

# RX671 Group

# RX671 OTA-supported flat panel HMI PoC with touch keys and LCD

# Introduction

This kit for RX671 touch keys and OTA-supported flat panel HMI PoC using LCD (hereinafter referred to as "RX671 PoC") is ideal for the development of IoT devices with HMI using capacitive touch sensors.

This application note introduces the HMI solution using RX671 PoC to realize touch functionality and LCD display with serial connection LCD. In addition, introduce the function to connect to the cloud and perform firmware updates using OTA.

The sample program described in this application note is configured using the following libraries.

• LCD Display : Embedded GUI software emWin

(hereinafter referred to as "emWin")

#### **Target Device**

#### RX671 Group

When using this application note with other Renesas MCUs, careful evaluation is recommended after making modifications to comply with the alternate MCU.2

# **Target Tool**

RX671 PoC

For more information on security, please refer to "Renesas MCU Firmware Update Design Policy (R01AN5548)"



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## 1. Outline

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This application note describes the operation and structure of the RX671 PoC. RX671 PoC is equipped with touch buttons, touch slider and LCD (240 x 320) and can be used as a demonstration to control the display and settings by imagining a microwave oven. In addition, RX671 PoC can rewrite the program OTA from the cloud.

The overall RX671 PoC image is shown below.



Figure 1-1 Overall RX671 PoC image



The system configuration is shown below.



Figure 1-2 System configuration

The software configuration is shown below.







# 2. Operation Confirmation Conditions

The operation of the sample program has been confirmed under the following conditions.

| Table 2-1 O | peration | Confirmation | Conditions |
|-------------|----------|--------------|------------|
|-------------|----------|--------------|------------|

| Item                          | Contents   |  |
|-------------------------------|--|--|
| MCU used                      | R5F5671EHDFM (RX671 Group)                             |  |
| Operating frequency           | Operating frequency (ICLK) : 120MHz                    |  |
|                               | Peripheral operating frequency (PCLKB) : 60MHz         |  |
| Operating voltage 3.3 V       |  |  |
| Integrated development        | Renesas Electronics                                    |  |
|                               | e <sup>2</sup> studio Version 2023-01 (23.1.0)         |  |
| C compiler                    | Renesas Electronics                                    |  |
|                               | C/C++ Compiler Package for RX Family V3.05.00          |  |
|                               | Compiler option  |  |
|                               | Default settings of integrated development environment |  |
| Smart Configurator            | V2.16.0  |  |
| Board support package (r_bsp) | V7.20  |  |
| Endian order                  | Little Endian  |  |
| Operating mode                | Single chip mode                                       |  |
| Processor mode                | Super visor mode                                       |  |
| Sample code version           | V1.00  |  |
| Emulator                      | E2 Emulator Lite                                       |  |

#### Table 2-2 Operation Confirmation Conditions (LCD, Wi-Fi)

| Item         | Contents  |  |
|--------------|---|--|
| LCD module   | 2.8 TFT SPI 240 × 320 serial port module        |  |
| Wi-Fi module | Wi-Fi-Pmod-Expansion-Board (RTK00WFMX0B00000BE) |  |



# 3. Sample Programs

#### 3.1 Demonstration Screen Flowchart

The demonstration screen flowchart of this sample program is shown below. For detail on each screen, refer to chapter 5.



Figure 3-1 Flowchart of demonstration screen (Cook)





Figure 3-2 Flowchart of demonstration screen (Defrost)



Recipe mode is not available with the firmware ver.0.90.







# 3.2 Flowchart

#### 3.2.1 Overall flowchart of LCD control

The overall flowchart of LCD control is shown below.



Figure 3-4 Overall flowchart of LCD control



## 3.2.2 Processing at touch keys operation

The flowchart for touch keys operation is shown below.



Figure 3-5 Flowchart for touch keys operation



#### 3.2.3 Processing at touch slider operation

The flowchart for touch slider operation is shown below.



Figure 3-6 Flowchart for touch slider operation



# 3.2.4 Processing when the "home" button is touched

The flowchart when the "home" button is touched is shown below.



Figure 3-7 Flowchart when the "home" button is touched



#### 3.2.5 Processing when the "select" button is touched

The flowchart when the "select" button is touched is shown below.



Figure 3-8 Flowchart when the "select" button touch is touched



#### 3.2.6 Processing when the "start" button is touched

The flowchart when the "start" button is touched is shown below.



Figure 3-9 Flowchart when the "select" button is touched

#### 3.2.7 Processing during cooking

The flowchart during cooking is shown below.



Figure 3-10 Flowchart during cooking



#### 3.2.8 Overall flowchart of touch control

The overall flowchart of touch control is shown below.



Figure 3-11 Overall flowchart of touch control



#### 3.2.9 Processing of touch judgement

The flowchart of touch judgement is shown below.

If the left side of the touch slider is touched after touching the right side of the touch slider, the touch slider is judged to have slid to the left. The same is true on the opposite side.



Figure 3-12 Flowchart of touch judgement



# 3.2.10 Processing of startup screen display

The flowchart of startup screen display is shown below.



Figure 3-13 Flowchart of startup screen display



# 3.2.11 Processing of 5 seconds wait

The flowchart of 5 seconds wait is shown below.



Figure 3-14 Flowchart of 5 seconds wait



# 3.2.12 Processing of flag clear for touch

The flowchart of flag clear for touch is shown below.



Figure 3-15 Flowchart of flag clear touch



# 3.2.13 Processing of screen initialization

The flowchart of screen initialization is shown below.



Figure 3-16 Flowchart of screen initialization



#### 3.2.14 Processing at moving to the menu screen

The flowchart for moving to the menu screen is shown below.



Figure 3-17 Flowchart for moving to the menu screen



#### 3.2.15 Processing of setting LED pattern to sleep

The flowchart of setting LED pattern to sleep is shown below.



Figure 3-18 Flowchart of setting LED pattern to sleep



# 3.3 Pins Used

The following shows lists pins used in this sample program.

#### **Table 3-1 List of Pins and Functions**

| Pin name          | Input/Output | Function                                  |
|-------------------|--------------|---|
| P12/RXD2          | Input        | UART2 receiving pin                       |
| P13/TXD2          | Output       | UART2 sending pin                         |
| PE1/TXD12         | Output       | UART12 sending pin                        |
| PE2/RXD12         | Input        | UART12 receiving pin                      |
| PA6/CTS12         | Input        | CTS signal input pin                      |
| P16/RXD3          | Input        | USB-UART3 receiving pin                   |
| P17/TXD3          | Output       | USB-UART3 sending pin                     |
| P27/RSPCKB-A      | Input/Output | RSPI1 clock pin                           |
| PE7/MISOB-B       | Input        | RSPI1 MISO pin                            |
| PE6/MOSIB-B       | Output       | RSPI1 MOSI pin                            |
| PC4/TSCAP         | -            | TSCAP pin                                 |
| P34/TS0           | Input        | Electrostatic capacitance measurement pin |
| P26/TS3           | Input        | Electrostatic capacitance measurement pin |
| P53/TS12          | Input        | Electrostatic capacitance measurement pin |
| PC6/TS13          | Input        | Electrostatic capacitance measurement pin |
| PC5/TS14          | Input        | Electrostatic capacitance measurement pin |
| PC1/TS15          | Input        | Electrostatic capacitance measurement pin |
| PC0/TS16          | Input        | Electrostatic capacitance measurement pin |
| PD40~43, PD2, PD3 | Output       | LED pin                                   |
| PB6/TIOCA5        | Output       | Buzzer pin                                |



# 3.4 Sample Program Structure

#### 3.4.1 Peripheral Functions Used

The following shows lists peripheral functions used in this sample program.

#### Table 3-2 List of Peripheral Functions Used and Functions

| Peripheral Functions | Functions  |
|----------------------|--|
| RSPI1                | SPI Communication with LCD module                |
| DMAC                 | Used for RAM to RSPI transfer                    |
| SCI2, SCI12          | UART communication with Wi-Fi module (2 systems) |
| S12AD0               | Used for inside CTSU FIT                         |
| CTSU                 | Used for touch buttons and touch slider          |
| СМТО                 | Used for internal emWin FIT                      |
| CMT2                 | Used for RTOS                                    |
| PORT                 | Used for LED                                     |
| TPU5                 | Used for buzzer                                  |



# 3.4.2 Components Used

The following shows lists components used in this sample program.

| Table 3-3 LISE OF COMPONENTS USED and FUnctions | Table 3-3 I | List of Co | mponents | Used and | <b>Functions</b> |
|---|-------------|------------|----------|----------|------------------|
|---|-------------|------------|----------|----------|------------------|

| Components                                      | Abbreviation      | Version     |
|---|-------------------|-------------|
| ADC Driver                                      | r_s12ad_rx        | 5.00        |
| AWS_device_shadow                               | AWS_device_shadow | 1.0.110     |
| AWS_ggd   | AWS_ggd           | 1.0.110     |
| AWS_mqtt  | AWS_mqtt          | 1.0.110     |
| AWS_secure_socket                               | AWS_secure_socket | 1.0.110     |
| AWS_tcp_ip                                      | AWS_tcp_ip        | 1.0.110     |
| Board Support Package                           | r_bsp             | 7.21        |
| Byte-based circular buffer library              | r_byteq           | 2.10        |
| CMT driver                                      | r_cmt_rx          | 5.40        |
| CTSU QE API                                     | r_ctsu_qe         | 2.20        |
| DMAC driver                                     | r_dmaca_rx        | 3.00        |
| Flash API for RX100, RX200, RX600, and RX700    | r_flash_rx        | 4.91        |
| FreeRTOS_kernel                                 | FreeRTOS_kernel   | 1.0.110     |
| FreeRTOS_Object                                 | FreeRTOS_Object   | 1.0.112     |
| GPIO Driver                                     | r_gpio_rx         | 4.70        |
| Graphic Library with Graphical User Interface   | r_emwin_rx        | 6.32.a.1.00 |
| PWM Mode Timer                                  | Config_TPU5       | 1.12.0      |
| RSPI Driver                                     | r_rspi_rx         | 3.04        |
| SCI Driver                                      | r_sci_rx          | 4.60        |
| Touch QE API                                    | rm_touch_qe       | 2.20        |
| Wi-Fi Module control functions for Renesas MCUs | r_wifi_sx_ulpgn   | 1.16        |
| Port  | Config_PORT       | 2.4.1       |



#### 3.4.3 Peripheral Function Settings

The Smart Configurator settings used in this sample program are shown below. The items and settings in each table in the Smart Configurator settings are described in the notation on the configuration screen.

Settings not listed are assumed to be default settings.

#### Table 3-4 Parameters of Smart Configurator (1/6)

| Category                    | Item   | Setting/Description                       |  |
|-----------------------------|--|---|--|
| Smart Configurator >> Clock |  | The following settings are made on the    |  |
|                             |  | "Clocks" Tab.                             |  |
|                             | VCC  | 3.3 (V)                                   |  |
|                             | Main clock                                       | Stopped: Unchecked.                       |  |
|                             | PLL circuit setting                              | Frequency Division: ×1                    |  |
|                             |  | Frequency Multiplication: ×15             |  |
|                             | HOCO clock                                       | Operation: Checked.                       |  |
|                             |  | HOCO oscillation enabled after reset      |  |
|                             | LOCO clock                                       | Stopped: Unchecked.                       |  |
|                             | IWDT dedicated clock                             | Clock source: HOCO                        |  |
|                             |  | Flash IF clock (FCLK): 60MHz              |  |
|                             |  | System clock (ICLK): 120MHz               |  |
|                             |  | Peripheral module clock (PCLKA): 120MHz   |  |
|                             |  | Peripheral module clock (PCLKB): 60MHz    |  |
|                             |  | Peripheral module clock (PCLKC): 60MHz    |  |
|                             |  | Peripheral module clock (PCLKD): 60MHz    |  |
| Smart Con                   | figurator >> System                              | Debugging interfaces setting: FINE        |  |
| Smart Con                   | figurator >> Components >> r_bsp                 | Default settings except following changes |  |
|                             | Heap size  | 0x4000                                    |  |
|                             | ROM Cache Enable Register                        | Disabled                                  |  |
|                             | Software Interrupt Unit2 (SWINT2)                | Used                                      |  |
|                             | Software Interrupt Task Buffer Number            | 8   |  |
|                             | Initial value of the software interrupt priority | Priority level 1                          |  |
|                             | Serial terminal select                           | Enabled                                   |  |
|                             | Channel for serial terminal                      | Channel 3                                 |  |
|                             | Bitrate for serial terminal                      | 115200                                    |  |
|                             | Interrupt priority serial terminal               | Priority level 3                          |  |
|                             | HOCO Trimming select                             | Disabled                                  |  |
| Smart Con                   | figurator >> Components >> r_dmaca_rx            | Default settings are used.                |  |
| Smart Con                   | figurator >> Components >> r_s12ad_rx            | Default settings except following changes |  |
|                             | Resources >> S12AD                               | ·   |  |
|                             | S12AD0   | Checked.                                  |  |
| Smart Con                   | figurator >> Components >> r_ctsu_qe             | Default settings except following changes |  |
|                             | TSCAP pin  | Use: Checked.                             |  |
|                             | TS0 pin  | Use: Checked.                             |  |
|                             | TS2 pin  | Use: Checked.                             |  |
|                             | TS3 pin  | Use: Checked.                             |  |
|                             | TS12 pin   | Use: Checked.                             |  |
|                             | TS13 pin   | Use: Checked.                             |  |
|                             | TS14 pin   | Use: Checked.                             |  |
|                             | TS15 pin   | Use: Checked                              |  |
|                             | TS16 pin   | Use: Checked.                             |  |



