ESP8266 & ESP32

WFA Certification and Test Guide

Version 1.0
Espressif Systems

About This Guide

This guide mainly describes the production testing schemes of the WFA certification for ESP8266 and ESP32 to obtain corresponding certificates.

Release Notes

Date	Version	Release notes
2018.12	V1.0	Initial release.
2020.05	V1.1	Support ESP32 WPA3 certification.

Documentation Change Notification

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Certification

Download certificates for Espressif products from *https://www.espressif.com/en/certificates*.

Table of Contents

1. Overview

This guide mainly describes the production testing schemes of the WFA certification for ESP8266 and ESP32 to obtain corresponding certificates.

Figure 1-1 provides the demanded testing programs for the certification.

Figure 1-1. Testing Program Files

Name	Testing Item
ESP32_WFA_CER.zip	11N, PMF, WPA3, WPS（波特率为 115200）

⚠ ***Notice:***

- *The BIN files listed in this guide are only for reference, please go to http://www.espressif.com/en/support/download/other-tools to download BIN files.*
- *Please note there are two different testing programs. Thus please provide two testing boards downloaded with separate testing programs for certifications. These two tests can be done simultaneously, since the testing laboratories for them are separate.*

2. Testing Preparation

2.1. ESP8266 Testing Preparation

2.1.1. Hardware connection and Configuration

Please connect and configure your ESP8266 according to table 2-1.

Table 2-1. Testing Programs

Pin	Description
3V3/CH_EN	Connect to a 3.3 V power supply.
RXD/TXD/GND	Lead out these 3 pins to the serial port line to make PC communicate with ESP8266, then control ESP8266.
MTDO (GPIO15) GPIO0 GPIO2	Used to switch operation modes on ESP8266.

2.1.2. Hardware Operation Modes

2.1.2.1. Download Mode

When MTDO (GPIO15) = 0, GPIO0 = 0, GPIO2 = 1, the ESP8266 is in Download mode.

In this mode, the ESP8266 will download programs in the external flash.

2.1.2.2. Flash Mode

When MTDO (GPIO15) = 0, GPIO0 = 1, GPIO2 = 1, the ESP8266 is in Flash mode.

When the ESP8266 is powered on in this mode, it will automatically read from flash and execute programs.

> ⚠ ***Notice:***
>
> *The Download mode is only used for downloading firmwares, while the Flash mode is for normal operations.*

2.2. ESP32 Testing Preparation

2.2.1. Hardware Connection and Configuration

Please connect and configure your ESP32 according to table 2-2.

Table 2-2. Testing Programs

Pin	Description
3V3/CH_EN	Connect to a 3.3 V power supply.
RXD/TXD/GND	Lead out these 3 pins to the serial port line to make PC communicate with ESP32, then control ESP32.
GPIO0 GPIO2	Used to switch operation modes on ESP32.

2.2.2. Hardware Operation Modes

2.2.2.1. Download Mode

When GPIO0 = 0, GPIO2 = 0, the ESP32 is in Download mode.

In this mode, the ESP32 will download programs in the external flash.

2.2.2.2. Flash Mode

When GPIO0 = 1, the ESP32 is in Flash mode.

When the ESP32 is powered on in this mode, it will automatically read from flash and execute programs.

> ⚠ ***Notice:***
>
> *The Download mode is only used for downloading firmwares, while the Flash mode is for normal operations.*

3. Connect Your Device

3.1. Serial Port Configuration Tool

3.1.1. Tool Introduction

SecureCRT, used to configure the communication serial port between the testing module and PC.

