

# Azure RTOS sample projects using e<sup>2</sup> studio or IAR EW

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#### **Important Notice:**

#### Notice 1:

On November 21, 2023, Microsoft announced that they have decided to contribute Azure RTOS to Open Source under the stewardship of the Eclipse foundation and Azure RTOS becomes Eclipse ThreadX.

For detailed information, please refer to the announcement titled at Microsoft Contributes Azure RTOS to Open Source.

The support strategy scheme for Eclipse ThreadX will be determined and communicated at a later date.

Microsoft will discontinue the Azure RTOS and Azure RTOS Middleware under the existing agreement LICENSED-HARDWARE.txt.

It's important to note that updates for Azure RTOS on these hardware will no longer be provided.

#### Notice 2:

Renesas announces to discontinue the existing Sequans-sourced LTE module known as the part number RYZ014A and will no longer be shipping this product.

With the discontinuation of RYZ014A, the CK-RX65N v1 board will also be discontinued. If you are using RYZ014A in a current design or production, the Sequans part numbers, GM01Q is a pin and functionally compatible replacement for RYZ014A.

Below Cellular driver of RX family works the below alternate product combination. - RYZ014A Cellular Module Control Module : Sequans GM01Q is the compatible module.

Regarding EOL notice of the RYZ014A, please see :

[The link] <u>https://www.renesas.com/us/en/document/eln/plc-240004-end-life-eol-process-select-part-</u>numbers?r=1503996

[The product page] <u>https://www.renesas.com/us/en/products/wireless-connectivity/cellular-iot-modules/ryz014a-lte-cat-m1-cellular-iot-module</u>



## Introduction

Azure RTOS sample projects for each component (ThreadX, FileX, GUIX, NetX Duo, and USBX) can be created using Renesas e<sup>2</sup> studio or IAR Embedded Workbench (EW) with the on-board emulator. All samples are designed to run on RX family.

This document guides how to create and use these sample projects.

## **Supported Sample Projects**

- ThreadX sample project Contains ThreadX source code
- Minimal sample project

Contains ThreadX source code

Simplest sample for ThreadX

- FileX RAM Disk sample project Contains FileX source code
- NetX Duo Ping sample project Contains NetX Duo ping sample project
- NetX Duo Iperf sample project Contains NetX Duo iPerf sample project
- **IoT Embedded SDK sample project** Sample project to connect to Azure IoT Hub using Azure IoT Middleware for Azure RTOS
- IoT Embedded SDK PnP sample project (Available up to Azure RTOS v.6.2.1\_rel-rx-2.0.0) Sample project to connect to Azure IoT Hub using Azure IoT Middleware for Azure RTOS via IoT Plug and Play
- GUIX 8bpp sample project Contains sample for GUIX 8BPP
- GUIX 16bpp sample project Contains sample for GUIX 16BPP
- GUIX 16bpp draw 2d sample project Contains sample for GUIX 16BPP with 2D Draw
- USBX device CDC-ACM Class sample project Contains USBX source code
- USBX Host Mass Storage Class sample project Contains USBX source code
- USBX Host Communication Device Class (CDC-ACM) sample project Contains USBX source code
- ThreadX Low Power sample project Contains ThreadX & low power utility source code
- Azure Device Update (ADU) sample project Sample project for OTA firmware update via Microsoft Azure
- Secure bootloader sample project Used together with ADU sample project to provide a secure boot

Supported Devices

- RX130
- RX140
- RX23E-B
- RX26T



- RX65N
- RX651
- RX660
- RX66T
- RX671
- RX72N

#### **Table 1 Supported Kits**

Device	vice RX65N			RX651	RX130	RX140	RX23E-B	RX26T	RX660	RX66T	RX72N	RX671	
Board	RSK	Cloud Kit	New CK	New CK	RSK RX65N	Target Board	RSK	RSSK	МСВ	RSK	RSK	Envision Kit	RSK
Connectivity	Ethernet	Wi-Fi	Ethernet	Cat M1	-	-		-	-		-	Ethernet	Wi-Fi
ThreadX sample	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimal sample	0	0	0	0	0	0	0	0	0	0	0	0	0
FileX sample	0	0	0	0	0	0	0	0	0	0	0	0	0
Ping sample	0	0	0	-	-	-	-	-	-	-	-	0	0
Iperf sample	0	-	0	-	-	-	-	-	-	-	-	0	-
IoT Embedded SDK sample	0	0	0	-	-	-	-	-	-	-	-	0	0
loT Embedded SDK sample using EWF	-	-	-	0	-	-	-	-	-	-	-	-	-
loT Embedded SDK PnP sample	0	0	0	-	-	-	-	-	-	-	-	0	0
loT Embedded SDK PnP sample using EWF	-	-	-	0	-	-	-	-	-	-	-	-	-
GUIX (8bpp, 16bpp, draw 2d) sample	0	-	-	-	-	-	-	-	-	-	-	0	-
USBX PCDC sample	0	0	0	0	-	-	-	-	-	-	-	-	-
USBX HMSC sample	0	-	0	0	-	-	-	-	-	-	-	0	0
USBX HCDC sample	0	-	0	0	-	-	-	-	-	-	-	0	0
Threadx Low Power sample	0	0	0	0	0	0	0	0	-	0	-	0	0
ADU sample	0	0	0	-	-	-	-	-	-	-	-	0	0
Bootloader sample	0	0	0	-	-	-	-	-	-	-	-	0	0

Supported sample projects are different by each device. For details, please refer to the following URL.

https://github.com/renesas/azure-rtos

## **Download Links for Development Environment**

• <u>e<sup>2</sup> studio : 2024-04 or later</u>

https://www.renesas.com/software-tool/e-studio

- Renesas C/C++ Compiler for RX Family CC-RX : V3.06.00 or later https://www.renesas.com/software-tool/cc-compiler-package-rx-family
- GCC for Renesas RX : 8.3.0.202311 or later https://gcc-renesas.com/rx-download-toolchains/
- IAR Embedded Workbench for RX : 4.20.1 or later

https://www.iar.com/products/architectures/renesas/iar-embedded-workbench-for-renesas-rx/

- RX Smart Configurator : V2.21.0 and later https://www.renesas.com/software-tool/smart-configurator
- Azure IoT Explorer

https://github.com/azure/azure-iot-explorer/releases



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## 1. Getting Started

To create new Azure RTOS project, the procedure is different between e<sup>2</sup> studio and IAR EW.

## 1.1 Creating project using e<sup>2</sup> studio

1. Launch e<sup>2</sup> studio, create new project: [File] > [New] > [Renesas C/C++ Project] and select Renesas RX and create a new workspace.

📴 e² studio I	Launcher X
	rectory as workspace es the workspace directory to store its preferences and development artifacts.
Workspace:	D\demo v Browse
Use this  Recent Wo	as the default and do not ask again <b>srkspaces</b>
	Launch Cancel

Figure 1.1 Workspace Creation Window

2. Select GCC for Renesas RX C/C++ Executable Project or Renesas CC-RX C/C++ Executable Project.

**Note :** For those who use CC-RX Evaluation Edition. After the trial period, the CC-RX features become limited to restrictions on the linkage size. RX Azure RTOS sample will exceed this restriction. Consider updating CC-RX Professional edition or using GCC for Renesas RX C/C++ Executable.

🕲 New C/C++ I	Project – 🗆 🗙
Templates for	Renesas RX Project
All C/C++	GCC for Renesas RX C/C++ Executable Project
	GCC for Renesas RX C/C++ Library Project
	<b>Renesas CC-RX C/C++ Executable Project</b>
	Renesas CC-RX C/C++ Library Project
	/
?	< Back Next > Finish Cancel

Figure 1.2 Toolchain Setting Window

- 3. Input the project name.
- 4. Click [Next].



