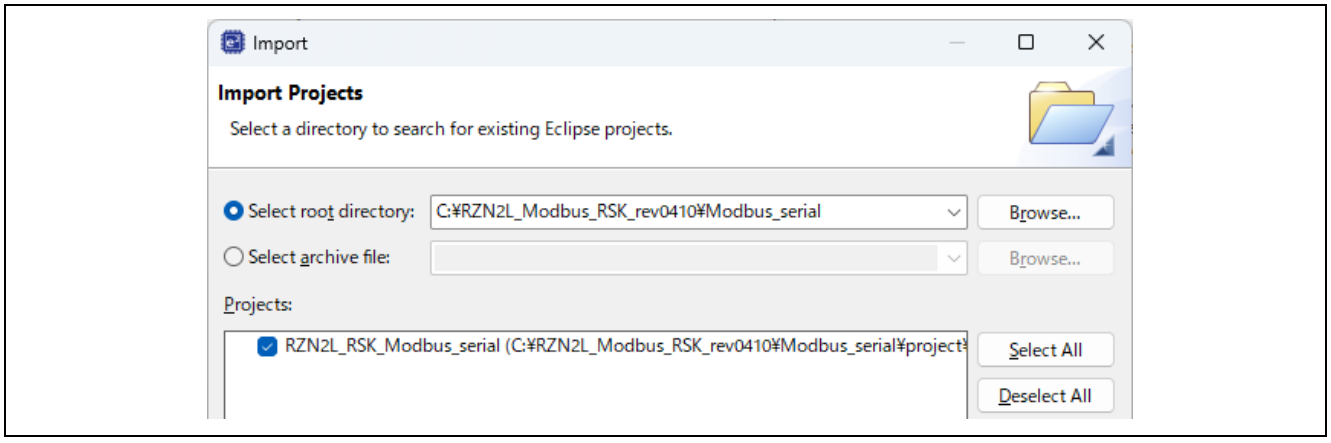
- When using e² studio, refer to section 5.1.
- When using EWARM, refer to section 5.2.

5.1 Setup sample project for e² studio

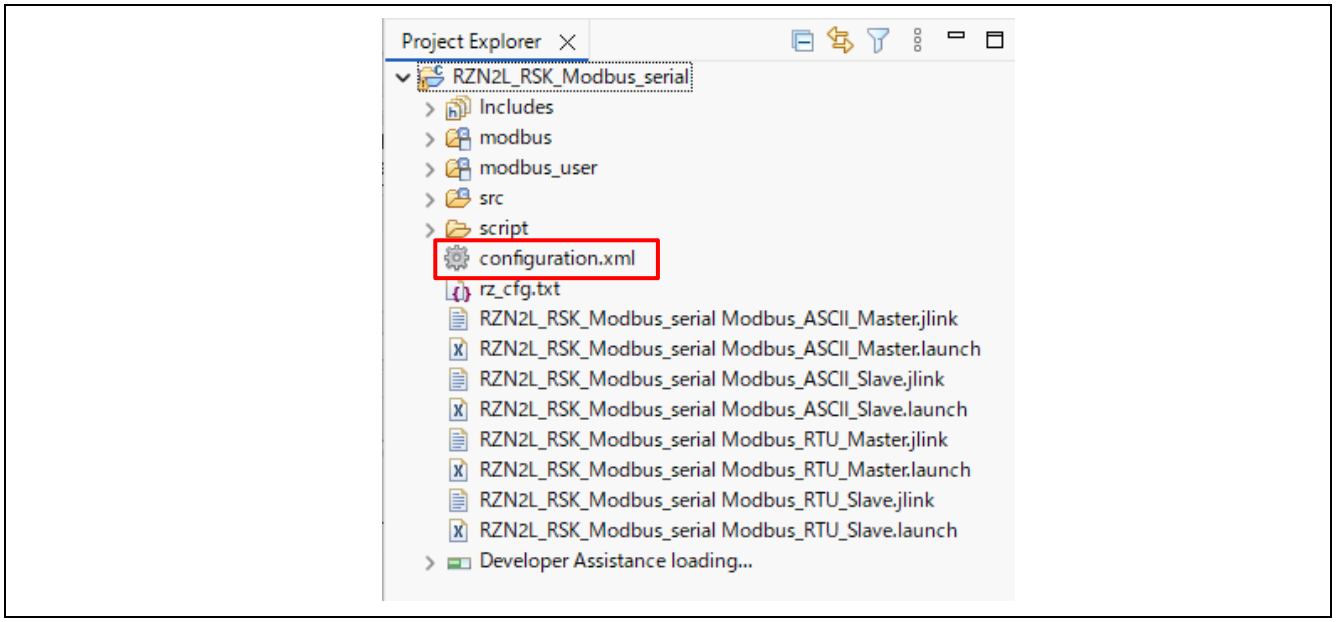
Build the sample code and load it into RAM using Renesas Electronics e² studio.

Note: Please install e² studio and adapt the RZ_FSP_Packs_v4.1.0 or later in advance.
Refer to the latest getting started guide. (r01an6434ejxxxx-rzt2-rzn2-fsp-getting-started.pdf)