> 📖 ***Notes:***
>
> *We will use SecureCRT in this chapter as the serial port configuration tool, please download and install it in advance.*

3.1.2. Steps

Please follow the steps below:

1. Double click SecureCRT.exe to open the application, the main interface will show as figure 3-1.

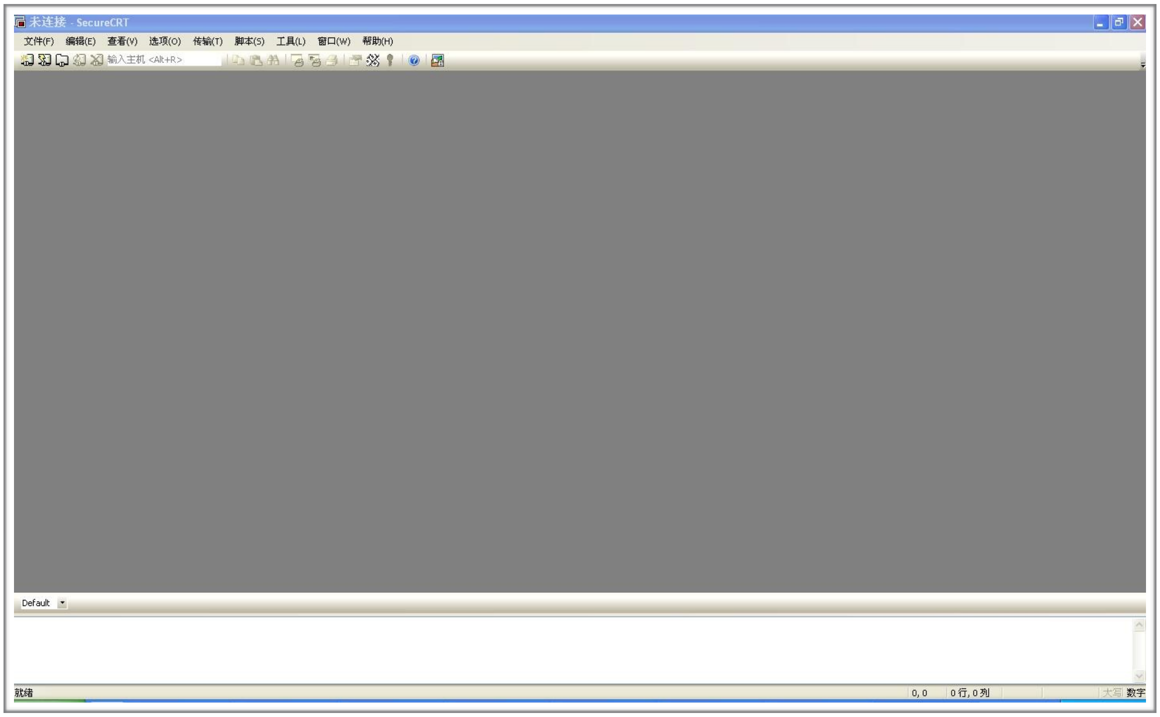
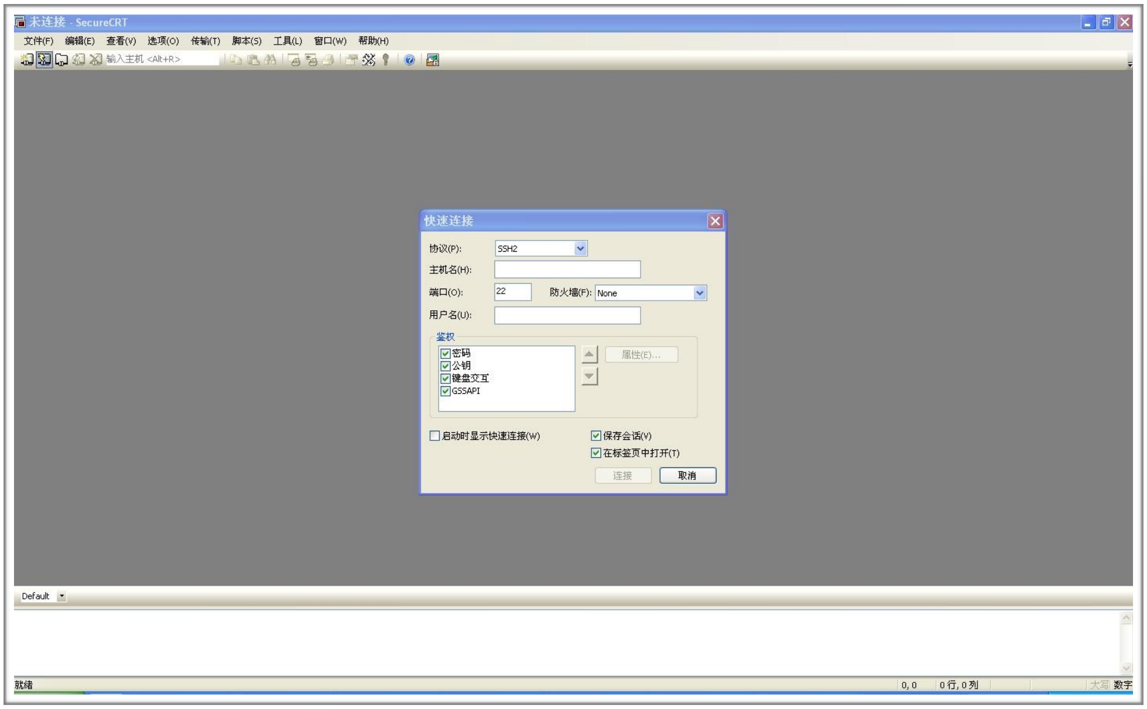