8		- 🗆 X
	as CC-RX Executable Project s CC-RX Executable Project	Ď
Project nam	e: demo	
🗹 Use defa	ult location	
Location:	D:\demo\demo	Browse
	Create Directory for Project	
	system: default ~	
Working se	5	
Add pro	ject to working sets	New
Working se	ts:	<ul> <li>Select</li> </ul>
0	< Back Next > Finish	Cancel

Figure 1.3 Project Creation Window

- 5. At RTOS, select "Azure RTOS".
- 6. Click Manage RTOS Versions... to download software package.
- 7. At **RTOS Version**, select a version that downloaded at step 6.
- 8. At Target Board, select a board that you are working on. Configurations are automatically set based on the target board.
- 9. Click [Next].

G		- 🗆 X
New	w Renesas CC-RX Executable Project	
Sele	lect toolchain, device & debug settings	
Lan Too Too	oolchain Settings           anguage:         © C \ C++           oolchain:         Renesas CC-RX           oolchain Version:         v3.06.00           Manage Toolchains.         Manage Toolchains.           TOS:         Azure RTOS	
RTC	TOS Version: 6.4.0_rel-rx-1.0.0  Manage RTOS Versions	
Der	Device Settings	Configurations
Tara	arget Board: CX-RX6SN V arget Device RSF36SNEH+FB  Intock Devices Endian: Little V Bank Mode Single Bank V	Create Hardware Debug Configuration E2 Lite (RX) Create Debug Configuration RX Simulator Create Release Configuration
0	Reck Nex	xt > Finish Cancel



10. Click [Next].

<b>0</b> - • ×
New Renesas CC-RX Executable Project
Use Smart Configurator Use Peripheral Code Generator
Smart Configurator is a single Lue Infinites that controlless the functionalities of Code Generator and II. Configurator with the infinite configuration with the functionalities of Code Generator and III. Configurator with the infinite configuration wile, interrupt configuration wiles and pin configurator in a conception of the infinite configuration wile, interrupt configuration wiles and pin configurator in a configuration wile, interrupt configuration wiles and pin configurator in a wandhal only for the supported Antonia. Ended Configurator is a wandhal only for the supported Antonia. Ended Configurator is a wandhal only for the supported Antonia. Ended Configurator is a wandhal only for the supported Antonia. Ended Configurator is a wandhal on the configuration in the functional of the supported Antonia. Ended Configurator is a wandhal on the supported Antonia. Ended Configurator is a wandhal on the supported Antonia. Ended Configurator is a wandhal on the supported Antonia. Ended Configurator is a sublicit on the sublicit on
⑦ < Back Next > Finish Cancel

Figure 1.5 Coding Assistant Setting Window



- 11. Select an application.
- 12. Click [Finish].



Figure 1.6 Select Application Window

13. Azure RTOS sample project including each component is created.

demo - demo/demo.scfg - e <sup>2</sup> studio File Edit Navigate Search Project Renesas Vi	un Run Mendeus Hale		- a ×				
	wareDebug Y 💿 📑 🕶 🗟 🕲 💌 🐐 🗣 🗃 🗐 🖉 🧭	en en la companya de	a e Senanenel -				
S S Debug C Debug	watebeoog • • Ica • tarto • • • • • • • al al • ! •						
	I □ □ @ demo.scfg ¤		< ার্জ টে/C++ 🕏 Smart Configurator				
► Project Explorer × E % 7 × ≦ demo (HardwareDebug)			MCU/MPU Package   MMU Layout				
demo [HardwareDebug] Indudes	Overview information	Generate Code Generate Report	🖺 🔺 🖉 🖉 🖻 Type pin function 🔹 Assigned 🔾 Default Roard				
> as libs	Allow general pin configuration and pin config	uration for selected software component					
> 👄 src	· · · · · · · · · · · · · · · · · · ·						
> 🐸 trash	Interrupt						
# demo.scfg	Allow general interrupt configuration and inter	rupt configuration for selected software component					
demo HardwareDebug.launch							
	Click here to get more information on User's	Anual, Release Note Application Notes Tool News					
	<ul> <li>Current Configuration</li> </ul>		RENESAS				
	Selected board/device: R5F565NEDxFC (ROM						
	Generated location (PROJECT_LOC\): src\smc_	Generated location (PRO/ECT_LOC): srctsmc.gen Edit Excess Selected components: extreminence					
	Selected components:						
	Component Versi		•				
		1_reL. threadx(used)	Address Construction (Address Construction Construction)				
	AzureRTOS Object     1.0.1		1				
	Board Support Packages. (r_bsp) 7.10     CMT driver (r cmt n) 5.10	r_bsp(used) r_cmt_rx(used)					
	< Store 10 - 5.10	r_cmt_ix(used)					
	Overview Board Clocks System Components F	ing Internunte	► Legend				
Console		T T Configuration Problems					
		0 items					
Smart Configurator Output M03000004: File modified:src\smc ger	\r config\r bsp config.h	Description	Type				
M00000002: Code generation is succes	sful:D:\demo\demo\src\smc_gen						
<		<b>`</b>					
		Ø demo					

Figure 1.7 Created Sample Project Window

- 14. Build project: Select the sample project in the e<sup>2</sup> studio workspace and right click and select build to build the sample project.
- 15. Make sure that target board is set to Debug mode in Jumper Settings. For the detail, see each board User manual.
- 16. Select Download and Debug to download and start execution of the project. By default, execution stops at a breakpoint set at main.

Note: Other debugger settings may be required depending on the board type you specify.

In the case of Renesas Starter Kit+ for RX65N-2MB: click **Debugger > Connection Settings > Power Target From The Emulator**, and set **No**.

17. Please review the sample descriptions later in this guide for additional setup and expected behavior.

## 1.2 Creating project using IAR EW

Please refer to following FAQ for the detailed instructions: English : <u>https://en-support.renesas.com/knowledgeBase/20533128</u> Japanese : <u>https://ja-support.renesas.com/knowledgeBase/20533124</u>



## 2. Sample Project Descriptions

Additional setup and expected behavior of each sample project are described in this section.

## 2.1 ThreadX sample project

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.

#### Supported Kits :

- Target Board for RX130
- Renesas Starter Kit for RX140
- Renesas Solution Starter Kit for RX23E-B
- MCB-RX26T Type A/B/C
- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit
- Renesas RX65N Cloud Kit
- Renesas Starter Kit for RX660
- Renesas Starter Kit for RX66T
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit

To run this sample, simply follow these steps (assuming the steps described in the previous section were done):

- 1. Set a breakpoint at any line.
- 2. Select Go to start execution of the sample project.



Figure 2.1 e<sup>2</sup> studio Debugger Screen





Figure 2.2 IAR EW Debugger Screen

After hitting **Break**, the debugger screen shot above shows various counters incremented by the ThreadX sample as each of the main components of the ThreadX are exercised.

To learn more about Azure RTOS ThreadX, view https://docs.microsoft.com/azure/rtos/threadx/.



## 2.2 Minimal sample project

This is minimal sample with one thread. It illustrates the usage of main ThreadX service. The sample outputs the message to serial terminal and blinks LED every second.

#### Supported Kits:

- Target Board for RX130
- Renesas Starter Kit for RX140
- Renesas Solution Starter Kit for RX23E-B
- MCB-RX26T Type A/B/C
- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit
- Renesas RX65N Cloud Kit
- Renesas Starter Kit for RX660
- Renesas Starter Kit for RX66T
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit

To run this sample, simply follow these steps (assuming the steps described in the previous section were done):

#### [For RX130 Target Board and MCB RX26T]

- 1. Select **Go** to start execution of the sample project
- 2. Open "Renesas Debug Virtual Console" .



Figure 2.3 Renesas Debug Virtual Console



3. As the project runs, it will output "Hello, RX AzureRTOS sample" to serial terminal per one second, and it will blink an LED on the board per one second.



## Figure 2.4 Minimal sample output [For target boards except for RX130 Target Board and MCB RX26T ]

1. Verify the serial port in your OS's device manager. It should show up as a COM port



Figure 2.5 Device Manager

2. Open your favorite serial terminal program such as Putty and connect to the COM port discovered above. Configure the following values for the serial port:

Baud rate: **115200** Data bits: **8** Parity: **none** Stop bits: **1** Flow control: **none** 

- 3. Select Go to start execution of the sample project
- 4. As the project runs, it will output "Hello, RX AzureRTOS sample" to serial terminal per one second, and it will blink an LED on the board per one second.

