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RX Family R01AN6928EJ0201 How to implement OTA by using Microsoft Azure **Services**

Important Notice:

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.

Introduction

This document describes how to create an environment that enables deployment of over-the-air (OTA) updating of IoT devices using Microsoft Azure. OTA updates employ an Azure service called Device Update for IoT Hub. This functionality is referred to as ADU in this document, and a step-by-step guide is presented.

In addition, by using QE for OTA, it is possible to simplify the process required to build an ADU project.

Note that the information presented in this document is subject to change without notice.

Target Devices

- CK-RX65N (Ethernet)
- Renesas Starter Kit+ for RX65N-2MB (Ethernet)
- RX65N Cloud Kit (Wi-Fi)
- RX72N Envision Kit (Ethernet)
- RX671 RSK (Ethernet)

Note: The descriptions in this document use the CK-RX65N as an example.



Development Environment Used

Integrated development environment (IDE)	<u>e2 studio 2024-04</u>				
Compiler	Renesas C/C++ Compiler for RX Family CC-RX V3.06.00				
Complier	GCC for Renesas 8.3.0.202311-GNURXGCC				
Driver package (RDP)	RX Driver Package V1.41				
Eirmwara undata modulo	Firmware Update module V1.06				
Firmware update module	Firmware Update module V2.01*1				
Azure RTOS	6.4.0_rel-rx-1.0.0				
Flash programming tool	Renesas Flash Programmer V3.15				
	Renesas Image Generator v3.03				
	(bundled with the sample project)				
MOT file conversion tool ^{*1}	Renesas Secure Flash Programmer				
	(RX MCUs mot file converter 2.0.2)				
	(Installation procedure described separately.)				
Puthon runtime environment	Python 3.12.0 (The installation procedure is described				
	separately.)				
Key generation tool	Win32/Win64 OpenSSL v3.1.3 Light (Installation procedure				
	described separately.)				

Note: 1. The sample project in this document comes in different versions, each of which is applicable to a specific combination of a supported target board and firmware update module. The MOT file conversion tool to be used also differs depending on the version of the firmware update module you use.

For valid combinations of these items, see the table below.

Table 1-1 Combinations of Target Boards and Firmware Update Modules

Supported target board	Firmware update module	MOT file conversion tool
CK-RX65N	v2.01	Renesas Image Generator
Renesas Starter Kit+ for RX65N-2MB RX65N Cloud Kit RX72N Envision Kit RX671 RSK	v1.06	Renesas Secure Flash Programmer

Note: For the version number of the firmware update module shown in this document, "v2" or "v1" generically refers to all its variations with different subversion numbers (that is, "v2.xx" or "v1.xx").



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1. Allocation of Memory Areas and Operations on Them for Using ADU

1.1 Firmware Memory Area Allocation

The initial firmware and updated firmware each occupy a 1 MB area of memory by the ADU sample project for RX65N.

Firmware update modules v1 and v2 share the same basic structure but have some portions that operate differently in ADU processing.

The following describes allocation of memory areas and operations on them.

1.1.1 Operations Performed by Firmware Update Module v1

The following figure shows an overview of the operations performed by firmware update module v1.



Figure 1.1 Memory Allocation for ADU (If the Version is v1)

 In the initial state, a 1 MB area is secured for both the initial firmware and update firmware. In addition, a 64 KB area is secured for the secure bootloader. The following shows the address of each type of data in the memory. 0xFFF0 0000 to 0xFFF0 02FF: Verification data 0xFFF0 0300 to 0xFFFE FFFF: Firmware 0xFFFF 0000 to 0xFFFF FFFF: Secure bootloader (Boot Loader)



2. The initial firmware and secure bootloader are written to the "execute area" by using a Renesas flash programmer.

Note that credential information, including the information for connecting to IoT Hub, is written to data flash memory.

- 3. When the secure bootloader is executed, it uses the verification data (written in the address range from 0xFFF00000 to 0xFFF002FF) to verify that the written initial firmware has not been falsified.
- 4. If the verification is successful, the initial firmware is executed, and then the secure bootloader is copied to the buffer area.
- 5. The update firmware is downloaded from Azure, and then the downloaded firmware is written to the buffer area (0xFFE0000 to 0xFFEEFFF).
- 6. After the download is complete, the system is reset. After the system reset is complete, the bootloader uses the verification data in the buffer area to verify that the update firmware has not been falsified.
- 7. When the verification is successful, the bank swapping functionality is used to swap the memory areas for the initial firmware and update firmware. After the bank swapping is complete, the bootloader deletes the initial firmware from the buffer area.
- The update firmware in the execute area is executed. Utilizing the bank swapping functionality makes it possible for the addresses referenced by the application to remain unchanged after the firmware update.



1.1.2 Operations Performed by Firmware Update Module v2

The following figure shows an overview of the operations performed by firmware update module v2.



Figure 1.2 Memory Allocation for ADU (If the Version is v2)

- In the initial state, a 1 MB area is secured for both the initial firmware and update firmware. In addition, a 64 KB area is secured for the secure bootloader. The following shows the address of each type of data in the memory. 0xFFF0 0000 to 0xFFF0 02FF: Verification data 0xFFF0 0300 to 0xFFFE FFFF: Firmware 0xFFFF 0000 to 0xFFFF FFFF: Secure bootloader
- The initial firmware and secure bootloader are written to the "execute area" by using a Renesas flash programmer.
 Note that credential information, including the information for connecting to IoT Hub, is written to data

flash memory. At the same time, the bootloader is written also in the buffer area.

3. When the secure bootloader is executed, it uses the verification data (written in the address range from 0xFFF00000 to 0xFFF002FF) to verify that the written initial firmware has not been falsified.



- 4. If the verification is successful, the initial firmware is executed.
- 5. The update firmware is downloaded from Azure, and then the downloaded firmware is written to the buffer area (0xFFE0000 to 0xFFEEFFF).
- 6. After the download is complete, the initial firmware uses the verification data in the buffer area to verify that the update firmware has not been falsified.
- 7. When the verification is successful, the bank swapping functionality is used to swap the memory areas for the initial firmware and update firmware, and then the system is reset. After the reset is complete, the bootloader starts and deletes the initial firmware from the buffer area.
- The update firmware in the execute area is executed. Because the bank swapping functionality is used, the addresses referenced by the application can be used as is (even after the firmware is updated).

1.2 Area Allocation in Data Flash Memory

In this sample project, credential information, including the information required for connection to Azure, is written to data flash memory.

The credential information includes the connection destination and MAC address of Azure.

Note that the area in which the credential information is written (area in the address range from 0x00100000 to 0x00100EFF) is reserved by the system.

Therefore, if the user application needs to use data flash memory, make sure that it uses a memory area in the range from 0x00100F00 to 0x00107FFF.



Figure 1.3 Area Allocation in Data Flash Memory

Note: In this sample project, writing of credential information to data flash memory occurs only when the initial firmware is written.

After the initial firmware has been created, therefore, do not make any changes that alter the credential information on the data flash memory. If the credential information is altered, rewrite the initial firmware.

The area allocation on data flash memory may differ depending on the build settings such as the optimization settings. Therefore, make sure that the initial firmware and update firmware are built using the same compiler and the same settings.



2. Creating Sample Projects

This section describes how to create projects that implement ADU.

ADU uses the secure boot that is RX security features. Therefore the following two sample projects are used for ADU operation.

- Azure Device Update (ADU) sample project
- Secure bootloader sample project

Follow the steps described in this section to create the two sample projects. It will be necessary to make changes to the settings, memory allocation, and source code of the newly created projects, and how to make these changes is described as well.

2.1 Creating a Workspace

Launch e² studio and create a new workspace. Keep the names of the workspace and project file as short as possible. If the total length of the full file path exceeds 256 bytes, an error will occur when you build the project.

Example: Creating a workspace in location C:\workspace

📴 e² studio Launcher	 [×
Select a directory as workspace			
e ² studio uses the workspace directory to store its preferences and development artifacts.			
Workspace: ⁹ C:\workspace	<u>B</u> ro	wse	
▶ <u>R</u> ecent Workspaces			
▶ <u>C</u> opy Settings			
② Launch	Ca	incel	

Figure 2.1 Workspace Creation Window

2.2 Creating the Sample Projects

2.2.1 Creating a New ADU Sample Project

After launching e^2 studio, from the File menu select New \rightarrow Renesas C/C++ Project \rightarrow Renesas RX to open the New C/C++ Project dialog box.

📴 ADU_samp	le - e² studio					
File Edit Nav	gate Search Project	Renesas Views Run	Wi	ndow Help		
New		Alt+Shift+N >		Renesas C/C++ Project	>	Renesas Debug
Open File.			C	C/C++ Project		Renesas RX
😂 Open Proj	ects from File System		2	Project		
Recent File	S	>		Other	Ctrl+N	

Figure 2.2 Menu Selection to Create a New Project



In the **New C/C++ Project** dialog box you will select the type of project to be created. Here, select **All** at the left, followed by **Renesas CC-RX C/C++ Executable Project**, then click the **Next >** button. A dialog box for the project type you selected (New Renesas CC-RX Executable Project) appears. To use GCC, you would select **GCC for Renesas RX C/C++ Execute Project**.

📴 New C/C++ Proje	d – 🗆 🗙
Templates for Re	nesas RX Project
All C/C++	GCC for Renesas RX C/C++ Executable Project A C/C++ Executable Project for Renesas RX using the GCC for Renesas RX Toolchain. GCC for Renesas RX C/C++ Library Project A C/C++ Library Project for Renesas RX using the GCC for Renesas RX Toolchain.
	Renesas CC-RX C/C++ Executable Project A C/C++ Project for Renesas RX using the Renesas CC-RX toolchain. Kenesas CC-RX C/C++ Library Project A C/C++ Library Project for Renesas RX using the Renesas CC-RX toolchain.
?	< <u>Back</u> <u>Next</u> > Einish Cancel

Figure 2.3 Project Type Selection Window



Next, specify a name for the project. For **Project name:** enter **adu_sample**, then click the **Next >** button. The **Select toolchain, device & debug settings** dialog box opens.

Figure 2.4 Project Name Setting Window

Select the toolchain, device, and debug settings to use for the project. The **Toolchain:** item is set based on the project type you selected earlier. To change the toolchain version, click the down arrow next to **Toolchain Version:** and select the version of your choice.

For **RTOS**: select **Azure RTOS**, and for **RTOS Version**: select **6.4.0_rel-rx-1.0.0**. When you use e² studio for the first time or when the desired version does not appear in the list, click **Manage RTOS Versions...** In the RTOS Module Download dialog box that appears, select the desired version, and then download it by clicking the **Download** button.



For Target Board: select CK-RX65N(DUAL). (Target Device: is selected automatically.)

For **Bank Mode:** select **Dual Bank**. Before you can use ADU, you must enable dual mode, in which the code flash memory on the device is treated as two bank areas.

When all the settings have been configured, click the **Next >** button.

Sei Sei	v Renesas CC-RX Executable Project ect toolchain, device & debug settings	×	
T L T T R T T T	olchain Settings nguage: C C ++ olchain: Renesas CC-RX olchain: Version: V3.06.00 Manage Toolchains TOS Version: Azure RTOS 6.4.0_rel-rx-1.0.0 Manage RTOS Versions rget Board: CK-RX65N rget Device: R5F565NEHxFB Interview Base Settings Interview Base Settings rget Device: R5F565NEHxFB Interview Base Settings Findian: Little Bank Mode Dual Bank	Configurations Create Hardware Debug Configuration E2 Lite (RX) Create Debug Configuration RX Simulator Create Release Configuration	
C) < Back Ne	xt > Finish Cancel	

Figure 2.5 Select toolchain, device & debug settings Window

RTOS Module Downle Select RTOS modules for	Dad or download and specify download location	on		Ľ
Title	Rev.	Issue date	^	Select All
Azure RTOS	v6.2.1_rel-rx-2.0.0	2024-01-31		Decelect All
Azure RTOS	v6.2.1_rel-rx-1.3.0	2023-10-11		Deselect All
Azure RTOS	v6.2.1_rel-rx-1.2.0	2023-08-08		
Azure RTOS	v6.2.1_rel-rx-1.1.0	2023-07-28		
Azure RTOS	v6.2.1_rel-rx-1.0.1	2023-05-10		
Azure RTOS	v6.2.1_rel-rx-1.0.0	2023-04-20		
Azure RTOS	v6.2.0_rel-rx-1.0.0	2023-01-31		
Azure RTOS	v6.1.12_rel-rx-1.0.1	2022-11-10		
Azure RTOS	v6.1.12_rel-rx-1.0.0	2022-10-20	~	
<			>	
Please refer to <u>GitHub</u> for Module Folder Path:	more detailed information of each releas	e		0

Figure 2.6 RTOS Module Download Window



The **Select Coding Assistant settings** dialog box appears. Click the **Next** > button without making any changes.



Figure 2.7 Select Coding Assistant settings Window

In the **Select RTOS Project Settings** dialog box a list of sample projects is displayed. Use the scroll bar to scroll down the list, select **Azure Device Update (ADU) sample project**, and click the **Next >** button.



Figure 2.8 Select RTOS Project Settings Window



The **Settings The Contents of Files to be Generated** dialog box appears. Click the **Next >** button without making any changes.

8	— 🗆 X
New 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	
(?) < Back Next	> <u>Einish</u> Cancel

Figure 2.9 Settings The Contents of Files to be Generated Window

A dialog box appears indicating that preparation for creation of the project is complete. If there are no problems, click the **Finish** button.

New Renesas CC-RX Executable Project Summary of project "adu_sample" TOOLCHAIN NAME: Renesas CC-RX TOOLCHAIN VAME: GENERATION FILES:	G	0	– 🗆 X	
TOOLCHAIN NAME : Renesas CC-RX TOOLCHAIN VERSION : v3.05.00 GENERATION FILES :	N 2	ww Renesas CC-RX Executable Project Summary of project "adu_sample"	Ž	
GENERATION FILES :	TT	OOLCHAIN NAME : Renesas CC-RX OOLCHAIN VERSION : v3.05.00	^	
	G	ENERATION FILES :		
			~	
(?) < Back Next > Einish Cancel	(? < Back Next >	<u>Einish</u> Cancel	

Figure 2.10 Window Indicating Completion of Preparation for Project Creation



If the Editors available on the Marketplace dialog box appears, click the Cancel button to dismiss it.



