QC-BEKITPOCZ

Setting Up an AWS MQTT Server with the QuickConnect Beginners Kit

This document describes the setup process and application of the QuickConnect (QC) Beginners Kit, QC-BEKITPOCZ. With the QC Beginners Kit, users can establish an IoT solution easily and quickly with a variety of sensors.

This guide highlights the publishing of various sensor information to an AWS MQTT server using the QC Beginners Kit, while a MQTT client obtains all this information by subscribing a specific topic.

Important: To ensure the QC Beginners Kit is set up correctly, complete the steps in the order listed in “Quick Start Procedure”.

The following are target devices:

- QC Beginners Kit (MCU Board): R7FA6E2BB3CFM
- Ultra-Low Power Wi-Fi + Bluetooth® Low Energy Combo Modules: DA16600MOD
- Relative Humidity and Temperature Sensor: HS4001
- Indoor Air Quality (IAQ) Sensor: ZMOD4410
- Outdoor Air Quality (OAQ) Sensor: ZMOD4510
- Multi-Mode Microphone with I2S Digital Output: ICS-43434

Contents

1. Kit Information

1.1 Kit Contents

To set up this demo, hardware and software components are required, and they are listed in sections 1.1.1 and 1.1.2.

1.1.1. Hardware Components

- RA6E2 – A chip with serial communications interface (SCI), serial sound interface enhanced (SSIE), general PWM timer, interrupt controller unit (ICU), and data transfer controller (DTC).
- DA16600PMOD – A single module integrating a low power Bluetooth LE DA14531 for network connecting configuration, and a low power Wi-Fi DA16200 for network connection.
- HS4001 – A highly accurate, ultra-low power, and fully-calibrated relative humidity and temperature sensor.
- ZMOD4410 – A firmware configurable indoor air quality (IAQ) sensor with embedded artificial intelligence (AI).
- ZMOD4510 – A firmware configurable outdoor air quality (OAQ) sensor with embedded artificial intelligence (AI).
- ICS-43434 – A digital I2S output bottom port microphone with multiple modes of operation.
- USB cable

1.1.2. Software Components

Category		Item	Remark
MCU	QC_Beginners_Kit.mot	Firmware	Must be downloaded to RA6E2 MCU.
	SEGGER J-Link V7.90g	Software	A flash programmer for downloading firmware to MCU.
DA16600 module	da16600_da14531_1_download.ttl	Image	Must be downloaded to DA16600.
	Tera Term	Software	A tool to program the firmware to DA16200MOD.
Mobile App	Renesas Wi-Fi Provisioning for iOS or Android	iOS or Android application	An app used to configurate an available router for the DA16600 network connection.
PC App	MQTT.fx-1.7.1	MQTT desktop client software	A tool to subscribe information from the QC Beginners Kit board.
AWS certification	QC Beginner certification.zip	Self-signed certification files	Files required for self-signed certificates when creating a profile in MQTT.fx.

1.1.3. Kit Features

- The QC Beginners Kit supports two operation modes:
  - The Sensor mode that is used for sampling sensor data.
  - The Voice Recognition mode that is used for identifying a 1k Hertz voice.
- All the information sampled by the various sensors is published to the AWS MQTT server by the Wi-Fi chip, while the data can be monitored on MQTT client by subscribing a specific topic.
- The router used for the network connection can be configured with a mobile phone application.

1.1.4. Kit Operation Image

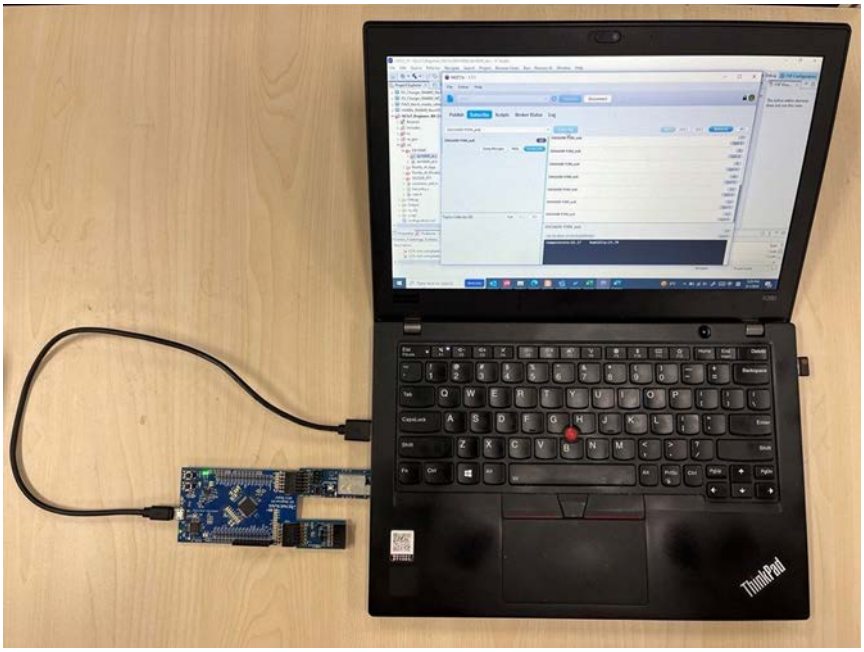


Figure 1. QC-BEKITPOCZ Operation Image

1.2 Kit Demo Preparation

1.2.1. Install the iOS / Android App

Use the Renesas Electronics WiFiProvisioning mobile app for iOS and Android to configure the DA16600 and DA16600 Wi-Fi profile information.