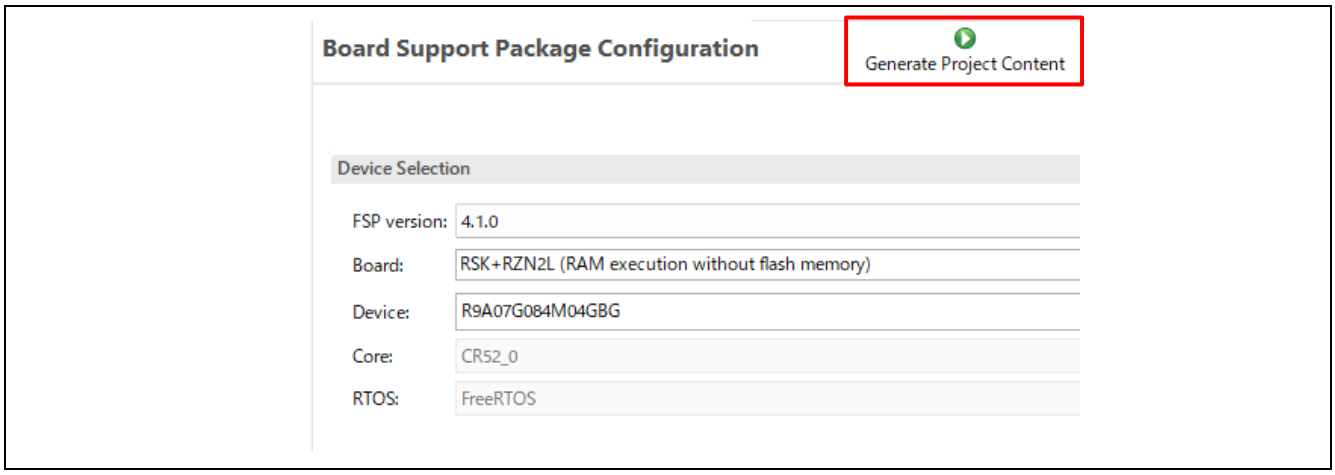
1. Import the sample project. After the program is started, by selecting [File] → [Import] → [Existing Projects into Workspace]. Check the "select root directory" and click “Browse…” button.
→Select “**RZN2L_Modbus_RSK_rev0410\Modbus_serial**” folder → [Finish].



2. Open "configuration.xml" in the "**RZN2L_RSK_Modbus_serial**" project.

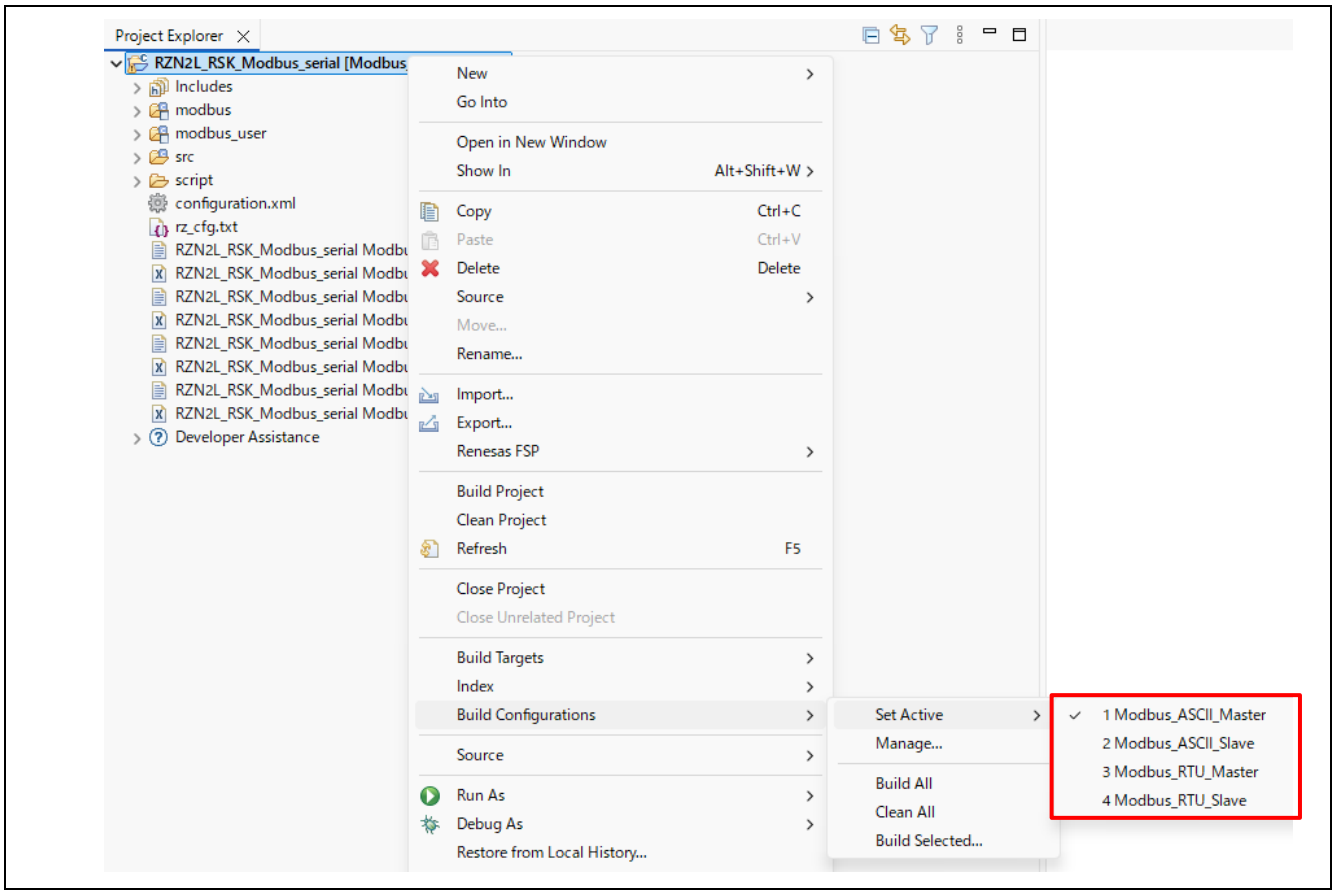


3. Check the boot mode project from BSP tab (following is RAM boot mode). And generate the code with "Generate Project Content".