Figure 2.11 Editors available in the Marketplace Window

The project is created in e^2 studio as shown below. If the Project Explorer view is not shown, click the C/C++ button at the top right of the window and select **Window** \rightarrow **Show View** \rightarrow **Project Explorer** from the menu.

: 🛄 👻 📷 🐨 🧐 👻 💌 🦌 🧯			
Project Explorer A		^r01an6455ej0102-rx-azure-rtos.pdf A	
> 🚝 ADU sample rdp139			There is no active editor that
		Application Note	provides un oddine.
		Azure RTOS sample projects ROIMMAGE.0002 using e ² studio or IAR EW 2002.120	
		Introduction Acuse RT05 samplessase at adult or LRR Entended Workberch (EW) with the on-board container. All created using Resease at adult or LRR Entended Workberch (EW) with the on-board emulator. All	
		samples are designed to run on riv, naminy. This document guides how to create and use these sample projects.	
		Supported Sample Projects	
		- ThreadX sample project Contains ThreadX source code	
		- FileX RAM Disk sample project Contains FileX source code	
		NetX Duo Ping sample project Contains NetX Duo ping sample project	
		NetX Uso tperf sample project Contains NetX Duo iPerf sample project	
		Io1 Embedded SUK sample project Sample project to connect to Azure IoT Hub using Azure IoT Middleware for Azure RTOS	
		 to tempedate sub Prim sample project Sample project to connect to Azure IoT Hub using Azure IoT Middleware for Azure RTOS via IoT Plug and Play 	
		 IoT Embedded SDK with IoT Plug and Play sample project Sample project with IoT Plug and Play using multiple components 	
		GUIX 8bpp sample project Contains sample for GUIX 8BPP	
		- GUIX 16bpp sample project Contains sample for GUIX 16BPP	
		Problems I Console X I Properties Smart Browser III Smart Manual	
	Sm	art Configurator Output	
	THE	0000004. File removed and and and and a file for my and the set of the file of	
	Me	3000004: File modified:src\smc_gen\r_flash_rX\src\targets\rX/2t\r_flash 3000004: File modified:src\smc_gen\r_config\r_bsp_config.h	_rx/20.0
	Me	0000002: Code generation is successful: <u>C:\workspace\ADU_sample_rdp139</u>	<pre>src\smc_gen</pre>
			×
	<		>

Figure 2.12 Window after Creation of ADU Sample Project



2.2.2 Creating a New Bootloader Sample Project

Follow the same procedure as that used to create the ADU sample project to create a bootloader sample project. The basic steps are the same as those for the ADU sample project. For **Project name:** enter **bootloader**, and in the **Select RTOS Project Settings** dialog box select **Secure bootloader sample project**. All other settings are the same as those for the ADU sample project.

	New Renesas CC-RX Executable Project Select RTOS Project Settings
	Select application:
3 – <u> </u>	This demonstration illustrates GUIX sample project with 16 bits RGB 565
New Renesas CC-RX Executable Project	O GUIX 16bpp draw 2d sample project This demonstration illustrates GUIX sample project with 16 bits RGB 565 and drawing 2d engine driver
Project name: booticader Use glefault location Courties: Courter Browse	O 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.
Create Directory for Project Choose file system: default	O USBX Host Mass Storage Class sample project This demonstration illustrates the setup and use of USBX host mass storage class to provide physical access to a data storage device.
Add project to working sets Neg Working sets Select	ThreadX Low Power sample project This demonstration illustrates how to use ThreadX with low power mode
	Azure Device Update (ADU) sample project This demonstration illustrates OTA firmware update. Note: this project requires bootloader project.
	Secure bootloader sample project This sample is used together with ADU sample project to provide a secure boot

Figure 2.13 Settings for Creating Bootloader Project



2.3 Changing Project Settings

It is necessary to change the settings of the newly created projects in order to implement ADU. Note that the steps described in this section must be performed on both the ADU sample project and the bootloader sample project. The description of the steps below mainly uses the bootloader sample project as an example.

2.3.1 About the Background Operation (BGO) Mode

The MCU of the RX72N, RX671, or RX65N Group mounted on this target board supports BGO (Back Ground Operation) mode in which the content of flash memory can be rewritten in the background.

In the sample project described in this document, BGO is enabled if firmware update module v1 is used, and BGO is disabled if firmware update module v2 is used. (Firmware update module v2 supports only the CK-RX65N.)

If BGO is enabled, writing to flash memory is performed in non-blocking mode. If BGO is disabled, writing to flash memory is performed in blocking mode. For details on BGO mode, refer to "RX Family Flash Module Using Firmware Integration Technology RX Driver Package" (<u>R01AN2184</u>) or "RX65N Group, RX651 Group Flash Memory User's Manual: Hardware Interface" (<u>R01UH0602</u>).

2.3.2 Integrating Components

When it is first set up, the e² studio environment may not include certain components. In the description below, the firmware update module (FIT) required for ADU is used as an example.

In Project Explorer, expand the **bootloader** project tree and double-click **bootloader.scfg** to open the Smart Configurator perspective for the **bootloader** project. In the Smart Configurator window, select the **Components** tab to open the **Software component configuration** window.

On the left of the window a tree of components that need to be integrated is displayed. The firmware update module corresponds to the **r_fwup** item in the tree.

Software component config	uration	Generate Coc
Components 🚵 🛃 🎘 🕒 🕀 莽	Configure	_
type filter text	Component is missing. The issue may be resolved by downloading it	er by <u>changing the version</u> .

Figure 2.14 Software component configuration Window

If the icon of the desired component is grayed out, the component has not been downloaded to e^2 studio. Use the procedure described below to download it.

Alternatively, you can also download all missing components from **downloading it**, which is displayed by clicking a component icon that is grayed out.



 Click the + button above the component tree. When the Software Component Selection window appears, select FWUP Library in the Components listing and click the Finish button. The gray overlay disappears from the blue icon in the component tree. (In the case of a component that was not originally shown in the tree, a new icon is added to the tree.)

The version of FWUP Library to be specified differs depending on the target board you use. Specify the appropriate version by referring to the following table.

Target board	FWUP Library (Firmware Update module)
CK-RX65N	v2.01
Renesas Starter Kit+ for RX65N-2MB RX65N Cloud Kit RX72N Envision Kit RX671 RSK	v1.06

 Table 2-1
 Version Compatibility of the Firmware Update Module

oftware Component Selection Select component from those available in list Category All Function All Filter Components Short Name FS2012 Sensor Middleware r_fs2012_rx FS2000 Sensor Middleware r_fs2012_rx FS2012 Sensor Middleware r_fs2012_rx FS2000 Sensor Middleware r_fs200_rx Firmware Integra. 1.03 FS2010 Sensor Middleware r_sys_time_rx Firmware Integra. 1.01 FOLD Driver r_gpio_rx Firmware Integra. 5.00 Graphic Library with Graphical User Interf r_emwin_rx Graphic Library with Graphical User Interf r_encopoint_rx Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra. 1.00 Show only latest version Y Showo only latest version Y	🗐 New Co	mponent				Х
Select component from those available in list Category All Category All Function All Components Short Name Type Version Filter Components Short Name Type Version FS2012 Sensor Middleware r_fs2012_rx Firmware Integra 1.03 FS2000 Sensor Middleware r_fs2012_rx Firmware Integra 1.03 FWUP Library r_fwup Firmware Integra 1.01 FWUP Library r_gpio_rx Firmware Integra 5.00 Graphic Library with Graphical User Interf Graphic Library with Graphical User Interf Graphic Library with One-Stop Develope Show only latest version Hide items that have duplicated functionality Description This software component provides configuration for 8-Bit Timer (TMR). TMR module can be used to count external events and also be used as a multifunction timer in a variety of annihizations, such as generation of counter reset signal interrunt requests and nulse output Download the latest FIT drivers and middleware Configure general settings	Software	Component Selection				
Category All Function All Filter	Select cor	nponent from those available in list			-	
Category All Function All Function All Function All Filter Components Short Name Type Version FS2012 Sensor Middleware r_fs2012_rx Firmware Integra 1.03 FS3000 Sensor Middleware r_fs3000_rx Firmware Integra 1.00 FWUP Library r_fwup Firmware Integra 1.01 FWUP Library r_fwup Firmware Integra 1.01 Generic system timer for RX MCUs using r_sys_time_rx Firmware Integra 1.01 Generic system timer for RX MCUs using r_sys_time_rx Firmware Integra 1.01 Graphic Library with Graphical User Interf r_emwin_rx Firmware Integra 1.00 Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Show only latest version Hide items that have duplicated functionality Description This software component provides configuration for 8-Bit Timer (TMR). TMR module can be used to count external events and also be used as a multifunction timer in a variety of annifications such as generation of counter reset signal interrupt requests and nulse output Configure general settings	C .					
Function All Filter	Category	All				~
Filter Components Filter Components FS2012 Sensor Middleware FS2012_rx Firmware Integra 1.03 FS2012 Sensor Middleware r_fs2012_rx Firmware Integra 1.03 FS2012 Sensor Middleware r_fs3000_rx Firmware Integra 1.00 FWUP Library r_fwup Firmware Integra 2.01 Generic system timer for RX MCUs using r_sys_time_rx Firmware Integra 1.01 GPIO Driver r_gpio_rx Firmware Integra 5.00 Graphic Library with Graphical User Interf Graphic Library with Graphical User Interf Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Filmware Integra 1.00 Filmware Integra 1.01 Filmware Integra 1.02 Filmware Integra 1.01 Filmware Integra 1.02 Filmware Integra 1.02 Filmware Integra 1.03 Filmware Integra 1.04 Filmware Integra 1.05 Filmware Integra 1.05 Filmware Integra 1.06 Filmware Integra 1.07 Filmware Integra 1.08 Filmware Integra 1.09 Filmware Integra 1.00 Fil	Function	All				\sim
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■ FS3000 Sensor Middleware r_fs3000_rx Firmware Integra 1.00 ■ FWUP Library r_fwup Firmware Integra 2.01 ■ Generic system timer for RX MCUs using r_sys_time_rx Firmware Integra 1.01 ■ GPIO Driver r_gpio_rx Firmware Integra 5.00 ■ Graphic Library with Graphical User Interf r_emwin_rx Firmware Integra 6.32.a ■ Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 ✓ ■ Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 ✓ ■ Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 ✓ ■ Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 ✓ ■ Show only latest version	₿ FS20	2 Sensor Middleware	r_fs2012_rx	Firmware Integra	1.03	
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Image: GPIO Driver r_gpio_rx Firmware Integra 5.00 Image: Graphic Library with Graphical User Interf r_emwin_rx Firmware Integra 6.32.a Image: Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Image: Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Image: Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Image: Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Image: Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Image: Graphic Library With One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Image: Graphic Library With One-Stop Develope r_aeropoint_rx Firmware Integra 1.00 Image: Graphic Library With One-Stop Develope - - - - Image: Graphic Library With One-Stop Develope - - - - Image: Graphic Library With One-Stop Develope - - - - Description - - -	Gener	ic system timer for RX MCUs using	r_sys_time_rx	Firmware Integra	1.01	
 Graphic Library with Graphical User Interf r_emwin_rx Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra Firmware Integra Graphic Library with One-Stop Develope r_aeropoint_rx Firmware Integra Firmware Integra Graphic Library with One-Stop Develope Firmware Integra Fi	H GPIO	Driver	r_gpio_rx	Firmware Integra	5.00	
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Description This software component provides configuration for 8-Bit Timer (TMR). TMR module can be used to count external events and also be used as a multifunction timer in a variety of applications, such as generation of counter reset signal interrupt requests, and pulse output Download the latest FIT drivers and middleware Configure general settings	✓ Hide it	ems that have duplicated functionalit	у			
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TMR module can be used to count external events and also be used as a multifunction timer in a variety of applications, such as generation of counter reset signal interrupt requests, and pulse output Download the latest FIT drivers and middleware Configure general settings	This soft	ware component provides configurat	ion for 8-Bit Timer (TM	R).		^
variety of applications, such as generation of counter reset signal interrunt requests, and pulse output Download the latest FIT drivers and middleware Configure general settings	TMR mo	dule can be used to count external ev	ents and also be used a	as a multifunction timer	in a	
Download the latest FIT drivers and middleware Configure general settings	variety o	f applications, such as generation of g	counter reset signal inte	errunt requests and nul	se output	~
Configure general settings	<u>Download</u>	the latest FIT drivers and middlewar	<u>e</u>			
	<u>Configure</u>	general settings				
(2) < Back Next > Finish Cancel	?	< Back	Next >	Finish	Cancel	

Figure 2.15 Software Component Selection Window

The latest version of the desired component may not appear in the software component list shown in the above figure. In such a case, the desired component can be downloaded by using procedure (1) or (2) shown later.

After the component has been downloaded, you can register it by using the dialog box shown in the above figure.

If the version of the firmware update module you use is v2, the component downloaded by using procedure (1) may not appear in the list. In such a case, use procedure (2).



(1) Using the FIT Module Download window of Smart Configurator to download the components Click the + button above the component tree. In the Software Component Selection window that appears, click **Download the latest FIT drivers and middleware** at the bottom of the window.

> Download the latest FIT drivers and middleware Configure general settings...

Figure 2.16 Downloading the Latest Versions of FIT Drivers

When the FIT Module Download window appears, clear the **Show RX Driver Package only** check box. Select the check boxes of the necessary modules in the FIT module list, and then click the **Download** button. The selected modules are downloaded and saved in the folder specified in **Module Folder Path**. These modules can be added to the sample project by using the **Software component configuration** window.

