AmebaD Amazon FreeRTOS Getting Started Guide

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USING THIS DOCUMENT

Though every effort has been made to ensure that this document is current and accurate, more information may have become available subsequent to the production of this guide.

1 AmebaD RTL8722DM Board

1.1 AmebaD Demo EVB

Ameba Demo board home page: https://www.amebaiot.com/amebad/

Ameba RTL8722DM Board (AMB 21)

Manual / Schematic / Layout

Buy it

CPU
- 32-bit Arm®Cortex®-M4, up to 200MHz
- 32-bit Arm®Cortex®-M0, up to 20MHz

Memory
- 512KB SRAM + 4MB PSRAM

Key Features
- Integrated 802.11a/n Wi-Fi SoC
- Trustzone-M Security
- Hardware SSL Engine
- Root Trust Secure Boot
- USB Host/Device
- SD Host
- BLE5.0
- Codec
- LCDC
- Key Matrix

Other Features
- 1 PCM interface
- 4 UART interface
- 1 I2S Interface
- 2 I2C interface
- 7 ADC
- 17 PWM
- Max 54 GPIO

1.2 PCB Layout Overview

The PCB layout of 2D and 3D are shown in Fig 1-1 and Fig 1-2.

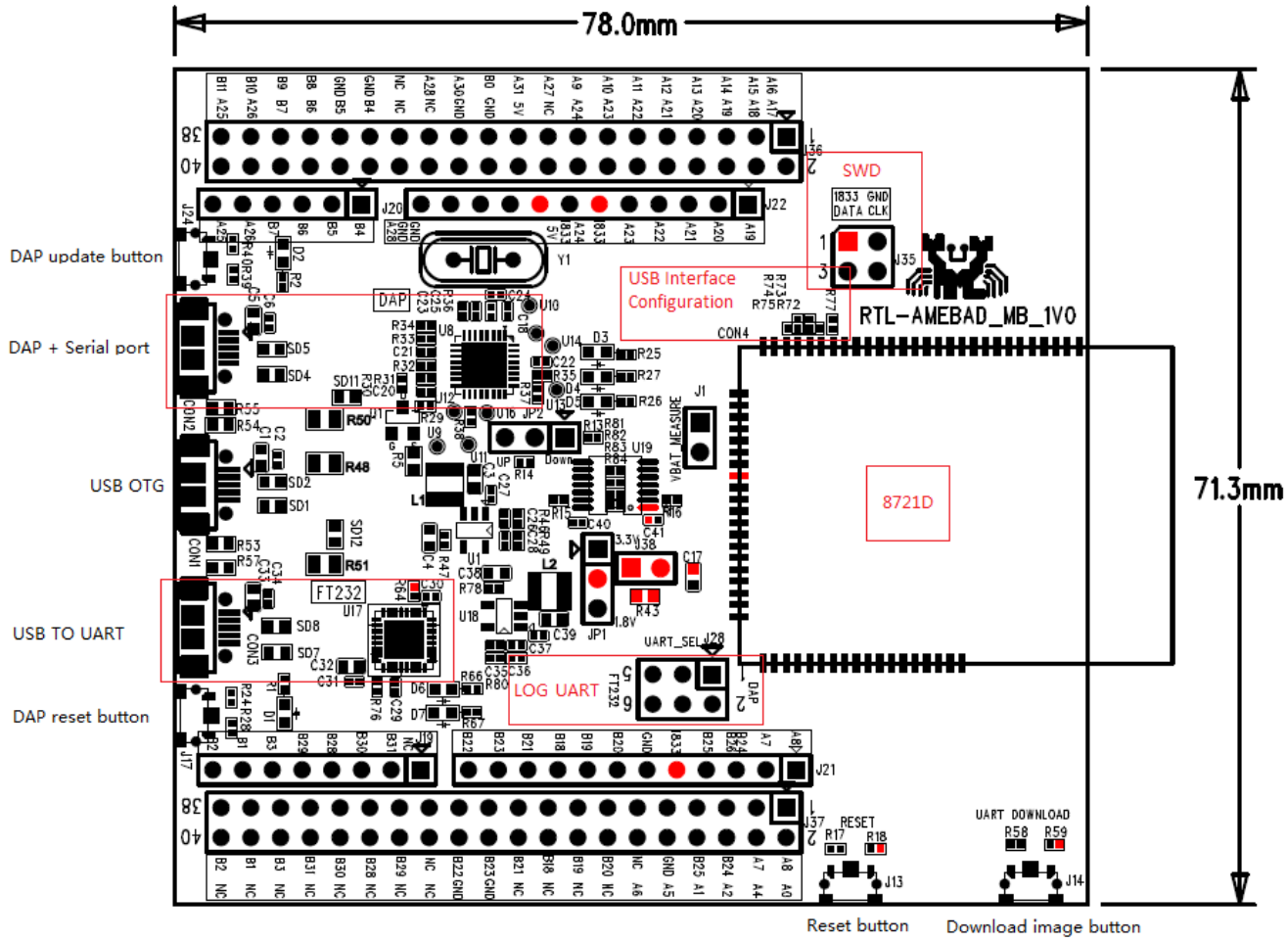


Fig 1-1 Demo board – PCB layout (2D)

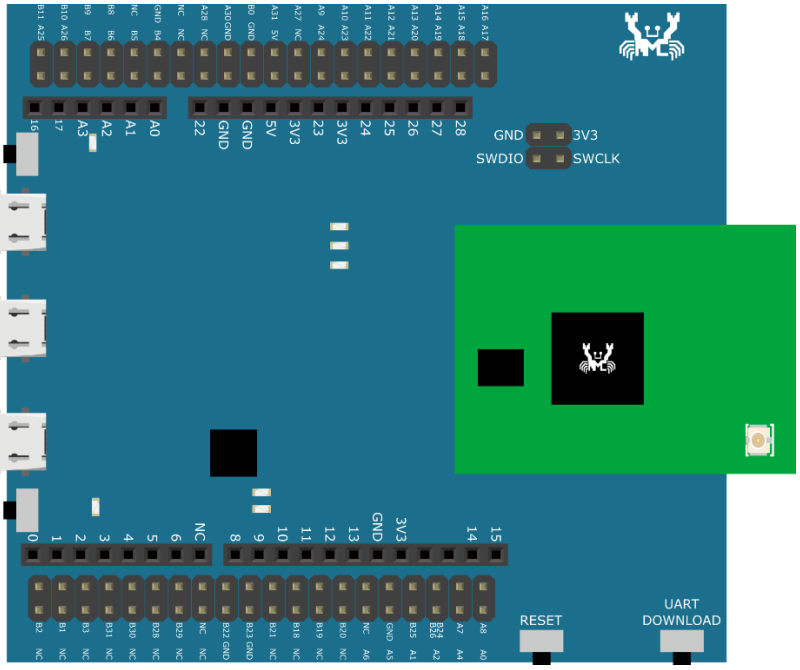


Fig 1-2 Demo board – PCB layout (3D)

1.3 Pin Out

The pin out board is shown in Fig 1-3.

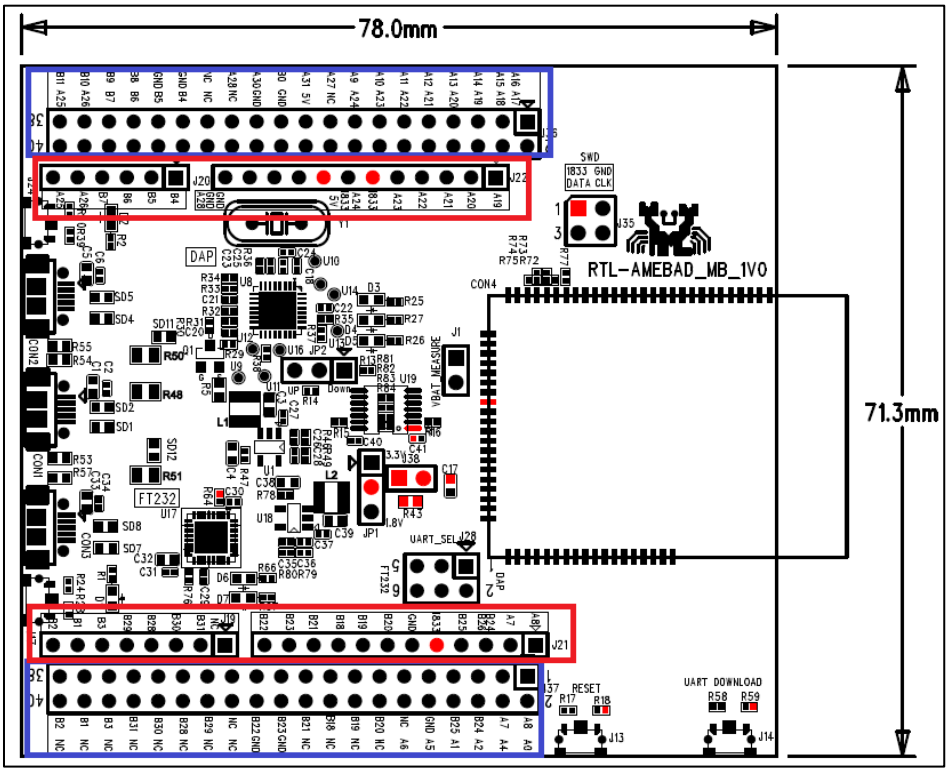


Fig 1-3 Demo board – pin out

There are four rows of pins on the board.

- The pins in the red box are used for Arduino REF.
- The pins in the blue box are all the GPIO pins.

1.4 DC Power Supply

The 3.3V/1.8V power supply board is shown in Fig 1-4.

- Jump JP1 is used to select 3.3V or 1.8V power supply
- Jump J38 is for current test. You can test the current power after taking off the R43.

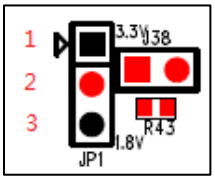


Fig 1-4 Demo board – 3.3V/1.8V power supply

When you select power supply, refer to Table 1-1.

Table 1-1 3.3V/1.8V power supply selection

Power Supply Select	JP1
3.3V	1-2 connected
1.8V	2-3 connected

1.5 USB Interface Configuration

The USB interface configuration board is shown in Fig 1-5 and Fig 1-6.

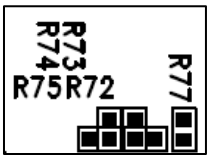


Fig 1-5 Mother board – USB interface configuration

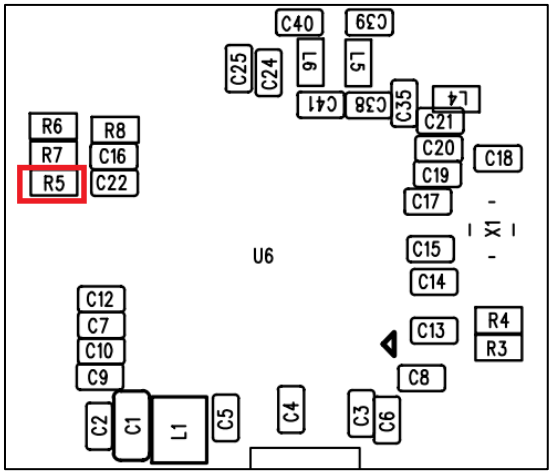


Fig 1-6 Module board – USB interface configuration

For normal GPIO usage by default, R72/R75/R77 on mother board will part on with 0 Ohm resistors, R5 on module board needs to take off. For USB usage, you need to take off R77, part on R73&R74 with 0 Ohm resistors on mother board and part on R5 on module board with a 12K Ohm 1% precision resistor.

1.6 LOGUART

The LOGUART board is shown in Fig 1-7. When you select LOGUART, please refer to Table 1-2.

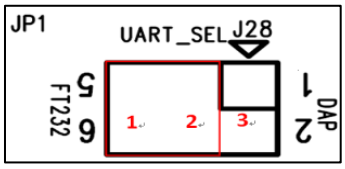


Fig 1-7 Demo board – LOGUART

Table 1-2 LOGUART selection

LOGUART Select	JP1
FT232	1-2 connected
DAP	2-3 connected

1.7 SWD

The SWD board is shown in Fig 1-8.

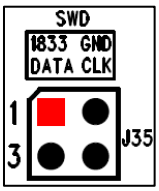


Fig 1-8 Demo board – SWD

Note: For 1V0 board, there is an issue, you should use CLK as DATA, and use DATA as CLK.

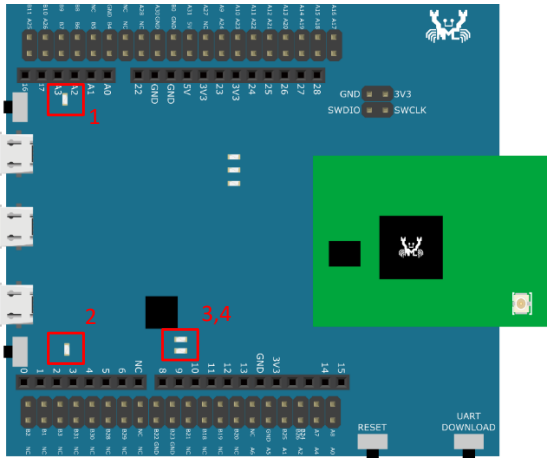
1.8 VBAT ADC

The VBAT ADC board is shown in Fig 1-9. J1 is used to test VBAT ADC.