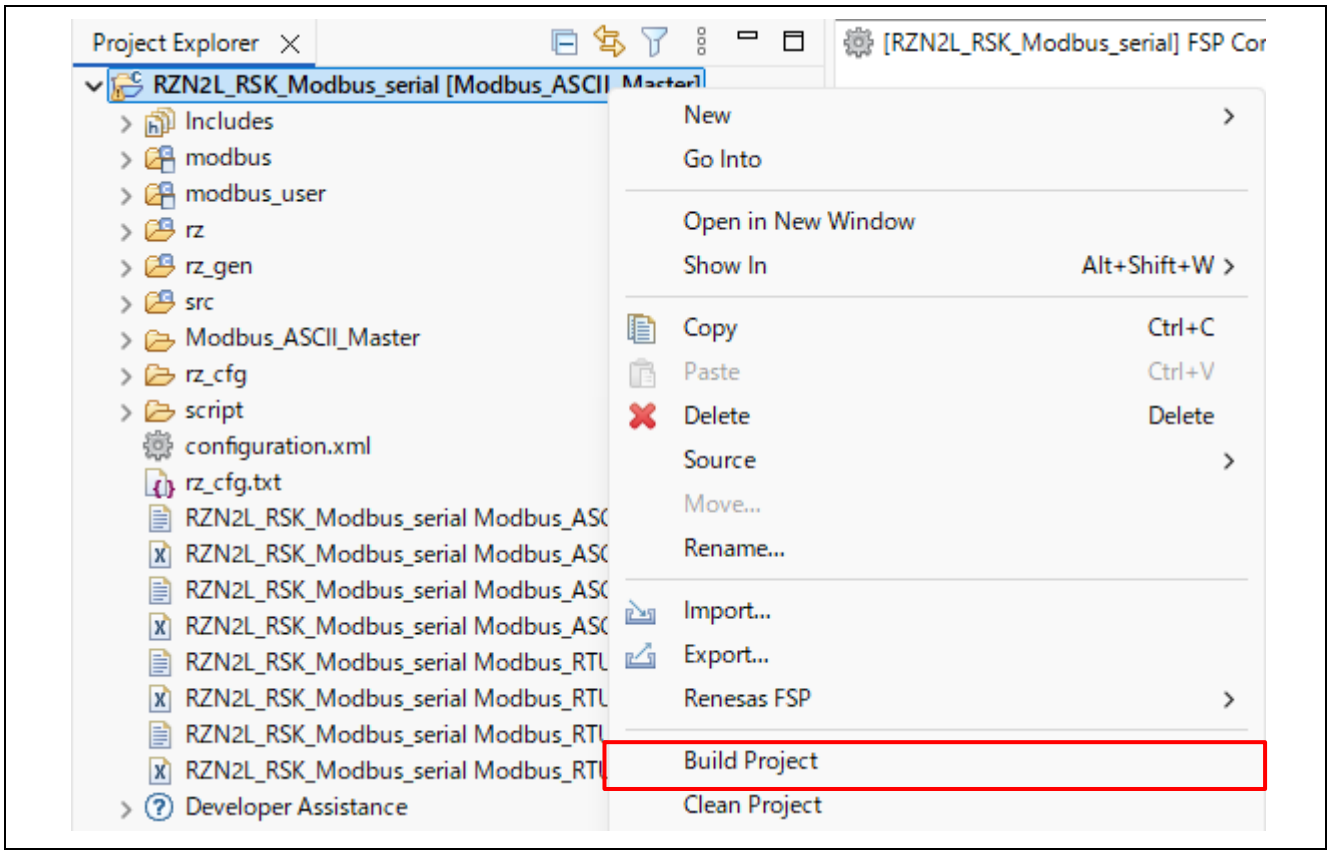


4. Select the following functions from “Build Configurations”.

“Modbus_ASCII_Master”
“Modbus_ASCII_Slave”
“Modbus_RTU_Master”
“Modbus_RTU_Slave”

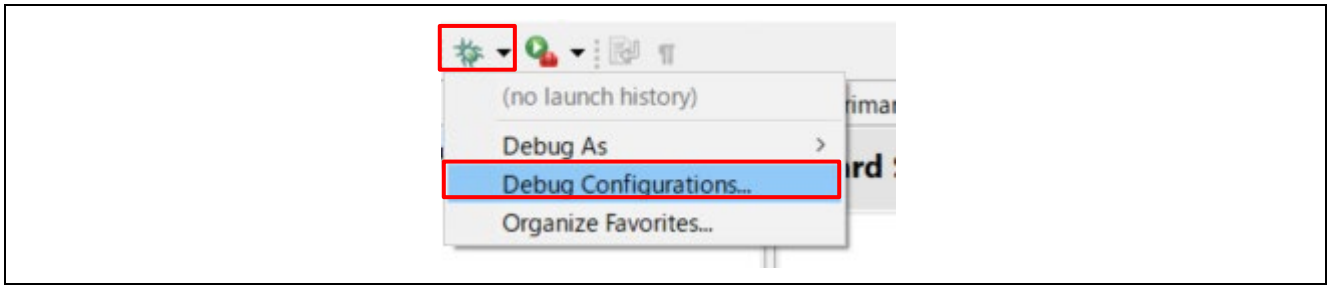


5. Execute the build.



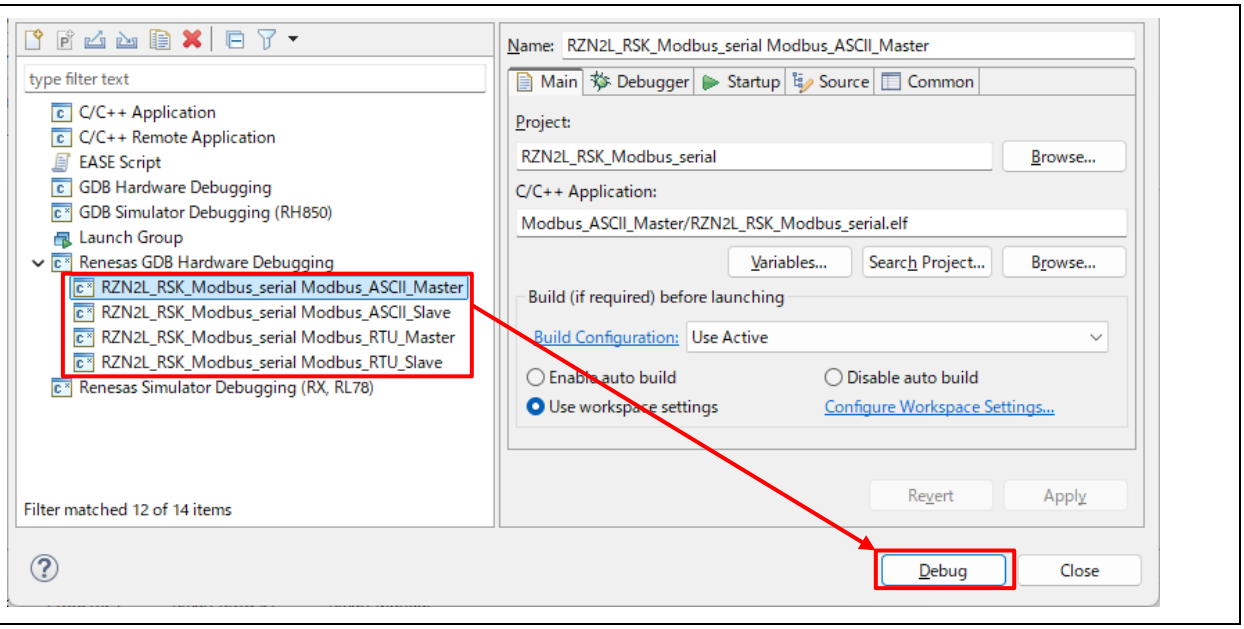
6. Press the “RESET” switch of the RSK + RZ/N2L board.

