

## Renesas RA Family

# RA AWS Cloud Connectivity on CK-RA6M5 with Ethernet – Getting Started Guide

## Introduction

This document provides instructions for running AWS cloud connectivity Application Project on CK-RA6M5 using Ethernet interface.

### Applies to:

- RA6M5 MCU Group

## Required Resources

To build and run the MQTT/TLS application example, the following resources are needed.

### Development tools and software

- Flexible Software Package (FSP) v5.0.0 and required tools ([renesas.com/us/en/software-tool/flexible-software-package-fsp](https://renesas.com/us/en/software-tool/flexible-software-package-fsp))

### Hardware

- Renesas CK-RA6M5 kit ([renesas.com/ra/ck-ra6m5](https://renesas.com/ra/ck-ra6m5))
- PC running Windows® 10 and an installed web browser (Google Chrome, Internet Explorer, Microsoft Edge, Mozilla Firefox, or Safari)
- Micro USB cables (included as part of the kit. See *CK-RA6M5 — User's Manual*).
- Ethernet cable
- A router with a least 1 available 100 Mbps/full duplex Ethernet port

## Prerequisites and Intended Audience

This application note assumes that the user is adept at operating the Renesas e<sup>2</sup> studio IDE with Flexible Software Package (FSP). If not, we recommend reading and following the procedures in the *FSP User's Manual* sections for 'Starting Development' including 'Debug the Blinky Project'. Doing so enables familiarization with e<sup>2</sup> studio and FSP and validates proper debug connection to the target board. In addition, this application note assumes prior knowledge of MQTT/TLS and its communication protocols.

The intended audience is users who want to develop applications with MQTT/TLS modules using Ethernet modules on Renesas RA6 MCU Series.

Note: If you are a first-time user of e<sup>2</sup> studio and FSP, we highly recommend you install e<sup>2</sup> studio and FSP on your system to run the Blinky Project and to get familiar with the e<sup>2</sup> studio and FSP development environment before proceeding to the next sections.

Note: This Application Project and Application Note are guaranteed to work only with FSP v5.0.0

### Prerequisites

1. Access to online documentation is available in the Cloud Connectivity References section.
2. Access to latest documentation for identified Renesas Flexible Software Package.
3. Prior knowledge of operating e<sup>2</sup> studio and built-in (or standalone) RA Configurator.
4. Access to associated hardware documentation such as User Manuals, Schematics, and other relevant kit information ([renesas.com/ra/ck-ra6m5](https://renesas.com/ra/ck-ra6m5)).

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## 1. Importing, Building, and Loading the Project

### 1.1 Importing

This project “aws\_ck\_ra6m5\_ethernet\_app” can be imported into the e<sup>2</sup> studio using the instructions provided in the *RA FSP User's Manual*. See section *Starting Development > e2 studio ISDE User Guide > Importing an Existing Project into e<sup>2</sup> studio ISDE*.

### 1.2 Building the Latest Executable Binary

Upon successfully importing and/or modifying the project into e<sup>2</sup> studio IDE, follow the instructions provided in the *RA FSP User's Manual* to build an executable binary/hex/mot/elf file. See Section *Starting Development > e2 studio ISDE User Guide > Tutorial: Your First RA MCU Project > Build the Blinky Project*.

### 1.3 Loading the Executable Binary into the Target MCU

The executable file may be programmed into the target MCU through any one of three means.

#### 1.3.1 Using a Debugging Interface with e<sup>2</sup> studio

Instructions to program the executable binary are found in the latest RA FSP User Manual. See Section *Starting Development > e2 studio ISDE User Guide > Tutorial: Your First RA MCU Project > Debug the Blinky Project*.

This is the preferred method for programming as it allows additional debugging functionality to be available through the on-chip debugger.

Follow the instructions for programming the board and proceed to section 1.4.

#### 1.3.2 Using J-Link Tools

SEGGER J-Link Tools such as J-Flash, J-Flash Lite, and J-Link Commander can be used to program the executable binary into the target MCU. Refer to User Manuals UM08001 and UM08003 on [www.segger.com](http://www.segger.com). Use the `.srec` or `.hex` file in Application Project to program the board and proceed to section 1.4.

#### 1.3.3 Using Renesas Flash Programmer

[Renesas Flash Programmer](#) provides usable and functional support for programming the on-chip flash memory of Renesas microcontrollers in each phase of development and mass production. Use the `.srec` or `.hex` file in the Application Project folder to program the board and proceed to section 1.4.

## 1.4 Connection Settings and Deviation

Reset the board assembly associated with this application note to the default electrical jumper settings as specified in the *CK-RA6M5 User's Manual* before proceeding with the next set of instructions.

Note: For this Ethernet based cloud connectivity application project and application note, the user is required to connect the Ethernet cable to the connector (J18) on the board.

## 1.5 Powering up the Board

To connect power to the board, connect the USB cable to the CK-RA6M5 board's J14 connector (USB\_DBG) and the other end to the PC USB port. Connect the second USB Cable to J20 connector of the CK-RA6M5 board and other end to the second USB Port of the PC (This will be the Console Port for Application). Users are required to use the Command Line Interface (CLI) to configure and run the Application. Connect the Ethernet cable from the port on the board to the router.

Then run the debug application, with the instructions in the next sections.

## 2. Running the Application Project

Note: The steps indicated below are tested on Window OS only.

### 2.1 Connecting the Board to the Serial port Console of the PC

1. On the host PC, open Windows Device Manager. Expand **Ports (COM & LPT)**, locate **USB Serial Device (COMxx)** and note down the COM port number for reference in the next step.

Note: USB Serial Device drivers are required to communicate between the CK-RA6M5 board and the terminal application on the host PC.

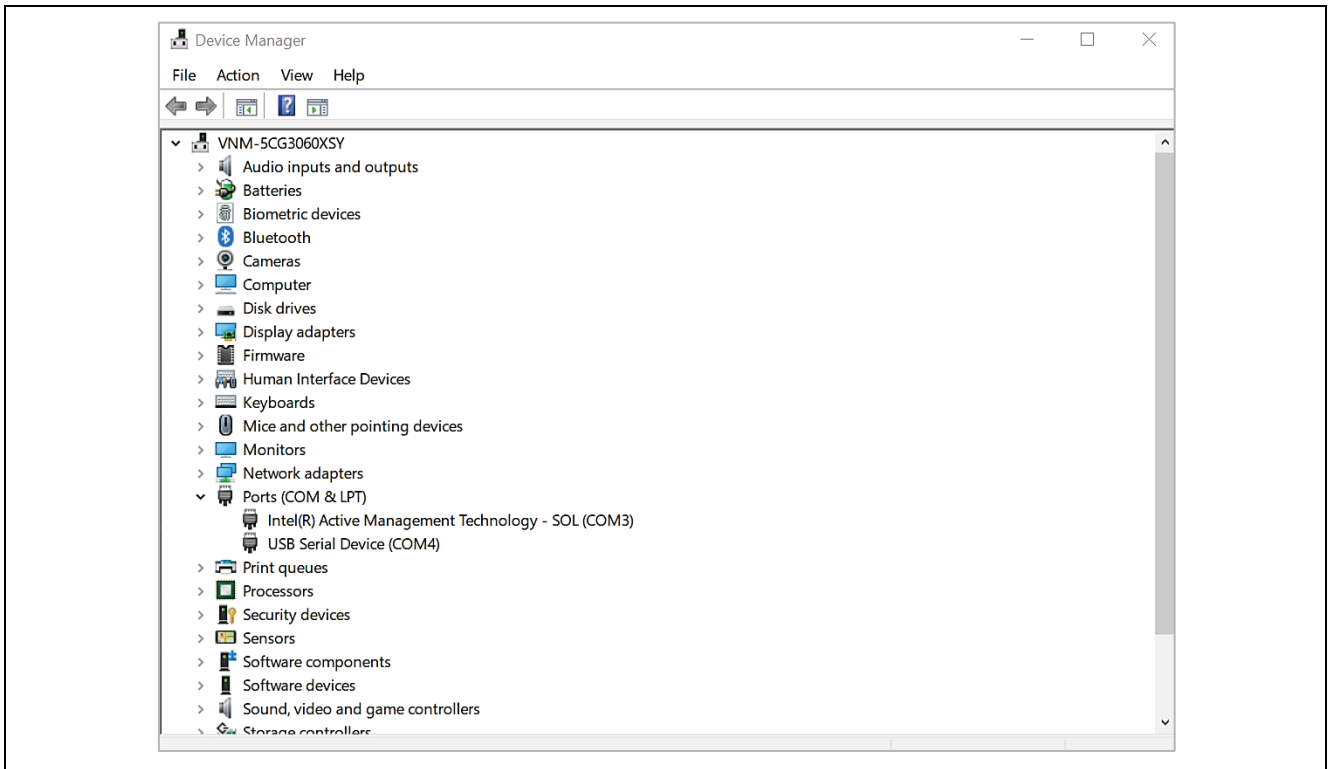


Figure 1. USB Serial Device in Windows Device Manager

2. Open Tera Term select **New connection** and select **Serial** and **COMxx: USB Serial Device (COMxx)** and click **OK**.

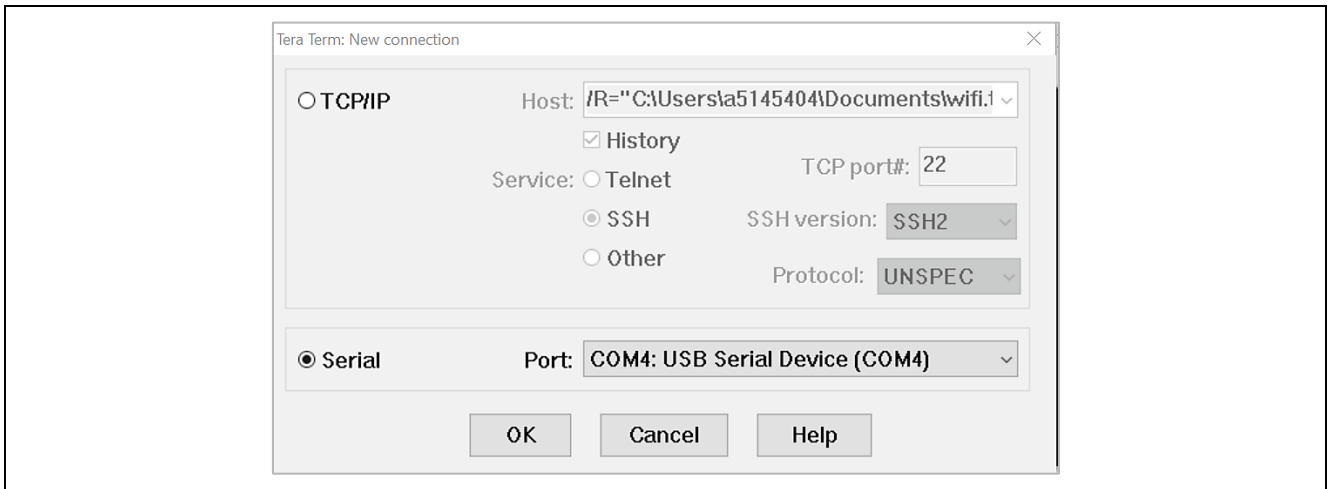
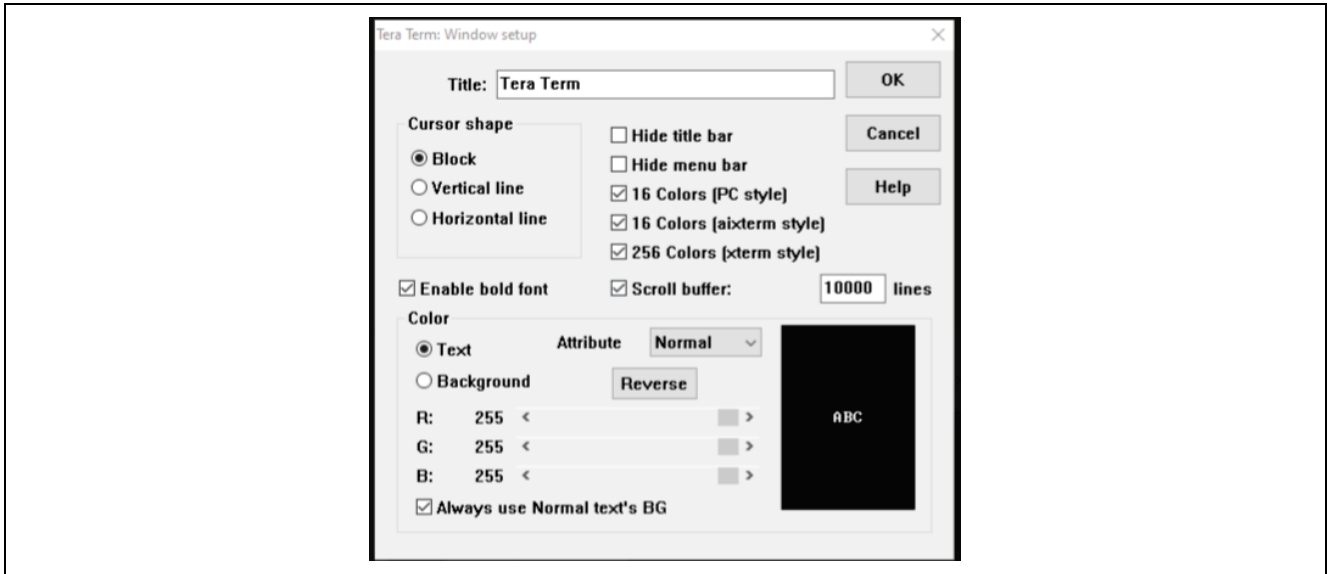


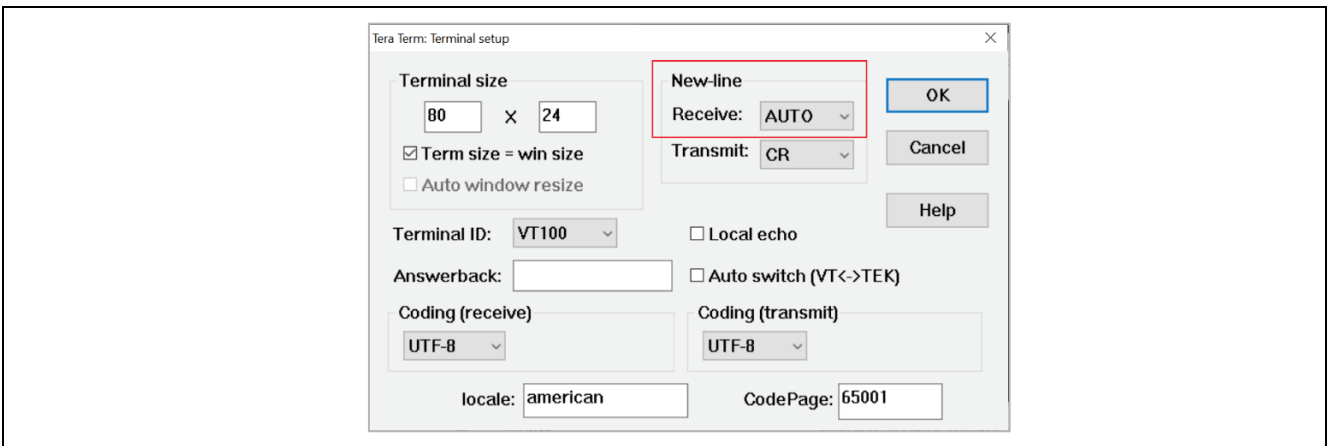
Figure 2. Selecting the Serial Port on Tera Term

3. Make sure Tera Term selects the black background, if not configure it from **Setup > Window** and make the following selections.