| Table 3-5 Parameters of Smart Configurator (2/6) |  |   |  |
|--|--|---|--|
| Category   | Item   | Setting/Description                       |  |
| Smart Confi                                      | gurator >> Components >> r_gpio_rx   | Default settings are used.                |  |
| Smart Confi                                      | gurator >> Components >> r_flash_rx  | Default settings except following changes |  |
|  | Enable code flash programming  | Includes code to program ROM area         |  |
|  | (FLASH_CFG_CODE_FLASH_ENABLE)  |   |  |
|  | Enable BGO/Non-blocking data flash operations                              | Enable BGO mode                           |  |
|  | (FLASH_CFG_DATA_FLASH_BGO)   |   |  |
|  | Enable BGO/Non-blocking code flash operations                              | Enable BGO mode                           |  |
|  | (FLASH_CFG_CODE_FLASH_BGO)   |   |  |
|  | Enable code flash self-programming   | Programming code flash while executing    |  |
|  | (FLASH_CFG_CODE_FLASH_RUN_FROM_ROM)  | from another segment in ROM               |  |
| Smart Confi                                      | gurator >> Components >> r_rspi_rx   | Default settings except following changes |  |
|  | Dummy data of reception  | 0x00                                      |  |
|  | RSPI channel 0   | Unused                                    |  |
|  | RSPI channel 1   | Used                                      |  |
|  | RSPI channel 2   | Unused                                    |  |
|  | Interrupt priority level of RSPI channel 1                                 | Level 3                                   |  |
|  | RSPI1  | Checked                                   |  |
|  | RSPCKB pin   | Use: Checked.                             |  |
|  | MOSIB pin  | Use: Checked.                             |  |
|  | MISOB pin  | Use: Checked.                             |  |
| Smart Confi                                      | gurator >> Components >> r_sci_rx  | Default settings except following changes |  |
|  | Use ASYNC mode   | Include                                   |  |
|  | Use SSPI mode  | Include                                   |  |
|  | Include software support for channel 2<br>(SCI_CFG_CH2_INCLUDED)           | Include                                   |  |
|  | Include software support for channel 3                                     | Include                                   |  |
|  | (SCI_CFG_CH3_INCLUDED)   |   |  |
|  | Include software support for channel 12                                    | Include                                   |  |
|  | (SCI_CFG_CH12_INCLUDED)  |   |  |
|  | ASYNC mode TX queue buffer size for channel 3<br>(SCI_CFG_CH3_TX_BUFSIZ)   | 2048                                      |  |
|  | ASYNC mode TX queue buffer size for channel 12<br>(SCI_CFG_CH12_TX_BUFSIZ) | 2048                                      |  |
|  | ASYNC mode RX queue buffer size for channel 3<br>(SCI_CFG_CH3_RX_BUFSIZ)   | 2048                                      |  |
|  | ASYNC mode RX queue buffer size for channel 12<br>(SCI_CFG_CH12_RX_BUFSIZ) | 2048                                      |  |
|  | Resources >> SCI   |   |  |
|  | SCI2   | Checked.                                  |  |
|  | RXD2/SMISO2/SSCL2 Pin  | Use: Checked.                             |  |
|  | TXD2/SMOSI2/SSDA2 Pin  | Use: Checked.                             |  |
|  | SCI3   | Checked                                   |  |
|  | RXD3/SMISO3/SSCL3 Pin  | Use: Checked                              |  |
|  | TXD3/SMOSI3/SSDA3 Pin  | Use: Checked                              |  |
|  | SCI12  | Checked.                                  |  |
|  | RXD12/SMISO12/SSCL12 Pin   | Use: Checked.                             |  |
|  | TXD12/SMOSI12/SSDA12 Pin   | Use: Checked.                             |  |
|  | CTS12#/RTS12#/SS12# Pin  | Use: Checked.                             |  |



# Table 3-6 Parameters of Smart Configurator (3/6)

| Category   | Item   | Setting/Description                   |
|--|--|---------------------------------------|
| Smart Con  | figurator >> Components >> r_cmt_rx                                    | Default settings are used.            |
| Smart Con  | figurator >> Components >> rm_touch_qe                                 | Default settings are used.            |
| Smart Configurator >> Components >> r_byteq                |  | Default settings are used.            |
| Smart Configurator >> Components >> r_wifi_sx_ulpgn        |  | Default settings except following     |
|  |  | changes                               |
|  | SCI Channel number for SX-ULPGN Initial Command                        | 12                                    |
|  | Port for AT command communication                                      |                                       |
|  | (WIFI_CFG_SCI_CHANNEL)   | -                                     |
|  | SCI Channel number for SX-ULPGN Second Command                         | 2                                     |
| Port for AT command communication                          |  |                                       |
|  | (WIFI_CFG_SCI_SECOND_CHANNEL)  | DODTH                                 |
|  | ULPGN EN pin (WIFI_CFG_RESET_PORT)                                     | PORTH                                 |
|  | Configure RTS Port No. for WIFI_CFG_SCI_CHANNEL<br>(WIFI_CFG_RTS_PORT) | PORTH                                 |
|  | Configure RTS Pin No. for WIFI_CFG_SCI_CHANNEL<br>(WIFI CFG RTS PIN)   | 1                                     |
|  | Socket Receive buffer size   | 1024                                  |
|  | (WIFI_CFG_SOCKETS_RECEIVE_BUFFER_SIZE)                                 |                                       |
| Smart Con  | figurator >> Components >> r_emwin_rx                                  | Other than the changes listed         |
|  |  | below, default settings are used.     |
|  | Configurations >> BasicSetting   |                                       |
|  | Work area size for GUI   | 10000                                 |
|  | Horizontal LCD size  | 240                                   |
|  | Vertical LCD size  | 320                                   |
|  | Color depth  | 16 bit per pixel                      |
|  | LCD orientation  | ORIENTATION_CCW                       |
|  | Configurations >> Select LCD Interface                                 |                                       |
|  | LCD interface  | LCD_IF_RSPI                           |
| Configurations >> Select LCD Interface >> SPI Interface Se |  | etting                                |
|  | LCD interface channel number   | 1                                     |
|  | Select LCD Driver IC   | LCD_DRV_IC_ILI9341                    |
|  | Communication baud rate of LCD interface                               | 3000000                               |
|  | Use or unused display cache  | Unuse: Unchecked.                     |
|  | Configurations >> Select LCD Interface >> LCD Interface P              | in Setting                            |
|  | Use Display Signal Pin   | Use Display Signal Pin                |
|  | Display Signal Pin   | GPIO_PORT_A_PIN_1                     |
|  | Use Backlight Pin  | Use Backlight Pin                     |
|  | Backlight Pin  | GPIO_PORT_D_PIN_6                     |
|  | Use Data/Command Pin   | Use Data/Command Pin                  |
|  | Data/Command Pin   | GPIO_PORT_A_PIN_2                     |
|  | Use Chip Select Pin  | Use Chip Select Pin                   |
|  | Chip Select Pin  | GPIO_PORT_D_PIN_5                     |
|  | Configurations >> Select Touch Interface                               |                                       |
|  | Use Touch function   | Not use Touch function:<br>Unchecked. |



#### Table 3-7 Parameters of Smart Configurator (4/6)

| Category  | Item  | Setting/Description               |
|---|---|-----------------------------------|
| Smart Configurator >> Components >> FreeRTOS Kernel   |   | Other than the changes listed     |
|   |   | below, default settings are used. |
|   | The total amount of RAM available in the FreeRTOS | (size_t)(200U * 1024U)            |
|   | heap  |                                   |
|   | Tick vector                                       | _CMT2_CMI2                        |
| Smart Configurator >> Components >> FreeRTOS_Object   |   | Other than the changes listed     |
|   |   | below, default settings are used. |
|   | Tasks   | Initialize: kernel start          |
|   |   | Task Code: touch_task             |
|   |   | Task Name: touch_task             |
|   |   | Stack Size: 512                   |
|   |   | Task Handler: NULL                |
|   |   | Parameter: NULL                   |
|   |   | Priority: 1                       |
|   |   | Initialize: kernel start          |
|   |   | Task Code: emwin_task             |
|   |   | Task Name: emwin_task             |
|   |   | Stack Size: 512                   |
|   |   | Task Handler: NULL                |
|   |   | Parameter: NULL                   |
|   |   | Priority: 1                       |
| Smart Configurator >> Components >> AWS_device_shadow |   | Default settings are used.        |
| Smart Configurator >> Components >> AWS_ggd           |   | Default settings are used.        |
| Smart Configurator >> Components >> AWS_mqtt          |   | Default settings are used.        |
| Smart Configurator >> Components >> AWS_secure_soket  |   | Default settings are used.        |
| Smart Configurator >> Components >> AWS_tcp_ip        |   | Default settings are used.        |



# Table 3-8 Parameters of Smart Configurator (5/6)

| Category   | Item   | Setting/Description                       |
|--|--|---|
| Smart Configurator >> Pins >> Serial Communication Interface >> SCI2 |  | Uncheck all settings except the following |
|  | RXD2   | Use: Checked.                             |
|  |  | Terminal Assignment: Set P12              |
|  | TXD2   | Use: Checked.                             |
|  |  | Terminal Assignment: Set P13              |
| Smart Configurator >> Pins >> Serial Communication Interface >> SCI3 |  | Uncheck all settings except the following |
|  | RXD3   | Use: Checked.                             |
|  |  | Terminal Assignment: Set P16              |
|  | TXD3   | Use: Checked.                             |
|  |  | Terminal Assignment: Set P17              |
| Smart Configurator >> Pins >> Serial Communication Interface >>      |  | Uncheck all settings except the           |
| SCI5   |  | following                                 |
|  | SCK5   | Use: Checked.                             |
|  |  | Terminal Assignment: Set PA1              |
|  | SMISO5   | Use: Checked.                             |
|  |  | Terminal Assignment: Set PA2              |
|  | SMOSI5   | Use: Checked.                             |
|  |  | Terminal Assignment: Set PA4              |
| Smart Con  | figurator >> Pins >> Serial Communication Interface >> | Uncheck all settings except the           |
| RSPI1  |  | following                                 |
|  | MISOB  | Use: Checked.                             |
|  |  | Terminal Assignment: Set PE7              |
|  | MOSIB  | Use: Checked.                             |
|  |  | Terminal Assignment: Set PE6              |
|  | RSPCKB   | Use: Checked.                             |
|  |  | Terminal Assignment: Set P27              |



#### Table 3-9 Parameters of Smart Configurator (6/6)

| Category  | Item                         | Setting/Description                          |
|---|------------------------------|--|
| Smart Configurator >> Components >> Config_PORT |                              | Other than the changes listed below, default |
|   |                              | settings are used.                           |
|   | PORT4                        | Checked.                                     |
|   | P40                          | Output: Checked                              |
|   |                              | Output 1: Checked                            |
|   | P41                          | Output: Checked                              |
|   |                              | Output 1: Checked                            |
|   | P42                          | Output: Checked                              |
|   |                              | Output 1: Checked                            |
|   | P43                          | Output: Checked                              |
|   |                              | Output 1: Checked                            |
|   | PORTD                        | Checked.                                     |
|   | PD2                          | Output: Checked                              |
|   |                              | Output 1: Checked                            |
|   | PD3                          | Output: Checked                              |
|   |                              | Output 1: Checked                            |
| Smart Configurator >> Components >> Config_TPU5 |                              | Other than the changes listed below, default |
|   |                              | settings are used.                           |
|   | Counter clear source         | TGRB5 compare match                          |
|   | Counter clock selection      | PCLK/64, rising edge                         |
|   | TIOCA5 pin                   | Output initial 0, 1 at compare match         |
|   | TGRB compare match operation | Output 0 from TIOCA5 pin                     |
|   | PWM cycle                    | 504µs  |
|   | TGRA initial value           | 38   |
|   | TGRB initial value           | 472  |



# 3.4.4 File Structure

The following shows file structure by sample program.