Fig 1-9 Demo board – VBAT ADC

1.9 LED State

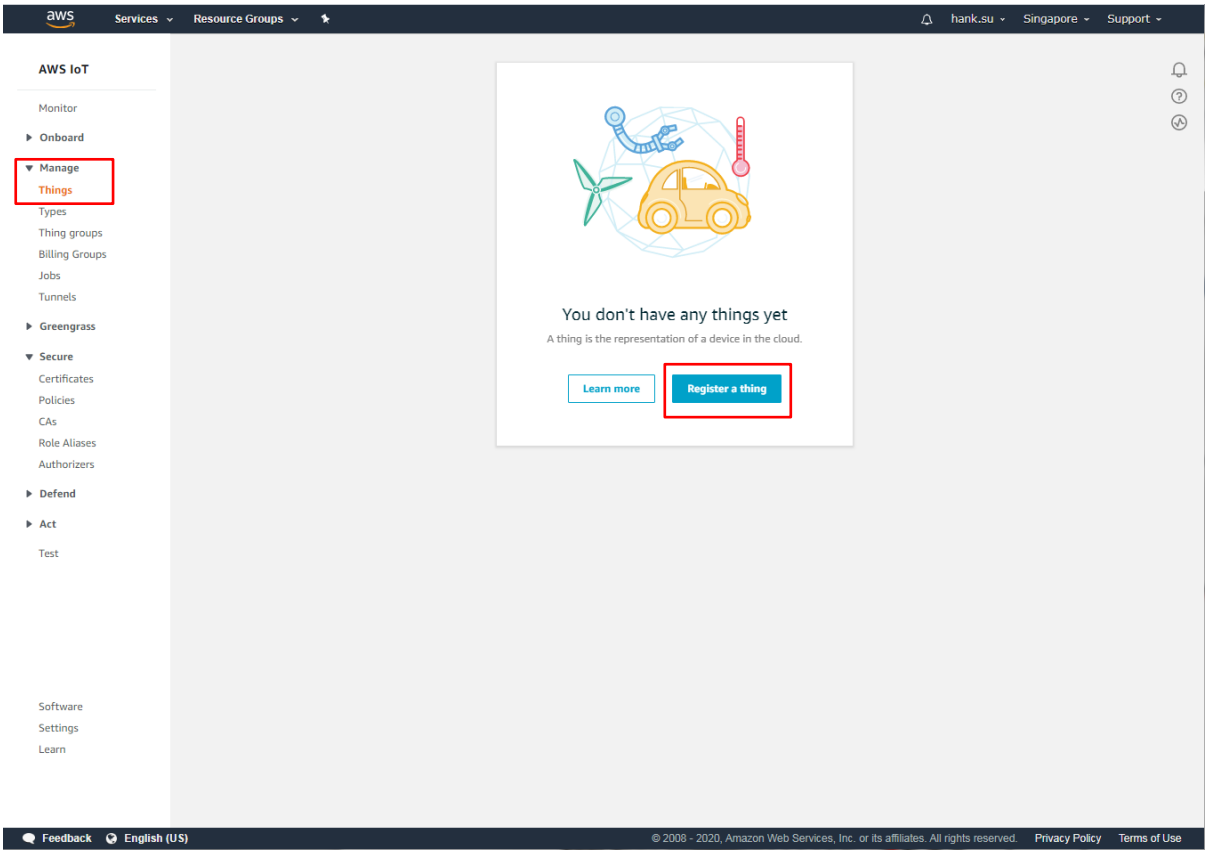
There are four LED on the AmebaD EVB. LED1 and LED2 lights steady green when device have power. LED3 and LED4 go with log uart, they flash red and green when uart communicating.

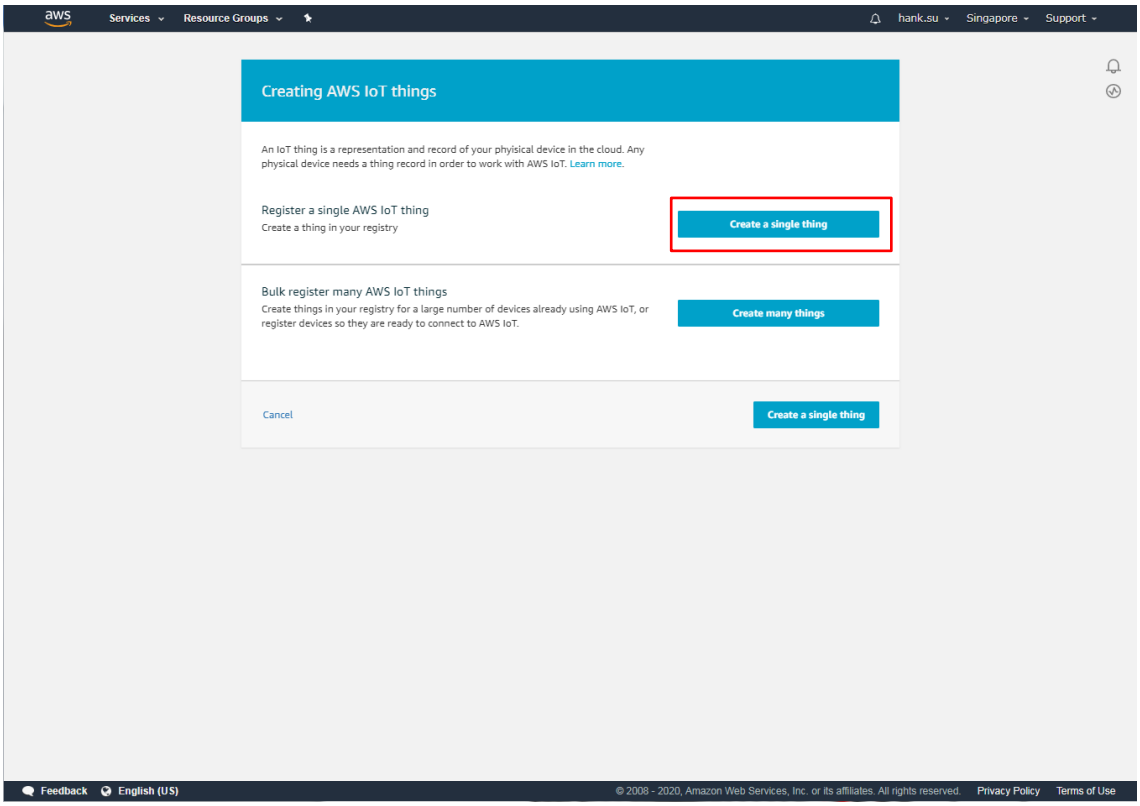


2 Configure AWS IoT Core

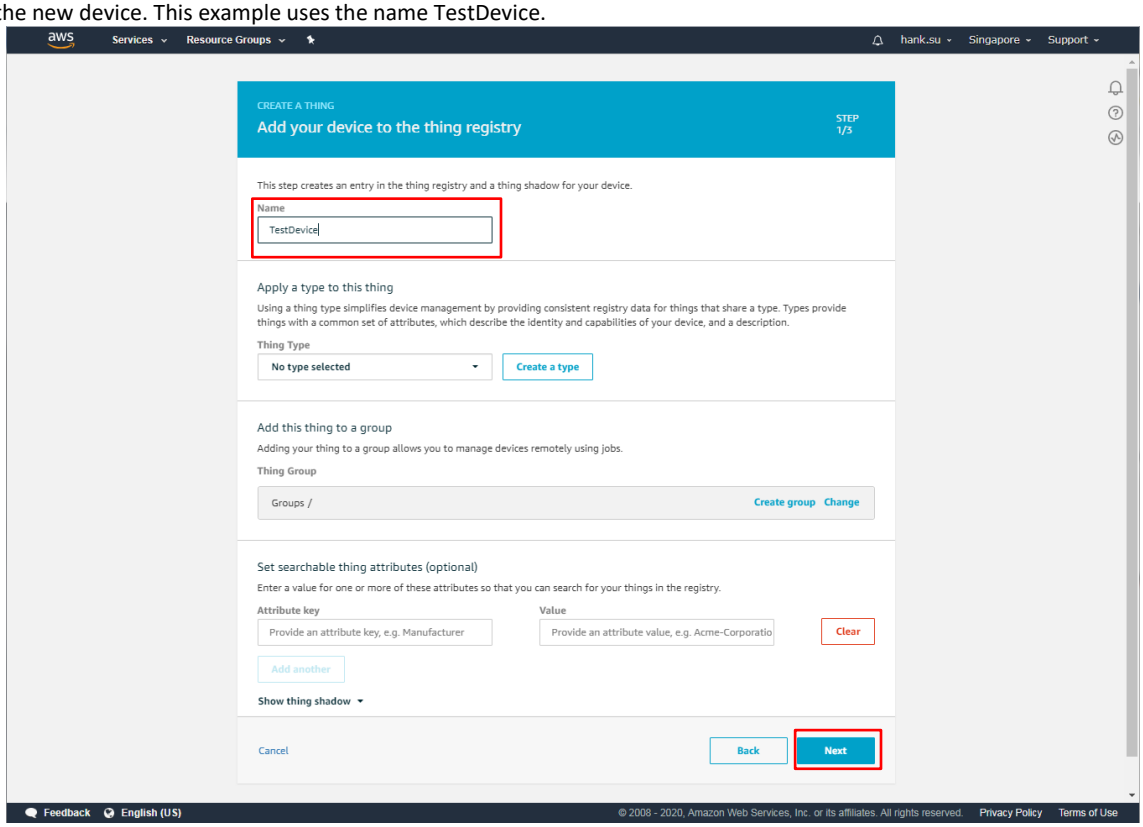
2.1 Create a New Device

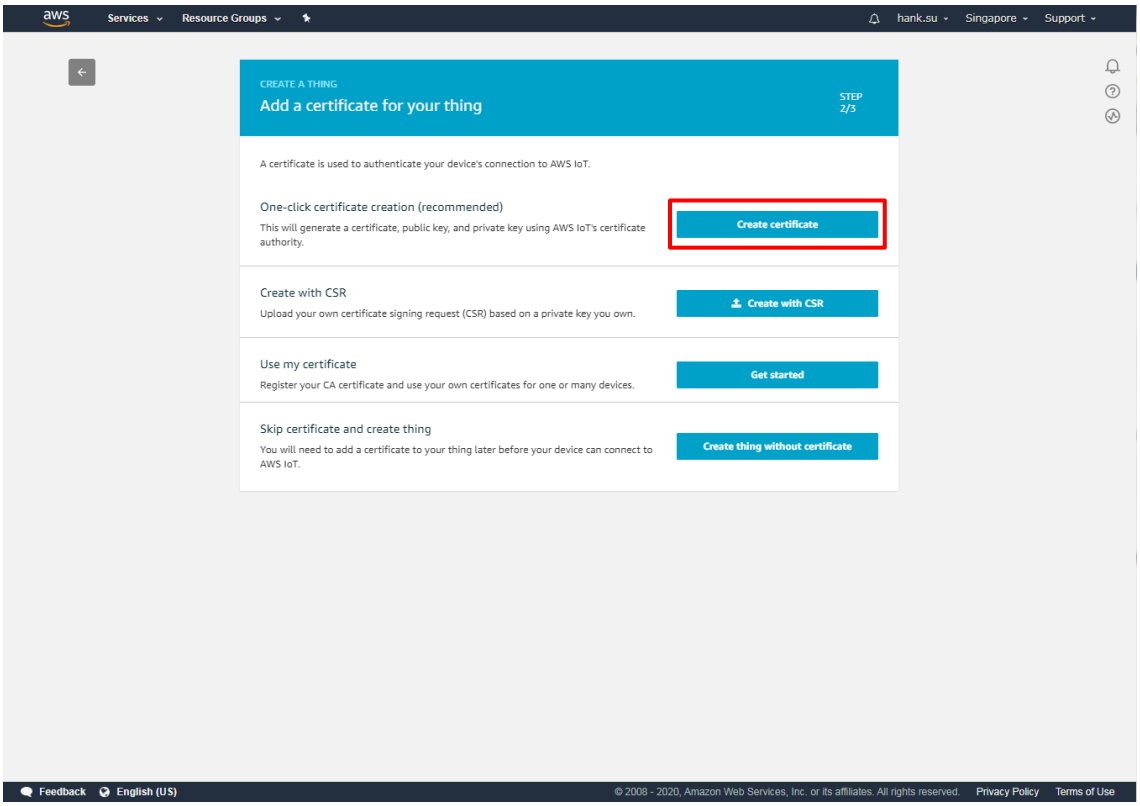
To create a new device, navigate to Manage -> Things in the left-hand navigation menu. Then click “Register a thing”.



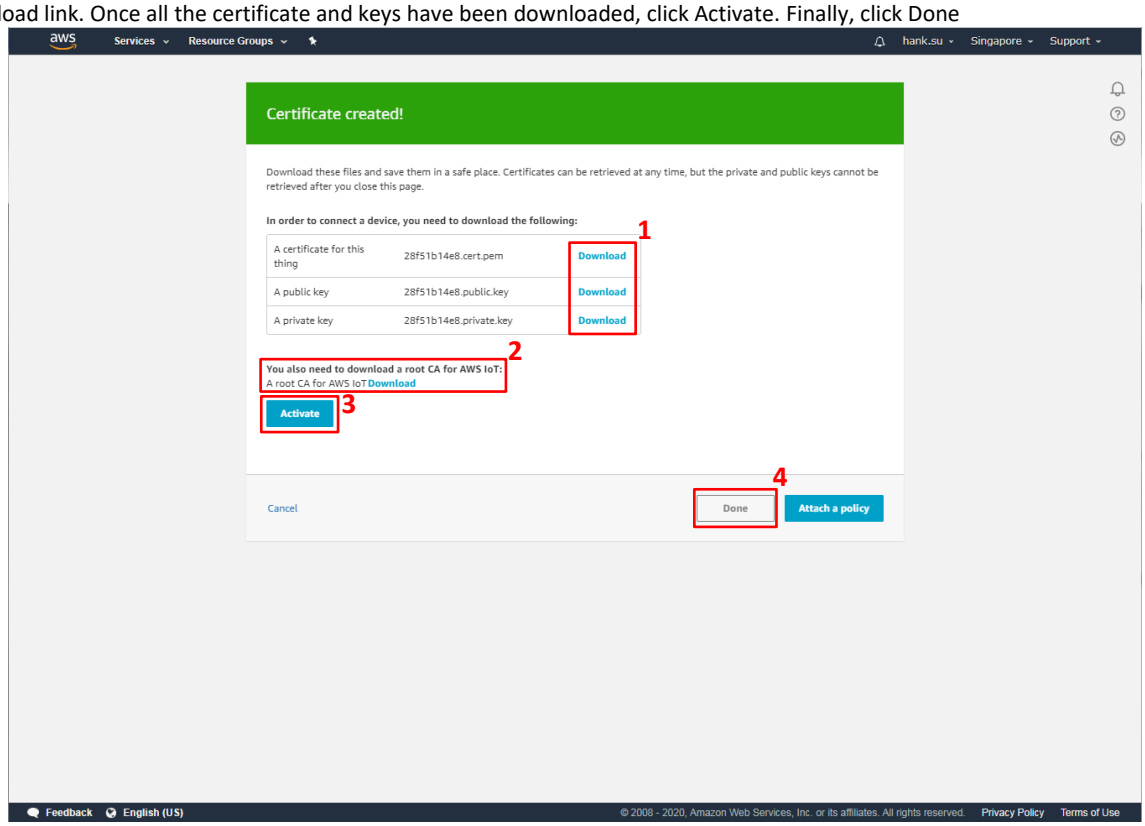


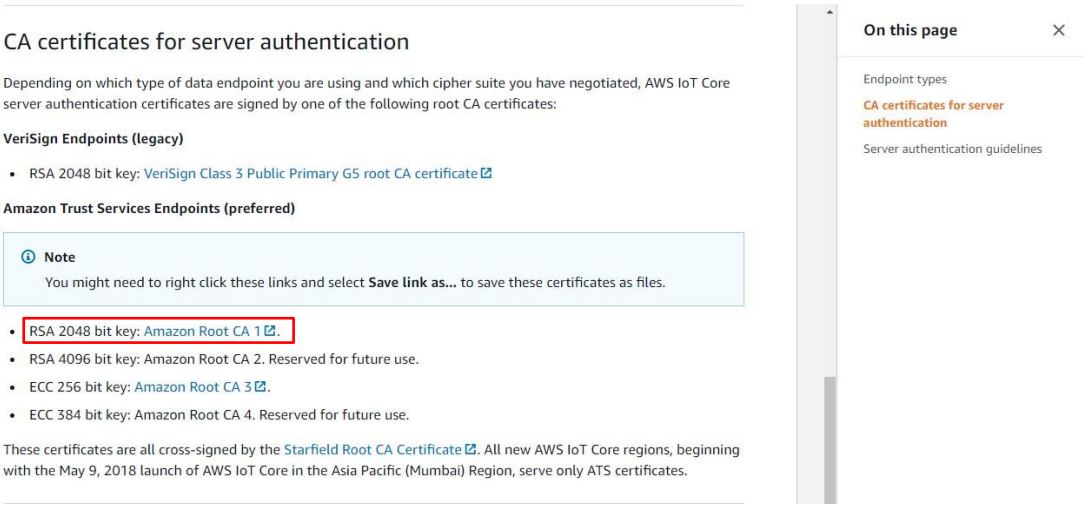
Then, name the new device. This example uses the name TestDevice.





