RX72M Group

Communications Board Modbus Startup Manual

Introduction

This application note is a quick start guide for Modbus communication with the RX72M communication board for industrial network evaluation.

Target Device

RX72M

Contents

1. Overview

This is a document of Modbus protocol stack that runs on RX72M, and gives an outline of functions, application programming interface (API), and application sample when developing and implementing an application that uses the protocol stack.

This package supports Ethernet-based Modbus TCP, RS-485 serial communication-based Modbus RTU, and Modbus ASCII protocols.

1.1 Feature

The Modbus protocol is a communication protocol developed by Modicon Inc. (Schneider Electric SA.) for programmable logic controllers (PLCs), the specifications of which are publicly available.
Refer to the protocol specification (PI-MBUS-300 Rev. J).

The Modbus protocol stack for RX72M allows easy development of the following applications: The stack mode is specified by the initialization API at application execution time.

- Modbus RTU slave
- Modbus RTU master
- Modbus ASCII slave
- Modbus ASCII master
- Modbus TCP server
- Modbus TCP gateway

The Modbus protocol stack for RX72M supports the following nine function codes:
- 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
- 15 (0x0F)-Write multiple coils
- 16 (0x10) – Write multiple registers
- 23 (0x17) – Read / Write multiple registers

For more information about Modbus, please refer to the following site.
http://www.modbus.org
「Modicon Modbus Protocol Reference Guide Rev.J」 (PI_MBUS_300.pdf)
「Modbus Application Protocol Specification V1.1b3」(Modbus_Application_Protocol_V1_1b3.pdf)

Note) The version number may be different due to the update. Please refer to the latest manual.

1.2 Operating Environment

The sample program covered in this manual run in the environment below.

Table 1.1 Operating Environment

Item	Description
Board	RX72M communications board TS-TCS07298 from Tessera Technology
CPU	RX CPU (RXv3)
Operating frequency	CPU clock (CPUCLK): 240 MHz
Operating voltage	3.3 V
Operating modes	• Single chip mode • Boot mode (SCI interface) • Boot mode (USB interface) • Boot mode (FINE interface)
Device requirements	R5F572MNDDBD • Code flash memory Capacity: 2/4 Mbytes ROM cache: 8 Kbytes • Data flash memory Capacity: 32 Kbytes • RAM/extended RAM Capacity: 512 Kbytes/512 Kbytes
Communications protocol	Modbus
Integrated development environment	e2Studio 2024-10 or later
Tool chain	C/C ++ compiler package V3.06.00 or later for RX family
Emulator (ICE)	Renesas E2 Lite
Evaluation tool	ModbusDemoApplication.exe: Modbus evaluation test program

1.3 Reference document

Technical information on Modbus is available from the Modbus Organization site, and information on the RX72M communication board is available from the Renesas Electronics site.

- Modbus Organization's site : http://www.modbus.org
- Renesas Electronics website : http://www.renesas.com

Table 1.2 Modbus related documents

Item	Description
1	Modbus_Application_Protocol_V1_1b3.pdf
2	PI_MBUS_300.pdf
3	Modbus_over_serial_line_V1_02.pdf
4	Modbus_Messaging_Implementation_Guide_V1_0b.pdf

Table 1.3 RX72M Communication board related documents

Item	Description
1	RX72M Group User's Manual: Hardware (R01UH0804EJ)
2	RX72M Communication Board Schematic (rx72m-com)

Table 1.4 Emulator related documents

Item	Description
1	E1 / E20 Emulator, E2 Emulator Lite User's Manual Supplement (RX User System Design) (R20UT0399EJ)
2	RX Family E1 / E20 Emulator User's Manual (R20UT0398EJ)

2. Hardware

For detailed information on the board, refer to the *RX72M Group Communications Board Hardware Manual*.

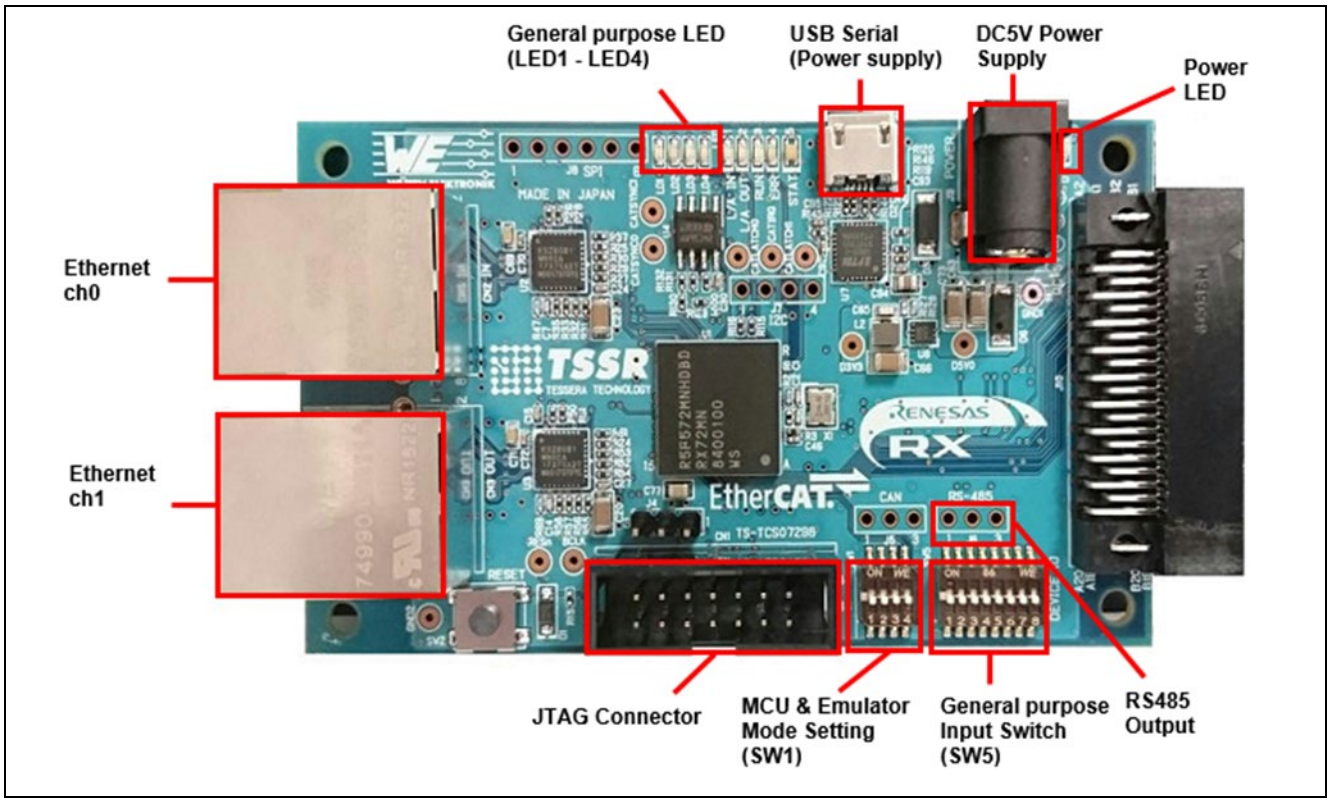


Figure 2.1 Configuration of the RX72M Communications Board

2.1 Setting up the Board

Before supplying power to the board, set up jumpers and connect the cables. In addition, make settings for the JTAG configuration mode. This mode is normally used with a short circuit between jumper pins 2 and 3. However, if the hot plug-in function is to be used, change the combination to jumper pins 1 and 2.
For the detailed locations of the related parts, refer to the *RX72M Communications Board Hardware Manual*.

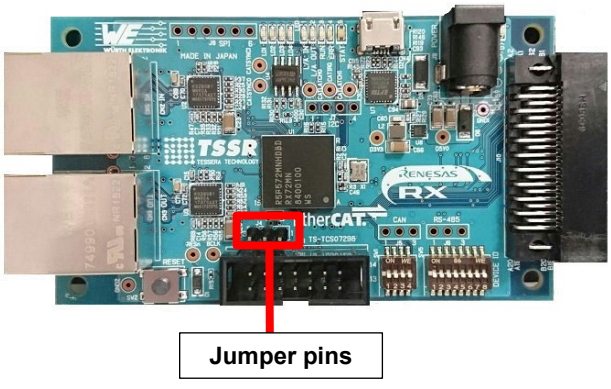


Figure 2.2 Setting up Jumper Pins

2.2 Selecting the Power Source

Power to the RX72M can be supplied from a 5-V DC power source or through the USB port. Use whichever is suitable for the configuration of your operating environment.

2.3 Debug environment

Source code debugging is performed by connecting a CPU board to a PC via the E2 Emulator Lite. The connection between the CPU board, the E2 emulator Lite and the host PC is shown in Figure 2.3.

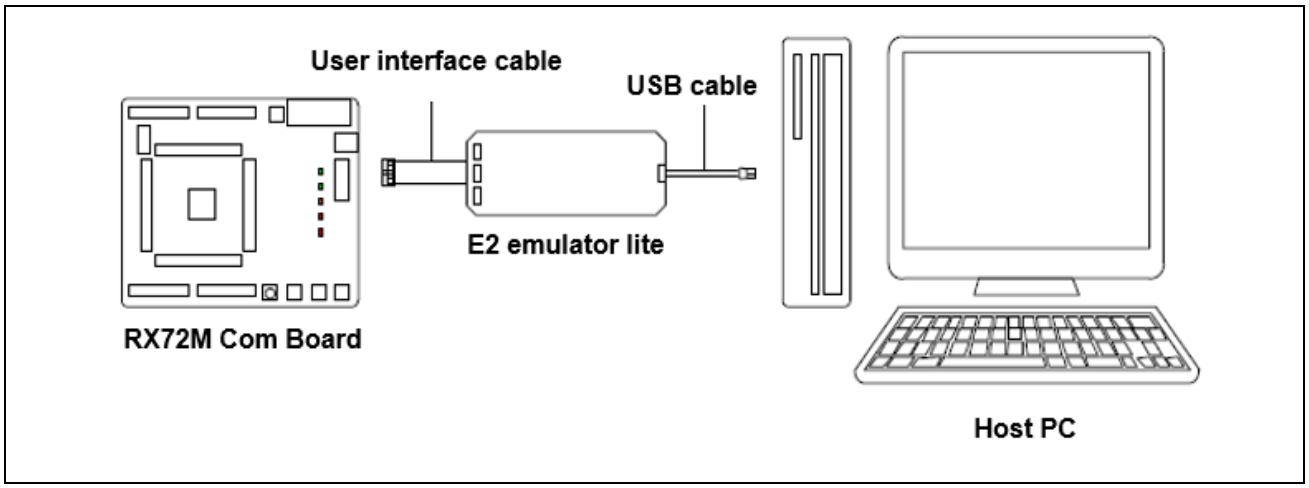


Figure 2.3 Connection between CPU board, E2 emulator Lite and host PC

The document about the CPU board is shown below.

- Reference document
  - RX72M Communication Board Schematic (rx72m-com)
- CPU board schematic
  - RX72M Group User's Manual: Hardware (R01UH0804EJ)
    Hardware specifications (pin layout, memory map, specifications of peripheral functions, electrical characteristics, timing) and operation description

The document about the Renesas development tool (E2 Emulator Lite) is shown below.

- Reference document
  - E1 / E20 Emulator, E2 Emulator Lite User's Manual Supplement (RX User System Design) (R20UT0399EJ)
  - RX Family E1 / E20 Emulator User's Manual (R20UT0398EJ)

3. Installing the e² studio

Download RX72M compatible e2studio (2024-10 or later) from the following website.

https://www.renesas.com/e2studio_download

3.1 Installing the CC-RX Compiler V3.06.00

The compiler selection screen appears while installing e2studio. By selecting [Renesas CCRX v3.0 6.00] and selecting [Next], CC-RX V3.0 6.00 compiler compatible with RX72M will be installed together.