Install the Renesas WiFiProvisioning app on the Apple App Store or Google Play Store using the keyword “WiFiProvisioning”.

For customers in countries or areas that Google Play Store is not available, an Android app named RenesasWiFiProvisioning_app_v2.4.0.apk is supplied in a zip folder. Install this app for the Android system.

For detailed information on Wi-Fi Provisioning, refer to the DA16200 DA16600 Provisioning Mobile App on the Renesas website.

Figure 2. Renesas WiFiProvisioning in the App Store

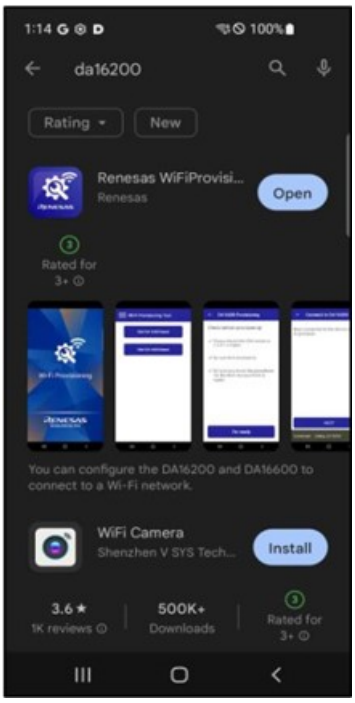


Figure 3. Renesas WiFiProvisioning in the Google Play Store

2. Operation Modes

There are two operation modes in this system, Sensor mode and Voice Recognition mode. The Sensor mode uses sensors (such as temperature, humidity, and indoor or outdoor air quality) to measure environmental data, and it is combined with embedded artificial intelligence to draw the final data. The Voice Recognition mode uses a microphone to collect voice information, and it is combined with Reality AI software to identify a 1k Hertz frequency.

2.1 Sensor Mode

The default hardware and code in QC Beginners Kit is the sensor mode. Sensors include HS4001, ZMOD4410, and ZMOD4510. Any one or two sensors can be used in the system; however, considering that ZMOD4410 is an indoor air sensor while ZMOD4510 is an outdoor air sensor, these two sensors cannot be used at the same time.

