

## **Renesas RX Family**

## Azure RTOS TraceX for Azure RTOS ThreadX Debugging

## Introduction

Azure RTOS ThreadX is an RTOS from Microsoft Corporation and is based on a high-performance embedded kernel.

Azure RTOS TraceX is a Windows-based analysis tool for use with real-time operating systems. It provides embedded developers with a graphical view of real-time system events and enables them to visualize and better understand the behavior of their real-time systems.

This application note describes procedures for checking Azure RTOS ThreadX thread and object states (referred to as resources) during the development of applications in the e<sup>2</sup> studio. The procedure for installing and starting Azure RTOS ThreadX is also explained.

## **Target Device**

RX65N Group (R5F565NEHDFB)

## **Operating Environment**

Target Board	CK-RX65N
Integrated Development	e <sup>2</sup> studio version 2023-01
Environment (IDE)	
Compiler	CC-RX V3.04.00
Trace Tool	Microsoft Azure RTOS TraceX v6.1.12.0
OS	Microsoft Azure RTOS ThreadX v6.2.0

Note: Please download the installer for the IDE from the page at the URL linked below in advance.  $e^2$  studio -information for RX Family | Renesas

This application note has been adapted for RX-support from the following application note.

RA Family Azure RTOS TraceX for Azure RTOS ThreadX Debugging

Refer also to the following documents.

- RX Smart Configurator User's Guide: e<sup>2</sup> studio site: RX Smart Configurator User's Guide: e<sup>2</sup> studio
- Azure RTOS ThreadX documents on the Microsoft site: <u>Azure RTOS ThreadX documentation | Microsoft Learn</u> Azure RTOS TraceX documentation | Microsoft Learn



## Renesas RX Family

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## 1. Installing the e<sup>2</sup> studio

Install the  $e^2$  studio with reference to the videos related to procedures for installing the  $e^2$  studio at links from the following URL.

RX Family Software & Tool Course | Renesas

## 2. Installing Azure RTOS TraceX

Download Azure RTOS TraceX from the following Microsoft Store Apps site and install it.

Azure RTOS TraceX - Microsoft Store Apps



Figure 2-1 Microsoft Store Apps





## 3. Setting the CK-RX65N Board and Connection to the Host PC

Figure 3-1 CK-RX65N Board

Make a jumper setting on the board and connect the board to the host PC with a USB cable as shown below.



Figure 3-2 Jumper Setting and Connection between the CK-RX65N Board and the Host PC



## 4. Creating a ThreadX Project in the e<sup>2</sup> studio

Create a project by following the procedure below.

## 4.1 **Procedure for Creating a Project**

(1) Select the [File] menu  $\rightarrow$  [New]  $\rightarrow$  [Renesas C/C++ Project]  $\rightarrow$  [Renesas RX].

		search risjee	L IVE	enesas Views Run Window He	ab .	
1	New	Alt+Shift+N >		Renesas C/C++ Project	>	Renesas Debug
(	Open File			Project		Renesas RA
-	Open Projects from File System Recent Files			Example		Renesas RH850 Renesas RL78

Figure 4-1 Selecting a Project Type and a Device Family

(2) Select the "Renesas CC-RX C/C++ Executable Project" template and click on [Next] to continue.

Figure 4-2 Selecting an Executable Project



(3) In the next dialog box, enter a project name and click on [Next].

New Renesas CC-RX Executable Project	
New Renesas CC-RX Executable Project	
Project name: RX_AzureRTOSThreadX	
Use default location	
Location: C:¥Users¥a5090542¥e2_studio¥workspac	e9e¥RX_AzureRTOSThreadX Browse
Create Directory for Project	
Choose file system: default 🖂	
Working sets	
Add project to working sets	Ne <u>w</u>
Working sets:	✓ Select
YYUTNITU SEUS	

#### Figure 4-3 Entering a Project Name

(4) In the device selection dialog box, enter information on the device and tool.

New Renesas C	C-RX Executable Project		
Select toolchain	, device & debug settings		
Toolchain Setti Language:	●C OC+ Select V3.0	00/00 or a later	version.
Toolchain:	Renesas CC-RX	~	Select Azure RTOS.
Toolchain Versi	on: v3.05.00	~	None
		ge Toolchains	None
RTOS:	None	~	Azure RTOS
RTOS Version:	Select CK-RX65N for Ta	rget Board.	FreeRTOS (kernel only) FreeRTOS (with IoT libraries)
Device Settings		c	onfigurations
Target Board:	CK-RX65N	~ 6	Create Hardware Debug Configuration
	Download addit	tional boards	E2 Lite (RX) 🗸
Target Device:	R5F565NEHxFB	[	Create Debug Configuration
	<u>Ur</u>	nlock Devices	RX Simulator
Endian:	Little	~	NY OMITALO
Project Type:	Default	~ [	Create Release Configuration

Figure 4-4 Selecting the Board and OS



(5) Use the default settings of the Smart Configurator.



Figure 4-5 Smart Configurator Settings

(6) Select "ThreadX sample project".