FIT I	Module Download ect the FIT modules for download				· ×
	Title RX Family RSPI Module Using Firmware I RX Family Flash Module Using Firmware I RX Family LVD Module Using Firmware Integr RX Family CAN API Using Firmware Integr RX Family Flash Memory Data Manageme RX Family RX Driver Package Ver.1.41 RX Family Memory Access Driver Interfac RX Family Memory Access Driver Interfac RX Family SDHI module using Firmware I RX Family Reality AI Data Shipper Control	Document No. R01AN1827EJ0 R01AN2184EJ0 R01AN3152EJ0 R01AN2472EU R01AN0507EJ0 R01AN6907EJ0 R01AN4548EJ0 R01AN3852EJ0 R01AN36965EJ0	Rev. Rev.3.40 Rev.5.11 Rev.4.60 Rev.5.50 Rev.2.20 Rev.1.41 Rev.1.20 Rev.2.11 Rev.1.00	Issue date 2023-10-05 2023-09-25 2023-09-25 2023-09-25 2023-08-35 2023-08-25 2023-08-15 2023-07-20 2023-07-20 >	Select All Deselect All
Mod	ered: Show RX Driver Package only dule Folder Path: C:\Users\\.eclipse\com.renesas.platt	form_download\FI	TModules Downlo	ad (Browse

Figure 2.17 FIT Module Download window



(2) Using the Renesas website to download and register the components

If there are modules whose versions are too new to appear in the FIT Module Download window, you can download them from the Renesas website and register them.

The following shows an example procedure applicable when firmware update module V2.01 is used.

- a) From the Renesas website, download the sample code for the firmware update module.
- b) Uncompress the downloaded ZIP file, and then copy the three files (shown in the following figure) from the FITModules folder to the folder indicated in **Module Folder Path** at the bottom of the FIT Module Download window (see (1) above).





Figure 2.18 Downloaded FIT Module Files

2. After the component has been configured, generate component code.*1 Click the **Generate Code** button at the top right of the **Software component configuration** window. The generated code is stored in the **\src\smc_gen** folder in the project folder.

Overview information	🔯 bootloader.scfg ×		
	Overview information	🛐 Generate Code	🛅 Generate Report

Figure 2.19 Generate Code Button

If there are other components with a gray overlay on their icons, repeat the above steps for each of them.

Note: 1. After changing settings in Smart Configurator, make sure to generate code as the final step.

Make sure that you also perform the above procedure for the "adu_sample" project.



2.3.3 Settings for Code Generation During Building

In this sample project, the settings additionally specified after code generation may be lost when code generation is performed again.

To prevent all source files from being re-created when you build or clean the project, perform the procedures in 1 to 3 below.

1. In the Project Explorer of e² studio, right-click the **bootloader** project, and then, in the context menu that appears, select **Properties**.

Make sure that you also perform this procedure for the "adu_sample" project.

	Team	>
	Compare With	>
	Replace With	>
1	System Explorer	
-	Command Prompt	
_	Configure	>
	Properties	Alt+Enter

Figure 2.20 Context Menu for a Project

2. In the menu of the Properties dialog box, select **Builders**, select the **SC Code Generation Builder** check box, and then click **Edit**. The window for configuring the builder appears.

Properties for sample_azure_ic	ot_embedded_sdk	_		×
type filter text	Builders	<	⇔ ↔ ↔	000
 Besource Builders C/C++ Build C/C++ General Git Project Natures Project References Renesas QE Run/Debug Settings Security Key Management Tr 	Configure the builders for the project:		New Import Edit Remove	
			Down	
?	Ар	ply and Close	Cancel	

Figure 2.21 Properties Dialog Box for the Project



3. In the Configure Builder dialog box, clear all check boxes, and then click **OK**. Then, in the Properties dialog box, click **Apply and Close**.

The settings specified here will prevent unexpected code generation. *1

🐻 Configure Builde		×
Run this builder:		
After a " <u>C</u> lean"		
During <u>m</u> anual b	ilds	
During <u>a</u> uto buik	s	
During a "Clean"		
ОК	Cancel	

Figure 2.22 Configure Builder Dialog Box

Note: 1. If you want to generate code, click the **Generate Code** button in the Smart Configurator.



2.4 Creating Key Information

This section describes how to generate key information used for settings in the sample project. OpenSSL is used to generate key information.

2.4.1 Installing OpenSSL

Access the Win32/Win64 OpenSSL <u>download site</u>, download the OpenSSL installer that matches your OS version, and run it to install the software.

After installation is complete, add the OpenSSL installation folder to the Path system variable of Windows.

64-bit version: C:\Program Files\OpenSSL-Win64\bin

In Windows 10, to access the system variable, select: Settings > System > About > Advanced system settings > System Properties > Advanced tab > Environment variables > System variables

To execute commands of OpenSSL, from the Windows Start menu, start the Win64 OpenSSL Command Prompt application.

Note: The name of the application to start differs depending on the Windows architecture. This is an example in the 64-bit edition.

2.4.2 Generating a Key Pair for ECC in OpenSSL

When creating firmware, use public and private keys for ECC. You can use OpenSSL to generate these keys. Enter the character strings shown below in blue, substituting appropriate values of your choice for the input values shown, at the command prompt.

Some commands require you to input settings. Enter the character strings shown below in blue.

If you just want to generate the ECC public and private keys, steps B, E, and F are sufficient.

A. Create a CA Certificate

openssl ecparam -genkey -name secp256r1 -out ca.key using curve name prime256v1 instead of secp256r1

openssl req -x509 -sha256 -new -nodes -key ca.key -days 3650 -out ca.crt

You are about to be asked to enter information that will be incorporated into your certificate request. What you are about to enter is what is called a Distinguished Name or a DN.

There are quite a few fields but you can leave some blank

For some fields there will be a default value,

If you enter '.', the field will be left blank.

- - -

Country Name (2 letter code) [AU]:JP

State or Province Name (full name) [Some-State]:Tokyo Locality Name (eg, city) []:Kodaira Organization Name (eg, company) [Internet Widgits Pty Ltd]:Renesas Electronics Organizational Unit Name (eg, section) []:Software Development Division Common Name (e.g. server FQDN or YOUR name) []:Renesas Tarou Email Address []:Tarou.Renesas@sample.com

B. Generate a Key Pair for Elliptic Curve Cryptography (Parameter: secp256r1) openssl ecparam -genkey -name secp256r1 -out secp256r1.keypair

using curve name prime256v1 instead of secp256r1



C. Create a Certificate for the Key Pair

openssl req -new -sha256 -key secp256r1.keypair > secp256r1.csr

You are about to be asked to enter information that will be incorporated into your certificate request. What you are about to enter is what is called a Distinguished Name or a DN. There are quite a few fields but you can leave some blank For some fields there will be a default value, If you enter '.', the field will be left blank. _ _ _ Country Name (2 letter code) [AU]: JP State or Province Name (full name) [Some-State]:Tokyo Locality Name (eg, city) []:Kodaira Organization Name (eg, company) [Internet Widgits Pty Ltd]:Renesas Electronics Organizational Unit Name (eg, section) []:Software Development Division Common Name (e.g. server FQDN or YOUR name) []:Renesas Tarou Email Address []:Tarou.Renesas@sample.com Please enter the following 'extra' attributes to be sent with your certificate request A challenge password []: An optional company name []:

D. Use the CA Certificate to Create a Certificate for the Key Pair openssl x509 -req -sha256 -days 3650 -in secp256r1.csr -CA ca.crt -CAkey ca.key -CAcreateserial -out

secp256r1.crt

Certificate request self-signature ok subject=/C=JP/ST=Tokyo/L=Kodaira/O=Renesas Electronics/OU=Software Development Division/CN= Renesas Tarou/emailAddress= Tarou.Renesas@sample.com

- E. Extract a Private Key for Elliptic Curve Cryptography (Parameter: secp256r1) openssl ec -in secp256r1.keypair -outform PEM -out secp256r1.privatekey read EC key writing EC key
- F. Extract a Public Key for Elliptic Curve Cryptography (Parameter: secp256r1) openssl ec -in secp256r1.keypair -outform PEM -pubout -out secp256r1.publickey read EC key writing EC key



2.4.3 Entering a Public Key

Open \src\key\code_signer_public_key.h from the bootloader project and the secp256r1.publickey file generated by OpenSSL in a text editor. Copy the contents of secp256r1.publickey to CODE_SIGNENR_PUBLIC_KEY_PEM.

Note that each line must be enclosed in straight quotes ("") and end with the backslash character (\).

If you are using firmware update module v2, you must also perform the same key information entry task for "\src\key\code_signer_public_key.h" of the "adu_sample" project.



Figure 2.23 Public Key Information Setting

2.5 Building the bootloader Project

Build the **bootloader** project and create a **bootloader.mot** file.

The MOT file is created in the following folder.

\bootloader\HardwareDebug/



2.6 Connection Information Macro Settings

Open \src\sample_config.h from the adu_sample project and specify setting values for HOST_NAME, DEVICE_ID, and DEVICE_SYMMETRIC_KEY. For the setting values, refer to the parameters configured on the Azure portal as described in 3.1, IoT Hub and Device Registration.

sample_cor	dig.h ×
62	⊕/* These values can be picked from device connection string which is of format : HostName= <host1>;Df</host1>
63	HOST_NAME can be set to <host1>,</host1>
64	DEVICE_ID can be set to <device1>,</device1>
65	DEVICE_SYMMETRIC_KEY can be set to <key1>. */</key1>
66	#ifndef HOST NAME
67	#define HOST_NAME "
68	#endif /* HOST_NAME */
69	
70	#ifndef DEVICE ID
71	#define DEVICE_ID "ADU_sample_test"
72	<pre>#endif /* DEVICE_ID */</pre>
73	
74	⊕ #else /* !ENABLE_DPS_SAMPLE */□
90	
91	/* Optional SYMMETRIC KEY. */
92	#ifndef DEVICE_SYMMETRIC_KEY
93	#define DEVICE SYMMETRIC KEY "
94	<pre>#endif /* DEVICE_SYMMETRIC_KEY */</pre>
95	

Figure 2.24 Azure Connection Information Settings

It is necessary to configure Wi-Fi connection settings in order to use RX65N Cloud Kit. Open \src\hardware_setup.h from the adu_sample project and specify setting values for WIFI_SSID and WIFI_PASSWORD. For the setting values, refer to the SSID and password of the Wi-Fi access point you wish to connect to.

1	
2	#ifndef HARDWARE SETUP H
3	#define HARDWARE SETUP H
4	
5	/* Wi-Fi is used to connect Azure cloud.*/
6	#define ENABLE WIET
7	
8	e #ifndef WIFI SSID
9	#define WIFI SSID "
10	<pre>#endif /* WIFI SSID */</pre>
11	
12	<pre>#ifndef WTFT PASSWORD</pre>
13	#define WIFI PASSWORD
14	<pre>#endif /* WIFI_SSID */</pre>
15	
16	<pre>void platform_setup(void);</pre>
17	
18	<pre>#endif // HARDWARE_SETUP_H</pre>
19	

Figure 2.25 Wi-Fi Connection Information Settings

2.7 Checking the Initial Firmware Version

Confirm that the initial firmware version is 1.0.0. Open **\src\sample_azure_iot_embedded_sdk_adu.c** from the **adu_sample** project and check to confirm that the value of **SAMPLE_DEVICE_INSTALLED_CRITERIA** is **1.0.0**.

<pre>#ifndef SAMPLE_DEVICE_INSTALLED_CRITERIA #define SAMPLE_DEVICE_INSTALLED_CRITERIA #endif /* SAMPLE_DEVICE_INSTALLED_CRITERIA */</pre>	"1.0.0"
--	---------

Figure 2.26 Initial Firmware Version

2.8 Building the adu_sample Project (for the Initial Firmware)

Build the adu_sample project and create a adu_sample.mot file.

The MOT file is created in the following folder.

\adu_sample\HardwareDebug\



2.9 Creating the Initial Firmware

Create the initial firmware to be downloaded to the target board.

When creating firmware, the creation procedure and the MOT file conversion tool to be used differ depending on whether the version of the firmware update module you use is v1 or v2. Refer to the procedure appropriate for the version of the firmware update module you use.

2.9.1 If Using Firmware Update Module v1

By using the MOT file conversion tool, merge the MOT files of "bootloader" and "adu_sample" to create an initial firmware image.

Use Renesas Secure Flash Programmer as the MOT file conversion tool.

Access the <u>Renesas Secure Flash Programmer (RX MCUs mot file converter 2.0.2</u>), download the **Source Code(zip)** and unzip it at a folder of your choice.



Figure 2.27 Renesas Secure Flash Programmer Download Page

After the download completes, double-click the file **mot-file-converter-2.0.2\Renesas Secure Flash Programmer\bin\Debug\Renesas Secure Flash Programmer.exe** to launch the program.

When you start Renesas Secure Flash Programmer, the following window appears:

Settings			
Select MCU	(select MCU) 🗸		
Select Firmware Verification Type	(select Firmware Verification Type) 🗸		
AES MAC Key (16 byte hex / 32 characters)			
Private Key Path (PEM Format)		Browse	
Select Output Format	(select Output Format) 🗸		
Boot Loader			
File Path (Motorola Format)		Browse	
Bankû User Program			
Firmware Sequence Number	(1 - 4294967295)		
File Path (Motorola Format)		Browse	
Bank1 User Program (Option)			
Firmware Sequence Number	(1 - 4294967295)		
File Path (Motorola Format)		Browse	
		Generate	

Figure 2.28 Renesas Secure Flash Programmer Window



In this window, click the **Initial Firm** tab, and then specify the settings as follows. The values to be specified are shown in blue font.

- Select MCU: RX65N Flash(Code=2MB, Data=32KB)/Secure Bootloader=64KB
- Select Firmware Verification Type: sig-sha256-ecdsa
- Private Key Path (PEM format): secp256r1.privatekey generated by OpenSSL in step E
- Select Output Format: Bank 0 User Program + Boot Loader (Motorola S Format)
- Boot Loader File Path (Motorola Format): \bootloader\HardwareDebug\bootloader.mot
- Firmware Sequence Number: 1
- Bank 0 User Program File Path (Motorola format): \adu_sample\HardwareDebug\adu_sample.mot

Settings		_		
Select MCU	RX65N Flash(Code=2MB, Data=32KB)/Secure Bootloader=64KB	~		
Select Firmware Verification Type	sig-sha256-ecdsa	~		
AES MAC Key (16 byte hex / 32 characters)				
Private Key Path (PEM Format)	C¥workspace¥ADU_KEY¥secp256r1privatekey		Browse	
Select Output Format	Bank0 User Program + Boot Loader (Motorola S Format)	~		
Boot Loader				
File Path (Motorola Format)	C:¥workspace¥bootloader¥HardwareDebug¥boot_loader.mot		Browse	
Bank0 User Program				
Firmware Sequence Number	1			
File Path (Motorola Format)	C:¥workspace¥adu_sample¥HardwareDebug¥adu_sample.mot		Browse	
Bank1 User Program (Option)				
Firmware Sequence Number	(1 - 4294967295)			
File Path (Motorola Format)			Browse	
			Ganavata	
			Generate.	:
1: generate succeeded				
» generate succeeded.				

