

RZ/N2L Group

RZN2L Industrial Network SOM Kit Application Note: Modbus TCP Slave Software

Introduction

This document explains Sample Program setup procedures for Modbus TCP functionalities with the adapted Modbus protocol stack code for Renesas RZ/N2L Industrial Network SOM Kit.

Target Device

RZ/N2L



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1. Overview

This document describes the procedure for testing the Modbus TCP slave function using Modbus protocol stack code compatible with the Renesas RZ/N2L Industrial Network SOM Kit.

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/N2L are available via Renesas.

Table 1.2 Technical Inputs for RZ/N2L

Index	Technical Inputs
1	r01uh0955ejxxxx-rzn2l.pdf (RZ/N2L User's Manual: Hardware)
2	r01an6434ejxxxx-rzt2-rzn2-fsp-getting-started.pdf (Getting started with Flexible Software
	Package)
3	r12ut0020edxxxx-rzn2l-som-kit-hw.pdf (RZ/N2L Industrial Network SOM Kit Use's Manual)

1.3 Limitation / Known Issue

None



2. Features

The Modbus protocol stack forRZ/N2L allows for quick and easy development of the Modbus TCP server. 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



Project Setup Requirements

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

Item	Vender	Description
Board	Renesas Electronics	RZ/N2L Industrial Network SOM Kit
IDE	IAR Systems	Embedded Workbench® for ARM Version 9.30.1 Please apply patch (EWARM_Patch_for_RZN2L_rev1.0.zip) which is available in http://www.renesas.com/rzn2l. Regarding how to apply the patch, please read the readme file in patch file.
	Renesas Electronics	e ² studio 2023-04 FSP Smart Configurator 2023-04 RZ/N2L Flexible Software Package (FSP) v1.2.0 Please download from the link below. https://github.com/renesas/rzn-fsp/releases/tag/v1.2.0
Emulator	IAR Systems	I-jet
	SEGGER	J-Link
Master demo tool	Renesas Electronics	ModbusDemoApplication.exe (Included in this package)



3.1 Hardware

This document describes the major hardware. Refer to RZ/N2L Industrial Network SOM Kit user's manual and schematic for more board details.



Figure 3.2 RZ/N2L Industrial Network SOM Kit



3.2 Setting the Board

Setting the board for running sample program is shown below.

1. Connect the I-jet to J2 or the USB cable to J5 for J-link OB on Carrier board.



Figure 3.3 Setting the SOM Kit

- 2. Power is supplied by connecting USB Micro-B cable to the USB connector "J5) of the Carrier board.
- 3. Connect Ethernet Cable to the Ethernet Connector "ETH0".



4. Setup a master tool

- 1. Open ModbusDemoApplication.exe which is included in this package.
- 2. Set the "Remote Modbus Server" IP Address (e.g. "192.168.1.100") and Port (e.g. "502").

Serial setting I15200bps I15200bps RTU RTU NONE Parity I stop bit Remote Modbus Server IP Adress VO Coils 00 Discrete Inputs 00 Slave ID 255 Connection Timeout 5000	Connection TCP server	Connect
115200bps Image: Construction of the second of the sec	Serial setting	
NONE Parity 255 1 stop bit Connection Timeout Remote Modbus Server IP Adress Port		
NONE Parity 255 1 stop bit 255 Connection Timeout 5000 IP Adress Port	RTU 🗸	Slave ID
Remote Modbus Server 5000	NONE Parity 🗸	
Remote Modbus Server 5000	1 stop bit 🗸	
IP Adress Port		
		5000
	192.168.1.100 502	
		-

Figure 4.1 ModbusDemoApplication remote server setting



5. Running the sample application

Refer to Section 3.2 Setting the Board for board settings.

The setup differs depending on the IDE.

- When using e² studio, refer to section 5.1 and 5.3
- When using EWARM, refer to section 5.2 and 5.3

* Replace the project name in the figure with the project name of this sample project.

5.1 Setup sample project for e² studio

5.1.1 Startup e² studio

- 1. Open the e² studio and select a directory as workspace.
- 2. Click "Open Projects from File System..." in File tab.

File	Edit Navigate Search Project	t Renesas Views H Alt+Shift+N >
	Open File	All Shire N
6	Open Projects from File System	-
_	Recent Files	>
	Close Editor	Ctrl+W
	Close All Editors	Ctrl+Shift+W
	Save	Ctrl+S
	Save As	
	Save All	Ctrl+Shift+S
	Revert	
	Move	
	Rename	F2
8	Refresh	F5
	Convert Line Delimiters To	>
₽	Print	Ctrl+P
പ്പ	Import	
4	Export	
	Properties	Alt+Enter
	Switch Workspace	>
	Restart	
	Exit	
	LAIL	

Figure 5.1 e² studio File tab



3. Import project folder.

"\project\rzn2l_soml\modbus\single\e2studio".