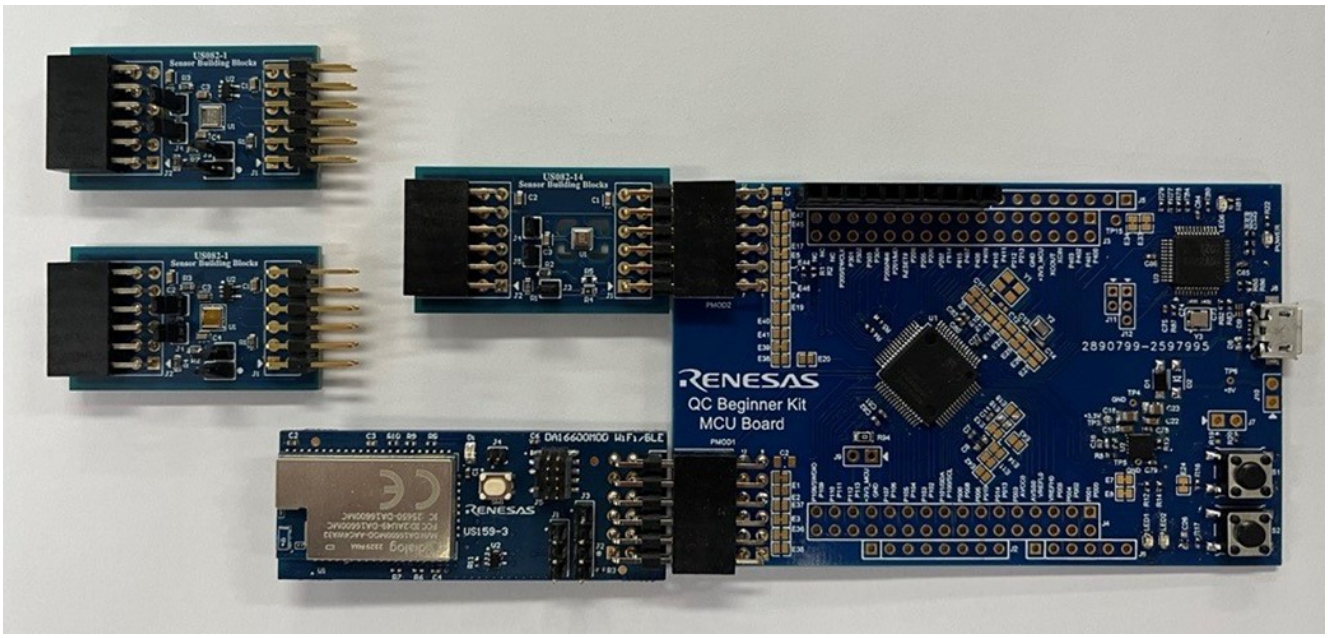


Figure 4. QC Beginner Kit MCU Board – Sensor Mode

2.2 Voice Recognition Mode

The second mode for the QC Beginners Kit is the Voice Recognition mode. Some connection points in the hardware are required to be adjusted for Digital MIC PMOD connection according to the following table.
Note: Points not listed in the table use the default configuration.

Mode	E4	E5	E17	E19	E20	E39
I2S	Open	Open	Closed	Closed	Closed	Open

A microphone on Digital MIC PMOD is used for collecting audio data, and after the software analysis, it identifies the input of 1k Hertz voice.

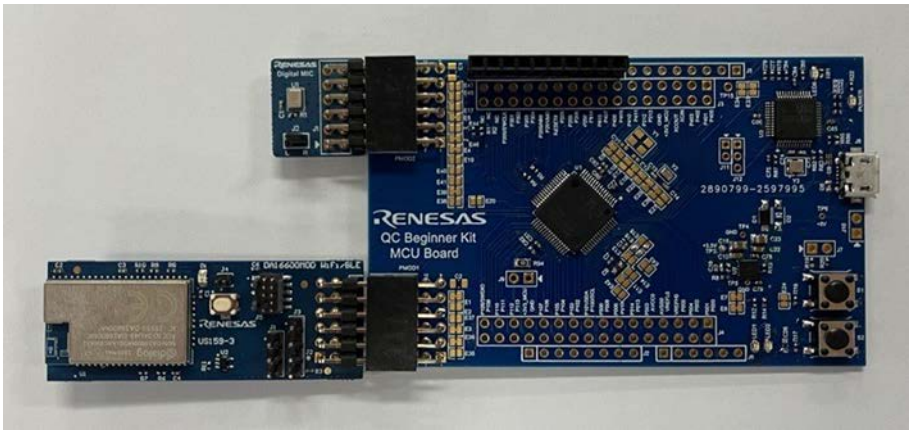


Figure 5. QC Beginner Kit MCU Board – Voice Recognition Mode

In e^2 studio, choose **project** > **src** > **user.h**, and delete the double slash in front of “#define I2S” for voice recognition mode.

For details on the settings and operation of the Voice Recognition mode, refer to reality-digital-micro-RA6E2.docx.

3. Quick Start Procedure

Complete the following quick-start steps in the order listed to operate the kit.

3.1 Power-on QC Beginners Kit

1. Plug either the sensor or microphone PMOD into PMOD2.
2. Plug DA16600 into PMOD1.

A USB cable supplies power. It takes five seconds for the system to boot.

3.2 Mode Recognition

When the board powers on, three statuses are possible. The QC Beginners Kit uses LED1 and LED2 to signal the current status. The three statuses are Waiting for Provisioning, MQTT Connecting, and MQTT Connection Successful.

- **Waiting for Provisioning**
  - When LED1 flickers quickly, it indicates that the kit requires provisioning. This status corresponds to the operation process listed below, the DA16600 Provisioning Stage. In this case, LED2 is off.
  - To provision DA16600, follow the steps in section 3.3.
- **MQTT Connecting**
  - LED1 flickers once every second to signal that the kit is connecting with the MQTT server. Be patient because it takes a few seconds to complete this process. In this case, LED2 is off.
  - No operation is required in this stage.
- **MQTT Connection Successful**
  - After connecting to the MQTT broker, LED1 lights up. LED2 flickers according to the sampling period of each sensor. If HS4001 is used only, LED2 flickers every six seconds. If ZMOD4410 is attached, the flicking period is six seconds. However, If ZMOD4510 is plugged into the PMOD interface, the flicking period changes to four seconds.
    Note: The ZMOD4410 and ZMOD4510 should not be used simultaneously.
  - This status corresponds to the operation process listed below, the MQTT Message Interaction Stage, the sampled data can be observed by any MQTT client, such as MQTT.fx (see section 3.4).

The operation process of the system consists of the following two stages.

- **DA16600 Provisioning Stage**

  The DA16600 must be re-provisioned each time there is a change in the router that connects to the network. Follow the steps in section 3.3 for provisioning DA16600.

- **MQTT Message Interaction Stage**

  After provisioning DA16600, the system connects to the AWS MQTT server, and the data collected from sensors in the system passing through the AWS MQTT server is sent to the MQTT client, which subscribes the topic specified by the QC Beginners Kit. Follow the steps in section 3.4 for data display.