Figure 2.29 Initial Firmware Creation Window

Next, click the **Generate...** button, and then, in the following window that appears, set any output destination folder of your choice, and enter the name of the output file. In this example, **userprog.mot** is entered as the output file name.



Click the **Save** button. The MOT file of the initial firmware is output to the specified folder. The process is complete when the message "generate succeeded." appears at the bottom of the window.

> < 🛧 📴 > This	PC > (C:) Windows > workspace	ce > ADU_sample > ADU_Firm >	ٽ ×	, Search ADU	_Firm
Organize 👻 New folder	,				== -
💻 This PC	^ Name	^ Date mo	dified Type	Size	
3D Objects					
🔜 Desktop					
Documents					
🕂 Downloads					
👌 Music					
Pictures					
🚆 Videos					
🏰 (C:) Windows					
	<u> </u>				
File <u>n</u> ame	og.mot				
Save as type: Motrol	a S format (*.mot)				

Figure 2.30 Outputting the MOT File of the Initial Firmware

The following figure shows the configuration of the "userprog.mot" file generated by Renesas Secure Flash Programmer.

The verification data, initial firmware, and bootloader have been merged into this MOT file.

The verification data contains the firmware address and other information required for verification.



Figure 2.31 File Configuration of userprog.mot (for Firmware Update Module v1)



2.9.2 If Using Firmware Update Module v2

By using the MOT file conversion tool, merge the MOT files of **bootloader** and **adu_sample** to create an initial firmware image.

Use Renesas Image Generator as the MOT file conversion tool.

1. Install Python.

Before you can use Renesas Image Generator, you must prepare the Python runtime environment. Download Python from <u>the Python download website</u>, and then install Python. We have confirmed correct operation with Python 3.12.0.

After installation is complete, add the Python installation folder path (shown below) to the Path system variable of Windows.

If the version of Python is v3.12.0, the path to be added is as follows: C:\Users\xxxx\AppData\Local\Programs\Python\Python312

Note: Replace *xxxx* by your Windows user name. The location of the installation folder may differ depending on the installation environment.

In Windows 10, to access the system variable, select:

Settings > System > About > Advanced system settings > System Properties > Advanced tab > Environment variables > System variables

When you have installed Python, install the Python encryption library (pycryptodome). The encryption library is downloaded and then installed by entering the following command from the command line:

> python -m pip install pycryptodome

When installation is complete, the message "Successfully installed pycryptodome-x.xx.x" appears.

2. Create an initial firmware image.

Create an image file of the initial firmware by using the following procedure:

(1) Open the "RenesasImageGenerator" folder that is bundled with the sample project. This folder is located in the "tools" folder of the sample project.

This folder contains three Renesas Image Generator files for ADU:

```
tools
|--RenesasImageGenerator
    |-- image-gen.py
    |-- RX65N_DualBank_Initial_PRM.csv
    |-- RX65N_DualBank_Update_PRM.csv
```

The table below provides a brief explanation of each file contained in the folder.

File name	Explanation
image-gen.py	Renesas Image Generator application (Python code)
RX65N_DualBank_Initial_PRM.csv	File containing the parameters for creating the initial firmware
RX65N_DualBank_Update_PRM.csv	File containing the parameters for creating an update firmware



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(2)	Cop	/ the	following	three	files to	o the	"Renesas	ImageGenerator'	' folder:
۰.	-	COP)		ronoming		11100 0		1100000	mageconorator	ioidoi.

/ 1 / 0		0
Private key	secp256r1.privatekey	Created in section 2.4.2, Generating a Key Pair for ECC in OpenSSL
Bootloader	bootloader.mot	Created in section 2.5, Building the bootloader Project
Initial firmware	adu_sample.mot	Created in section 2.8, Building the adu_sample Project (for the Initial Firmware)

Make sure that you copy the files to the "RenesasImageGenerator" folder in the following structure. The files in red font are the files you copy.

```
RenesasImageGenerator
|-- image-gen.py
|-- RX65N_DualBank_Initial_PRM.csv
|-- RX65N_DualBank_Update_PRM.csv
|-- secp256r1.privatekey
|-- bootloader.mot
|-- adu sample.mot
```

- (3) Open the Command Prompt window, and then change the current directory to the "RenesasImageGenerator" folder.
- (4) Execute the following command from the command prompt. An image file of the initial firmware will be created.

```
> python image-gen.py -iup adu_sample.mot -ip RX65N_DualBank_Initial_PRM.csv -o
userprog -ibp bootloader.mot -vt ecdsa
```

Creation takes some time.

When the message "Successfully generated the userprog.mot file" appears, creation is complete. The initial firmware image "userprog.mot" is output to the "RenesasImageGenerator" folder.

The following figure shows the configuration of the "userprog.mot" file generated by Renesas Image Generator.



Figure 2.32 File Configuration of userprog.mot (for Firmware Update Module v2)

The initial firmware image "userprog.mot" is a MOT file that contains headers, the initial firmware, and bootloaders.

The "Header (Certificate)" area stores the information for verifying the firmware and the "Header (Address)" area stores the address information of the firmware.

Note that this file also contains the bootloader in the buffer area.



2.10 Installing the Flash Programming Tool

Access the Renesas Flash Programmer <u>download site</u>, download the Renesas Flash Programmer V3.11.02 Windows installer, and run it to install the tool.

2.11 Programming the Initial Firmware

A) Flash Programming of Initial Firmware (Linear Mode \rightarrow Dual Mode)

Program the initial firmware on the target board.

In this procedure, you change the mode of the RX65 board to dual mode from the (initial) linear mode, and then program the firmware.

First, launch flash_project.rpj, which is located in the

\adu_sample\tools\Flash_Project\CKRX65N_ADU_Write folder. Next, on the Operation tab specify userprog.mot for Program File and click the Start button to program the previously generated initial firmware file userprog.mot to the RX65N.

Programming is complete when the message "Operation completed." appears at the bottom of the window.

E Renesas Flash Programmer V3 11 01		_		×
File Target Device Help				~
The larger bevice Thep				
Operation Operation Settings Block Settin	gs Connect Settings Unique Code	•		
Project Information				
Current Project: flash_projectrpj				
Microcontroller: RX Group		Endian: Little	~	
Program File				
	¥CCBX v 100¥rdp 139¥userprog mot	Bro		
	CBC-32	BAA9E58E	J7730	
	0100 02	DIMINEVOL		
Flash Operation				
Erase >> Program >> Verify				
			,	
Sta	art	OK		
Config Averal 0xEE7EED00 - 0xEE7EED0E	aina : 49			4
[Config Area] 0xFE7F5D40 - 0xFE7F5D7F	size: 64			
Verificing data				
[Config Area] 0xFE7F5D00 - 0xFE7F5D2F	size:48			
[Config Area] 0xFE7F5D40 - 0xFE7F5D7F	size: 64			
Disconnecting the tool				
Operation completed.				
1		Clear status an	d maccag	~
		olear status an	u messag	e

Figure 2.33 Programming the Initial Firmware to the Device

Running the initial firmware transitions the MCU from linear mode(normal mode) to dual mode (a mode in which the code flash memory is divided into two banks). Subsequently, if it is necessary once again to program the initial firmware to the flash memory, first perform B) to erase the flash memory and change to linear mode, then A) to program the flash memory.



B) Flash Erasing (Dual Mode \rightarrow Linear Mode)

The ROM is initialized by "Flash Erasing", and the RX65N changes from dual mode to linear mode. Launch erase_project.rpj in the **CKRX65N_ADU_Erase** folder in tools/Flash_Project and click the Start button on the Operation tab to erase the chip.

File Target Device File Target Device Help Operation Operation Operation Current Project Image: Start Command Erase Start
Project Information Current Project: eraserpj Microcontroller: RX Group Endian: Little Program Files Command Erase Start
Operation Operation Block Settings Connect Settings Unique Code Project Information Current Project: erase rpj Endian: Little Ittle Ittle <t< td=""></t<>
Project Information Current Project: eraserpj Microcontroller: RX Group Endian: Little V Program Files Command Erase Start

Figure 2.34 Erasing the Flash Memory and Changing the Mode to Linear Mode

Renesas Flash Programmer recognizes linear mode and dual mode as separate MCUs. In procedure A, the programming of flash memory starts after the device recognizes that it is placed in linear mode. In procedure B, erasure of flash memory starts after the device recognizes that it is placed in dual mode. Therefore, if either procedure A or B is repeated in succession, the device information becomes inconsistent, resulting in the E3000107 error (the device and connection information do not agree).



2.12 Executing the Initial Firmware

After programming of the initial firmware is complete, the program operates on the RX65N. For the actual operation procedure, refer to section 3.8.1, Execution on the Target Board. The following shows the program startup sequence from the programming.

- 1. The program operates after programming of the initial firmware is complete.
- 2. After the program runs, the bootloader runs and decrypts the encrypted hash value using the public key that was programmed to the verification data area.
- 3. The program calculates the hash value for the entire firmware, and checks whether it is identical to the decrypted hash value.

If the values match, it launches the firmware.

If you are using firmware update module v1, the bootloader is copied to the buffer area after verification of the firmware is complete.



Figure 2.35 Operation of the Bootloader (for Firmware Update Module v1)



Figure 2.36 Operation of the Bootloader (for Firmware Update Module v2)



2.13 Modifying the Code of the Updated Firmware

Open \src\sample_azure_iot_embedded_sdk_adu.c from the adu_sample project and change the value of SAMPLE_DEVICE_INSTALLED_CRITERIA to 1.1.0.*1

Note: 1. If the firmware version set in the Azure IoT Hub is already present, set the value to a different version number.

If necessary, add any needed update processing.



Figure 2.37 Updated Firmware Setting

2.14 Building the adu_sample Project (for the Update Firmware)

Build the **adu_sample** project and create an **adu_sample.mot** file. The MOT file is generated in the following folder: \adu sample\HardwareDebug\



2.15 Creating the Updated Firmware

Convert the updated firmware to RSU format.*1

The procedure for creating firmware differs depending on whether the version of the firmware update module is v1 or v2.

Refer to the procedure applicable to the version you use.

Note that a specific procedure also applies in the case where you use firmware update module v2 with a bootloader created by using firmware update module v1. In this case, refer to the applicable procedure.

Note: 1. The MOT file format (the data format generally used for firmware) provides no mechanism for storing data other than the actual data to be programmed to the device (for example, verification data such as hash values). In addition, MOT files consist of text data, so they tend to be around twice as large as files consisting of binary data.

To avoid these limitations, Renesas Secure Update (RSU), a binary file format exclusive to Renesas that allows storage of verification data alongside the actual firmware data, is used for ADU releases.

2.15.1 If Using Firmware Update Module v1

Create an RSU file of the update firmware by adding verification data to the firmware **adu_sample.mot**. Use Renesas Secure Flash Programmer to create the update firmware.

Double-click the file **mot-file-converter-2.0.2\Renesas Secure Flash Programmer\bin\Debug\Renesas Secure Flash Programmer.exe** to launch the program. Click the **Update Firm** tab, and then specify the settings as follows. The values to be specified are shown in blue font.

- Select MCU: RX65N Flash(Code=2MB, Data=32KB)/Secure Bootloader=64KB
- Select Firmware Verification Type: sig-sha256-ecdsa
- Private Key Path (PEM format): secp256r1.privatekey generated by OpenSSL in step E
- Firmware Sequence Number: 1
- File Path (Motorola format): \adu_sample\HardwareDebug\adu_sample.mot

Salaat MCU		
	RX65N Flash(Code=2MB, Data=32KB)/Secure Bootloader=64KB	~
Select Firmware Verification Type	sig-sha256-ecdsa	~
AES MAC Key (16 byte hex / 32 characters)		
Private Key Path (PEM Format)	C¥workspace¥ADU_KEY¥secp256r1privatekey	Browse
Bankû User Program Firmware Sequence Number File Path (Motrola Format)	1 C:¥workspace¥adu_sample¥HardwareDebug¥adu_sample.mot	Browse
		Generate

Figure 2.38 Updated Firmware Creation Window


Finally, click the **Generate...** button, and then, in the following window that appears, set any output destination folder of your choice, and enter the name of the output file. In this example, **firmware_1.1.0.rsu** is entered as the output file name.^{*1}

Click the **Save** button. The RSU file of the update firmware is output to the specified folder. The process is complete when the message "generate succeeded." appears at the bottom of the window.

Note: 1. The "1.1.0" portion in the file name differs depending on the version of the update firmware that you set.

	ikspace / add_sample	tools > AzureDeviceUpdat	eScripts >	× 0 ×	Search Az	ureDeviceUpda	ateS.
Organize 🔻 New folde	r						•
💻 This PC	Name	^	Date modified	Туре	Size		
3D Objects	AduC	mdlets	5/15/2023 10:30 AM	File folder			
📃 Desktop							
Documents							
👆 Downloads							
👌 Music							
Pictures							
Videos	_						
(C:) Windows							
	~						
File name: firmw	are_1.1.0.rsu						
_	· .						

Figure 2.39 Outputting an RSU File of the Update Firmware

When the message "generate succeeded" appears, processing is complete.

The following figure shows the configuration of the RSU file of the update firmware generated by Renesas Secure Flash Programmer.

Verification data	
Updated firmware	_ adu_sample.mot

Figure 2.40 Configuration of the RSU File of the Update Firmware (for Firmware Update Module v1)

The update firmware image "firmware_1.1.0.rsu" is a binary file in which verification data and the update firmware (MOT file) have been merged.