port Projects from	File System or Archive			
his wizard analyzes th	e content of your folder or archive file to	find projects and import them in t	the IDE.	
mport source:	Extracted zip folder path	\project\rzt2m_rsk+rzt2m\r	modbus_single\e2stuc ~	Directory Archive
ype filter text				Select All
Folder			mport as	Deselect All
✓ e2studio			clipse project	1 of 1 selected
				Hide already open project
-				
Close newly import	ed projects upon completion			
		\backslash		
se installed project co	onfigurators to:	\backslash	\	
Ise <u>installed project co</u> Search for nested p Detect and configu	onfigurators to: rojects		\backslash	
se <u>installed project co</u> Search for nested p Detect and configu	onfigurators to: rojects			
se <u>installed project co</u> Search for nested p Detect and configu	onfigurators to: rojects re project natures			New
se <u>installed project co</u> Search for nested p Detect and configu Working sets	onfigurators to: rojects re project natures			New V Select
se <u>installed project co</u> Search for nested p Detect and configu Working sets Add project to w	onfigurators to: rojects re project natures			∨ Select
se <u>installed project co</u> Search for nested p Detect and configu Working sets Add project to w	onfigurators to: rojects re project natures			
Ise <u>installed project co</u> Search for nested p Detect and configu Working sets Add project to w	onfigurators to: rojects re project natures			∨ Select

Figure 5.2 Import project on e² studio



5.1.2 Board IP address setting

Set the IP address in the following procedure. This is so that server and client are in the same domain.

1. Set desired server network address in main_thread_entry.c for src folder.

In this example will be used:



Figure 5.3 Static IP address

- 2. Set the IP address of the PC used must be in the same domain as the board. In this example will be used:
 - IP address 192.168.1.101
 - Subnet mask 255.255.255.0



5.1.3 How to generate source code and how to build

1. Click the Configuration.xml.

workspace_v2022_04 - RZT	M_RSK_Modbus/sr	c/main	1
File Edit Source Refacto	Navigate Searc	h Pro	1
🔦 🔯 🔳 🕸 De	oug 🗸 🗸	C *	1
! b → A → t → t → t → t	<> → 🛃		
🍋 Project Explorer 🗙	🖹 🔩 🍸 🕴 🗖		
✓ ₩ RZT2M_RSK_Modbus (i	e2studio)		
> 🔊 Includes			
> 🚰 modbus			
> 🚰 modbus_user			
> 🚰 src			
> 🗁 script			
🌼 configuration.xml			
R9A07G075M28GBG	pincfg		
rzt_cfg.txt			
RZT2M_RSK_Modbu	Debug_Flat.jlink		
RZT2M_RSK_Modbu	Debug_Flat.launch		
	-		

Figure 5.4 Configuration.xml

2. Click 'Generate Project Content' button then generate rzt, rzt_gen, rzt_cfg folder.

ation.xml - e ² studio		
oject Renesas Views Run Window Help		
RZT2M_RSK_Modbus Debug_Flat 🗸 🌞 🗄 😁 🖛 🔚 🌚 🗸 🔦	- 🗟 📲 🔍 🕨 II 🔳 🕅 3. O. R	≂, ∞ : ∅ : 🗞 ね - ۹ - ! ∿ - ね ⊪ - □□ 🖗 🖏 🕹 : ∅ : ∅ : ∅ - ∅ -
🖻 main_thread_entry.c 🛛 🌞 [RZT2M_RSK_Modbus] FSP Configuration	×	
Stacks Configuration		Generate Project Content
Threads New Thread 🔊 Remove 📄	HAL/Common Stacks	🚯 New Stack > 🐣 Extend Stack > 🔬 Remove
 ✓ ALL/Common ♥ g.joport I/O Port Driver on r_joport ♥ Main thread ♥ FreeRT0S+TCP ♥ Heap 4 	 g_ioport I/O Port Driver on r_ioport i 	

Figure 5.5 Generate Project Content





Figure 5.6 Generate project folder

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

File Edit Source	Refactor Navigate S	earch Project	Renesas Views Rui	n Window He	lp	_	_
🍕 🗱 🔳	🎄 Debug	✓ C™ RZT2M	I_RSK_Modbus Debu	g_Flat 🗸 🌼	1 🗖 🗝 🖬 🔞	8 - 3	- 🗟 🖶 🔪

Figure 5.7 Build button







5.1.4 Download application and run debugger

1. Click the Debug button in tool bar to download the built application program and launch the debugger.

File Edit Source Refactor Navigate Search Project Renesas Views Run Window Help	Workspace_v2022_04 - RZT2M_RSK_Modbus/com	
	🐔 🔅 🔳 🔯 Debug 🗸	
Project Explorer X 🖹 🕏 🎖 🖁 🗖 🗴 🦗 [RZT2M_RSK_Modbus] FSP Configuration X		RZT2M_RSK_Modbus] FSP Configuration ×

Figure 5.9 Debug button

2. Click to "Switch" button.

Cor	firm Perspective Switch X
2	This kind of launch is configured to open the Debug perspective when it suspends.
	This Debug perspective supports application debugging by providing views for displaying the debug stack, variables and breakpoints.
	Switch to this perspective?
Ren	nember my decision
	Switch No