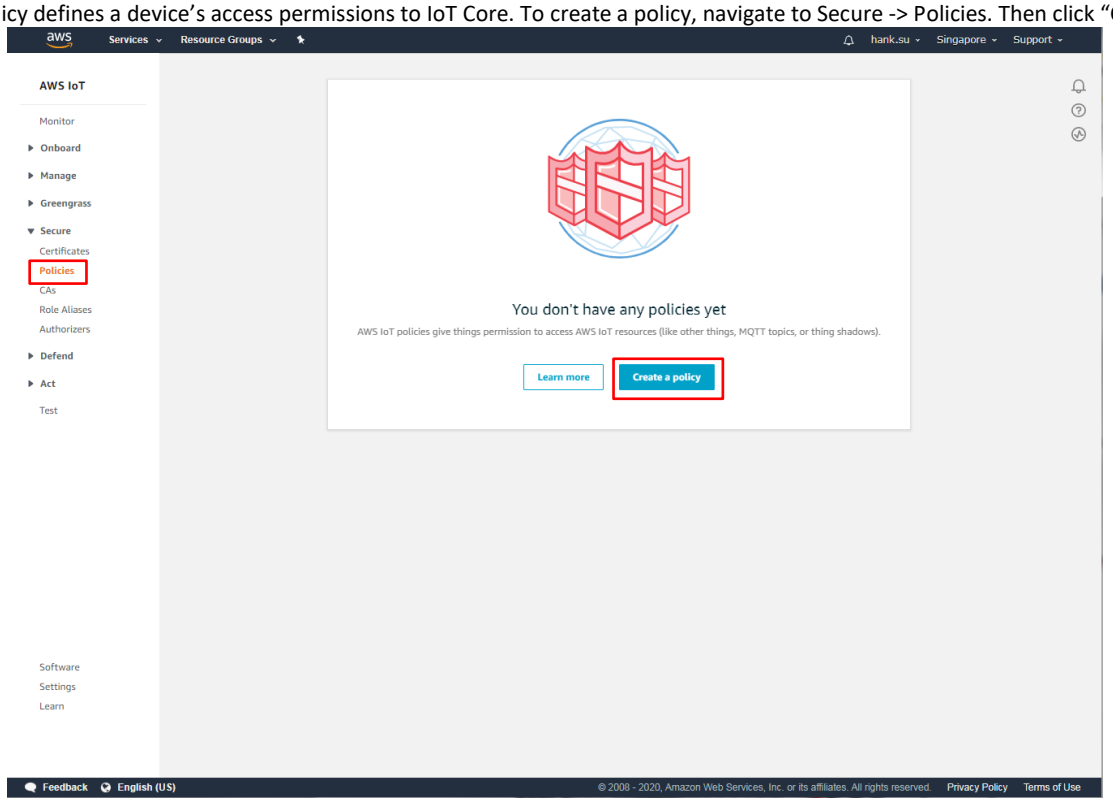
Download the certificate, public key, and private key for the device by clicking Download. Next, download the root CA for AWS IoT by clicking to the Download link. Once all the certificate and keys have been downloaded, click Activate. Finally, click Done



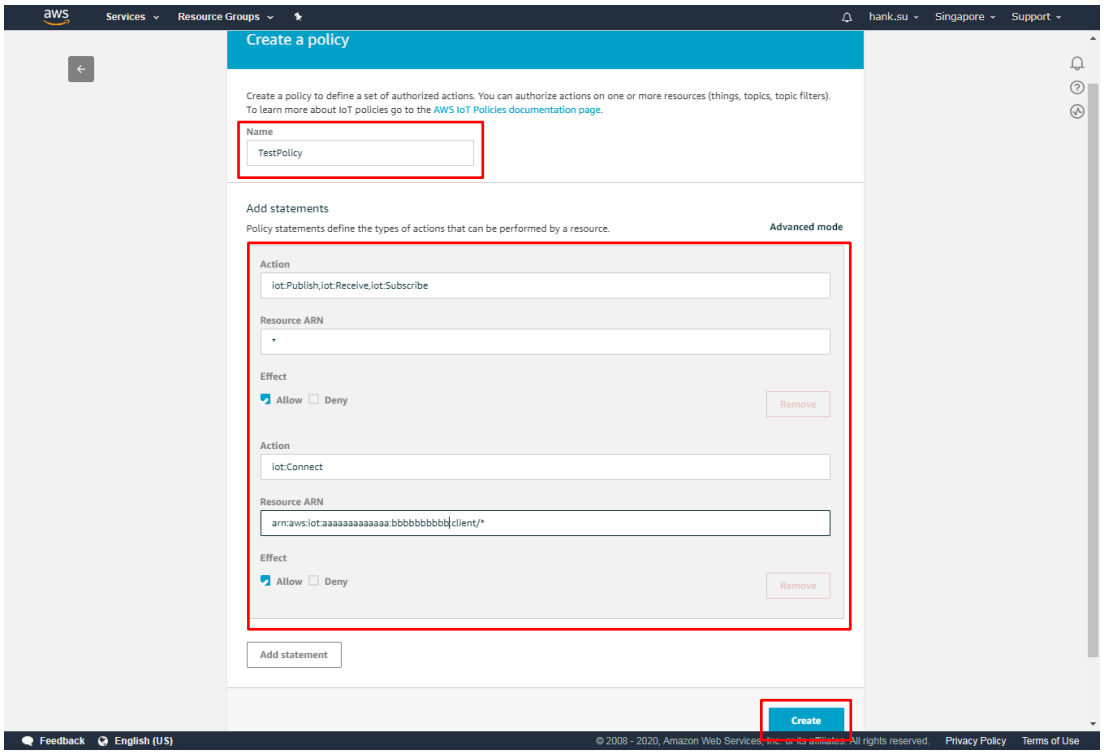


2.2 Create a policy

A policy defines a device's access permissions to IoT Core. To create a policy, navigate to Secure -> Policies. Then click "Create a policy"

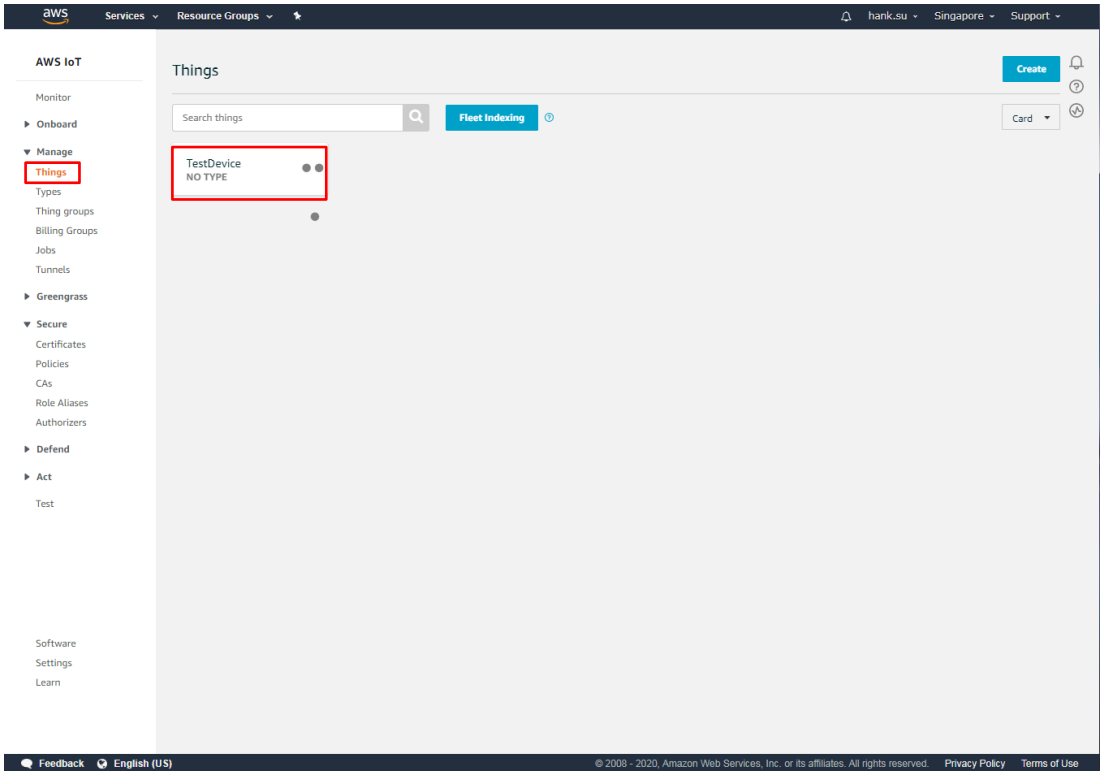


NOTE – this policy grants unrestricted access for all iot operations, and is to be used only in a development environment. For non-dev environments, all devices in your fleet must have credentials with privileges that authorize intended actions only, which include (but not limited to) AWS IoT MQTT actions such as publishing messages or subscribing to topics with specific scope and context. The specific permission policies can vary for your use cases. Identify the permission policies that best meet your business and security requirements.
For sample policies, refer to https://docs.aws.amazon.com/iot/latest/developerguide/example-iot-policies.html.
Also refer to https://docs.aws.amazon.com/iot/latest/developerguide/security-best-practices.html