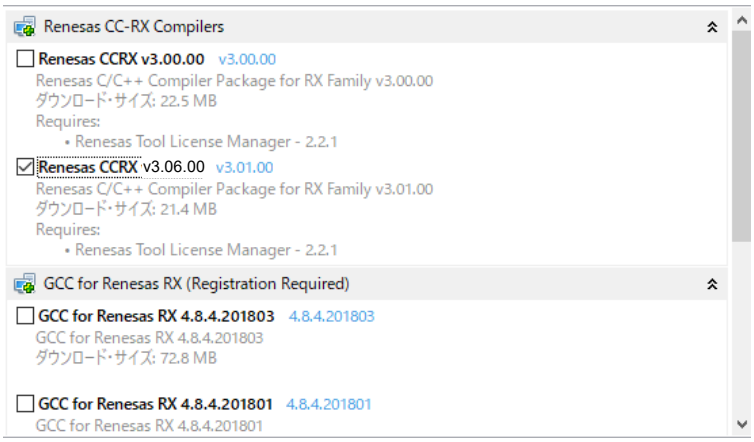


Figure 3.1 e2studio-Compiler selection

To start e2studio, please run "e2studio.exe" located in the installed folder below.

e2_studio_rx72m\eclipse

3.2 Registering the Tool Chain

Register the CC-RX compiler v3.06.00 so that it can be used with the e² studio for RX72M.

(1) Start the e² studio for RX72M.

(2) Select [File] → [New] → [C/C++Project].

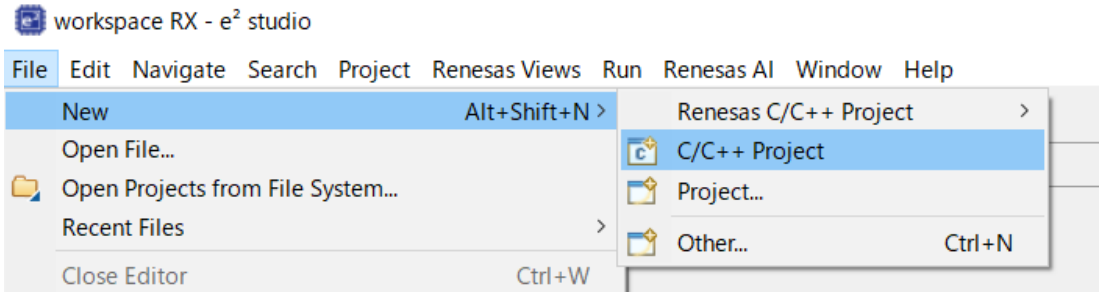


Figure 3.2 e2studio-Project selection

(3) In the [Templates for New C/C++ Project] dialog box, select [Renesas RX] → [Renesas CC-RX C/C++ Executable Project] → [Next].

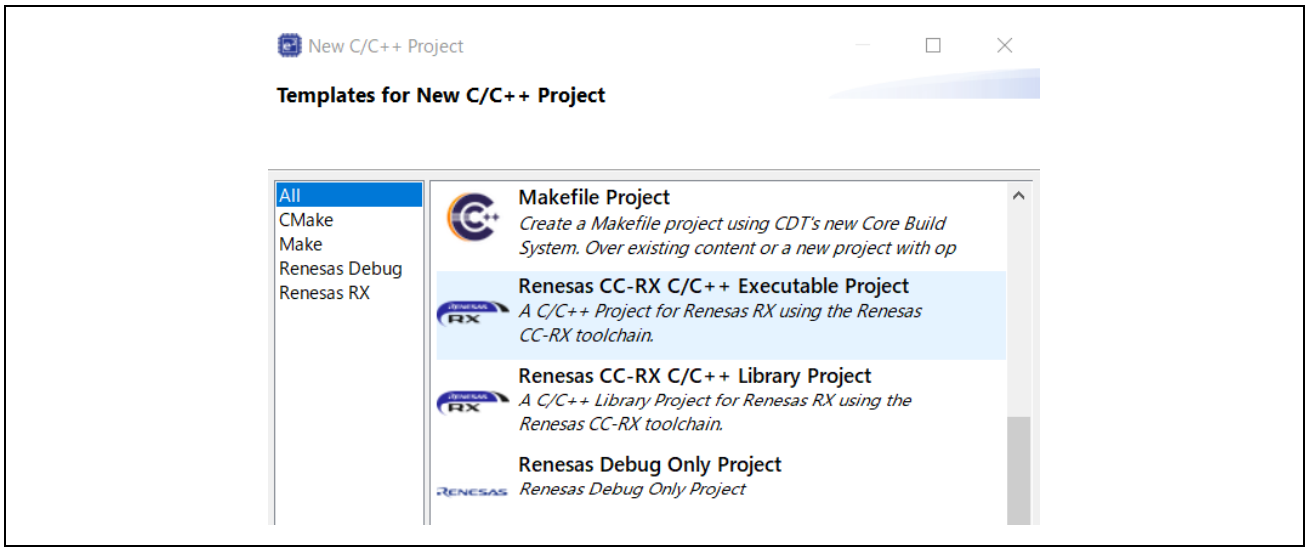


Figure 3.3 e2studio-Project selection

(4) In the [New Renesas CC-RX C/C++ Executable Project] dialog box, enter a desired project name and select [Next].

(5) In the [Select toolchain, device & debug settings] dialog box, select [Toolchain Management] under [Toolchain Settings].

(6) In the [Renesas Toolchain Management] dialog box, select [Add] → [Browse...] to refer to the installation folder "C:¥Renesas¥RX¥3_0_6".
The registration was successful if "v3.06.00 has been added under "Renesas CCRX".

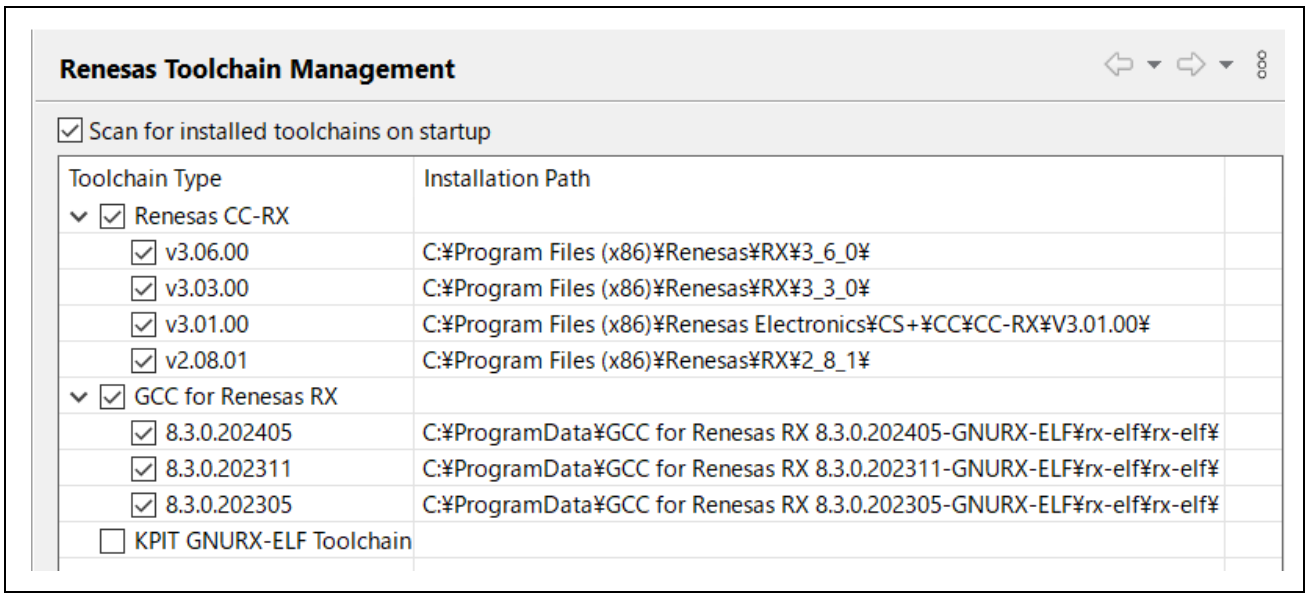


Figure 3.4 e2studio-Project selection

4. Sample application

4.1 Overview

This sample application program can be divided three blocks broadly.

1. Real time OS and TCP/IP stack.
2. Modbus protocol stack sample program, which uses FRTOS+TCP.
3. Modbus application sample program, which uses Modbus protocol stack sample program.

4.1.1 Modbus protocol stack (Sample program)

This sample application includes a sample program of Modbus protocol stack, which provides TCP or serial communication based on Modbus protocol. This sample program uses RTOS and TCP/IP stack (for Modbus TCP protocol).

4.1.2 Modbus application (Sample program)

This sample application includes Modbus application sample program, which use FRTOS+TCP and Modbus protocols stack sample program.
Please refer to this chapter and chapter 5. Test communication by sample application in detail.

4.2 Block diagram

A block diagram of this sample application is shown in Figure 4.1.

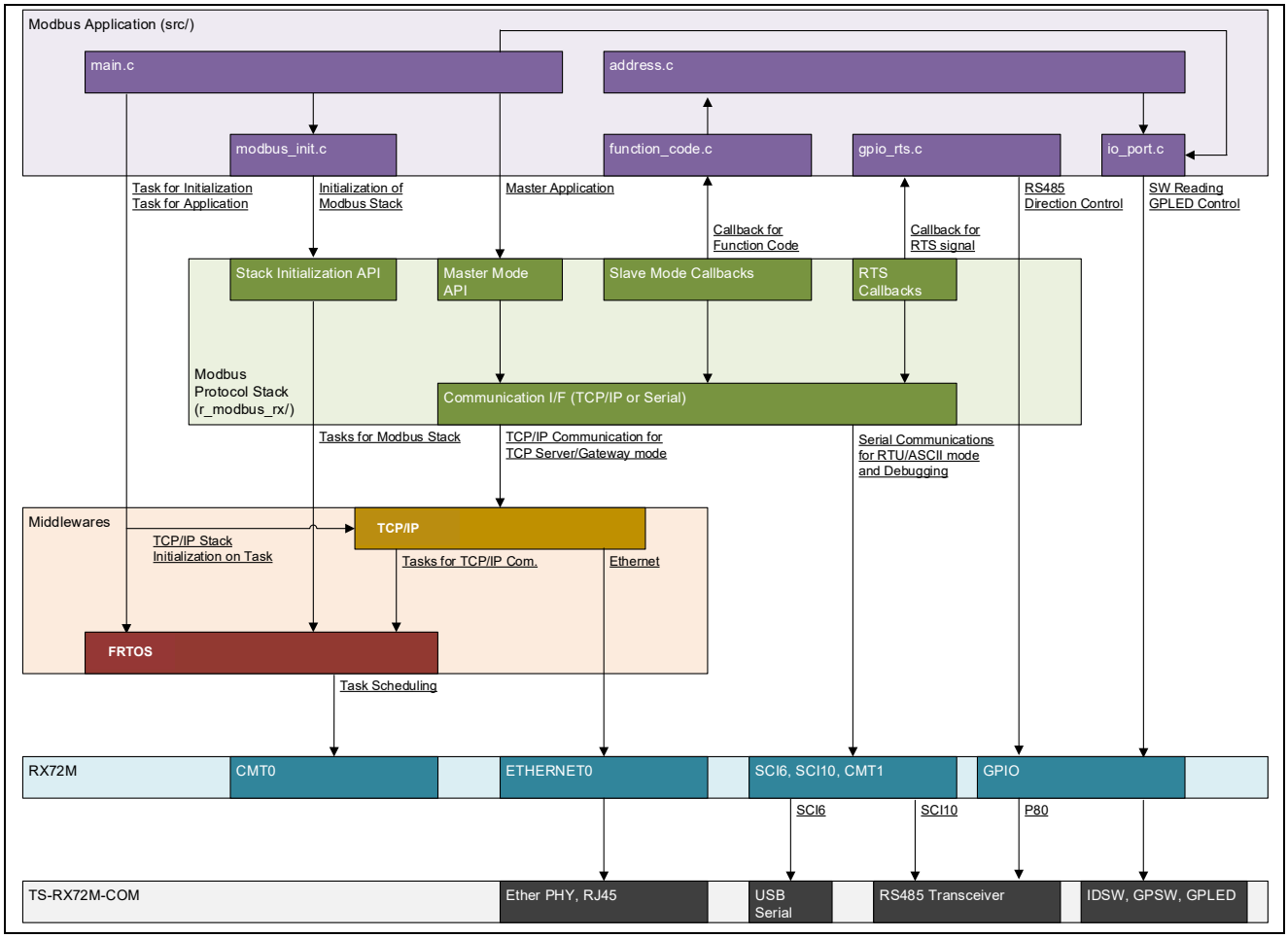


Figure 4.1 Feature block diagram of sample application

5. Test communication by sample application

5.1 Hardware connection

The Modbus protocol stack has different hardware connection methods depending on the stack mode.