New Renesas CC-RX Executable Project         Select RTOS Project Settings         Select application: <ul> <li>ThreadX sample project</li> <li>Project includes ThreadX, BSP, and CMT. This sample is the standard 8-thread ThreadX example, that illustrates the use of the main ThreadX services, including threads, message queues, timers, semaphores, byte memory pools, block memory pools, event flag groups, and mutexes                <li>FileX RAM Disk sample project         Project includes ThreadX, FileX, BSP, CMT. This sample illustrates the use of the FileX embedded FAT file system. The example creates a small RAM-disk with a sample file and data, and reads the file data back into memory                <ul> <li>MetX Duo Ping sample project</li> <li>This sample project illustrates the setup and use of NetX Duo IPv4/IPv6 TCP/IP stack via ping from another node on the local network. By default, this demonstration requests an II Address via DHCP and displays the status and assigned IP Address via terminal I/O window Note: default baudrate setting is 115200                <ul> <li>NetX Duo Iperf sample project</li> <li>This demonstration illustrates TCP and UDP network throughput, using Express Logic's NetX Duo IPv4/IPv6 TCP/IP stack, and the industry-standard Iperf network throughput</li> </ul></li></ul></li></li></ul>
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This sample project illustrates the setup and use of NetX Duo IPv4/IPv6 TCP/IP stack via ping from another node on the local network. By default, this demonstration requests an II Address via DHCP, and displays the status and assigned IP Address via terminal I/O window Note: default baudrate setting is 115200     NetX Duo Iperf sample project This demonstration illustrates TCP and UDP network throughput, using Express Logic's NetX Duo IPv4/IPv6 TCP/IP stack, and the industry-standard Iperf network throughput
O This demonstration illustrates TCP and UDP network throughput, using Express Logic's NetX Duo IPv4/IPv6 TCP/IP stack, and the industry-standard Iperf network throughput
benchmark, with Jperf GUI. Note: default baudrate setting is 115200
IoT Embedded SDK sample project

Figure 4-6 Selecting "ThreadX sample project"



(7) Click on [Finish] to complete project creation.

lew Renesas CC-RX Executable Project Settings The Contents of Files to be Generated		Ď
What kind of initialization routine would you like to create? Use Renesas Debug Virtual Console Size of I/O Stream Buffer: 3  C < Back Next > Eir	nish	Cancel

Figure 4-7 Completing Project Creation

(8) Select the current text editor.

Editors available on the Marketplace
Editors available on the Marketplace Better editor support for '*.md' files is available on the Marketplace.
Your '*.md' file was opened in a simple text editor. Better editor support is available on the Marketplace.
Associate "".md" files with current editor (Text Editor) and do not ask again
See also <u>Preferences for File Associations</u> OK Cancel

Figure 4-8 Selecting a Text Editor



## 4.2 Downloading a Component

Click on "RX\_AzureRTOSThreadX.cfg" to open the [Software component configuration] panel.

If the icon for "r\_cmt\_rx" is gray, the component is disabled. Download it as follows.



Figure 4-9 Downloading a Component



nt configuration	1	
Configure		
22		
The color of the	e icon has changed to	blue
bject		
	The color of the	The color of the icon has changed to

Figure 4-10 Component after Updating

Check the versions of the components on the [Overview] tabbed page.

RX_AzureRTOSThreadX.scfg ×				
Overview information			Generate Code Gener	ate Report
Browse related videos What's New Check out <u>what's new</u> in the latest re	elease.	RTOS Device Drivers	Configurator	
Product Documentation User manual and release notes Application Notes		MCU Hardware	9	
Tool news				
Current Configuration Selected board/device: R5F565NEHxFB (ROM size:				
<ul> <li>✓ Current Configuration</li> <li>Selected board/device: R5F565NEHxFB (ROM size: Generated location (PROJECT_LOC¥): src¥smc_generated location</li> </ul>		ount: 144) Edit		
✓ Current Configuration Selected board/device: R5F565NEHxFB (ROM size: Generated location (PROJECT_LOC¥): src¥smc_generated location (PROJECT_LOC¥): src¥smc_generated components:				
✓ Current Configuration Selected board/device: R5F565NEHxFB (ROM size: Generated location (PROJECT_LOC¥): src¥smc_generated location				
Current Configuration Selected board/device: R5F565NEHxFB (ROM size: Generated location (PROJECT_LOC¥): src¥smc_get Selected components:	n	Edit		
✓ Current Configuration Selected board/device: R5F565NEHxFB (ROM size: Generated location (PROJECT_LOC¥): src¥smc_get Selected components: Component	n Version	Edit		
Current Configuration Selected board/device: R5F565NEHxFB (ROM size: Generated location (PROJECT_LOC¥): src¥smc_get Selected components: Component Azure RTOS ThreadX	n Version 6.2.0_rel-rx-1.0.0	Edit Configuration threadx(used)		
Current Configuration Selected board/device: R5F565NEHxFB (ROM size: Generated location (PROJECT_LOC¥): src¥smc_get Selected components: Component Azure RTOS ThreadX Azure RTOS ThreadX AzureRTOS Object	n Version 6.2.0_rel-rx-1.0.0 1.0.112	Edit Configuration threadx(used) azurertos_object(used)		

Figure 4-11 Checking the Versions of the Components Used



## 4.3 Configuring Components

(1) Enable the trace events shown in the figure below under [Property] in the [Configure] panel for the ThreadX component.



Figure 4-12 Setting ThreadX Properties



(2) Open the [Software Component Selection] dialog box and add "Ports".