💆 COM4 - Tera Term VT	_	×
File Edit Setup Control Window Help		
Hello, RX AzureRTOS sample. [0] Hello, RX AzureRTOS sample. [1] Hello, RX AzureRTOS sample. [2] Hello, RX AzureRTOS sample. [3] Hello, RX AzureRTOS sample. [4] Hello, RX AzureRTOS sample. [5] Hello, RX AzureRTOS sample. [6] Hello, RX AzureRTOS sample. [7] Hello, RX AzureRTOS sample. [8] Hello, RX AzureRTOS sample. [8]		*

Figure 2.6 Minimal sample output



Board	LED
CK-RX65N	LED4
RX65N Cloud Kit	LED1
RSK RX65N-2M	LED0
RSK RX671	LED2
RX72N Envision Kit	LED2
RX130 Target Board	LED0
RSK RX140	LED0
RX660-Starter-Kit	LED0
RX66T-Starter-Kit	LED0
MCB RX26T	LED1
RSSK RX23E-B	LED1

## Table 2 Assigned LED on the board

## 2.3 FileX RAM Disk sample project

This sample illustrates the use of the FileX embedded FAT file system. The example creates a small RAMdisk with a sample file and data, and reads the file data back into memory. The debugger can show the data being read.

#### Supported Kits:

- Target Board for RX130
- Renesas Starter Kit for RX140
- Renesas Solution Starter Kit for RX23E-B
- MCB-RX26T Type A/B/C
- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit
- Renesas RX65N Cloud Kit
- Renesas Starter Kit for RX660
- Renesas Starter Kit for RX66T
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit

To run this sample, simply follow these steps (assuming the workspace is already open):

- 1. Open **sample\_filex\_ram\_disk.c** and set a breakpoint around Line 201 at if (status != FX\_SUCCESS)
- 2. Select Go to start execution of the sample project
- 3. In the **Expression** window for e<sup>2</sup> studio or **Watch** window for IAR EW, ensure you watch the **local\_buffer** variable as expression.









Figure 2.8 IAR EW Debugger Screen

The debugger screen shot above shows the file data read back in the RAM disk sample.

To learn more about Azure RTOS FileX, view <a href="https://docs.microsoft.com/azure/rtos/filex/">https://docs.microsoft.com/azure/rtos/filex/</a>.



## 2.4 NetX Duo Ping sample project

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 IP Address via DHCP, and displays the status and assigned IP Address via Terminal program.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit (Ether)
- Renesas RX65N Cloud Kit
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit
- To run this sample project, simply follow these steps (assuming the workspace is already open):
- 5. Verify the serial port in your OS's device manager. It should show up as a COM port



## Figure 2.9 Device Manager

6. Open your favorite serial terminal program such as Putty and connect to the COM port discovered above. Configure the following values for the serial port:

Baud rate: **115200** Data bits: **8** Parity: **none** Stop bits: **1** Flow control: **none** 

- 7. Select **Go** to start execution of the sample project
- 8. As the project runs you should observe the IP address assigned via DHCP in the output window



## Figure 2.10 IP Address Assigned via DHCP

9. The example above shows that the assigned IP address of the RX MCU is 192.168.2.115. When the demonstration is running it can be pinged by any machine on the network. The following is an example of a ping from a Windows machine on the same local network (using the DOS command window).





Figure 2.11 Ping Response

To learn more about Azure RTOS NetX Duo, view https://docs.microsoft.com/azure/rtos/netx/.



## 2.5 NetX Duo Iperf sample project

This demonstration illustrates TCP and UDP network throughput, using NetX Duo IPv4/IPv6 TCP/IP stack, and the industry-standard Iperf network throughput benchmark, with Jperf GUI. By default, this demonstration requests an IP Address via DHCP, and displays the status and assigned IP Address via Terminal program.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit (Ether)
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit

To run the NetX Duo Iperf Sample project, simply follow these steps (assuming the workspace is already open):

Note: This sample is Ethernet based and therefore assumes an Ethernet cable is connected to the Ethernet connector on the board.

1. Verify the serial port in your OS's device manager. It should show up as a COM port.

#### Figure 2.12 Device Manager

2. Open your favorite serial terminal program such as Putty and connect to the COM port discovered above. Configure the following values for the serial port:

Baud rate: **115200** Data bits: **8** Parity: **none** Stop bits: **1** Flow control: **none** 

- 3. Select **Go** to start execution of the sample project.
- 4. As the project runs you should observe the IP address assigned via DHCP in the output window.

SCOM10 - PuTTY	-		
DHCP In Progress IP address: 10.172.14.40 Mask: 255.255.254.0 <mark>.</mark>		^	
		~	

#### Figure 2.13 IP address assigned via DHCP

5. Once running, simply browse to target IP address (in the screen shot above it is 10.172.14.40) to view the NetX Duo Iperf server page, which provides options for running each Iperf test as well as displays the results of each test. Here is as sample view after browsing 10.172.14.40:



Azure RTOS sample projects using e2 studio or IAR EW

	>
$\begin{array}{ c c c c c c c c } \hline \square & \text{NetX IPerf Demonstration} & \textbf{x} & \textbf{+} \\ \hline \leftarrow & \rightarrow & \bigcirc & \bigcirc & \bigcirc & \text{Not secure} & 10.172.14.40 \end{array}$	Q ☆ @ 0 0
O Vot secure   10.172.14.40	<u> </u>
Microsoft Azure	N E T 🗶
NetX IP Address: 10.172.14.40 fe80:0:0:0:0:0:0:3Start UDP Transmit Test Destination IP Address: Test Time(Seconds):Destination Port: Exact Size:Start UDP Receive Test Test Time(Seconds):Start TCP Transmit Test Destination IP Address: Exact Size:Start TCP Transmit Test Destination Port: Exact Size:Start TCP Transmit Test Destination IP Address: Exact Size:Destination IP Address: Exact Time(Seconds):10Start TCP Receive Test Test Time(Seconds):Test Time(Seconds):10	Choose a test from the left.

Figure 2.14 NetX Duo Iperf Server Page

Note: Static IP address assignment is also possible by disabling NX\_ENABLE\_DHCP in the project settings and modifying the default static IP address of 192.168.1.211 in the source file "sample\_netx\_duo\_iperf.c" file. To learn more about Azure RTOS NetX Duo, view <a href="https://docs.microsoft.com/azure/rtos/netx/">https://docs.microsoft.com/azure/rtos/netx/</a>.



## 2.6 IoT Embedded SDK sample project

This demonstration connects to Azure IoT Hub using Azure IoT middleware for Azure RTOS. This demonstration also publishes the message to IoT Hub every few seconds.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit (Ether/ Cellular)
- Renesas RX65N Cloud Kit
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit

It is also possible to view device properties, view device telemetry, update device twin, call a direct method on device and send cloud-to-device message using Azure IoT Explorer.

Following videos guide how to set up and run this Azure RTOS sample project in detail. This video uses CK-RX65N to introduce, but the setup follow is common to every board.

Azure RTOS Tutorial (1/3) CK-RX65N Azure RTOS Tutorial (2/3) CK-RX65N: Program Build Azure RTOS Tutorial (3/3) CK-RX65N: Cloud Operation

Projects with cellular connectivity have "with EWF" at the end of the project name on Select Application Window.

 Prepare Azure resources such as creating an IoT Hub and registering an IoT device by referring Microsoft document.
 For details, places refer to the Application Nate (DX65N Groups Visualization of Sensor Data using

For details, please refer to the <u>Application Note (RX65N Group: Visualization of Sensor Data using RX65N Cloud Kit and Azure RTOS</u>), specifically chapters 3.1.

- 2. Confirm that you have the copied the following values to use in the next step.
  - hostname
  - deviceID
  - primaryKey
- 3. Open **sample\_config.h** to set the Azure IoT device information constants to the values that you saved in step 2.