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

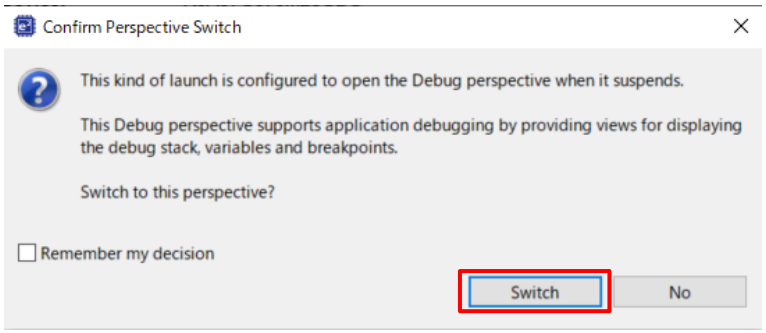


[Renesas GDB Hardware Debugging] → [**RZN2L_RSK_Modbus Modbus_xxx_yyy**] item, then press [Debug].

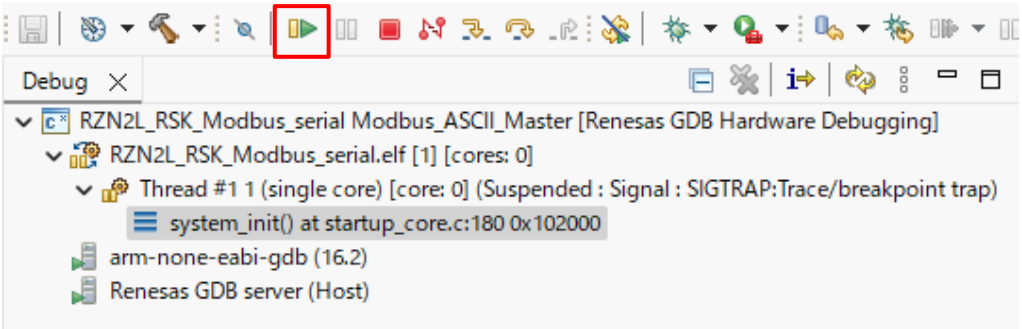
Note), xxx is RTU or ASCII, yyy is Master or Slave



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.



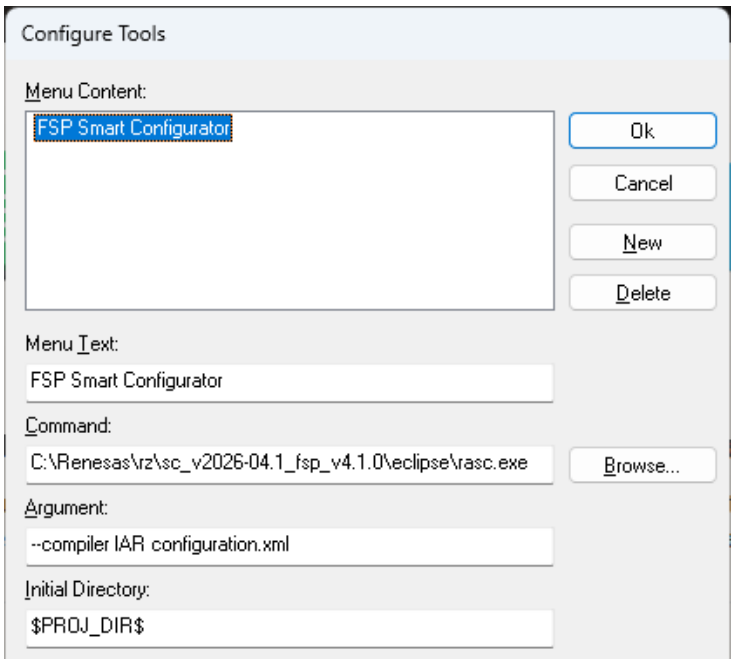
5.2 Setup sample project for EWARM

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

Note: Please install EWARM and adapt the RZ_FSP_Packs_v4.1.0 or later in advance.
Refer to the latest getting started guide. (r01an6434ejxxxx-rzt2-rzn2-fsp-getting-started.pdf)

Note). In EWARM, set the Smart Configurator startup settings as follows.
[Tools] -> [Configure Tools]