Software Component Selection         Select component from those available in list         Category All         Function       All         Filter       ~         Components       Short Name       Type         Version       Code Generator       1.11.0         Code Generator       2.3.0       Code Generator         How Power Consumption       Code Generator       2.3.0         Normal Mode Timer       Code Generator       1.2.0         PWM Mode Timer       Code Generator       2.4.0         Phase Counting Mode Timer       Code Generator       2.4.1         Proors       Code Generator       1.11.0         Water Dable       Code Generator       1.11.0         Voltage Detection Circuit       Code Generator       1.11.0         Show only latest version       Show only latest version       Show only latest version         Hide items that have duplicated functionality       Description       Show only latest version	Select component from those available in list	Select component from those available in list         Category       All         Function       All         Filter          Components       Short Name       Type         Version       Code Generator       1.11.0         Code Generator       2.3.0       Code Generator         Low Power Consumption       Code Generator       1.2.0         Normal Mode Timer       Code Generator       1.2.0         PMWM Mode Timer       Code Generator       1.2.0         Phase Counting Mode Timer       Code Generator       1.2.0         Phase Counting Mode Timer       Code Generator       1.1.0         Phors       Code Generator       1.1.0         Ports       Code Generator       1.5.0         Code Generator       1.5.0       Code Generator         Woltage Detection Circuit       Code Generator       1.5.0         Voltage Detection Circuit       Code Generator       1.5.0         Hide items that have duplicated functionality       Description       All         Dependency : r_cmt_rx version(s) 4.70       Dependency : r_gic.r_x version(s) 3.60       All	🕲 New Co	omponent				×
Function       All         Filter	Function       All         Filter	Function       All         Filter			st			
Components     Short Name     Type     Version       # IzC Slave Mode     Code Generator     1.11.0       # Interrupt Controller     Code Generator     2.3.0       # Low Power Consumption     Code Generator     2.3.0       # Normal Mode Timer     Code Generator     1.12.0       # PWM Mode Timer     Code Generator     1.12.0       # Phase Counting Mode Timer     Code Generator     2.4.0       # Ports     Code Generator     2.4.1       # Ports     Code Generator     2.4.1       # Ports     Code Generator     1.11.0       * Show only latest version     Yoltage Detection Circuit     Voltage Liems that have duplicated functionality       Description     Description     Version     Version	Components     Short Name     Type     Version         # Iz2 Slave Mode     Code Generator     1.11.0       # Interrupt Controller     Code Generator     2.3.0       # Low Power Consumption     Code Generator     2.3.0       # Normal Mode Timer     Code Generator     1.12.0       # PMM Mode Timer     Code Generator     1.12.0       # Phase Counting Mode Timer     Code Generator     2.4.0       # Ports     Code Generator     2.4.1       # Ports     Code Generator     1.10.0       * Otlage Detection Circuit     Code Generator     1.11.0       * Show only latest version     Yelde items that have duplicated functionality       Description     Dependency : r_cmt_rx version(s) 4.70       Dependency : r_gidcd_rx version(s) 3.60     A	Components       Short Name       Type       Version         It I2C Slave Mode       Code Generator       1.11.0         Interrupt Controller       Code Generator       2.3.0         Low Power Consumption       Code Generator       2.3.0         Normal Mode Timer       Code Generator       1.12.0         PWM Mode Timer       Code Generator       1.12.0         Phase Counting Mode Timer       Code Generator       2.4.0         Phorts       Code Generator       2.4.1         Port Output Enable       Code Generator       1.11.0         Voltage Detection Circuit       Code Generator       1.5.0         Voltage Detection Circuit       Code Generator       1.11.0         Version       Show only latest version       1.11.0         Hide items that have duplicated functionality       Description          Dependency : r_gic.r_x version(s) 4.70       Dependency : r_gic.r_x version(s) 2.46          Download the latest FIT drivers and middleware	Function					_
Image: Programmable Pulse Generator       1.5.0         Image: Programmable Pulse Generator       1.5.0         Image: Programmable Pulse Generator       1.11.0         Image: Pulse Generator	Image: Programmable Pulse Generator       1.5.0         Image: Programmable Pulse Generator       1.5.0         Image: Code Generator       1.11.0         Image: Show only latest version       Image: Code Generator         Image: Hide items that have duplicated functionality         Description         Dependency : r_glcdc_rx version(s) 1.50         Dependency : r_glcdc_rx version(s) 3.60	Programmable Pulse Generator Voltage Detection Circuit Show only latest version Hide items that have duplicated functionality Description Dependency: r_gicdc_rx version(s) 4.70 Dependency: r_gicdc_rx version(s) 1.50 Dependency: r_gicdc_rx version(s) 3.60 Dependency: r_gicdc_rx version(s) 2.46 Download the latest FIT drivers and middleware	I2C SI Intern Low Norm PWM	lave Mode rupt Controller Power Consumption nal Mode Timer 4 Mode Timer e Counting Mode Timer	Short Name	Type Code Generator Code Generator Code Generator Code Generator Code Generator Code Generator	1.11.0 2.3.0 2.3.0 1.12.0 1.12.0 2.4.0	^
Image Detection Circuit     Code Generator     1.11.0     v       Image: Show only latest version     Image: Show only latest version     Image: Show only latest version       Image: Hide items that have duplicated functionality     Image: Show only latest version     Image: Show only latest version       Image: Description     Image: Show only latest version     Image: Show only latest version     Image: Show only latest version	Workinge Detection Circuit                  What ge Detection Circuit          Code Generator          1.11.0                 Show only latest version               Code Generator          1.11.0                 Show only latest version               Description               A                 Dependency: r_cmt_rx version(s) 4.70               A                 Dependency: r_glodc_rx version(s) 3.60               A	Workspectrum     Code Generator     1.11.0       Show only latest version       Hide items that have duplicated functionality       Description       Dependency : r_gicdc_rx version(s) 4.70       Dependency : r_gicdc_rx version(s) 5.60       Dependency : r_gicdc_rx version(s) 2.46       Download the latest FIT drivers and middleware	H Ports			Code Generator	2.4.1	
Hide items that have duplicated functionality Description	✓ Hide items that have duplicated functionality         Description         Dependency : r_cmt_rx version(s) 4.70         Dependency : r_glocd_rx version(s) 1.50         Dependency : r_glocd_rx version(s) 3.60	✓ Hide items that have duplicated functionality         Description         Dependency : r_cmt_nx version(s) 4.70         Dependency : r_glicd_rx version(s) 1.50         Dependency : r_glicity reversion(s) 3.60         Dependency : r_sci_itic_nx version(s) 2.46         Download the latest FIT drivers and middleware						~
	Dependency : r_glcdc_rx version(s) 1.50 Dependency : r_gpio_rx version(s) 3.60	Dependency : r_glcdc_rx version(s) 1.50 Dependency : r_gpio_rx version(s) 3.60 Dependency : r_sci_iic_rx version(s) 2.46 Vownload the latest FIT drivers and middleware	Hide it	tems that have duplicated function	nality			