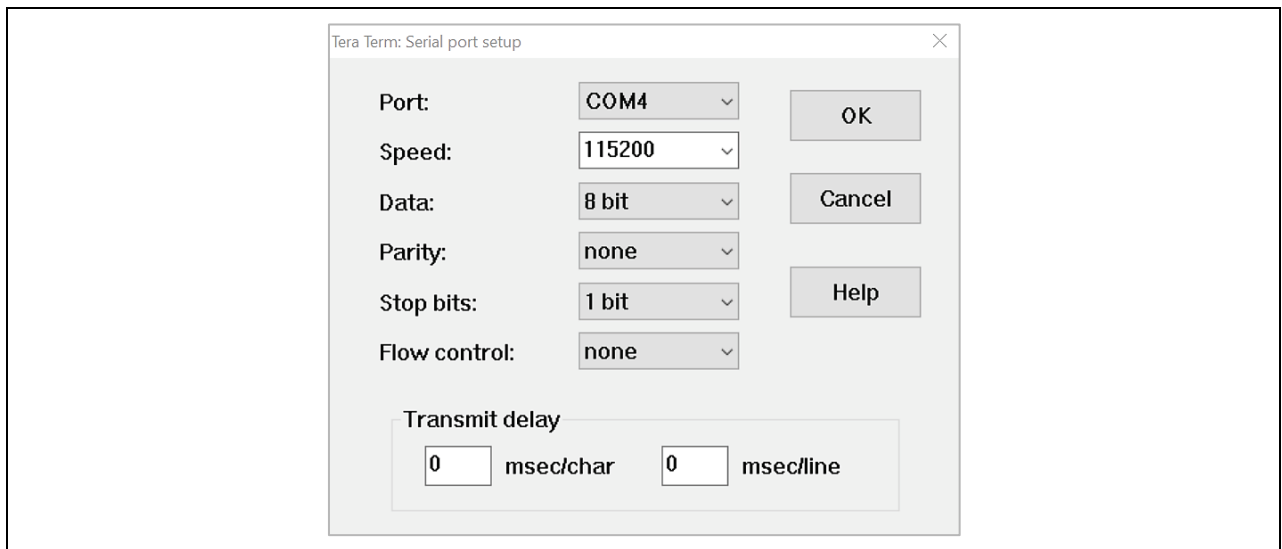
**Figure 3. Configuring the Black Background for Serial Port on Tera Term**

4. Configure for the terminal from **Setup > Terminal...**, select **New-line Receive** as **AUTO**.



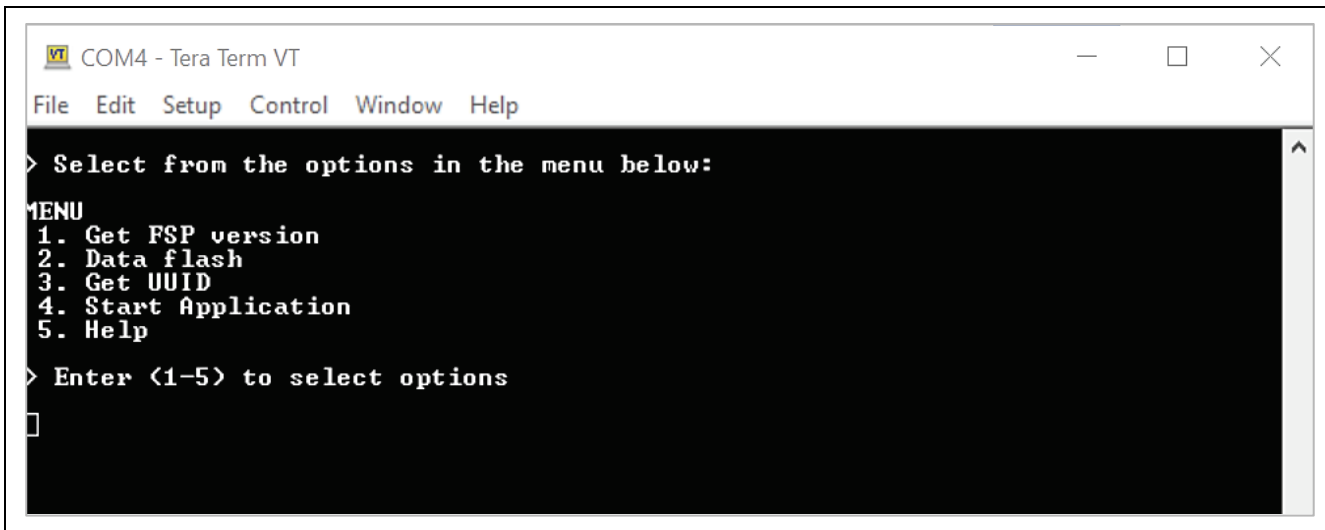
**Figure 4. Configuring Terminal**

5. Using the **Setup > Serial port...** and ensure that the speed is set to **115200**, as shown below.



**Figure 5. Select 115200 on the Speed Pulldown Menu**

- Complete the connection. The Configuration CLI Menu will be displayed on the console as shown below.  
Note: Please reset the board by pressing the **S1** user switch if the menu is not displayed.



```
COM4 - Tera Term VT
File Edit Setup Control Window Help
> Select from the options in the menu below:
MENU
1. Get FSP version
2. Data flash
3. Get UUID
4. Start Application
5. Help
> Enter <1-5> to select options

```

Figure 6. Main Menu

- In the CLI shown in the preceding screenshot, choose the number to select the commands. For example, when you press **1**, the FSP version of the application is displayed as shown below. At any point of time, press the space bar to return to the previous menu.



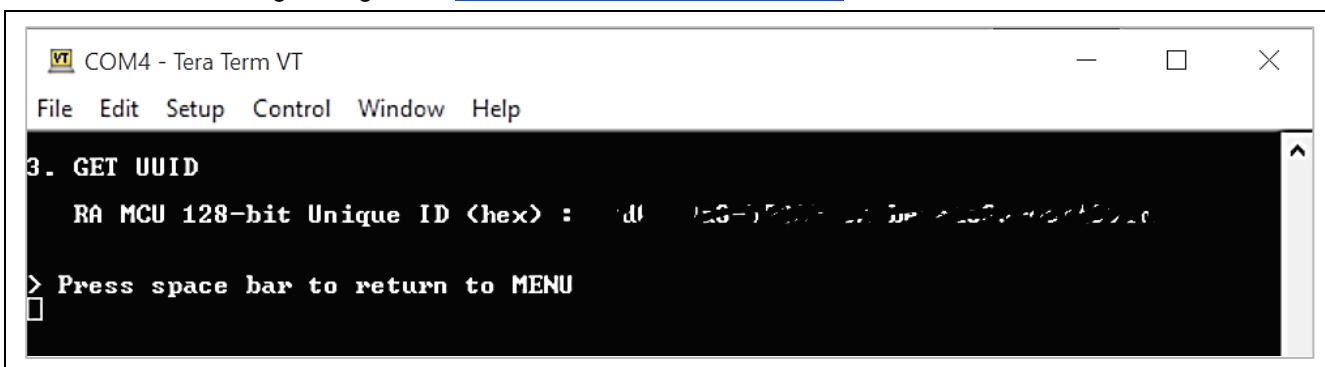
```
COM4 - Tera Term VT
File Edit Setup Control Window Help
1. GET FSP VERSION
   5.0.0
> Press space bar to return to MENU

```

Figure 7. FSP Version Information

## 2.2 Getting the UUID Information of the Board

- Press **3** from the **Main Menu** to display the board UUID. This command obtains the UUID information of the board and displays it on the console as shown in the screenshot below. You will need this information for registering to the [Renesas AWS Cloud Dashboard](#).



```
COM4 - Tera Term VT
File Edit Setup Control Window Help
3. GET UUID
   RA MCU 128-bit Unique ID (hex) : 00 150-15000-10 0000000000000000
> Press space bar to return to MENU

```

Figure 8. Getting Board UUID Information

## 2.3 Registering to Renesas AWS Cloud Dashboard

AWS dashboard for Renesas CK-RA6M5 cloud kit is custom designed to visualize the data of all the sensors on the cloud kits. The dashboard connects to AWS IoT services through AWS IoT core and enables users to utilize the cloud services to full potential.

To allow users to experience a hassle free first experience of the cloud kits, every cloud kit is credited with \$10 USD AWS credits upon registration.

The dashboard can be accessed at <https://renesas.cloud-ra-rx.com/>

### 2.3.1 Sign up

After establishing the access of the RA and RX kit to kit-associated AWS sub account, where all necessary infrastructure will be provisioned, each user should sign up:

1. Go to the <https://renesas.cloud-ra-rx.com/>
2. If you don't have an account, click on the **Sign up** button. You are directed to the **Sign up** page.

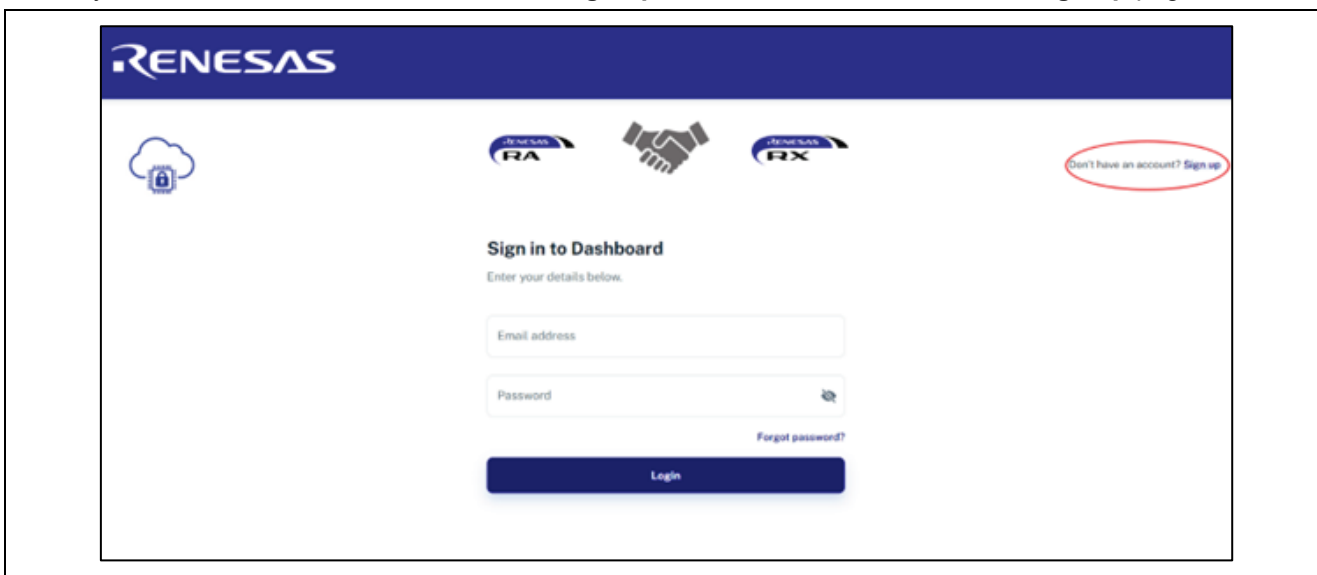


Figure 9. Creating Account

3. Enter your first name, last name, email address and password and press on the button **Register**.

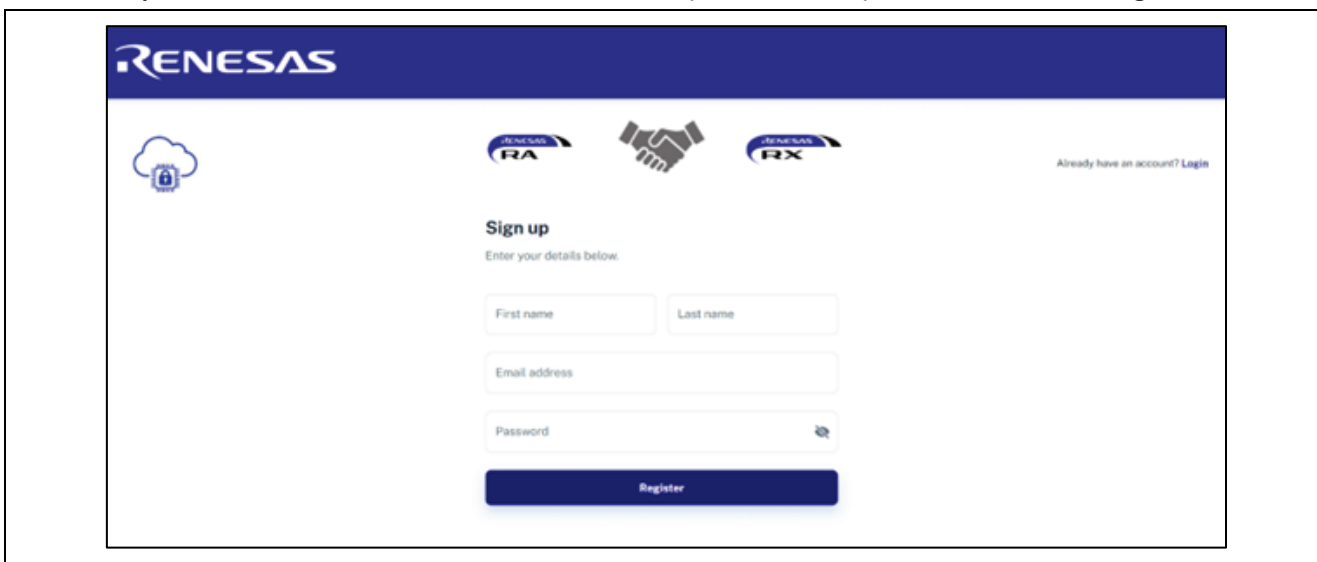


Figure 10. Registering Information

**The rules for a valid first name and last name:**

- Length Constraints: Minimum length of 2. Maximum length of 24.
- Information must be entered in English or another Latin character-based language.