Constant name	Value
HOST_NAME	{Your loT hub hostName value}
DEVICE_ID	{Your deviceID value}
DEVICE_SYMMETRIC_KEY	{Your primaryKey value}

4. **[Wi-Fi]** Open **main.c** to set the Wi-Fi network parameters when you use the boards of which connectivity is Wi-Fi.

Constant name	Value
WIFI_SSID	{Your Wi-Fi SSID value}
WIFI_PASSWORD	{Your Wi-Fi password}

5. **[Cellular]** Open **scfg file in your project** and choose components on the tab. Then click **ewf** in components on the left side and **set** your **SIM APN** in "The SIM operator APN".



Software component configuration
Components 🚵 🚵 $\mathbb{P}_{\mathbb{Z}}  \boxdot  \mathfrak{P}_{\mathbb{Z}}  \mathfrak{D}$ Configure
yper filter test yper filter test

- 6. **[Ethernet]** You don't need to set specific parameters when you use the boards of which connectivity is ethernet.
- 7. Verify the serial port in your OS's device manager. It should show up as a COM port.

Figure 2.15 Device Manager

8. Open your favorite serial terminal program such as Putty and connect to the COM port discovered above. Configure the following values for the serial port:

Baud rate: **115200** Data bits: **8** Parity: **none** Stop bits: **1** Flow control: **none** 

- 9. Build project
- 10. Select **Download and Debug** to download and start execution of the project
- 11. As the project runs, the demo prints out status information to the terminal output window. The demo also publishes the telemetry message to IoT Hub every few seconds. Check the terminal output to verify that messages have been successfully sent to the Azure IoT hub.

Initializing Wi-Fi Wi-Fi connected. IP address: 192.168.0.5 Mask: 255.255.255.0 Gateway: 192.168.0.1 Syncing time Time server IP address: 132.246.148.30 Time: 1632723050 Time: 1632723050 Time: Sync successful. IoTHub Host Name: Connected to IoTHub. Telemetry message send: ["Message ID":0].
Telemetry message send: ["Message ID":4]. Telemetry message send: ["Message ID":5]. Telemetry message send: ["Message ID":6]. Telemetry message send: ["Message ID":7].

Figure 2.16 Status Information and Telemetry Message



You can use the **Azure IoT Explorer** to view and manage the properties of your devices. In the following steps, you'll add a connection to your IoT hub in IoT Explorer.

- 1. Download and install latest (above v0.14.5) Azure IoT Explorer from: <u>https://github.com/Azure/azure-iot-explorer/releases</u>
- Copy the connection string: <u>Microsoft Azure Portal</u> > sign in > select your IoT Hub > [Share access policies] > [iothubowner] > [Primary connection string].

Home >			iothubowner	×
	Shared access	policies 🖈 …		
IoT Hub     Search (Ctrl+/)	Shared access policies may be used to g	generate security tokens to consume IoT hub functional	Regenerate primary key     Regenerate secondary key     Swap keys Primary key	
Security settings	<ul> <li>Connect using shared access policies</li> </ul>			D
🐍 Identity	🗟 Save 🏷 Discard change		Secondary key	
Shared access policies	Allow		••••••	D
Networking	Deny	1	Primary connection string	٦
🔎 Certificates			HostName=kuwada-rx65n-cloud-kit-1.azure-devices.net,SharedAccessKeyName=io 🧠	Ð
Defender for IoT	Manage shared access policies		Secondary connection string	_
Overview	+ Add shared access policy 🖔 Re	2fresh 🗉 Delete	····· @	D
Ø Security Alerts	Policy Name	Permissions	Permissions	
Recommendations			Registry Read	
Settings	iothubowner	Registry Read, Registry Write, Service Connect	Registry Write	
Monitoring	service	Service Connect	Service Connect	
			Device Connect	

Figure 2.17 Primary Connection String

- 3. In Azure IoT Explorer, select **IoT hubs > Add connection**.
- 4. Paste the connection string into the **Connection string** box.
- 5. Select Save.

Home > IoT hubs × • v6 112 has been interace. Please clock here is down • v6 112 has been interace. Please clock here is down • v6 v6 v12 has ended here is down • v6 v6 v12 has ended here is down • v6 v6 v12 has ended here is down • v6	Azure IoT Explorer (p	neview)	Notifications	Settings
Introduction       Fraction         Introduction       Shared access p	Home > IoT hubs			×
Koronection String     So lot Plug and Play     So lot Save your hub connection string?     Please do not save your hub connection string to any unsafe locations     Host name     Into Shared access policy have     Host name     Shared access policy key	() v0.11.2 has been released. (	Please click here to down	Edit connection string	
S <sup>o</sup> toT Plug and Play     Connection Strik     Where do I get an IoT hub connection string?       Connection Strik     Please do not save your hub connection string to any unsafe locations       View devices in     Active devices net       Shared access policy name     iothuboomer       Host name     Shared access policy key	=	+ Add connect		1.1
por fol Plug and Pluy     Connection String       Where do 1 get an IoT hub connection string?       Please do not save your hub connection string to any unsale locations       View devices int       View devices int       Stared access policy name       intubuoner       Yost name	and IoT hubs	Shared access p		
Write do Type and in the connection string       Write do Type and in the connection string to any unsafe locations       Vew devices init       Stared access policy name       Introduction string       Shared access policy key	6 <sup>9</sup> IoT Plug and Play			
View devices int View devices net View devices policy name View devices policy name View devices policy key View devices int View devices int View devices int View devices int View devices net		Connection Strin	Where do I get an IoT hub connection string?	
View devices int azure-devices net  Shared access policy name  rtos-pp-buz Iothubowner  Nost name Shared access policy key				
Shared access policy name           rtos-pp-buz         iothubowner           Host name         Shared access policy key		View devices in t		
rtos-pp-buz iothubowner 🕅 Kost name Shared access policy key				
Host name Shared access policy key		rtos-pp-buc	in the second	D
			Shared access policy key	
		Tiost nume		٥

#### Figure 2.18 Azure IoT Explorer

6. If the connection succeeds, the Azure IoT Explorer switches to a Devices view and lists your device.

## To view device properties using Azure IoT Explorer:

- 1. Select the link for your device identity. IoT Explorer displays details for the device.
- 2. Inspect the properties for your device in the **Device identity** panel.



Home >       >       Devices >       MyDevKit >       Device identity         □       Device Identity       Device identity       Device identity         □       Device identity       Device Identity       Device Identity         □       Device tride       Device ID ○       Device Identity       Device Identity         □       Device tride       Device Identity       Device Identity	Azure IoT Explorer (preview) File Edit View Window Help Azure IoT Explorer (pre		Notifications	Setting
	Home >	> <u>Devices</u> > MyDevKit > Device identity		
Device twin     Device ID ○       □ Telemetry     MyDevKit     ID       > Direct method     Primary key ○     ID       Image: Cloud-to-device m     Image: Cloud-to-device m     ID       Image: Kinet Module Identity     Secondary key ○     ID       Image: Kinet Module Identity     Secondary key ○     ID       Image: Violation Play c     Primary connection string ○     ID		🗟 Save 🔍 Manage keys 🗠		
Telemetry     MyDex/St       > <sup>5</sup> Direct method     Primary key ©       Cloud-to-device m     Image: Cloud-to-device m       Pt Module identity     Secondary key ©       8 <sup>o</sup> Iot Plug and Play c     Primary connection string ©		Device identity		
>> Direct method     Primary key ©       Cloud-to-device m     Image: Cloud-to-device m       Image: Cloud-to-device m	C Telemetry			
R: Module identity     Secondary key O       Secondary key O     Image: Compary connection string O	✓ Direct method			_
of a lot Plug and Play c       Primary connection string O				۵ (
Primary connection string 0				۵ (
	p for hug and hug c			

Figure 2.19 Azure IoT Explorer

## To view device telemetry using Azure IoT Explorer:

- 1. In IoT Explorer select **Telemetry**. Confirm that **Use built-in event hub** is set to Yes.
- 2. Select Start.
- 3. View the telemetry as the device sends messages to the cloud.