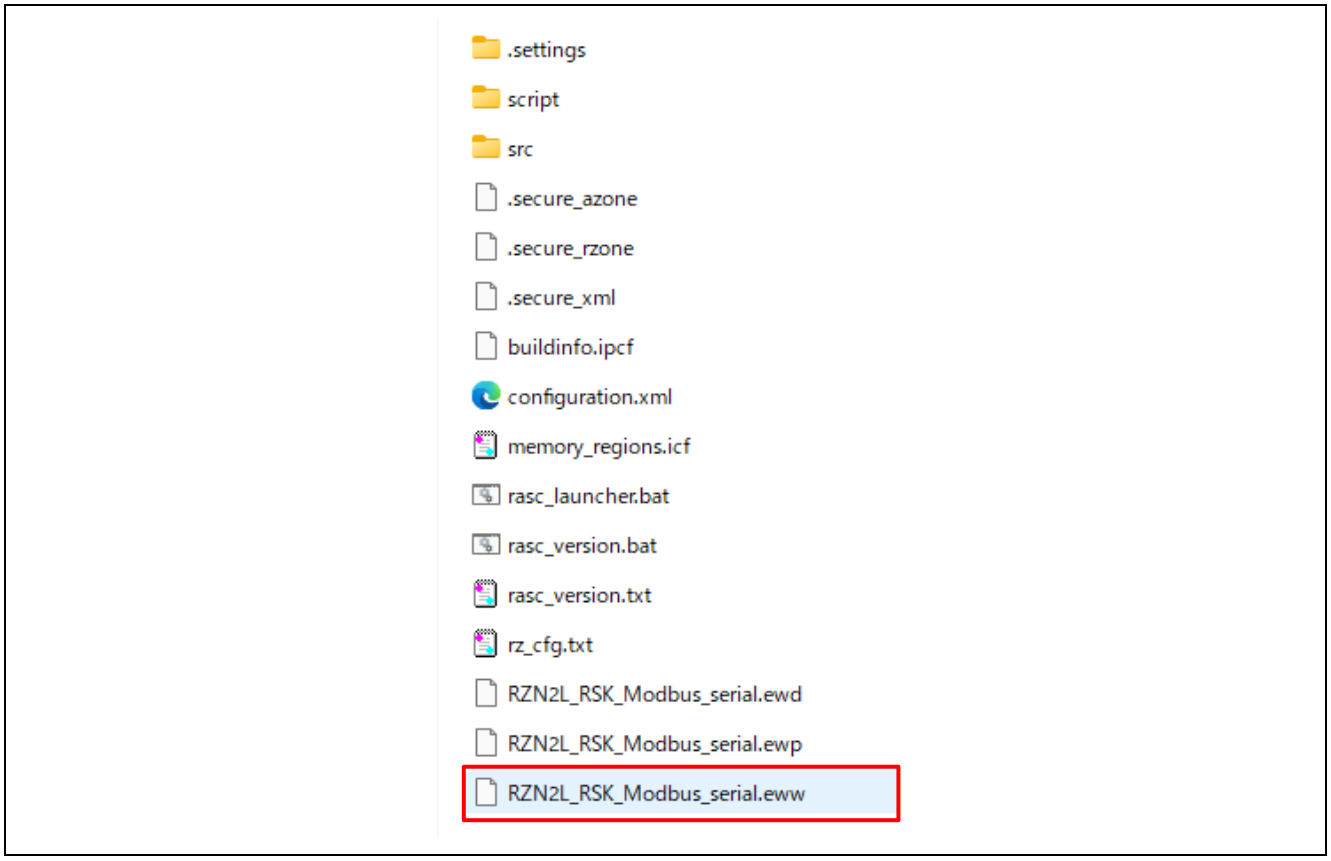
- Menu Text: **FSP Smart Configurator**
- Command: **$RASC_EXE_PATH$** (The following example is "C:\Renesas\rz\sc_v2026-04.1_fsp_v4.1.0\eclipse\rasc.exe")
- Argument: **--compiler IAR configuration.xml**
- Initial Directory: $**PROJ_DIR$**



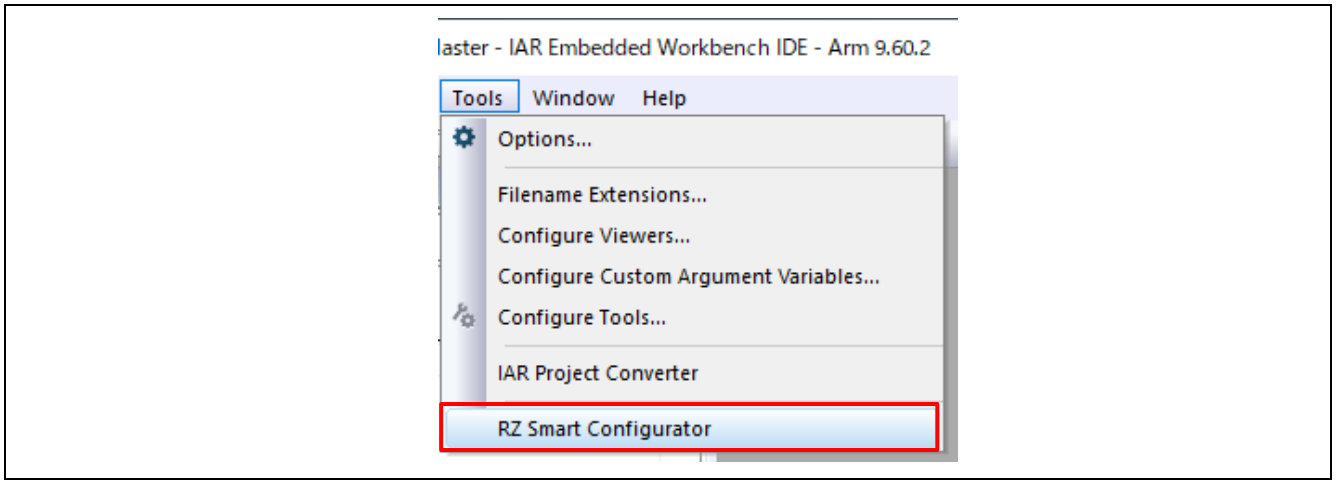
Edit "**buildinfo. Ipcf**" file. Open the buildinfo.ipcf file and edit "**RASC_EXE_PATH**" to match the installation path of "**rasc.exe**".

```
<customArgVars>
    <group name="RA Smart Configurator">
        <argVar>
            <name>RASC_EXE_PATH</name>
            <value>C:¥Renesas¥rz¥sc_v2026-04.1_fsp_v4.1.0¥eclipse¥rasc.exe</value>
        </argVar>
        <argVar>
            <name>RASC_DEVICE_FAMILY</name>
            <value>rz</value>
        </argVar>
```