Figure 3-1. SecureCRT Main Interface

2. Select ***"File > Quick Connection…"*** option or directly click 🗲 button. A ***"Quick Connection"*** pop-up box will show as figure 3-2.



未连接 - SecureCRT
文件(F) 编辑(E) 查看(V) 选项(O) 传输(T) 脚本(S) 工具(L) 窗口(W) 帮助(H)
输入主机 <Alt+R>
Default
就绪
0, 0
0 行, 0 列
大写 数字

快速连接

协议(P): SSH2

主机名(H):

端口(O): 22 防火墙(F): None

用户名(U):

鉴权

☑ 密码
☑ 公钥
☑ 键盘交互
☑ GSSAPI

属性(E)...

□ 启动时显示快速连接(W)

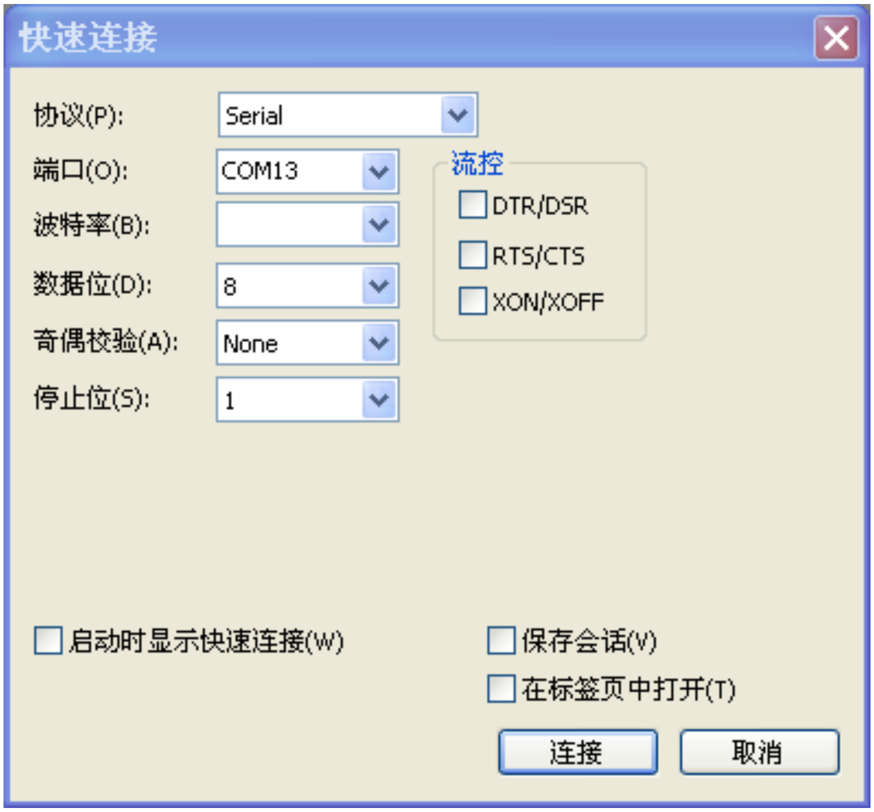
☑ 保存会话(V)