#### Table 3-10 File Structure

| Folder name, File name | Outline                                      |  |
|------------------------|--|--|
| application_code       | -  |  |
| F LCD                  | -  |  |
| │                      | Folders for images and fonts                 |  |
| I └ Source             | -  |  |
| LCD_custom_func.c      | Source file for LCD related                  |  |
| LCD_custom_func.h      | Header file for LCD related                  |  |
| ⊢ renesas_code         | -  |  |
| I ⊢ frtos_startup      | Generated folder for Amazon FreeRTOS         |  |
| │                      |  |  |
| I ⊢ main_task.c        | Amazon FreeRTOS main task                    |  |
| I └ frtos_skeleton     | -  |  |
| emwin_task.c           | Task for emWin control                       |  |
| <pre>l</pre>           | Include file for emwin_task.c, touch_task.c  |  |
| ↓ Louch_task.c         | Task for touch control                       |  |
| ⊢ touch                | -  |  |
| ↓ + touch_func.c       | Source file for touch related                |  |
| ↓ Louch_func.h         | Header file for touch related                |  |
| ⊢qe_gen                | Generated folder for QE for capacitive touch |  |
| └ main.c               | Source file for main processing              |  |
| config_files           | Generated folder for Amazon FreeRTOS         |  |
| demos                  |  |  |
| freertos_kernel        |  |  |
| libraries              |  |  |
| QE-Touch               | Generated folder for QE for capacitive touch |  |
| vendors                | Generated folder for Amazon FreeRTOS         |  |
| └ renesas              | -  |  |
| └ boards               | -  |  |
| └ rx671-rsk            | -  |  |
| Laws_demos             | -  |  |
| L src                  | -  |  |
| └ smc_gen              | Smart Configurator generation                |  |
| Config_PORT            |  |  |
| Config_TPU5            |  |  |
| ⊢ general              |  |  |
| ⊢ r_cmt_rx             |  |  |
| ⊢ r_config             |  |  |
| ⊢ r_ctsu_qe            |  |  |
| ⊢ r_dmaca_rx           |  |  |
| ⊢ r_emwin_rx           |  |  |
| ⊢ r_gpio_rx            |  |  |
| ⊢ r_pincfg             |  |  |
| ⊢ r_rspi_rx            |  |  |
| └ rm_touch_qe          | ]  |  |



# 3.4.5 Variables

The following shows the variables that are used in this sample program.

| Variable name         | Туре     | Contents   |
|-----------------------|----------|--|
| g_sleep_flg           | uint8_t  | Flag indicating LCD sleep state                        |
| g_lcd_left_slide_flg  | uint8_t  | Flag indicating that touch slider is slid to the left  |
| g_lcd_right_slide_flg | uint8_t  | Flag indicating that touch slider is slid to the right |
| g_lcd_push_enter_flg  | uint8_t  | Flag indicating that "2" button was touched.           |
| g_lcd_push_back_flg   | uint8_t  | Flag indicating that "1" button was touched.           |
| g_screen_en_flg       | uint8_t  | Flag indicating initial screen status                  |
| s_flg_countdown       | uint8_t  | The countdown is in progress on the LCD flag           |
| s_flg_touch           | uint8_t  | Touch buttons status                                   |
| s_startup_cnt         | uint8_t  | Counter for initial screen display time<br>management  |
| s_sleep_cnt           | uint16_t | Counter for no-operation time management               |
| s_mode_num            | uint8_t  | Mode status  |
| s_setting_target      | uint8_t  | Flags indicating screen status                         |

# Table 3-11 List of variables used in the sample code



# 3.4.6 Constants

The following shows the constants that are used in this sample program.

| Constant Name       | Setting Value       | Contents  |
|---------------------|---------------------|---|
| LCD_BACKLIGHT       | (PORT7.PODR.BIT.B1) | Pin to control LCD backlight                            |
| OFF                 | (0U)                | Value at backlight off                                  |
| ON                  | (1U)                | Value at backlight on                                   |
| TOUCH_NO            | (0U)                | Value at no-operation                                   |
| TOUCH_LEFT_SLIDE    | (4U)                | Value indicating that touch slider is slid to the left  |
| TOUCH_RIGHT_SLIDE   | (3U)                | Value indicating that touch slider is slid to the right |
| TOUCH_SELECT        | (1U)                | Value indicating that "2" button was touched            |
| TOUCH_HOME          | (2U)                | Value at moving to the previous screen                  |
| SLEEP_COUNT         | (SLEEP_TIME /       | When the counter in the program equals this             |
|                     | DELAY_TIME)         | value, the LCD is turned off                            |
| MODE_RECIPE_DETAIL  | (6U)                | Value of detail setting in Recipe mode                  |
| MODE_COOK_DETAIL    | (3U)                | Value of detail setting in Cook mode                    |
| MODE_DEFROST_DETAIL | (4U)                | Value of detail setting in Defrost mode                 |
| MODE_COOK           | (1U)                | Value of start cooking in Cook mode                     |
| MODE_DEFROST        | (2U)                | Value of start cooking in Defrost mode                  |
| MODE_RECIPE         | (5U)                | Value of start cooking in Recipe mode                   |
| TOUCH_START         | (5U)                | Value of execution in each mode                         |
| SETTING_TOP         | (0U)                | Value of initial screen                                 |
| MODE_MENU           | (0U)                | Value of mode not selected                              |
| LED_HOME            | (PORT4.PODR.BIT.B0) | P40   |
| LED_SELECT          | (PORT4.PODR.BIT.B1) | P41   |
| LED_START           | (PORT4.PODR.BIT.B2) | P42   |
| LED_MINUS           | (PORT4.PODR.BIT.B3) | P43   |
| LED_BAR             | (PORTD.PODR.BIT.B3) | PD3   |
| LED_PLUS            | (PORTD.PODR.BIT.B2) | PD2   |
| LED_ON              | (1U)                | Value of LED turning on                                 |
| LED_OFF             | (0U)                | Value of LED turning off                                |
| APP_VERSION_MAJOR   | (1U)                | Version display   |
| STARTUP_COUNT       | (STARTUP_TIME /     | Display the initial screen until the counter in         |
|                     | DELAY_TIME)         | the program equals this value                           |

#### Table 3-12 List of constants used in the sample code


# 3.4.7 Functions

The following shows the functions that are used in this sample program.

| Function name         | Outline   |
|-----------------------|---|
| emwin_task            | LCD Control   |
| GUI_Init              | Initializing emWin  |
| screen_init           | Menu screen is displayed on LCD   |
| change_screen         | LCD screen update   |
| slide_func            | Processing at touch slider operation                                    |
| select_pushed_func    | Processing when "select" button is touched                              |
| home_pushed_func      | Processing when "home" button is touched                                |
| start_pushed_func     | Processing when "start" button is touched                               |
| countdown_func        | Processing the countdown  |
| slide_icons           | Processing of cursor movement on menu screens and mode selection        |
|                       | screens for Cook, Defrost and Recipe                                    |
| setting_cook          | Setting the number of watts and seconds in Cook mode                    |
| setting_defrost       | Setting the level of defrosting and the number of grams in Defrost mode |
| setting_recipe        | Setting the number of cupcakes in Recipe mode                           |
| mode_select_enter     | Change the mode and display the LCD screen according to the mode        |
| change_target_cook    | Change the setting target of the detail setting screen in Cook mode     |
| change_target_defrost | Change the setting target of the detail setting screen in Defrost mode  |
| mode_change_menu      | Move to the menu screen   |
| start_cook            | Start cooking in Cook mode  |
| start_defrost         | Start defrosting in Defrost mode  |
| start_recipe          | Start cooking in Recipe mode  |
| countdown_cook        | Processing during cooking in Cook mode                                  |
| countdown_defrost     | Processing during defrosting in Defrost mode                            |
| countdown_recipe      | Processing during cooking in Recipe mode                                |
| touch_task            | Initializes CTSU and calls the touch judgement function                 |
| touch_judge           | Touch judgement   |
| show_startup_screen   | Processing of startup screen display                                    |
| led_sleep_on          | Set LED pattern to sleep  |
| wait_5sec_once        | Processing of 5 seconds wait  |
| clear_touch_flags     | Processing of flag clear for touch                                      |
| draw_choices_v09      | Processing of version 0.90 display                                      |
| draw_choices          | Processing of version 1.00 display                                      |
| cnt_1s                | Processing of 1 second count  |
| end_show_comp         | Processing of cooking completion screen wait                            |
| show_comp             | Processing of cooking completion screen display                         |
| start_cook_detail     | Start of detail setting in Cook mode                                    |
| start_defrost_detail  | Start of detail setting in Defrost mode                                 |
| start_recipe_detail   | Start of detail setting in Recipe mode                                  |
| led_off               | Processing of LED turning off   |

#### Table 3-13 List of functions used in the sample code



# 3.4.8 Function Specifications

The following shows function specifications that are used in this sample program.

| [Function name]    | emwin_task  |
|--------------------|---|
| Outline            | LCD Control   |
| Header             | task function.h   |
| Declaration        | void touch task (void * pvParameters)                       |
| Description        | Initializes emWin FIT and controls LCD.                     |
| Arguments          | pyParameters  |
| Return value       | None  |
| Remarks            | None  |
|                    |   |
| [Function name]    | GUI_Init  |
| Outline            | Initializing emWin  |
| Header             | GUI.h   |
| Declaration        | void GUI_Init (void)  |
| Description        | Initializes emWin's internal data structures and variables. |
| Arguments          | None  |
| Return value       | None  |
| Remarks            | None  |
|                    |   |
| [Function name] s  |   |
| Outline            | Menu screen is displayed on LCD                             |
| Header             | LCD_custom_func.h   |
| Declaration        | void screen_init (void)                                     |
| Description        | Menu screen is displayed on LCD.                            |
| Arguments          | None  |
| Return value       | None  |
| Remarks            | None  |
| [Function name] of | change_screen   |
| Outline            | LCD screen update   |
| Header             | LCD custom func.h   |
| Declaration        | void change_screen (void)                                   |
| Description        | Updates the LCD screen by touch operation.                  |
| Arguments          | None  |
| Return value       | None  |
| Remarks            | None  |
|                    |   |
|                    | snow_startup_screen   |
| Outline            | Processing of startup screen display                        |
| Header             | LCD_custom_tunc.h   |
| Declaration        | void shoe_startup_screen (void)                             |
| Description        | Performs startup screen display.                            |
| Arguments          | None  |
| Return value       | None  |
| Remarks            | None  |
|                    |   |
|                    |   |
|                    |   |



RX671 OTA-supported flat panel HMI PoC with touch keys and LCD

### RX671 Group

# [Function name] led\_sleep\_on

| Outline      | Set LED pattern to sleep  |
|--------------|---------------------------|
| Header       | LCD_custom_func.h         |
| Declaration  | Void led_sleep_on (void)  |
| Description  | Sets LED pattern to sleep |
| Arguments    | None                      |
| Return value | None                      |
| Remarks      | None                      |
|              |                           |

#### [Function name] touch\_task

| Outline      | Initializes CTSU and calls the touch judgement function  |
|--------------|--|
| Header       | task_function.h  |
| Declaration  | void touch_task (void * pvParameters)                    |
| Description  | Initializes CTSU and calls the touch judgement function. |
| Arguments    | pvParameters   |
| Return value | None   |
| Remarks      | None   |

# [Function name] touch\_judge

| Outline      | Touch judgement  |
|--------------|--|
| Header       | touch_func.h   |
| Declaration  | <pre>void touch_judge (uint64_t button_status, uint16_t slider_position)</pre> |
| Description  | Performs touch judgement and sets the judgement result to a flag.              |
| Arguments    | button_status, slider_position   |
| Return value | None   |
| Remarks      | None   |



# 3.4.9 ROM/RAM usage

ROM/RAM usage for this sample program is shown below.

#### Table 3-14 ROM usage

| Size(KByte)    | Description                                  |
|----------------|--|
| 550            | Amazon FreeRTOS                              |
| 200            | LCD Graphic data                             |
| 115            | emWin, LCD control                           |
| 15             | demo program, LCD_custom_func                |
| 24             | Other  |
| Total 904KByte | MAX 1024KByte (88% Used) : 1024KByte x 2Bank |

#### Table 3-15 RAM usage

| Size(KByte)    | Description               |
|----------------|---------------------------|
| 200            | OS Heap area              |
| 16             | Heap area                 |
| 64             | AWS demo program          |
| 37             | AWS cloud (exp. OTA)      |
| 11             | emWin                     |
| 18             | Other                     |
| Total 356KByte | MAX 384KByte (92.7% Used) |



# 4. Importing a Project

The sample programs are distributed in  $e^2$  studio project format. This section shows how to import a project into  $e^2$  studio or CS+. After importing a project, check the build and debug settings.

# 4.1 **Procedure in e<sup>2</sup> studio**

To use sample programs in e<sup>2</sup> studio, follow the steps below to import them into e<sup>2</sup> studio. In projects managed by e<sup>2</sup> studio, do not use space codes, multibyte characters, and symbols such as "\$", "#", "%" in folder names or paths to them.