5.1.1 Modbus TCP Server Stack Mode

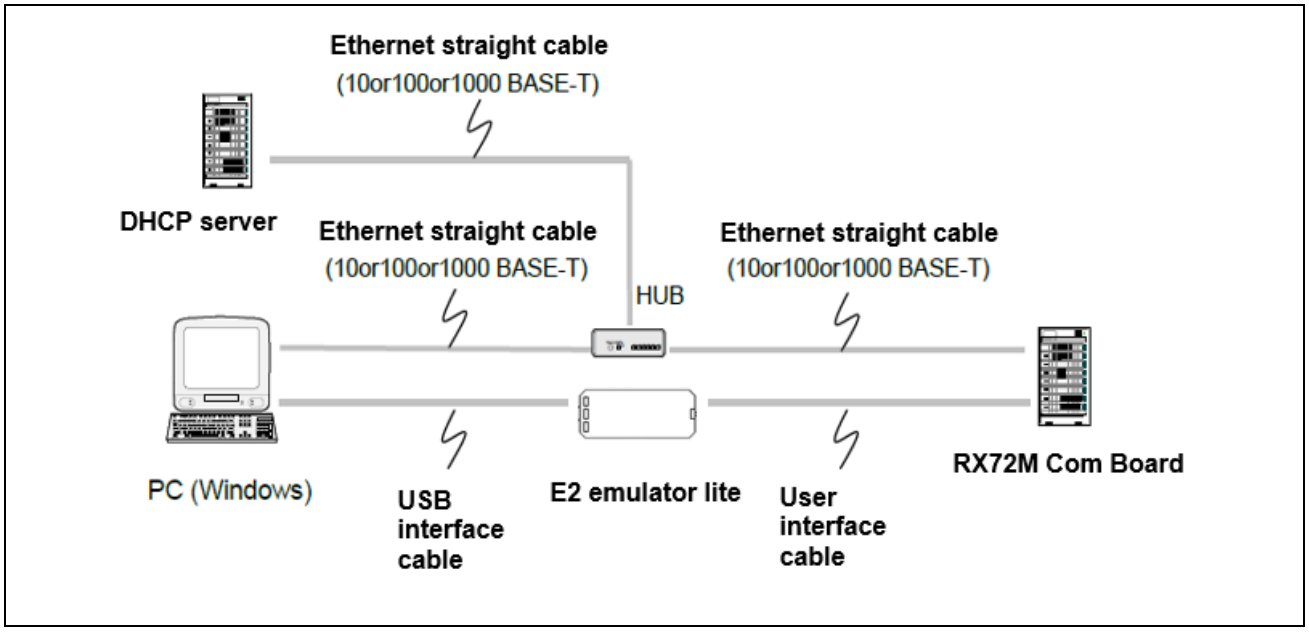


Figure 5.1 Hardware connection example in Modbus TCP server stack mode

In this sample program, the IP address is automatically acquired from the DHCP server. When the sample program starts, the log message shown in Figure 5.2 is output to the terminal software.

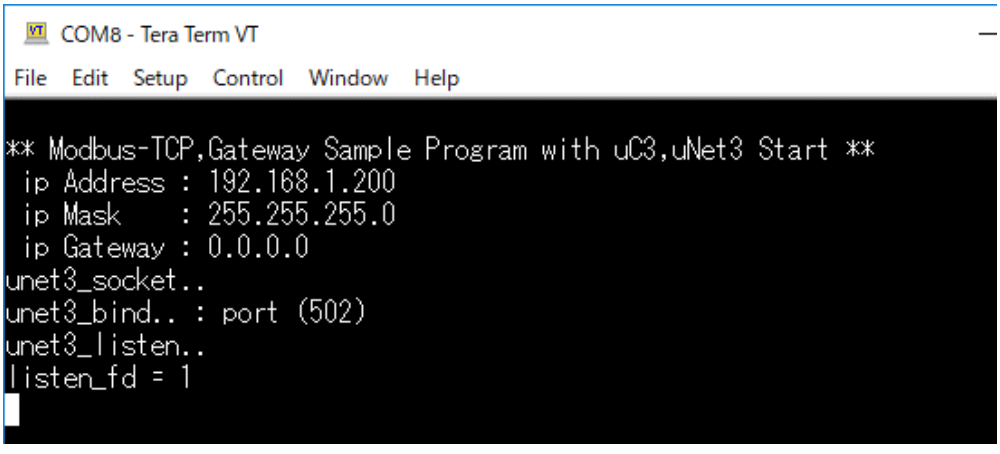


Figure 5.2 Modbus TCP sample program startup log output message

5.1.2 Modbus RTU/ASCII stack mode

Use RS-485 communication to connect the RX72M communication board to the PC.
The RS-485 transceiver module on the RX72M communication board is connected to the serial I / F channel 10 of the MCU, and the J6 pin is connected to RS-485.

Table 5.1 RS-485 I/F connection pin for Modbus RTU/ASCII (channel 6)

MCU port Channel 10	RS-485 transceiver connection pin (MCU side)	RS-485 transceiver connection pin (J6 side)
P86(RXD10)	R	A(1)
PC7(TXD10)	D	B(2)
P80(RTS10)	DE	GND(3)
Board_3V3	VCC	-
GND	GND	-
P86(RXD10)	R	A(1)

Figure 5.4 is an example of connection when setting up Modbus RTU / ASCII communication with RX72M communication board.

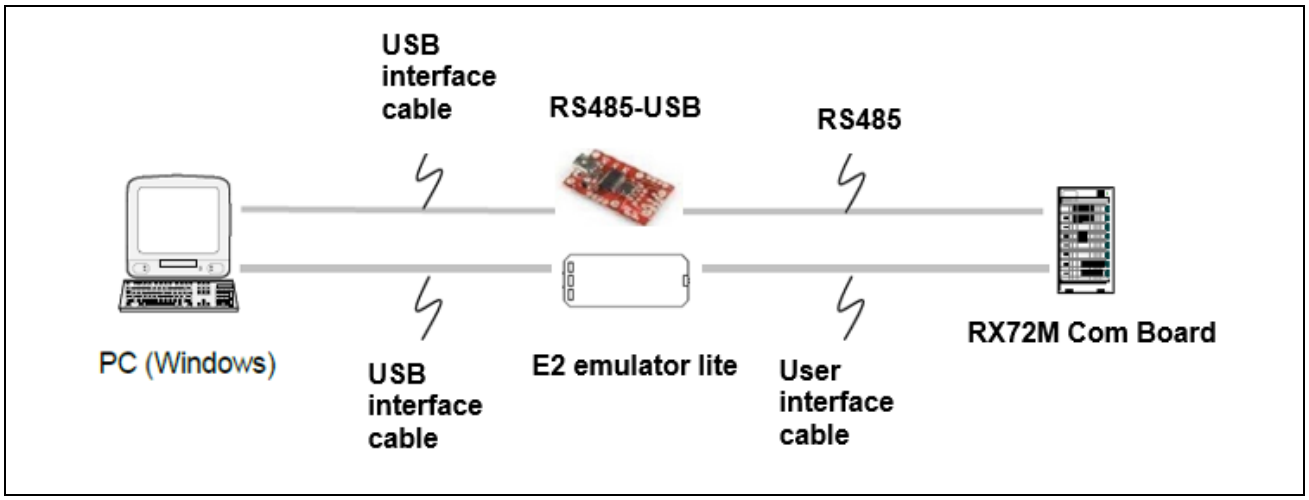


Figure 5.3 Hardware connection example in Modbus RTU/ASCII stack mode

5.1.3 Modbus TCP Serial gateway stack mode

Change the LED display on the Modbus RTU / ASCII slave device via the gateway device using the application that runs on Windows PC and the Modbus command.

Two evaluation boards are required to check the operation. It becomes evaluation board A (for gateway device) and evaluation board B (RTU / ASCII slave device)

On the evaluation board B (RTU / ASCII slave device) side, please download the RTU_SLAVE executable file of Modbus RTU / ASCII stack referring to the mounting procedure of Modbus RTU / ASCII stack.

Table 5.1 Gateway device default settings

Operation mode	MODBUS_RTU_MASTER_MODE
Baud rate	115200bps
Parity	None
Stop bit	1

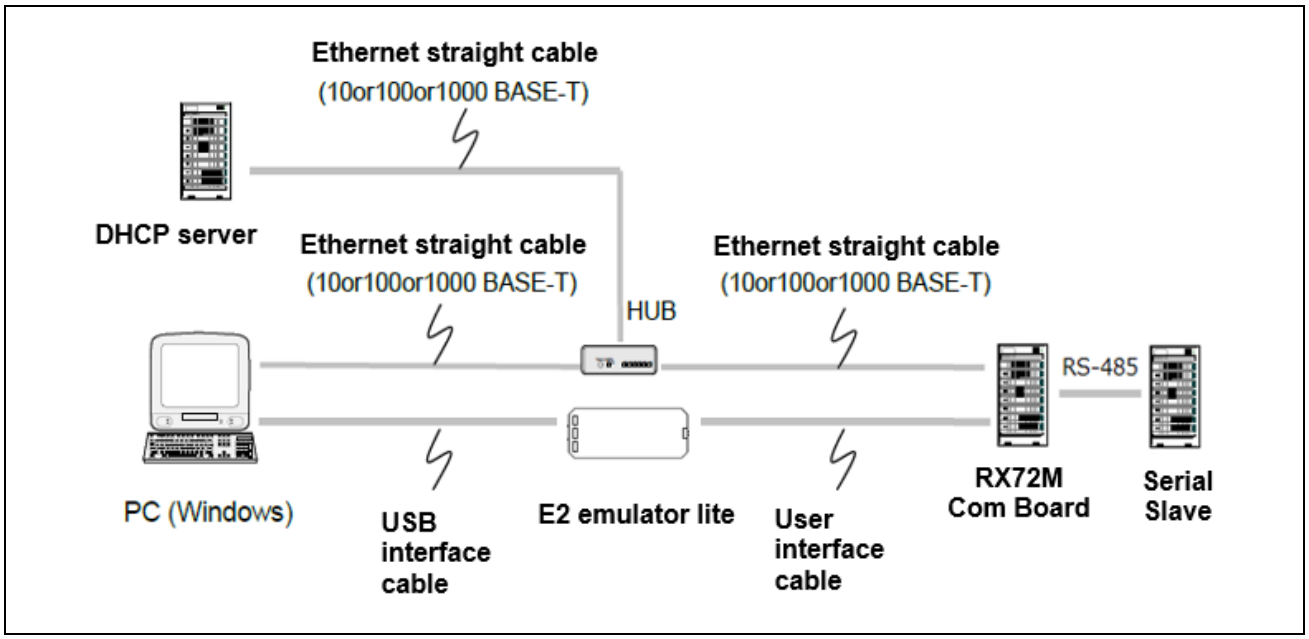


Figure 5.4 Hardware connection example in Modbus TCP serial gateway stack mode

【Limitations】
The gateway function uses the function of Modbus RTU / ASCII master mode.
Therefore, in Modbus TCP serial gateway mode, Modbus communication is only possible with function codes supported in Modbus RTU / ASCII master mode.

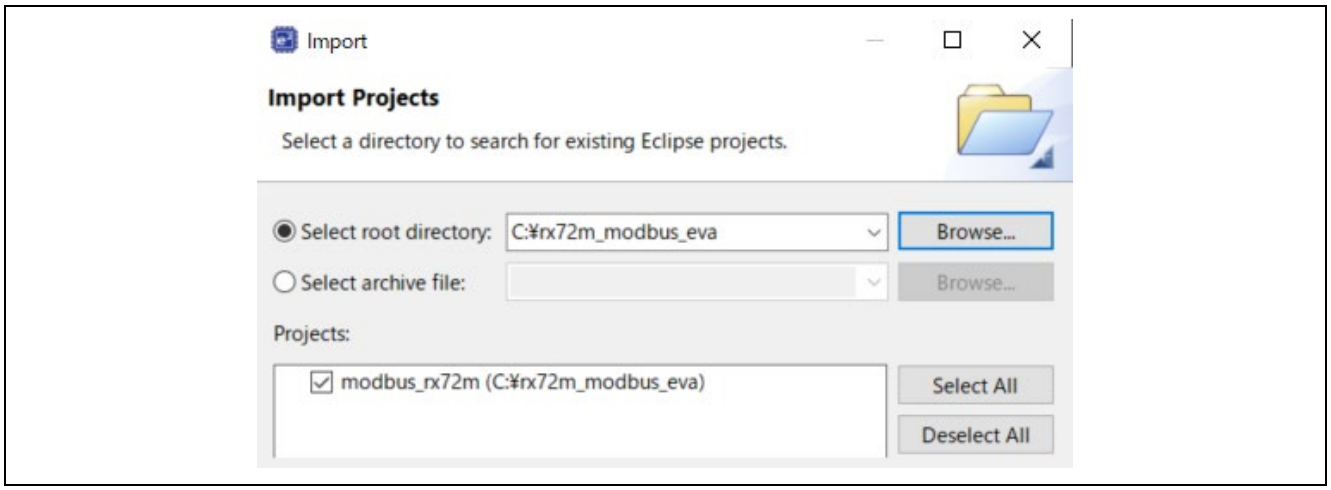
6. Project Setup

Describes the procedure to execute communication in the sample application.
Complete the hardware connection according to the protocol stack mode to be operated by the sample application referring to 5.1 Hardware Connection in advance.