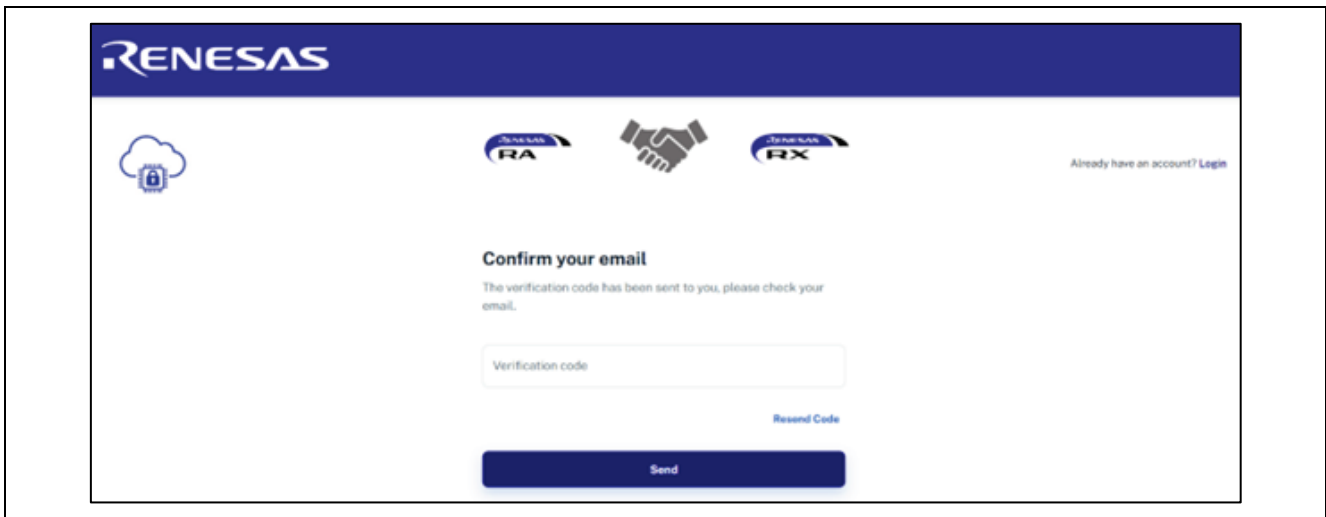
**The rules for a valid email address:**

- The address must be a minimum of 6 and a maximum of 64 characters long.
- All characters must be 7-bit ASCII characters.
- There must be one and only one @ symbol, which separates the local name from the domain name.
- The local name cannot contain any of the following characters: whitespace, " ' ( ) < > [ ] : ; , \ | % &
- The local name cannot begin with a dot (.)
- The local name cannot contain double Plus, for example: [account+rns+alpha@domain.com](#)
- The domain name can consist of only the characters [a-z],[A-Z],[0-9], hyphen (-), or dot (.)
- The domain name cannot begin or end with a hyphen (-) or dot (.)
- The domain name must contain at least one dot.

**The rules for a valid password:**

- The password must be a minimum of 8 and maximum of 64 characters long.
- Password must contain at least one uppercase character, one lowercase character, one number, one special character: ! # \$ % & \* ? @.

4. Verification code will be sent to your email. Enter the code and press on the **Send** button. You are redirected to the **Register Device** page.



**Figure 11. Confirming Email**

If you do not receive an email with the code, please click on **Resend Code**.

5. Enter the UUID of the kit to complete the registration process. UUID is the unique ID of your board. Refer to "CK-RA6M5 AWS Application Project" for steps for obtaining the UUID of the kit.

Note: Only 1 device will be assigned to an account.



**Figure 12. Registering Device**



6. The registration page indicates that the device registration is in progress.



Figure 13. Device Registration in Progress

7. After the sub account is registered, it is provisioned. Refresh the page for change of status of registration and to download the certificates.



Figure 14. Sub Account Registration

8. Wait for the buttons **Download Certificate** and **Go To Dashboard** turn available on the registration page. This process may take up to **1-5 min** for device provisioning to complete.

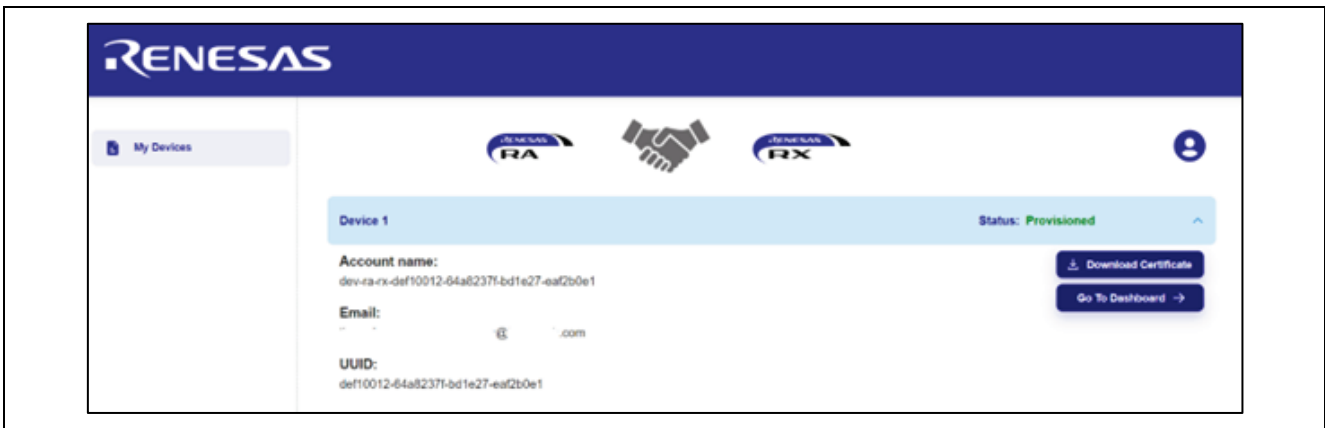


Figure 15. Completing Device Provisioning

### 2.3.2 Sign in

If you have already registered on our web portal, you need to Sign in entering your email and password.

### 2.3.3 Forgot Password

1. Click **Forgot password** on **Sign into Dashboard** page. You are directed to the **Restore Password** page.

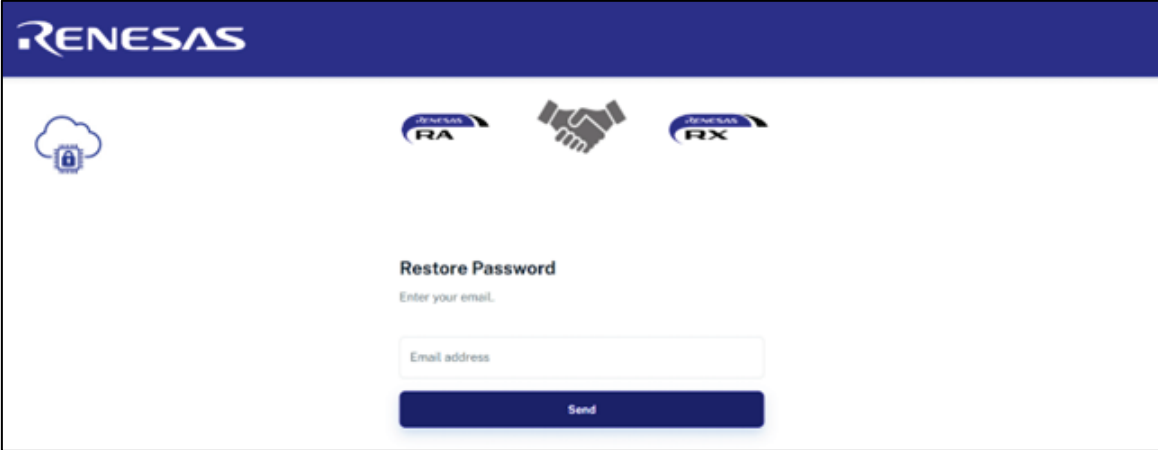


Figure 16. Restoring Password 1

2. Enter your email and click on the button **Send**.

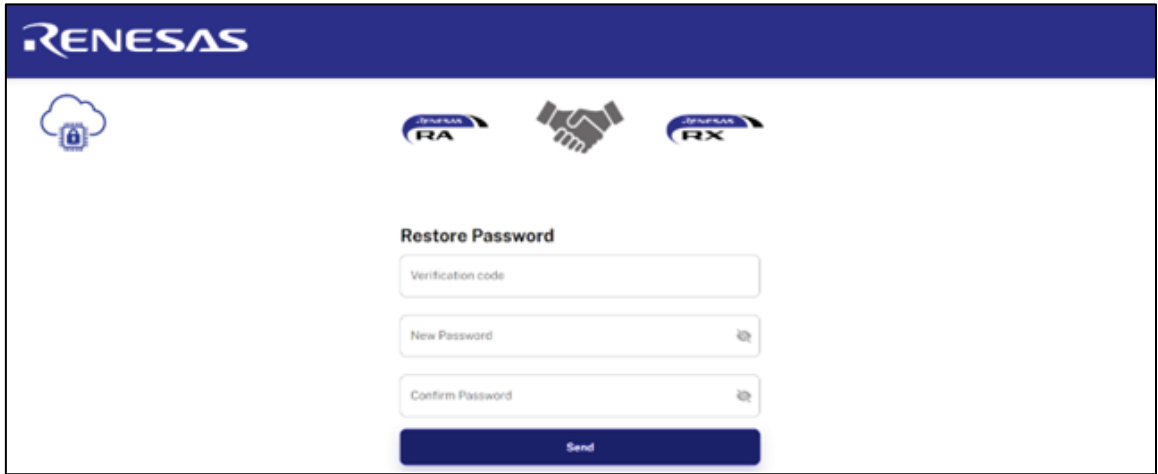


Figure 17. Restoring Password 2

3. You should receive a verification code to your email.
4. Enter the code, your new password and confirm it.
5. To end the process, press on the button **Send**.

### 2.3.4 Profile Page

To see your profile page:

1. Click on your user's picture - top right. Select Profile.



Figure 18. Selecting Profile

You are redirected to the Profile page:

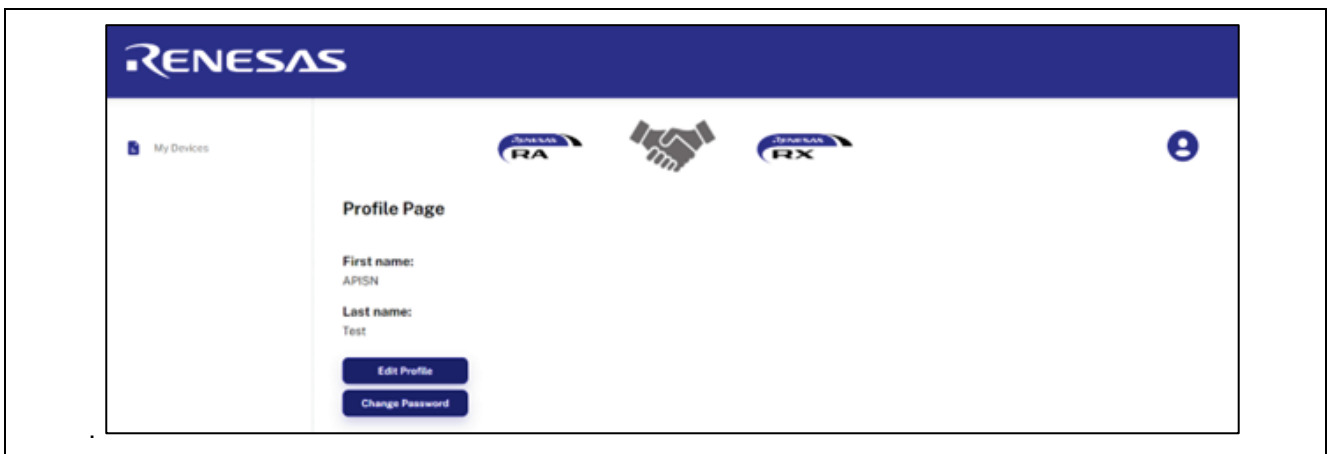


Figure 19. Profile Page

On the page you can edit your profile:

- A. Press on the button Edit Profile.
- B. Change your First name and Last name.
- C. Press on the button Send.
- D. Your Account Name is updated.

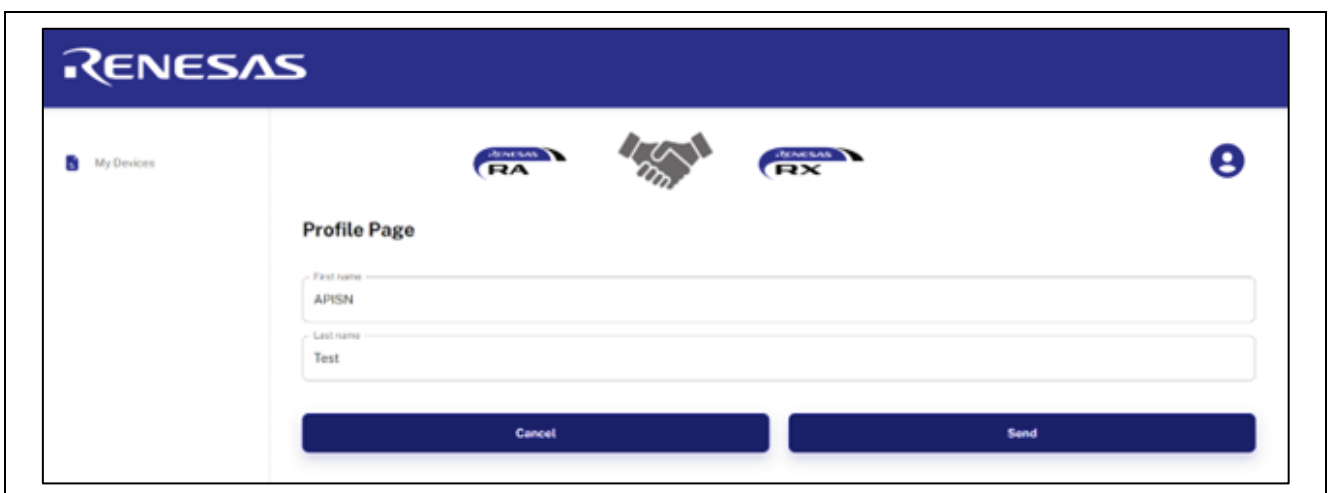


Figure 20. Updated Profile Page

Also, you can change your password, the rules for a valid password have been mentioned above:

- A. Press on the button Change Password.
- B. Enter your Old Password.
- C. Enter your New Password.
- D. Confirm your New Password and press the button Send.
- E. Your password is updated.



Figure 21. Changing Password on Profile Page

### 2.3.5 Support Page

To see your support page:

Click on your user's picture - top right. Select Support page.