☑ 在标签页中打开(T)

连接 取消

Figure 3-2. "Quick Connection" Pop-up Box

3. Select "***Serial***" in the "***Protocol***" menu and set necessary data for serial connection.



快速连接

协议(P): Serial

端口(O): COM13

波特率(B):

数据位(D): 8

奇偶校验(A): None

停止位(S): 1

流控

□ DTR/DSR
□ RTS/CTS
□ XON/XOFF

□ 启动时显示快速连接(W)

□ 保存会话(V)

□ 在标签页中打开(T)

连接 取消

Figure 3-3. Configuration for Serial Connection

- **Port:** select a serial port to connect the external device, e.g., "COM6".

- **Baud Rate:** the baud rate for ESP32 and ESP8266 when using serial port communication should be 115200 and 74880, respectively.
- **Flow Control:** un-select ***"RTS/CTS"*** option.

4. Click ***"Connect"***. If it shows **"*serial-com6*"**, then the connection is fully completed, as shown in figure 3-4.

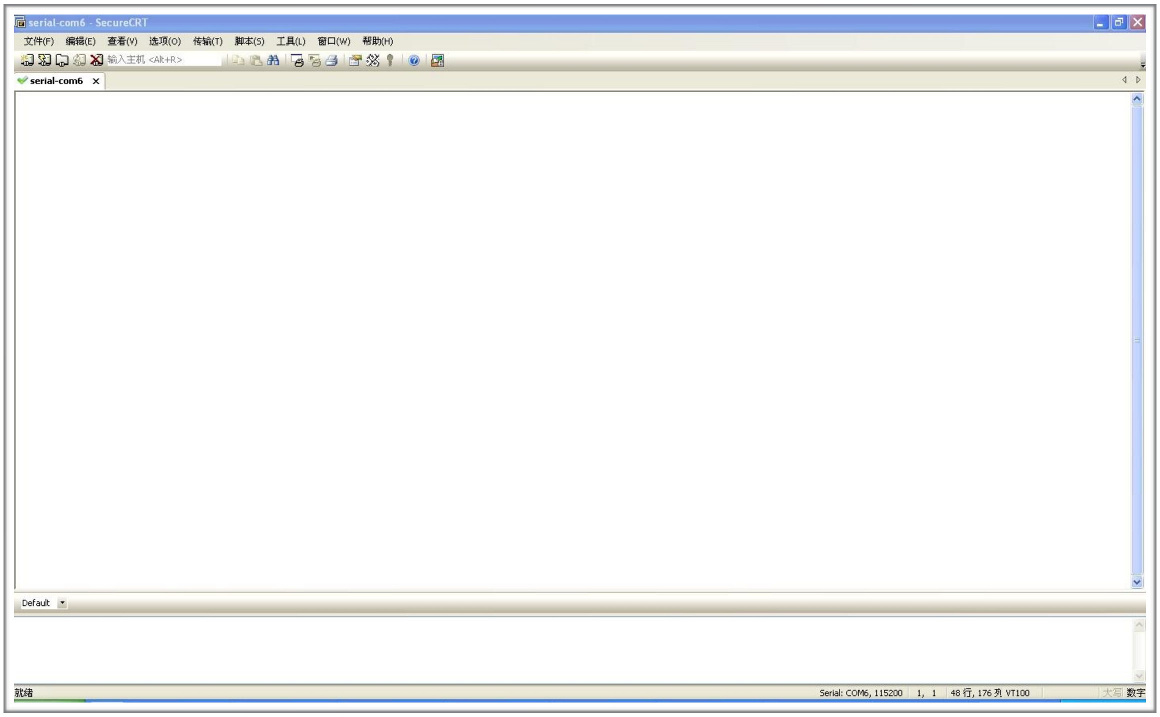


Figure 3-4. A New Session "serial-com6"