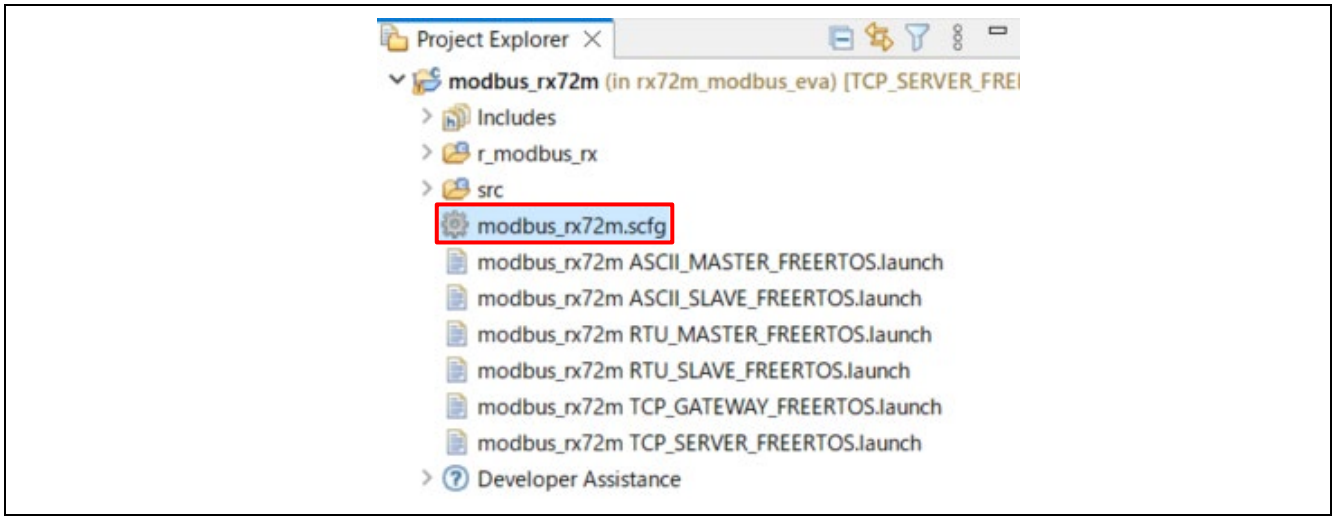
6.1 Modbus TCP Server Setup Procedure

This chapter describes the procedure for building Modbus TCP.

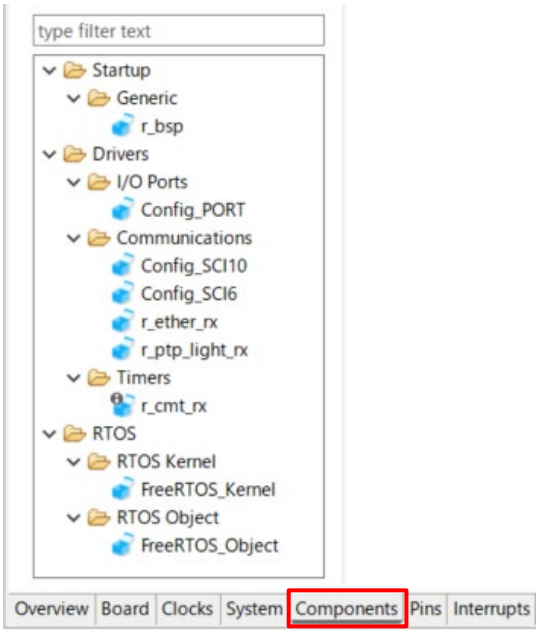
1. Import the sample project. After the program is started, by selecting [File] → [Import] → [Existing Projects into Workspace]. Check the "select root directory" and click “Browse…” button.
   →Select ”**rx72m_modbus_eva**” →Check “**modbus_rx72m**” → [Finish].



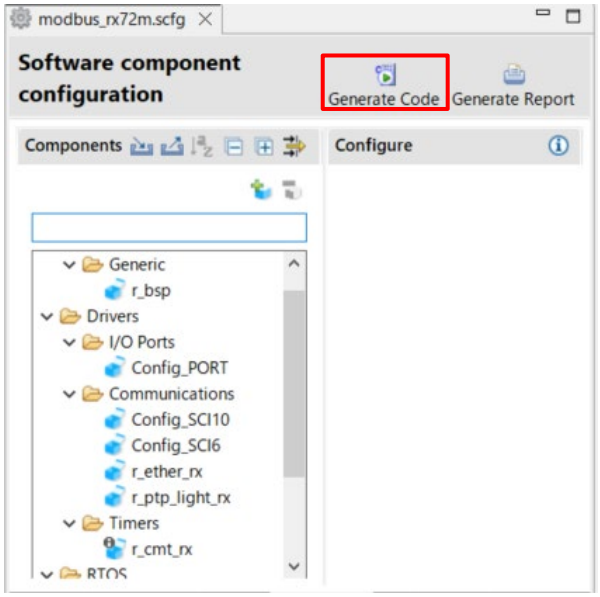
2. Open "cofiguration.xml".



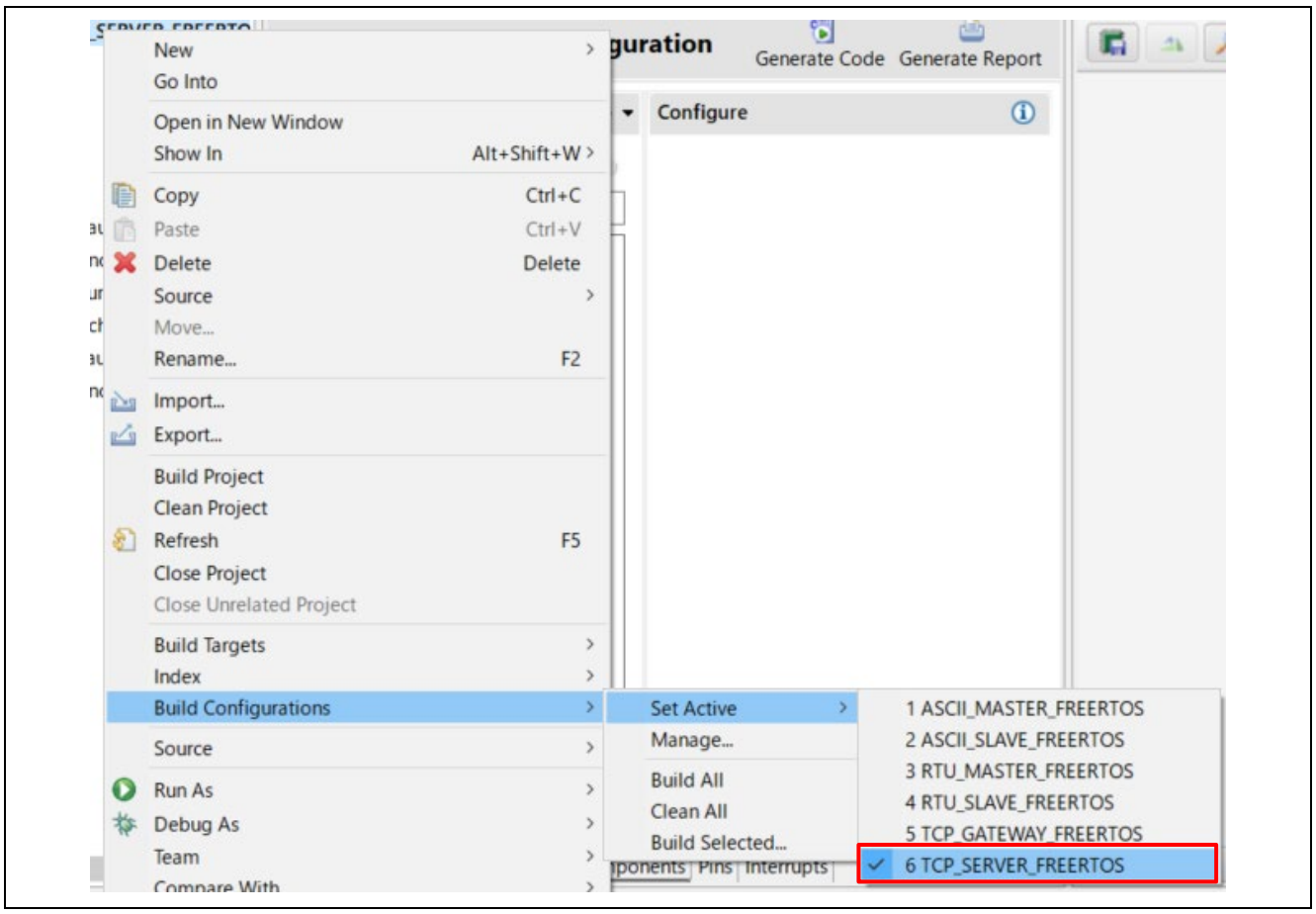
3. Select the "Components" tab.
   Confirm that all components are enabled.



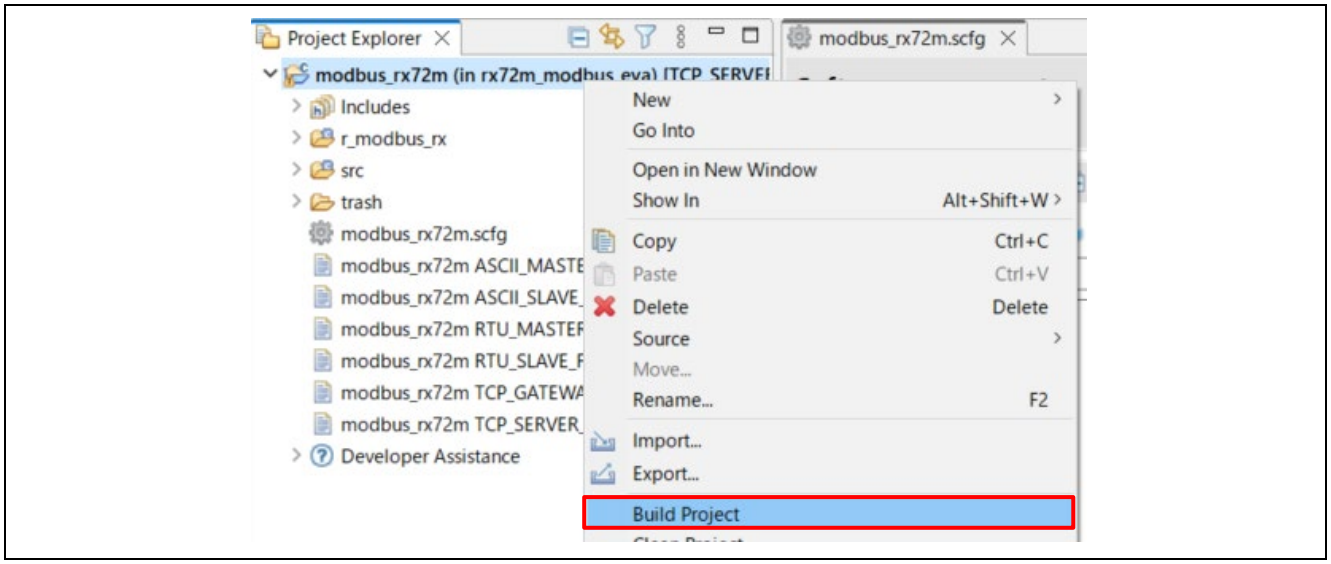
4. Generate the code with the "Generate Code" button.