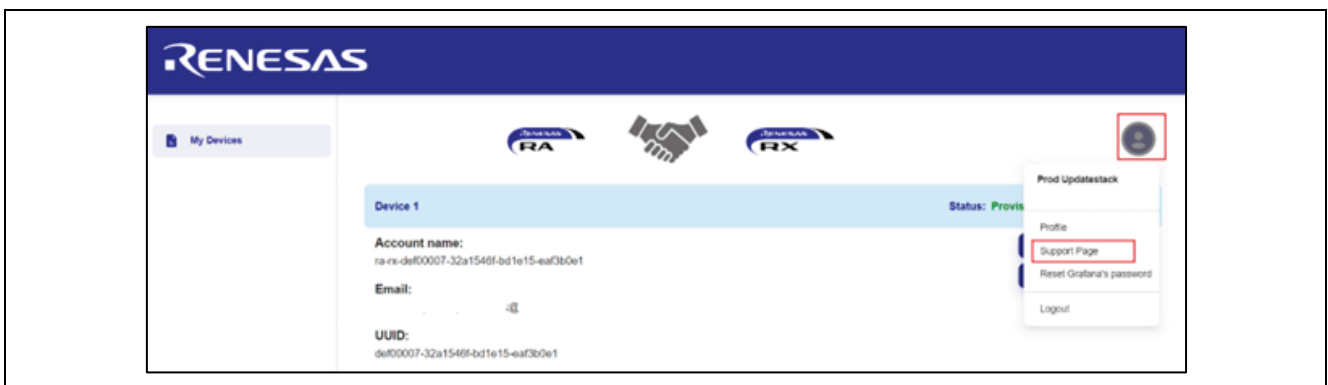


Figure 22. Selecting Support Page

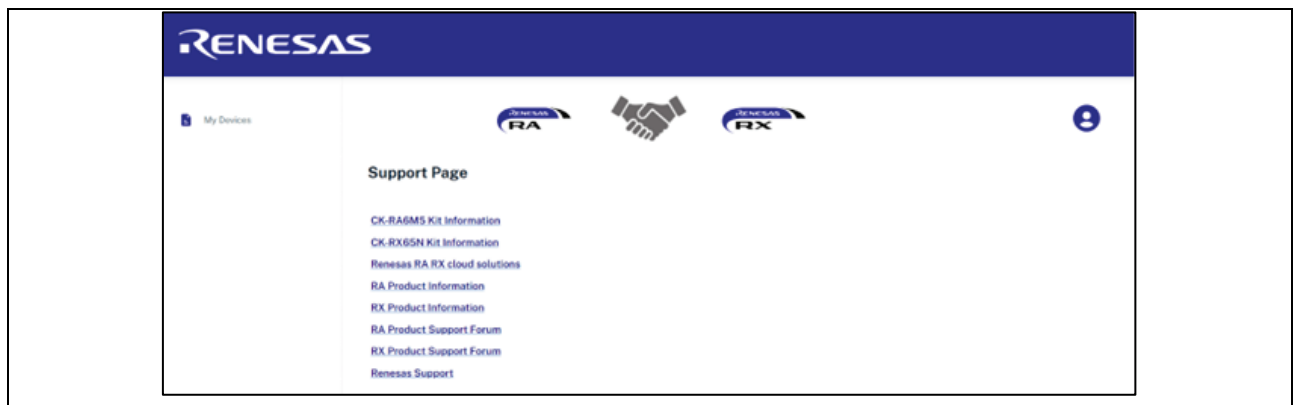


Figure 23. Support Page

### 2.3.6 Downloading the Certificate

Click on the **Download Certificate** button to download the credentials, **certs.zip** file and unzip this file.

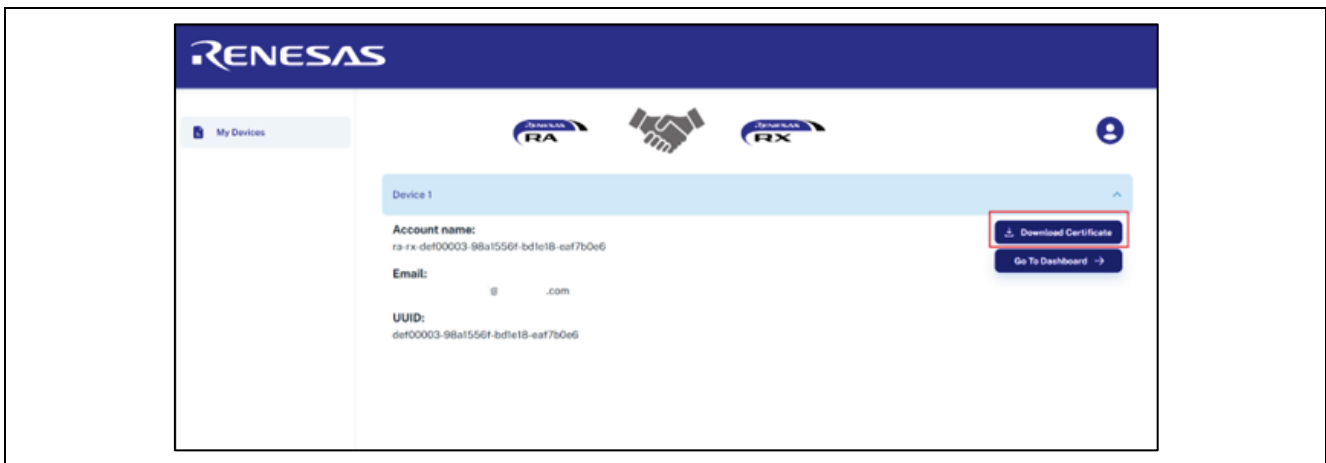


Figure 24. Downloading the Certificate

## 2.4 Storing the Device Certificate, Key, MQTT Broker Endpoint, and IoT Thing Name

Device Certificate, Device Private Key, MQTT Broker Endpoint, and IOT Thing name need to be stored in the data flash for the application to work.

1. Press **2** on the **Main Menu** to display **Data Flash** related commands as shown in the following screenshots. This sub menu has commands to store, read, and validate the data.

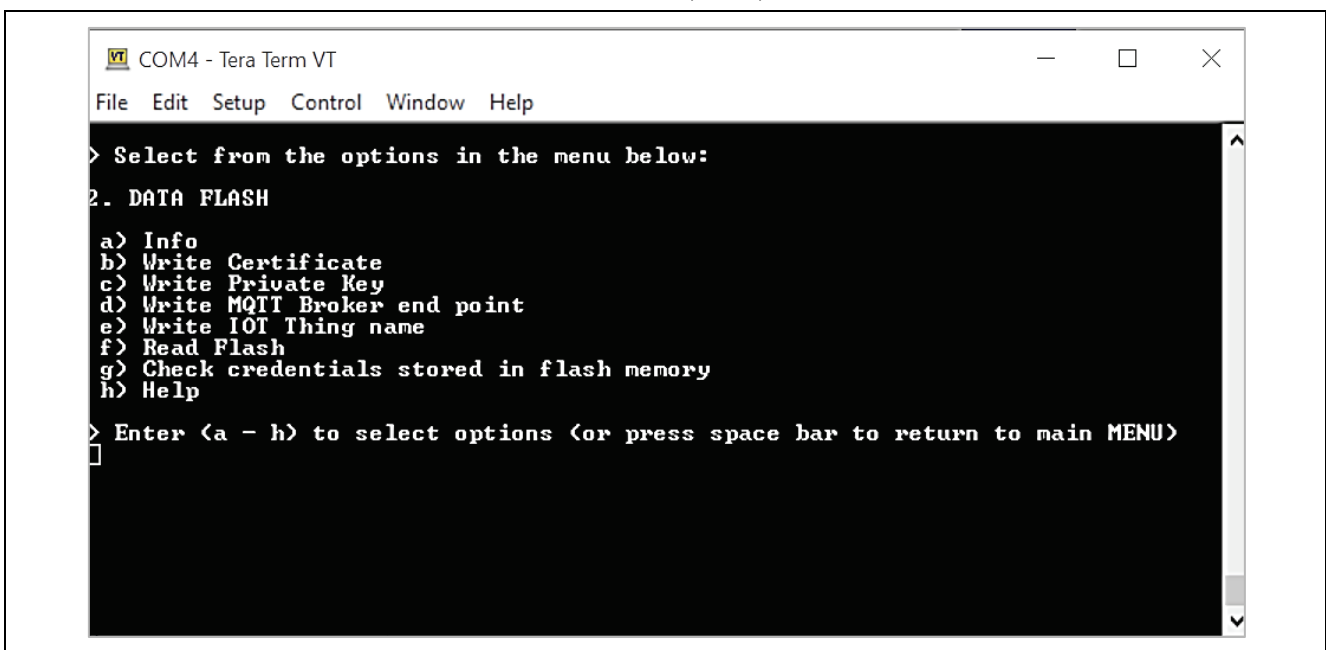


Figure 25. Data Flash related Menu and Commands

2. To store the **Device Certificate**, press the option **b** and Click the **File** tab of the Tera Term and **Send File** option and choose the device certificate file 'xxxxxcertificate.pem.crt' from the downloaded **certs.zip** file in section [2.3.10](#).

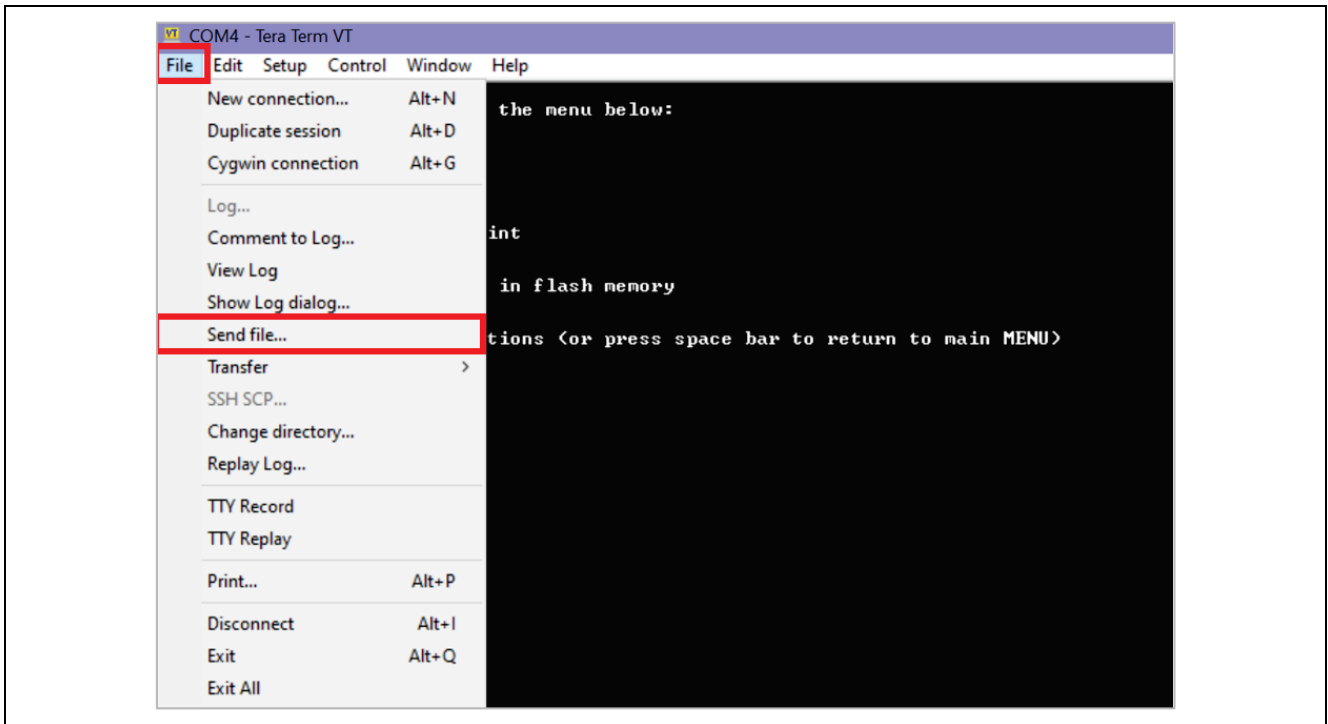


Figure 26. Accessing the Device Certificate

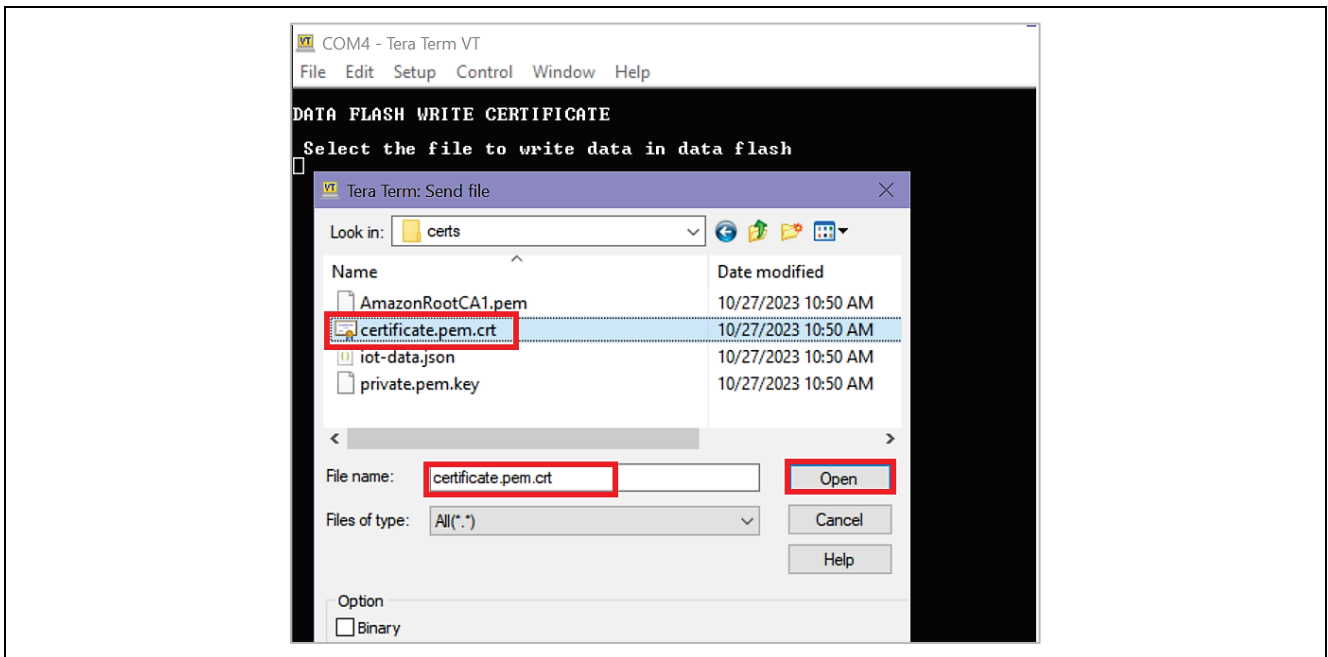


Figure 27. Downloading the Device Certificate into the Data Flash

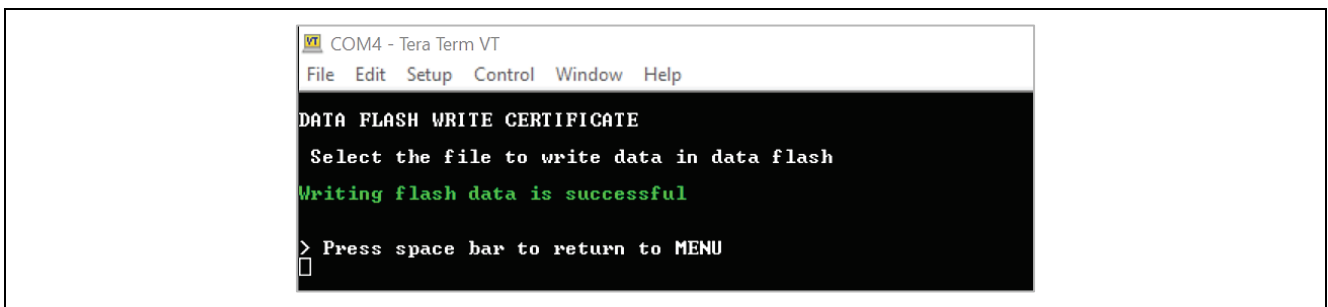
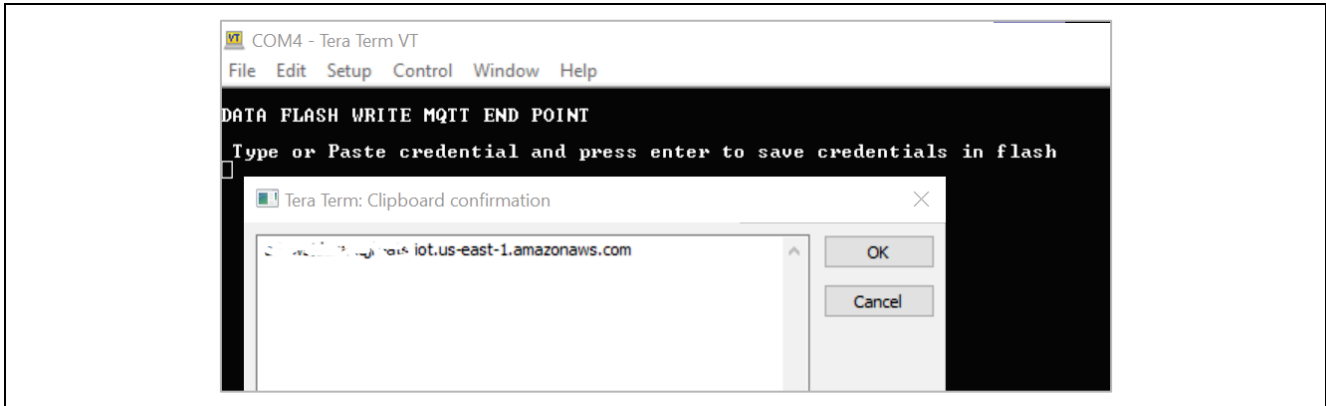