Figure 5.10 Confirm Perspective Switch



3. The program will break at "system_init" for startup.

381	" ldr pc,=FIQ_Handler \n"
382	::: "memory");
383	}
384	
386	⊕ * After boot processing, LSI starts executing here
388	BSP_TARGET_ARM BSP_ATTRIBUTE_STACKLESS void system_init (void)
389	{
390	asm volatile (
391	"set_hactlr: \n"
392	<pre>" MOVW r0, %[bsp_hactlr_bit_1] \n" /* Set HACTLR bits(L) */</pre>
393	" MOVT r0, #0 \n"
394	" MCR p15, #4, r0, c1, c0, #1 \n" /* Write r0 to HACTLR */
395	<pre>::[bsp_hactlr_bit_l] "i" (BSP_HACTLR_BIT_L) : "memory");</pre>
396	
397	asm volatile (
398	"set hcr: \n"
399	" MRC p15, #4, r1, c1, c1, #0 \n" /* Read <u>Hyp</u> Configuration Register */
400	" ORR r1, r1, %[bsp_hcr_hcd_disable] \n" /* HVC instruction disable */
401	" MCR p15, #4, r1, c1, c1, #0 \n" /* Write Hyp Configuration Register */
402	::[bsp_hcr_hcd_disable] "i" (BSP_HCR_HCD_DISABLE) : "memory");
403	

Figure 5.11 Break point 1

- 4. Before running the loaded program, please change the CPSR register of CR52 general register on Registers tabs.
- Change the "T" register bit (bit 5 in CPSR register), which is Thumb execution state bit, from "1" to "0" to switch the instruction mode from "Thumb" to "Arm".
 - For example, when the register value is "0x000001fa", set it to "0x000001da".

Please note that the program halts at Default_Handler() when running if the value of "T" bit in CPSR register is not changed

Console	Registers 🗙 🕖	Debug Shell	🔗 Search	🖹 Problems	🙀 Debugger Console	🌸 Smart Browser	📋 Memory 🛛 🖓 RTOS Resources
Name						Value	
1010 r9						0x0	
10101 r10						0x0	
1010 r11						0x0	
1010 r12						0xe51ff004	
1010 sp						0x101fe8	
1010 lr						0x10006d	
1010 pc						0x102000	

Figure 5.12 CPSR register of CR52 generic register on Registers tab



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5. Click the Resume button. The program will break at the first of main function.



Figure 5.13 Resume button



Figure 5.14 Break point2

6. Click the **Resume** button again to execute the program. If the program is working properly, it will be waiting for the TCP/IP connection request.



5.2 Setup sample project for EWARM

5.2.1 Startup EWARM

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

🕑 r	nain - I	AR Eml	bedd	ed Wo	orkben	ch IDE		
File	Edit	View	Pr	roject	Tools	s Wi	indow	Help
b	New F	ile					Ctr	I+N
1	New V	Norkspa	ace					
ð	Open	File					Ctr	I+O
1	Open	Worksp	oace.					
P	Open	Header	/Sou	rce Fil	le	Ct	trl+Shif	t+H
0	Close						Ctrl	+F4
5	Save V	Norkspa	ace					
		Norkspa						
5	Close	Worksp	ace					
	Save						Ct	rl+S
Ð,	Save A	As						
	Save A	AII						
5	Page 5	Setup						
	Print						Ct	rl+P
	Recen	t Files						•
	Recen	t Works	space	es				•
8	Exit							

Figure 5.15 EWARM file tab

3. Select the Workspace File(.eww) and click the "Open" button.

"\project\rzn2l_som\modbus_single\ewarm\RZN2L_SOM_Modbus.eww".

← → ~ ↑ <mark>.</mark> ·	≪ project → rzt2m_rsk+rzt2m → modbus	single → ewarm	✓ ♂ Search	:h ewarm	
Organize 🔻 New	folder				
📥 OneDrive - R ^	Name	Date modified	Туре	Size	
My PC: REL-(.settings	6/28/2022 3:04 PM	File folder		
		6/28/2022 3:04 PM	File folder		
3D Objects	rzt	6/28/2022 3:04 PM	File folder		
E Desktop	rzt_cfg	6/28/2022 3:04 PM	File folder		
😫 Documents	rzt_gen	6/28/2022 3:04 PM	File folder		
🕂 Downloads	script	6/28/2022 3:04 PM	File folder		
👌 Music	settings	6/28/2022 3:04 PM	File folder		
Pictures	src	6/28/2022 3:04 PM	File folder		
Videos	RZT2M_RSK_Modbus.eww	6/10/2022 2:13 PM	IAR IDE Workspace	1 KB	
(C:) Windov					
Network					
I I I I I I I I I I I I I I I I I I I	File name: RZT2M_RSK_Modbus.eww		 Workspac 	e Files (*.eww)	\sim
			Open		ancel

Figure 5.16 Open project file



5.2.2 Board IP address setting

Set the IP address on the following procedure. The server and client must be in the same domain.

- 1. Set desired server network address in main_thread_entry.c.
- In this example will be used:



Figure 5.17 Static IP address

2. Set the IP address of the PC used must be in the same domain as the board.

In this example will be used:

- IP address 192.168.1.101
- Subnet mask 255.255.255.0



5.2.3 How to generate source code and how to build

 Click the "Tool -> FSP Smart Configurator" on tool bar. If you have not set up FSP Smart Configurator yet on EWARM, refer to r01an6434ejxxxx-rzt2m-fsp-getting-started.pdf in which section 5.4 describes how to set up it.