3.2. Download Tool

3.2.1. Tool Introduction

> 📖 ***Notes:***
>
> *We will use ESP Flash Download Tool in this chapter, please download from our official website: https://www.espressif.com/sites/default/files/tools/flash_download_tools_v3.6.5.zip.*

3.2.2. Steps

Please follow the steps below:

1. Run Flash Download Tool.

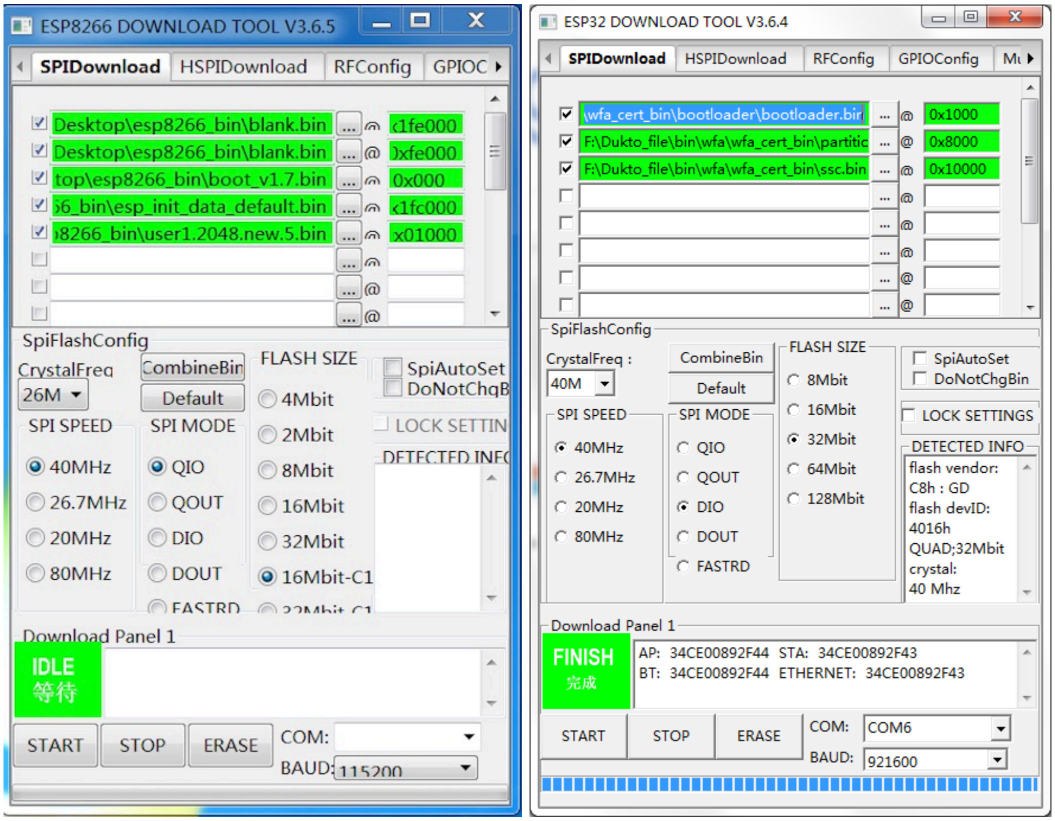
   Please make sure the ESP8266 and ESP32 are both under Download mode, and the port number is not occupied.

2. Click ***"…"*** under **"*SPIDownload*"** menu, select the testing program files you need to download, cancel the selection of other paths.

- If the file path is valid, it will show green shading;
- If the file path is invalid, it will show red shading.

3. Fill in the following blocks with corresponding start addresses, e.g., "0x000" or "0x1000".
4. Set other options based on the specific features of ESP8266 and ESP32.
5. Click **"*Start*"** to start downloading.

   If there is something wrong with your configuration, the error type will be printed out under the **"*Download Panel 1*"** and the command prompt.
6. After the download process finished, the status column will show **"*FINISH*"**. Please see figure 3-5 for the flash addresses and settings of ESP8266 and ESP32.