Note: If the system cannot run normally because of any unknown reasons or unstable network connections, restart the system.

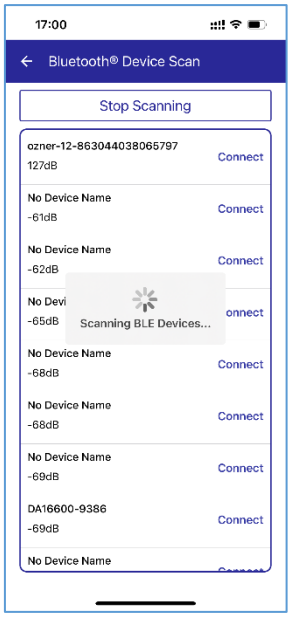
3.3 Provisioning DA16600 on a Mobile Phone

DA16600 supports a provisioning feature called Wi-Fi Provisioning that simplifies network configuration. Follow the provisioning steps with a mobile phone while Bluetooth is activated.

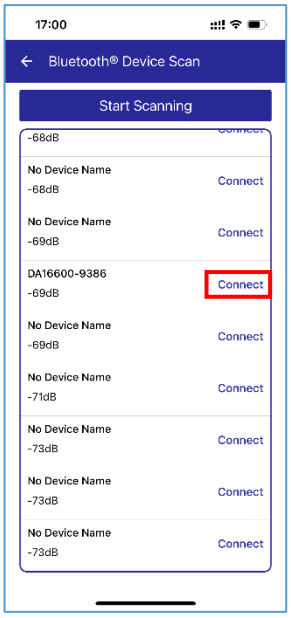
If LED1 on QC Beginners Kit flickers quickly, DA16600 must be provisioned. Start the Renesas Provisioning Tool, find DA16600, and follow the steps below on a mobile phone with the iOS system.

1. Click the **Start DA16600-based** button.

2. Click the **Start** button.

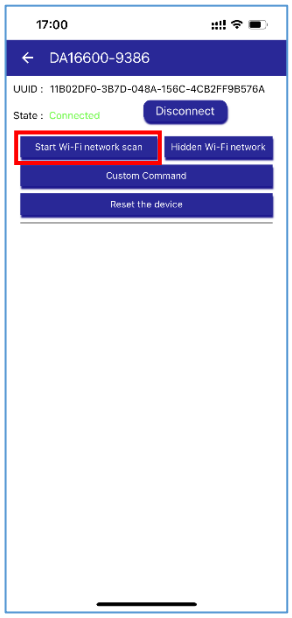


3. The phone scans for Bluetooth devices.

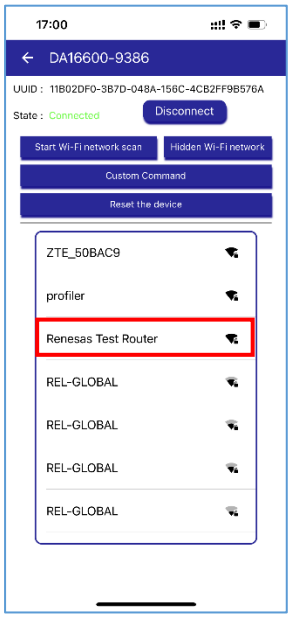


4. Click the **Connect** button to connect to DA16600 Bluetooth Low Energy.
   Note: Remember the name of DA16600-XXXX for later use.

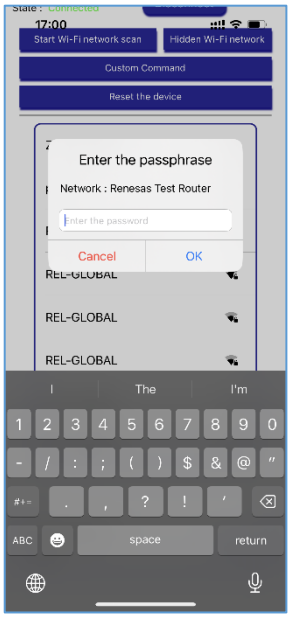
Note: The name of DA16600 is used as the first part of the topic that MQTT client subscribed. Refer to the subscribe part in section 3.4 for topic setting.



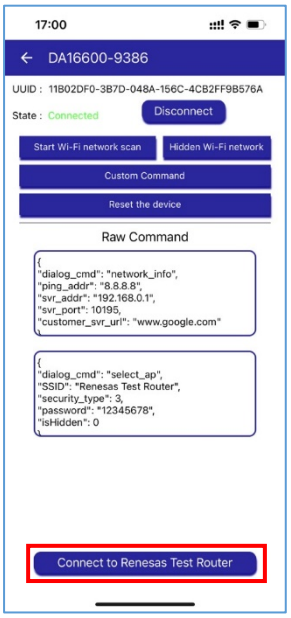
5. When the app connects to the DA16600 Bluetooth Low Energy, click the **Start Wi-Fi network scan** button.