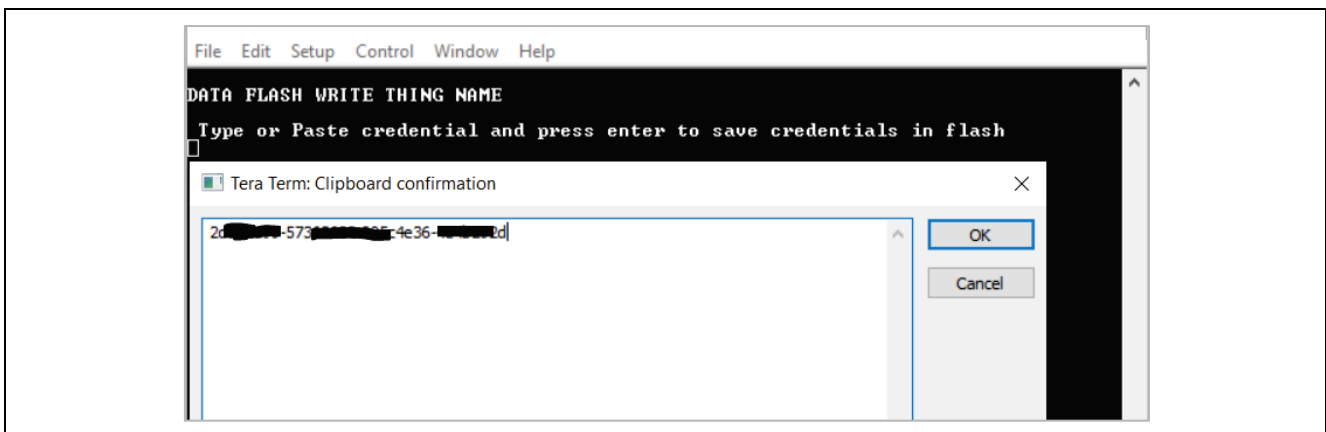
Figure 28. Status of the Downloaded Device Certificate into the Data Flash

- To store the **Device Key**, press option **c** and click the **File** tab of the Tera Term. Select the **Send File** option and choose the Device Key "xxxxxxxprivate.pem.key" from the downloaded **certs.zip** file in section [2.3.10](#).
- To store the MQTT Broker end point, copy the end point string xxxxxxxxxxx3ku-ats.iot.us-east-1.amazonaws.com from the **iot-data.json** file in **certs.zip** file. Press option **d** and click the **Edit** tab of the Tera Term and **Paste<CR>**. Verify and confirm the valid string and press **OK**.  
Note: Make sure to NOT copy the double quotes when copying the MQTT Broker end point.



**Figure 29. Storing the MQTT Endpoint into the Data Flash**

- To store the IOT Thing Name, copy the Thing Name string xxxxxxxxxxx-5736xxxx-xxxxxxxx-4e4bxxxx from the **iot-data.json** file in **certs.zip** file in section [2.3.10](#). Press option **e** and click the **Edit** tab of the Tera Term and **Paste<CR>**. Verify and confirm the valid string and press **OK**.  
Note: Make sure to NOT copy the double quotes when copying the Thing Name.



**Figure 30. Storing the MQTT Endpoint into the Data Flash**

- Press option **f** and **g** to read and validate the stored information in the data flash. Press the space bar to go to the previous menu.

Note: Validation of the stored data is very limited and validates minimum set of data points. Users are required to input the valid data to the flash obtained from the Dashboard for the proper working of the application.

## 2.5 IoT Cloud Configuration and Connecting to AWS IoT

Sign in to Renesas AWS dashboard at <https://renesas.cloud-ra-rx.com/login> using an email account that has been used to sign up for AWS account previously.

Note: It is important to sign up with an email that is not used previously to open an AWS account since the dashboard creates a new AWS account linked to the email address.

Note: Store the invitation email for future, it may be required to access the AWS account.

Note: For Ethernet Applications, firewalls in the network may prevent connectivity to AWS IoT. Configure the network to allow access to the MQTT Port 8883.

## 2.6 Starting the Application

After registering to the Dashboard, configuring the required Cloud credentials through the CLI, the application is ready to run. Press option “4. Start Application” to start the application. The application prints a Welcome screen along with the status of validating the Cloud credentials data present in the data flash as shown below.

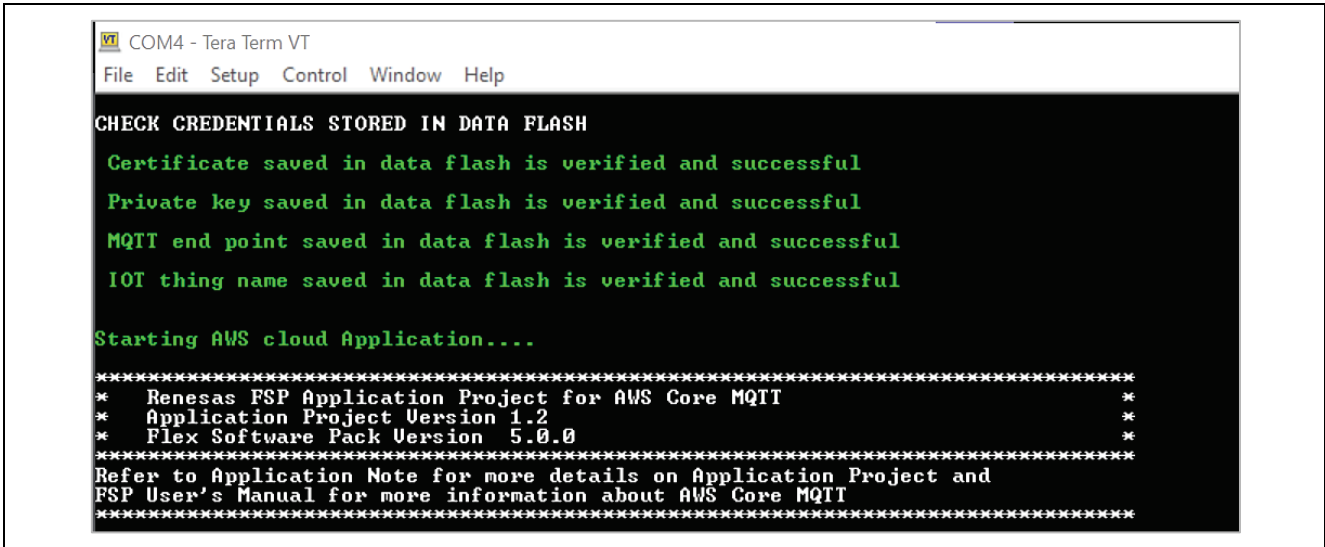


Figure 31. Welcome Screen on the Console

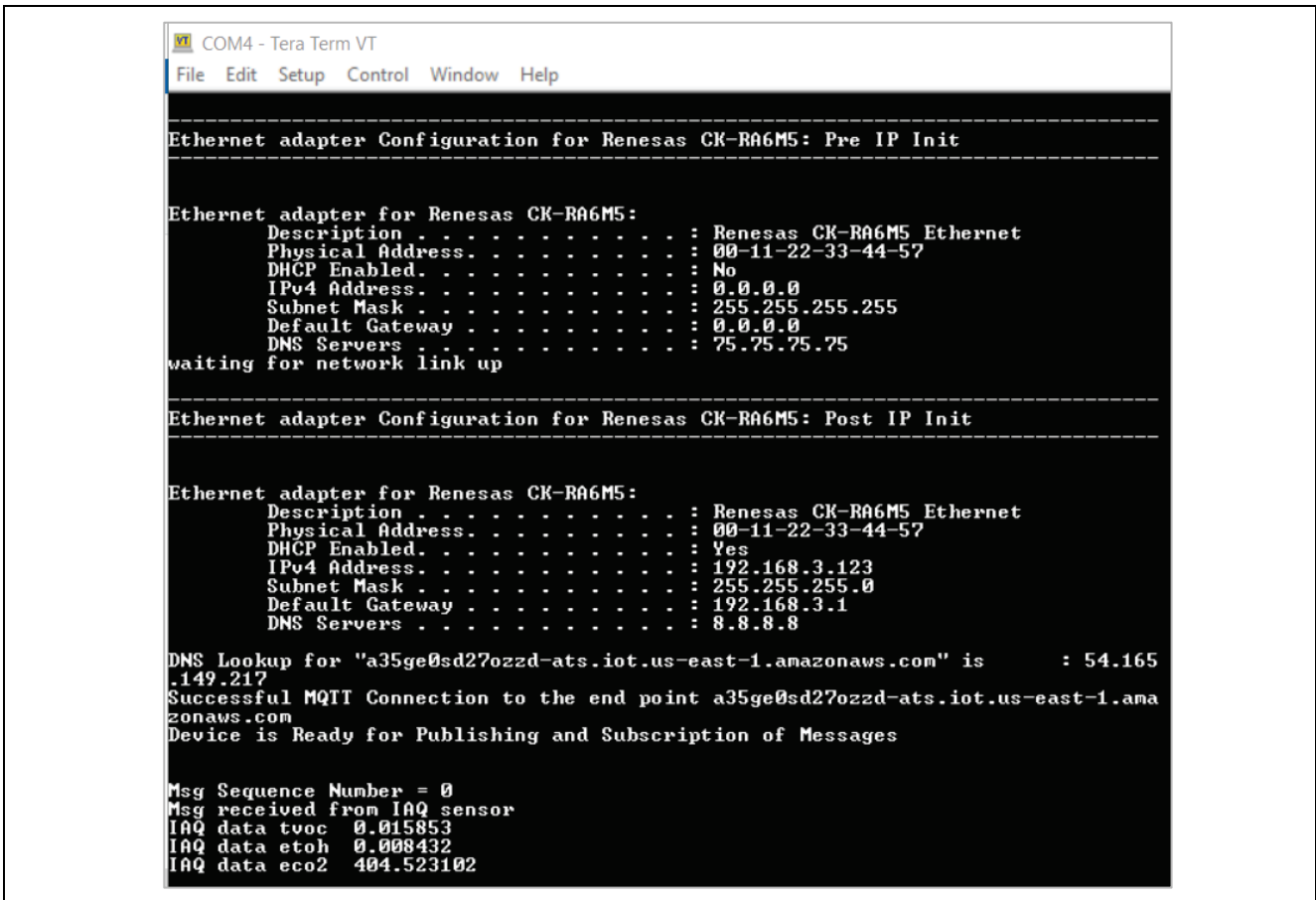


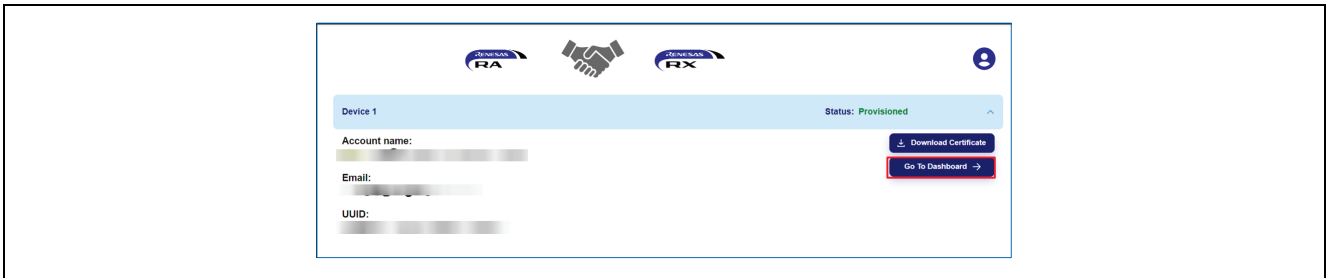
Figure 32. Connecting to the Network and AWS IoT



## 2.7 Verifying the Application Project from the Renesas Dashboard

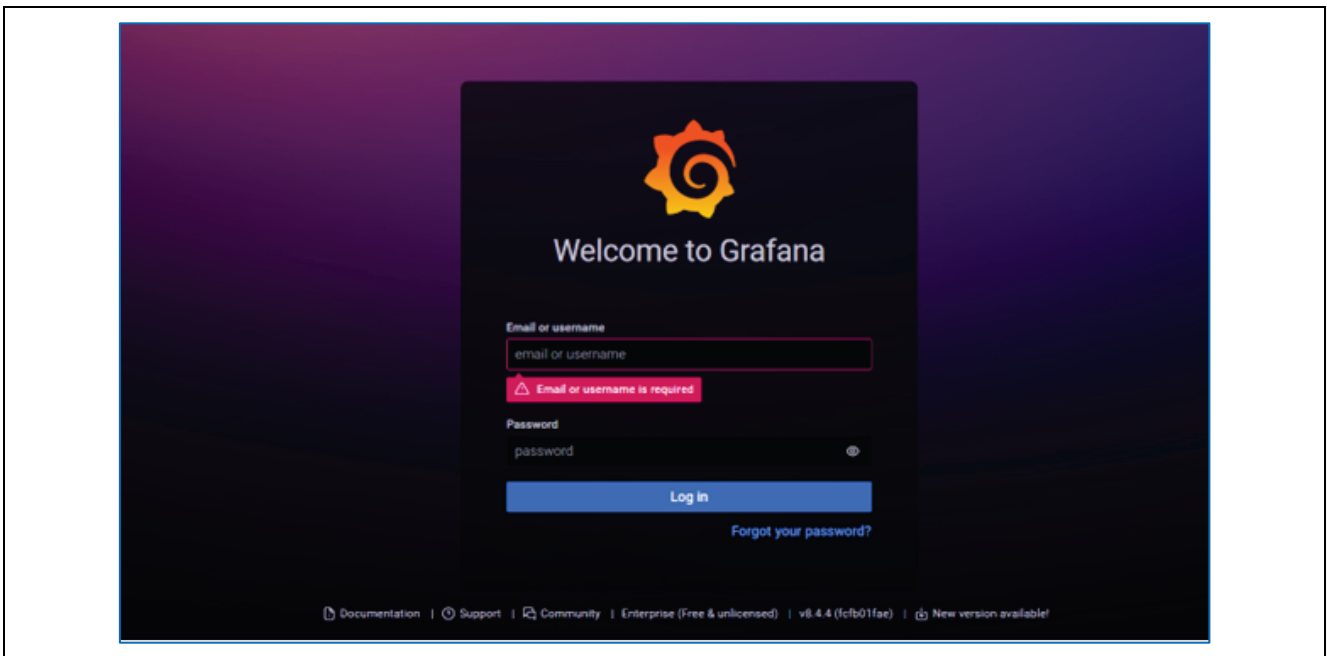
Renesas AWS dashboard can be accessed from [renesas.cloud-ra-rx.com](https://renesas.cloud-ra-rx.com) by clicking on **Go to Dashboard**.