RZT2M_RSK_Modbus - IAR Er	nbed	Ideo	d Workbench IDE - Arm 9.30.1	
File Edit View Project I-j	et	Too	ls Window Help	
i 🗅 🗅 🔛 🚇 i 🖴 i 👗 🖆	d d	¢	Options	
Workspace 🔻	‡ :		Filename Extensions	
Debug	`		Configure Viewers	
Files	¢		Configure Custom Argument Variables	
🗆 🌒 RZT2M_RSK_Mod	~	P ₀	Configure Tools	
⊢⊞ 🖬 Flex Software ⊢⊞ 🛋 modbus			IAR Project Converter	
⊢⊞ i modbus_user	-		FSP Smart Configurator	

Figure 5.18 Tools tab

2. Click 'Generate Project Content' button then will be generate rzt, rzt_gen, rzt_cfg folder.

Summary	SP Configuration X		Generate Project Content	
Project Sum	mary	Rene		
Board:	RSK+RZT2M (RAM execution without flash memory)			
Device:	R9A07G075M28GBG			
FSP Version:				
Project Type:	Flat			RENESAS
Location:	C:/ProjectPath/RZT2M_Modbus_FSPv1t2m_rsk+rzt2m/mo	dbus single/ewarn	n 🗇	
	vare components ort Package Common Files	v1.0.0		
I/O Port	or rackage common riles	v1.0.0		
FreeRTOS		v1.0.0		
Arm CMSIS	Version 5 - Core (R)	v5.7.0+renesas.1	2	
Board suppo	ort package for R9A07G075M28GBG	v1.0.0		
Board suppo	ort package for RZT2M	v1.0.0		
Board suppo	ort package for RZT2M - FSP Data	v1.0.0		
RSK+RZT2	M Board Support Files (RAM execution without flash memory)	v1.0.0		
Ethernet PH	Y	v1.0.0	~	
				-

Figure 5.19 FSP SC Smart Configurator



3. Click on Project -> Make from menu bar or Make button on tool bar to build. Once the build is completed, the build message is displayed in the Build Console window that displays compilation target files and the number of error/warnings.



Figure 5.20 Make button1

: C ⊇ ⊇ ⊇ : L & D I C I · · · · · · · · · · · · · · · · ·	
Workspace V # X	
Debug ~	
Files O	
● RZT2M_RSK_Mod ✓ Hex Software	
🗕 🖬 Flex Software	
La modbus	
modbus_user	
He ≣ modbus_user → Dubulanto.pd em © Othou	
RZT2M_RSK_Modbus	
Build	
Messages	
50% Generating Secure Bundle100% Generating Secure Bundle	
Total number of errors: 0	
Total number of errors, o Total number of warnings: 155	
For Remote of Workings, For	
Build succeeded	

Figure 5.21 Make button2 and Build console



5.2.4 Download application and run debugger

1. Click the Debug button in tool bar to download the built application program and launch the debugger. The program will break at the first code in main function.



Figure 5.22 Download and Debug button





Figure 5.23 Break point

2. Click the Go button. If the program is working properly, it will be waiting for the TCP/IP connection request.



Figure 5.24 Go button



5.3 Demonstration

Users can see the simple demonstration with using this Modbus protocol stack in this sample project.

5.3.1 Specification of demonstration

By communicating with PC through the Modbus TCP 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.

1. PC application checks the state of the switch (J6), by using Modbus "Read_Discrete_Inputs" function code. The [SW setting value] is the 8-bits of data calculated by the state of J6.

8-bits SW setting value

Bit number	7	6	5	4	3	2	1	0
Value	J6-4	J6-3	J6-2	J6-1	0	0	0	0

- 2. According to the states of the switch, the states of the output ports, which are connected to LED, is updated periodically.
 - When [SW setting value] is less than 0x7F

Update span = ([SW setting value] +1) * 10 [msec]

• When [SW setting value] is equal to or greater than 0x7F

Update span = 10 [msec]

ex. J6-1, J6-3 = ON (1) J6-2, J6-4 = OFF (0)

SW setting value = 0101 0000b = 0x50 = 80

Update span = (80 +1) + 10 = 810 [msec]



5.3.2 Connect TCP communication

- 1. Refer to Chapter 4 Setup a master tool for Maser tool setup.
- 2. Click the **Connect** button to start TCP communication and the LED will start blinking.

Modbus Demo File(F) Help	– 🗆 X
Connection TCP server	Connect
Remote Modbus Server IP Adress Port 192.168.1.100 502 Ready	5000

Figure 5.25 Connect button

3. Check the coils status and SW setting value.

🖳 Modbus Demo File(F) Help		- 0	×
Connection TCP server	~	Disconne	ect
Serial setting 115200bps RTU NONE Parity 1 stop bit	×	I/O Coils 08 Discrete Inputs 30 Slave ID 255	
Remote Modbus Server IP Adress 192.168.1.100	Port 502	Connection Timeout 5000	
WRITE MULTIPLE COIL			

Figure 5.26 Modbus Demo Application TCP connection



Appendix A. DHCP mode

- 1. Open configuration.xml
- 2. Click "Stacks" tab to open the Stacks Configuration pane and select the "FreeRTOS + TCP" in the left threads pane.
- 3. Open the properties, change "Use DHCP" to "Enable" and click "Generate Project Content" button.