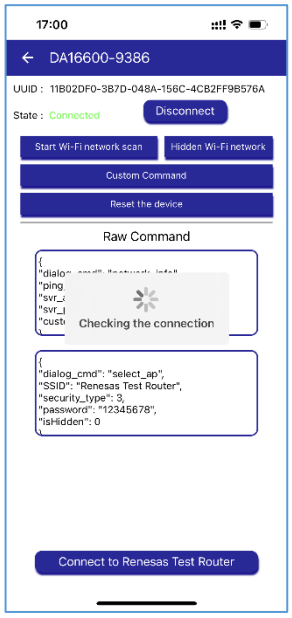
6. The app receives Wi-Fi network information from DA16600, and a list appears.
7. Click the name of the Wi-Fi network in the list.



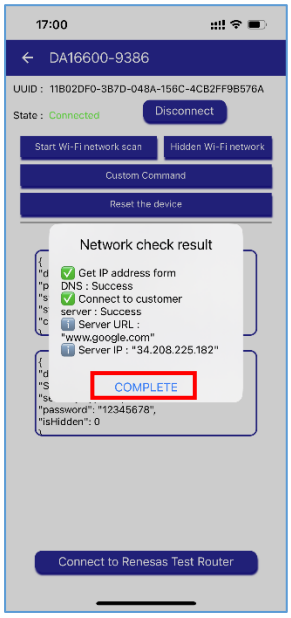
8. Enter the passphrase and click the **OK** button.



9. Click the **Connect to (Wi-Fi network name)** button.



10. DA16600 checks the network.



11. (a) DA16600 Provisioning Stage – The provisioning has ended successfully. Click **COMPLETE** to finish the provisioning.

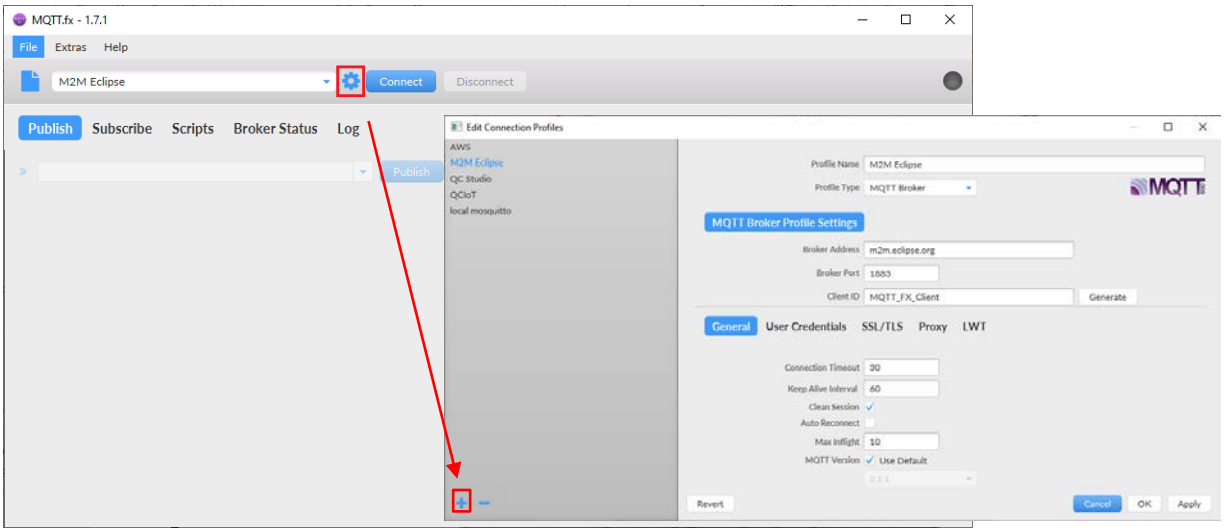
11. (b) MQTT Message Interaction Stage – In some countries or areas, the website connection might appear forbidden, and a notification of failure can appear. Ignore the notification and click the **COMPLETE** button to finish the provisioning. This does not affect the subsequent operations.

For detailed information on installing WI-FI Provisioning, reference the DA16200 DA16600 Provisioning Mobile App on the Renesas website.