=	Stop Show system properties 🔋 Clear events	
<ul> <li>Device identity</li> <li>Device twin</li> </ul>	Telemetry <sup>©</sup>	
C Telemetry	Consumer group	
✓ Direct method	Use built-in event hub	
Cloud-to-device m	Receiving events	
St Module identity	), monoparatient", "2020-07-30707:56:03.0362", "propertyM": "valueA", "propertyM": "valueA", )	
	3:55:58 PM, 07/30/2020:	
	<pre>{     "Dody": {         "Hessage ID": 15     },     requesedTime": "2020-07-J0T07:55:58.0402",     "propertien";     "propertien";     "propertyA": ValueA",     "propertyM": ValueA",     "propertyM": ValueA",     "propertyM": ValueA",     "propertyM": ValueA",     "propertyM": ValueA",     "propertyM": ValueA",     "propertyM: ValueA",</pre>	

## Figure 2.20 Telemetry Message

## To update device twin using Azure IoT Explorer:

- 1. In IoT Explorer select **Device twin**.
- 2. Modify the **desired** section of the Device twin, you can add a custom twin:



3. Select Save.



Azure IoT Explorer (	preview)	🗘 Notifications 🛛 🗔 Setti
Home >	> <u>Devices</u> > MyDevKit > Device twin	
<ul> <li>Device identity</li> </ul>	🖒 Refresh 📓 Save	
🔁 Device twin	Device twin ①	
<ul> <li>□ Telemetry</li> <li>&gt; Direct method</li> <li>□ Cloud-to-device m</li> <li>♀ Module identity</li> <li>∞ IoT Plug and Play c</li> </ul>	<pre>is a control prime ; in all primery function in all primers and in a second seco</pre>	.86854142*

Figure 2.21 Device Twin

- 4. View the notification for the device twin update status.
- 5. In the terminal output window, you can view the desired device twin properties are received.

Telemetry message send: {"Message ID":68}.	
Telemetry message send: {"Message ID":69}.	
Telemetry message send: {"Message ID":70}.	
Telemetry message send: {"Message ID":71}. Telemetry message send: {"Message ID":72}.	
Telemetry message send: {"Message ID":73}.	
Telemetry message send: {"Message ID":74}.	
Telemetry message send: {"Message ID":75}	
Receive desired property call: {"weather":{"temperature":"25"},"\$version":2} Telemetry message send: {"Message ID".70).	
Telemetry message send: {"Message ID":77}.	
Telemetry message send: {"Message ID":78}.	
Telemetry message send: {"Message ID":79}. Telemetry message send: {"Message ID":80}.	
Telemetry message send: { Message ID :00}.	
Telemetry message send: {"Message ID":82}.	
Telemetry message send: {"Message ID":83}.	
Telemetry message send: ("Message ID":84).	

Figure 2.22 Received Desired Device Twin Properties

## To call a direct method on device using Azure IoT Explorer:

You can also use Azure IoT Explorer to call a direct method that you have implemented on your device. Direct methods have a name, and can optionally have a JSON payload, configurable connection, and method timeout. To call a direct method in Azure IoT Explorer:

- 1. In IoT Explorer select **Direct method**.
- 2. Send a direct method to mimic the device reboot with payload. The device will receive and output the payload as dummy data.
  - Method name: reboot
  - Payload: {"timeout": 500}

=	≻ Invoke method	
<ul> <li>Device identity</li> <li>Device twin</li> </ul>	Direct method 0	
C Telemetry	Method name *	
> Direct method	Payload O	
Cloud-to-device m	("timeout": 500)	
	Connection timeout in seconds 0	A
	-0	10

Figure 2.23 Direct Method



## 3. Select Invoke method.

4. In the terminal output window, you can view the method is invoked on the IoT Device.

Telemetry message set		^	
Telemetry message set			
Telemetry message ser			
Telemetry message set			
Telemetry message set			
Telemetry message set			
	nd: {"Message ID":243}.		
	nd: {"Message ID":244}		
Receive method call:	reboot, with payload:{"timeout":500}		

Figure 2.24 Invoked Method

#### To send cloud-to-device message using Azure IoT Explorer:

- 1. In IoT Explorer select Cloud-to-device message.
- 2. Enter the message in the Message body:

{ "Hello": "Azure RTOS" }	
- J	

3. Check Add timestamp to message body.

Device identity	Send message to device	
<ul> <li>Device twin</li> </ul>	Cloud-to-device message 🛈	
C Telemetry	Message body  ( 'Hello', 'Azure RTOS' )	
✓ Direct method		
Cloud-to-device		
8 Module identity	Add timestamp to message body	
S <sup>9</sup> IoT Plug and Play c	Properties     O     O     Add custom property     O     Add system property     I     Delete	

Figure 2.25 Cloud-to-device message

- 4. Select Send message to device.
- 5. In the terminal output window, you can view the message is received by the IoT Device.



Figure 2.26 Received Message



## 2.7 IoT Embedded SDK PnP sample project (Available up to Azure RTOS v.6.2.1\_rel-rx-2.0.0)

This demonstration connects to Azure IoT Hub using Azure IoT middleware for Azure RTOS. This demonstration also publishes the message to IoT Hub every few seconds.

It is also possible to view device properties, view device telemetry, update device twin and call a direct method on device using Azure IoT Explorer.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit (Ether/ Cellular)
- Renesas RX65N Cloud Kit
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit

To run this project, simply follow 2.5 IoT Embedded SDK sample project.

Moreover, this sample can interact with IoT Plug and Play components using Azure IoT Explorer.

#### To interact with IoT Plug and Play components using Azure IoT Explorer:

You can use Azure IoT Explorer to interact with IoT Plug and Play components.

Azure IoT explorer needs a local copy of the model file that matches the **Model ID** your device sends. The model file lets Azure IoT explorer display the telemetry, properties, and commands that your device implements.

To use the Azure IoT explorer to verify the IoT Plug and Play device application is working:

- 1. In IoT Explorer, select the IoT Plug and Play Settings.
- 2. Select Add and select Public Repository.
- 3. Select Save.

=		Save + Add $\checkmark$ $\stackrel{\circ}{\sim}$ Revert ? Help
윰 loT hubs		Model repository locations specify where the application looks to find IoT Plug and Play model
		definitions. Locations are saved to application storage and can be edited or removed at any time.
		Help:
Q Notification Center		What is IoT Plug and Play
		Model Repository Locations:
		We'll look for your model definition in the following order. Please drag and drop to change it. Click 'Add' to enable more ways to can resolve your model definitions.
		Before enabling us to retrieve model definition from a local folder, please read Microsoft Privacy Statement
	1	Public Repository       X         The id-plugandplay-models GitHub repository includes DTDL models that are made publicly available on https://devicemodels.azure.com.         Repository endpoint       https:// devicemodels.azure.com

Figure 2.27 IoT Plug and Play Setting



- 4. On the **IoT hubs** page, click on the name of the hub you want to work with. You see a list of devices registered to the IoT hub.
- 5. Click on the **Device ID** of the device you created previously.
- 6. The menu on the left shows the different types of information available for the device.
- 7. Select **IoT Plug and Play components** to view the model information for your device.

=	C) Refresh
Device identity	IoT Plug and Play components IoT Plug and Play documentation
🔁 Device twin	
C Telemetry	Step 1. Your device has been discovered as a loT Plug and Play device Model ID
Cloud-to-device message	dtmi:com:example:Thermostat:4
🛠 Module identities	Step 2. We've resolved your IoT Plug and Play model
$\mathcal{S}^{\mathcal{G}}$ loT Plug and Play components	You model definition has been resolved from: Public Repository 🛞 Configure
	Step 3. Continue your IoT Plug and Play journey by drilling down to each component
	If you have defined 'Property', 'Command' or 'Telemetry' in model dtmi:com:example:Thermostat;4, you would be able to see 'Default component' in the table below. If you have defined 'Component', you would be able to see a list of components down below.
8.	Components Model content

Figure 2.28 Model Information

- 9. You can view the different components of the device. The default component and any additional ones. Select a component to work with.
- 10. Select the **Telemetry** page and then select Start to view the telemetry data the device is sending for this component.
- 11. Select the **Properties (read-only)** page to view the read-only properties reported for this component.
- 12. Select the **Properties (writable)** page to view the writable properties you can update for this component.
- 13. Select a property by its name, enter a new value for it, and select Update desired value.
- 14. To see the new value show up select the **Refresh** button.
- 15. Select the Commands page to view all the commands for this component.
- 16. Select the command you want to test set the parameter if any. Select **Send command** to call the command on the device. You can see your device respond to the command in the command prompt window where the sample code is running.