(Note that depending on the version of e<sup>2</sup> studio you are using, the interface may appear somewhat different from the screenshots below.)

| New  | Alt+Shift+N > h            | <b>6 1 1</b>   |   |   | ~  |
|--|----------------------------|--|---|---|--|
| Open File  | -                          | Select   |   |   |  |
| Open Projects from File System   |                            | Create new projects from   | n an archive file or directory.   |   |  |
| Recent Files   | >                          | Colort on incordania and   |   |   |  |
| Close Editor   | Ctrl+W                     | Select an import wizard:   |   |   |  |
| Close All Editors  | trl+Shift+W                | x 🕞 Gonoral  |   |   |  |
| Save As  | Ctrl+S                     | Archive File   |   |   |  |
| Save All   | ctri+shift+s               | Existing Projects  | into Workspace  |   |  |
| Revert   | bre orbust                 | 🔍 File System  |   |   | Brojacto into Workens  |
| Move select the Fi   | le >> [Import]             | Preferences  Projects from Fo  | older or Archive  | Select [Existing  |  |
| Rename   | io >> [import].            | ⊯ Rename & Impo  | ort Existing C/C++ Project in   | o Workspace   |  |
| Convert Line Deline terre To   | F5                         | 😂 Renesas CCRX p   | project conversion to Renesa  | s GCC RX  |  |
|  | Ci li D                    | 😂 Renesas CS+ Pro  | oject for CA78K0R/CA78K0  |   | ~  |
| Print  | CuitP                      |  |   |   |  |
| Export   |                            |  |   |   |  |
| Properties   | Alt+Enter                  |  |   |   |  |
| Switch Workspace   | >                          | 3  | < Back Nex  | dt > Finish   | Cancel   |
| Restart  |                            |  |   |   |  |
| Exit   |                            |  |   |   |  |
|  |                            |  |   |   |  |
| Import  Import  Select a directory to search for existing Ect  Select root directory:  M0110-rx23e-a¥r  Select archive file:   | lipse projects.            | ple > Browse   | Select [Select  | root directory:].   | ]  |
| Import Import Projects Select a directory to search for existing Eco elect root directory: x0110-rx23e-a¥r Select archive file: Projects: x23ea_thermocouple (C:¥Application)  | ipse projects.             | Ple V Browse<br>V Browse<br>23e-a¥ Select All<br>Deselect All<br>Refresh   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application                                     | root directory:].<br>ectory which stored<br>47_rx23ea_thermo<br>on note has its ow  | d the project.<br>acouple)<br>n project name.                      |
| Import Import Import Projects Select a directory to search for existing Ecc Import directory: Import direct  | lipse projects.            | Iple     >       Browse       Browse       Select All       Deselect All       Refresh   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each applicatio                                      | root directory:].<br>actory which stored<br>t7_rx23ea_thermo<br>on note has its ow  | t the project.<br>couple)<br>in project name.                      |
| Import Import Import Select a directory to search for existing Eco Import directory:   | lipse projects.            | Ple      Select All     Deselect All     Refresh   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each applicatio                                      | root directory:].<br>actory which stored<br>t7_rx23ea_thermo<br>on note has its ow  | t the project.<br>couple)<br>n project name.                       |
| Import Import Import Projects Select a directory to search for existing Eco Import addression of the existing Eco Imp  | lipse projects.            | ple → Browse<br>→ Browse<br>23e-a¥<br>Select All<br>Deselect All<br>Refresh  | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each applicatio                                      | root directory:].   | t the project.<br>couple)<br>n project name.                       |
| Import Import Import Projects Select a directory to search for existing Ecc Import directory: Import direct  | ipse projects.             | Ple      Select All     Deselect All     Refresh   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application                                     | root directory:].   | the project.<br>couple)<br>n project name.                         |
| Import Import Import Projects Select a directory to search for existing Eco Import directory:  | ipse projects.             | Iple     >       Browse       Browse       Select All       Deselect All       Refresh   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application<br>Select [Copy p<br>when to copy p | root directory:].<br>ectory which stored<br>t7_rx23ea_thermo<br>on note has its ow<br>on note has its ow                        | d the project.<br>vouple)<br>n project name.<br>pace(C)]<br>ce.    |
| Import          Import Projects         Select a directory to search for existing Ec         Import Projects         Select archive file:         Projects:         Import rs23ea_thermocouple (C:¥Application)         Search for nested projects         Options         Search for nested projects         Copy projects into workspace         Close newly imported projects upon cc         Hide projects that already exist in the w         Working sets  | on_note¥r01an4747xx0110-rx | ple → Browse Browse 23e-a¥ Select All Deselect All Refresh >   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application<br>Select [Copy p<br>when to copy p | root directory:].<br>ectory which stored<br>t7_rx23ea_thermo<br>on note has its ow  | d the project.<br>vocuple)<br>n project name.<br>pace(C)]<br>ce.   |
| Import          Import Projects         Select a directory to search for existing Ec         Import Projects         Select archive file:         Projects:         Import rx23ea_thermocouple (C:¥Application)         Search for nested projects         Copy projects into workspace         Close newly imported projects upon cc         Hide projects that already exist in the w         Working sets   | ipse projects.             | Browse       23e-a¥     Select All       Deselect All       Refresh  | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application<br>Select [Copy p<br>when to copy p | root directory:].<br>ectory which stored<br>t7_rx23ea_thermo<br>on note has its ow  | d the project.<br>vocuple)<br>n project name.<br>pace(C)]<br>ce.   |
| Import          Import Projects         Select a directory to search for existing Ec         Import Projects         Select archive file:         Projects:         Import rx23ea_thermocouple (C:¥Application         Import rx23ea_thermocouple (C:¥Application         Search for nested projects         Copy projects into workspace         Close newly imported projects upon cc         Hide project to that already exist in the w         Working sets         Working sets:   | ipse projects.             | Browse       Browse       Browse       Browse       Browse       Browse       Browse       New       Select  | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application<br>Select [Copy p<br>when to copy p | root directory:].<br>ectory which stored<br>47_rx23ea_thermo<br>on note has its ow<br>projects into works<br>project to workspa | d the project.<br>vocuple)<br>n project name.<br>pace(C)]<br>ce.   |
| Import          Import Projects         Select a directory to search for existing Ec         Import Projects         Select archive file:         Projects:         Import rx23ea_thermocouple (C:¥Application         Import rx23ea_thermocouple (C:¥Application         Search for nested projects         Import rx23ea_thermocouple (C:¥Application         Import rx23ea_thermocouple (C:¥Application <td>ipse projects.</td> <td>Image: Select All       23e-a¥       Select All       Deselect All       Refresh</td> <td>Select [Select<br/>Select the dire<br/>(e.g. r01an474<br/>Each application<br/>Select [Copy p<br/>when to copy p</td> <td>root directory:].<br/>ectory which stored<br/>t7_rx23ea_thermo<br/>on note has its ow<br/>projects into works<br/>project to workspa</td> <td>d the project.<br/>prouple)<br/>n project name.<br/>pace(C)]<br/>ce.</td> | ipse projects.             | Image: Select All       23e-a¥       Select All       Deselect All       Refresh   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application<br>Select [Copy p<br>when to copy p | root directory:].<br>ectory which stored<br>t7_rx23ea_thermo<br>on note has its ow<br>projects into works<br>project to workspa | d the project.<br>prouple)<br>n project name.<br>pace(C)]<br>ce.   |
| Import          Import Projects         Select a directory to search for existing Ec         Select root directory:         x0110-rx23e-a¥r         Select archive file:         Projects:         rx23ea_thermocouple (C:¥Application         Search for nested projects         Copy projects into workspace         Close newly imported projects upon cc         Hide projects that already exist in the w         Working sets         Working sets:  | ipse projects.             | Image: Select All       23e-a¥       Select All       Deselect All       Refresh   | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application<br>Select [Copy p<br>when to copy p | root directory:].   | d the project.<br>pocuple)<br>n project name.<br>pace(C)]<br>ce.   |
| Import          Import Projects         Select a directory to search for existing Ec         Select root directory:         x0110-rx23e-a¥r         Select archive file:         Projects:         rx23ea_thermocouple (C:¥Applicatic         Options         Search for nested projects         Copy projects into workspace         Close newly imported projects upon cc         Hide project to working sets         Working sets:   | ipse projects.             | Iple       >       Browse         ✓       Browse         23e-a¥       Select All         Deselect All       Refresh         →       New         ✓       Select | Select [Select<br>Select the dire<br>(e.g. r01an474<br>Each application<br>Select [Copy p<br>when to copy p | root directory:].   | d the project.<br>hocouple)<br>in project name.<br>pace(C)]<br>ce. |

Figure 4-1 Import a Project into e<sup>2</sup> Studio



### 4.2 Procedure in CS+

To use sample programs in CS+, follow the steps below to import them into CS+. In projects managed by CS+, do not use space codes, multibyte characters, and symbols such as "\$", "#", "%" in folder names or paths to them.

(Note that depending on the version of CS+ you are using, the interface may appear somewhat different from the screenshots below.)



Figure 4-2 Importing a Project into CS+



# 5. Start Demonstration

Disconnect the E2 Emulator Lite and turn on the RX671 PoC to start the demonstration program. This demonstration program assumes control of the display and settings of a microwave oven. Set the cooking conditions and recipe selections using the touch buttons and touch slider while checking the LCD.

Hereinafter, touch buttons are described as buttons and touch slider is described as slider.



Figure 5-1 Demonstration screen and operation panel



# 5.1 Powered on RX671 PoC and menu screen

When RX671 PoC is powered on, the LCD panel displays the RX logo and RX671 features (initial screen) for approximately 5 seconds. When the display finishes, the sample program starts and becomes a menu screen.

And while the initial screen is displayed, can immediately move to the menu screen by touching any button.



Figure 5-2 Start of the demonstration

# 5.2 Menu screen

"Cook", "Defrost" or "Recipe" can be selected with the slider operation on the menu screen.



Figure 5-3 How to operate the menu screen



# 5.3 Cook setting

#### 5.3.1 Move to mode selection screen

While "Cook" is selected on the menu screen, touching the "select" button can move to the Cook mode selection screen.



Figure 5-4 Move to the Cook mode selection screen

### 5.3.2 Select mode

While the Cook mode selection screen is displayed, "Auto" or "Manual" can be selected with the slider operation.



Figure 5-5 How to operate the Cook mode selection screen



### 5.3.3 Select Auto

While "Auto" is selected on the Cook mode selection screen, touching the "start" button can start cooking.



Figure 5-6 Start cooking in Auto mode

#### 5.3.4 Select Manual

While "Manual" is selected on the Cook mode selection screen, touching the "select" button can move to the Cook detail setting screen.



Figure 5-7 Move to the Cook detail setting screen



### 5.3.4.1 Set the number of watts

While the cursor is on the upper side, the number of watts can be set with the slider. "500W", "600W" and "700W" can be selected as the power level.



Figure 5-8 Setting the number of watts

### 5.3.4.2 Move the cursor

While the Cook detail setting screen is displayed, touching the "select" button can move the cursor. The item with a light-colored background is selected.



Figure 5-9 How to operate the cursor on the Cook detail setting screen



#### 5.3.4.3 Set the number of seconds

While the cursor is on the lower side, the number of seconds can be set with the slider. "10s", "20s" and "30s" can be selected as the cooking time.



Figure 5-10 Setting the number of seconds

### 5.3.4.4 Start cooking

While the Cook detail setting screen is displayed and the cursor is on the lower side, touching the "start" button can start cooking.



Figure 5-11 Start cooking in Manual mode



### 5.4 Defrost setting

#### 5.4.1 Move to mode selection screen

While "Defrost" is selected on the menu screen, touching the "select" button can move to the Defrost mode selection screen.



Figure 5-12 Move to the Defrost mode selection screen

### 5.4.2 Select mode

While the Defrost mode selection screen is displayed, "Manual", "Fish" or "Meat" can be selected with the slider operation.



Figure 5-13 How to operate the Defrost mode selection screen



#### 5.4.3 Select Manual

While "Manual" is selected on the Defrost mode selection screen, touching the "select" button can move to the Defrost detail setting screen.



Figure 5-14 Move to the Defrost detail setting screen

#### 5.4.3.1 Set the level of defrosting

While the cursor is on the upper side, the level of defrosting can be set with the slider. "Level1", "Level2" and "Level3" can be selected as the defrosting level.



Figure 5-15 Setting the level of defrosting



#### 5.4.3.2 Move the cursor

While the Defrost detail setting screen is displayed, touching the "select" button can move the cursor. The item with a light-colored background is selected.



Figure 5-16 How to operate the cursor on the Defrost detail setting screen

### 5.4.3.3 Set the number of grams

While the cursor is on the lower side, the number of grams can be set with the slider. "100g", "200g" and "300g" can be selected as the defrosting amount.



Figure 5-17 Setting the number of grams



### 5.4.3.4 Start defrosting

While the Defrost detail setting screen is displayed and the cursor is on the lower side, touching the "start" button can start defrosting.



Figure 5-18 Start defrosting in Manual mode

### 5.4.4 Select Fish

While "Fish" is selected on the Defrost mode selection screen, touching the "start" button can start defrosting with the settings for "Fish".



Figure 5-19 Start defrosting in Fish mode



### 5.4.5 Select Meat

While "Meat" is selected on the Defrost mode selection screen, touching the "start" button can start defrosting with the settings for "Meat".



Figure 5-20 Start defrosting in Meat mode



# 5.5 Recipe setting

Recipe mode is not available with the firmware ver.0.90.

#### 5.5.1 Move to recipe selection screen

While "Recipe" is selected on the menu screen, touching the "select" button can move to the Recipe selection screen.



Figure 5-21 Move to the Recipe selection screen

### 5.5.2 Select recipe

While the Recipe selection screen is displayed, "Beef Stew", "Garlic Shrimp" or "Cup Cake" can be selected with the slider operation.