3.4 Provisioning the MQTT Desktop Client

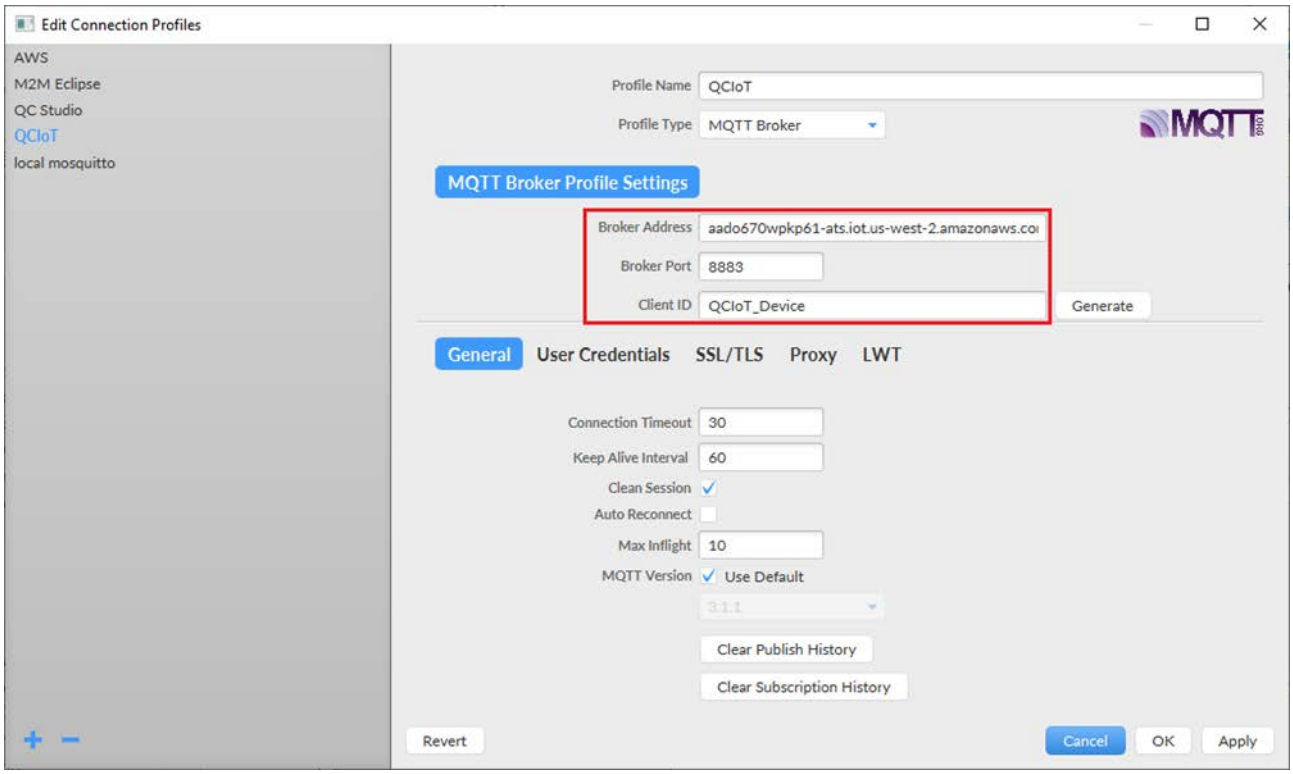
A MQTT desktop client application named MQTT.fx is used to receive message published by QuickConnect Beginners Kit.

1. Install MQTT.fx 1.7.1 and follow the default installation steps (free trial available).
2. Open the MQTT.fx client program. Click the cogwheel icon to open the settings, and click the plus icon, **+**, to create a profile.