Refer to section 7.1, Download Data Format, in the application note <u>Renesas MCU Firmware Update Design</u> <u>Policy</u> for details on RSU files.

Also, this item provides details of the verification data (0x00000000 to 0x000002FF).

Once the updated firmware has been created, refer to section 3, Operations on Microsoft Azure Portal, and follow the instructions to register the updated firmware on the IoT Hub and update the firmware.



2.15.2 If Using Firmware Update Module v2

Create an RSU file of the update firmware by adding header data to the firmware "adu_sample.mot".

Use Renesas Image Generator to create the update firmware. Create an image file of the update firmware by using the following procedure:

- 1. Open the "RenesasImageGenerator" folder that is bundled with the sample project.
- This folder contains the following three files:

```
RenesasImageGenerator
|-- image-gen.py
|-- RX65N_DualBank_Initial_PRM.csv
|-- RX65N_DualBank_Update_PRM.csv
```

2. Copy the following two files to the "RenesasImageGenerator" folder:

1,5		
Private key	secp256r1.privatekey	Created in section 2.4.2, Generating a Key Pair for ECC in OpenSSL
Update firmware	adu_sample.mot	Created in section 2.14, Building the adu_sample Project (for the Update Firmware)

Make sure that you copy the files to the "RenesasImageGenerator" folder in the following structure. The files in red font are the files you copy.

RenesasImageGenerator

```
|-- image-gen.py
```

```
|-- RX65N DualBank Initial PRM.csv
```

```
|-- RX65N DualBank Update PRM.csv
```

- |-- secp256r1.privatekey
- |-- adu sample.mot
- 3. Open the Command Prompt window, and then change the current directory to the "RenesasImageGenerator" folder.
- 4. Execute the following command from the command prompt. An image file of the update firmware will be created.

> python image-gen.py -iup adu_sample.mot -ip RX65N_DualBank_Update_PRM.csv -o firmware_1.1.0 -vt ecdsa

The string in red font in the above command line is the file name of the update firmware image. In the file name, the "1.1.0" portion is the version number of example update firmware. Change the value of this portion according to the version of the update firmware that you set.

Creation of firmware takes some time.

When the message "Successfully generated the firmware_1.1.0.rsu file" appears, creation is complete. The RSU file of the update firmware image "firmware_1.1.0.rsu" is output to the "RenesasImageGenerator" folder.



The following figure shows the configuration of the RSU file of the update firmware generated by Renesas Image Generator.



Figure 2.41 Configuration of the RSU File of the Update Firmware (for Firmware Update Module v2)

The update firmware image "firmware_1.1.0.rsu" is a binary file in which verification data and the update firmware (MOT file) have been merged.

The verification data is located in two areas. The "Header (Certificate)" area stores the information for verifying the firmware, and the "Header (Address)" area stores the address information of the firmware.

For details on RSU files, refer to section 4.2.1, Update Image File, in the application note "<u>Firmware Update</u> <u>Module Using Firmware Integration Technology (Rev2.01)</u>".

Note that this section also describes the RSU header format (Verification data: 0x00000000 to 0x000002FF) in detail.

Once the updated firmware has been created, refer to section 3, Operations on Microsoft Azure Portal, and follow the instructions to register the updated firmware on the IoT Hub and update the firmware.

2.15.3 If Using Firmware Update Module v2 in the Bootloader v1 Environment

The RSU files created by firmware update modules v1 and v2 have different formats. Therefore, the bootloader created by firmware update module v1 cannot handle raw update firmware created by firmware update module v2.

For this bootloader to handle such update firmware, create an update firmware image by using the procedure shown below.*1

Note: 1. The update firmware image created by using the procedure shown below cannot be used for a bootloader created by firmware update module v2. If you use a bootloader created by firmware update module v2, use the procedure described in section 2.15.2, If Using Firmware Update Module v2.



 When you build update firmware, specify the following settings. Select r_fwup in the component tree of the Smart Configurator, set Enabled for the FWUP v1 compatible Setting property, and then build "adu_sample". After you have changed the settings in the Smart Configurator, click the Generate Code button to generate code.



Figure 2.42 Settings of Firmware Update Module v1 to Ensure Compatibility with v2

2. Open the "RenesasImageGenerator" folder that is bundled with the sample project. This folder contains the following three files:

```
RenesasImageGenerator
|-- image-gen.py
|-- RX65N_DualBank_Initial_PRM.csv
|-- RX65N_DualBank_Update_PRM.csv
```

3. Copy the following two files to the "RenesasImageGenerator" folder:

eepy are renetting are	nee te the Tterreedennag	
Private key	secp256r1.privatekey	Created in section 2.4.2, Generating a Key Pair for ECC in OpenSSL
Update firmware	adu_sample.mot	Created in section 2.14, Building the adu_sample Project (for the Update Firmware) Built with FWUP v1 compatible Setting enabled

RenesasImageGenerator is deployed in the folder as follows. The files in red font are the files you copy.

```
RenesasImageGenerator

|-- image-gen.py

|-- RX65N_DualBank_Initial_PRM.csv

|-- RX65N_DualBank_Update_PRM.csv

|-- secp256r1.privatekey

|-- adu_sample.mot
```

4. Open the Command Prompt window, and then change the current directory to the "RenesasImageGenerator" folder.



5. Execute the following command from the command prompt. An image file of the update firmware will be created.

> python image-gen.py -iup adu_sample.mot -ip RX65N_DualBank_Update_PRM.csv -o
firmware_1.1.0 -vt ecdsa -ff BAREMETAL_FWUP_V2_V1_DATA

The string in red font in the above command line is the file name of the update firmware. In the file name, the "1.1.0" portion is the version number of example update firmware. Change the value of this portion according to the version of the update firmware that you set.

Creation takes some time.

When the message "Successfully generated the firmware_1.1.0.rsu file" appears, creation is complete. The RSU file of the update firmware image "firmware_1.1.0.rsu" is output to the "RenesasImageGenerator" folder.

Once the updated firmware has been created, refer to section 3, Operations on Microsoft Azure Portal, and follow the instructions to register the updated firmware on the IoT Hub and update the firmware.



3. Operations on Microsoft Azure Portal

The Microsoft Azure operation procedure for implementing ADU is described below.

3.1 IoT Hub and Device Registration

Create an IoT Hub and device on the Azure portal.*¹ This process is described in section 3.1 of the application note <u>Visualization of Sensor Data using RX65N Cloud Kit and Azure RTOS</u>.

Note: 1. The screenshots of windows at the link may be modified.

In order to implement ADU it is necessary to select the Standard tier and edition type S1 in the pricing options for the IoT Hub. Note that it is not possible to implement ADU using the Free edition type.

You can set S1 as the edition level by setting **Tier** to **Standard** and **Daily message limit** to **400,000** in the IoT Hub creation window shown in the following figure.

Daily message limit * ① 400,000 (//month) //
See all options

Figure 3.1 Pricing Option Settings

The IoT hub created here has the following three parameters. Specify these parameters in the source code of the ADU sample project by referring to section 2.6, Connection Information Macro Settings.

- Host name: HOST_NAME
- Device ID: DEVICE_ID
- Primary key: DEVICE_SYMMETRIC_KEY

3.2 Creating a Device Update Account and Instance

To execute ADU, a device update resource for IoT Hub is required. In this section, you create this resource. Be aware that a paid account is required in order to use Device Update.

1. In the home page of the Azure portal site, click Create a resource. The Create a resource page opens.



Figure 3.2 Azure Home Page



2. Create a Device Update account for IoT Hub. In the search box on the **Create a resource** page, enter **device update**, and then perform a search. **Device Update for IoT Hub** is displayed as the search result on the **Marketplace** page.



Figure 3.3 [Create a resource] page



3. From the **Create** drop-down list at the bottom of the **Device Update for IoT Hub** area, select **Device Update for IoT Hub**. The **Create Device Update** page appears.

in the second se	⊡ ■ IoT Device Man Platform by TT
Microsoft	Transition Technolc
Azure Service	Azure Application
Securely and Reliably update your devices with Device Update for IoT Hub.	loT based platform f devices managemen
Device Update for IoT Hub	Price varies
Create 🗸 🛛 De	ice Update for IoT Hub

Figure 3.4 [Device Update] Page for IoT Hub

4. On the **Create Device Update** page, specify the following settings. After completing the settings, click the **Next: Diagnostics** button at the bottom of the page.

(1)	Subscription	Specify the subscription ID that you used when you created the IoT hub.
(2)	Resource group	Specify the resource group that you used when you created the IoT hub.
(3)	Name (account details)	Specify any character string of your choice as the name of the Device Update account.
(4)	Location (account details)	Specify the Azure region in which the Device Update account will be deployed.
(5)	SKII	Do not change the initial setting (Standard)
(0)	SKU	bo not change the initial setting (Standard).
(6)	Grant Access to Account	This check box is used to determine whether to assign administrator privileges. Leave the check box selected.
(6) (7)	Grant Access to Account	This check box is used to determine whether to assign administrator privileges. Leave the check box selected. Do not change the displayed value because the account name is set as is.



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Home > Create a resource > N	Marketplace >	
Create Device Upo Azure Device Update	date …	
Basics Diagnostics Netv	working Encryption Review	
Create a Device Update account learn more about Device Update	to get your IoT devices up to date with the latest features and securi $\ref{eq:security}$ of $\ref{eq:security}$	ty updates. Want to
Project details		
Select the subscription to manag	ge deployed resources and costs. Use resource groups like folders to	organize and
manage all your resources.		
Subscription *		
Resource group * 🛈	adu_test_ResourceGroup	\checkmark
Account Details		
Name *	adu-test-Account	 ()
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Device Update for IoT Hub levers outage. Your data will be duplica created. Learn More SKU Grant Access to Account Sky Assign Device Update Admi Instance Details Instance Name * IoT Hub Name * () Grant Access to IoT Hub	ages Microsoft-initiated failover and manual failover in the event of a ated to East Asia. You cannot account change this setting after the res Standard inistrator role. () (6) adu-test-Accoun adu-test-iothub	a data center iource has been
Device Update for IoT Hub levers outage. Your data will be duplica created. Learn More SKU Grant Access to Account Assign Device Update Admi Instance Details Instance Name * IoT Hub Name * ① Grant Access to IoT Hub	ages Microsoft-initiated failover and manual failover in the event of a ated to East Asia. You cannot account change this setting after the res Standard inistrator role. () (6) adu-test-Accoun adu-test-iothub	I to set up and
Device Update for IoT Hub levers outage. Your data will be duplica created. Learn More SKU Grant Access to Account Sky Assign Device Update Admi Instance Details Instance Name * IoT Hub Name * ① Grant Access to IoT Hub	ages Microsoft-initiated failover and manual failover in the event of a ated to East Asia. You cannot account change this setting after the res Standard inistrator role. (6) adu-test-Accoun adu-test-iothub d IoT Hub Data Contributor access to Azure Device Update Service Principa	I data center iource has been
Device Update for IoT Hub levers outage. Your data will be duplica created. Learn More SKU Grant Access to Account Assign Device Update Admi Instance Details Instance Name * IoT Hub Name * ① Grant Access to IoT Hub Device Update has assigned operate the service. Learn More	ages Microsoft-initiated failover and manual failover in the event of a ated to East Asia. You cannot account change this setting after the res Standard inistrator role. (6) adu-test-Accoun adu-test-iothub d IoT Hub Data Contributor access to Azure Device Update Service Principa	I data center iource has been

Figure 3.5 [Create Device Update] Page



5. In the **Diagnostics**, **Networking**, and **Encryption** tabs, leave the initial settings unchanged. Click the **Next** button at the bottom of the page. In the **Encryption** tab, click the **Review + create** button to display the following confirmation page.

In the confirmation page, the registration information is validated. When validation is complete, a message to that effect appears, and the **Create** button at the bottom of the page is enabled. When you have confirmed that the specified settings are correct, click the **Create** button. Creation of a device update account starts.

Home > Create a resource	ce > Marketplace >
Create Device	Update ····
Azure Device Update	
Validation passed.	
Basics Diagnostics	Networking Encryption Review
In cases where an Az Device Update for lo purpose of anti-mali not agree to such us <u>More.</u>	zure region is unavailable due to an outage, data contained in the update files submitted to the of Hub service may be sent to a specific Azure region for the duration of the outage, for the ware scanning and making the updates available on the Device Update service endpoints. If you do ie, you can choose to discontinue your use of Device Update. Click here to view the terms <u>Learn</u>
To maintain the qual Customer Data whici not agree to such us	lity and availability of the Device Update service, Microsoft collects certain telemetry from your h may be stored and processed outside of your Azure region. To learn more, click here. If you do se, please do not proceed with creating a Device Update account. <u>Learn More</u> .
Basics	
Subscription	IoT_Hub
Resource group	adu_test_ResourceGroup
Name	adu-test-Account
Location	Southeast Asia
Pricing Details	Standard
Grant Access to Resource	true
Instance Summary	
Instance Name	adu-test-Accoun
IoT Hub Subscription	IoT_Hub
IoT Hub Name	adu-test-iothub
Grant access to resource	true
Create	Previous Next

Figure 3.6 Confirmation Page for Creating a Device Update Account



6. Registration (deployment) of a Device Update account may take a long time (approximately 10 to 20 minutes). When registration is complete, click the **Go to resource** button. The device update window for the IoT hub that you created appears.



Figure 3.7 Registering a Device Update Account

7. In the Device Update page for the IoT hub that you created, click **View Device Update Instances** or **Instances** under **Instance Management** in the menu on the left of the page. The instance registration status is displayed.

The IoT hub name linked with the instance name that was set during creation of the Device Update account is displayed. If **Succeeded** appears in the **Provisioning State** column, creation of the Device Update account is complete.



Figure 3.8 [Device Update for IoT Hub] Page



3.3 Creating a Storage Account Container

Create storage for storing update firmware.

Before you can use storage, you must prepare a storage account and container that stores files.

 As in section 3.2, Creating a Device Update Account and Instance, in the home page of the Azure portal site, click Create a resource, and then, use the search box to perform a search for the string storage. When Storage account appears as the search result, from the Create drop-down list, select Storage account. The storage account creation page appears.