5. Select [Build Configurations] → [Set Active] → [TCP_SERVER_FREERTOS]

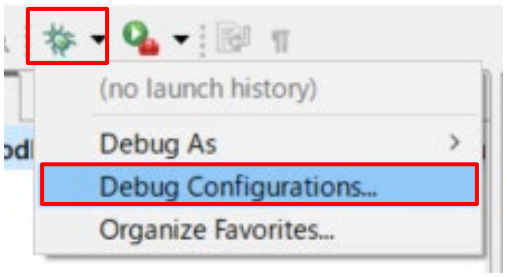


6. Execute the build.

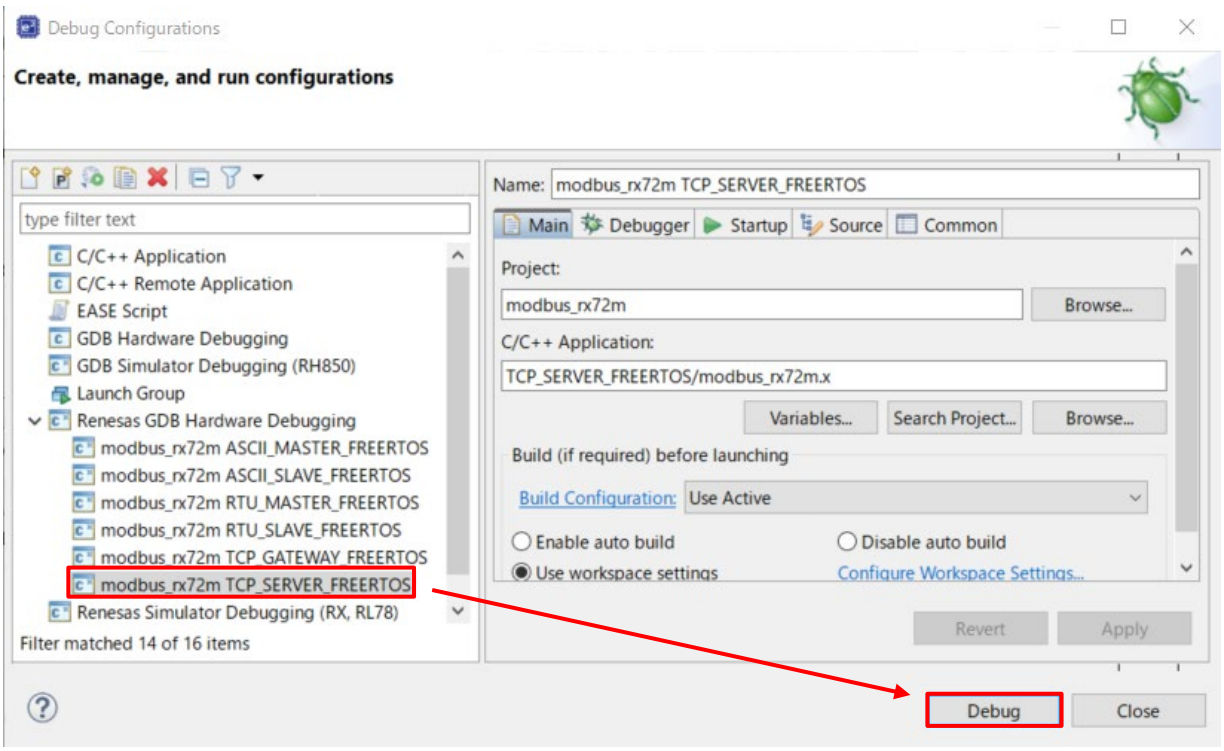


7. After connecting the board and J-Link, start debugging in the following procedure.

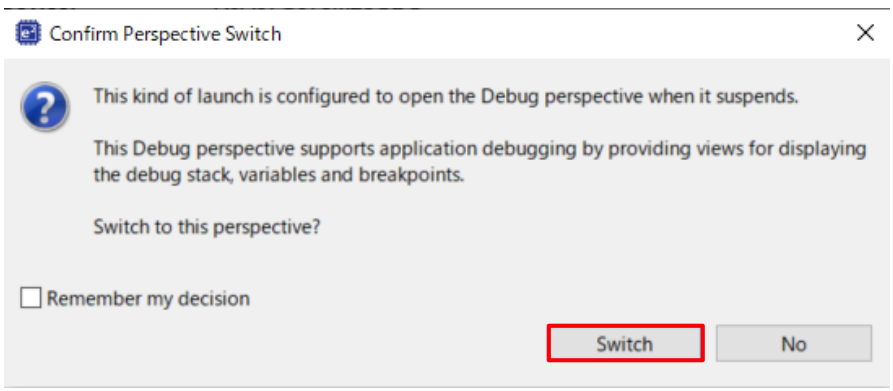
8. Select the drop-down menu next to the bug icon and selecting “Debugger Configurations ”



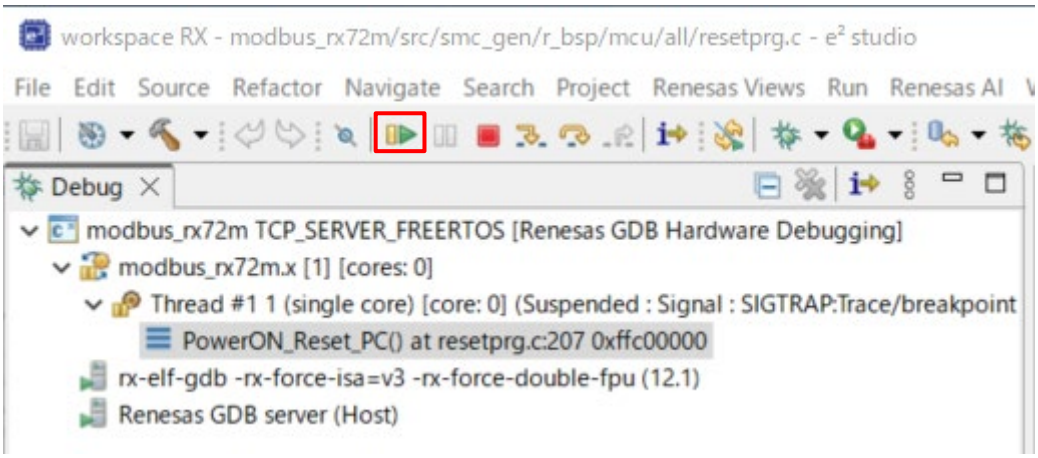
[Renesas DBG Hardware Debugging] → [modbus_rx72m_TCP_SERVER_FREERTOS] item, then press [Debug].



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



9. Click the "Resume" button. The program will run.

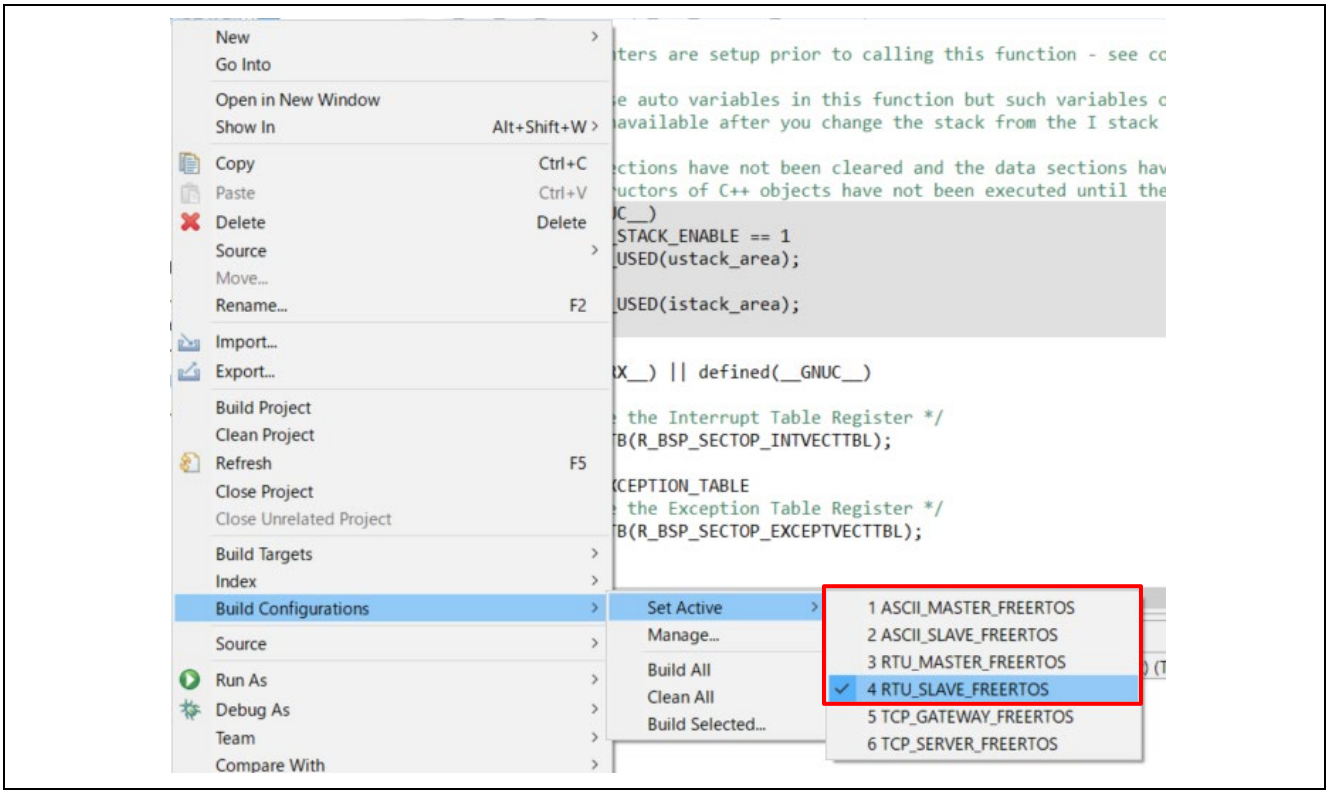


6.2 Modbus RTU/ASCII Setup Procedure

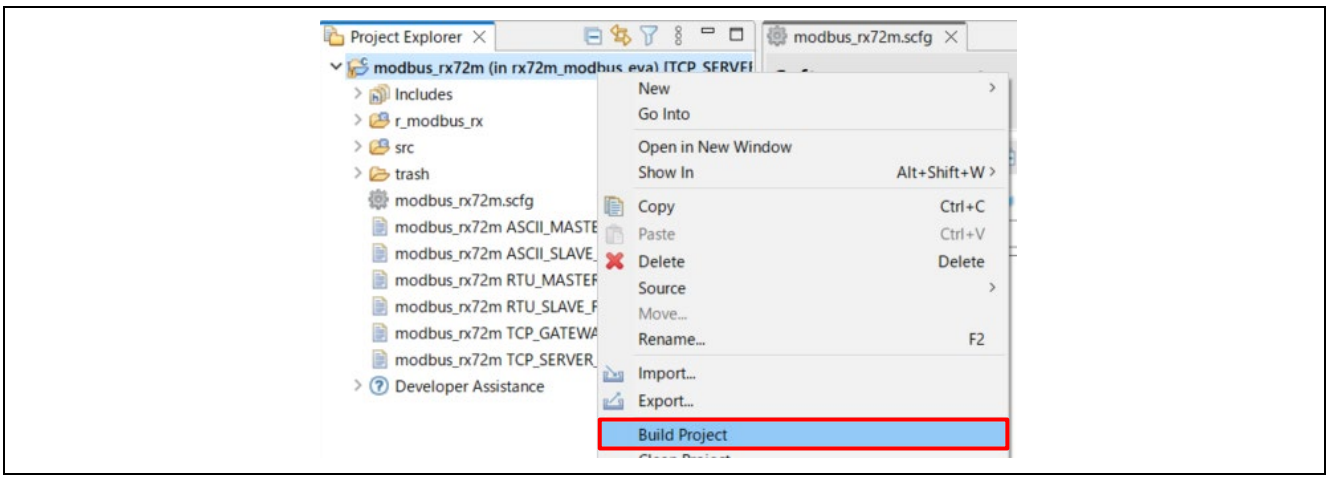
This chapter describes the procedure for building Modbus RTU/ASCII.
Since the program import has been completed in steps 1, 2, 3, and 4 of Chapter 6.1, there is no need to import it separately.
This chapter describes the explanation starting from switching the Serial mode.