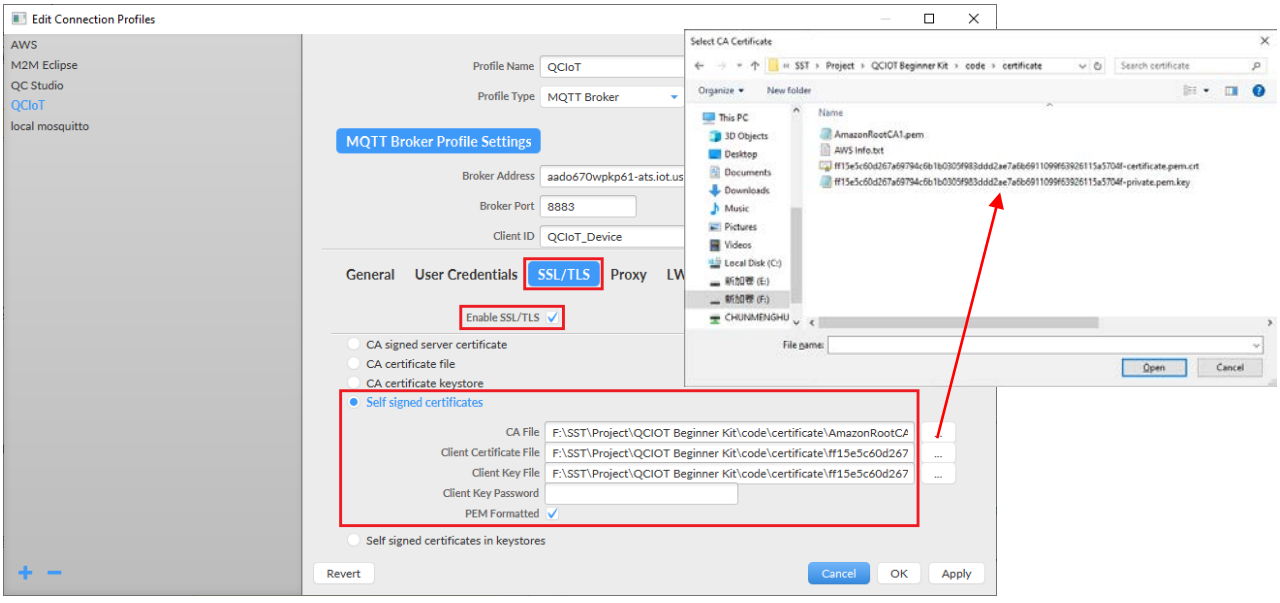


Enter a **Profile Name** (the example uses QCIoT) and complete the connection profile including **Broker Address** (the example uses the AWS IoT endpoint: aado670wpkp61-ats.iot.us-west-2.amazonaws.com), **Broker Port** (the example uses 8883), and **Client ID** (the default name that the system generates is acceptable).

Note: To set the **MQTT Broker Profile Settings**, the **Profile Type** must be MQTT Broker.



3. Use the **SSL/TLS** tab for certificate verification.
   a. Select **Enable SSL/TLS**. Navigate to the location where the **Self signed certificates** option is available. Click on the checkbox to select it. Next, use the browse button **(…)** to import the self-signed certificates from a PC folder.

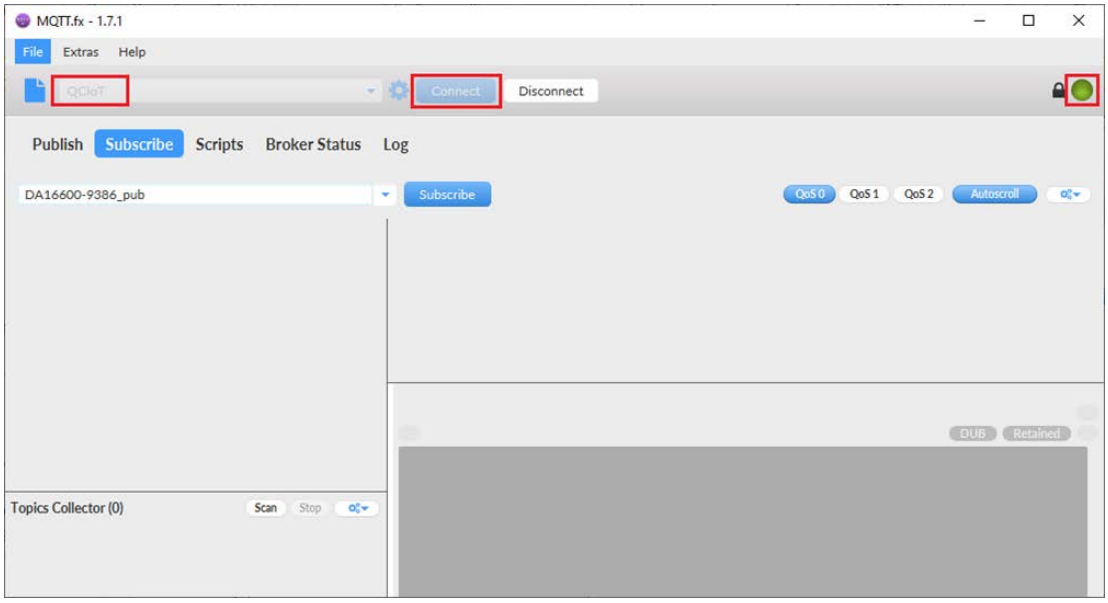


Note the following:

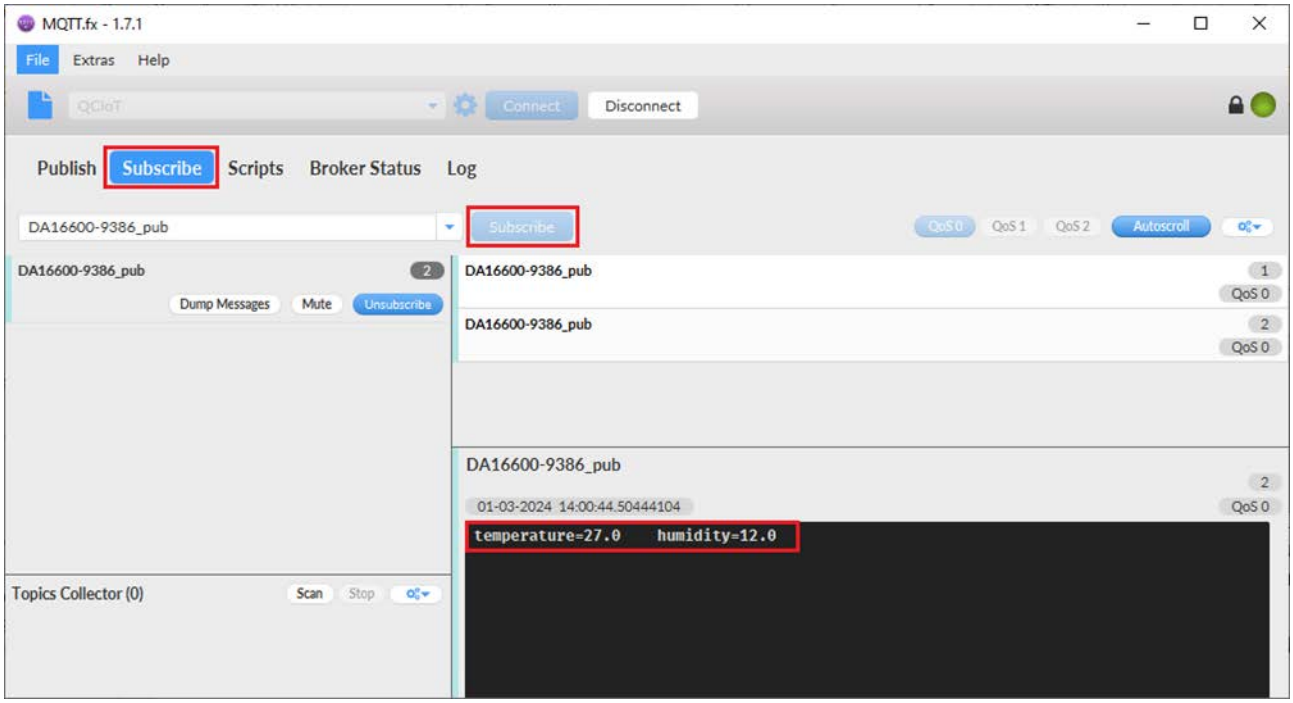
- **CA File** corresponds to AmazonRootCA1.pem.
- **Client Certificate File** corresponds to xxx-certificate.pem.crt.
- **Client Key File** corresponds to xxx-private.pem.key.
- Verify that the **PEM Formatted** box is selected.

4. After completing the previous steps, click **Apply** > **OK** to save.
5. Next, select the name of the file that was created in the profile box. Click **Connect**.

If the round icon in the top-right corner is green, the connection to the AWS MQTT server is successful, and the publishing and subscribing operations can be performed.



6. Select the **Subscribe** tab, enter a topic name, which is recorded in step 4 of section 3.3, plus underline and pub, such as DA16600-9386_pub, and click **Subscribe** to subscribe to the topic. The subscribing result can be queried through window in the bottom-right corner.



3.5 Output Format of Various Sensors

- For HS4001, temperature and humidity values publish to the MQTT server, and the client subscribing to it receives data such as the following:

  - temperature=xx.x humidity=xx.x
- For ZMOD4410, the first 100 data is invalid for applications while counting down from 100, therefore, 300 seconds is required before the sensor stabilizes. After 5 minutes, information on the indoor air quality (IAQ) and total volatile organic compounds (TVOC) outputs.
- For ZMOD4510, the first 900 data is invalid for applications while counting down from 900 to 0, therefore, 1800 seconds is required before the sensor stabilizes. After 30 minutes, information on the ozone concentration and air quality index (AQI) outputs.
- HS4001 can be used with either ZMOD4410 or ZMOD4510, but ZMOD4410 and ZMOD4510 cannot be used together. (Each sensor can also be used independently.) The output adjusts according to the sensors in the system.
- With the microphone, the following can occur for the output of information:
  - If there is not a sound source: **no 1k voice**.
  - When a 1k Hertz audio is close to the microphone: **1k voice**.

Note: Only 1k Hertz sound recognition is supported.

4. Reference Documents

- RA6E2 - Entry-Line 200MHz Arm® Cortex®-M33 General Purpose Microcontroller | Renesas
- DA16600MOD - Ultra-Low Power Wi-Fi + Bluetooth® Low Energy Combo Modules for Battery Powered IoT Devices | Renesas
- HS4001 - Relative Humidity and Temperature Sensor, Digital Output, ±1.5% RH | Renesas
- ZMOD4410 - Firmware Configurable Indoor Air Quality (IAQ) Sensor with Embedded Artificial Intelligence (AI) | Renesas
- ZMOD4510 - Gas Sensor for O3 and NO2 | Renesas

Technical Updates or News

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

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5. Revision History

Revision	Date	Description
1.01	Oct 1, 2024	Updated sections 1.1.2, 1.2.1, 2.1, 3.2, and 3.4.
1.00	Jun 5, 2024	Initial release.

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 reaches the level at which resetting is specified.
3. Input of signal during power-off state
   Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.
4. Handling of unused pins
   Handle unused pins in accordance with the directions given under handling of unused pins in the manual. The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of the LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible.
5. Clock signals
   After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is stabilized. When the clock signal is generated with an external resonator or from an external oscillator during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Additionally, when switching to a clock signal produced with an external resonator or by an external oscillator while program execution is in progress, wait until the target clock signal is stable.
6. Voltage application waveform at input pin
   Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (Max.) and V_{IH} (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (Max.) and V_{IH} (Min.).
7. Prohibition of access to reserved addresses
   Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.
8. Differences between products
   Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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