Figure 5-22 How to operate the Recipe selection screen



#### 5.5.3 Select Beef Stew

While "Beef Stew" is selected on the Recipe selection screen, touching the "start" button can start cooking for the Settings for Beef Stew.



Figure 5-23 Start cooking in Beef Stew mode

#### 5.5.4 Select Garlic Shrimp

While "Garlic Shrimp" is selected on the Recipe selection screen, touching the "start" button can start cooking for the Settings for Garlic Shrimp.



Figure 5-24 Start cooking in Garlic Shrimp mode



### 5.5.5 Select Cup Cake

While "Cup Cake" is selected on the Recipe selection screen, touching the "start" button can start cooking for the Settings for Cup Cake.



Figure 5-25 Move to the Cup Cake detail setting screen

#### 5.5.5.1 Set the number of cupcakes

You can set the number of cupcakes with the slider. "1pc", "2pcs" and "3pcs" can be selected as the cooking amount.



Figure 5-26 Setting the number of cupcakes



# 5.5.5.2 Start cooking

While the Cup Cake detail setting screen is displayed, touching the "start" button can start cooking.



Figure 5-27 Start cooking in Cup Cake mode



# 5.6 About the "home" button

The "home" button returns to the menu screen from any screen.



Figure 5-28 Example of "home" button operation



# 5.7 About the cooking completion screen

While completed cooking, the cooking completion screen is displayed for 3 seconds. After that, move to the menu screen automatically.



Figure 5-29 Example of cooking completion operation

# 5.8 Automatic LCD off function

If no touch operation is performed for 10 seconds, the LCD will turn off. Touching any buttons will return to the previous screen.



## 6. Update firmware version

Two version of firmware are available in this application note. One of them has firmware version 0.90 and its file name is userprog\_v0.90.rsu, the other firmware version is 1.00 and its file name is userprog\_v1.00.rsu. In the initial state, version 0.90 firmware including a bootloader that supports FOTA is written, and can update it to version 1.00 firmware by following the procedure described later.

The differences by firmware version are shown below. The firmware version in use is displayed on the initial screen. In addition, the menu screen is different for each version.



Figure 6-1 Differences by firmware version



1. Upload and save the OTA update firmware userprog\_v0.90.rsu oruserprog\_v1.00.rsu to Amazon S3 bucket as described in "1.2 Create an Amazon S3 bucket" in "How to implement FreeRTOS OTA by using Amazon Web Services on RX65N".

| mazon S3 > Buckets > rx671   |   |                             |
|--|---|-----------------------------|
| x671   |   |                             |
| Objects Properties Permissions Metrics Management Access Po  | ints                                      |                             |
| Objects (3)  |   |                             |
| Objects are the fundamental entities stored in Amazon S3. You can use Amazon S3 inventory 🖸 to get a list of | all objects in your bucket. For others to | access your objects, you'll |
| C     □     Copy S3 URI     □     Copy URL     [1] Download     Open [2]                                     | Delete Actions V                          | Create folder               |
|  |   |                             |
| Q. Find objects by prefix     Show versions  |   | < 1 > 🔘                     |
| Name ▲ Type ⊽ Last modified  | ⊽ Size ⊽                                  | Storage class ⊽             |
| □ D SignedImages/ Folder -   | -   | -                           |
| Userprog_v0.90.rsu rsu October 5, 2022, 09:44:07 (UTC+09   | 959.5 KB                                  | Standard                    |
| Userprog_v1.00.rsu rsu October 5, 2022, 09:44:05 (UTC+09   | 959.5 KB                                  | Standard                    |

Figure 6-2 userprog.rsu upload



2. Create job to update firmware on RX671 PoC.

AWS IoT Jobs is a service that notifies one or more connected devices that they have a pending "job". A job can be used to manage large numbers of devices, update firmware and security certificates on devices, or perform administrative tasks such as rebooting and diagnostics devices.

—Select [AWS IoT]  $\rightarrow$  [Manage]  $\rightarrow$  [Jobs]  $\rightarrow$  [Create]  $\rightarrow$  [Create OTA Update job]  $\rightarrow$  Set job name  $\rightarrow$  [Next]

 Create a FreeRTOS OTA update job as below: Select the name of the thing. (Figure 6-3 (a), Figure 7-11) Select Code signing profile. (Figure 6-3 (b)) Select firmware image from S3 for FOTA. (Figure 6-3 (c)) Select IAM role. (Figure 6-3 (d))

-Click [Next]

| This OTA update job will cand your file securely over MOTT or HTTP to the FreePTOS-based things and/or the thing groups that you choose   |
|---|
| This of A dpdate job with serial your the securely over most for thit is to the theek to s-based dnings and/or the thing groups that you choose.  |
| Devices to update   |
| Choose things and/or thing groups   |
| [rs671] (a)   |
| Select the protocol for file transfer   |
| Select the protocol that your device supports.  |
|   |
|   |
| File Info   |
|   |
| Sign and choose your file<br>Code signing ensures that devices only run code published by trusted authors and that the code hasn't<br>been changed or corrupted since it was signed. You have three options for code signing.   |
| Sign a new file for     Choose a     Use my custom  |
| me. previously signed signed file. file.  |
| existing code signing profile  Existing code signing profile  Profile_rx671_ota  File  Upload a new file.  S3 URL  (C)  s3//rx671_fuserprog_v1.00.rsu  View  Browse S3 Format S3//bucket/prehyzoget.  Path name of file on device This is the name and location where the file will be stored on the FreeRTOS device.  e.g. /device/updates |
| File type - optional  |
| IAM role Info   |
| Role<br>Choose a role that grants AWS IoT access to 53, AWS IoT jobs, and AWS Code signing resources.   |

Figure 6-3 Job creation (1)



3. Click [Create job].

| OTA job configuration un  |
|---|
|   |
| Job run type<br>Choose how to run this job.   |
| <ul> <li>Your job will complete after deploying to the devices and groups that you chose<br/>(snapshot)</li> </ul>  |
| <ul> <li>Your job will continue to deploy to any devices added to the groups that you chose<br/>(continuous)</li> </ul>   |
| Job start rollout configuration - optional  |
| Specify how quickly devices will be notified when a pending job starts.   |
| Job stop configuration - optional   |
| These configurations define when to automatically stop the job. The job stops if a percentage of devices fail the deployment after a minimum number have deployed. The job cancels if any of the criteria are met after the job starts. |
| Job run timeout configuration - optional  |
| Specify how long the job will run.  |
| Cancel Back Create job  |

Figure 6-4 Job creation (2)



4. Open Tera Term and confirm that the firmware has been updated.

| 💆 COM3 - Tera Term VT — 🗌 🖂 🗡  |   |
|--|---|
| <u>File Edit Setup Control Window H</u> elp  |   |
| bute.72 373 [Tmr Svc]<br>73_373 [Tmr Svc] [INFO] [PKCS11] [core_pkcs11_mbedtls.c:2638] 74 373 [Tmr Svc] Creating a 0x3 type object.75 373 [Tm  | î |
| r Svc]<br>76 373 [Tmr Svc] [DEBUG] [PKCS11] [core_pkcs11_mbedtls.c:2158] 77 373 [Tmr Svc] Successfully found the key type in t<br>he templete 72 274 [Tmr Svc]   | : |
| 79 374 [Tmr Svc] [DEBUG] [PKCS11] [core_pkcs11_mbedtls.c:2187] 80 374 [Tmr Svc] Successfully found the label in the template.81 374 [Tmr Svc]  |   |
| 22 374 [Tmr Svc] [DEBUG] [PKCS11] [core_pkcs11_mbedtls.c:1243] 83 374 [Tmr Svc] Key was private type.84 374 [Tmr Svc]  | : |
| 91 660 [Tmr Svc] [INFO] [PKCS11] [core_pkcs11_mbedtls.c:2033] 92 660 [Tmr Svc] Successfully closed PKCS #11 session.<br>93 660 [Tmr Svc]   |   |
| 94 663 Liot_thread] LINFO JLDEMOJL663]STARTING DEMO  |   |
| 95 663 Liot_thread] LINFO ]LINII][663] SDK successfully initialized.<br>96 107527 [iot_thread] [INFO ][DEMO][107527] Successfully initialized the demo. Network type for the demo: 1<br>97 107527 [iot_thread] [INFO ][MQTT][107527] <u>MQTT library successfully</u> initialized.<br>98 107527 [iot_thread] [INFO ][DEMO][107527] <mark>OTA demo version 1.0.0</mark> |   |
| 99 107527 [iot_thread] [INFO ][DEMO][107527] Connecting to broker  | ~ |

Figure 6-5 Check Execution Result

The Tera Term setup is shown below. If do not have Tera Term on PC, please download from https://ttssh2.osdn.jp/index.html.en.

| 💹 COM11 - Tera Term VT  |  |                            | _ |   |  |
|---|--|----------------------------|---|---|--|
| File Edit Setup C Tera Term: Serial por   | t setup and connection   |                            | × |   |  |
| Port:<br>Speed:   | COM11 ~  | New setting                |   | Â |  |
| Data:<br>Parity:  | 8 bit ~  | Cancel                     |   |   |  |
| Stop bits:<br>Flow control:   | 1 bit v  | Help                       |   |   |  |
| Device Friendly N<br>Device Instance<br>Device Manufac<br>Provider Name: I<br>Driver Date: 6-21<br>Driver Version: 1/ | mit delay<br>msec/char 0<br>Name: USB シリアル デバイス<br>ID: USB¥VID_0458&PID_81<br>turer: Microsoft<br>Microsoft<br>-2006<br>2.0.19041.1202 | (COM11)<br>11¥000000000001 | ~ |   |  |
| <   |  | >                          |   |   |  |
|   |  |                            |   | ~ |  |

Figure 6-6 Tera Term



OTA demonstration version is 1.00 and has been updated successfully.

5. Check job status to be "Succeeded".

| Device Advisor     |  |   |                        |                           |
|--------------------|--|---|------------------------|---------------------------|
| MQTT test client   | AFR_OTA-job_ota_                       | rx671 Info  |                        | C Edit Save as a job temp |
|                    | Details Job executions                 | Job document Job targets Tags                       |                        |                           |
| All devices        |  |   |                        |                           |
| Greengrass devices | Execution overview                     |   |                        |                           |
| -<br>LPWAN devices | When canceling and deleting execution  | refresh this page if the summary does not match.    |                        |                           |
| Remote actions     |  |   |                        |                           |
| Jobs               | Succeeded                              | Failed  | Canceled               | Rejected                  |
| Job templates      |  | 0   | 0                      | 0                         |
| Secure tunnels     | Queued                                 | In progress   | Bemoved                | Timed out                 |
| Message Routing    | 0                                      | 0   | 0                      | 0                         |
| Retained messages  | Ŭ                                      | 8   | 8                      | 0                         |
| Security           |  |   |                        |                           |
| Fleet Hub          | Job executions (1) Info                |   |                        | C Cancel execu            |
|                    | Devices currently processing this job. |   |                        |                           |
| vice Software      | Q Find job executions                  |   | All job executions (1) |                           |
| ng groups          |  |   |                        |                           |
| tings              | □ Thing name ▼ Ret                     | ry attempts Retries remai Last updat 🔻              | Queued at              |                           |
| 120                |  | Detailed and and a Constant of Constant of Constant | Contraction O          |                           |

Figure 6-7 Check Succeeded



### 7. How to create a user program that supports OTA

This section describes how to rewrite the program from the cloud by OTA.

The program is rewritten in the background and automatically switched to the new program at the next power-on.

First, user can select the version of Amazon FreeRTOS package. The selected version will be downloaded from GitHub and imported automatically into the project. This makes it easier for the user, so that the user can focus only on Amazon FreeRTOS configuration and writing program.

### 7.1 AWS Preparation

To perform OTA from the cloud, it is necessary to prepare a cloud environment. Use AWS as the cloud. Refer to the following for more information on preparing for AWS. RX Family How to implement FreeRTOS OTA by using Amazon Web Services on RX65N (R01AN5549).