_	
≡	Interface Properties (read-only) Properties (writable) Commands Telemetry
Device identity	C) Refresh 🕞 Back
🔁 Device twin	You model definition has been resolved from: Public Repository 🛞 Configure
C Telemetry	Interface id
✓ Direct method	dtmi:com:example:Thermostat4
☑ Cloud-to-device message	Name
	Thermostat D
🛠 Module identities	Description
6 <sup>57</sup> IoT Plug and Play compone	Reports current temperature and provides desired temperature control.
	<pre>1 ([ 2 "@context": "dtmirdtdl:context;2", 3 "@id": "dtmircom:example:Thermostat;4", 4 "@type:" "Interface; 5 "displayMaer: "Thermostat", 6 "displayMaer: "Thermostat", 7 "extends: "dtmirsumeriot:current temperature and provides desired temperature control.", 7 "extends: "dtmirsumeriot:deviceUpdateContractModel;2", 8 " "contents" [</pre>

Figure 2.29 IoT Plug and Play Components



## 2.8 GUIX 8bpp/16bpp/16bpp\_draw2d sample project

This demonstration illustrates Washing Machine application using advanced GUIX features such as:

- Widget creation
- Creating multiple screens inside the main screen
- Attaching and detaching the child screen when you switch screens
- Double-buffer toggle control for screen transition without tearing
- Radial slider, vertical and horizontal slider creation
- Running animation

It also illustrates 2 kinds color depth and use of 2D drawing engine (DRW2D) on RX family.

- sample\_guix\_8bpp: sample for display of size 480 \* 272 with 8 bits color look-up table (CLUT8).
- sample\_guix\_16bpp: sample for display of size 480 \* 272 with 16 bits RGB 565.
- sample\_guix\_16bpp\_draw2d: sample for display of size 480 \* 272 with 16 bits RGB 565 with 2D drawing engine.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- RX72N Envision Kit

To run each GUIX Sample project, simply follow these steps (assuming the steps described in the previous section were done):

1. Select **Go** to start execution of the demonstration. As the project runs you should observe Washing Machine GUI on board TFT panel. The four different screens are demonstrated as:



#### Figure 2.30 Main Screen



Figure 2.31 Garments selection screen





Figure 2.32 Water level selection screen

Microsoft Azure 12:31 PM Tuesday	<b>≜</b>
Feb 21,2017	Derature
Cold Vish Spin Rinse Spin	Start Garments Water Level Vivater Level Siss 70 ° Temperature O Power Off

Figure 2.33 Temperature selection screen

The application demonstrates the simulation of the Washing Machine controller from the GUI perspective. This project initializes the GUIX system, configures the GUIX drivers, initializes Canvas, creates screens using widget creation APIs, starts the GUIX and handles the Touch Events from the Touch driver. All these

are done from the Application Thread.

To learn more about Azure RTOS GUIX, view https://docs.microsoft.com/azure/rtos/guix/.



## 2.9 USBX device CDC-ACM Class sample project

This demonstration illustrates the setup and use of USBX device CDC-ACM Class to communicate with the host as a serial device. This project initializes the USBX system and device stack, set the parameters for callback when insertion/extraction of a CDC device, read from the CDC class and write to the CDC instance using device CDC-ACM APIs.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit
- Renesas RX65N Cloud Kit

Before build the sample and run, you need to connect the USB0 Function on Renesas Starter Kit+ for RX65N-2MB to your computer using the USB-MiniB cable: (assuming Renesas Starter Kit+ for RX65N-2MB is specified as Target Board)



Figure 2.34 USB0 Function on Renesas Starter Kit+ for RX65N-2MB

To run the device CDC-ACM Sample project, simply follow these steps (assuming the steps described in the previous section were done):

- 1. Select Go to start execution of the demonstration.
- 2. Verify the serial port in your OS's device manager. It should show up as a COM port for the CDC-ACM device.

Figure 2.35 Device Manager

- 3. Open your favorite serial terminal program such as Putty and connect to the COM port discovered above. In this sample project, it is not necessary to set any other settings on the terminal program.
- 4. As the project runs, you should be able to observe "abcdef" returned from the CDC-ACM device when you input **enter** key to the CDC-ACM device via the terminal.





Figure 2.36 Serial Terminal Window

To learn more about Azure RTOS USBX, view https://docs.microsoft.com/azure/rtos/usbx/.



## 2.10 USBX Host Mass Storage Class sample project

This demonstration illustrates the setup and communication with MSC device (USB flash drive) using USBX HMSC. The sample program initializes the FileX, USBX system and USB driver stack. When a MSC device is inserted, it reads and writes a file to MSC device using device FileX APIs.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit
- Renesas RX65N Cloud Kit
- Renesas Starter Kit+ for RX671
- 1. Change the jumper pins (J7 and J16) on Renesas Start Kit+(RSK) for RX65N-2MB to set to USB Host mode. (assuming Renesas Starter Kit+ for RX65N-2MB is specified as Target Board)

Note: Jumper pin numbers are different for each RSK.

- 2. Build USBX HMSC sample project and run.
- 3. Connect MSC device to USB Standard A connector (red frame) on RSK.



Figure 2.37 USB Standard A Connector on Renesas Starter Kit+ for RX65N-2MB

When the USBX HMSC driver recognizes that MSC device is connected, the sample application program creates a "counter.txt" file to MSC device using FileX API.

- 4. Disconnect MSC device from RSK and connect MSC drive to PC.
- 5. Confirm that "counter.txt" file is generated at the root folder in the MSC device.



Azure RTOS sample projects using e2 studio or IAR EW

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Pin to Quick Cop access	Paste Shortcut	Move Copy to * Copy Organize	New ite New folder New
$\leftarrow \rightarrow \checkmark \uparrow$	→ (D:) USB Drive	~	ට 🔎 Sear
I My PC: 이가 3D Obje 이 Desktog 한 Docum 나 Downlo	ents	counter.txt	

Figure 2.38 Root Folder in MSC Device

6. Open "counter.txt" file using the binary editor on PC. It contains count up numbers from 0x0000 to 0x00FF from the address 0x00000000 as following.

_ADDRESS 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F	
00000000 00 00 01 00 02 00 03 00 04 00 05 00 06 00 07 00	
00000010 08 00 09 00 0A 00 0B 00 0C 00 0D 00 0E 00 0F 00	
00000030 18 00 19 00 1A 00 1B 00 1C 00 1D 00 1E 00 1F 00	
00000040 20 00 21 00 22 00 23 00 24 00 25 00 26 00 27 00	.!.".#.\$.%.&.'.
00000050 28 00 29 00 2A 00 2B 00 2C 00 2D 00 2E 00 2F 00	(.).*.+.,/.
00000060 30 00 31 00 32 00 33 00 34 00 35 00 36 00 37 00	
00000070 38 00 39 00 3A 00 3B 00 3C 00 3D 00 3E 00 3F 00	
00000090 48 00 49 00 4A 00 4B 00 4C 00 4D 00 4E 00 4F 00	
000000B0 58 00 59 00 5A 00 5B 00 5C 00 5D 00 5E 00 5F 00	
00000000 60 00 61 00 62 00 63 00 64 00 65 00 66 00 67 00	
000000D0 68 00 69 00 6A 00 6B 00 6C 00 6D 00 6E 00 6F 00	
000000E0 70 00 71 00 72 00 73 00 74 00 75 00 76 00 77 00	
000000F0 78 00 79 00 7A 00 7B 00 7C 00 7D 00 7E 00 7F 00	
00000110 88 00 89 00 8A 00 8B 00 8C 00 8D 00 8E 00 8F 00	
00000130 98 00 99 00 9A 00 9B 00 9C 00 9D 00 9E 00 9F 00	
00000140 A0 00 A1 00 A2 00 A3 00 A4 00 A5 00 A6 00 A7 00	

Figure 2.39 Content of "counter.txt"

- 7. Disconnect MSC device from PC and connect the MSC device to RSK. This sample program reads "counter.txt" in MSC device and adds the count up data from the address (0x00000200) in this file.
- 8. Disconnect MSC device from RSK and connect the MSC drive to PC.
- 9. Open "counter.txt" file using the binary editor on PC. It contains count up numbers from 0x0000 to 0x00FF from the address 0x00000200 as following.