Threads	🛃 New Thread	👔 Remove
 ✓ Main thread ♥ GreeRTOS+TCP ♥ Heap 4 		
Objects	🛃 New Object	t > 🔊 Remo
		t> 🔊 Remo
Summary BSP Clocks Pins Interrupts Event Links Stacks Com		t> 🔊 Remo
Objects Objects Summary BSP Clocks Properties Smart Browser FreeRTOS + TCP		t> 🔊 Remo
Summary BSP Clocks Pins Interrupts Event Links Stacks Com Properties × Smart Browser FreeRTOS + TCP Settings Property Stack size in words (not bytes) Network Events call vApplicationIPNetworkEve Max UDP send block time Use DHCP DHCP Register Hostname	ponents Value configMINIMAL_STACK_SIZE * 5	

Figure A.1 Use DHCP mode



- 4. Build and debug.
- 5. If you want to check the IP address etc. in DHCP mode, use the arp command on command line.
- 6. Check the physical Address "00-11-22-33-44-55".

Command Prompt						-	×
Microsoft Windows [Ver (c) 2019 Microsoft Cor		reserved.					
C:¥Users}							
Ințerface: 192.168.1.1		Ŧ					
Internet Address	Physical Address 00-11-22-33-44-55	Tvpe dynamic					
192.168.1.255	ft-ft-ft-ft-ft	static					
224.0.0.22	01-00-5e-00-00-16	static					
224.0.0.251	01-00-5e-00-00-fb	static					
224.0.0.252 239.255.255.250	01-00-5e-00-00-fc 01-00-5e-7f-ff-fa	static					
L 700.700.700.700	ff-ff-ff-ff-ff-ff	static static					





Appendix B. Application Programming Interface				
Function				
· Modbus_tcp_ini	it_ip_table			
[Description]				
Modbus set host IP li	ist properties			
[Format]				
void				
Modbus_tcp_init_ip_ta	able(
	ENABLE_F	FLAG e_flag,		
	TABLE_MO	DDE e_mode		
);				
[Parameter]				
ENABLE_FLAG	e_flag	Status is whether the connection table enabled or disabled		
TABLE_MODE	e_mode	Status indicating the list contain IP to be accepted or rejected		
[Return value]				
None				
[Error code]				
None				
 Modbus_tcp_ad [Description] 	ld_ip_addr			
Modbus add an IP ad	ddress to host IP I	list		
[Format]				
uint32_t				
Modbus_tcp_add_ip_a	addr(
	pchar_t pu	8_add_ip		
)				
[Parameter]				
pchar_t	pu8_add_ip	Host IP address in numbers and dots notation. ex. 192.168.1.100		
[Return value]				
Error code				
[Error code]				
ERR_OK ERR_IP_ALREADY_ ERR_MAX_CLIENT ERR_TABLE_DISAE	_	On success If address already present in list If maximum connections reached. If IPlist is disabled		



· Modbus_tcp_delete_ip_addr [Description] Modbus delete an IP address to host IP list [Format] uint32 t Modbus_tcp_delete_ip_addr(pchar_t pu8_del_ip) [Parameter] pchar t pu8 del ip Host IP address in numbers and dots notation ex. 192.168.1.100 [Return value] Error code [Error code] ERR OK On success ERR_IP_NOT_FOUND IPlist is not found ERR TABLE EMPTY IF the list is empty ERR_TABLE_DISABLED If the IPlist is disabled Modbus_slave_map_init [Description] Modbus function code mapping API [Format] uint32 t Modbus_slave_map_init(p_slave_map_init_t pt_slave_func_tbl) [Parameter] p_slavemap_init Structure pointer to function code mapping table pt_slave_func_tbl [Return value] Error code [Error code] ERR OK On success ERR_INVALID_STACK_INIT_PARAMS If parameter is null If memory allocation failed ERR_MEM_ALLOC



• Modbus_tcp_ser [Description]	ver_init_stack	
Modbus TCP stack ini	tialization API	
[Format]		
uint32_t		
Modbus_tcp_server_ir	nit_stack(
	uint32_t u32_additio	onal_port,
	uint8_t u8_tcp_multi	ple_client
)		
[Parameter]		
Uint32_t	u32_additonal_port	Additional port configured by user
Uint8_t	u8_tcp_multiple_client	Status whether multiple clients is enabled
[Return value]		
Error code		
[Error code]		
ERR_OK ERR_STACK_INIT	• · · · · · · · · · · · · · · · · · · ·	ization of the task or mailbox task or mailbox failed