#### 7.2 Import, configurate head file and build aws\_demos and boot\_loader

The figure below shows how to import Amazon FreeRTOS project:

- 1. Launch e<sup>2</sup> studio.
- 2. Select [File]  $\rightarrow$  [Import...]
- 3. Select [Renesas GitHub FreeRTOS (with IoT libraries) Project]

Figure 7-1 Importing Projects



4. Click [Check for more version...] to show the "FreeRTOS (with IoT libraries)" dialog.

| Renesas GitHub FreeRTOS (with IoT libraries) Project                        |        |
|---|--------|
| Select KTOS version   |        |
| Specify a folder to copy selected RTOS version in order to import the proje | ct.    |
| Folder: C:¥afr_v202012.00-rx-1.0.1  | Browse |
| RTOS version setting  |        |
| Version: v202012.00-rx-1.0.1  | ~      |
| Check for hole version  |        |
|   |        |
|   |        |
|   |        |
|   |        |
|   |        |
|   |        |
| C < <u>B</u> ack <u>N</u> ext > <u>Finish</u> C                             | ancel  |

Figure 7-2 "FreeRTOS (with IoT libraries)" dialog

5. Select the latest version. (If the latest version is not displayed, create a new e<sup>2</sup> studio workspace)

| FreeRTOS (with IoT libraries) N<br>Select RTOS modules for download | lodule Download<br>and specify download location |            |              | Ľ            |
|---|--|------------|--------------|--------------|
| Title   | Rev.   | Issue date | ^            | Select All   |
| FreeRTOS (with IoT libraries)                                       | v202107.00-rx-1.0.1                              | 2022-06    |              | Deselect All |
| FreeRTOS (with IoT libraries)                                       | v202107.00-rx-1.0.0                              | 2022-04    |              | Deselect All |
| FreeRTOS (with IoT libraries)                                       | v202012.00-rx-1.0.1                              | 2022-03    |              |              |
| FreeRTOS (with IoT libraries)                                       | v202012.00-rza2m-1.0.0                           | 2021-12    |              |              |
| FreeRTOS (with IoT libraries)                                       | v202012.00-re-1.0.0                              | 2021-10    |              |              |
| FreeRTOS (with IoT libraries)                                       | v202012.00-rl78-1.0.0                            | 2021-10    |              |              |
| FreeRTOS (with IoT libraries)                                       | v202012.00-rx-1.0.0                              | 2021-10    |              |              |
| FreeRTOS (with IoT libraries)                                       | v202002.00-rx-1.0.5                              | 2021-05    |              |              |
| FreeRTOS (with IoT libraries)                                       | v202002.00-rx-1.0.4                              | 2021-03    |              |              |
| FreeRTOS (with IoT libraries)                                       | v202002.00-rl78-1.0.3                            | 2021-02    | $\checkmark$ |              |
| Module Folder Path:   |  |            |              |              |
|   |  |            |              |              |

Figure 7-3 Select OS version



6. Agree to the end user license agreement

| End User License Agreement(Sample Code)                      | ×   |  |
|--|-----|--|
| This content is subject to the following license agreements: |     |  |
| Accept Not Acce  | ept |  |

Figure 7-4 Agree to End User License Agreement

7. Wait for the download to complete.

| Progres | s Information  |
|---------|--|
|         | FreeRTOS module download   |
|         |  |
| afr-v20 | 2012.00-rx-1.0.1 - doc/Amazon FreeRTOS Qualification Developer Guide.pdf |
|         |  |
|         | Cancel   |
|         |  |

Figure 7-5 Waiting for download



8. Select the project to import. Select [aws\_demos] and [boot\_loader] project.

#### The aws\_demos and boot\_loader used in this demonstration have not been officially released in May 2023. Please contact our distributors and sales offices to request individual supplies. Import Projects Select a directory to search for existing Renesas projects. • Select root directory: C:¥afr-v202012.00-rx-1.0.1 ~ Browse... Projects: rx671 × Select All ✓ aws\_demos (C:¥afr-v202012.00-rx-1.0.1¥projects¥renesas¥rx671-rsk¥e2studio¥aws\_demos) Deselect All aws\_demos (C:¥afr-v202012.00-rx-1.0.1¥projects¥renesas¥rx671-rsk¥e2studio-gcc¥aws\_demos) Refresh aws\_tests (C:¥afr-v202012.00-rx-1.0.1¥projects¥renesas¥rx671-rsk¥e2studio¥aws\_tests) aws tests (C:¥afr-v202012.00-rx-1.0.1¥proiects¥renesas¥rx671-rsk¥e2studio-acc¥aws tests boot\_loader (C:¥afr-v202012.00-rx-1.0.1¥projects¥renesas¥rx671-rsk¥e2studio¥boot\_loader boot\_loader (C:¥afr-v202012.00-rx-1.0.1¥projects¥renesas¥rx671-rsk¥e2studio-gcc¥boot\_loader) Options Search for nested projects Hide projects that already exist in the workspace ? < <u>B</u>ack <u>N</u>ext > <u>F</u>inish Cancel

Figure 7-6 Select a project to import



9. Open [Project]  $\rightarrow$  [Properties]  $\rightarrow$  [C/C++ Build]  $\rightarrow$  [Tool Chain Editor] in both projects and select "Toolchain" and "Builder" to set the toolchain. Also, select [Setting]"  $\rightarrow$  [Toolchain] to set the version.



Figure 7-7 Tool Chain and Versioning



10. Select [Project]  $\rightarrow$  [Properties]  $\rightarrow$  [C/C++ Build]  $\rightarrow$  [Settings]  $\rightarrow$  [Converter]  $\rightarrow$  [Output] and set [Motorola S format file].



Figure 7-8 Motorola S format File output settings



#### 11. Input the public key

In bootloader project, open

projects\renesas\rx671-rsk\e2studio\boot\_loader\src\key\code\_signer\_public\_key.h and input public key. Please refer to "Renesas MCU Firmware Update Design Policy" section "7.3 Generating ECDSA-SHA256 Key Pairs with OpenSSL" to create public key.

When completed to create public key, build and generate the boot\_loader.mot file for the boot loader project.

The aws\_demos and boot\_loader used in this demonstration have not been officially released in May 2023. Please contact our distributors and sales offices to request individual supplies.



Figure 7-9 Input the public key


### 12. Open AWS IoT console

- —Browse to the AWS IoT console.
- ---Select [Settings]. Make a note of the Endpoint. (Figure 7-10(e))

| Device data endpo            | int Info  | (                           |
|------------------------------|---|-----------------------------|
| Your devices can use your ac | count's device data endpoint to connect to AWS.                   |                             |
| Each of your things has      | a REST API available at this endpoint. MQTT clients and AWS IoT D | Device SDKs 🛃 also use this |

Figure 7-10 Check AWS Endpoint

—Select [Manage]  $\rightarrow$  [Things]. Make a note of AWS IoT thing name. (Figure 7-11(f))

| onitor               | rx671   | Info   |                           |                             |
|----------------------|---|--|---------------------------|-----------------------------|
| onnect               | Thing details                                       |  |                           |                             |
| Connect one device   |   |  |                           |                             |
| Connect many devices | rx671 (f)   |  |                           | Type<br>-                   |
|                      | ARN   |  |                           | Billing group               |
| st                   | ð   |  |                           | -                           |
| Device Advisor       |   |  |                           |                             |
| MQTT test client     |   |  |                           |                             |
|                      | Attributes C  | ertificates Thing groups Device S  | hadows Interact Activity  | Jobs Alarms Defender metric |
| anage                |   |  |                           |                             |
| All devices          | Attributes (0)                                      | Info   |                           |                             |
| Things               | Attributes are key-val                              | ue pairs that can be searchable or non-searchable. Sea                                     | rchable attributes can be |                             |
| Thing groups         | used to filter lists of the find things, but only v | hings without using fleet indexing. Non-searchable at<br>when fleet indexing is turned on. | ributes can be used to    |                             |
| Thing types          |   |  |                           |                             |
| Fleet metrics        | Key   | ♥ Value  | ⊽ Туре                    |                             |
| Greengrass devices   |   |  |                           | No attributor               |
|                      |   |  |                           | no attributes               |

### Figure 7-11 thing name



13. Open aws\_demos project.

—Open /demos/include/aws\_clientcredential.h and specify the following values #define clientcredentialMQTT\_BROKER\_ENDPOINT "Figure 7-10 (e) The Endpoint" #define clientcredentialIOT\_THING\_NAME "Figure 7-11 (f) thing name"

| 2   | * * FreeRTOS V202012.00  |
|-----|--|
| 25  |  |
| 26  | S#ifndef AWS CLIENTCREDENTIAL H  |
| 27  | #define AWS CLIENTCREDENTIAL H   |
| 28  |  |
| 29  | ⇔ / <b>*</b>   |
| 30  | * Whrief MOTT Broker endpoint.   |
| 31  | *  |
| 132 | * @todo Set this to the fully-qualified DNS name of your MOTT broker.            |
| 33  |  |
| 34  | #define clientcredentialMOTT BROKER ENDPOINT ".iot.ap-northeast-1.amazonaws.com" |
| 35  |  |
| 36  | ⊖ /*   |
| 37  | * @brief Host name.  |
| 38  | *  |
| 139 | * @todo Set this to the unique name of your IoT Thing.                           |
| 40  | * Please note that for convenience of demonstration only we                      |
| 41  | * are using a #define here. In production scenarios the thing                    |
| 42  | * name can be something unique to the device that can be read                    |
| 43  | * by software, such as a production serial number, rather                        |
| 44  | * than a hard coded constant.  |
| 45  | */   |
|     |  |
| 46  | #define clientcredentialIOT_THING_NAME "   |

Figure 7-12 Input the endpoint and thing name

14. Open "Certificate Configuration Tool"

- —Move to the FreeRTOS path downloaded in 7.1 step 5.
- $--\text{Open [tools]} \rightarrow [\text{certificate\_congiguration}] \rightarrow \text{CertificateConfigurator.html}$
- —Import certificate PEM file and Private Key PEM file which were downloaded on 1.1 step (4) of "How to implement FreeRTOS OTA by using Amazon Web Services on RX65N"
- -Generate awa\_clientcredential\_keys.h.

| Certificate Configuration Tool<br>FreeRTOS Developer Demos   |  |  |  |
|--|--|--|--|
| Provide client certificate and private key PEM files downloaded from the AWS IoT Console.  Certificate PEM file: Choose File No file chosen  Private Key PEM file: Choose File No file chosen  Generate and save aws_clientcredential_keys.h |  |  |  |
| Save the generated header file to the demos/common/include folder of the demo project.<br>Copyright (C) 2017 Amazon.com, Inc. or its affiliates. All Rights Reserved.  |  |  |  |

Figure 7-13 Generate clientcredential key



15. Open aws\_demos project again

---Replace the aws\_clientcredentia\_keys.h generated above with the file in /demos/include/.

- -Open /demos/include/aws\_ota\_codesigner\_certificate.h specify values below
- signingcredentialSIGNING\_CRETIFICATE\_PEM [] = "xxxx";

"xxxx" is value from secp256r1.crt. Remember the "\" after each line of certification.

For creating secp256r1.crt please refer to "How to implement FreeRTOS OTA by using Amazon web Services on RX65N" section "7.3 Generating ECDSA-SHA256 Key Pairs with OpenSSL".



### Figure 7-14 Input clientcredential



## 7.3 Install the initial version of firmware

1. Check the FreeRTOSApplicationConfig.h setting.

| FreeRTOSAppli  | ationConfig.h $	imes$  |
|----------------|--|
| * 1<br>2<br>3  | <pre>#ifndef FREERTOS_APPLICATION_CONFIG_H #define FREERTOS_APPLICATION_CONFIG_H</pre> |
|                | #define OTA (Used)   |
| 6              | <pre>#define Used (1) #define Unused (0)</pre>   |
| 9<br>10        | #define CONNECTION (WIFI)  |
| 11<br>12<br>13 | #define ETHER (1)<br>#define WIFI (0)  |
| 14<br>15<br>16 | <pre>#if (CONNECTION == 1) #error "Connection type ETHER not supported' #endif</pre>   |
| 17<br>18       | #endif   |

Figure 7-15 Check Setup

2. Open amazon-freertos/demos/include/ aws\_application\_version.h, set initial version of firmware to 0.90.

| 2  | * FreeRTOS V202012.00                            |
|----|--|
| 25 |  |
| 26 | <pre>#ifndef _AWS_APPLICATION_VERSION_H_</pre>   |
| 27 | <pre>#define _AWS_APPLICATION_VERSION_H_</pre>   |
| 28 |  |
| 29 | <pre>#include "iot_appversion32.h"</pre>         |
| 30 | extern const AppVersion32_t xAppFirmwareVersion; |
| 31 |  |
| 32 | #define APP_VERSION_MAJOR (0U)                   |
| 33 | #define APP VERSION MINOR (9U)                   |
| 34 | #define APP VERSION BUILD (0U)                   |
| 35 |  |
| 36 | #endif   |
| 37 |  |

Figure 7-16 Firmware initial version definition



3. Open Section Viewer by selecting [Project]  $\rightarrow$  [Properties]  $\rightarrow$  [C / C ++ Build]  $\rightarrow$  [Settings]  $\rightarrow$  [Tool Settings] tab  $\rightarrow$  [Linker]  $\rightarrow$  [Section]  $\rightarrow$  [...] and change section of aws\_demos as following picture.