ADDRESS 00	01 02 03 04 0	15 06 07 08 09 0A 0B 0C 0D (	DE OF 0123456789ABCDEF	
00000200 00	01 01 01 02 0	1 03 01 04 01 05 01 06 01 0	07 01	
00000210 08	01 09 01 0A 0	1 OB 01 OC 01 OD 01 OE 01 (	)F 01	
00000220 10	01 11 01 12 0	1 13 01 14 01 15 01 16 01 1		
	01 19 01 1A 0			
	01 21 01 22 0		27 01 .!.".#.\$.%.&.'.	
	01 29 01 2A 0		2F 01 (.).*.+.,/.	
	01 31 01 32 0		37 01 0.1.2.3.4.5.6.7.	
	01 39 01 3A 0		3F 01 8.9.:.;.<.=.>.?.	
	01 41 01 42 0		17 01 @.A.B.C.D.E.F.G.	
	01 49 01 4A 0		F 01 H.I.J.K.L.M.N.O.	
	01 51 01 52 0		57 01 P.Q.R.S.T.U.V.W.	
	01 59 01 5A 0			
	01 61 01 62 0		57 01 `.a.b.c.d.e.f.g.	
	01 69 01 6A 0			
	01 71 01 72 0		77 01 p.q.r.s.t.u.v.w.	
	01 79 01 7A 0		7F 01 x.y.z.{. .}.~	
	01 81 01 82 0		7.01	
	01 89 01 8A 0		01	
	01 91 01 92 0		07.01	
00000330 98			DE 01	
00000340 A0			۲٫01۲.J۶.۶.۶.	
00000340 40	01 A1 01 A2 0		47 UI	

Figure 2.40 Content of "counter.txt"



10. By repeating steps 8 and 9 above, the sample program keeps updating count data to "counter.txt" file in the MSC device.

To learn more about Azure RTOS USBX, view <u>https://docs.microsoft.com/azure/rtos/usbx/</u>.



## 2.11 USBX Host Communication Device Class (CDC-ACM) sample project

This demonstration illustrates the setup and communication with HCDC device using USBX HCDC driver (HCDC-ACM). This project initializes the USBX system and USB driver, set the parameters for callback when insertion/extraction of a CDC device, read from the CDC class and write to the CDC instance using Host CDC-ACM APIs.

Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit
- Renesas RX65N Cloud Kit
- Renesas Starter Kit+ for RX671
- 1. Change the jumper pins (J7 and J16) on Renesas Start Kit+(RSK) for RX65N-2MB to set to USB Host mode. (assuming Renesas Starter Kit+ for RX65N-2MB is specified as Target Board)

Note: Jumper pin numbers are different for each RSK.

- 2. Build USBX HCDC sample project and run.
- 3. Connect CDC device to USB Standard A connector (red frame) on RSK.



Figure 2.41 USB Standard A Connector on Renesas Starter Kit+ for RX65N-2MB

Note:

Please connect this CDC device to a PC (Windows) via UART and start the terminal program on this PC.

- 4. When user input key data on the terminal, the input key data send to CDC device via UART.
- 5. CDC device received key data sends the key data to USB Host CDC device (RSK) via USB.
- 6. USB Host CDC device (RSK) received key data sends the key data to CDC device. (Loopback)
- 7. CDC device received key data sends to terminal program on PC via UART.
- 8. User is able to observe key data on terminal program.





Figure 2.42 Serial Terminal Window

To learn more about Azure RTOS USBX, view https://docs.microsoft.com/azure/rtos/usbx/.



## 2.12 ThreadX Low Power sample project

This sample project illustrates how to use ThreadX's Low Power feature. You can confirm the transition to and resume from the following low power modes supported by the device using the Low Power Consumption Device Driver Module ( $r_lpc_rx$ ).

Kits	Target Board for RX130 Renesas Starter Kit for RX140 Renesas Solution Starter Kit for RX23E-B	Renesas Starter Kit+ for RX65N- 2MB CK-RX65N cloud kit Renesas RX65N Cloud Kit Renesas Starter Kit for RX660 Renesas Starter Kit+ for RX671 RX72N Envision Kit
Device	RX130, RX140, RX23E-B	RX65N, RX651, RX660, RX72N, RX671
Supported low power mode	Sleep Mode	Sleep Mode
	Deep Sleep Mode	Software Standby Mode
	Software Standby Mode	Deep Software Standby Mode

## 2.12.1 Overview of sample project

- 1. The sample project creates one thread **thread\_0**. The **thread\_0** turns on the LED when it starts.
- 2. After executing for about 3 seconds, suspend the own thread by **tx\_thread\_suspend**.
- 3. Since there is no other thread to run, **Demo\_LowPower\_Enter** configured in ThreadX "Enter low power function" configuration is called from **tx\_low\_power\_enter** of ThreadX.
- 4. **Demo\_LowPower\_Enter** turns off the LED and transitions to the low power consumption mode.
- 5. The low power consumption mode is resumed by the interruption of pressing the user switch. The interrupt handler **Demo\_callback** is called and **tx\_thread\_resume** resumes **thread\_0**. At this point, **thread\_0** does not run.
  If it has transitioned to the deep software standby made, it will be resumed by the user switch press.

If it has transitioned to the deep software standby mode, it will be resumed by the user switch press interrupt or RTC alarm interrupt and reboots from the reset vector.

- Next, the Demo\_LowPower\_Exit configured in the ThreadX "Exit low power function" configuration is called from tx\_low\_power\_exit of ThreadX. Demo\_LowPower\_Exit turns on the LED and returns to ThreadX.
- 7. The resumed **thread\_0** runs.
- 8. Repeat the transition to the same low power consumption mode in steps 2 to 7 three times in total and execute all low power consumption modes in the following order.

For RX130, RX140 and RX23E-B:

Sleep Mode (3 times) => Deep Sleep Mode (3 times) => Software Standby Mode (3 times)

For RX65N, RX651, RX660, RX72N, RX671:

Sleep Mode (3 times) => Software Standby Mode (3 times) => Deep Software Standby Mode (1 time)



The figure shows the execution flow from suspending the thread\_0 with tx\_thread\_suspend to resuming.



Figure 2.43 Execution Flow after tx\_thread\_suspend (&thread\_0)

#### 2.12.2 Execute sample project

To run the sample project, simply follow these steps for each board:

#### Target Board for RX130, Renesas Starter Kit for RX140 and Renesas Solution Starter Kit for RX23E-B:

- 1. Select Launch to download the program.
- 2. Select **Resume** to start execution of the project. The program stops at the breakpoint of main function.
- 3. Select Resume to restart.
- 4. The program turns LED0(RX130 and RX140)/LED1(RX23E-B) on and runs for 3 seconds.
- 5. The program turns LED0(RX130 and RX140)/LED1(RX23E-B) off and transitions to sleep mode. e<sup>2</sup> studio status bar will change from Running to Sleeping as below:

Sleeping

- 6. The program is resumed by pressing the user switch (SW1). This cycle is repeated 3 times.
- 7. Similarly, transitions to deep sleep mode and resume by pressing the user switch is repeated 3 times. e<sup>2</sup> studio status bar will change from Running to Sleeping as below:

Sleeping

8. Similarly, transitions to software standby mode and resume by pressing the user switch is repeated 3 times. e<sup>2</sup> studio status bar will change from Running to Standby as below:

Standby

- 9. Repeat from sleep mode to software standby mode.
  - (\*) e2 studio status bar when sleep mode and deep sleep are the same. So please check MSTPCRC.DSLPE register value before executing wait instruction.
    - sleep mode: MSTPCRC.DSLPE =0
    - deep sleep: MSTPCRC.DSLPE =1

#### **RX65N Cloud Kit:**

- 1. Select Launch to download the program.
- 2. Select **Resume** to start execution of the project. The program stops at the breakpoint of main function.
- 3. Select Resume to restart.