1. Select [Build Configurations] → [Set Active] → [xxxx_yyyy_FREERTOS]
   Select "xxxx_yyyy" if necessary.

   ASCII_MASTER_FREERTOS
   ASCII_SLAVE_FREERTOS
   RTU_MASTER_FREERTOS
   RTU_SLAVE_FREERTOS

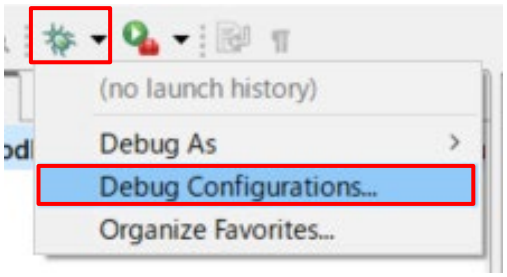


2. Execute the build.



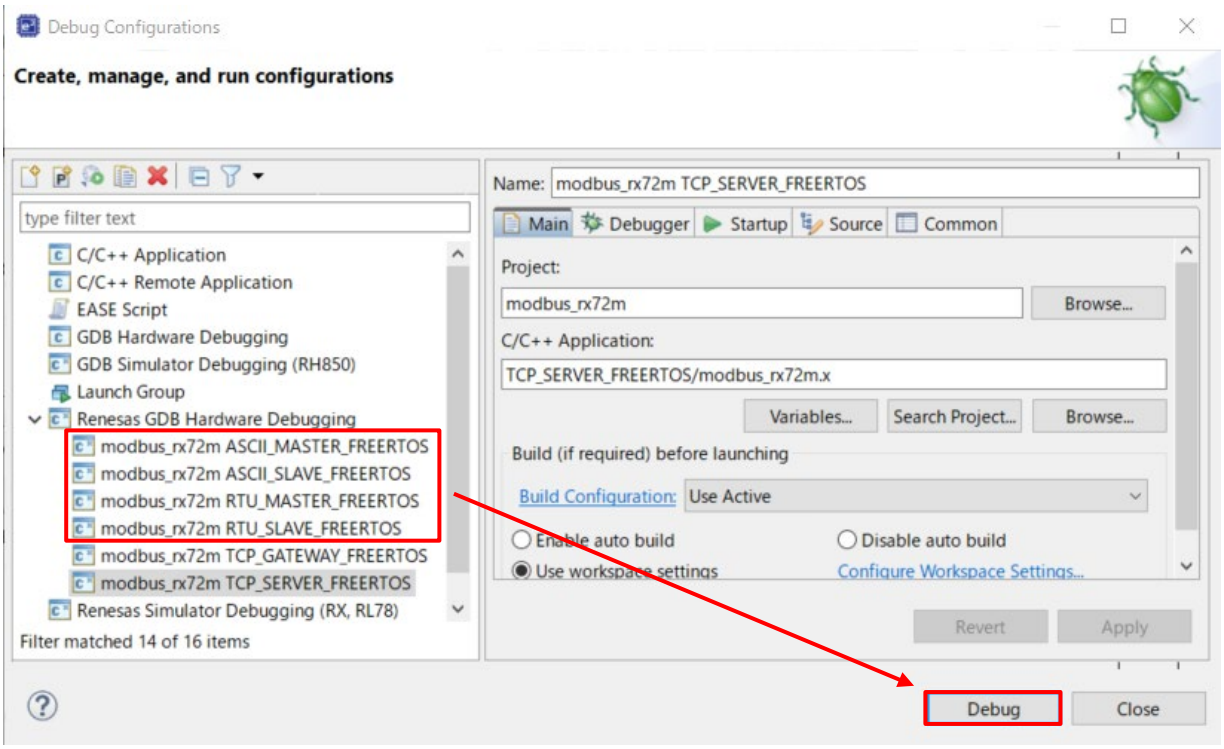
3. After connecting the board and J-Link, start debugging in the following procedure.

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

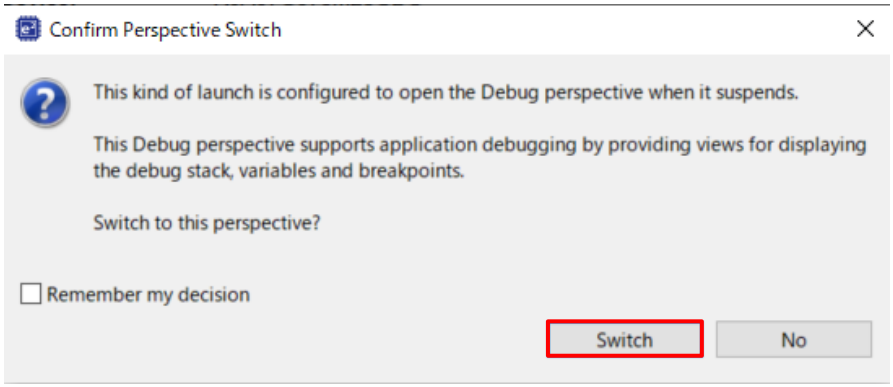


[Renesas DBG Hardware Debugging] → [modbus_rx72m_xxxx_yyyy_FREERTOS] item, then press [Debug].

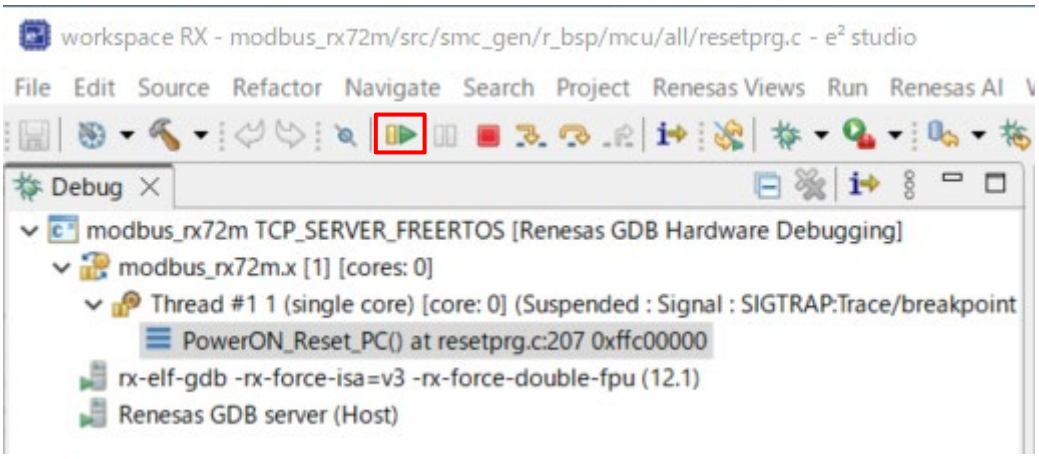
ASCII_MASTER_FREERTOS
ASCII_SLAVE_FREERTOS
RTU_MASTER_FREERTOS
RTU_SLAVE_FREERTOS



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



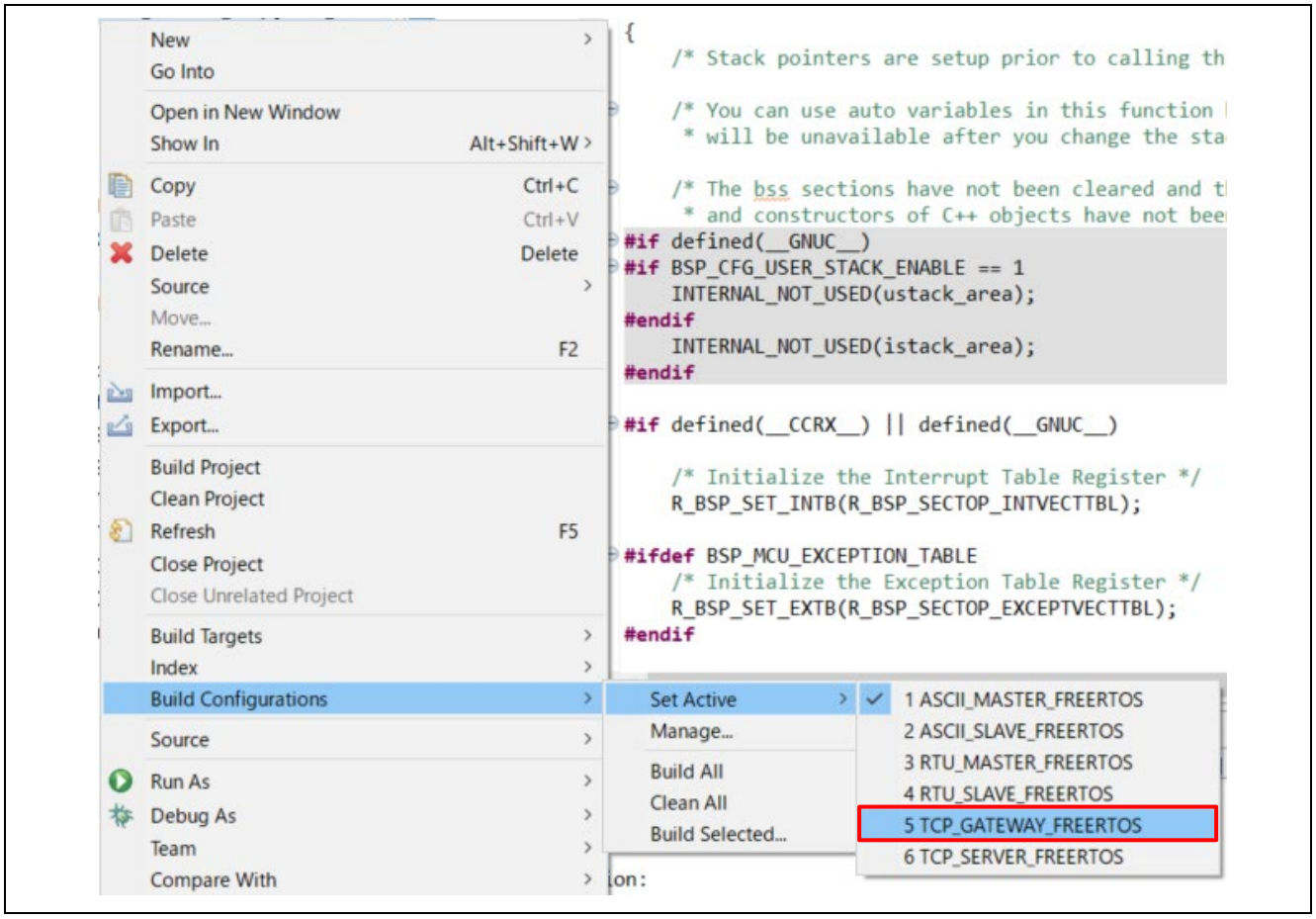
5. Click the "Resume" button. The program will run.



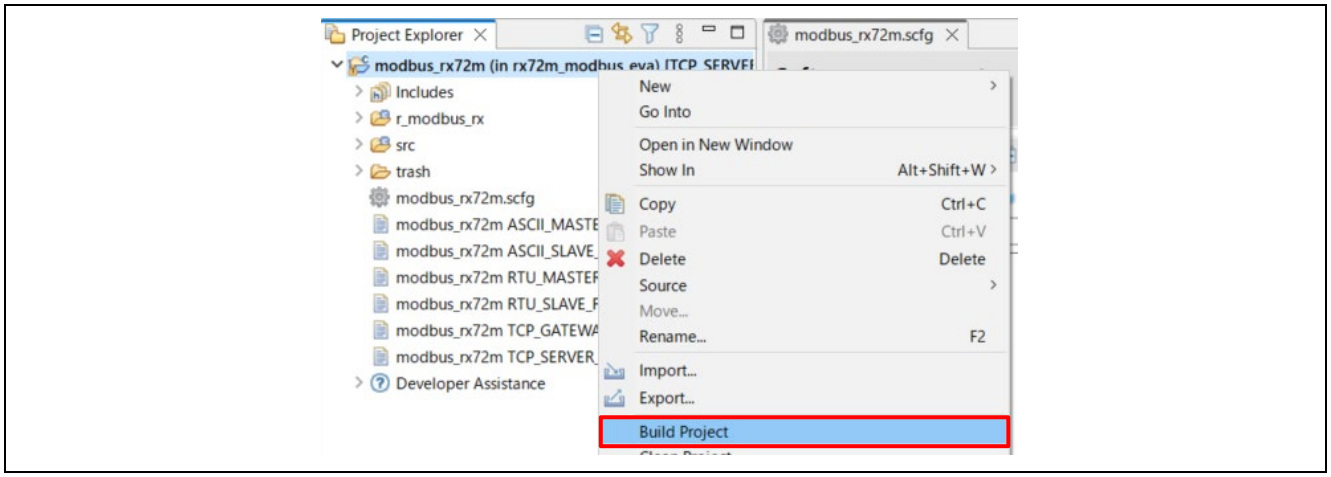
6.3 Modbus TCP Serial Gateway Setup Procedure

This chapter describes the procedure for building Modbus TCP Serial Gateway.
Since the program import has been completed in steps 1, 2, 3, and 4 of Chapter 6.1, there is no need to import it separately.