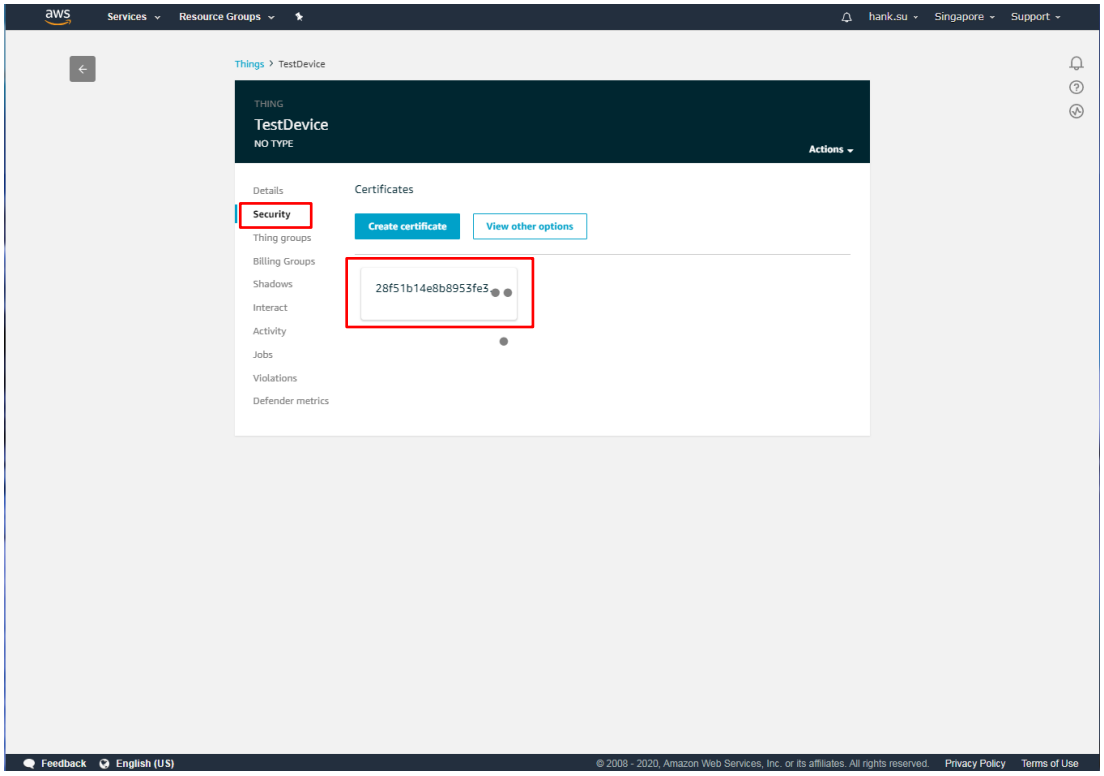


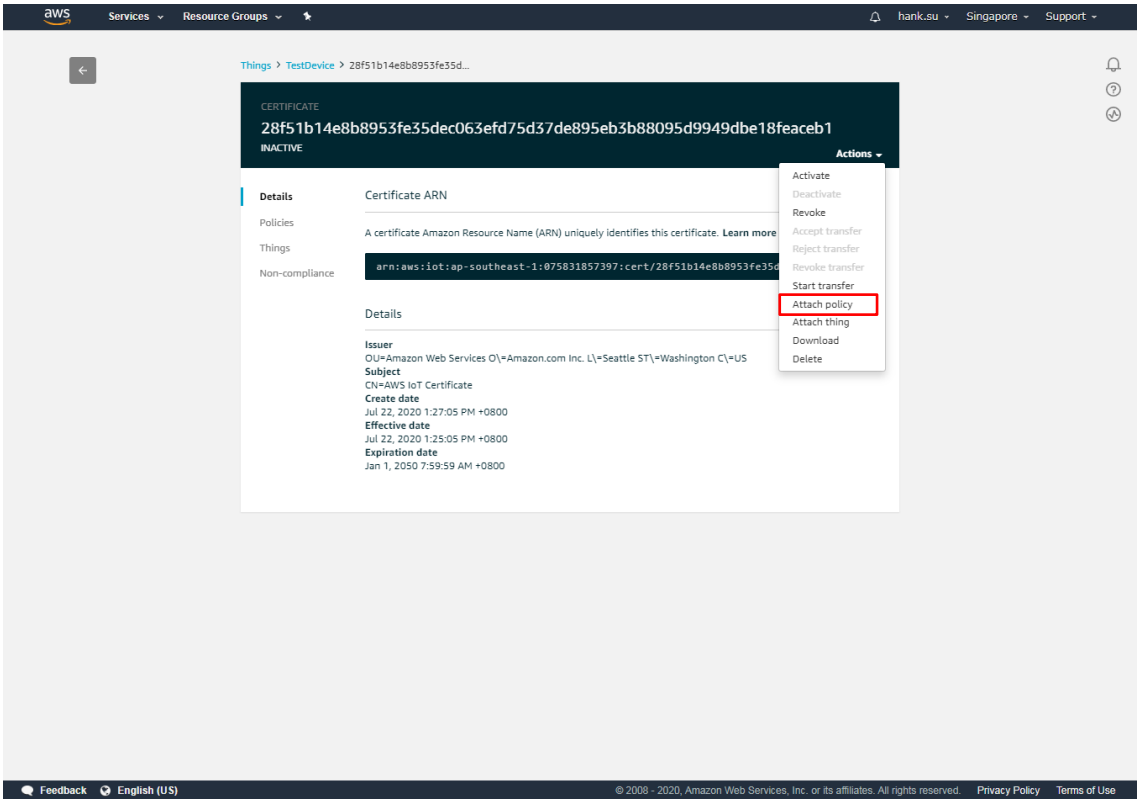
2.3 Attach Policy

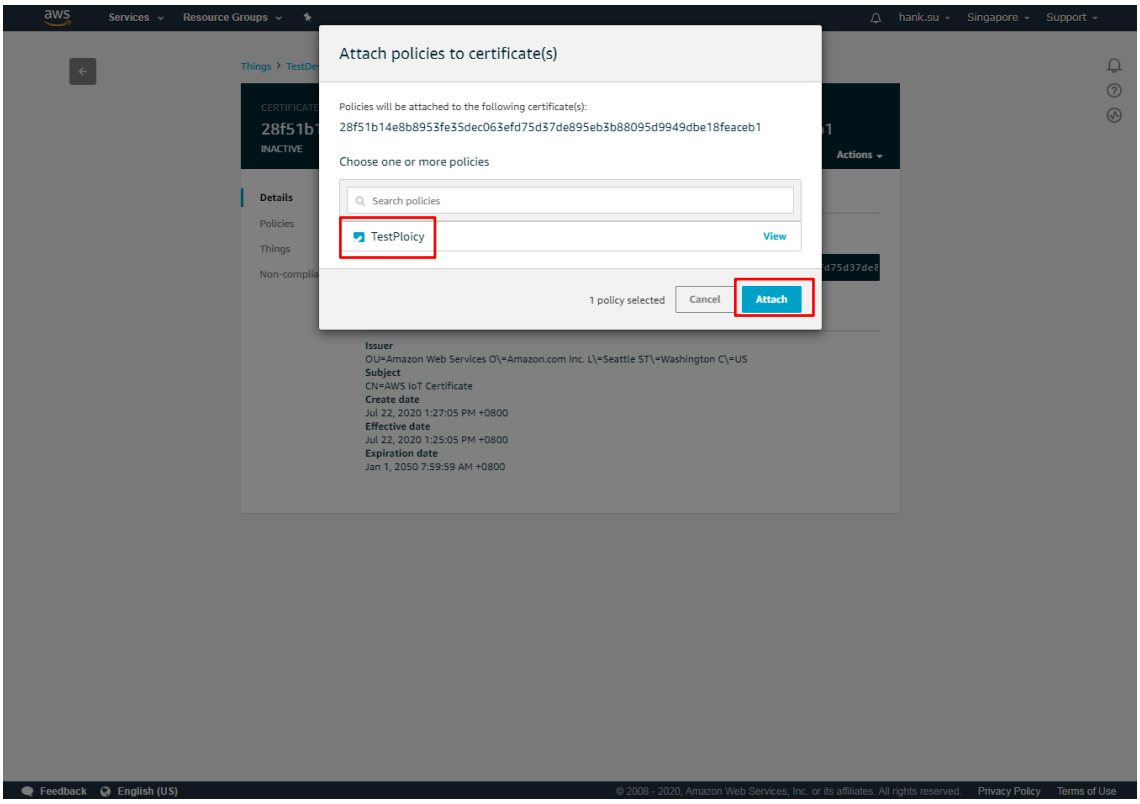
The last step to configuring the device is attaching a policy. To attach a policy to new device, navigate to Manage -> Things. Then click on the device which was created.



Click Security, then click the certificate create in previous step.



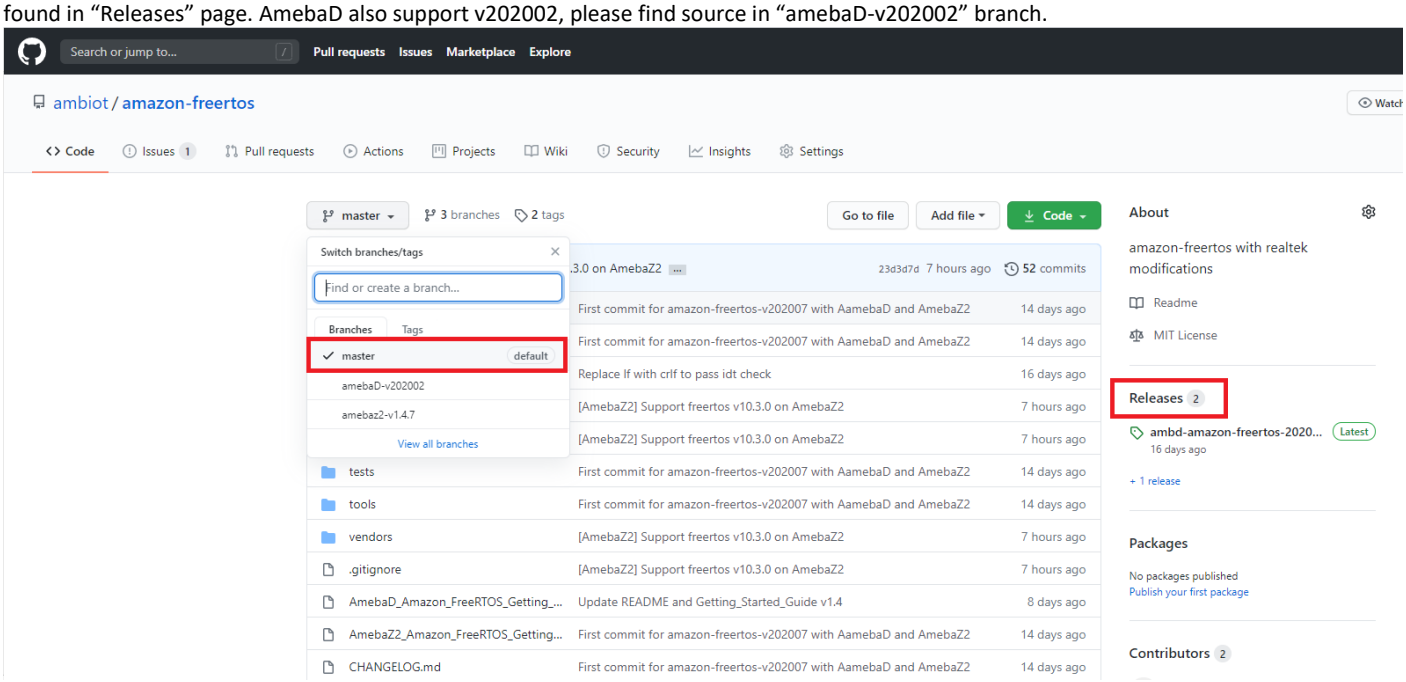




3 Configure AmebaD Amazon FreeRTOS

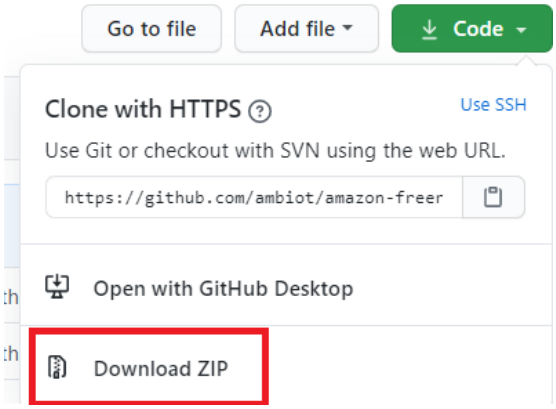
3.1 Download Source Code from github

Open source link: https://github.com/ambiot/amazon-freertos and select master for get newest source code. The stable version could be found in “Releases” page. AmebaD also support v202002, please find source in “amebaD-v202002” branch.



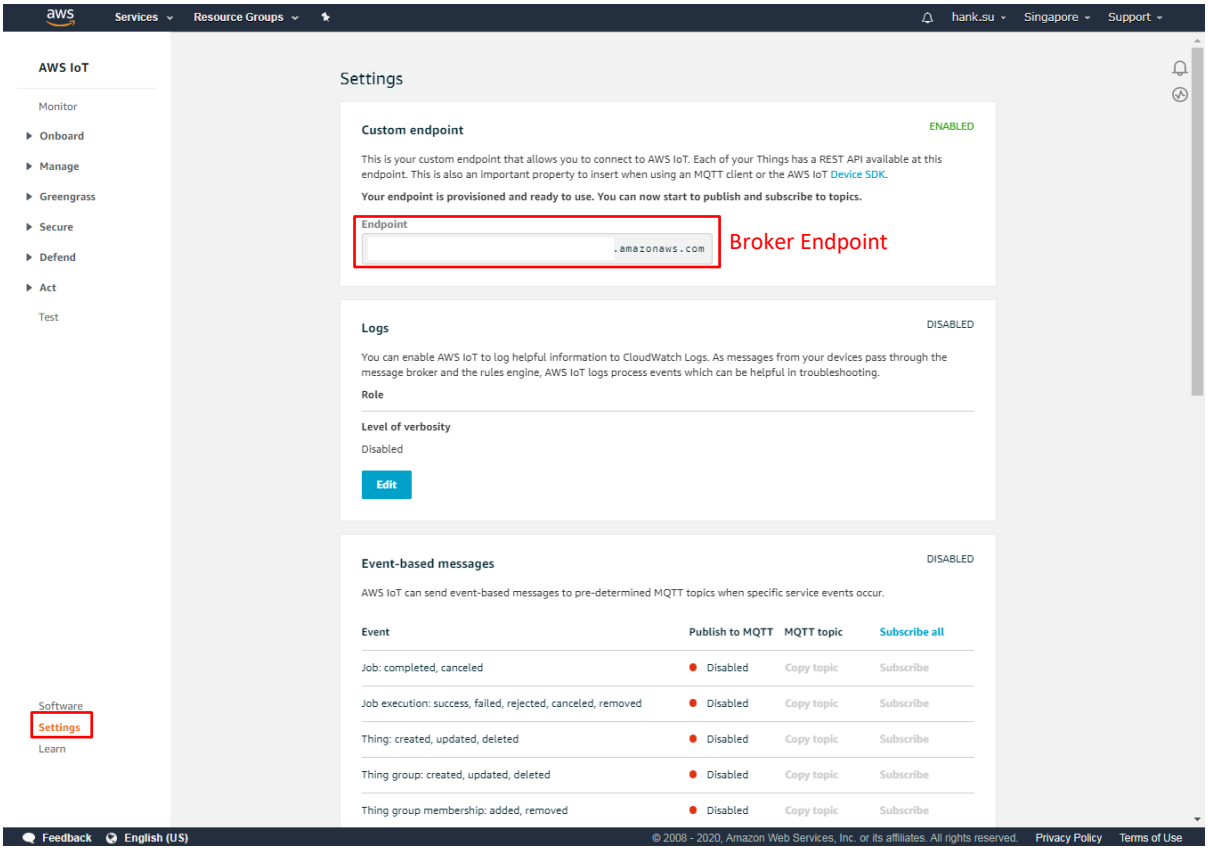
3.1.1 Cloning a repository by Download ZIP

1. On GitHub, navigate to the main page of the repository.
2. Above the list of files, click **Code**.
3. Click **Donwload ZIP** to get source code.

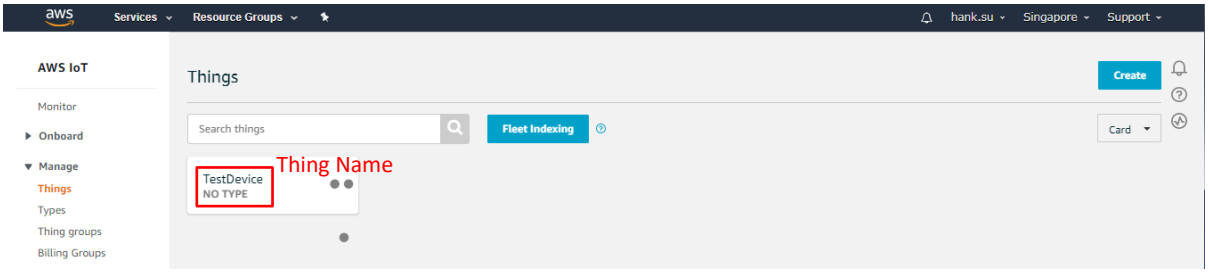


For more information, please refer "Cloning a repository from GitHub to GitHub Desktop."

3.2 Get Broker Endpoint by AWS IoT Core



3.3 Get Thing Name



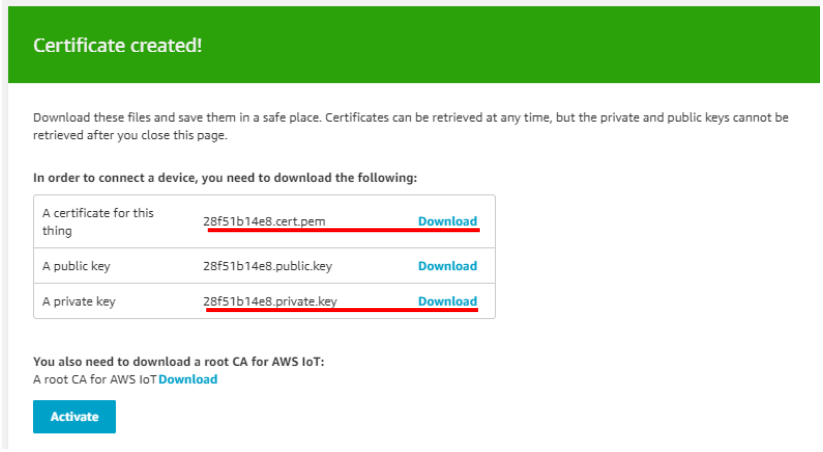
3.4 Setup IoT Core Information with AmebaD Amazon FreeRTOS

Setup BROKER_ENDPOINT, THING_NAME, WIFI_SSID, PASSWORD in “amazon-freertos/demos/include/aws_clientcredential.h”

```
#define clientcredentialMQTT_BROKER_ENDPOINT        "xxxxxxxxxxxxxx.amazonaws.com"

/*
 * @brief Host name.
 *
 * @todo Set this to the unique name of your IoT Thing.
 */
#define clientcredentialIOT_THING_NAME              "TestDevice"

/*
 * @brief Port number the MQTT broker is using.
 */
#define clientcredentialMQTT_BROKER_PORT            8883

/*
 * @brief Port number the Green Grass Discovery use for JSON retrieval from cloud is using.
 */
#define clientcredentialGREENGRASS_DISCOVERY_PORT   8443

/*
 * @brief Wi-Fi network to join.
 *
 * @todo If you are using Wi-Fi, set this to your network name.
 */
#define clientcredentialWIFI_SSID                   "TestAP"

/*
 * @brief Password needed to join Wi-Fi network.
 * @todo If you are using WPA, set this to your network password.
 */
#define clientcredentialWIFI_PASSWORD               "password"

/*
 * @brief Wi-Fi network security type.
 *
 * @see WIFISecurity_t.
 *
 * @note Possible values are eWiFiSecurityOpen, eWiFiSecurityWEP, eWiFiSecurityWPA,
 * eWiFiSecurityWPA2 (depending on the support of your device Wi-Fi radio).
 */
#define clientcredentialWIFI_SECURITY               eWiFiSecurityWPA2

#endif /* ifndef __AWS_CLIENTCREDENTIAL__H__ */
```

3.4.1 Setup Thing’s Private Key and Certificate

Filled keyCLIENT_CERTIFICATE_PEM and keyCLIENT_PRIVATE_KEY_PEM in “amazon-freertos/demos /include/aws_clientcredential_keys.h” by xxxxxxxx-certifiacte.pem and xxxxxxxx-private.pem.key.