Structure

slave_map_init_t

Member variables type	Member variables	Description
fp_function_code1_t	fp_function_code1	Callback function pointer for Modbus function code 1 (Read coils) operation.
fp_function_code2_t	fp_function_code2	Callback function pointer for Modbus function code 2 (Read Discrete Inputs) operation.
fp_function_code3_t	fp_function_code3	Callback function pointer for Modbus function code 3 (Read Holding Registers) operation.
fp_function_code4_t	fp_function_code4	Callback function pointer for Modbus function code 4 (Read Input RegisterRead coils) operation.
fp_function_code5_t	fp_function_code5	Callback function pointer for Modbus function code 5 (Write Single Coil) operation.
fp_function_code6_t	fp_function_code6	Callback function pointer for Modbus function code 6 (Write Single Register) operation.
fp_function_code15_t	fp_function_code15	Callback function pointer for Modbus function code 15 (Write Multiple Coils) operation.
fp_function_code16_t	fp_function_code16	Callback function pointer for Modbus function code 16 (Write Multiple Registers) operation.
fp_function_code23_t	fp_function_code23	Callback function pointer for Modbus function code 23 (Read/Write Multiple Registers) operation.

• p_req_read_coils_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_start_addr	Specifies address of the first coil
uint16_t	u16_num_of_coils	Specifies the number of coils to be read



• p_req_read_inputs_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_start_addr	Specifies address of the first discrete input
uint16_t	u16_num_of_inputs	Specifies the number of discrete inputs to be read

· p_req_read_holding_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_start_addr	Specifies address of the first holding register
uint16_t	u16_num_of_reg	Specifies the number of registers to be read

• p_req_read_input_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_start_addr	Specifies address of the first input register
uint16_t	u16_num_of_reg	Specifies the number of registers to be read

p_req_write_single_coil_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_output_addr	Specifies address of the coil
uint16_t	u16_output_value	Data to be written



• p_req_write_single_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_register_addr	Specifies address of the register
uint16_t	u16_register_value	Data to be written

· p_req_write_multiple_coils_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_start_addr	Specifies address of the first coil
uint16_t	u16_num_of_outputs	Specifies the number of coils to be written
uint8_t	u8_num_of_bytes	Specifies the number of bytes of data
uint8_t	aru8_data[MAX_DISCRETE_DATA]	Data to be written

* MAX_DISCRETE_DATA is defined in 251

· p_req_write_multiple_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_start_addr	Specifies address of the first register
uint16_t	u16_num_of_reg	Specifies the number of registers to be written
uint8_t	u8_num_of_bytes	Specifies the number of bytes of data
uint16_t	aru16_data[MAX_REG_DATA]	Data to be written

* MAX_REG_DATA is defined in 125



· p_req_read_write_multiple_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected
uint16_t	u16_read_start_addr	Specifies address of the first register to be read from
uint16_t	u16_num_to_read	Specifies the number of registers to be read
uint16_t	u16_write_start_addr	Specifies address of the first register to be written to
uint16_t	u16_num_to_write	Specifies the number of registers to be written
uint8_t	u8_write_num_of_bytes	Specifies the number of bytes of data
uint16_t	aru16_data[MAX_REG_DATA]	Data to be written

* MAX_REG_DATA is defined in 125

· p_resp_read_coils_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero, if the exception code is nonzero the aru8_data will be ignored
uint8_t	u8_num_of_bytes	Specifies the number of bytes of data
uint8_t	aru8_data[MAX_DISCRETE_DATA]	Data to be read

* MAX_DISCRETE_DATA is defined in 251



• p_resp_read_inputs_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero, if the exception code is nonzero the aru8_data will be ignored
uint8_t	u8_num_of_bytes	Specifies the number of bytes of data
uint8_t	aru8_data[MAX_DISCRETE_DATA]	Buffer to store the read data

* MAX_DISCRETE_DATA is defined in 251

• p_resp_read_holding_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero, if the exception code is nonzero the aru16_data will be ignored
uint8_t	u8_num_of_bytes	Specifies the number of bytes of data
uint16_t	aru16_data[MAX_REG_DATA]	Buffer to store the read data

* MAX_REG_DATA is defined in 125

p_resp_read_input_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero, if the exception code is nonzero the aru16_data will be ignored
uint8_t	u8_num_of_bytes	Specifies the number of bytes of data
uint16_t	aru16_data[MAX_REG_DATA]	Buffer to store the read data

* MAX_REG_DATA is defined in 125



• p_resp_write_single_coil_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero
uint16_t	u16_output_addr	Specifies address of the coil
uint16_t	u16_output_value	Data to be written

• p_resp_write_single_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero
uint16_t	u16_register_addr	Specifies address of the register
uint16_t	u16_register_value	Data to be written

· p_resp_write_multiple_coils_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero
uint16_t	u16_start_addr	Specifies address of the first coil
uint16_t	u16_num_of_outputs	Specifies the number of coils to be written



· p_resp_write_multiple_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero
uint16_t	u16_start_addr	Specifies address of the first register
uint16_t	u16_num_of_reg	Specifies the number of registers to be written

• p_resp_read_write_multiple_reg_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero, if the exception code is nonzero the aru16_read_data will be ignored
uint8_t	u8_num_of_bytes	Specifies the number of complete bytes of data
uint16_t	aru16_read_data[MAX_REG_DATA]	Data to be read