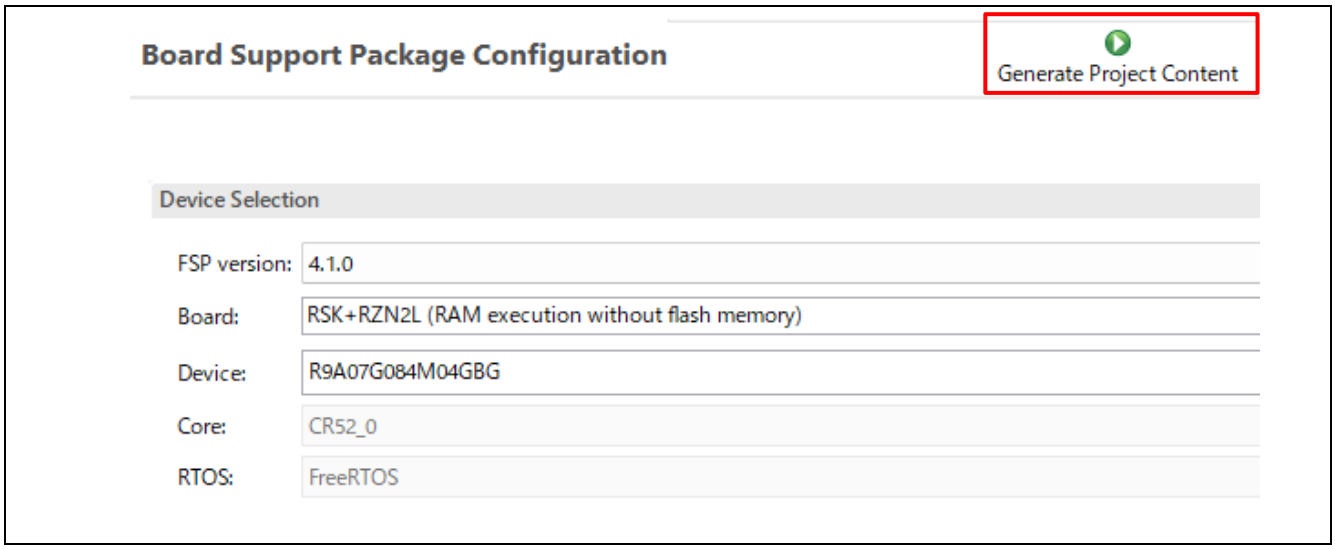
1. Open the sample project.
   “**RZN2L_Modbus_RSK_rev0410\Modbus_serial\project\ewarm\RZN2L_RSK_Modbus_serial\RZN2L_RSK_Modbus_serial.eww**”



2. Open the “RZ Smart Configurator”

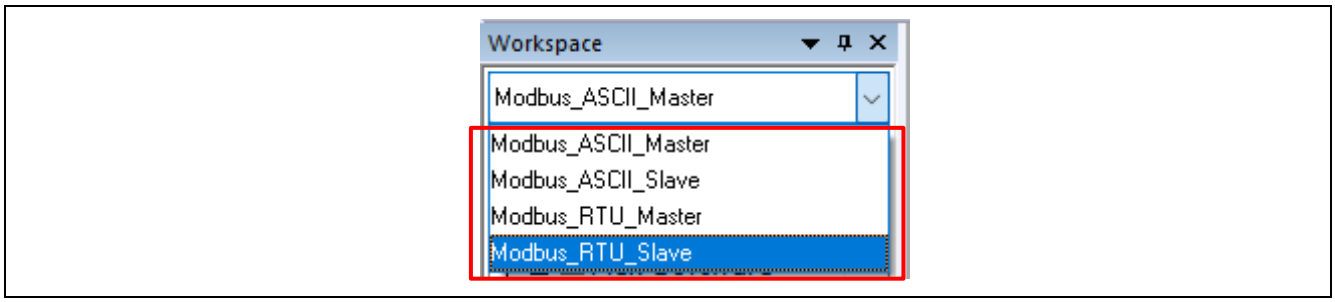


3. Check the boot mode project from BSP tab (following is RAM boot mode). And generate the code with "Generate Project Content".

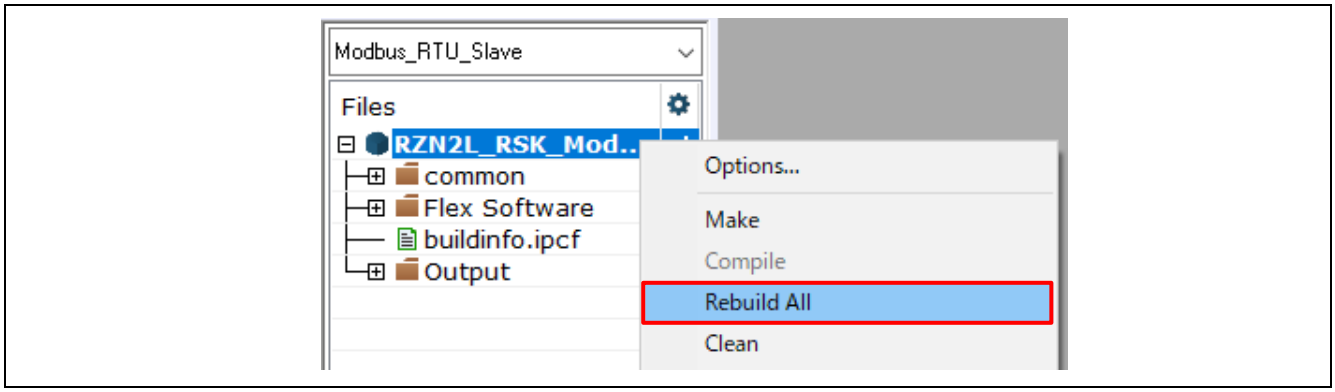


4. Select the following functions from the drop-down menu.

"Modbus_ASCII_Master"
"Modbus_ASCII_Slave"
"Modbus_RTU_Master"
"Modbus_RTU_Slave"