Note: Users will have access to Grafana dashboard only when the device is provisioned, and the device status is “Active”.



**Figure 33. Accessing Renesas AWS Cloud Dashboard**

First time users will access the dashboard with credentials “admin” for both username and password and will be directed to change the password.



**Figure 34. Welcome to Grafana Screen**

Click **Skip** to access the dashboard.

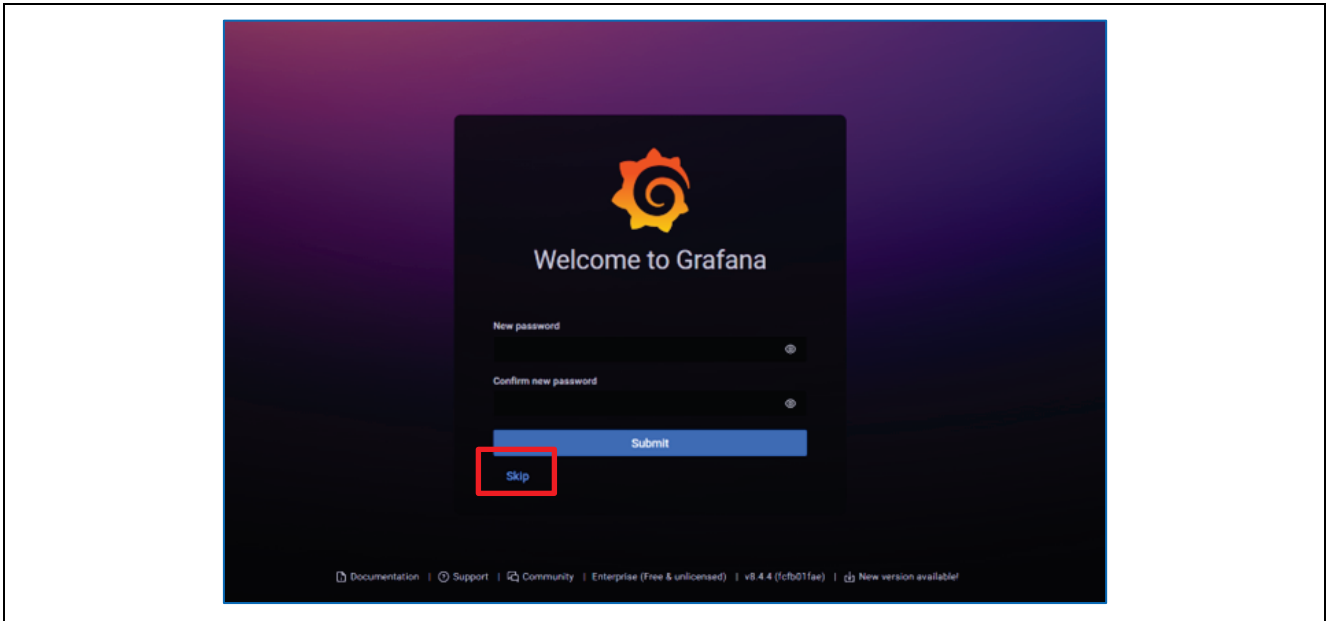


Figure 35. Skipping Grafana Screen to Access Dashboard

On the Renesas dashboard page, the sensors data can be viewed by clicking on the “arrow” next to each of the sensor data tabs. Allow up to 60 seconds for the data to be displayed on the dashboard. If the data is not updated as expected, refresh the page.

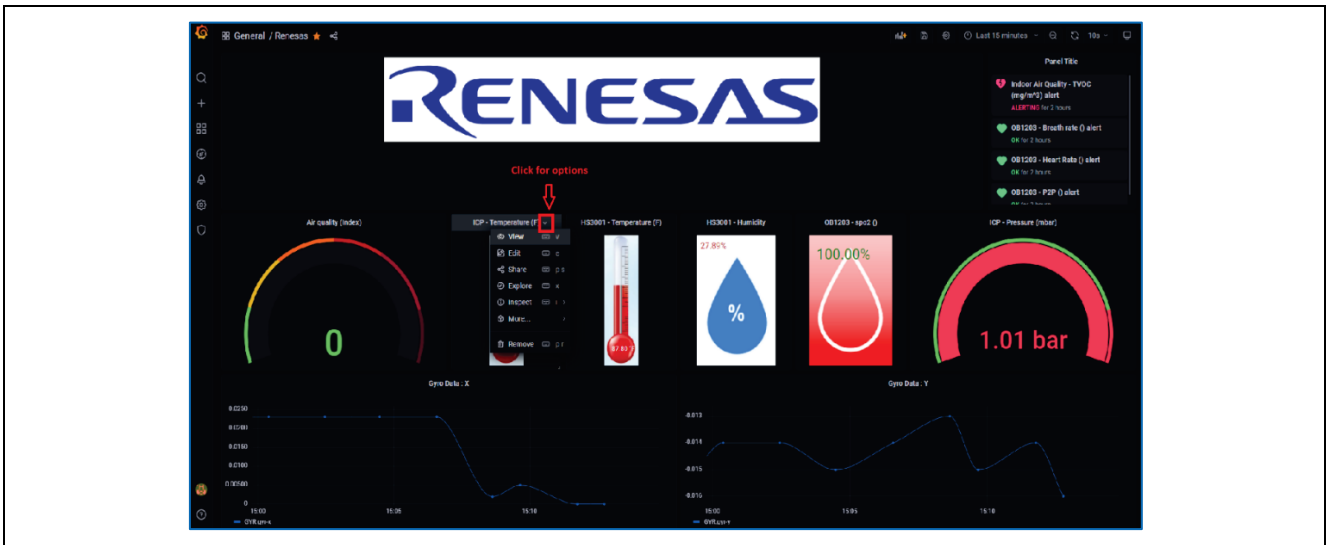


Figure 36. Renesas AWS Cloud Dashboard

### 3. Dashboard Types

Depending on the sensors, you can choose one of the dashboard types: Renesas 9-Axis sensor or Renesas. Click on **Renesas** option.



Figure 37. Renesas AWS Cloud Dashboard Types

Choose Renesas 9-Axis sensor.



Figure 38. Choosing Renesas 9-Axis Sensor



Figure 39. Renesas Dashboard displays 9-Axis Sensor

### 4. Sensor Data for Cloud Kits

The Grafana dashboard displays the following Data from sensors.

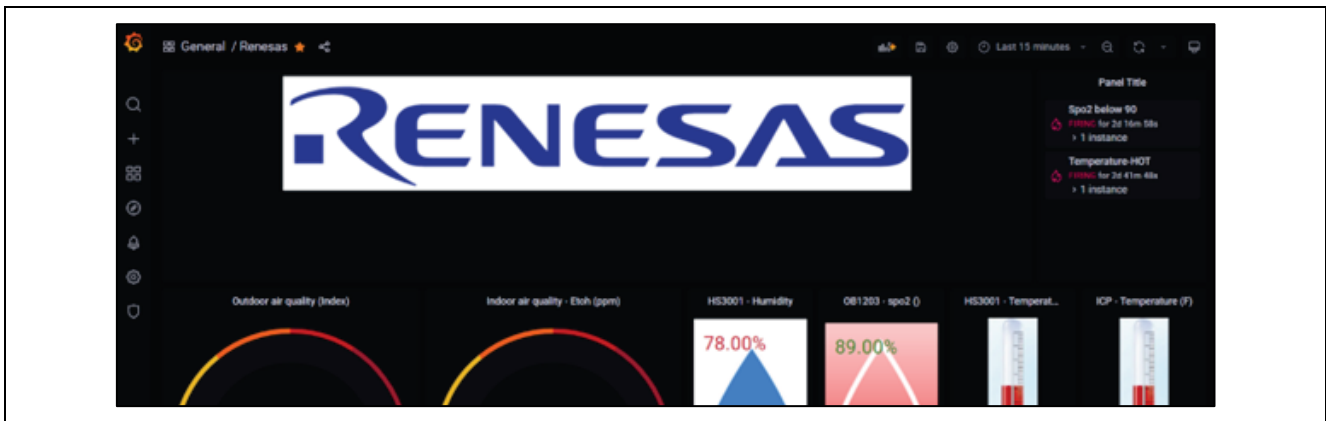
**Table 1. Sensor Data from Grafana Dashboard**

Sensor	Data
HS3001- Humidity and Temperature Sensor	Temperature, F
	Humidity, %
ZMOD4410- Indoor Air Quality Sensor	Etoh, ppm
	ECO2- Estimated Carbon dioxide, ppm
	TVOC - Total Organic Compounds, mg/m <sup>3</sup>
OB1203 - Heart Rate, Blood Oxygen Concentration, Pulse Oximetry, Proximity, Light and Color Sensor	SPO2, %
	HR (Heart Rate), bpm (beats per minute)
	RR (Respiration Rate), breaths per minute
	P2P
ICP10101 - Barometric Pressure and Temperature Sensor	Temperature, F
	Barometric Pressure, mbar
ICM-20948 Motion Tracking Sensor	Acc values, unit: g
	Gyro Data, unit: dps (degrees per sec)
	Mag Data, unit: mT
OAQ – Outdoor Air Quality	OAQ, ppm

### 5. Alerting and Anomaly Detection

Grafana alerts are a way to send notifications when a metric crosses a threshold that has been configured. By default, the dashboard has thresholds for the following sensors:

- OB1203-SPO2: SPO2 above 90, SPO2 below 90
- HS3001 - Temperature, F:
  - Temperature – Cold: below 65
  - Temperature – Warm: within range from 65 to 85
  - Temperature – Hot: above 85



**Figure 40. Sensor Status Feedback**

Sensor status feedback is sent to the device which is indicated by the LEDs.

## 6. AWS Account Sign up and Payment Preference Updates

Access the AWS account by clicking [here](#).

1. Use the same email address that was provided at the registration in section 2.3.1 step 3.

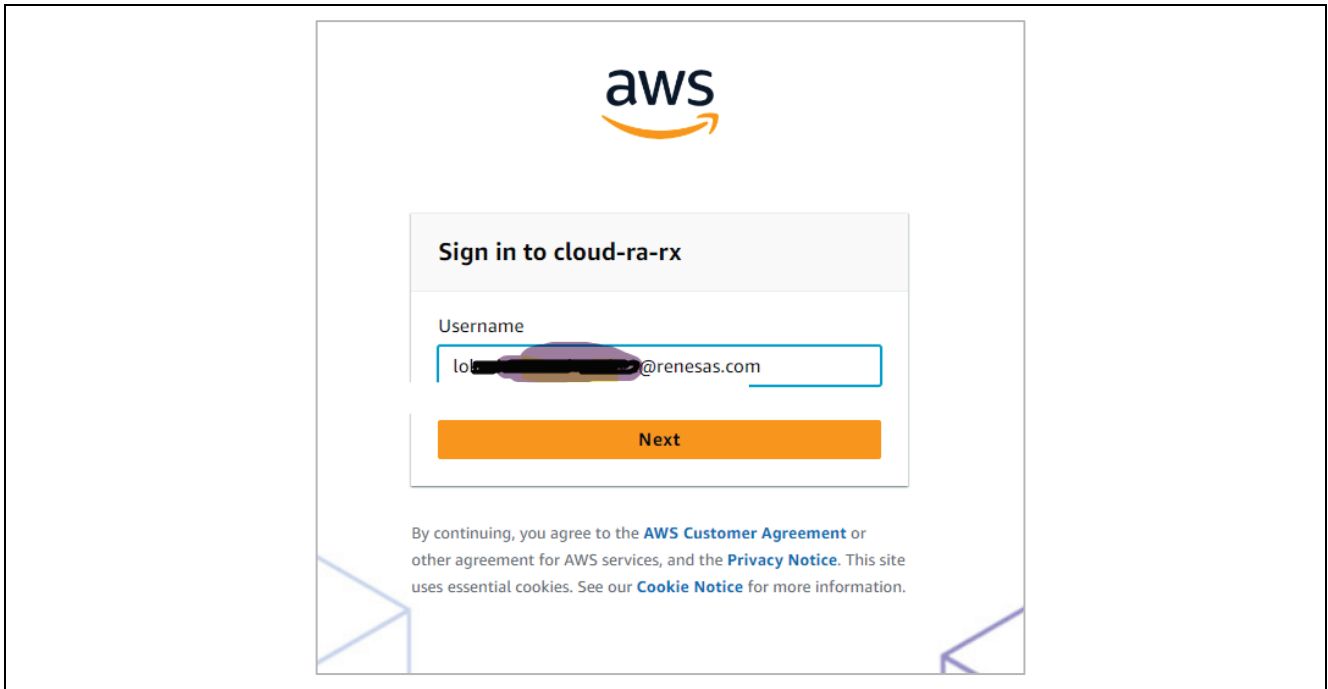


Figure 41. AWS Sign up Page

2. To access your AWS account, you will need to reset your password. Click the "Forgot Password" button to initiate the password reset process. Expect to receive password reset instructions via email.