It can done by amazon-freertos/tools/certificate_configuration/CertificateConfigurator.html

Final aws_clientcredential_keys.h overview.

```
/*
 * @brief PEM-encoded client certificate.
 *
 * @todo If you are running one of the FreeRTOS demo projects, set this
 * to the certificate that will be used for TLS client authentication.
 *
 * @note Must include the PEM header and footer:
 * "-----BEGIN CERTIFICATE-----\n"\
 * "...base64 data...\n"\
 * "-----END CERTIFICATE-----\n"
 */
#define keyCLIENT_CERTIFICATE_PEM \
"-----BEGIN CERTIFICATE-----\n"\
"MIIDWjCCAkKgAwIBAgIVAIDLSSoG+EARSbBprT4Im1uu8j2vMA0GCSqGSIb3DQEB\n"\
"                                                                \n"\
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"                                                                \n"\
"k5+NsBroU/YdvOUmzKn6XfI4nX4hLQJ2TbhAT8aq1ounGk6ZGqCbxt4mg5bB0w==\n"\
"-----END CERTIFICATE-----"
```

```
/*
 * @brief PEM-encoded client private key.
 *
 * @todo If you are running one of the FreeRTOS demo projects, set this
 * to the private key that will be used for TLS client authentication.
 *
 * @note Must include the PEM header and footer:
 * "-----BEGIN RSA PRIVATE KEY-----\n"\
 * "...base64 data...\n"\
 * "-----END RSA PRIVATE KEY-----\n"
 */
#define keyCLIENT_PRIVATE_KEY_PEM \
"-----BEGIN RSA PRIVATE KEY-----\n"\
"MIIEpAIBAAKCAQEAwop96WNucGebARFjD8O+CLsqcBNn/AHyhEcozLZC8qoECUOn\n"\
"                                                                \n"\
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"pOWEuLUuz2FAv1noAbN/6OQ8H/PT0AFJT/ghA04GnIUF0kjSzY60ehS2mVp6neP+\n"\
"AZjzZ6QJY1b5/PFz9oES448kpyaAoS2ke86+R4r4YOMBK+I5RVbfSQ==\n"\
"-----END RSA PRIVATE KEY-----\n"
```

3.4.2 Enable FreeRTOS demo on AmebaD

Find platform_opts.h in amazon-freertos\vendors\realtek\boards\amebaD\aws_demos\config_files and enable **CONFIG_EXAMPLE_AMAZON_FREERTOS**

```
/* For Amazon FreeRTOS SDK example */
#define CONFIG_EXAMPLE_AMAZON_FREERTOS   1
```

Find aws_demo_config.h in amazon-freertos\vendors\realtek\boards\amebaD\aws_demos\config_files and add **CONFIG_CORE_MQTT_MUTUAL_AUTH_DEMO_ENABLED**

```
/* To run a particular demo you need to define one of these.
 * Only one demo can be configured at a time
 *
 *          CONFIG_CORE_HTTP_MUTUAL_AUTH_DEMO_ENABLED
 *          CONFIG_CORE_HTTP_S3_DOWNLOAD_DEMO_ENABLED
 *          CONFIG_CORE_HTTP_S3_DOWNLOAD_MULTITHREADED_DEMO_ENABLED
 *          CONFIG_CORE_HTTP_S3_UPLOAD_DEMO_ENABLED
 *          CONFIG_CORE_MQTT_MUTUAL_AUTH_DEMO_ENABLED
 *          CONFIG_CORE_MQTT_CONNECTION_SHARING_DEMO_ENABLED
 *          CONFIG_DEVICE_SHADOW_DEMO_ENABLED
 *          CONFIG_DEVICE_DEFENDER_DEMO_ENABLED
 *          CONFIG_JOBS_DEMO_ENABLED
 *          CONFIG_MQTT_BLE_DEMO_ENABLED
 *          CONFIG_GREENGRASS_DISCOVERY_DEMO_ENABLED
 *          CONFIG_TCP_ECHO_CLIENT_DEMO_ENABLED
 *          CONFIG_POSIX_DEMO_ENABLED
 *          CONFIG_OTA_UPDATE_DEMO_ENABLED
 *          CONFIG_BLE_GATT_SERVER_DEMO_ENABLED
 *          CONFIG_BLE_NUMERIC_COMPARISON_DEMO_ENABLED
 *
 *  These defines are used in iot_demo_runner.h for demo selection */

#define CONFIG_CORE_MQTT_MUTUAL_AUTH_DEMO_ENABLED
```

Now you can start to compile AmebaD Amazon FreeRTOS

4 Compile AmebaD Amazon FreeRTOS

4.1 IAR Build Environment Setup

Currently the amazon-freertos of AmebaD supported by the IAR Embedded workbench ver.8.30.1. For windows operating system only. This chapter illustrates how to setup IAR development environment for Realtek Ameba-D SDK, including building projects and downloading images.

4.2 Pre-Requisite

- Required source code. (https://github.com/ambiot/amazon-freertos)
- AmebaD Demo board
- Realtek Image Tool
- IAR Embedded Workbench ver.8.30.1

IAR provides an IDE environment for code building, downloading, and debugging. Check “IAR Embedded Workbench” on http://www.iar.com/, and a trail version is available for 30 days.

Note: To support ARMv8-M with Security Extension (Ameba-D HS CPU, also called KM4), IAR version must be 8.30 or higher.

4.3 How to Use IAR SDK

4.3.1 IAR Project Introduction

Because Ameba-D is a dual-core CPU platform, two workspaces provided to build for each core in **amazon-freertos/projects/realtek/amebaD/IAR/aws_demos**

- Project_lp_release.eww (KM0 workspace) contains the following projects:
  - km0_bootloader
  - km0_application
- Project_hp_release.eww (KM4 workspace) contains the following projects:
  - km4_bootloader
  - km4_application

4.3.2 IAR Build

When building SDK for the first time, you should build both KM0 project and KM4 project. Other times, you only need to rebuild the modified project.

4.3.2.1 Building KM0 Project

The following steps show how to build KM0 project:

(1) Open **amazon-freertos\projects\realtek\amebaD\IAR\aws_demos\Project_lp_release.eww**.

(2) Make sure km0_bootloader and km0_application are in Workspace. Click **Project** > **Options**, **General Options** > **Target** > **Processor Variant** > **Core**, verify the CPU configurations according to Fig 4-1

(3) Right click the project and choose “Rebuild All”, as Fig 4-2 shows. The km0_bootloader and km0_application should compile in order.

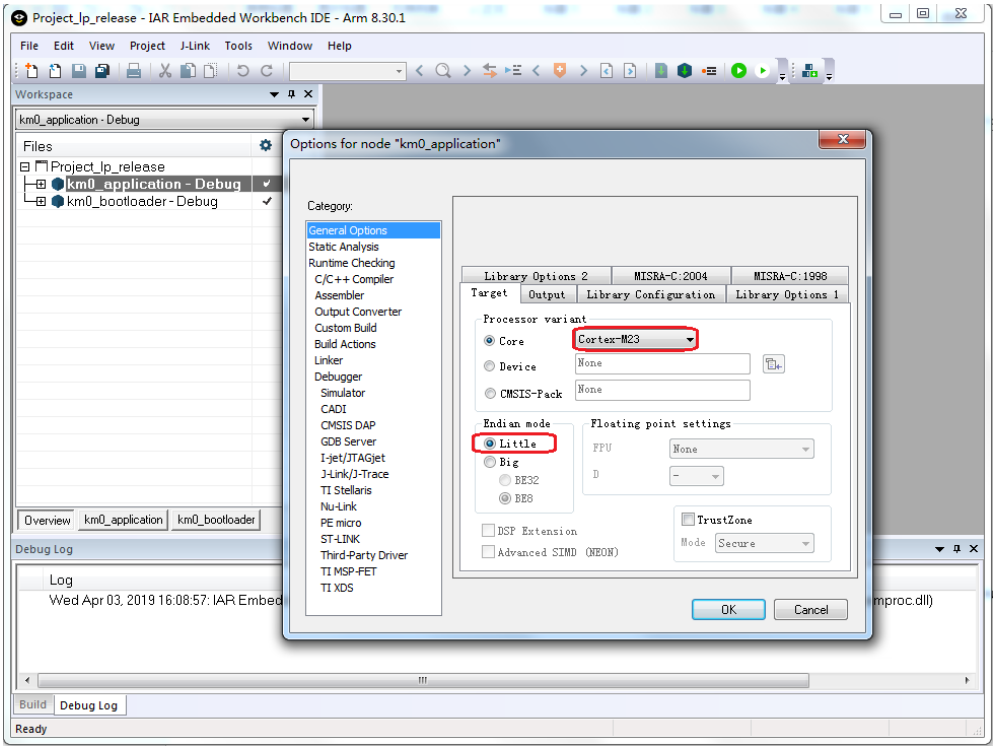


Fig 4-1 KM0 processor options

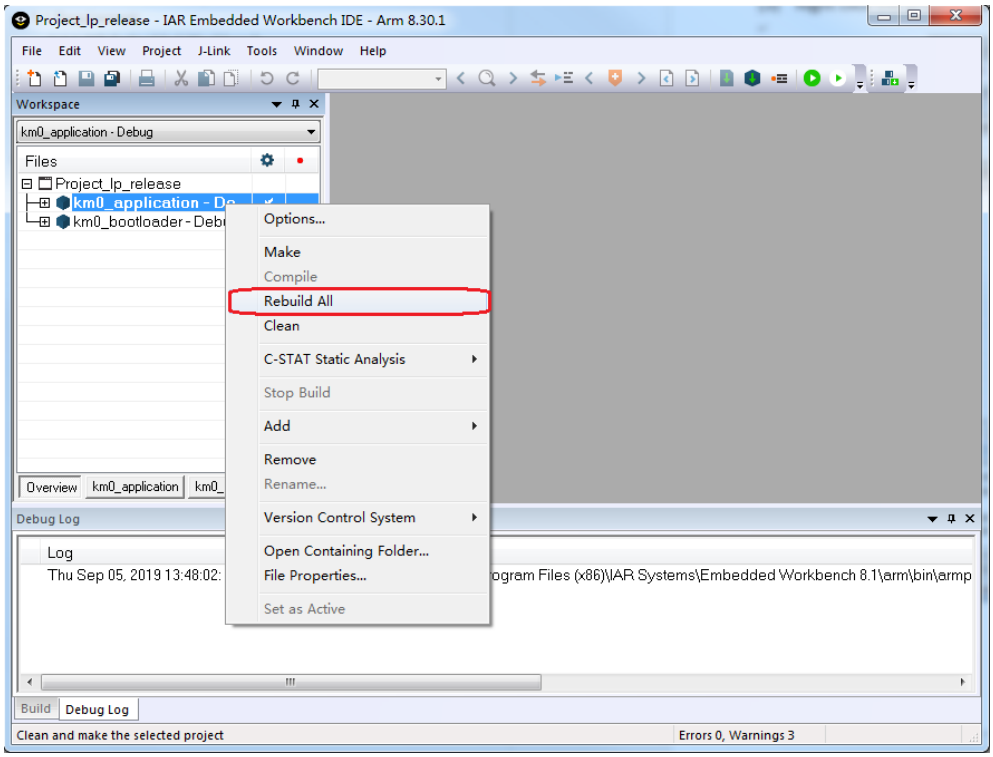
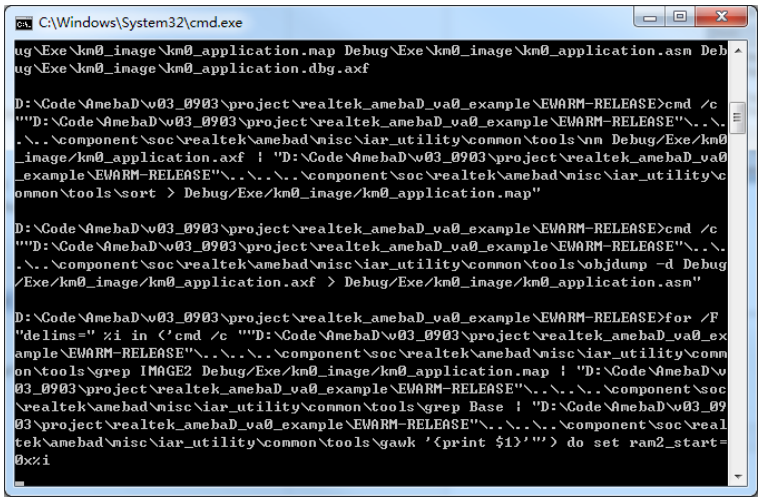


Fig 4-2 Building KM0 project

Note: After building each project, IAR will pop up a command prompt window to execute post-build action to generate images from executable files. This may takes several seconds. Do not stop it while it is in progress. After post-build action is completed, the window would disappear automatically.



(4) After compile, the images km0_boot_all.bin and km0_image2_all.bin can be find in **amazon-freertos\projects\realtek\amebaD\IAR\aws_demos\Debug\Exe\km0_image**.

4.3.2.2 Building KM4 Project

The following steps show how to build KM4 project:

(1) Open **amazon-freertos\projects\realtek\amebaD\IAR\aws_demos\Project_hp_release.eww**.

(2) Refer to 4.3.1 and choose the build configurations for each project according to your application.

(3) Click **Project** > **Options**, **General Options** > **Target** > **Processor Variant** > **Core**, verify the CPU configurations according to Fig 4-3.