Get Started	₽ storage	× Pricing : All × O	perating System : All × Publi:
Service Providers		Publisher name : All	X
Management	Azure services only		·
Private Marketplace	🔩 New! Get Al-generated	suggestions for your search.	View suggestions
Private Offer Management	Chausing 1 to 20 of 2217 and the feet	dament Classicate	
My Marketplace	Showing 1 to 20 of 2217 results for	storage'. <u>Clear search</u>	
Favorites		۱	
My solutions	Storage account	Azure Storage Mover	Azure Blob Storage on IoT Edge
Recently created	Microsoft	Microsoft	Microsoft
Private plans	Azure Service	Azure Service	lot Edge Modules
Categories	Use Blobs, Tables, Queues, Files, and Data Lake Gen 2 for reliable, economical cloud storage.	Azure Storage Mover is a migration service that migrates your on- premises file shares to Azure Storage	Azure consistent block blob storage on IoT Edge
Storage (1218)			
Compute (547)			
	<u> </u>	Crusta V D	Create V C

Figure 3.9 Storage Account Creation



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2. On the **Create a storage account** page, specify the following settings. After completing the settings, click the **Next: Advanced** button at the bottom of the page.

	(1)	Subscription	Specify the subscription ID that you used when you created the IoT hub.
	(2)	Resource group	Specify the resource group that you used when you created the IoT hub.
	(3)	Storage account name	Specify any character string of your choice as the name of the storage account.
	(4)	Region	Specify the Azure region in which the storage account will be deployed.
Not	te: F	or the settings other than the	ne above, leave the initial values unchanged.

	Irce > Marketp	lace >				
Create a stora	age accou	unt …				
Basics Advanced	Networking	Data protection	Encryption	Tags	Review	
Azure Storage is a Micro redundant. Azure Storag Tables. The cost of your storage accounts	osoft-managed se ge includes Azure storage account	ervice providing cloud Blobs (objects), Azure depends on the usage	storage that is h 2 Data Lake Stora 2 and the options	ighly avail ge Gen2, A you choo	able, secure, durable, so Azure Files, Azure Queu se below. Learn more a	alable, and es, and Azure bout Azure
Project details						
Select the subscription i manage your storage ac	n which to create count together v	the new storage acco vith other resources.	ount. Choose a ne	ew or exist	ing resource group to c	organize and
Subscription *						— ~ ('
Resource group	*	adu_test_Resourc	eGroup			~ (ž
Instance details						
Instance details Storage account name	① *	aduteststorageac	count			
Instance details Storage account name Region ① *	·) *	aduteststorageac (Asia Pacific) Japa	count n East			(;
Instance details Storage account name Region ① *	(j) *	aduteststorageac (Asia Pacific) Japa Deploy to an edge z	count n East			(i
Instance details Storage account name Region ① * Performance ① *	(j) *	aduteststorageac (Asia Pacific) Japa Deploy to an edge z Standard: Rec	count n East one commended for r	nost scena	rios (general-purpose v	(; (; (
Instance details Storage account name Region ① * Performance ① *	1) *	aduteststorageac (Asia Pacific) Japa Deploy to an edge z Standard: Rec Premium: Rec	count n East one commended for r	nost scena	rios (general-purpose v hat require low latency.	(; (/2 account)
Instance details Storage account name Region ① * Performance ① *	· *	aduteststorageac (Asia Pacific) Japa Deploy to an edge z Standard: Rec Premium: Rec Geo-redundant st	n East one commended for r commended for s torage (GRS)	nost scena	rios (general-purpose v hat require low latency.	(; (; /2 account)
Instance details Storage account name Region ① * Performance ① * Redundancy ① *	(j) *	aduteststorageac (Asia Pacific) Japa Deploy to an edge z Standard: Rec Premium: Rec Geo-redundant st Make read acc	count n East commended for r commended for s torage (GRS) ess to data availa	nost scena scenarios t	rios (general-purpose v hat require low latency. event of regional unav.	/2 account)
Instance details Storage account name Region ① * Performance ① * Redundancy ① *	(j) *	aduteststorageac (Asia Pacific) Japa Deploy to an edge z Standard: Rec Premium: Rec Geo-redundant st Make read acc	count n East commended for r commended for s torage (GRS) ess to data availa	most scena scenarios t	rios (general-purpose v hat require low latency. event of regional unav	/2 account)
Instance details Storage account name Region ① * Performance ① * Redundancy ① *	() *	aduteststorageac (Asia Pacific) Japa Deploy to an edge z Standard: Rec Premium: Rec Geo-redundant si Make read acc	count n East commended for r commended for s torage (GRS) ress to data availa	nost scena scenarios t able in the	rios (general-purpose v hat require low latency. event of regional unav	/2 account) ailability.

Figure 3.10 Creating a Storage Account



3. Leave the initial values unchanged in the Advanced, Networking, Data protection, Encryption, and Tags tabs. Click the Next button at the bottom of the page. In the Tags tab, click the Next: Review button to display the following confirmation page.

In the confirmation page, the registration information is validated. When validation is complete, the **Create** button at the bottom of the page is enabled.

When you have confirmed that the specified settings are correct, click the **Create** button. Creation of a storage account starts.

Basics Advanced Networ	king Data protection Encryption Tags Review
Basics	
Subscription	
Resource Group	adu_test_ResourceGroup
Location	japaneast
Storage account name	aduteststorageaccount
Deployment model	Resource manager
Performance	Standard
Replication	Read-access geo-redundant storage (RA-GRS)
Advanced	
Enable hierarchical namespace	Disabled
Enable network file system v3	Disabled
Allow cross-tenant replication	Disabled
Access tier	Hot
Enable SFTP	Disabled
Large file shares	Disabled
Networking	
Network connectivity	Public endpoint (all networks)
Default routing tier	Microsoft network routing
Endpoint type	Standard

Figure 3.11 Settings Confirmation Page for Storage Account Creation



4. Registration (deployment) of a storage account takes some time. When registration is complete, click the **Go to resource** button. Registration is complete when the page of the storage account that you created appears.

Home > aduteststorageacco Deployment	unt_1	••• Deployment in progress × Deployment to resource group 'adu_test_ResourceGroup' is in progress.
✓ Search «	🔟 Delete 🚫 Cancel 🕕 Redeploy 👱 Download 🔘 Refresh	
👶 Overview	Deployment is in progress	
Inputs		
i Outputs	Subscription: IoT Hub Correlation ID: 2bee1h10-2650-4f03-b	1952-160
E Template	Resource group: adu_test_ResourceGroup	Microsoft Defender for Cloud

Figure 3.12 Storage Account Registration

 Next, create a container in which to store update firmware files. On the storage account page, in the menu on the left side, click **Container** under **Data storage**. The **Containers** page appears.

Home > aduteststorageacco Storage account P Search «	Dunt & ☆ … ↑ Upload Nove > C)	Refresh 🔹 Open in mobile 📑 CLI / PS 🔗 Feedback	;
Cverview	A Essentials A A A		JSON View
Activity log	Resource group (move)	Performance	
🗳 Tags	adu test ResourceGroup	Standard	
🗙 Diagnose and solve problems	Location	Replication	
Access Control (IAM)	japaneast	Read-access geo-redundant storage (RA-GRS)	
💕 Data migration	Primary/Secondary Location Primary: Japan East, Secondary: Japan West	Account kind StorageV2 (general purpose v2)	
🗲 Events	Subscription (move)	Provisioning state	
Storage browser	loT Hub	Succeeded	
隢 Storage Mover	Subscription ID	Created 12/1/2023, 6:10:01 PM	
Data storage	Disk state		
Containers	Primary: Available, Secondary: Available		
📫 File shares	Tags (<u>edit</u>)		
	Add tone		

Figure 3.13 Completion of Storage Account Registration



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6. On the **Containers** page, click **+Container**. When the page for creating a new container appears, enter any container name of your choice, and then click the **Create** button. For the other settings, leave the initial values unchanged. The processing is complete when the container name that you entered is displayed in the list.

		,	🗐 Delete 🛛 🖓 Give feedba	ack
Overview	Search containers by prefix			Show deleted conta
Activity log				
Tags	Name	Last modified	Anonymous access level	Lease state
Diagnose and solve problems	\$logs	12/1/2023, 6:10:31 PM	Private	Available
	Anonymous access level ()	255)	J	
	Private (no anonymous acco	/		
	The access level is set to disabled on this storage	o private because anonymous access is account.		

Figure 3.14 Creating a New Container



3.4 Preparing the Updated Firmware

3.4.1 Building the Updated Firmware

Create update firmware by referring to Chapter 2, Creating Sample Projects, and then create an RSU file.

3.4.2 Creating a Manifest File

A manifest file is a JSON file that defines information about the updated program required by Device Update for IoT Hub. The manifest file and binary file are used as a pair when uploading updated firmware to a IoT Hub. Follow the steps below to create a manifest file.

<u>PowerShell v7.0</u> is used to create manifest files. Download and run the installer that matches your OS.
 Note: Normally, download v7 (version released most recently). The following figure is an example when the version is v7.3.4.

PowerShell-7.3.4-win-fxdependent.zip	24.9 MB
PowerShell-7.3.4-win-fxdependentWinDesktop.zip	24.3 MB
PowerShell-7.3.4-win-x64.msi	101 MB
PowerShell-7.3.4-win-x64.zip	103 MB
PowerShell-7.3.4-win-x86.msi	93.5 MB
PowerShell-7.3.4-win-x86.zip	94.8 MB

Figure 3.15 PowerShell Installer Download

2. Launch PowerShell and change the current directory to the directory containing the scripts for creating ADU project manifest files.

\adu_sample\tools\AzureDeviceUpdateScripts

- 3. Run the following command in PowerShell. Set-ExecutionPolicy -ExecutionPolicy RemoteSigned -Scope Process
- 4. Copy the RSU file created as described in 2.15, Creating the Updated Firmware, to the folder referenced in step 2. Assign the following name to the copied RSU file:

firmware_1.1.0.rsu

Replace **1.1.0** in the file name with the version number specified for the updated firmware. Also, do not change the file name again after the manifest file has been created.

5. Run the script shown below. Some items require input when the script is run, so enter the character strings shown in blue text below. The names of the scripts differ according to the names of the target boards they are intended to be used with. When reading the explanation, replace the relevant portion of the file name of the script as appropriate. The LeafPath item refers to the path setting of the child device connected to the target board, so press the Enter key for this item without entering anything.

.\CreateCKRX65NUpdate.ps1

cmdlet CreateCKRX65NUpdate.ps1 at command pipeline position 1 Supply values for the following parameters: (Type !? for Help.) Version: 1.1.0 HostPath: ./firmware_1.1.0.rsu LeafPath: Preparing update RENESAS.CK-RX65N.1.1.0 ... Preparing parent update RENESAS.CK-RX65N.1.1.0 ... Generating an import manifest RENESAS.CK-RX65N.1.1.0... Saving parent manifest file and payload(s) to .\RENESAS.CK-RX65N.1.1.0...





Figure 3.16 Script Run Window

- 6. When the script completes successfully, a folder named RENESAS.CK-RX65N.1.1.0 is created in the script folder with the RSU file and manifest file listed below saved to it. Upload these two files to the storage container:
 - RENESAS.CK-RX65N.1.1.0.importmanifest.json
 - firmware_1.1.0.rsu

3.5 Uploading the Firmware Update to the Storage Container

Upload the previously generated updated firmware to the storage container. On the **Home** page of the Azure portal, perform the following steps.

On the **Home** page, click **Storage accounts** \rightarrow <name of storage account to use> \rightarrow **Containers** (under **Data storage**) \rightarrow <name of container to use>. The **Containers** page appears. On the **Containers** page, click **Upload** to display the page for uploading updates (**Upload blob**).



Figure 3.17 Containers Page



Drag and drop to the **Upload blob** page the **RENESAS.CK-RX65N.1.1.0** folder containing the firmware update binary file and manifest file prepared as described in section 3.4. When the files are registered, click the **Upload** button. When the upload completes, click the × button to close the **Upload blob** page. The added folder (or files) appear in the container contents list.

Upload blob		×
2 file(s) selected: firmware_1.1.0.rsu, R Drag and drop files he	EENESAS.CK-RX65N.1.1.0.importma rer or Browse for files	
Overwrite if files already exist		
✓ Advanced		
Upload	R Give fee	dback
↑ Upload A Change access level C) Refresh	ier
Authentication method: Access key (Switch Location: adusample	n to Azure AD User Account)	
Search blobs by prefix (case-sensitive)		
Name RENESAS.CK-RX65N.1.1.0	Modified	A

Figure 3.18 Uploading Update Files



3.6 Registering the Firmware Update

Register the firmware update uploaded to the storage container on the **IoT Hub** page. For the IoT Hub you are using, click **Updates** under **Device management** to display a list of updates. On this page, click **Updates** tab \rightarrow **Import a new update**.

Home > 1			
SP23OC M-HoT- Inc	🚛 🛶 Updates 🗦	∻ ★ …	
Search «	 Please ensure the Azure D otherwise be blocked. After granted. 	evice Update service principal has <u>required pa</u> r granting permission, initiate a Device Sync o	ermission. Key management actic operation from the Diagnostics ta
Activity log	Updates Groups and De	ployments Diagnostics 🔺 Get s	tarted
 ℜ Access control (IAM) Tags 	Import, view, and delete updat	es. View 'Groups and Deployments' to dep	oloy.
Diagnose and solve problems	+ Import a new update) Refresh 📋 Remove 🕚 View imp	ort history
🗲 Events	Drovider	Namo	Version
Device management	Provider	Name	version
Devices			
IoT Edge			
🙎 Configurations + Deployments			
🧼 Updates			
Dueries			

Figure 3.19 Updates List Page

The **Import update** page is displayed. Enter a description of the firmware update in the **Descriptive label** text field and click **Select from storage container**.

Home >> 💀 - 284 all is an i Updates >	
Import update	
2020 C. Y. Isonaka w	
Import an update by selecting update files and import manifests.	
Descriptive label	
ADU Run Test v1.1.0 CK-RX65N Secure Bootloader	
+ Select from storage container	

Figure 3.20 Entering a Description of the Update



Select **Storage account name > Containers name** in which the update firmware is to be stored. Check the boxes next to the names of the firmware binary file and manifest file previously registered on the **Containers** page, and click the **Select** button.