Figure 4-13 Adding "Ports"

#### (3) Configuring a port component

To control LED6 on the board, configure the corresponding port pin with the Smart Configurator.

LED6 LED2			
LED3	Indication on the Board	Color of LED	Connected Ports
	LED2	Color LED	P17, PA5, PA7
and the second	LED6	Red LED	P25
LED4	LED3	Green LED	P22
	LED4	Blue LED	PA3

Figure 4-14 LED to be Controlled on the Board

LED6 is connected to P25.

The following diagram shows the connection of LED6 on the board. As the LED turns on when 0 is output from the port pin, the initial output value should be set to 1.





Figure 4-15 Schematic of LED6 Connection

(4) Configuring PORT2

Select the checkbox for PORT2.

Software component co	onfiguration		
Comp $\succeq \  \  \  \  \  \  \  \  \  \  \  \  \ $	Configure		
type filter text	Port selection PORT2  PORT0  PORT2  PORT4  PORT4  PORT6  PORT8  PORTA  PORTA  PORTA  PORTC  PORTE	PORT1 PORT3 PORT5 PORT7 PORT9 PORTB PORTD PORTD	

Figure 4-16 Configuring PORT2



(5) Setting P25 as an output port pin

As the LED turns on when 0 is output from the port pin, set the initial value to "Output 1".

Port selection PORT	2						
Apply to all Unused GPIO	⊖ In	Out	Pull-up	CMOS output	~	Output 1	
P20							
Unused GPIO	OIn	Out	Pull-up	CMOS output	~	Output 1	High-drive output
P21							
Unused GPIO	OIn	Out	Pull-up	CMOS output	~	Output 1	High-drive output
P22							
Unused GPIO	OIn	Out	Pull-up	CMOS output	~	Output 1	High-drive output
P23							
Unused GPIO	$\bigcirc$ In	Out	Pull-up	CMOS output	~	Output 1	High-drive output
P24							
Unused GPIO	OIn	Out	Pull-up	CMOS output	~	Output 1	
P25							
O Unused GPIO	OIn	<ul> <li>Out</li> </ul>	Pull-up	CMOS output	~	Output 1	

Figure 4-17 Configuring P25

## 4.4 Generating Source Files

Click on the [Generate Code] button to generate source files.

📴 🖃 🕶 🔂 🕶 🧮
Information will be displayed on the
[Console] panel.
space9e\RX AzureRTOSThre
k

Figure 4-18 Reflecting the Configuration on Source Files



## 4.5 Editing Source Files

Open "hardware\_setup.c" in the project tree.



Figure 4-19 Opening a Source File in the Project Tree

Add the lines shown in red boxes below to "hardware\_setup.c".





Edit "tx\_api.h".



Figure 4-20 Target File and Content of Editing



#### 4.6 Building the Project

Build the project.