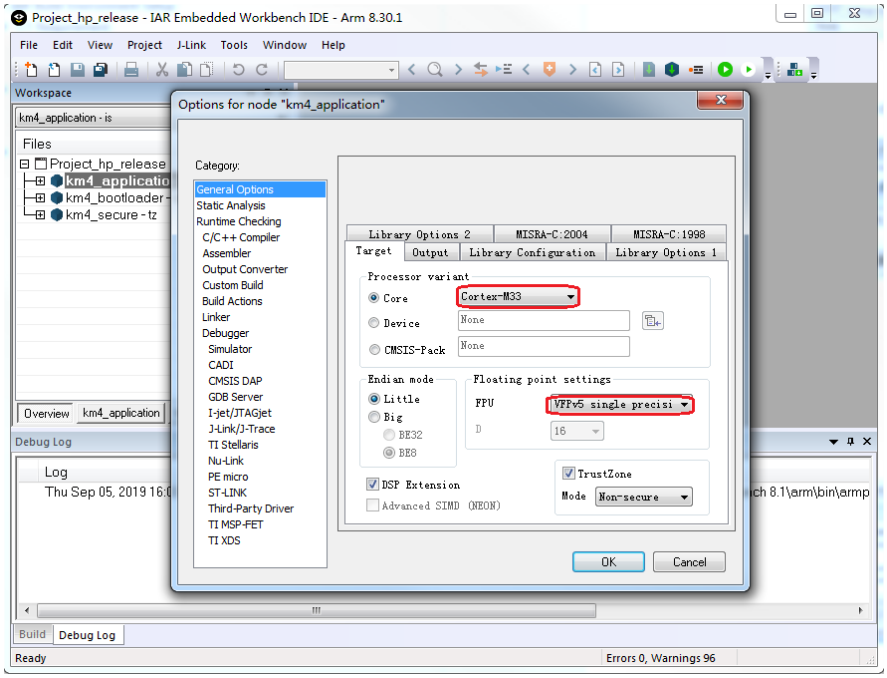


Fig 4-3 KM4 processor options

(4) Right click the project and choose “Rebuild All”, as Fig 4-4 shows. The km4_bootloader, km4_application should compile in order.

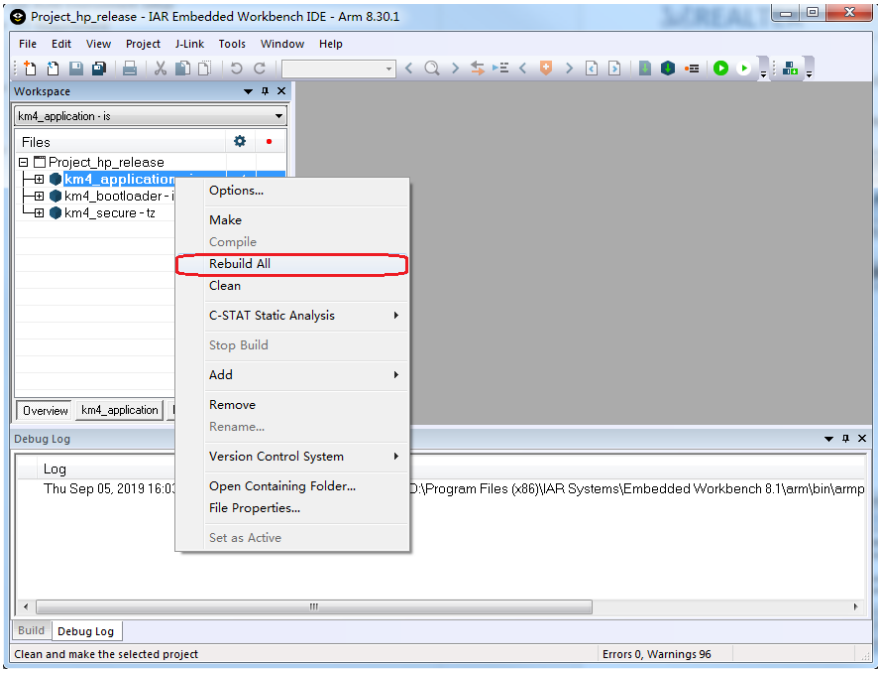
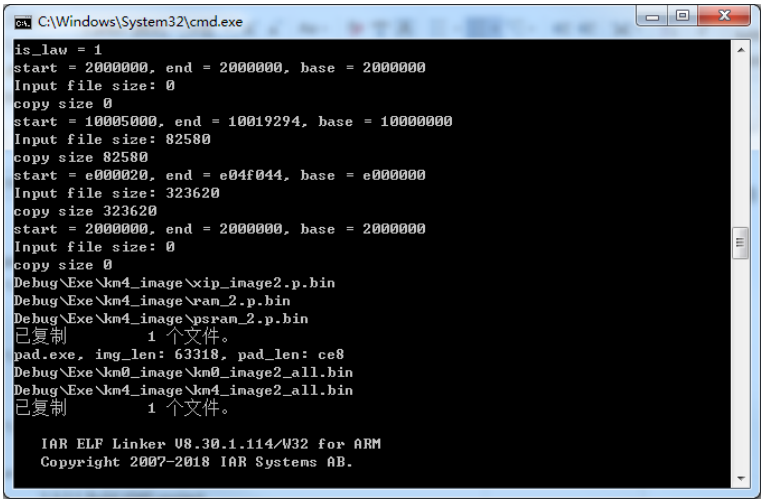


Fig 4-4 Building KM4 project

Note:

- After building each project, IAR will pop up a command prompt window shown in bellow to execute post-build action to generate images from executable files. This may takes several seconds. Do not stop it while it is in progress. After post-build action is completed, the window would disappear automatically.



(5) After compile, the images km4_boot_all.bin and km0_km4_image2.bin can be find in **amazon-freertos\projects\realtek\amebaD\IAR\aws_demos\Debug\Exe\km4_image**.

(6) The generated images can be downloaded to flash by ImageTool:

5 ImageTool

The tool can be find in amazon-freertos\vendors\realtek\tools\ameba-image-Tool-v2.4.1\

5.1 Introduction

This chapter introduces how to use ImageTool to encrypt, generate and download images. As show in Fig 5-1, ImageTool has four tabpages.

- Download: used as image download server to transmit images to Ameba through UART.

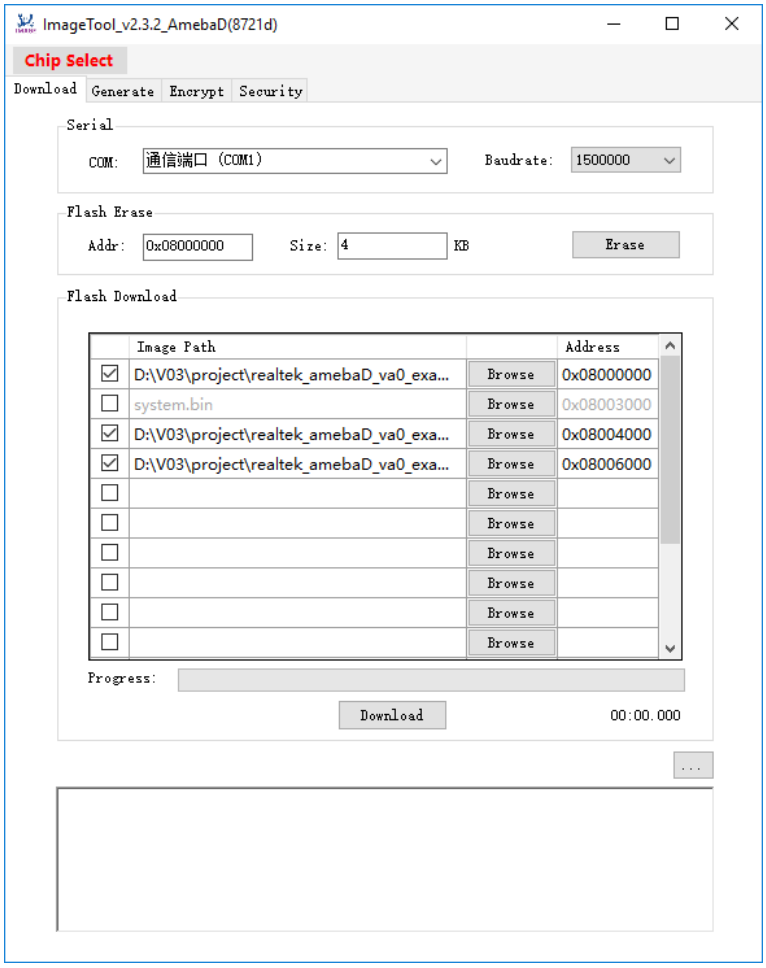


Fig 5-1 ImageTool UI

5.2 Environment Setup

5.2.1 Hardware Setup

The hardware setup is shown in Fig 5-2.

Note: If using external UART to download images, FT232 USB to UART dongle must be used.

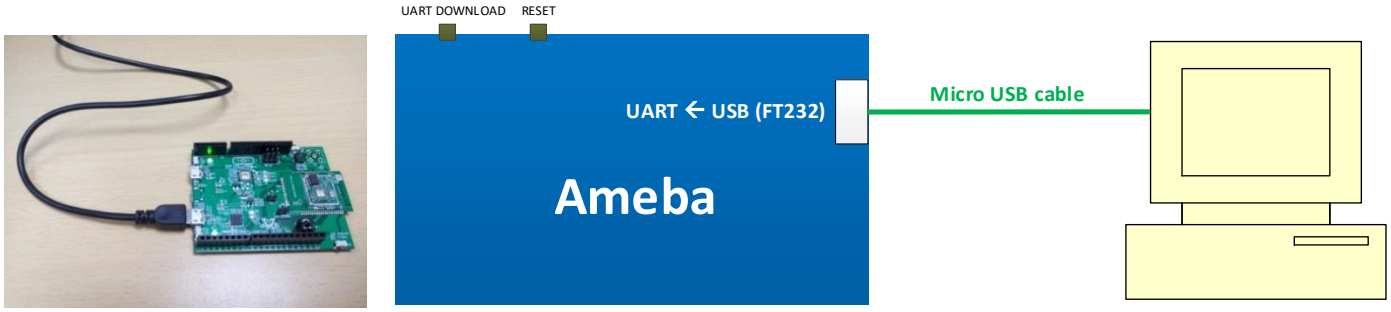


Fig 5-2 Hardware setup

5.2.2 Software Setup

- Environment Requirements: EX. WinXP, Win 7 Above, Microsoft .NET Framework 3.5
- ImageTool.exe Location: **vendors\realtek\tools\ameba-image-Tool-v2.4.1\ImageTool.exe**

Name	Date modified	Type	Size
ChangeLog.txt	7/29/2019 11:52 AM	Text Document	4 KB
Download.ini	11/4/2019 5:44 PM	Configuration sett...	2 KB
Encrypt.ini	11/4/2019 5:44 PM	Configuration sett...	1 KB
ImageTool.exe	7/29/2019 11:52 AM	Application	282 KB
ImageTool.pdb	7/29/2019 11:52 AM	VisualStudio.pdb....	178 KB
ImageTool.vshost.exe	8/20/2018 1:41 PM	Application	14 KB
ImageTool.vshost.exe.manifest	8/20/2018 1:41 PM	MANIFEST File	1 KB
imgtool_flashloader_amebad.bin	6/6/2019 3:15 PM	BIN File	5 KB
imgtool_flashloader_amebaz.bin	6/6/2019 3:15 PM	BIN File	6 KB
SB.exe	8/20/2018 1:41 PM	Application	189 KB
system.bin	8/6/2019 9:53 AM	BIN File	4 KB
TestListView.dll	8/20/2018 1:41 PM	Application extens...	5 KB
TestListView.pdb	8/20/2018 1:41 PM	VisualStudio.pdb....	14 KB

5.3 Download

5.3.1 Image Download

Assuming that the ImageTool on PC is a server, it sends images files to Ameba (client) through UART. There are two ways to download images to board.

5.3.1.1 Based on Hardware Reset

The way based on hardware reset is a manual method to download images, and it is the primary and recommended method.

(1) Enter into UART_DOWNLOAD mode.
   a) Push the **UART DOWNLOAD** button and keep it pressed.
   b) Re-power on the board or press the **Reset** button.
   c) Release the **UART DOWNLOAD** button.
   Now, Ameba board gets into UART_DOWNLOAD mode and is ready to receive data.

(2) Click **Chip Select** (in red) on UI and select chip (AmebaD).

(3) Select the corresponding serial port and transmission baud rate. The default baud rate is 1.5Mbps (recommended).

(4) Click the **Browse** button to select the images (**km0_boot_all.bin/km4_boot_all.bin/km0_km4_image2.bin**) to be programmed and input addresses.
   - The image path is located in **{*path*}\projects\realtek\amebaD\IAR\aws_demos\Debug\Exe\km0_image** and **{*path*}\projects\realtek\amebaD\IAR\aws_demos\Debug\Exe\km4_image**, where **{*path*}** is the location of the project on your own computer.
   - The default target address is the SDK default image address, you can use it directly.

(5) Click **Download** button to start. The progress bar will show the transmit progress of each image. You can also get the message of operation successfully or errors from the log window.