Home >> ** • • • • • • • • • • • • • • • • •	ort update > Storage acc	ounts > Containers >		
Location: adusample / RENESAS.CK-RX65N.1.1.0 Search blobs by prefix (case-sensitive)				
Name	Modified	Access tier	Archive status	Blc
[]				
🔄 📄 firmware_1.1.0.rsu	5/15/2023, 5:24:26 PM	1		Blc
PRENESAS.CK-RX65N.1.1.0.importmanifest.jso	on 5/15/2023, 5:24:26 PM	1		Blc
Select				

Figure 3.21 Selecting Update Files

The files you checked are already registered on the **Import update** page, so click the **Import update** button.

Home > FIF J J J J J J J J J J J J J J J J J J
Import an update by selecting update files and import manifests.
Descriptive label
ADU Run Test v1.1.0 CK-RX65N Secure Bootloader
+ Select from storage container
V RENESAS CK-RX65N 1.1.0
RENESAS.CK-RX65N.1.1.0.importmanifest.json
firmware_1.1.0.rsu
Import update Cancel

Figure 3.22 Import update Page



When import starts, a pop-up window shown in the following figure may appear at the top right of the page.

Updates Groups and Deployments Diagnostics Get started Import, view, and delete updates. View 'Groups and Deployments' to deploy. The update may still successfully import. You can monitor status by viewing import history under IoT Hu Updates. Updates.	dates 🖈 🛪 …	A problem occurred monitoring import of update:
Import, view, and delete updates. View 'Groups and Deployments' to deploy. The update may still successfully import. You can monitor status by viewing import history under IoT Hu Updates.	Updates Groups and Deployments Diagnostics Get started	Provider: RENESAS Name: CK-RX65N Version: 1.1.0
+ Import a new undate (1) Refresh III Remove (1) View import history	Import, view, and delete updates. View 'Groups and Deployments' to deploy.	The update may still successfully import. You can monitor status by viewing import history under IoT Hub Updates.
	+ Import a new update 🕐 Refresh 🛍 Remove 🕚 View import history	

Figure 3.23 Warning Pop-Up Window for Import

Even when this pop-up window appears, the import processing is actually running. Therefore, check the import status by clicking **View import history**.

Giou	ps and Deployments	2			
Import, view, and de	elete updates. View 'Gro	oups and Deployments' to	deploy.		
+ Import a new	update 💍 Refresh	🕅 Remove 🕄 View i	import history		
Provider		Name	Version		Descript
		Z Z	7		
	Update imp	oort history		×	
	Update imp adu-test-iothub View update import his	port history		×	
	Update imp adu-test-iothub View update import his O Refresh	story for past seven days.		×	
	Update imp adu-test-iothub View update import his C Refresh Provider	story for past seven days.		×	
	Update imp adu-test-iothub View update import his C Refresh Provider Name	renesas CK-RX65N		×	
	Update imp adu-test-iothub View update import his C Refresh Provider Name Version	RENESAS CK-RX65N 1.1.0		×	
	Update imp adu-test-iothub View update import his C Refresh Provider Name Version Descriptive label	RENESAS CK-RX65N 1.1.0 ADU RUN Test v1.1.0	CK-RX65N Secure Bootloader	×	
	Update imp adu-test-iothub View update import his C Refresh Provider Name Version Descriptive label Status	RENESAS CK-RX65N 1.1.0 RUNN Test v1.1.0 Running	CK-RX65N Secure Bootloader	×	

Figure 3.24 Viewing the Import History

The import processing takes some time.

If the status is **Running**, the import processing is in progress. Therefore, wait for a while.

Note that the import history is not automatically refreshed. To see the latest information, manually click the **Refresh** button.

When the status becomes **Succeeded**, the import processing is complete. If the import processing fails, correct the problem, and then reperform the processing.



After the import processing ends normally, when you click the **Refresh** button, the imported firmware is added to the update program list.

Updates Groups and Deploy	rments Diagnostics 🔺 Get st	arted	۵
Import, view, and delete updates. V	'iew 'Groups and Deployments' to dep	loy.	
+ Import a new update 💍 R	efresh 🔟 Remove 🕔 View impo	ort history	
Provider	Name	Version	Descriptive label
RENESAS	CK-RX65N	1.1.0	ADU Run Test v1.1.0 Details CK-RX65N Secure

Figure 3.25 List of Updates



3.7 Creating an ADU Group

Add an ADU group to the update. Configure settings to add an ADU group in order to link the IoT Hub device and the ADU group. On the **IoT Hub** page, click **Devices** under **Device management**. From the list of devices, select the device created as described in 3.1 to open the **Device settings** page. On the **Device settings** page, click **Tags (edit)** to display the **Edit tags** page.

Primary key ①	<u>ه</u>	¢↓	ß
Secondary key ①	<u>ه</u>	ţ↓	D
Primary connection string ①		. 👁	D
Secondary connection string ①	·····	. 👁	D
Tags (<u>edit)</u> No tags			

Figure 3.26 Device settings Page

On the **Edit tags** page, enter values for **Name** and **Value**. For **Name** enter **ADUGroup**, and for **Value** enter a character string of your choice. After entering the above, click the **Save** button to close the **Edit tags** page. Confirm that the **Name** and **Value** tags you specified have been registered on the **Device settings** page, then click the **Save** button at the top left of the page.

Edit tags ADU_sample_test			×	
Tags are name/value pairs that enable you to categorize devices by case sensitive. <u>Learn more</u>	y ap	olying the same tag to multiple devices. Device tag names and va	ues are	
Tags				
Basic Advanced				
Name		Value		
ADUGroup]	ADU_TEST_GROUP	Î	
e.g. environment	:	e.g. production		
Device				
ADU_sample_test				
1 to be added ①				
Save				

Figure 3.27 Edit tags Page

On the **IoT Hub** page, click **Updates** under **Device management** \rightarrow **Groups and Deployments**. The group for which you specified the **Value** tag should have been added to the list of groups that is displayed.*¹

Note: 1. A group may fail to be added to the list of ADU groups in the case of a device where no communication has ever taken place with the target board. In this case, connect once from the target board to the IoT Hub device to be used with ADU.



3.8 Updating the Firmware

Download the firmware update registered to the IoT Hub to the target board.

3.8.1 Execution on the Target Board

To begin, run the initial firmware previously programmed to the target board. For the CK-RX65N, operation starts when you connect the USB of J14 to a USB port on the PC to supply power by connecting a jumper line from JP16 to the RUN side.

Also, by connecting a PC to the J20 USB connector it is possible to monitor the operating state using a terminal emulator program such as Tera Term. When you establish a USB connection between J20 and the PC, a port is registered in Windows Device Manager. You can then connect to the target board by specifying the newly registered COM port number in the terminal emulator program. Configure the serial port communication settings as follows.

- Data rate: 115,200 bps
- Data bits: 8
- Stop bits: 1
- Parity: None

When you run the project, the sample program sends status information as serial output to the terminal emulator program, as shown in the example below.*¹ Check the text displayed by the terminal emulator program to confirm that a connection has successfully been established to the IoT Hub and device. Also confirm the current firmware version indicated following **Installed Criteria:**.

Note: 1. The information output to the terminal emulator program may differ depending on which project you built.



Figure 3.28 Output in Terminal Emulator Window (Example)



3.8.2 Deploying the Firmware Update

Deploy the firmware update from the IoT Hub to the environment, and update the target firmware. For the IoT Hub you are using, click **Updates** under **Device management** to display a list of updates, and then click **Groups and Deployments**. A list of devices in the device group is displayed.

iot Hub	R I III · II Updates
P Search	Please ensure the Azure Device Update service principal has required permission. Key management actions like deployment creation and new device registration will otherwise be blocked. After granting permission initiate a Device Surg operation from the Diagnostics tab to register any devices or gravialized before permission was
💦 Overview	granted.
 Activity log 	Updates Groups and Deployments Diagnostics 🔺 Get started
Access control (IAM)	View energingen information for devices composited to Device Undet for InT Units
🔷 Tags	view compliance information for devices connected to bevice opdate for for Hub.
Diagnose and solve problems	New updates available: 1 Updates in propress: 0
🗲 Events	On latest update: 1
Device management	Total: 2
Devices	
IoT Edge	
😤 Configurations + Deployments	
🧼 Updates	view device groups and depicy updates to member devices. Device groups are automatically created based on device tags, <u>team more</u>
🔎 Queries	🕐 Refresh 📋 Remove
Hub settings	Group page t Croated Davie Status
- Built-in endpoints	Gloup name Greated Devic Status
1 A	ADU_TEST_GROUP 6/8/2023, 5:49: 1 One or more new updates are available for this group. Deploy

Figure 3.29 Groups and Deployments Display

Groups are displayed in the list of device groups using ADU group names registered as described in 3.6. Click the group name to be used as the firmware update. The **Group details** page appears. On the **Group details** page, click the **Group basics** tab and then click **Deploy** in the center of the page. Alternatively, you can click **Deploy** next to the desired group name on the **Groups and Deployments** page.

	cs Current updates Deployment history			
Group deta	 nils			
Name	ADU_TEST_GROUP	New	updates available: 1	
Туре	IoT Hub tag based group	Upda	tes in progress: 0	
Created	6/8/2023, 5:49:11 PM GMT+9	On lat	test update: 0	
i One c	r more new updates are available for this group. <u>Deploy</u>			
i One o	r more new updates are available for this group. <u>Deploy</u>	U		
i One o Device list	r more new updates are available for this group. <u>Deploy</u>	U		
One c	r more new updates are available for this group. <u>Deploy</u>	U		
One c	r more new updates are available for this group. <u>Deploy</u> n 	ID. Deployment status: All		

Figure 3.30 Group details Page



On the **New updates** page that appears, check that the version number is correct, then click the **Deploy** button. The **Create deployment** page is displayed.

New update	S	×
View best available upo	ates for devices in the group.	
Provider	RENESAS	
Name	CK-RX65N	
Version	1.1.0	
More update details		
> Target devices		🕞 Deploy

Figure 3.31 New updates Page

On the Create deployment page, click the Create button. Deployment starts.

C	Create deployment ×
C	Create a new deployment targeting devices in this group.
(5)	Jpdate properties Provider RENESAS Name CK-RX65N Version 1.1.0
	Group name ADU_TEST_GROUP
s	Specify when this deployment should start. * Start immediately. Start at a scheduled date and time.
C	Rollback all applicable devices in the group to a different update if rollback criteria is met
(Create Cancel

Figure 3.32 Create deployment Page

Once deployment starts, the download status is output to the terminal emulator program connected to the CK-RX65N. The downloaded firmware update is written to the flash memory, and version checking and verification data are used to verify the firmware. Next, bank switching takes place on the device, and the firmware update is applied after a software reset.



Figure 3.33 Downloading the Firmware



After the firmware is downloaded, the update is complete when the firmware version indicated following **Installed Criteria:** matches that of the firmware update.



Figure 3.34 Firmware Update Complete

After the firmware update finishes, the **Deployment status** shown on the **Group details** page is **Succeeded**.

Device list Organization Deployment status: All Search entries by device ID or device ID followed by a 'space' and module ID. Deployment status: All Name Deployment status Installed update Last attempted update On latest update ADU_sample_test Succeeded RENESAS CK-RX65N 1.1.0 Yes	Home > Constant and Constant Const	Peployment history	New updates available: 0 Updates in progress: 0 On latest update: 1 Total: 1			
Name Deployment status Installed update Last attempted update On latest update ADU_sample_test Succeeded RENESAS CK-RX65N 1.1.0 Yes	Device list					
Search entries by device ID of lowed by a 'space' and module ID. Deployment status: All Name Deployment status: Installed update Last attempted update On latest update ADU_sample_test Succeeded RENESAS CK-RX65N 1.1.0 Yes	🕐 Refresh					
Name Deployment status Installed update Last attempted update On latest update ADU_sample_test Succeeded RENESAS CK-RX65N 1.1.0 RENESAS CK-RX65N 1.1.0 Yes	search entries by device ID or device	ID followed by a 'space' and module ID.	Deployment status: All			
ADU_sample_test Succeeded RENESAS CK-RX65N 1.1.0 RENESAS CK-RX65N 1.1.0 Yes	Name	Deployment status	Installed update	Last attempted update	On latest update	
	ADU_sample_test	Succeeded	RENESAS CK-RX65N 1.1.0	RENESAS CK-RX65N 1.1.0	Yes	

Figure 3.35 Group details Page



You can deploy a version of the firmware that is not the latest version by clicking the applicable group name in the device group list, clicking the **Current updates** tab on the **Group details** page, and then clicking **View available updates** under **Deployment details** to display the **Available updates** page. You can then select the desired version from a list and deploy it.