	Refactor Navigate Search Project Renesas Views R		
S 🕸 🔳	🎄 Debug 🗸 🔽 RX_AzureRTOSThreadX H	ardwareD 🗸 🌞 🗄 📩 👘 🛛 🐯 🔻 🖞	s <b>- ⊡</b> : ⊑ : ©
	New	>	
Project Explo	Go Into	dX.scfg demo_threadx.c ×	hardware_setup.c
> 💦 Binari	Open in New Window	<pre>#include "hardware_setup.h"</pre>	
> 🔊 Incluc	Show In Alt+Shift+V	<pre>&gt; #define DEMO STACK SIZE</pre>	1024
> 🔁 Hardv	Show in Local Terminal	<pre>&gt; #define DEM0_BYTE_POOL_SIZE</pre>	9120
> 🔂 libs > 🏳 src 📗	Copy Ctrl+0	#define DEMO_BLOCK_POOL_SIZE #define DEMO QUEUE SIZE	100 100
> 🗁 rto 👔	Paste Ctrl+		
> 🧁 sm 🗙	Delete Delete	/* Define the ThreadX object com	ntrol blocks
> .c dei > .c hai	Source	> TX THREAD thread (	a:
> h hai	Move	TX_THREAD thread_1	1;
> 🇭 trash	Rename F.	TX_THREAD thread_ TX_THREAD thread	
LICEN	Import	TX_THREAD thread_4	4;
A r01an	Export	TX_THREAD thread_ TX_THREAD thread	
📄 READI 🚖	Send project settings to Reality AI Tools®	TX_THREAD thread_	7;
RX_Az	Build Project Incremental Build of Selected	Projects EMAPHORE gueue_0	
🔅 RX_Az	Clean Project	TX_MUTEX mutex_0	;
SECUE ST	Refresh F	TX_EVENT_FLAGS_GROUP event_f: TX_BYTE_POOL byte pool	
0.0.1			1.0

Figure 4-21 Building the Project

On completion of the build process, check that no errors have occurred.



Figure 4-22 Results of Building



## 4.7 Executing the Project

Select a debug configuration and click on [Debug] to download and execute the program.



Figure 4-23 Selecting a Debug Configuration and Executing the Program



Figure 4-24 Appearance of the Board during Execution



## 5. Sample Project

The sample file "demo\_threadx.c" contains a standard ThreadX project, which has eight threads.

This sample project file illustrates how to use major services of ThreadX such as threads, a message queue, a timer, a semaphore, a byte memory pool, a block memory pool, an event flag group, and a mutex.

Select [Window]  $\rightarrow$  [Show View]  $\rightarrow$  [Outline] in the e<sup>2</sup> studio.



Figure 5-1 Selecting [Outline]

Select a thread in the outline view for "demo\_threadx.c" and the display will jump to the function of the selected thread.



Figure 5-2 A Thread Displayed in the Outline View



The comment at the beginning of each function is a summary of the processing by the thread. The summaries in the list below have been slightly modified for clarity from the summary comments in the code.

Thread	
Number	Processing by the Thread
0	This thread simply sits in a while-forever-sleep loop.
1	This thread simply sends messages to a queue shared with thread 2.
2	This thread retrieves messages placed on the queue by thread 1.
3	This function is executed as both thread 3 and thread 4. As can be seen from the loop in
4	the code, the threads run as this function alternate between ownership of semaphore_0.
5	This thread simply waits for an event in an endless loop.
6	This function is executed as both thread 6 and thread 7. As can be seen from the loop in
7	the code, the threads run as this function alternate between ownership of mutex_0.

#### Table 5-1 Summary of the Threads in the Sample Project



## 6. Setting the Trace Buffer for Use by TraceX

Azure RTOS TraceX displays the system event information collected by ThreadX that is being executed on the target embedded system.

Enabling analysis by TraceX requires that the program specify a trace buffer for use in analysis.

Use the following API function.

tx\_trace\_enable (VOID \*trace\_buffer\_start, ULONG trace\_buffer\_size, ULONG registry\_entries);

This API function enables event tracing in ThreadX. The application is required to specify the size of the trace buffer and the maximum number of ThreadX objects.

Open "demo\_threadx.c" and add the following global variable.

Project Explorer ×	- 0	RX_AzureRTC	SThreadX.scfg	mo_threadx.c × 🖻 hardware_setup.c
□ \$	7 8	21	TX_THREAD	thread_4;
RX_AzureRTOSThreadX	0 0	22	TX_THREAD	thread_5;
		23	TX THREAD	thread 6;
> 😹 Binaries		24	TX THREAD	thread 7;
> 🔊 Includes		25	TX_QUEUE	queue_0;
> 🔁 HardwareDebug		26	TX_SEMAPHORE	semaphore_0;
> 🔂 libs		27	TX_MUTEX	mutex_0;
		28	TX EVENT FLAGS	GROUP event flags 0;
V 🗁 src		29	TX BYTE POOL	byte pool 0;
> 🔁 rtos_config		30	TX BLOCK POOL	block pool 0;
> 🔁 smc_gen		31	UCHAR	<pre>memory_area[DEM0_BYTE_POOL_SIZE];</pre>
> c demo_threadx.c		32		
> c hardware setup.c		33	UCHAR	g_trace_buffer[ 16384 ];
		34	/* Define the d	counters used in the demo application */
h hardware_setup.h		35		

Figure 6-1 Adding a Global Variable

In addition, add the following API function to the tx\_application\_define function in "demo\_threadx.c".



#### Figure 6-2 Adding an API Function

- Notes: 1. The buffer size is set to 16384 in this example, but it can be set to a greater value such as 32768 if the RAM of the MCU has enough unused space.
  - 2. Build the project again after the global variable and API function have been added to "demo\_threadx.c".

For details, refer to the following page on the Microsoft educational site:

Chapter 5 - Generating trace buffers | Microsoft Learn



## 7. Using the [RTOS Resources] View

The e<sup>2</sup> studio has an RTOS resource view function that displays the state of Azure RTOS ThreadX resources. The following is a description of the procedure for using the [RTOS Resources] view.