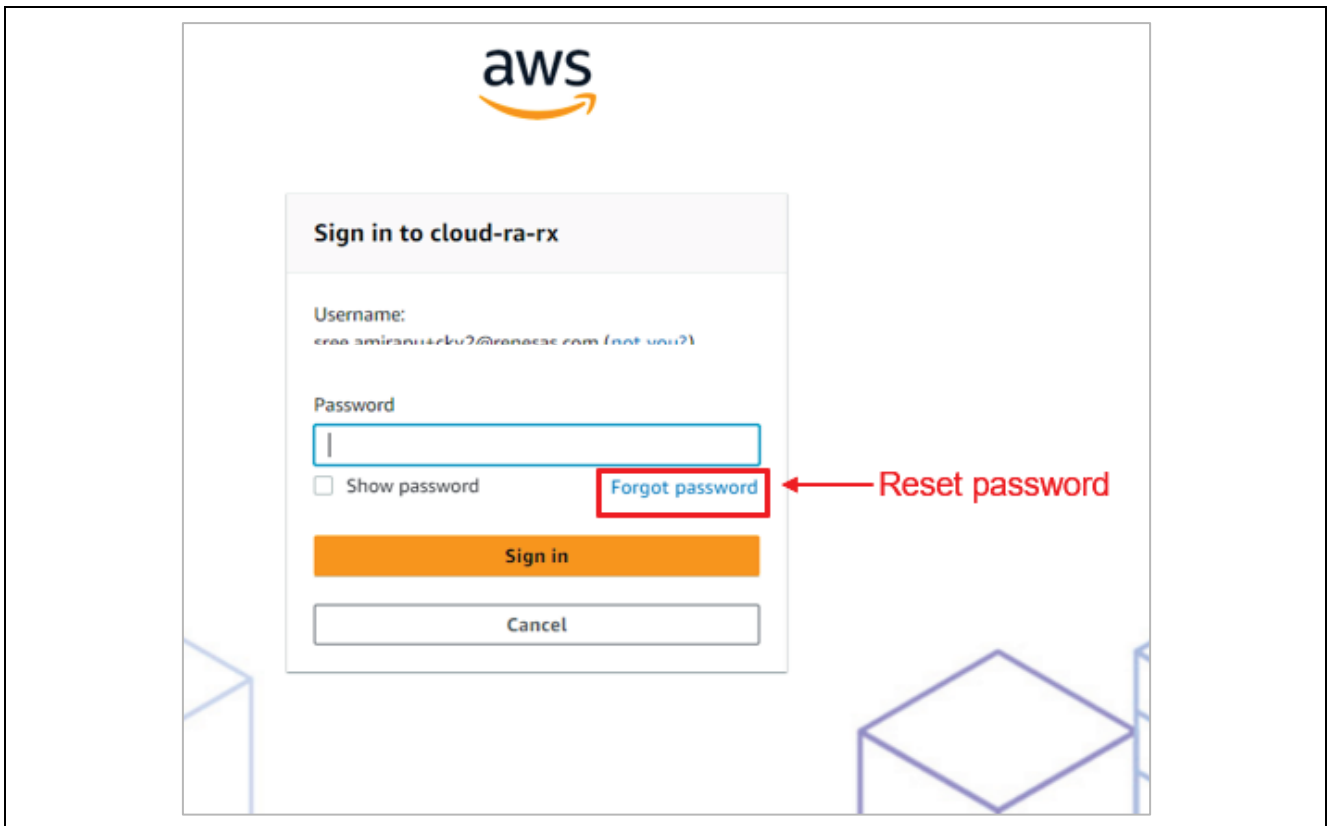


Figure 42. Reset Password

- 3. After login you are redirected to Single Sign-On page. The AWS sub account can be accessed from the Management console link.

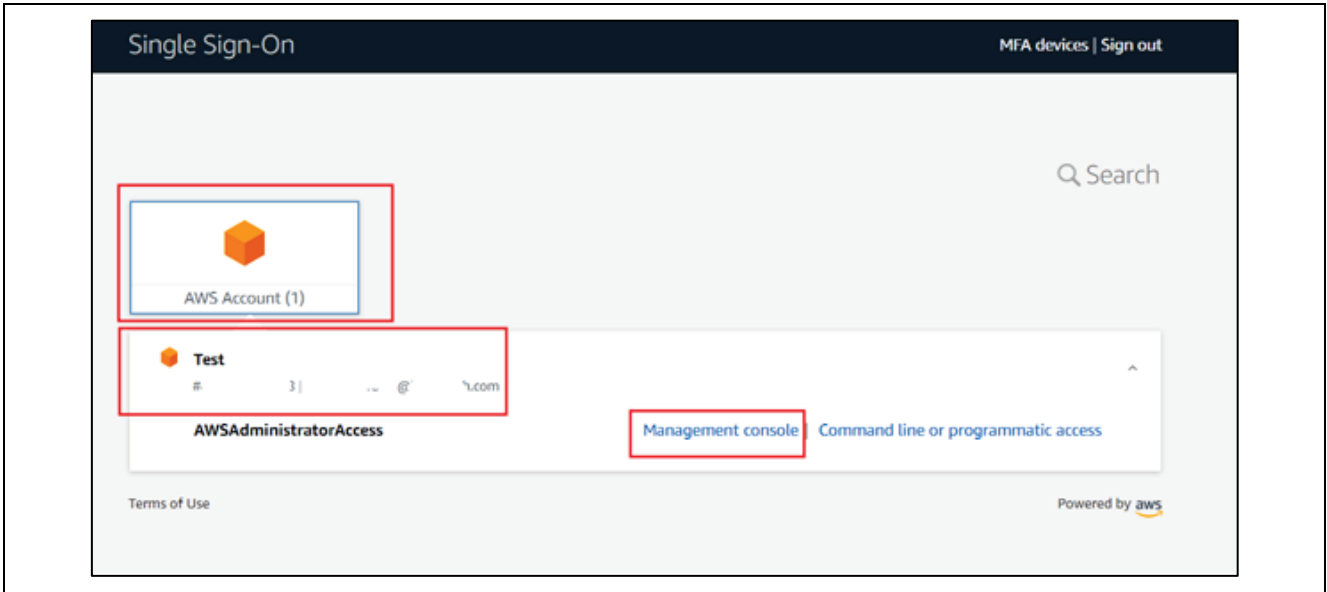


Figure 43. Single Sign-On Page

### 6.1 Update Payment Options

**Note:** To avoid account from being quarantined post the usage of \$10 AWS credits, payment options must be updated.

- 1. Payment options can be accessed from the 'Billing and Cost Management' section of the console.

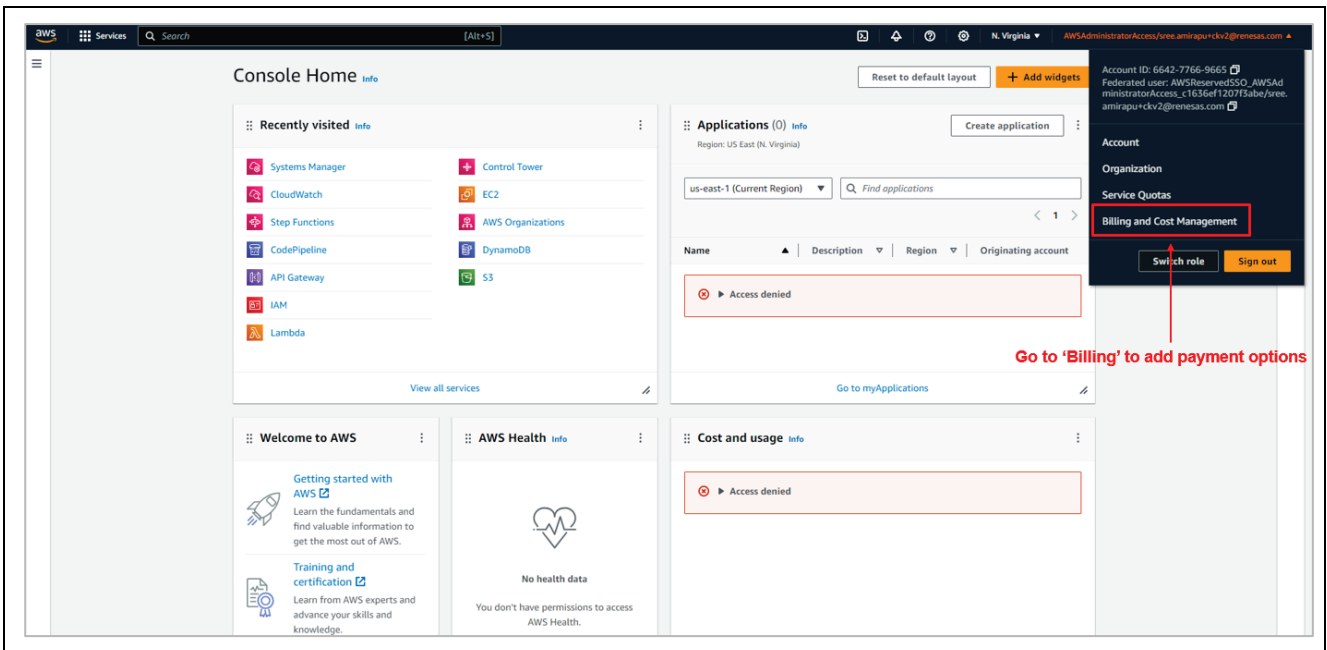


Figure 44. Billing and Cost Management

2. Scroll to the 'Payment Preferences'.

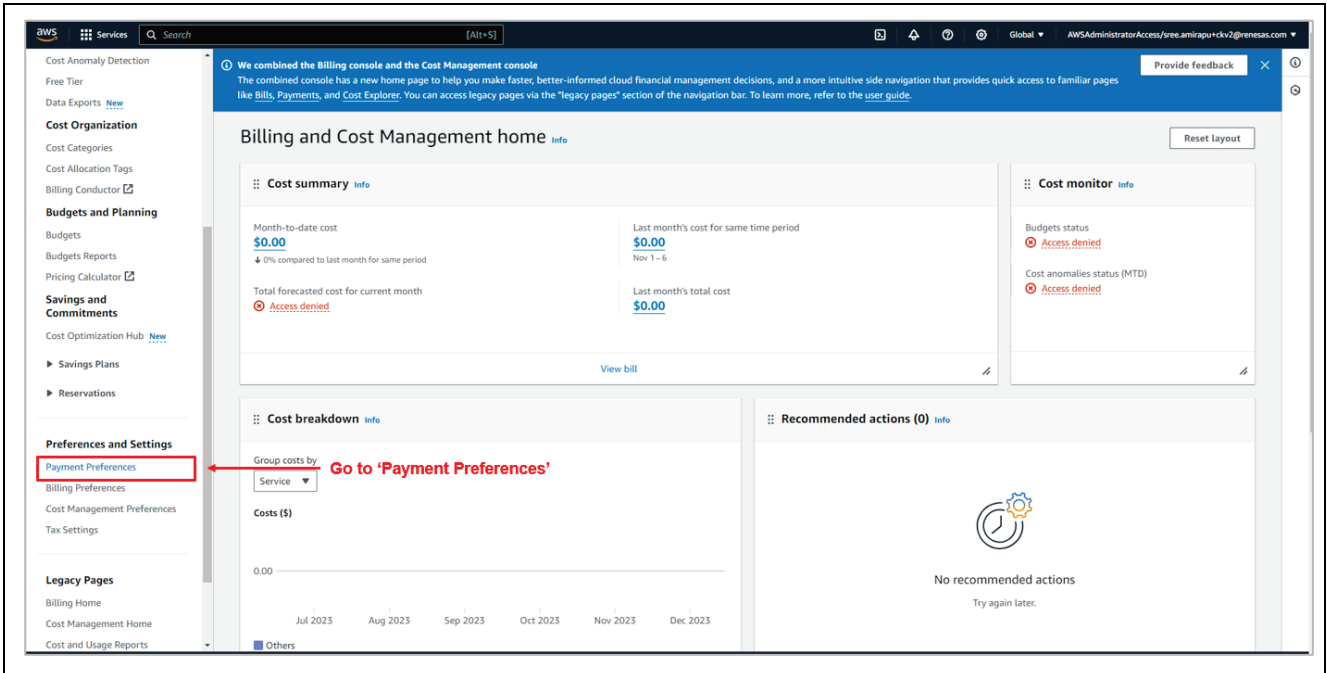


Figure 45. Payment Preferences

3. Add payment method.

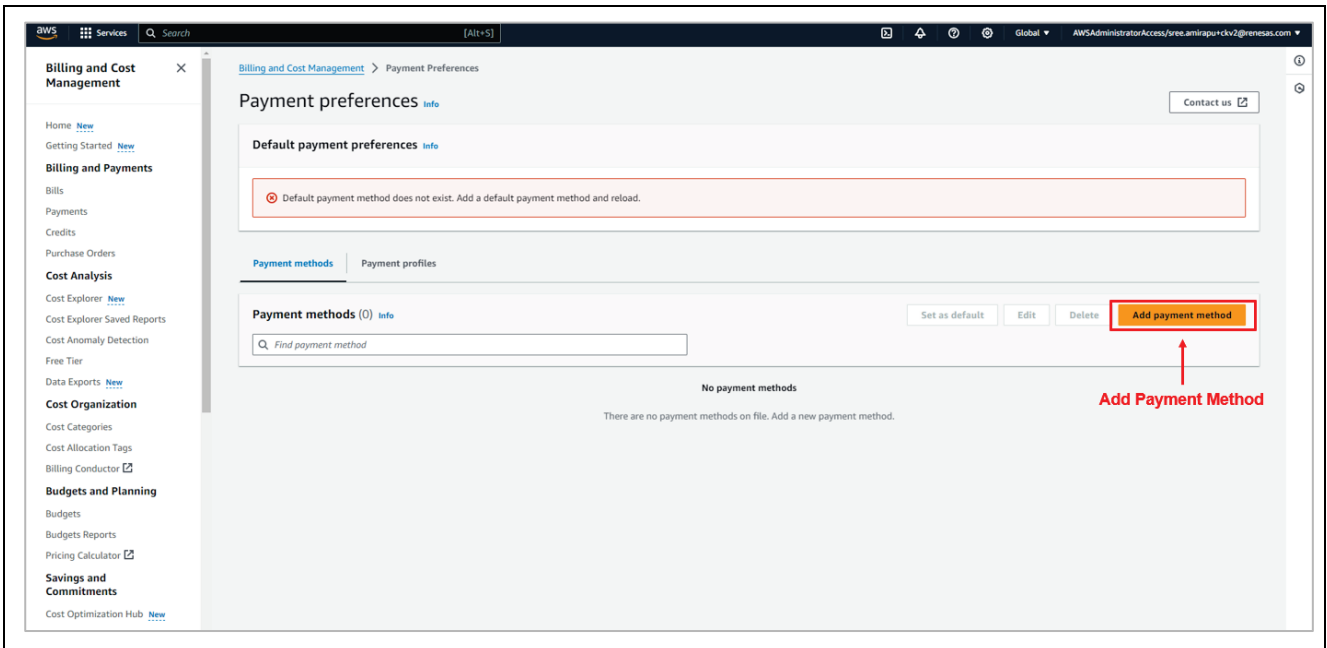


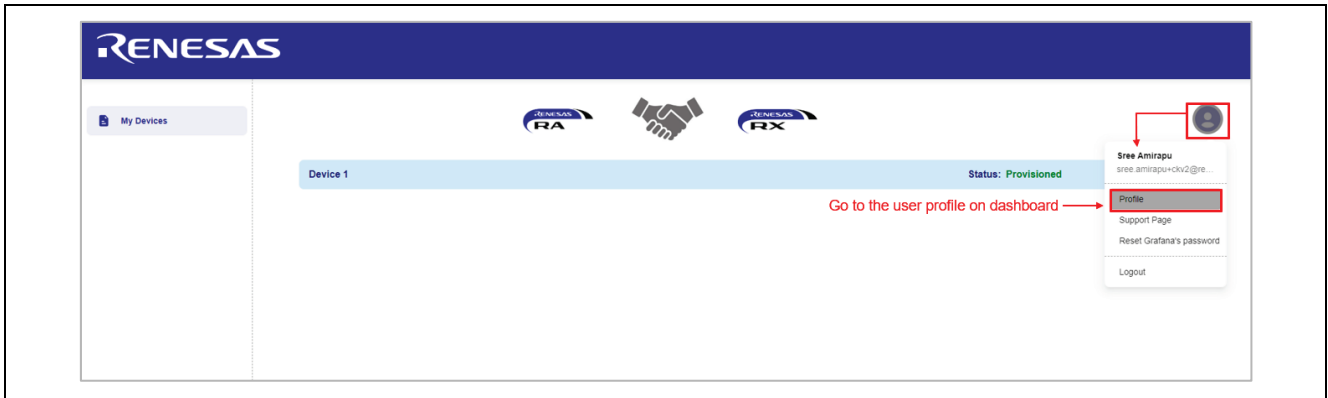
Figure 46. Add Payment Method

## 7. Renesas AWS Dashboard Account Credits and Quarantine

Every kit registered to the dashboard will include a \$10 AWS credit. When the credit is exhausted the account is quarantined.