- 4. The program turns LED1 on and runs for 3 seconds.
- 5. The program turns LED1 off and transitions to sleep mode. e<sup>2</sup> studio status bar will change from Running to Sleeping as below:

## Sleeping

- 6. The program is resumed by pressing the user switch. This cycle is repeated 3 times.
- 7. Similarly, transitions to software standby mode and resume by pressing the user switch is repeat 3 times. e<sup>2</sup> studio status bar will change from Running to Standby as below: <sup>(\*)</sup>

## Standby

8. The program transitions to deep software standby. e<sup>2</sup> studio status bar will change from Running to Standby as below: (\*)

#### Standby

- 9. The program reboots by pressing the user switch.
- (\*) e2 studio status bar when deep software standby and software standby are the same. So please check SBYCR.SSBY and DPSBYCR.DPSBY register value before executing wait instruction.
  - software standby: SBYCR.SSBY=1, DPSBYCR.DPSBY=0
  - deep software standby: SBYCR.SSBY=1, DPSBYCR.DPSBY=1

## Renesas Starter Kit+ for RX65N-2MB, Renesas Starter Kit for RX660, Renesas Starter Kit for RX671, RX72N Envision Kit and CK-RX65N:

- 1. Select Launch to download the program.
- 2. Select **Resume** to start execution of the project. The program stops at the breakpoint of main function.
- 3. Select **Resume** to restart.
- 4. The program turns LED (usually LED0) on and runs for 3 seconds.
- 5. The program turns LED off and transitions to sleep mode. e<sup>2</sup> studio status bar will change from Running to Sleeping as below:

Sleeping

- 6. The program is resumed by pressing the user switch (usually SW1). This cycle is repeated 3 times.
- 7. Similarly, transitions to software standby mode and resume by pressing the user switch is repeat 3 times. e<sup>2</sup> studio status bar will change from Running to Standby as below: <sup>(\*)</sup>

## Standby

8. The program transitions to deep software standby. e<sup>2</sup> studio status bar will change from Running to Standby as below: <sup>(\*)</sup>

Standby

9. The program reboots by RTC alarm interrupt after about 30 seconds.

(\*) e2 studio status bar when deep software standby and software standby are the same. So please check SBYCR.SSBY and DPSBYCR.DPSBY register value before executing wait instruction.



- software standby: SBYCR.SSBY=1, DPSBYCR.DPSBY=0
- deep software standby: SBYCR.SSBY=1, DPSBYCR.DPSBY=1

## 2.12.3 Configuration of ThreadX Low Power by Smart Configurator

• You can develop own system low power operation for your product referring to this sample project and using Smart Configurator's component configuration feature as below. Each configurable item description is displayed in Macro definition view by clicking the configuration item.

øverride byte pool searchs delay			
# Enable low power mode	☑ Enable		
# Enter low power function	Demo_LowPower_Enter()		
# Exit low power function	Demo_LowPower_Exit()		
# Enable tickless operation in low power mode	🖾 Disable		
# Enable threadx timer setup	# Enable threadx timer setup		
# Low power timer setup function	Demo_LowPower_Timer_Setup		
# Enable threadx user timer adjust	🗵 Enable		
# Low power user timer adjust function	Demo_LowPower_User_Timer_Adju		
# Enable threadx wait	Disable		
		~	
	user-defined low power consumption function (call tx_low_power_enter/exonly WAIT instruction in ThreadX (tx_low_power_enter/exit are not called)	cit)	
ase 3: TX_LOW_POWER == 0 and TX_ENABLE_WAIT == 0: no supp ase 4: TX_LOW_POWER == 1 and TX_ENABLE_WAIT == 1: execute			

#### Figure 2.44 Configuration of ThreadX Low Power

- If the Low Power Consumption Device Driver Module (r\_lpc\_rx) is used, the module executes "WAIT" instruction inside the r\_lpc\_rx module. Therefore, please note that "Enable threadx wait" must be disabled.
- If you define your own function for "Enter low power function", "Exit low power function", "Low power timer setup function" and "Low power user timer adjust function", please modify the prototype definition for each function in libs/threadx/tx\_user.h manually as well.





Figure 2.45 libs/threadx/tx\_user.h

- The "tx\_low\_power\_next\_expiration" parameter is passed to the "TX\_LOW\_POWER\_TIMER\_SETUP" function. Since the tx\_low\_power\_next\_expiration is the next timer deadline (i.e., the number of ticks before the next wakeup), a low power mode timer must be set so that the low power mode is resumed before this tick number elapses.
   When the tx\_low\_power\_next\_expiration is 0xffffffff, there is no next timer expiration date (there is no thread waiting for a timeout), so the user may resume from the low power mode at any time. When the tx\_low\_power\_next\_expiration is very small value, the transition to the low power consumption mode may be omitted by judging from the transition process time and the resume process time because it depends on the processing time of the user-defined function.
- For the latest information of Low Power APIs, please refer to <u>https://github.com/azure-rtos/threadx/blob/master/utility/low\_power/low\_power.md</u>.



## 2.13 Azure Device Update (ADU) sample project

This sample project illustrates over-the-air (OTA) firmware update via Microsoft Azure. Azure ADU is a cloud service provided by Microsoft that enables deployment of OTA updating of IoT devices.

When implementing ADU, secure boot loader sample project must be used together with this project. The secure bootloader function is to verify that firmware to be run is reliable, make sure it has not been tempered, and update it.

#### Supported Kits:

- Renesas Starter Kit+ for RX65N-2MB
- CK-RX65N cloud kit (Ether/ Cellular)
- Renesas RX65N Cloud Kit
- Renesas Starter Kit+ for RX671
- RX72N Envision Kit

#### **Development Environment:**

• e2 studio : 2023-10 or later

To run this sample, please see the document <u>"RX Family How to implement OTA by using Microsoft Azure Services"</u>.

To learn more about Azure ADU, view https://learn.microsoft.com/azure/iot-hub-device-update/.



## **Revision History**

		Description	
Rev.	Date	Page	Summary
1.00	Jul. 20, 2022	—	First edition issued
1.01	Oct. 20, 2022	1, 22	Changed project name from "PnP Temperature Control sample project" to "IoT Embedded SDK with IoT Plug and Play sample project"
		2	Added Azure IoT Explorer
1.02	Jan. 20, 2023	6	Improved creation procedure for IAR EW project
		24, 25	Added USBX Host Mass Storage Class sample project
		31	Added Azure Device Update sample project and secure bootloader sample project
1.03	July. 28, 2023	-	Add minimal sample explanation Remove IoT Embedded SDK with IoT Plug and Play sample project
2.00	Jan. 12, 2024	-	Supported RX23E-B Added USBX HCDC sample Updated Azure Device Update (ADU) sample project explanation.
2.10	July. 1, 2024	-	Supported Azure RTOS v.6.4.0 Unsupported IoT Embedded SDK PnP sample project from Azure RTOS v.6.4.0



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

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

#### 1. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

#### 2. Processing at power-on

The state of the product is undefined at the time when power is supplied. The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the time when power is supplied. In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the time when power is supplied until the reset process is completed. In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the time when power is supplied until the power 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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## **Corporate Headquarters**

TOYOSU FORESIA, 3-2-24 Toyosu, Koto-ku, Tokyo 135-0061, Japan

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