1. Select [Build Configurations] → [Set Active] → [TCP_GATEWAY_FREERTOS]
   Select "xxxx_yyyy" if necessary.

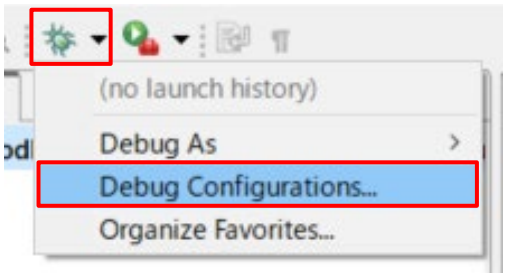


2. Execute the build.

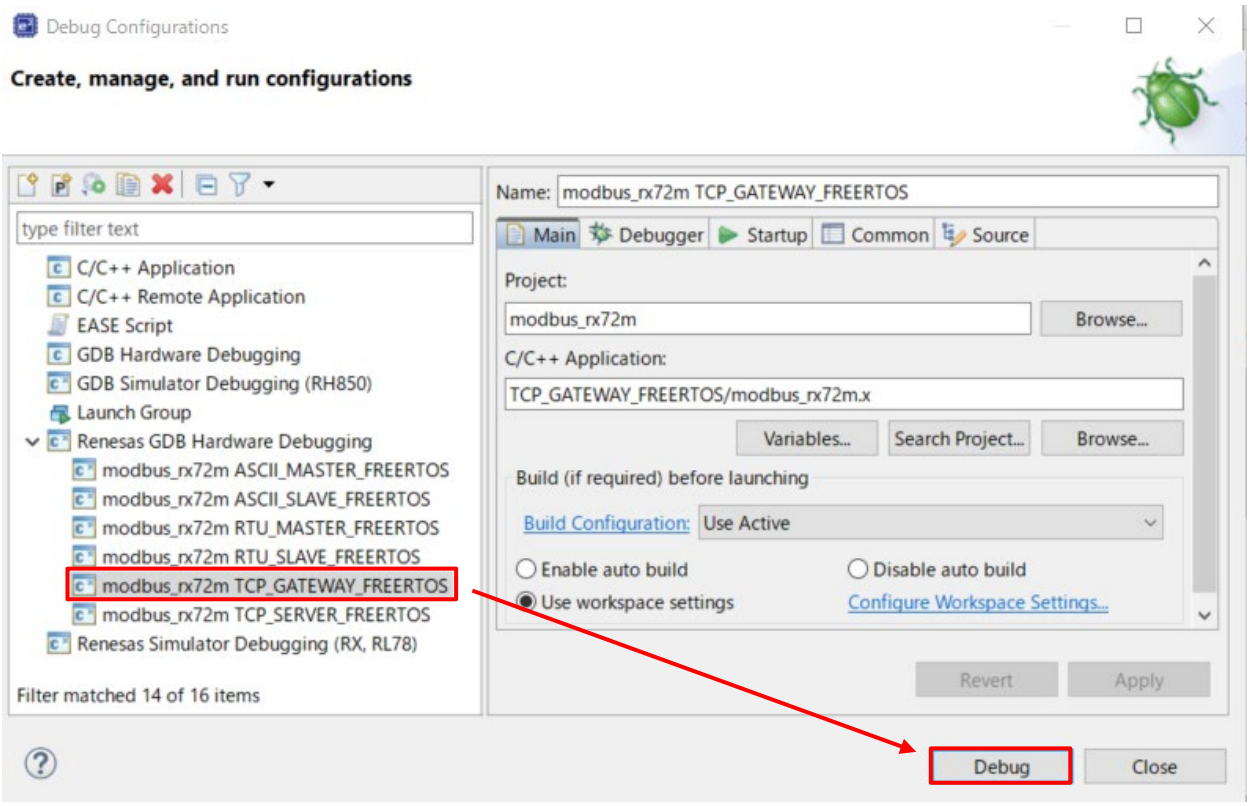


3. After connecting the board and J-Link, start debugging in the following procedure.

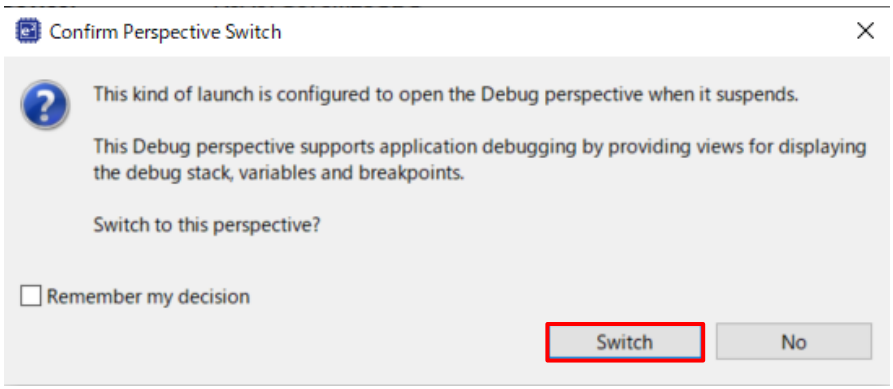
4. Select the drop-down menu next to the bug icon and selecting “Debugger Configurations ”



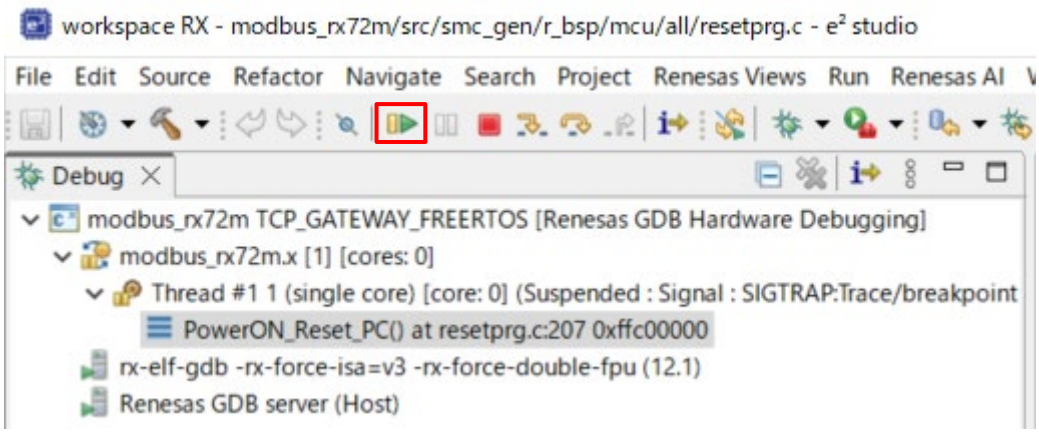
[Renesas DBG Hardware Debugging] → [modbus_rx72m_TCP_GATEWAY_FREERTOS] item, then press [Debug].



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



5. Click the "Resume" button. The program will run.



7. Setup a master tool & Demonstration

7.1 Modbus TCP Server

1. Connect “TCP Server” as described in section 5.1.1.

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

3. Set the "Remote Modbus Server" IP Address (e.g., "**192.168.1.100**") and Port (e.g.,"**502**").

4. Press "Connect", the coils will be updated periodically and LEDs 1-4 of the connected TCP server will be updated and flashing.

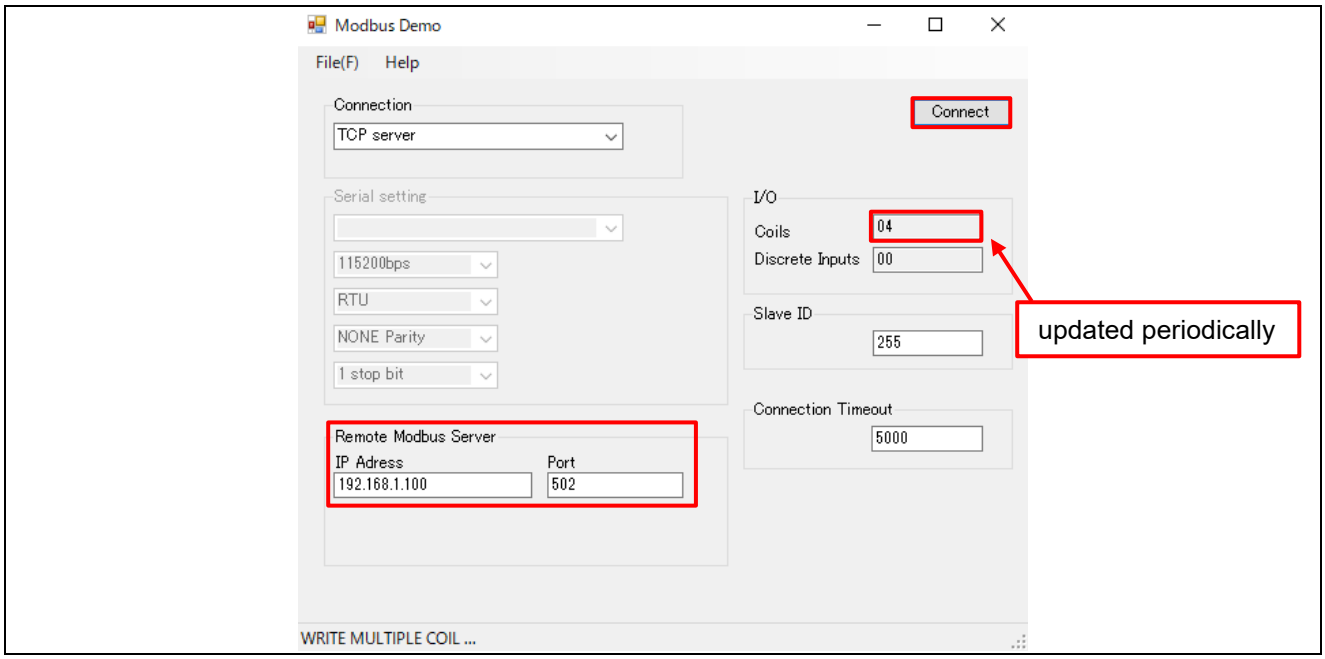


Figure 7.1: ModbusDemoApplication tcp server setting

7.2 Modbus RTU/ASCII Slave

1. Connect “RTU/ASCII slave” as described in section 5.1.2.

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

3. Set the Serial settings
   Connection : **Serial Slave**
   COMxx : **Adapt to each environment**
   Baud rate : **Match the sample program settings**
   Mode : **RTU or ASCII**
   Parity : **No**
   Stop bit : **1**
   Slave ID : **1**

4. Press "Connect", the coils will be updated periodically and LEDs 1-4 of the connected RTU/ASCII slaves will be updated and flashing.

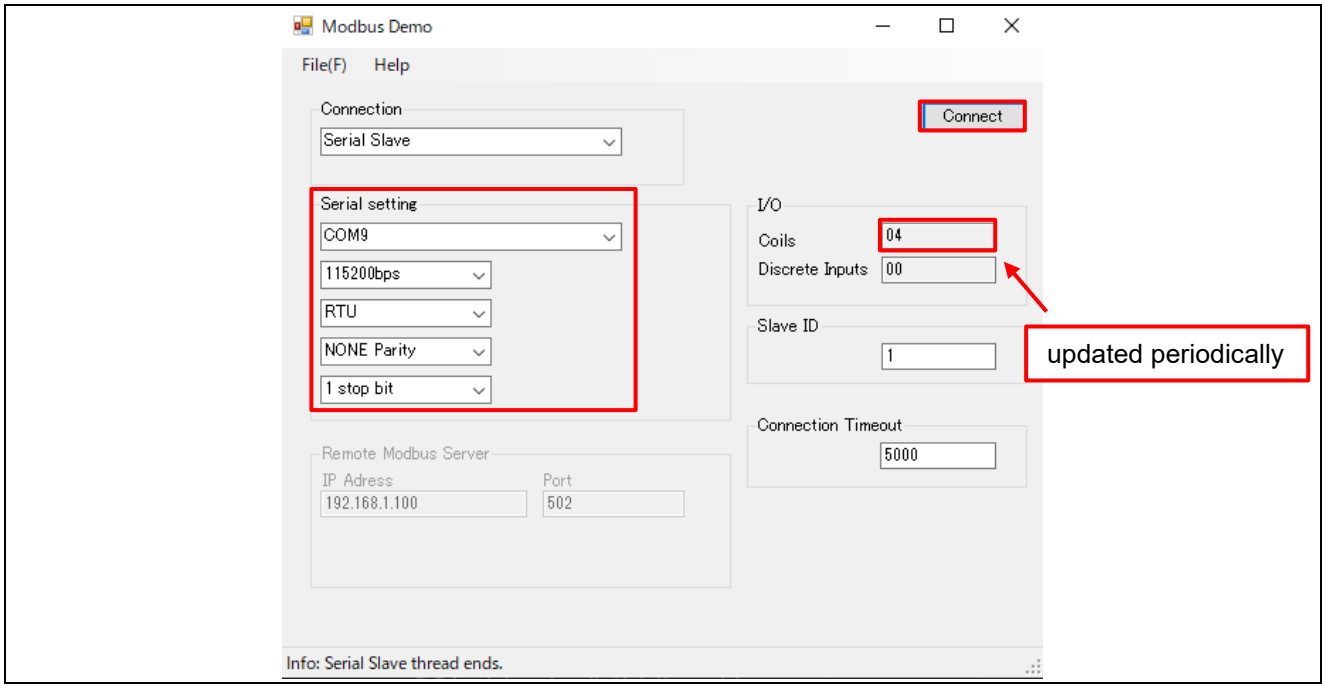


Figure 7.2: ModbusDemoApplication RTU/ASCII slave setting

7.3 Modbus RTU/ASCII Master

1. Connect “RTU/ASCII slave” as described in section 5.1.2.

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

3. Set the Serial settings
   Connection : **Serial Master**
   COMxx : **Adapt to each environment**
   Baud rate : **Match the sample program settings**
   Mode : **RTU or ASCII**
   Parity : **No**
   Stop bit : **1**
   Slave ID : **1**