## 7.1 Displaying the [RTOS Resources] View

The [RTOS Resources] view is only available while the debugger is running. Start the debugger and then select [Renesas Views]  $\rightarrow$  [Partner OS]  $\rightarrow$  [RTOS Resources]. After the [Select OS] dialog box is displayed, select "ThreadX" as shown in Figure 7-2. The [RTOS Resources] view will appear as shown in the figure.



Figure 7-1 Selecting [RTOS Resources]

		<sup>"hreadX</sup> ] Never sho	ow display	the Select OS at o	v			
E Console	ources X							
Profile Stack Thread MessageQueue	CountingSemapl	hore Mutex	EventFlag	MemoryBlockPool	MemoryBytePool	Timer	System	ReadyQueue(No.=Priority)
No. Name Entry Status	SuspendedF	actor(Contro	Block*)	OwnedTX_MUTEX*(t	op) Priority	RunCou	nt	

Figure 7-2 Selecting the OS and Displaying the [RTOS Resources] View



## 7.2 Context Menu

Display the context menu by right-clicking on the mouse with the cursor in the [RTOS Resources] view.

Cr Cr	Real-time Refresh Column > Real-time Refresh Interval	>	
619 000	Stack Setting		
S	Update information		
	Jump to source		
	Save File		
<b>@</b> <sub>R</sub>	Select OS		

Figure 7-3 Context Menu

#### • Real-time Refresh Column:

Enables or disables real-time updating of information displayed in the individual columns (tabbed pages). This is grayed out and not selectable while the program is running.

#### • Real-time Refresh Interval:

Specifies the interval for real-time updating of the display. The specifiable values are in the range from 500 ms to 10000 ms.

This is grayed out and not selectable while the program is running.

#### • Stack Setting:

Enables or disables loading of the stack data and specifies the threshold for the stack warning function. This is grayed out and not selectable while the program is running.

#### • Update information:

Updates the displayed information.

#### • Jump to source:

Opens an editor view displaying the source code of the task/thread or handler. Double-clicking on a task/thread or a handler also opens an editor view.

This is grayed out and not selectable while the program is running.

#### • Save File:

Saves the data on the currently selected tabbed page in a text file (\*.txt). This is grayed out and not selectable while the program is running.

#### • Select OS:

Opens the [Select OS] dialog box. This is grayed out and not selectable while the program is running.



## 7.3 Stack Setting

This is for enabling the loading of stack data and setting the stack threshold.

- a. Open the context menu and select [Stack Setting].
- b. To load stack data to the [RTOS Resources] view, check the [Enable loading Stack data] checkbox in the [Stack Setting] dialog box. If this option is not enabled, stack data will not be loaded in the next debugging session.
- c. A desired threshold value can be set in the [Stack Threshold (%)] textbox. Click on [OK] to save the setting. The value is set to 80% in this example.



Figure 7-4 Settings for the Stack



## 7.4 Tabbed Pages

Table 7-1 lists the items displayed on the individual tabbed pages.

Name of the Tabbed Page in the [RTOS Resources] View	Name of Displayed Information and Selection	Information to be Displayed			
Profile	The facilities of the [Profile] tabbed page are not currently available.	_			
Stack	Name	Names of the threads			
	Entry	Function that started each thread			
	StackPointer	Current stack pointer			
	StackStart	Address of the beginning of the stack			
	StackEnd	Address of the end of the stack			
	StackSize(bytes)	Stack size			
	MaxStackUsage(bytes)	Maximum amount of stack currently in use			
Thread	Name	Names of the threads			
	Entry	Function that started the given thread			
	Status	State of each thread			
	Suspended Factor (Control Block*)	Resource that is the source of suspension			
	OwnedTX_MUTEX*(top)	Top acquired mutex			
	Priority	Priority			
	RunCount	Number of times the thread has been executed			
MessageQueue	Name	Names of the message queues			
	UsedCount	Number of message queues in use			
	FreeCount	Number of available message queues			
	TotalCount	Total number of message queues			
	MessageSize	Message size			
	SuspendedTX_THREAD*(top)	Top waiting thread in the queue			
	SuspendedCount	Number of suspended threads			
	StartAddress	Address where the message queue starts			
	EndAddress	Address where the message queue ends			
CountingSemaphore	Name	Names of the semaphores			
	SemaphoreCount	Number of semaphores			
	SuspendedTX_THREAD*(top)	Top waiting thread in the queue			
	SuspendedCount	Number of suspended threads			
Mutex	Name	Names of the mutexes			
	OwnerTX_THREAD*	Acquiring thread			
	OwnerCount	Number of owners			
	SuspendedTX_THREAD*(top)	Top waiting thread in the queue			
	SuspendedCount	Number of suspended threads			
EventFlag	Name	Names of the event flags			
	Flag	Current flag pattern			
	SuspendedTX_THREAD*(top)	Top waiting thread in the queue			
	SuspendedCount	Number of suspended threads			