* MAX_REG_DATA is defined in 125

• p_resp_invalid_function_code_t

Member variables type	Member variables	Description
uint16_t	u16_transaction_id	Specifies the transaction ID
uint16_t	u16_protocol_id	Specifies the protocol ID
uint8_t	u8_slave_id	Identification of a remote slave connected (Own ID)
uint8_t	u8_exception_code	Error detected during processing the request. On success the exception code should be zero
uint8_t	u8_num_of_bytes	Specifies the number of complete bytes of data



RZ/N2L Group	RZ/N2L Industrial Ne	etwork SOM Kit Application Note: Modbus TCP Slave Software
Callback function		
 fp_function_code1 		
[Description]		
Callback function pointer	r for Modbus function code 1	1 (Read coils) operation.
[Format]		
uint32_t		
(*fp_function_code1_t)(
	p_req_read_coils_t pt_req	_read_coils,
	p_resp_read_coils_t pt_res	sp_read_coils
);		
[Parameter]		
p_req_read_coils_t	pt_req_read_coils	structure pointer from stack to user with read coils request information
p_resp_read_coils_t	pt_resp_read_coils	structure pointer to stack from user with read coils response data
[Return value]		
0: success		
1: failure		
 fp_function_code2 		
[Description]		
Callback function pointer	r for Modbus function code 2	2 (Read Discrete Inputs) operation.
[Format]		
uint32_t		
(*fp_function_code2_t)(
	p_req_read_inputs_t pt_i	
`	p_resp_read_inputs_t pt	_resp_read_inputs
);		
[Parameter]		
p_req_read_inputs_t	pt_req_read_inputs	structure pointer from stack to user wirh read discreate inputs request information
p_resp_read_inputs_t	pt_resp_read_inputs	structure pointer from stack to user with read discrete inputs response data
[Return value]		
0: success		
1: failure		



fp_function_code3

[Description]

Callback function pointer for Modbus function code 3 (Read Holding Registers) operation.

[Format]

uint32_t

(*fp_function_code3_t(

p_req_read_holding_reg_t pt_req_read_holding_reg,
p_resp_read_holding_reg_t pt_resp_read_holding_reg

);

[Parameter]

p_req_read_holding_reg_t	pt_req_read_holding_reg	structure pointer from stack to user wirh read holding registers request information
p_resp_read_inputs_t	pt_resp_read_inputs	structure pointer to stack from user wirh read holding registers response data

[Return value]

0: success

1: failure

· fp_function_code4

[Description]

Callback function pointer for Modbus function code 4 (Read Input RegisterRead coils) operation.

[Format]

uint32_t

(*fp_function_code4_t(

p_req_read_input_reg_t pt_req_read_input_reg,

p_resp_read_input_reg_t pt_resp_read_input_reg

);

[Parameter]

p_req_read_input_reg_t	pt_req_read_input_reg	structure pointer from stack to user with read input registers request information
p_resp_read_input_reg_t	pt_resp_read_input_reg	structure pointer to stack from user with read input registers response data
[Return value]		

0: success



· fp_function_code5

[Description]

Callback function pointer for Modbus function code 5 (Write Single Coil) operation.

[Format]

uint32_t

(*fp_function_code5_t(

p_req_write_single_coil_t pt_req_write_single_coil,
p_resp_write_single_coil_t pt_resp_write_single_coil

);

[Parameter]

p_req_write_single_coil_t	pt_req_write_single_coil	structure pointer from stack to user with write single coil request information
p_resp_write_single_coil_t	pt_resp_write_single_coil	structure pointer to stack from user with write single coil response

[Return value]

0: success

1: failure

· fp_function_code6

[Description]

Callback function pointer for Modbus function code 6 (Write Single Register) operation.

[Format] uint32_t

(*fp_function_code6_t(

p_req_write_single_reg_t pt_req_write_single_reg,

 $p_resp_write_single_reg_t\ pt_resp_write_single_reg$

);

[Parameter]

p_req_write_single_reg_t	pt_req_write_single_reg	structure pointer from stack to user wirh write single register request information
p_resp_write_single_reg_t	pt_resp_write_single_reg	structure pointer to stack from user wirh write single register response

[Return value]

0: success



fp_function_code15

[Description]

Callback function pointer for Modbus function code 15 (Write Multiple Coils) operation.

[Format] uint32_t

(*fp_function_code15_t(

p_req_write_multiple_coils_t pt_req_write_multiple_coils, p_resp_write_multiple_coils_t pt_resp_write_multiple_coils

);

[Parameter]

p_req_write_multiple_coils_t	pt_req_write_multiple_coils	structure pointer from stack to user wirh write multiple coils request information
p_resp_write_multiple_coils_t	pt_resp_write_multiple_coils	structure pointer to stack from user wirh write multiple coils response

[Return value]

0: success

1: failure

fp_function_code16

[Description]

Callback function pointer for Modbus function code 16 (Write Multiple Registers) operation.