| Address         Section Na           0x00000004         SU           SI         R           R_1         R_2           R         R           RPFRAM         B_RX_DESC_1           B_TX_DESC_1         B_TX_DESC_1           B_1         B_2           B_8         R           R/FRAM2         Add Section           New Overlay         Remove Section           0x00100000         C_BOOTLO           0x00100000         C_PKCS11           0x00100000         C_PKCS11           0x00100000         C_PKCS11           0x0FFF003000         C_1           C_2         C           C         C           0xFFFF003000         C_1           P*         C           0xFFFFEFF80         EXCEPTVECT           0xFFFEFF80         EXCEPTVECT           0xFFFFEFFFE         RESETVECT | Section Viewer |             |                |
|---|----------------|-------------|----------------|
| 0x0000004         SU           SI         R_1           R_2         R           R         R           B_RX_DESC_1         B_TX_DESC_1           B_TX_DESC_1         B           B_1         B_2           Add Section         New Overlay           RPFRAM2         Remove Section           0x00100000         C_BOOTLO           0x00100000         C_BOOTLO           0x00100000         C_PKCS11           C_2         Move Up           0x00100000         C_1           C_2         Export           C         S*           D*         W*           L         P*           C_8         C           0xFFFEFF80         EXCEPTVECT  | Address        | Section Na  |                |
| SI         R_1           R_2         R           RPFRAM         B_RX_DESC_1           B_TX_DESC_1         B_TX_DESC_1           B_1         B_2           B_8         Remove Section           0x00100000         C_BOOTLO           0x00100000         C_PKCS11           C_2         C           C         C           C         C           C         C           D*         W*           L         P*           C_8         EXCEPTVECT           0xFFFEFF80         EXCEPTVECT  | 0x00000004     | SU          |                |
| R_1         R_2         R         RPFRAM         B_RX_DESC_1         B_TX_DESC_1         B_1         B_2         B_8         R_8         RPFRAM2         0x00100000         C_BOOTLO         0x00100000         C_SYSTEM         0xFFF00300         C_1         C_2         C         C\$*         D*         W*         L         P*         C_8         0xFFFEFF80       EXCEPTVECT         0xFFFEFFFC  |                | SI          |                |
| R_2         R         RPFRAM         B_RX_DESC_1         B_TX_DESC_1         B_TX_DESC_1         B_1         B_2         Add Section         Remove Section         0x00100000         C_BOOTLO         0x00100000         C_SYSTEM         0xFFF00300         C_1         C_2         C         C\$*         D*         W*         L         P*         C_8         0xFFFEFF80         EXCEPTVECT         0xFFFEFFEC   |                | R_1         |                |
| R           RPFRAM           B_RX_DESC_1           B_TX_DESC_1           B_TX_DESC_1           B_TX_DESC_1           B_1           B_2           B_8           R_8           RPFRAM2           0x00100000           C_BOOTLO           0x00100800           C_PKCS11           C_SYSTEM           0xFFF00300           C_1           C_2           C           C\$*           D*           W*           L           P*           C_8           0xFFFEFF80           EXCEPTVECT           0xFFFEFFFC   |                | R_2         |                |
| RPFRAM         B_RX_DESC_1         B_TX_DESC_1         B_1         B_2         Add Section         B_8         R_8         RPFRAM2         0x00100000         C_BOOTLO         0x00100800         C_PKCS11         C_SYSTEM         0xFFF00300         C_1         C_2         C         C\$*         D*         W*         L         P*         C_8         0xFFFEFF80         EXCEPTVECT         0xFFFEFFC  |                | R           |                |
| B_RX_DESC_1         B_TX_DESC_1         B_IX_DESC_1         B_IX_DESC_1         B_IX_DESC_1         B_IX_DESC_1         B_IX_DESC_1         B_IX_IDESC_1         Add Section         New Overlay         Remove Section         Ox00100000         C_INCONNON         C_INT_INT   |                | RPFRAM      |                |
| B         B           B_1         B_2           B_8         Rest           R_8         New Overlay           RPFRAM2         Remove Section           0x00100000         C_BOOTLO           0x00100800         C_PKCS11           C_SYSTEM         Move Up           0xFFF00300         C_1           C_2         Export           C         C\$*           D*         W*           L         P*           C_8         0xFFFEFF80           0xFFFEFF60         EXCEPTVECT           0xFFFEFFFC         RESETVECT  |                | B_KX_DESC_1 |                |
| B_1         B_2         B_8         R_8         RPFRAM2         0x00100000         C_BOOTLO         0x00100800         C_PKCS11         C_SYSTEM         0xFFF00300         C_1         C_2         C         C_2         C         C\$*         D*         W*         L         P*         C_8         0xFFFEFF80         EXCEPTVECT         0xFFFEFFFC  |                | B_TA_DESC_T |                |
| B_2       Add Section         B_8       Remove Section         0x00100000       C_BOOTLO         0x00100800       C_PKCS11         C_SYSTEM       Move Up         0xFFF00300       C_1         C_2       Export         C       C*         D*       W*         L       P*         C_8       EXCEPTVECT         0xFFFEFF80       EXCEPTVECT  |                | B 1         |                |
| B_8     Add Section       R_8     New Overlay       RPFRAM2     Remove Section       0x00100000     C_BOOTLO     Move Up       0x00100800     C_PKCS11     Move Down       C_SYSTEM     Import       0xFFF00300     C_1     Export       C_2     Export       C     C       S*     D*       W*     L       P*     C_8       0xFFFEFF80     EXCEPTVECT       0xFFFEFFF0     RESETVECT  |                | B_2         |                |
| R_8     New Overlay       RPFRAM2     Remove Section       0x00100000     C_BOOTLO     Move Up       0x00100800     C_PKCS11     Move Down       C_SYSTEM     Import       0xFFF00300     C_1       C_2     Export       C     C\$*       D*     W*       L     P*       C_8     CxFFFEFF80       0xFFFEFF80     EXCEPTVECT       0xFFFEFFFC     RESETVECT  |                | B_8         | Add Section    |
| RPFRAM2         Remove Section           0x00100000         C_BOOTLO         Move Up           0x00100800         C_PKCS11         Move Down           C_SYSTEM         Import         Import           0xFFF00300         C_1         Export           C_2         C         Export           C\$*         D*         W*           L         P*         C_8           0xFFFEFF80         EXCEPTVECT         EXEPTVECT  |                | R_8         | New Overlay    |
| 0x00100000         C_BOOTLO         Move Up           0x00100800         C_PKCS11         Move Down           C_SYSTEM         Import         Import           0xFFF00300         C_1         Export           C_2         C         C           C\$*         D*         W*           L         P*         C_8           0xFFFEFF80         EXCEPTVECT         0xFFFEFF80   |                | RPFRAM2     | Remove Section |
| Ox00100800         C_PKCST1         Move Down           0xFFF00300         C_1         Import           C_2         Export         Export           C         C\$*         D*           W*         L         P*           C_8         OxFFFEFF80         EXCEPTVECT           0xFFFEFFF0         RESETVECT  | 0x00100000     | C_BOOTLO    | Move Up        |
| OxFFF00300         C_1         Import           C_2         Export         Export           C\$*         D*         W*           L         P*         C_8           OxFFFEFF80         EXCEPTVECT         EXCEPTVECT           OxFFFEFFFC         RESETVECT         EXCEPTVECT  | 0x00100800     | C_PKCSTI    | Move Down      |
| C_2<br>C_2<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C<br>C   | 0xFFF00300     | C 1         | Import         |
| C<br>C\$*<br>D*<br>W*<br>L<br>P*<br>C_8<br>0xFFFEFF80 EXCEPTVECT<br>0xFFFEFFFC RESETVECT  |                | C_2         | Export         |
| C\$*<br>D*<br>W*<br>L<br>P*<br>C_8<br>0xFFFEFF80 EXCEPTVECT<br>0xFFFEFFFC RESETVECT   |                | с           |                |
| D*<br>W*<br>L<br>P*<br>C_8<br>0xFFFEFF80 EXCEPTVECT<br>0xFFFEFFFC RESETVECT   |                | C\$*        |                |
| W*           L           P*           C_8           0xFFFEFF80         EXCEPTVECT           0xFFFEFFFC         RESETVECT  |                | D*          |                |
| L<br>P*<br>C_8<br>0xFFFEFF80 EXCEPTVECT<br>0xFFFEFFFC RESETVECT   |                | W*          |                |
| P*<br>C_8<br>0xFFFEFF80 EXCEPTVECT<br>0xFFFEFFFC RESETVECT  |                | L           |                |
| 0xFFFEFF80 EXCEPTVECT<br>0xFFFEFFFC RESETVECT   |                | P*          |                |
| 0xFFFEFFFC RESETVECT  | OvEFFFFF80     |             |                |
|   | 0xFFFEFFFC     | RESETVECT   |                |
|   | Override Lin   | nker Script | Browse         |
| Override Linker Script  |                |             | DIOWSE         |
| Override Linker Script Browse   |                | Re-Apply    |                |
| Override Linker Script<br>Browse<br>Re-Apply  |                |             | ou c 1         |

Figure 7-17 Section Settings

4. Build to create aws\_demos.mot file.



 ${\small 5. Create userprog.mot from Renesas Secure Flash Programmer.}$ 

userprog.mot is a combination of aws\_demos.mot and boot\_loader.mot. Users can flash this file to RX671 PoC to install initial firmware.

Download Renesas Secure Flash Programmer release 1.0.1 and open Renesas Secure Flash Programmer.exe. Also downloads other files.

- -Select [Initial Firm] tab and then set parameters as following picture.
- Private Key Path : location to secp256r1.privatekey
- Boot Loader File Path : location to boot\_loader.mot (¥projects¥renesas¥rx671-rsk¥e2studio¥boot\_loader¥HardwareDebug)
- Bank 0 User Program File Path : location to aws\_demos.mot (¥projects¥renesas¥rx671-rsk¥e2studio¥aws\_demos¥HardwareDebug)

—Select [Generate] to generate userprog.mot and save it in the init\_firmware folder. Check Generate succeeded is displayed.

| Select MCU                                | RX671(ROM 2MB)/Secure Bootloader=64KB $\checkmark$   |        |
|---|--|--------|
| Select Firmware Verification Type         | sig-sha256-ecdsa 🗸 🗸                                 |        |
| AES MAC Key (16 byte hex / 32 characters) |  |        |
| Private Key Path (PEM Format)             | C.¥tmp¥secp258r1privatekey                           | Browse |
| Select Output Format                      | Bank0 User Program + Boot Loader (Motorola S Format) | ~      |
| Boot Loader                               |  |        |
| File Path (Motorola Format)               | C:¥tmp¥boot_loader_64KB.mot                          | Browse |
| Bank0 User Program                        |  |        |
| Firmware Sequence Number                  |  | _      |
| File Path (Motorola Format)               | C.¥tmp¥aws_demos.mot                                 | Browse |
| Bank1 User Program ( Option )             |  |        |
| Firmware Sequence Number                  | (1 - 4294967295)                                     |        |
| File Path (Motorola Format)               |  | Browse |

Figure 7-18 Generate userprog.mot



6. Erase the flash ROM of the RX671 PoC.

- —Download the latest version of Renesas Flash Programmer below. https://www.renesas.com/rfp
- —Open the following project in Renesas Flash Programmer. ¥vendors¥renesas¥rx\_mcu\_boards¥boards¥rx671-rsk¥aws\_demos¥flash\_project ¥erase\_from\_bank¥erase.rpj
- -Select [Operation] tab and click [Start] to erase the flash ROM.

| 要修正   |                           |
|---|---------------------------|
| 🕻 Renesas Flash Programmer V3.10.00   |                           |
| ファイル(E) ターゲットデバイス( <u>D</u> ) ヘルプ( <u>H</u> )   |                           |
| 操作 操作設定 ブロック設定 接続設定 ユニークコード   |                           |
| プロジェクト情報<br>現在のプロジェクト: eraserpj<br>マイクロコントローラ: RX Group   | エンディアン( <u>E</u> ): リトル 〜 |
| プログラムファイル   |                           |
|   | 参照( <u>B</u> )            |
| スタート( <u>S</u> )  | 正常終了                      |
| 通信速度:1500000bps<br>ターゲットデバイスを設定します。<br>選択されたブロックを消去します。<br>[Data Flash 1] 0x00100000 - 0x00101FFF サイズ:8 K<br>[Code Flash 1] 0xFFE00000 - 0xFFFFFFFF サイズ:2.0 M | ŕ                         |
| ッニットがらがあります。<br>操作が成功しました。  |                           |
|   |                           |

Figure 7-19 Flash ROM erase



7. Write initial firmware on RX671 PoC.

- -Create a new project with Renesas Flash Programmer (Ex : flash\_project.rpj)
- —Select [Operation] tab and set userprog.mot stored in the init\_firmware folder of the Program File.
- -Click [Start].

| 要修正  |
|--|
| 🌌 Renesas Flash Programmer V3.05.00 (Free-of-charge Edition) — 🛛 🔅 🗙   |
| File Device Information Help   |
| Operation Operation Settings Block Settings Connect Settings Unique Code   |
| Project Information<br>Current Project flach projectrpj<br>Microcontroller: RX Group Endian Little ✓<br>Program File<br>D-¥Temp¥projects¥renesas¥rx65n-rsk¥e2studio¥init¥userprog.mot<br>CRO-32 : SEE7F851   |
| Flash Operation  |
| Erase >> Program >> Verify Start OK  |
| [Config Area] 0xFE7F5D00 - 0xFE7F5D2F       size: 48         [Config Area] 0xFE7F5D40 - 0xFE7F5D7F       size: 64         Verifying data       [Config Area] 0xFE7F5D40 - 0xFE7F5D2F         [Config Area] 0xFE7F5D40 - 0xFE7F5D7F       size: 64         [Config Area] 0xFE7F5D40 - 0xFE7F5D7F       size: 64         Disconnecting the tool       Operation completed. |
| Clear status and message   |
|  |