Table 7-1 Contents of Individual Tabbed Pages



## Renesas RX Family

## Azure RTOS TraceX for Azure RTOS ThreadX Debugging

MemoryBlockPool	Name	Names of the memory blocks			
	FreeCount	Number of available blocks			
	TotalCount	Total number of blocks			
	BlockSize(bytes)	Block size			
	TotalSize(bytes)	Total size of memory block pools			
	SuspendedTX_THREAD*(top)	Top waiting thread in the queue			
	SuspendedCount	Number of suspended threads			
	StartAddress	Top address of a memory block pool			
MemoryBytePool	Name	Names of the memory pools			
	Free(bytes)	Number of available bytes			
	Total(bytes)	Total size of memory byte pools			
	FragmentCount	Number of fragments			
	SuspendedTX_THREAD*(top)	Top waiting thread in the queue			
	SuspendedCount	Number of suspended threads			
	StartAddress	Address where the memory byte pool starts			
Timer	Name	Names of the timers			
	Remaining Tick	Remaining time in ticks			
	Re-initialization Tick	Cycle time in ticks			
System	SystemClock	System clock			
ReadyQueue(No. = Priority)	QueuedTX_THREAD*(top)	Top ready thread			



## 8. Starting Debugging of a Project with Azure RTOS TraceX

Select the [Run] menu  $\rightarrow$  [Debug] to launch the debugger.

Create a data file for Azure RTOS TraceX by following the procedure below.

## 8.1 Acquiring the Address of the TraceX Data Buffer

Use the [Add Watch Expression] menu to add "g\_trace\_buffer" in "demo\_threadx.c" to the expressions to be watched and acquire the address of the data buffer for Azure RTOS TraceX. The address is "0x736c" in the following example.

RX_AzureRTOSTh	nreadX.scfg	. demo_threadx.c $\times$	loc hardware_setup.c		(x)= Variables 💁 Break	poi 陷 Project E	🕵 Expressi 🔇
69	(* D-f		unter lasks like */	^		1 🕂 🕞	K % 🚺 🐝 🛛
70 71	/* Det:	ine what the initial s	ystem looks like. "/		Expression	Туре	Value
72 ffe09e25	⊖void	tx_application_define	e(void *first_unused_	memory)	gTimer	volatile uint8_t	0 '¥0'
73	{				> g_trace_buffer	UCHAR [16384]	0x736c <g_t< td=""></g_t<>
74 75 ffe09e2b	CHAR	<pre>*pointer = TX_NULL;</pre>			Add new expres	ssioi	
76 77 ffe09e34 78	_t	x_trace_enable( & <mark>g_tra</mark>	ce_buffer, 16384, 30	);			
79		Create a byte memory					
80 ffe09e40	tx	_byte_pool_create(&byte	e_pool_0, "byte pool	0", memory_a			

Figure 8-1 Acquiring the Address of the Data Buffer

## 8.2 Exporting a Data File for TraceX

Export a data file for TraceX by following the procedure below.

Execute the program with the  $\blacksquare$  button and then stop it with the  $\blacksquare$  button.

Profile	Stack Thre	ad Message	eQueue Counting	gSemaphore	Mutex	EventFlag	Men	noryBlockPool	MemoryBy	tePool	Timer	System	ReadyQ
No.	Name	Entry	Status	Suspende	edFactor	(ControlBlo	ck*)	OwnedTX_MI	JTEX*(top)	Priorit	ty	RunCour	nt
1	System T	_tx_tim	SUSPENDED					0000003a		0		58	
2	thread 0	_thread	SLEEP					0000000c		1		12	
3	thread 1	_thread	READY	_queue_0				0000d043		16		53343	
4	thread 2	_thread	RUNNING	_queue_0	Constant of the			0000d042		16		53343	
5	thread 3	_thread	SLEEP	_semaphe	ore_0			000003b		8		59	
6	thread 4	_thread	SEMAPHORE	_semapho	ore_0			000003b		8		59	
7	thread 5	_thread	EVENT_FLAG	_event_fla	ags_0			0000000c		4		12	
8	thread 6	thread	SLEEP	mutex 0				0000003b		8		59	

Figure 8-2 Information Displayed on the [Thread] Tabbed Page



#### **Renesas RX Family**

- a. Select [Window]  $\rightarrow$  [Show View]  $\rightarrow$  [Memory].
- b. Open the [Monitor Memory] dialog box and enter the address of the data buffer for Azure RTOS TraceX that was acquired in section 8.1.

Monitor Memory	×
Enter address or expression to r 0x736c	~
ОК	Cancel

Figure 8-3 Entering the Address for Monitoring

- c. Press the [Export] button to the right of the [Memory] tab.
- d. The [Export Memory] dialog box will pop up.
- d. For [Format], select "RAW Binary".
- f. For [Start address], enter the address of the TraceX data buffer that was acquired in section 8.1.
- g. For [Length], enter 16384\* as the size of the TraceX data buffer, "g\_trace\_buffer".
- h. For [File name], create a desired file name with the extension ".trx".
- i. Press [OK]. The data file for TraceX is then exported with the file name specified in (h).

🖳 Console 🌸 Smart Brows	er 🚺 Memory 🗙	RTOS Resources				010 1010
Monitors	÷ X 🖗	0x736c : 0x736C <hex int<="" th=""><th>teger&gt; 🗙 🕂</th><th>New Rendering</th><th>js</th><th></th></hex>	teger> 🗙 🕂	New Rendering	js	
Ox736c		Address	0 - 3	4 - 7	8 - B	C - F
		000000000007360	00000000	00004FCC	00004F3C	54585442
		0000000000007770	CCCCCCCC	00007266	00007205	00200000
Export Memory	-			— C		0000945C
					E	00800100
Format: RAW Binary	<ul> <li>✓ e.</li> </ul>			g.	Э	74737953
Start address: 0x736c	f End ad	dress: 0xb36c			В	00646165
Start address: 0x736c	f. End ad	dress: UXD36C	Length:	16384	в	00000800
File name: ¥RX_AzureRT	OSThreadX¥RX_Azure	RTOSThreadX.trx h.	Brov	vse	Э	65747962
					Э	00000000
_					9	01800100
?			O	( (	ancel	65726874

Figure 8-4 Exporting a Data File

Note: \* Enter the size specified in section 6, Setting the Trace Buffer for Use by TraceX.