4. Press “Connect” and the coil will wait for input. As you enter values, LEDs 1 to 4 on the connected Master will update and light up.
   Ex),
   Input 00 : LED off
   Input 01 : LED1 on
   Input FF : LED1-4 on

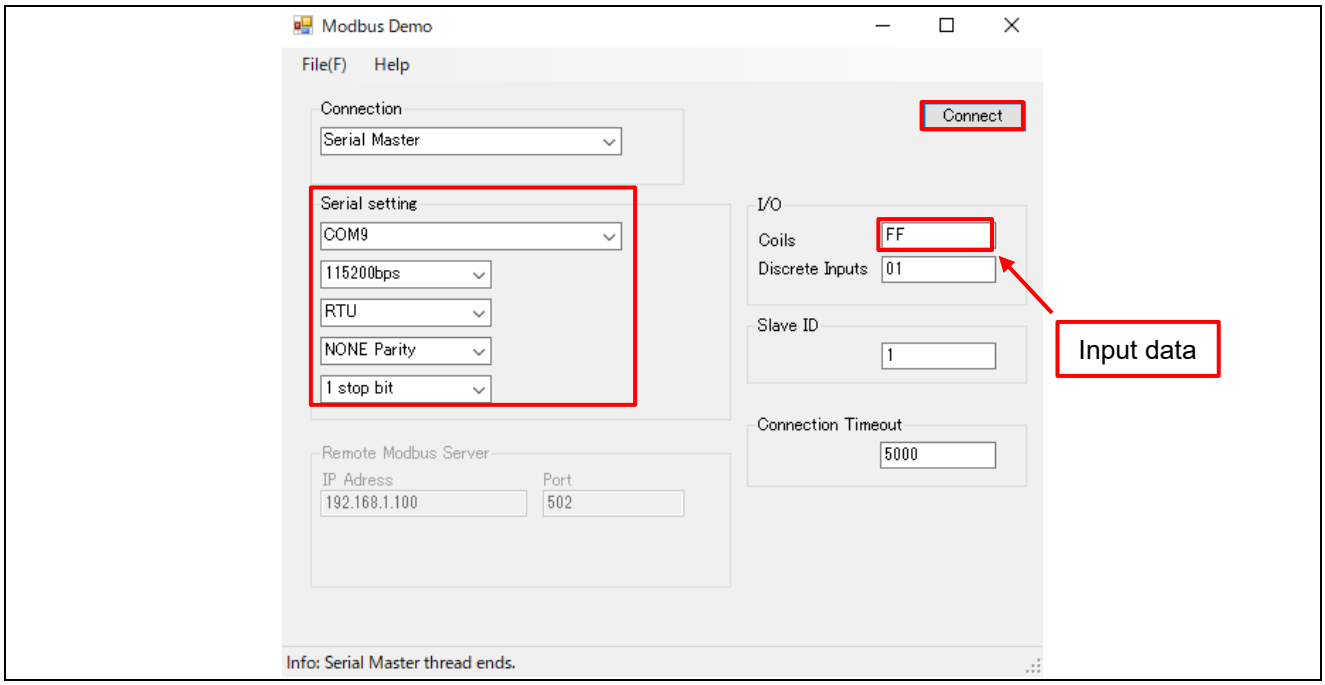


Figure 7.3: ModbusDemoApplication RTU/ASCII master setting

7.4 Modbus TCP Serial Gateway

1. Connect another “RTU slave” as described in section 5.1.3.

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

3. Set the "Remote Modbus Server" IP Address (e.g., "**192.168.1.100**") and Port (e.g.,"**502**").

4. Press "Connect", the coils will be updated periodically and LEDs 1-4 of the connected RTU slaves will be updated and flashing.

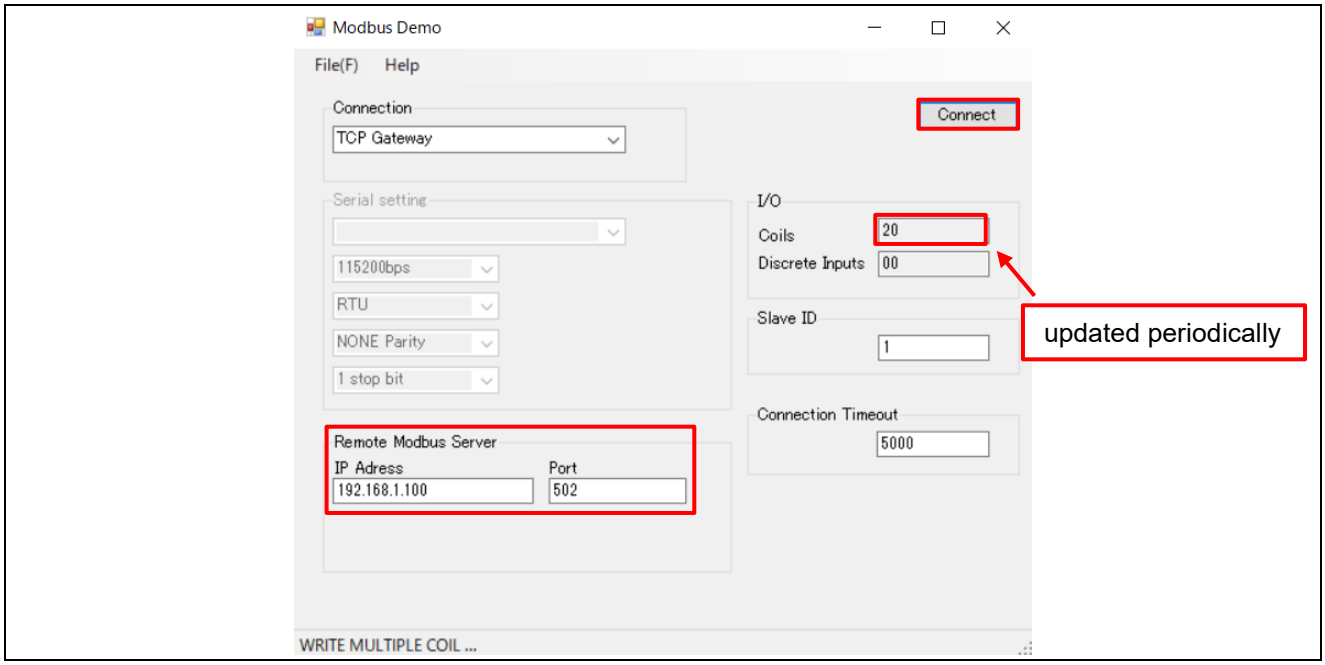


Figure 7.4: ModbusDemoApplication TCP gateway setting

8. Appendix

8.1 Appendix A. DHCP mode

1. When operating with DHCP, enable the setting for "**ipconfigUSE_DHCP**" to "1".
   "**rx72m_modbus_eva\src\frtos_config\FreeRTOSIPConfig.h**"

2. Build and debug.

```
/* If ipconfigUSE_DHCP is 1 then FreeRTOS+TCP will attempt to retrieve an IP
 * address, netmask, DNS server address and gateway address from a DHCP server.  If
 * ipconfigUSE_DHCP is 0 then FreeRTOS+TCP will use a static IP address.  The
 * stack will revert to using the static IP address even when ipconfigUSE_DHCP is
 * set to 1 if a valid configuration cannot be obtained from a DHCP server for any
 * reason.  The static configuration used is that passed into the stack by the
 * FreeRTOS_IPInit() function call. */
#define ipconfigUSE_DHCP                        0
#define ipconfigDHCP_REGISTER_HOSTNAME          0
#define ipconfigDHCP_USES_UNICAST               1
```

8.2 Appendix B. Setting the baud rate

1. In the release environment, the baud rate is set to 115200bps. To change the baud rate, change the following variable.
   "**rx72m_modbus_eva\src\modbus_init.c**"

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

2. Build and debug.

```
#if defined( MODBUS_RTU ) || defined( MODBUS_ASCII ) || defined( MODBUS_GATEWAY )
    /* serial connection setting */
    st_init_info.u32_baud_rate            = UART_BAUD_115200;      /* Baud rate for serial port config
    st_init_info.u8_parity                = UART_PARITY_NONE;      /* Parity for serial port configura
    st_init_info.u8_stop_bit              = UART_STOPBIT_1;        /* Stop bit for serial port configu
    st_init_info.u8_uart_channel          = UART_CHANNEL_0;        /* The hardware UART channel to be
    st_init_info.u8_timer_channel         = TAU_CHANNEL_1;         /* The hardware timer channel to be
    st_init_info.u32_response_timeout_ms  = 2000;                  /* Response shall be received withi
    st_init_info.u32_turnaround_delay_ms  = 200;                   /* Delay in between consecutive rec
    if (st_init_info.u32_baud_rate == 0)
    {
        return ERR_INVALID_STACK_INIT_PARAMS;
```

8.3 Appendix C. Setting Slave ID

1. When changing the Slave ID, please change the following settings. (renge : 1 to 247)
   "**rx72m_modbus_eva\src\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
```

8.4 Appendix D. Multi-client configuration

This project supports multiple clients.
The initial state is enabled, and clients that can receive will be able to register their IP addresses. Please add your IP address in the section below.
In the initial state, the only valid IP address is "**192.168.1.101**"

Example of adding "192.168.1.102" and "192.168.1.103".

“**rx72m_modbus_eva\src\modbus_init.c**”

```
uint32_t modbus_init(void);

***********************************************************************************
 @brief  Initialize MODBUS protocol stack
 @param  none
 @retval error code
 ***********************************************************************************
 */
uint32_t modbus_init(void)
{
    uint32_t ercd;
#if defined( MODBUS_RTU ) || defined( MODBUS_ASCII ) || defined( MODBUS_GATEWAY )
    serial_stack_init_info_t    st_init_info;
    serial_gpio_cfg_t           st_gpio_cfg;
#endif
    slave_map_init_t st_slave_map;

#if defined( MODBUS_TCP ) || defined( MODBUS_GATEWAY )
    /* Enable IP table */
    Modbus_tcp_init_ip_table (ENABLE, ACCEPT);

    /* register IP address */
   ercd = Modbus_tcp_add_ip_addr ("192.168.1.101");
    ercd = Modbus_tcp_add_ip_addr ("192.168.1.102");
   ercd = Modbus_tcp_add_ip_addr ("192.168.1.103");
    if (ercd != ERR_OK)
    {
        return ercd;
    }
```

Note), The number of clients is limited to 8.

9. Limitations

None

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	July. 31, 2019	-	First edition issued
1.01	Nov. 01, 2019	-	-Replaced due to lack of content in the configuration diagram
1.02	Feb. 07, 2020	-	-Update Ether driver and startup file (prst.src) -Corrected the supply clock to PHY from 50MHz to 25Mhz -Corrected erroneous description of evaluation tool operation method
1.03	Nov 20, 2020	-	-Update all documents by updating sample application. -Add explanations for Modbus application programs -Change the switch configuration and its explanation. -Remove modbus_init function from API -Remove modbus_init function from API
2.00	Dec. 25, 2024	-	-Changed from uNET3 to FREERTOS+TCP -2 ports enabled

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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