Figure 7-20 Writing initial firmware



### 8. Open Tera Term

The Tera Term setup is shown below.

|  | 女修正  |  |     |  |
|--|--|--|-----|--|
| 💆 COM11 - Tera Term VT   |  |  | — [ |  |
| File Edit Setup C Tera Term: Serial p  | port setup and connection  |  | ×   |  |
| Port:  | COM11 ~  | New setting                            |     |  |
| Speed:   | 115200 ~   |  |     |  |
| Data:  | 8 bit 🗸 🗸  | Cancel                                 |     |  |
| Parity:  | none 🗸   |  |     |  |
| Stop bits:   | 1 bit 🛛 🗸  | Help                                   |     |  |
| Flow control:  | none 🗸   |  |     |  |
| Device Friend  | ansmit delay<br>0 msec/char 0<br>Iv Name: USB シリアル デパイス  | msec/line                              | ~   |  |
| Device Instan<br>Device Manu<br>Provider Nam<br>Driver Date: 6<br>Driver Version | ce ID: USB¥VID_045B&PID_81<br>facturer: Microsoft<br>he: Microsoft<br>-21-2006<br>h: 10.0.19041.1202 | 11¥00000000000000000000000000000000000 |     |  |
| <  |  | >                                      | ×   |  |
|  |  |  | ]   |  |

Figure 7-21 Tera Term

Version 0.90 (initial version) is installed in RX671 PoC. RX671 PoC is now ready to receive OTA updates. The output log is shown below.a

```
_____
RX671 secure boot program
_____
Checking data flash ROM status.
Loading user code signer public key: not found.
provision the user code signer public key: OK.
Checking code flash ROM status.
bank 0 status = 0xfc [LIFECYCLE_STATE_INITIAL_FIRM_INSTALLED]
bank 1 status = 0xff [LIFECYCLE_STATE_BLANK]
bank info = 1. (start bank = 0)
started 10us software timer using CMT channel 0.
integrity check scheme = sig-sha256-ecdsa
bank0(execute area) on code flash integrity check...OK
erase bank1 secure boot mirror area...OK
OK
copy secure boot (part2) from bank0 to bank1...OK
jump to user program
0 83 [Tmr Svc] [DEBUG] [PKCS11] [core pkcs11 mbedtls.c:449] 1 83 [Tmr Svc] PKCS #11
module was successfully initialized.2 83 [Tmr Svc]
3 83 [Tmr Svc] [INFO] [PKCS11] [core_pkcs11_mbedtls.c:1504] 4 83 [Tmr Svc] PKCS #11
successfully initialized.5 83 [Tmr Svc]
6 83 [Tmr Svc] [DEBUG] [PKCS11] [core_pkcs11_mbedtls.c:1717] 7 83 [Tmr Svc] Successfully
Returned a PKCS #11 slot with ID 1 with a count of 1.8 83 [Tmr Svc]
9 83 [Tmr Svc] [WARN] [PKCS11] [core_pkcs11_mbedtls.c:1749] 10 83 [Tmr Svc]
C_GetTokenInfo is not implemented.11 83 [Tmr Svc]
12 83 [Tmr Svc] [WARN] [PKCS11] [core pkcs11 mbedtls.c:1839] 13 83 [Tmr Svc] C InitToken
is not implemented.14 83 [Tmr Svc]
70 373 [Tmr Svc] [DEBUG] [PKCS11] [core pkcs11 mbedtls.c:471] 71 373 [Tmr Svc]
Successfully found object class attribute.72 373 [Tmr Svc]
```



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73 373 [Tmr Svc] [INFO] [PKCS11] [core pkcs11 mbedtls.c:2638] 74 373 [Tmr Svc] Creating a 0x3 type object.75 373 [Tmr Svc] 76 373 [Tmr Svc] [DEBUG] [PKCS11] [core\_pkcs11\_mbedtls.c:2158] 77 373 [Tmr Svc] Successfully found the key type in the template.78 374 [Tmr Svc] 79 374 [Tmr Svc] [DEBUG] [PKCS11] [core\_pkcs11\_mbedtls.c:2187] 80 374 [Tmr Svc] Successfully found the label in the template.81 374 [Tmr Svc] 82 374 [Tmr Svc] [DEBUG] [PKCS11] [core pkcs11 mbedtls.c:1243] 83 374 [Tmr Svc] Key was private type.84 374 [Tmr Svc] 91 660 [Tmr Svc] [INFO] [PKCS11] [core\_pkcs11\_mbedtls.c:2033] 92 660 [Tmr Svc] Successfully closed PKCS #11 session.93 660 [Tmr Svc] 94 663 [iot\_thread] [INFO ][DEMO][663] -----STARTING DEMO------95 663 [iot thread] [INFO ][INIT][663] SDK successfully initialized. 96 107527 [iot\_thread] [INFO ][DEMO][107527] Successfully initialized the demo. Network type for the demo: 1 97 107527 [iot thread] [INFO ][MQTT][107527] MQTT library successfully initialized. 98 107527 [iot\_thread] [INFO ][DEMO][107527] OTA demo version 0.9.0 99 107527 [iot thread] [INFO ][DEMO][107527] Connecting to broker... 100 107527 [iot thread] [INFO ][DEMO][107527] MQTT demo client identifier is rx671 POC (length 9). 101 109439 [iot thread] [WARN] [PKCS11] [core pkcs11 mbedtls.c:1499] 102 109439 [iot thread] Failed to initialize PKCS #11. PKCS #11 was already initialized.103 109439 [iot\_thread] 104 109439 [iot thread] [DEBUG] [PKCS11] [core pkcs11 mbedtls.c:1717] 105 109439 [iot thread] Successfully Returned a PKCS #11 slot with ID 1 with a count of 1.106 109439 [iot thread] 107 109439 [iot thread] [DEBUG] [PKCS11] [core pkcs11 mbedtls.c:1953] 108 109439 [iot\_thread] Assigned a 0x2 Type Session.109 109439 [iot\_thread] 110 109439 [iot thread] [DEBUG] [PKCS11] [core\_pkcs11\_mbedtls.c:1964] 111 109439 [iot\_thread] Assigned Mechanisms to no operation in progress.112 109439 [iot\_thread] 113 109439 [iot\_thread] [DEBUG] [PKCS11] [core\_pkcs11\_mbedtls.c:1980] 114 109439 [iot thread] Current session count at 0115 109439 [iot thread] 167 111156 [iot\_thread] [DEBUG] [PKCS11] [core\_pkcs11\_mbedtls.c:1073] 168 111156 [iot\_thread] Found object in list by handle.169 111156 [iot\_thread] 170 111156 [iot thread] [DEBUG] [PKCS11] [core pkcs11 mbedtls.c:3780] 171 111157 [iot thread] Successfully started sign operation.172 111157 [iot thread] 173 112138 [iot\_thread] [DEBUG] [PKCS11] [core\_pkcs11\_mbedtls.c:3966] 174 112138 [iot thread] Ended Sign operation.175 112138 [iot thread] 176 112223 [iot\_thread] [INFO ][MQTT][112223] Establishing new MQTT connection. 177 112223 [iot\_thread] [INFO ][MQTT][112223] (MQTT connection 23f18, CONNECT operation 240b8) Waiting for operation completion. 178 112351 [NetRecv] [INFO] [MQTT] [core\_mqtt\_serializer.c:970] 179 112351 [NetRecv] CONNACK session present bit not set.180 112351 [NetRecv] 181 112351 [NetRecv] [INFO] [MQTT] [core mqtt serializer.c:912] 182 112351 [NetRecv] Connection accepted.183 112351 [NetRecv] no 184 112351 [iot thread] [INFO ][MQTT][112351] (MQTT connection 23f18, CONNECT operation 240b8) Wait complete with result SUCCESS. 185 112351 [iot thread] [INFO ][MQTT][112351] New MQTT connection 6a54 established. 186 112353 [iot thread] [OTA AgentInit internal] OTA Task is Ready. 187 112353 [OTA Agent T] [prvPAL\_GetPlatformImageState] is called. 188 112353 [OTA Agent T] Function call: prvPAL GetPlatformImageState: [2] 189 112353 [OTA Agent T] [prvExecuteHandler] Called handler. Current State [Ready] Event [Start] New state [RequestingJob] 190 112358 [OTA Agent T] [INFO ] [MQTT] [112358] (MQTT connection 23f18) SUBSCRIBE operation scheduled. 191 112358 [OTA Agent T] [INFO ][MQTT][112358] (MQTT connection 23f18, SUBSCRIBE operation 2a960) Waiting for operation completion. 192 112473 [OTA Agent T] [INFO ] [MQTT] [112473] (MQTT connection 23f18, SUBSCRIBE operation 2a960) Wait complete with result SUCCESS. 193 112473 [OTA Agent T] [prvSubscribeToJobNotificationTopics] OK: \$aws/things/rx671\_POC/jobs/\$next/get/accepted 194 112478 [OTA Agent T] [INFO ][MQTT][112478] (MQTT connection 23f18) SUBSCRIBE operation scheduled. 195 112478 [OTA Agent T] [INFO ] [MQTT] [112478] (MQTT connection 23f18, SUBSCRIBE operation 241f8) Waiting for operation completion.



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196 112585 [OTA Agent T] [INFO ] [MQTT] [112585] (MQTT connection 23f18, SUBSCRIBE operation 241f8) Wait complete with result SUCCESS. 197 112585 [OTA Agent T] [prvSubscribeToJobNotificationTopics] OK: \$aws/things/rx671 POC/jobs/notify-next 198 112585 [OTA Agent T] [prvRequestJob Mqtt] Request #0 199 112594 [OTA Agent T] [INFO ][MQTT][112594] (MQTT connection 23f18) MQTT PUBLISH operation queued. 200 112594 [OTA Agent T] [INFO ][MQTT][112594] (MQTT connection 23f18, PUBLISH operation 241f8) Waiting for operation completion. 201 112670 [OTA Agent T] [INFO ][MQTT][112670] (MQTT connection 23f18, PUBLISH operation 241f8) Wait complete with result SUCCESS. 202 112670 [OTA Agent T] [prvExecuteHandler] Called handler. Current State [RequestingJob] Event [RequestJobDocument] New state [WaitingForJob] 203 112672 [OTA Agent T] [prvParseJSONbyModel] Extracted parameter [ clientToken: 0:rx671 POC ] 204 112672 [OTA Agent T] [prvParseJSONbyModel] Extracted parameter [ timestamp: 1662611090 ] 205 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: execution 206 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: jobId 207 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: jobDocument 208 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: afr\_ota 209 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: protocols 210 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: files 211 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: filepath 212 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: filesize 213 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: fileid 214 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: certfile 215 112672 [OTA Agent T] [prvParseJSONbyModel] parameter not present: sig-sha256-ecdsa 216 112672 [OTA Agent T] [prvParseJobDoc] No active jobs available in the service for execution. 217 112674 [OTA Agent T] [prvParseJobDoc] Ignoring job without ID. 222 113353 [iot thread] [INFO ][DEMO][113353] State: Ready Received: 1 Queued: 0 Processed: 0 Dropped: 0 223 114353 [iot\_thread] [INFO ][DEMO][114353] State: WaitingForJob Received: 1 Queued: Processed: 0 Dropped: 0 0 224 115353 [iot thread] [INFO ][DEMO][115353] State: WaitingForJob Received: 1 Queued: 0 Processed:  $\overline{0}$ Dropped: 0 225 116353 [iot thread] [INFO ][DEMO][116353] State: WaitingForJob Received: 1 Queued: Processed: 0 Dropped: 0 226 117353 [iot\_thread] [INFO ][DEMO][117353] State: WaitingForJob Received: 1 Queued: Processed: 0 0 Dropped: 0 227 118353 [iot thread] [INFO ][DEMO][118353] State: WaitingForJob Received: 1 Queued: Processed: 0 Dropped: 0



## 8. Restriction

This section describes restriction for this application note.

• FreeRTOS OTA programs with big endian operate abnormally. Build and operate programs with little endian.



## 9. Reference Documents

- RX671Group User's Manual: Hardware (R01UH0905)
- Renesas Starter Kit+ for RX671User's Manual (R20UT4879)
- RX Family Using QE and FIT to Develop Capacitive Touch Applications (R01AN4516)
- RX Family QE for Display GUI Display Application Development Guide using Serial Connection LCD (R20AN0688)
- Renesas MCU Firmware Update Design Policy (R01AN5548)
- How to implement FreeRTOS OTA by using Amazon Web Serviceson RX65N (R01AN5549)

The latest version can be downloaded from the Renesas Electronics website.

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# **Revision History**

|      |           | Description |               |
|------|-----------|-------------|---------------|
| Rev. | Date      | Page        | Summary       |
| 1.00 | Apr.24.23 | -           | First edition |
|      |           |             |               |



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

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

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

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

### 2. Processing at power-on

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

3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

4. Handling of unused pins

Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.

5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.

### 6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between  $V_{IL}$  (Max.) and  $V_{IH}$  (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between  $V_{IL}$  (Max.) and  $V_{IH}$  (Min.)

7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a systemevaluation test for the given product.

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(Rev.5.0-1 October 2020)

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