#### Renesas RX Family

## 9. Launching Azure RTOS TraceX

Launch Azure RTOS TraceX that has been installed on the host PC.

Click on the [File] menu  $\rightarrow$  [Open] for Azure RTOS TraceX.

Select the TraceX data file "\*\*\*\*.trx" exported according to the steps in section 8.2.

Trace information will be shown in TraceX.

## 9.1 Display of Trace Information

Trace information can be displayed in either of the following two ways.

- Sequential view mode
- Time view mode

#### 9.1.1 Sequential View Mode

The sequential view shows events immediately followed by others without regard to the elapsed times between events. This mode is useful to get an overview of the system operation.

Azure RTOS TraceX 6.1.12.0 - [C:¥Users¥a505	90542¥e2_studio¥workspace9	¥RX_AzureRTOSThread>	(¥RX_AzureRTOSThread)	X.trx]	_	□×
<u>File View Options H</u> elp						
2 🚺 🖬 🗟 🔍 🦇	583 🔍	- <b>-</b>	• • 0	Event		0 Delta
Sequential View Time View						
Context Summary	tł	nread 2 (0x00004930)				
Event Summary	Q Q Q Q Q Q Q Q Q Q Q I Q 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	I Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q
Event ID	60	70	80	90 100	110	120
	_ <u></u>					
Interrupt	<u> </u>					
Initialize/Idle						
System Timer Thread (0x00004250) [Priority: 0]						
Thread 0 (0x00004780) [Priority: 1]						
Thread 1 (0x00004858) [Priority: 16]	Q Q Q Q Q Q Q Q Q Q Q I 5 5 5 5 5 5 5 5 5 5 5 5 5					
Thread 2 (0x00004930) [Priority: 16]	Q	I Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q Q	Q Q Q Q Q Q Q Q Q Q R R R R R R R R R R
Thread 3 (0x00004A08) [Priority: 8]						
Thread 4 (0x00004AE0) [Priority: 8]						
Thread 5 (0x00004BB8) [Priority: 4]						
Thread 6 (0x00004C90) [Priority: 8]						
Thread 7 (0x00004D68) [Priority: 8]						
	<					>
	¢					>

Figure 9-1 Display in the Sequential View



## 9.1.2 Time View Mode

This mode is useful to find the locations where the bulk of processing takes place in the system and can help the user to tune the system for better performance or responsiveness.

Sequential View Time View Context Summary Event Summary Time (Ticks)		thread 2	(0x000049 <mark>t</mark>	read 1 (0x	000048 <sup>th</sup>	<b>a</b> rread 2 (0:	0	Event					0 De
Context Summary Event Summary Time (Ticks)			(0x000049th	nread 1 (0x	(000048 th	nread 2 (0:	x000049						
Event Summary Time (Ticks)			(0x000049.tl	hread 1 (0x	(000048 <mark>t</mark> h	nread 2 (0:	x000049						
Time (Ticks)													
		10	0	200		300		400	500	600		700	
Interrupt	1111	սոր		سلب	шш	цш	шц	ىبىل	 Luu	 վա	ш	سلب	ш
Initialize/Idle													
System Timer Thread (0x00004250) [Priority: 0]													
Thread 0 (0x00004780) [Priority: 1]													
Thread 1 (0x00004858) [Priority: 16]													
Thread 2 (0x00004930) [Priority: 16]													
Thread 3 (0x00004A08) [Priority: 8]			-										
Thread 4 (0x00004AE0) [Priority: 8]													
Thread 5 (0x00004BB8) [Priority: 4]													
Thread 6 (0x00004C90) [Priority: 8]													
Thread 7 (0x00004D68) [Priority: 8]													

Figure 9-2 Display in the Time View

## 9.2 Analysis Facilities of TraceX

For details of the analysis facilities, see [Help]  $\rightarrow$  [Manual].

Refer to the following descriptions in "<u>Chapter 3 – Description of Azure RTOS TraceX</u>" of the *TraceX User Guide* | Microsoft Docs.

- Sequential View Mode
- Time View Mode

Also refer to the following descriptions in "<u>Chapter 4 - Azure RTOS TraceX performance analysis</u>" of the *TraceX User Guide* | Microsoft Docs.

- Execution Profile
- Popular Services
- Thread Stack Usage
- Performance Statistics
- FileX Statistics
- NetX Statistics
- Trace File Information



## Website and Support

Visit the following URLs to learn about key elements of the RX family, download components, and related documentation, and get support.

RX Family Product Information

RX Family Product Support Forum

www.renesas.com/rx www.renesas.com/rx/forum www.renesas.com/support

Renesas Support



## **Revision History**

		Description	n
Rev.	Date	Page	Summary
1.00	Mar. 01, 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.

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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