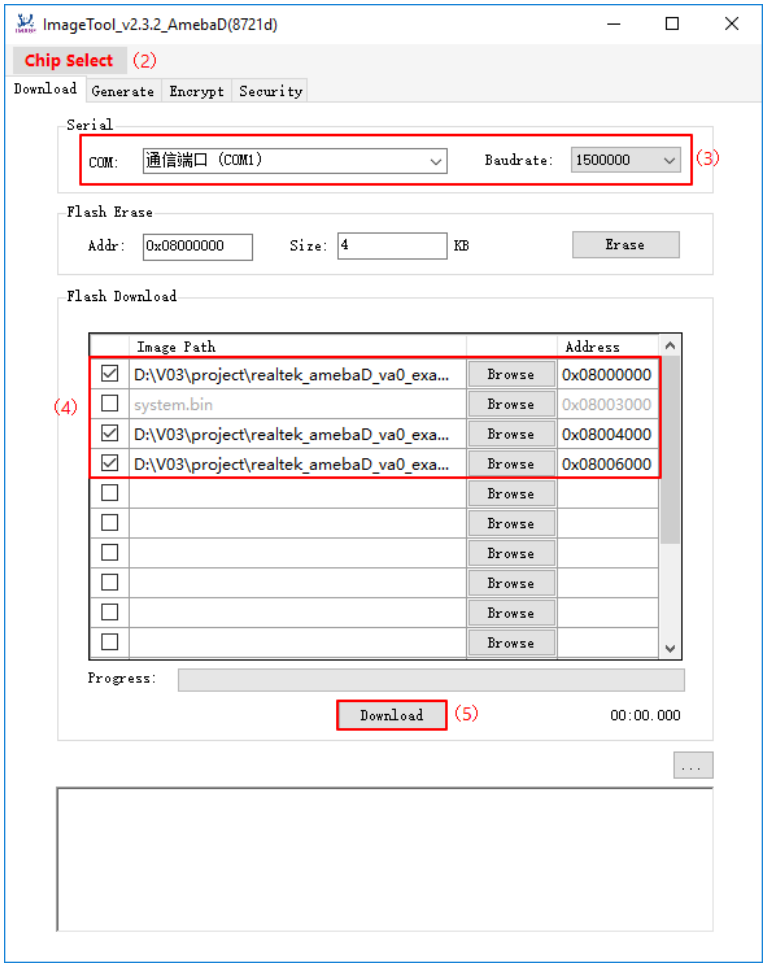


Fig 5-3 ImageTool 'Download' tabpage setting

6 MQTT Demo

6.1 Get Device Log

Install Tera Term to get device log

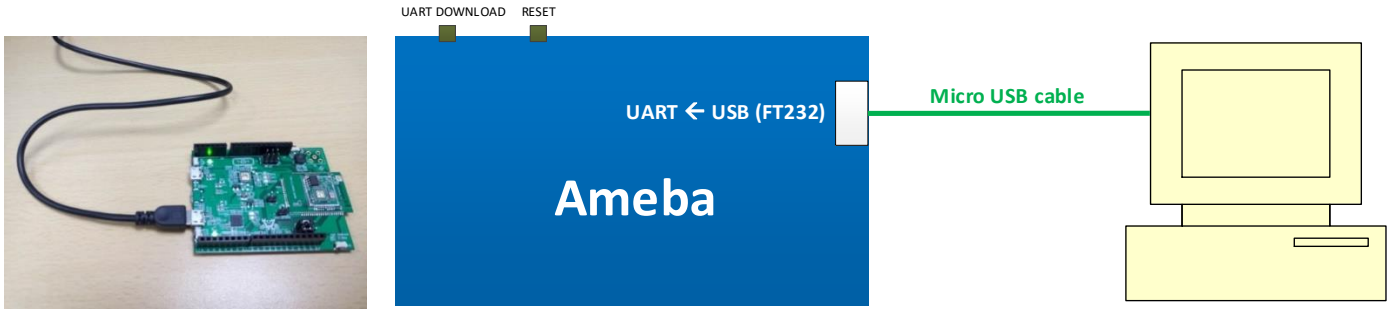
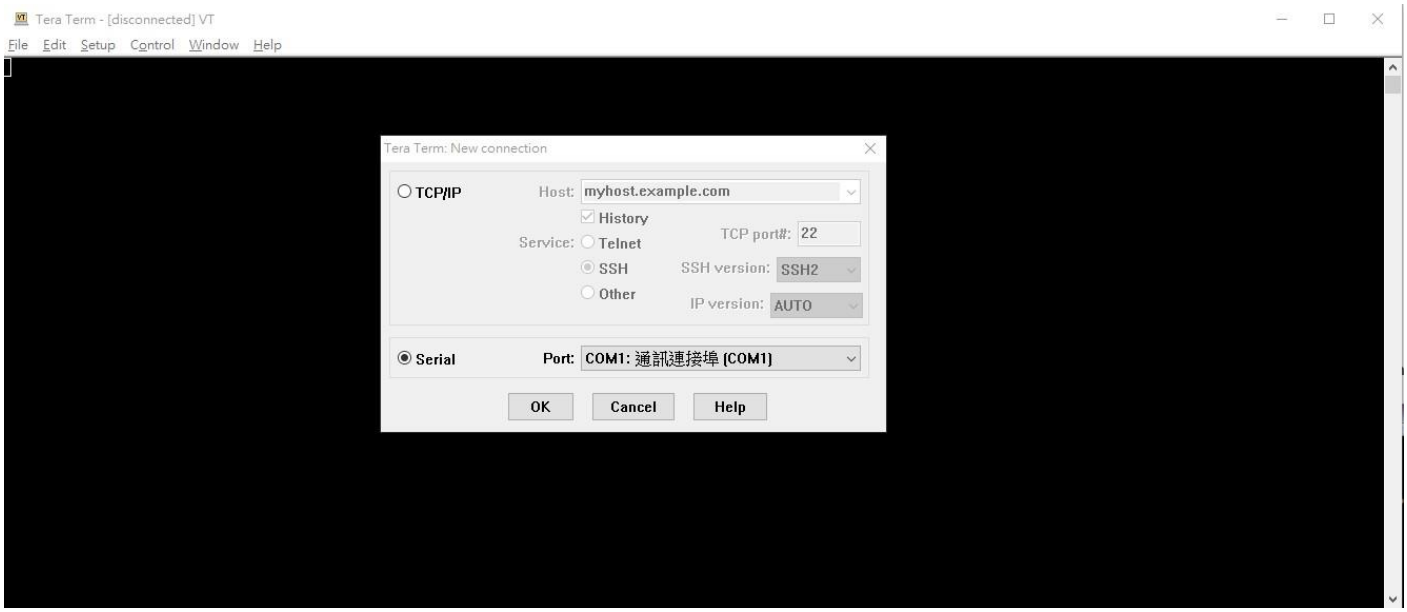


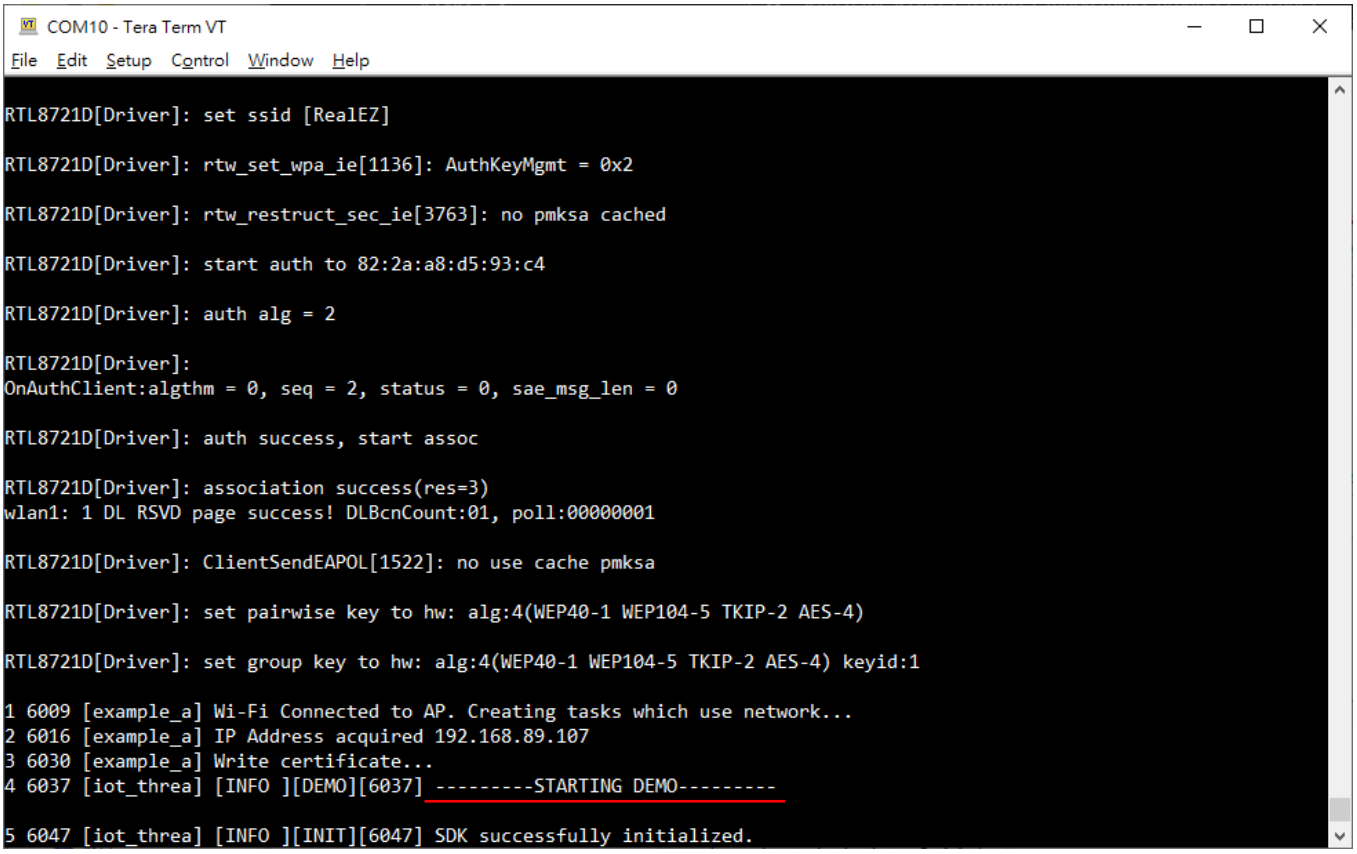
Fig 6-1 Hardware setup

The serial port is same with ImageTool that get from 5.3.1.1 step (3).

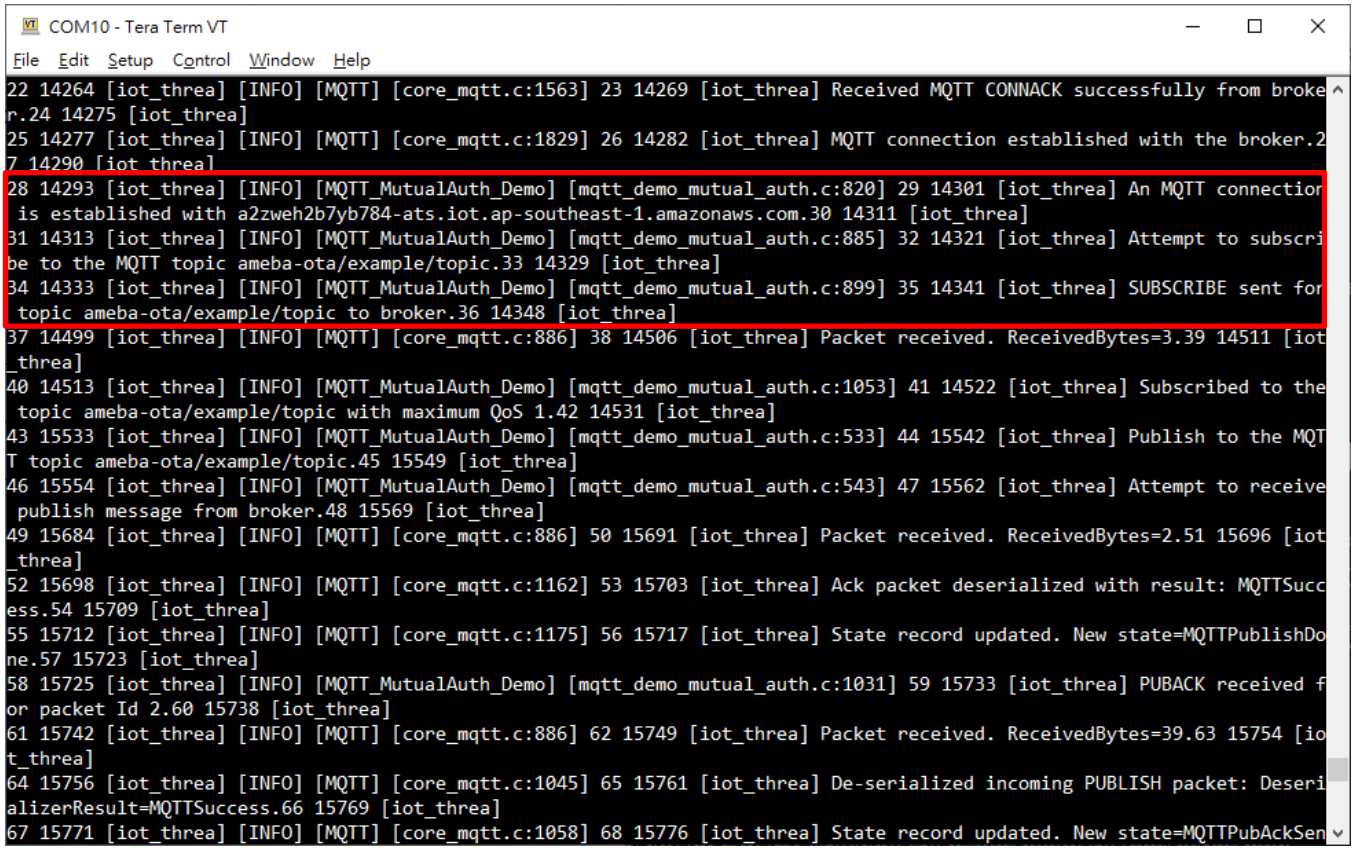


6.2 Run MQTT Demo

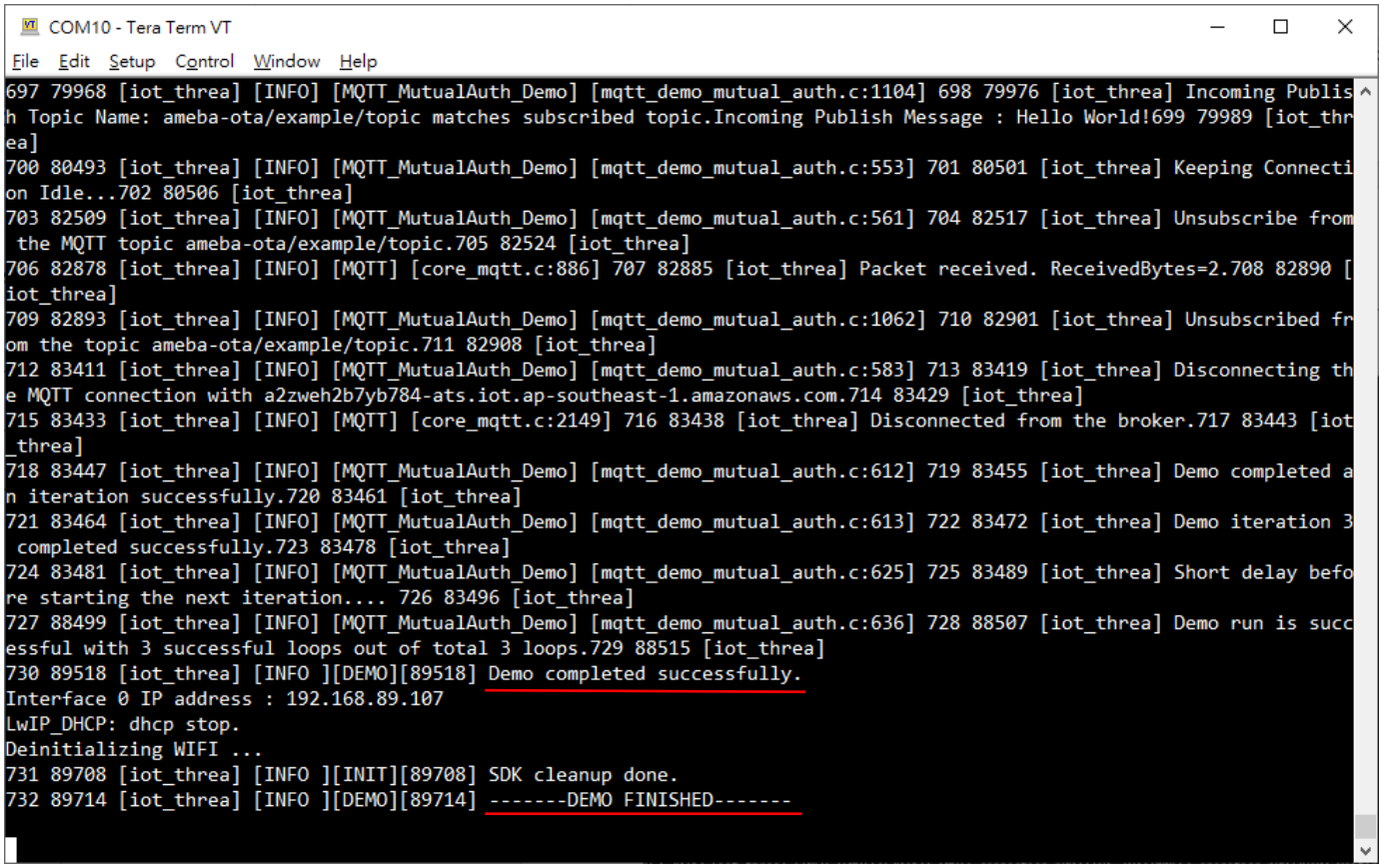
Default setting of SDK are enable MQTT demo. Once the AmebaD EVB has rebooted, the application will automatically start run MQTT demo and communicate to IoT Core.