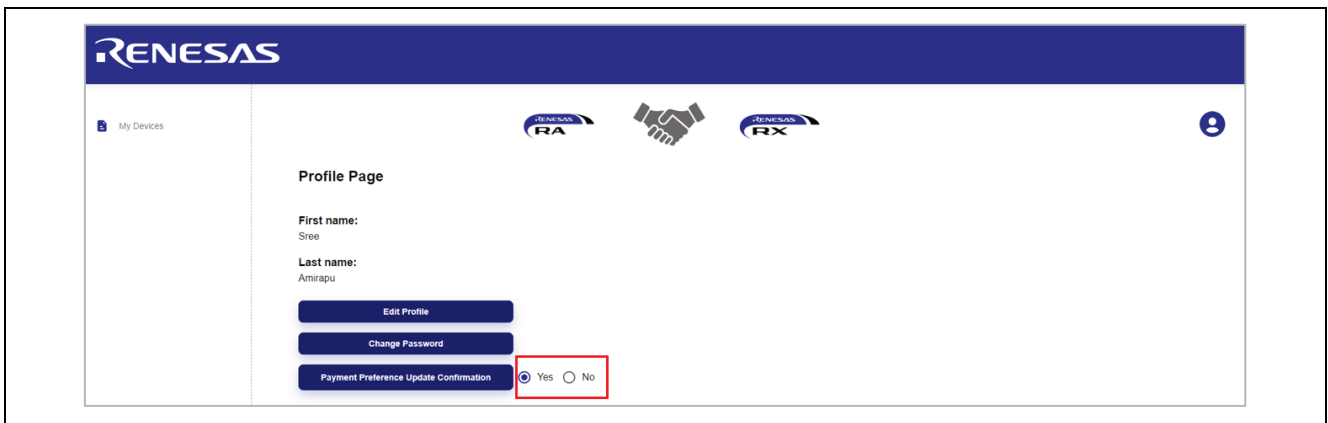
To avoid the account from being quarantined, use the following steps:

1. Update the payment method in the AWS account as shown in section 6.1.
2. In addition, the dashboard must be updated with the payment preference from the user profile on the dashboard page.
  - A. Go to the user profile.



**Figure 47. User Profile on Dashboard**

- B. Confirm the payment preference updates.



**Figure 48. Payment Preference Update**

**Note:** Failure to complete either of the steps 1 or 2 will result in the account being quarantined. For access to quarantined accounts, please contact Renesas Support team.



### 7.1 Disable EC2 Instance to Save Credits.

To avoid account credit usage when the device is not in use, disable the EC2 instance.

1. Access EC2 from the AWS account by logging into the account as mentioned in section 6, and following the below steps

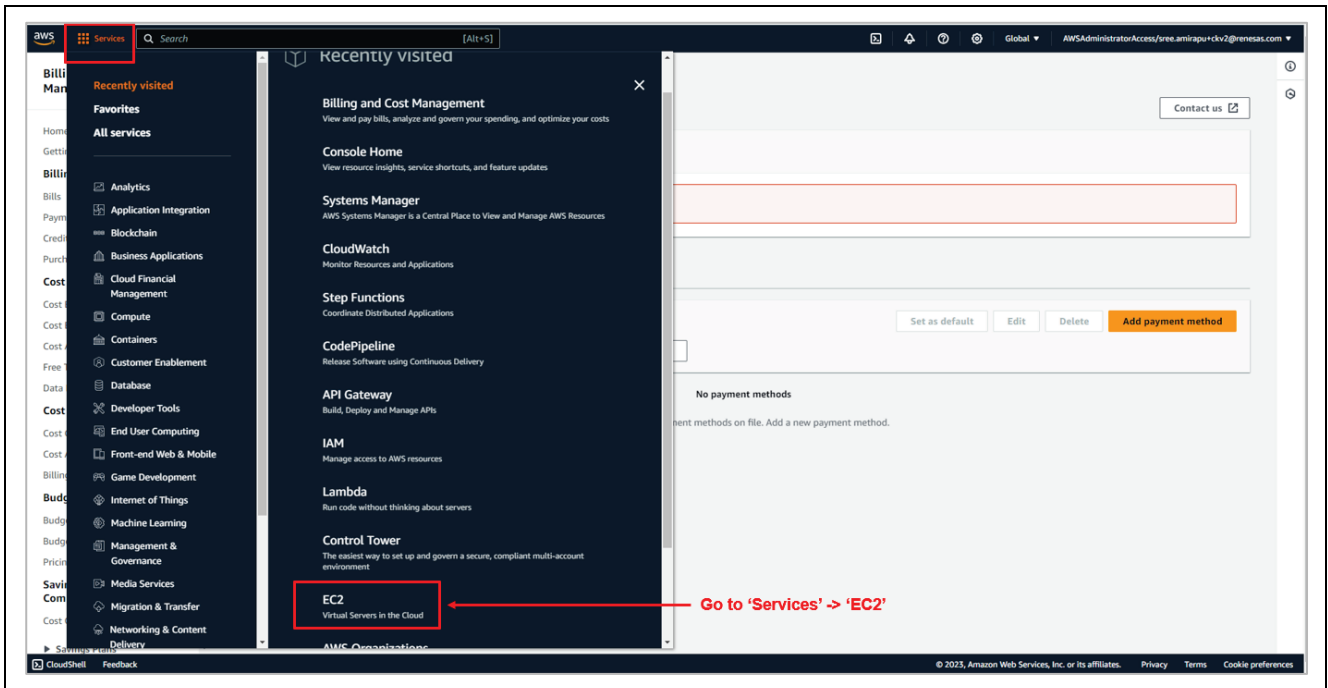


Figure 49. Go to EC2 Services

2. Go to the instances.

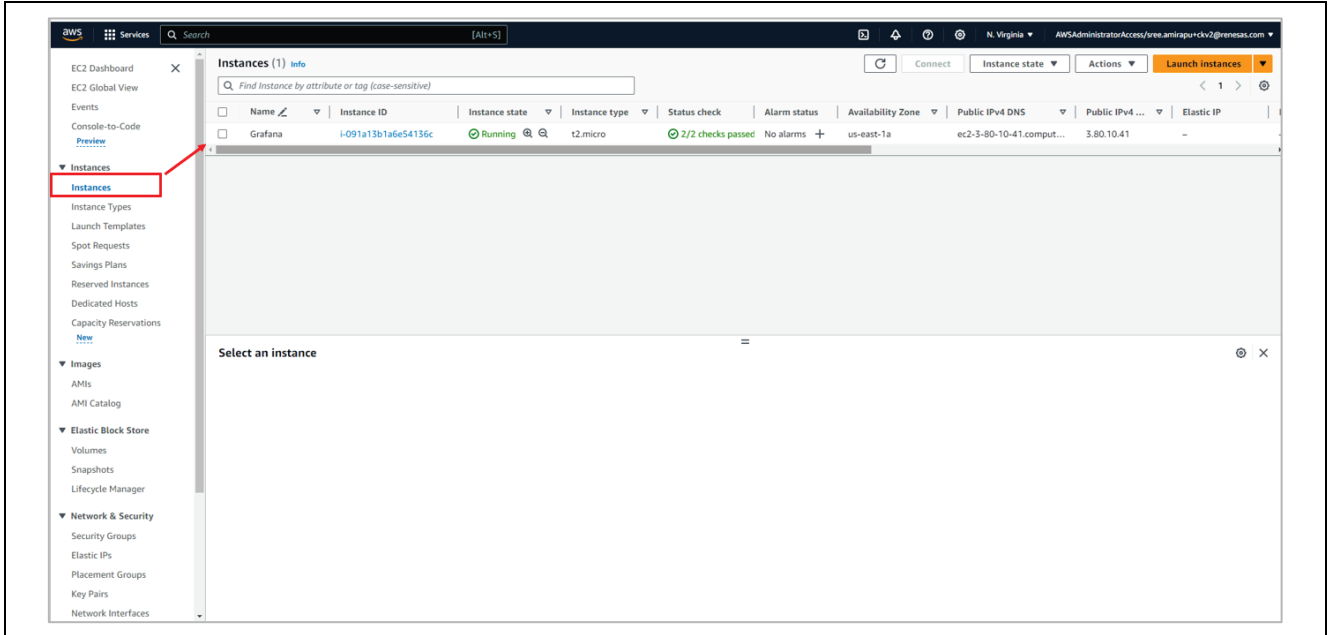


Figure 50. Go to EC2 Instances

3. Select the instance to be disabled and change the 'Instance State' to 'Stop instance'.

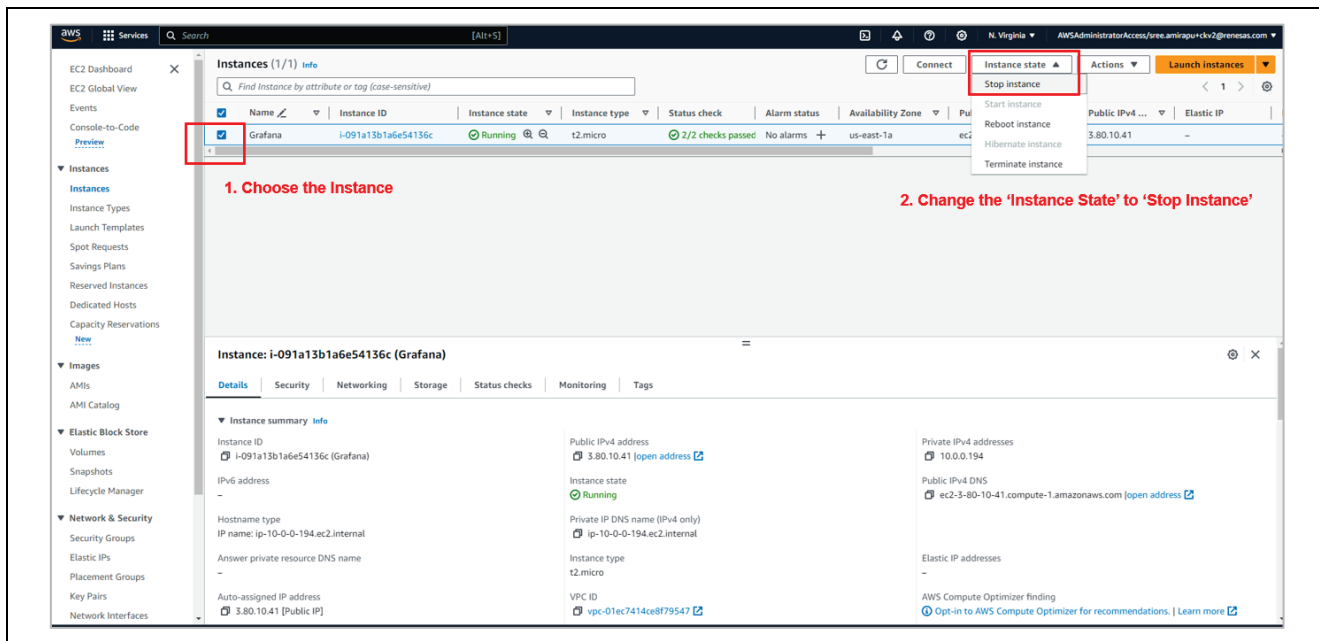


Figure 51. Change the EC2 Instance State

Note: For further details on Renesas AWS dashboard types, dashboard quarantine, activation, and dashboard customization, refer to “AWS Dashboard for CK-RA6M5 and CK-RX65N Application Note” (R11AN0609EU0101).

### 8. Sensor Stabilization Time

Table 2 gives the time required for the sensors to sense and provide the valid data to the users. Here you will see 2 columns, 1) when powered up for the first time 2) after soft or hard reset. If the system boots up from cold start, the time for the sensors to provide the valid data is up to (1 min – 4 hours), whereas if the system boots up from warm start, the time for the sensors to provide the valid data is up to (10 sec – 2 hours). For more details, refer to the specific sensor data sheet.

Table 2. Sensor Stabilization Time

Sensor Name	When Powered Up First Time	After Soft or Hard Reset
ZMOD4410 IAQ	Up to 1 min	Up to 1 min
ZMOD4510 OAQ	Up to 1.5 hours	Up to 1 hours
OB1203	Up to 20 min  (After putting figure on sensor, it may take up to 60 seconds to sense data)	Up to 20 sec  (After putting figure on sensor, it may take up to 60 seconds to sense data)
HS3001	Up to 30 sec	Up to 10 sec
ICP	Up to 30 sec	Up to 10 sec
ICM	Up to 30 sec	Up to 10 sec

Note: Stabilization time of the sensor provided above is from the point of sensor initialized.

## 9. Known Issues and Troubleshooting

- This section talks about the known FSP and tool related issues. More details can be found at the link: <https://github.com/renesas/fsp/issues>.
- It is recommended to use the dashboard with Microsoft edge browser; it does not work properly with Google Chrome browser.
- When running debug on e2studio, if the application is rerun multiple times, it might randomly occur issue with i2c communication of OB1203 sensor. Users need to reconnect the USB cable (J14) to reset OB1203 sensor and run the application again.

## 10. Debugging

Enable the `USR_LOG_LVL (LOG_DEBUG)` macro in the application project for additional information of the error, during debugging.

**Website and Support**

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

CK-RA6M5 Kit Information	<a href="https://renesas.com/ra/ck-ra6m5">renesas.com/ra/ck-ra6m5</a>
RA Cloud Solutions	<a href="https://renesas.com/cloudsolutions">renesas.com/cloudsolutions</a>
RA Product Information	<a href="https://renesas.com/ra">renesas.com/ra</a>
RA Product Support Forum	<a href="https://renesas.com/ra/forum">renesas.com/ra/forum</a>
RA Flexible Software Package	<a href="https://renesas.com/FSP">renesas.com/FSP</a>
Renesas Support	<a href="https://renesas.com/support">renesas.com/support</a>

**Revision History**

Rev.	Date	Description	
		Page	Summary
1.00	Mar.15.23	—	Initial release
1.10	Dec.22.23	—	Migrate to FSP 5.0.0

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

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

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

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity.

Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

### 2. Processing at power-on

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