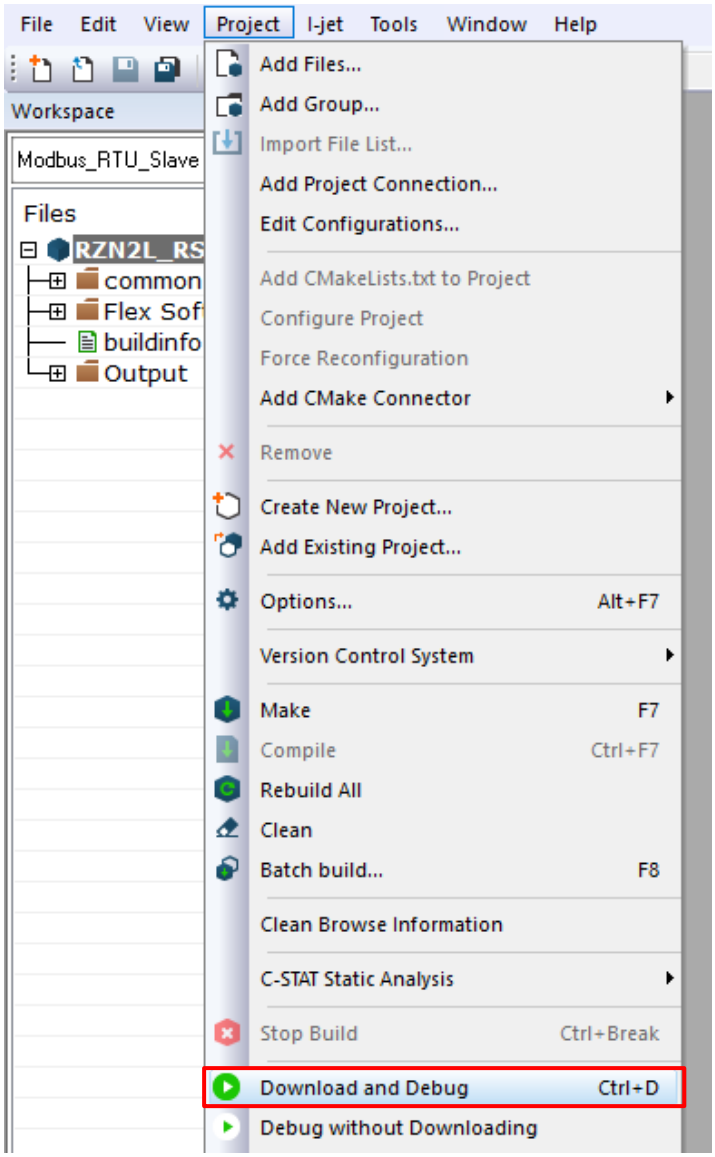


5. Select the "Rebuild All" item from the "Project" menu to rebuild the project.

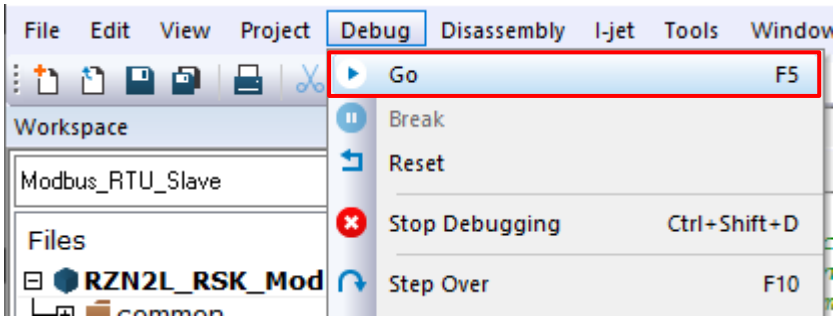


6. Press the "RESET" switch of the RSK + RZ/N2L board.

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



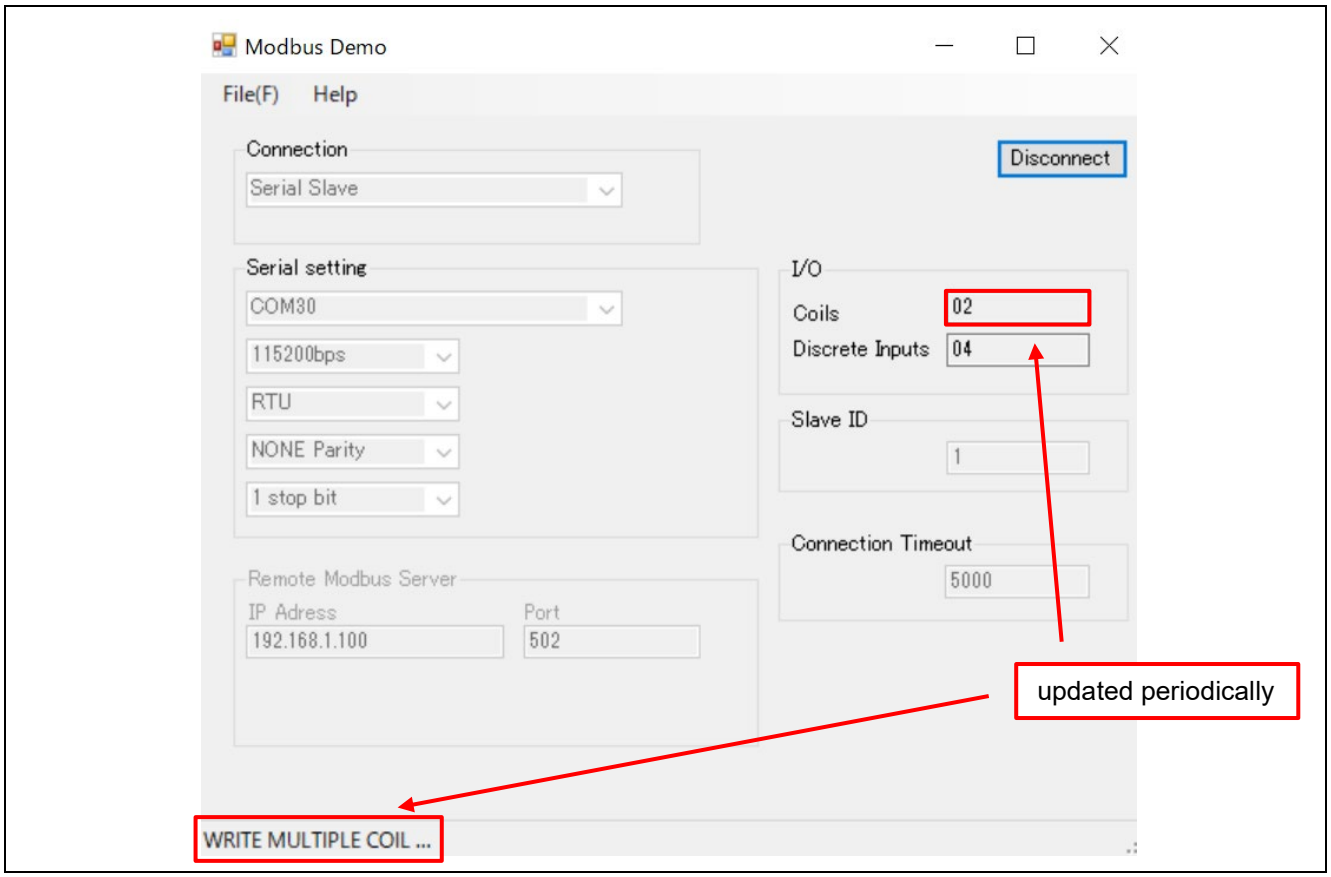
8. First, press the "Resume" button. Program will run.