Group details: ADU_TEST_GRO	DUP
e conta mante a	
roup basics Current updates Deployment h	iistory
C Refresh	
Update	Target devices
Provider RENESAS	Devices in this group with attributes:
Name CK-RX65N	manufacturer: RENESAS model: CK-RX65N
Version 1.1.0	Contract Name: Device Update Model V2
Descriptive label ADU Run Test v1.1.4 CK-RX65N Se	cure Bootloader Contract ID: dtmi:azure:iot:deviceUpdateContractModel;2
More update details	Assign a descriptive label
Deployment details	Device statistics
Start time 6/8/2023, 6:09:08 PM GMT+9	Total devices 1
Retried No	In progress 0
Cloud rollback No	Canceled 0
Status Active (Succeeded 1
	Failed 0
C Retry failed devices X Cancel deploymer	t View devices
View available updates	_
View available updates	
View available updates	
View available updates	
View available updates	s ×
View available updates	s ×
View available updates Available update View best and other installable u	s ×
View available updates Available update View best and other installable u	s × pdates for devices sharing the same attributes.
View available updates Available update View best and other installable update Provider RENES	s × pdates for devices sharing the same attributes. AS
View available updates Available update View best and other installable update Provider RENES Name CK-RX	s × pdates for devices sharing the same attributes. AS 65N
View available updates Available update View best and other installable update Provider RENES Name CK-RX Version 1.1.4	s × pdates for devices sharing the same attributes. AS 65N
View available updates Available update View best and other installable update Provider RENES Name CK-RX Version 1.1.4 More update details	s × pdates for devices sharing the same attributes. AS 65N
View available updates Available update View best and other installable update View best and other installable update Provider RENES Name CK-RX Version 1.1.4 More update details	s × pdates for devices sharing the same attributes. AS 65N (current update) ③ Redeploy
View available updates Available update View best and other installable u Provider RENES Name CK-RX Version 1.1.4 More update details Provider	s × pdates for devices sharing the same attributes. AS (current update) ③ Redeploy
View available updates Available update View best and other installable update View best and other installable update Provider RENES Name CK-RX Version 1.1.4 More update details Provider RENES	s × pdates for devices sharing the same attributes. AS for devices sharing the same attributes. (current update) • Redeploy AS
View available updates Available update View best and other installable u Provider RENES Name CK-RX Version 1.1.4 More update details Provider Provider RENES Name CK-RX Version 1.1.4 More update details Provider Name CK-RX Version 1.1.4	s × pdates for devices sharing the same attributes. AS 65N (current update) ③ Redeploy AS 65N
View available updates Available update View best and other installable u Provider RENES Name CK-RX Version 1.1.4 More update details Provider Provider RENES Name CK-RX Version 1.1.4 More update details Provider Provider RENES Name CK-RX Version 1.1.0	s × pdates for devices sharing the same attributes. AS 65N (current update) ③ Redeploy AS 65N
View available updates Available update View best and other installable update View best and other installable update Provider RENES Name CK-RX Version 1.1.4 More update details Provider RENES Name CK-RX Version Descriptive label ADU R	s × pdates for devices sharing the same attributes. AS 65N (current update) • Redeploy AS 65N un Test v1.1.4 CK-RX65N Secure Bootloader
View available updates Available update View best and other installable update View best and other installable update Provider RENES Name CK-RX Version 1.1.4 More update details Provider RENES Name CK-RX Version 1.1.0 Descriptive label ADU R More update details	s × pdates for devices sharing the same attributes. AS 65N (current update) • Redeploy AS 65N un Test v1.1.4 CK-RX65N Secure Bootloader

Figure 3.36 Selecting Among Available Updates



4. Appendix

4.1 Control of Commands in Azure ADU and the Sample Project

This sample project performs several kinds of control for updating the firmware according to the commands received from Azure. The application that controls these commands is called an "ADU agent". This control is the main processing that this sample project performs.

The ADU agent performs various kinds of processing according to the request commands received from Azure.

The following table lists the request commands supported by this sample project.

Command	Function in this sample project	Support status
INITIALIZE	Initializes the firmware update module and other items.	Supported
PREPROCESS	Performs no processing in this sample project.	Supported
WRITE	Writes the firmware data that was sent from Azure to flash memory.	Supported
INSTALL	Installs firmware. This command also verifies the firmware written to the flash memory. If verification fails, this command deletes the update firmware.	Supported
APPLY	Applies the firmware. In this sample project, this command switches the startup bank, and then performs a software reset.	Supported
CANCEL	Not supported by this sample project.	Not supported
UPDATE_CHECK	Not supported by this sample project.	Not supported

The request commands listed above are common to the sample projects that support firmware update modules v1 and v2.



4.2 Firmware Debugging Method

How to source debug initial and updated firmware using e² studio is described below.

4.2.1 Debugging the Initial Firmware

Change the debug settings for the bootloader project as follows in e² studio.
 From the menu bar select Run → Debug Configurations..., and then click bootloader Hardware Debugging in the pane at the left of the Debug Configurations window. Click the Main tab, click the Browse... button under C/C++ Application:, and select the userprog.mot file containing the initial firmware created as described in 2.9, Creating the Initial Firmware.

📄 Main 🔅 Debugger 🕨 Startup 🦆 Sou	urce 🔲 Common	
Project:		
bootloader		Browse
C/C++ Application:		
C:\workspace\ADU_sample\ADU_Firm\userp	orog.mot	
	Variables Search Project	Browse
Build (if required) before launching		
Build Configuration: Select Automatically		
○ Enable auto build	O Disable auto build	
<u></u>	C - C - We desce C Wash	

Figure 4.1 Specifying userprog.x for C/C++ Application

In the **Debugger** tab, open the **Connection Settings** tab. Then, set **Change startup bank** to **Yes** and **Startup bank** to **Bank 0**.

Main 🕉 Debugger 🍉 Startup 🐓 Source 🔲 Con	amon	
india proceeding in startup y source in con		
Debug hardware: E2 Lite (RX) V Target Device	RSF565NE DUAL	
GDB Settings Connection Settings Debug Tool Setting	s	
Clock	3	
Clock		
> Connection with Target Board		
> Power		
✓ CPU Operating Mode		
	Single Chip	~
Register Setting		~
Register Setting Mode pin	Single-chip mode	
Register Setting Mode pin Change startup bank	Single-chip mode Yes	~

Figure 4.2 Changing the Startup Bank



Select **Debugger** tab \rightarrow **Debug Tool Settings** and set **Debug the program re-writing the on-chip PROGRAM ROM** to **Yes**.

Mair 🗱 Debugger 🕨 Startup 🤤 Source 🔲 Common	
a main proceedinger produce a common	
Debug hardware: E2 Lite (RX)	
GDB Settings Connection Settings Debug lool Settings	
abb betangs connection betangs	
> IO	
 > IO > General Debug 	
Kongeleinen in den seinen s	
> IO > General Debug > Memory	
IO General Debug Memory System Debug the program re-writing the on-chip PROGRAM ROM Yes	

Figure 4.3 Debug Tool Settings Tab

- 2. In the debug settings for the same **bootloader** project, click the **Startup** tab and under **Load image and symbols** add items and settings as follows.
 - Change the Load type of userprog.mot to Image only.
 - Add adu_sample.x by clicking Add... → File system... and change the Load type to Symbols only.
 - Add bootloader.x by clicking Add... → File system... and change the Load type to Symbols only.

Reset and Delay (seconds): 0				
☐ Halt				
Load image and symbols				
Filename	Load type	Offset (hex)	On connect	
		0		
 Program Binary [userprog.mot] 	Image only	0	Yes	
 ✓ Program Binary [userprog.mot] ✓ ADU_sample_rdp139.x [C:\workspace\ADU 	Image only Symbols only	0	Yes	
 Program Binary [userprog.mot] ADU_sample_rdp139.x [C:\workspace\ADU bootloader_rdp139.x [C:\workspace\ADU_s 	Image only Symbols only Symbols only	0	Yes Yes Yes	
 Program Binary [userprog.mot] ADU_sample_rdp139.x [C:\workspace\ADU bootloader_rdp139.x [C:\workspace\ADU_s 	Image only Symbols only Symbols only	0	Yes Yes Yes	
 Program Binary [userprog.mot] ADU_sample_rdp139.x [C:\workspace\ADU bootloader_rdp139.x [C:\workspace\ADU_s 	Image only Symbols only Symbols only	0	Yes Yes Yes	Add
Program Binary [userprog.mot] ADU_sample_rdp139.x [C:\workspace\ADU bootloader_rdp139.x [C:\workspace\ADU_s	Image only Symbols only Symbols only	0	Yes Yes Yes	Add Edit
Program Binary [userprog.mot] ADU_sample_rdp139.x [C:\workspace\ADU bootloader_rdp139.x [C:\workspace\ADU_s	Image only Symbols only Symbols only	0	Yes Yes Yes	Add Edit

Figure 4.4 Load image and symbols Settings



3. Start debugging the **bootloader** project and make sure it breaks at the main function of **bootloader/src/bootloader.c**. The following figure is an example when the version of the firmware update module is v1.





Also, check that the firmware starts normally by setting a breakpoint at the main function in **adu_sample/src/main.c**.

	[main.c]
🚺 main.c 🗡	
209 210 211 212 213 214	<pre>/* Define main entry point. */ e int main(void) { #ifdef SAMPLE_BOARD_SETUP</pre>
215 fff7f80b	SAMPLE_BOARD_SETUP();
216 217 218 219 fff7f80f 220 fff7f815	<pre>#endit /* SAMPLE_BOARD_SETUP */ /* Enter the ThreadX kernel. */ tx_kernel_enter(); }</pre>

Figure 4.6 Breakpoint in main.c

If execution does not break at the main function, set a breakpoint at the location shown above.

When generating the initial firmware **userprog.mot**, a MOT file with blank area filled with 0xFF is generated. In other words, even if you are not using the data flash area, this area is filled with 0xFF. At this time, if you rewrite the data in the data flash area by the program, download initial firmware again, and execute debugging, it will be overwritten with 0xFF.

In this case, copy the rewritten data flash area before downloading initial firmware, and write it back after downloading. In the case of e^2 studio, it is possible to output the memory contents to a file and read it from the file by using the **dump/restore** command.

Example:

To output the data flash area at address 0x100000-0x107FFF to S-format file and read it, execute the following GDB command in the **Debugger Console** view.

• When outputting to **memdump.mot** file

dump srec memory memdump.mot 0x100000 0x107FFF

• When writing from **memdump.mot** file to memory

restore memdump.mot 0 0x100000 0x107FFF

Note that **memdump.mot** is generated in the project folder.



4.2.2 Debugging the Updated Firmware

To debug the firmware update, create separate projects for the initial firmware and firmware update. Running the bootloader executes the initial firmware.

1. After the initial firmware starts, set a breakpoint before the bootloader boots the update firmware. The position at which to set a breakpoint differs depending on whether the version of the firmware update module is v1 or v2. For details, refer to the following sections.

(a) If the version of the firmware update module is $v\mathbf{1}$

The following process in the **bootloader/src/smc_gen/r_fwup/src/r_fwup_boot_loader.c** file is the process that boots the updated firmware.

[r_fwup_boot_loader.c]				
r_fwup_boot_load	er.c ×			
2063 2068 ffff5b4a	<pre># Function Name: R_FWUP_ExecuteFirmware # void R_FWUP_ExecuteFirmware(void)</pre>			
2069	{ { # ## £ (DCD MCH CEDTEC DY700 DCD MCH CEDTEC DY700 DCD MCH CEDTEC DY700 DCD MCH			
2071 2072	volatile uint32_t addr;			
2073	/* stop all interrupt completely */			
2074 ffff5b4e 2075 ffff5b56	<pre>R_BSP_SET_PSW(0); addr = *(uint32 t*) USER_RESET_VECTOR_ADDRESS; /* CODE CHECKER, this is OK as a</pre>			
2076 ffff5b58	((void (*) ()) addr)();			
2078	/* Fix me for other MCU family */			
2079 2080	<pre>#endif /* BSP_MCU_SERIES_RX700 BSP_MCU_SERIES_RX600 BSP_MCU_SERIES_RX200 BS }</pre>			
2082	End of function R_FWUP_ExecuteFirmware[]			



- (b) If the version of the firmware update module is $\ensuremath{v2}$
- Firmware is started by the following processing in the "bootloader/src/smc_gen/r_fwup/src/r_fwup.c" file:

	[r_fwup.c]			
In a straight of the strai	🔓 r_fwup.c ×			
442				
443	/************************************			
444	* Function Name: R FWUP ExecImage			
445	* Description : Execute image program			
446	* Arguments : None			
447	* Return Value : None			
448	***************************************			
449 ffff3976	<pre></pre>			
450	{			
451	uint32_t vect_addr;			
452				
453 ffff397d	<pre>vect_addr = *(uint32_t*)(FWUP_CFG_MAIN_AREA_ADDR_L + (FWUP_CFG_AREA_SIZE - 4U))</pre>			
454 ffff397f	r_fwun_wrap_disable_interrunt():			
🚽 455 ffff3983	((void (*)(void))vect_addr)();			
456	}			
458	End of function R_FWUP_ExecImage			
100				



- 2. After updating the firmware with ADU, a bank swap and software reset occur.
- 3. Just before the updated firmware starts, it breaks at the breakpoint specified in step 1 above.
- 4. After the break, execute the following GDB command to update the symbol information. Use the **Debugger Console** at the bottom of e² studio to execute GDB commands. Example: In the case where the .x file of update firmware is located in "C:\workspace\ADU_sample\HardwareDebug"¹ The following is an example when the .x file of update firmware is "ADU_sample.x". symbol-file C:/workspace/\ADU_sample\HardwareDebug/\ADU_sample.x -readnow^{*1}

Note: 1. Add a forward slash (/) before each backslash (\) when specifying the path.





Figure 4.9 Command to Update Symbol Information

5. After you set a breakpoint in any source code of the updated firmware and restart debugging, confirm that it breaks at that breakpoint.



Online technical support and information is available at: <u>https://en-support.renesas.com/dashboard</u> Technical contact details: <u>https://www.renesas.com/support/contact.html</u>


Revision History

		Description	
Rev.	Date	Page	Summary
1.00	July 31, 2023		First edition issued
2.00	Dec. 21, 2023	1	Updated the development environment used.
		2	Added a table that lists combinations of a target board and a firmware update module (FWUP).
		5 to 8	Added a description of memory area allocation and operation (FWUP v1/v2). Added a description of area allocation in data flash memory.
		11, 12	Changed the Azure RTOS version and target board type to be specified. Added a description of dual mode.
		17	Added a description of BGO mode.
		17 to 20	Modified the description of adding missing components. Added a procedure for installing FWUP v2.
		21, 22	Added a description of code generation during the build processing. Deleted the procedures for changing the dual mode, section, and symbol settings, because it is no longer necessary to change these settings.
		26 to 29	Added a procedure for creating firmware that supports FWUP
		35 to 41	FIT v2.
		34	Modified the section that describes execution of the initial firmware.
		42 to 47	Added a supplementary note on creating an IoT hub. Added procedures for creating a Device Update account and a storage account.
		58	Added a description of a warning message (about a storage container) that appears when uploading firmware.
		66	Added a description of controlling Azure ADU commands.
		70	Added a description about FWUP FIT v2 to the update firmware debugging method.
2.01	July 1, 2024	-	Supported Azure RTOS v.6.4.0
		12	Added a description of the Bank Mode setting.



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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.).

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