...



…

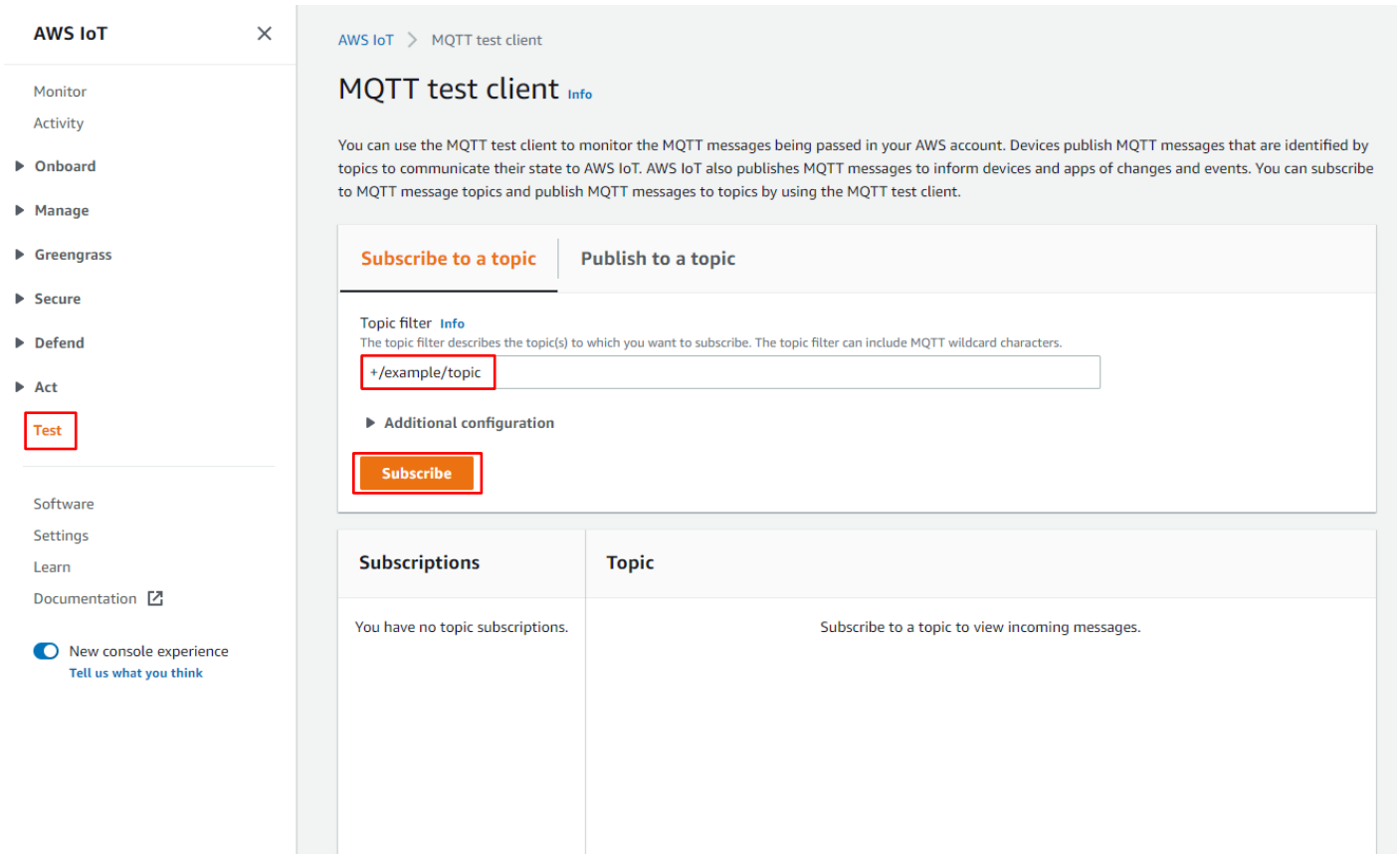


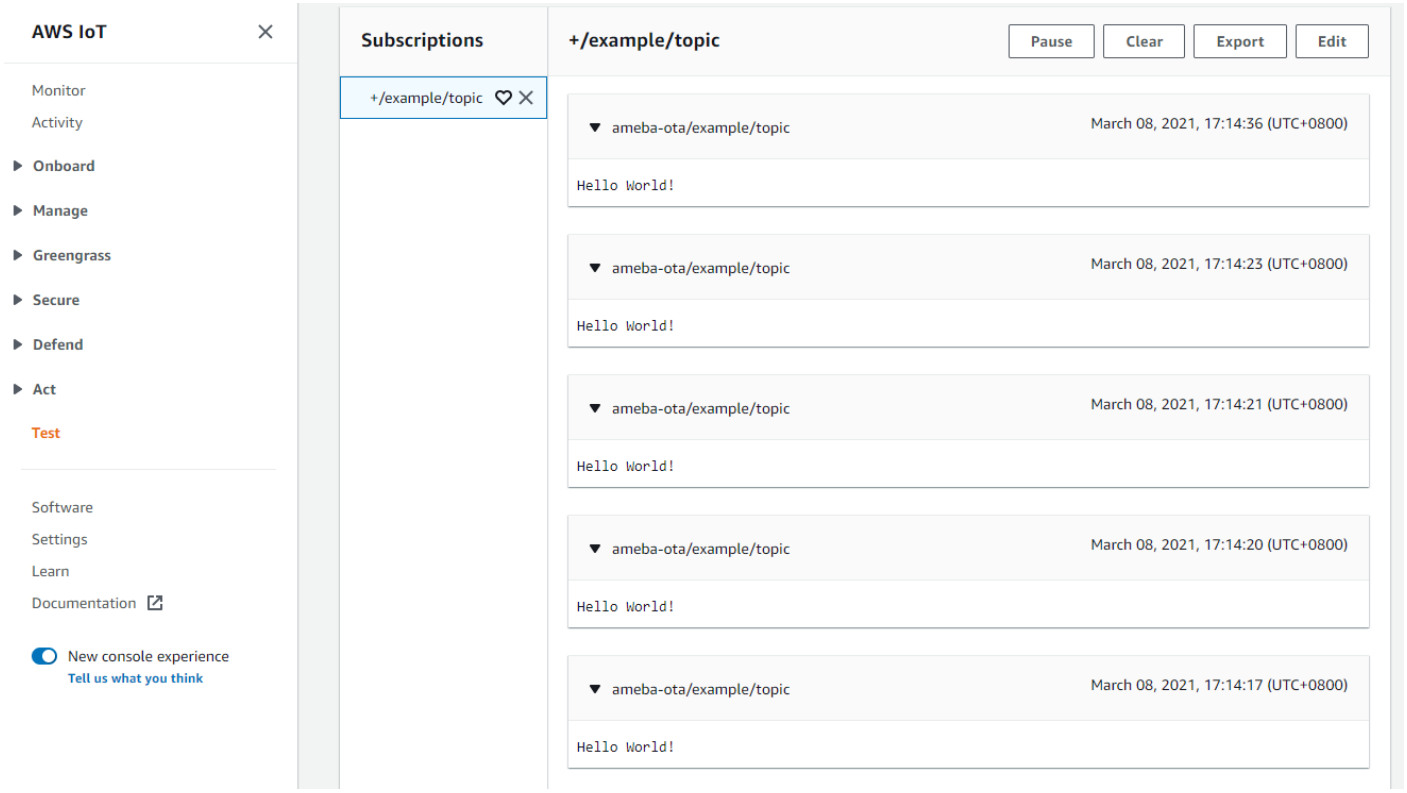
Monitor connection summary.

6.3 Monitoring MQTT messages on the cloud

To subscribe to the MQTT topic with the AWS IoT MQTT client

1. Sign in to the AWS IoT console.
2. In the navigation pane, choose Test to open the MQTT client.
3. In Subscription topic, enter “+/example/topic”, and then choose Subscribe to topic.





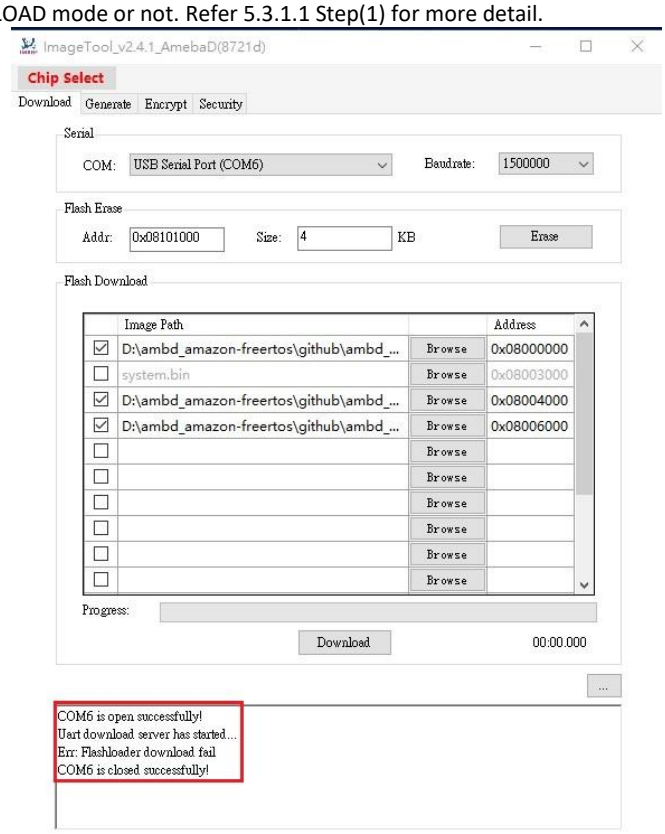
7 Troubleshooting

If these steps don't work, look at the device log in the serial terminal. You should see some text that indicates the source of the problem.

For general troubleshooting information about Getting Started with FreeRTOS, see Troubleshooting getting started.

7.1 Flashloader download fail

Please check device in UART_DOWNLOAD mode or not. Refer 5.3.1.1 Step(1) for more detail.



7.2 ERROR: Invalid Key

Please check **WIFI_SSID** and **WIFI_PASSWORD** in in amazon-freertos /demos/include/aws_clientcredential.h

```
Enter SSID for Soft AP started
3 1098 [example_a] Wi-Fi configuration successful.
4 1108 [iot_threa] [INFO ][DEMO][1108] ---------STARTING DEMO---------

5 1115 [iot_threa] [INFO ][INIT][1115] SDK successfully initialized.

LwIP_DHCP: dhcp stop.
Deinitializing WIFI ...
WIFI deinitialized
Initializing WIFI ...
WIFI initialized

Joining BSS by SSID ...

ERROR:Invalid Key
ERROR: Can't connect to AP
Joining BSS by SSID ...

ERROR:Invalid Key
ERROR: Can't connect to AP
Joining BSS by SSID ...
```

7.3 Failed to establish new MQTT connection

Please check **clientcredentialMQTT_BROKER_ENDPOINT** in amazon-freertos /demos/include/aws_clientcredential.h

```
6 12508 [iot_threa] [INFO ][DEMO][12508] Successfully initialized the demo. Network type for the demo: 1
7 12517 [iot_threa] [INFO ][MQTT][12517] MQTT library successfully initialized.
8 12524 [iot_threa] [INFO ][DEMO][12524] MQTT demo client identifier is ameba-ota (length 9).
9 12624 [iot_threa] [ERROR][NET][12624] Failed to resolve [redacted].amazonaws.com.
10 12934 [iot_threa] [ERROR][MQTT][12934] Failed to establish new MQTT connection, error NETWORK ERROR.
11 12943 [iot_threa] [ERROR][DEMO][12943] MQTT CONNECT returned error NETWORK ERROR.
12 12951 [iot_threa] [INFO ][MQTT][12950] MQTT library cleanup done.
13 12957 [iot_threa] [ERROR][DEMO][12957] Error running demo.
Interface 0 IP address : 192.168.90.185
LwIP_DHCP: dhcp stop.
Deinitializing WIFI ...
14 13094 [iot_threa] [INFO ][INIT][13094] SDK cleanup done.
15 13099 [iot_threa] [INFO ][DEMO][13099] -------DEMO FINISHED-------
```

7.4 TLS_Connect fail

Please check **keyCLIENT_CERTIFICATE_PEM** and **keyCLIENT_PRIVATE_KEY_PEM** in amazon-freertos/demos/include/aws_clientcredential_keys.h

```
8 13501 [iot_threa] [INFO ][DEMO][13501] Successfully initialized the demo. Network type for the demo: 1
9 13511 [iot_threa] [INFO ][MQTT][13511] MQTT library successfully initialized.
10 13518 [iot_threa] [INFO ][DEMO][13518] MQTT demo client identifier is ameba-ota (length 9).
11 20102 [iot_threa] ERROR: Private key not found. 12 20107 [iot_threa] TLS Connect fail (0x7d4, [redacted].amazonaws.com)
13 20115 [iot_threa] [ERROR][NET][20115] Failed to establish new connection. Socket status: -1.
14 20424 [iot_threa] [ERROR][MQTT][20424] Failed to establish new MQTT connection, error NETWORK ERROR.
15 20433 [iot_threa] [ERROR][DEMO][20433] MQTT CONNECT returned error NETWORK ERROR.
16 20441 [iot_threa] [INFO ][MQTT][20441] MQTT library cleanup done.
17 20447 [iot_threa] [ERROR][DEMO][20447] Error running demo.
Interface 0 IP address : 192.168.90.185
LwIP_DHCP: dhcp stop.
Deinitializing WIFI ...
18 20586 [iot_threa] [INFO ][INIT][20586] SDK cleanup done.
19 20591 [iot_threa] [INFO ][DEMO][20591] -------DEMO FINISHED-------
```