5.3 Demonstration

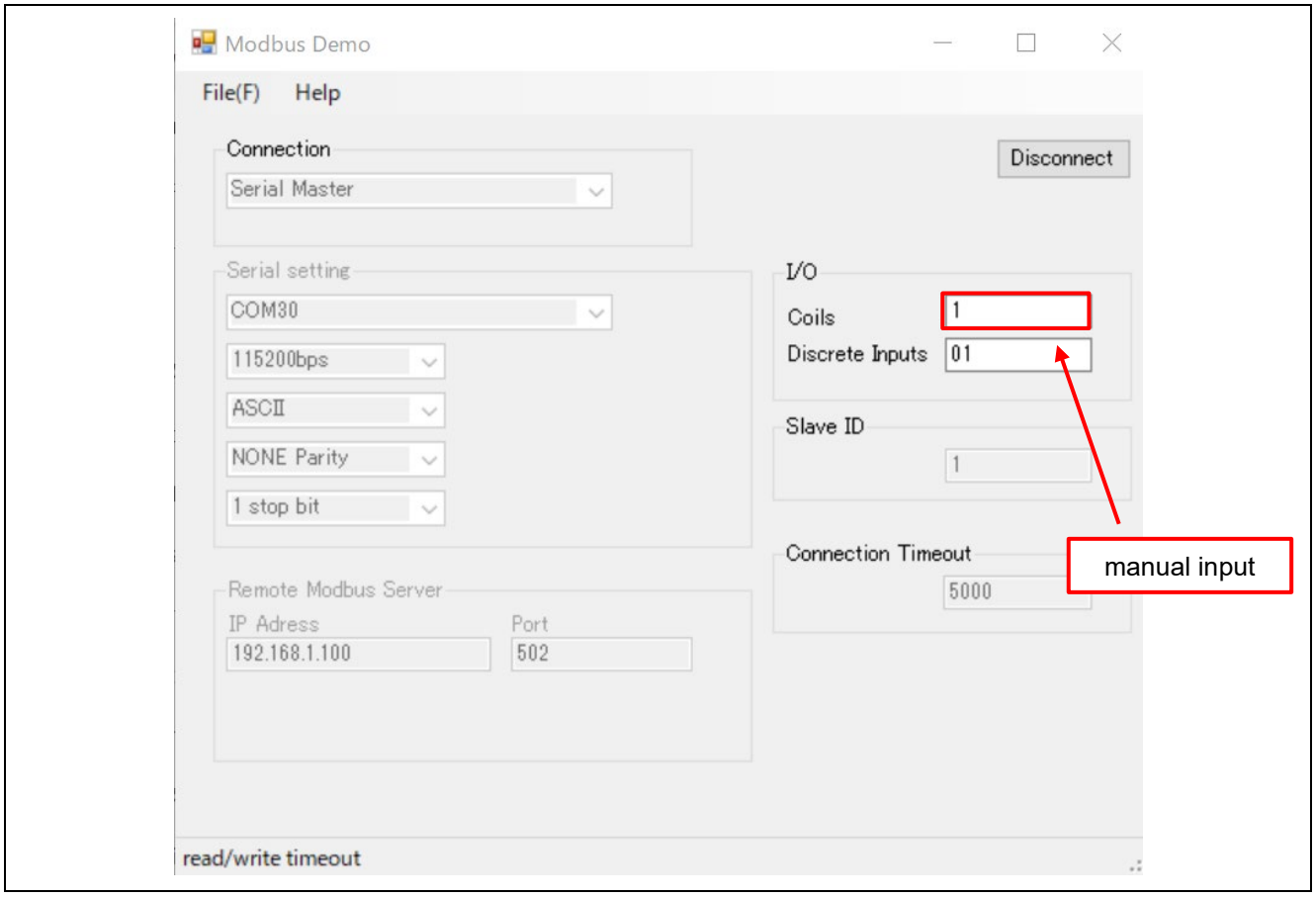
5.3.1 Server Application

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.



5.3.2 Client Application

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 ON/OFF switching is controlled.
For this control, "Read_Discrete_Inputs" and "Write_Single_Coil" function codes are used. Specifically, the following sequence is executed.
LED lights up depending on the manual input of the coil value of the demo application's I/O.



6. Appendix

6.1 Appendix A. Setting the baud rate.

1. Open
   "RZN2L_Modbus_RSK_rev0410\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)
   "**RZN2L_Modbus_RSK_rev0410\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
2.10	Jan 31, 2025	-	Modbus serial updated to FSP2.1.0
2.11	Jun 20, 2025	-	Added FSP2.2 compatibility method
3.00	Nov 7, 2025	-	Supports RZ/N2 FSP3.0.0
4.00	Apr 3, 2026	-	Supports RZ FSP4.0.0
4.10	Jul 31, 2026	-	Supports RZ FSP4.1.0 Modbus serial RTU/ASCII Master added

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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