[Format] uint32 t

(*fp_function_code16_t(

p_req_write_multiple_reg_t pt_req_write_multiple_reg,

 $p_resp_write_multiple_reg_t\ pt_resp_write_multiple_reg$

);

[Parameter] p_req_write_multiple_reg_t pt_req_write_multiple_reg structure pointer from stack to user wirh write multiple registers request information p_resp_write_multiple_reg_t pt_resp_write_multiple_reg structure pointer to stack from user wirh write multiple registers response [Return value]

0: success



fp_function_code25

[Description]

Callback function pointer for Modbus function code 23 (Read/Write Multiple Registers) operation. **[Format]**

uint32_t

(*fp_function_code23_t(

p_req_read_write_multiple_reg_t pt_req_read_write_multiple_reg, p_resp_read_write_multiple_reg_t pt_resp_read_write_multiple_reg

);

[Parameter]

p_req_read_write_multiple_reg_t pt_req_read_write_multiple_reg structure pointer from stack to user with read/write multiple registers request information

request information structure pointer to stack from user with read/write mltiple response

[Return value]

0: success



Enumeration type

Enumeration type	Enumerator	Description
ENABLE_FLAG	DISABLE	IPlist is disabled.
	ENABLE	IPlist is enabled.
TABLE_MODE	REJECT	Reject the connection.
	ACCEPT	Accept the connection.
ERR_CODE	ERR_OK	On success.
	ERR_STACK_INIT	In stack initialization failure.
	ERR_MEM_ALLOC	Memory allocation failure.
	ERR_INVALID_STACK_INIT_PARAMS	Specifies invalid stack init information from user.
	ERR_TCP_IP_TABLE_DISABLED	IPlist is disabled.
	ERR_TCP_IP_TABLE_IP_ALREADY_PRESE NT	Address already present in list.
	ERR_TCP_IP_TABLE_MAX_CLIENT	Maximum connections reached.
	etc.	Other error codes used in internal function.



Appendix C. FSP Configuration for VSC8531

RZ/N2L Industrial Network SOM Kit has VSC8531 as PHY chip.

If reconfiguring by latest FSP, FSP configuration and source code needs to change from default.

(1) Regenerate source files by lates FSP

Remove the following four folders. After that, open the project according to section 5. - When using e2studio, \project\rzn2l som\modbus single\e2studio

- When using EWARM, \project\rzn2l som\modbus single\ewarm



Figure 6-1 Remove folder generated by FSP

(2) Change ethernet driver configuration for VSC8531

Configure g_ether_phy0 Ethernet Driver on r_ether_phy for VSC8531. Configuration value for VSC8531 shows in Table 6-1.



Figure 6-2 Ethernet Driver Configuration for VSC8531 (e.g. ETH0)

Table 6-1 FSP Configuration V	alue for VSC8531
-------------------------------	------------------

Items	Default value	Config value for VSC8531	
		ETH0	ETH1
PHY-LSI Address	0	0	1
Select PHY	Default	VSC8541	VSC8541



(3) Add initialization code for VSC8531

The following code for VSC8531 initialization should be added to "ether_phy_targets_initialize_vsc8541" function in rzn/fsp/src/r_ether_phy/r_ether_phy.c. The inclusion of "board_som.h" is also required for code activation.

<pre>#include "board_som.h"</pre>			
~~ Omission ~~			
<pre>void ether_phy_targets_initialize_vsc8541 (ether_phy_instance_ctrl_t * p_instance_ctrl) {</pre>			
~~ Omission ~~			
<pre>/* LED Behavior */ reg = ether_phy_read(p_instance_ctrl, ETHER_PHY_REG_LED_BEHAVIOR); reg &= ~(1U << ETHER_PHY_REG_LED0_FEATURE_DISABLE_OFFSET); reg = 1U << ETHER_PHY_REG_LED1_FEATURE_DISABLE_OFFSET; ether_phy_write(p_instance_ctrl, ETHER_PHY_REG_LED_BEHAVIOR, reg); #if defined(BOARD_RZN2L_SOM_KIT) /* for VSC8531 */ /* select extended page 2 register */ ether_phy_write(p_instance_ctrl, ETHER_PHY_REG_EXTEND_GPI0_PAGE, 0x02);</pre>			
<pre>/* read WoL and MAC Interface Control */ reg = ether_phy_read(p_instance_ctrl, 0x1b);</pre>			
<pre>/* set control to slow */ reg &= 0xFF9F; ether_phy_write(p_instance_ctrl, 0x1b, reg);</pre>			
<pre>/* Configure RX_CLK delay and TX_CLK delay to 2.0ns */ ether_phy_write(p_instance_ctrl, ETHER_PHY_REG_EXPAGE2_RGMII_CTRL, 0x0044);</pre>			
<pre>/* select extended page 0 register */ ether_phy_write(p_instance_ctrl, ETHER_PHY_REG_EXTEND_GPI0_PAGE, 0x00); #endif</pre>			
<pre>} /* End of function ether_phy_targets_initialize() */</pre>			



Revision History

		Description	
Rev.	Date	Page	Summary
1.0	Aug. 7, 2023	-	First Edition issued



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

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

1. 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 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 systemevaluation test for the given product.

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