ESP8266 DOWNLOAD TOOL V3.6.5

SPIDownload | HSPIDownload | RFConfig | GPIOC

☑ Desktop\esp8266_bin\blank.bin @ x1fe000
☑ Desktop\esp8266_bin\blank.bin @ xfe000
☑ top\esp8266_bin\boot_v1.7.bin @ 0x000
☑ 56_bin\esp_init_data_default.bin @ x1fc000
☑ 8266_bin\user1.2048.new.5.bin @ x01000

SpiFlashConfig
CrystalFreq: 26M
SPI SPEED: ● 40MHz ○ 26.7MHz ○ 20MHz ○ 80MHz
SPI MODE: ● QIO ○ QOUT ○ DIO ○ DOUT ○ FASTRD
FLASH SIZE: ○ 4Mbit ○ 2Mbit ○ 8Mbit ○ 16Mbit ○ 32Mbit ● 16Mbit-C1 ○ 32Mbit-C1
□ SpiAutoSet □ DoNotChgBin □ LOCK SETTIN
DETECTED INFO

Download Panel 1
IDLE 等待
COM:
BAUD: 115200

ESP32 DOWNLOAD TOOL V3.6.4

SPIDownload | HSPIDownload | RFConfig | GPIOConfig | Mu

☑ \wfa_cert_bin\bootloader\bootloader.bin @ 0x1000
☑ F:\Dukto_file\bin\wfa\wfa_cert_bin\partitic @ 0x8000
☑ F:\Dukto_file\bin\wfa\wfa_cert_bin\ssc.bin @ 0x10000

SpiFlashConfig
CrystalFreq : 40M
SPI SPEED: ● 40MHz ○ 26.7MHz ○ 20MHz ○ 80MHz
SPI MODE: ○ QIO ○ QOUT ● DIO ○ DOUT ○ FASTRD
FLASH SIZE: ○ 8Mbit ○ 16Mbit ● 32Mbit ○ 64Mbit ○ 128Mbit
□ SpiAutoSet □ DoNotChgBin □ LOCK SETTINGS
DETECTED INFO
flash vendor:
C8h : GD
flash devID:
4016h
QUAD;32Mbit
crystal:
40 Mhz

Download Panel 1
FINISH 完成
AP: 34CE00892F44 STA: 34CE00892F43
BT: 34CE00892F44 ETHERNET: 34CE00892F43
COM: COM6
BAUD: 921600

Figure 3-5. Flash Download Tool

3.2.3. Configuration Description

The meaning of corresponding configuration options are described in table 3-1.

Table 3-1. Parameter Configuration Description

Option	Meaning	Description
CrystalFreq	Plug-in crystal oscillator frequency type	40 M, based on the crystal oscillator used on ESP8266 and ESP32.

CombineBin	Combine BIN files	Combine multiple BIN files into one.
SPI Speed	SPI speed	Select corresponding SPI speed from: 40 MHz, 26.7 MHz, 20 MHz and 80 MHz.
SPI Mode	SPI mode	Select corresponding SPI mode from: QIO, QOUT, DIO and DOUT.
Flash Size	flash size	Select flash size used in ESP8266 and ESP32.
COM	Port number of the device	Select port number for the serial port of corresponding modules.
Baudrate	Baud rate	Select the speed for downloading test program files, 115200 by default.
MAC Address	MAC address	After the download succeed, the corresponding MAC address will show automatically.

4. Static IP address Configuration

How to configure parameters under STA mode:

Open the serial port tool (with baud rate set to 115200), input ssc commands to configure the DUT (the device to be tested). The ssc commands are listed below:

Table 4-1. Static ip Address Configuration Steps

Steps		ssc Command	Notes
1	Configure the module to STA mode	`op -S -o 1`	-
2	Disable the module's dynamic DHCP function	`dhcp -E`	-
3	Set up connection between the module and AP	`sta -C -s <AP_SSID> -p <AP_Password>`	For example: `sta -C -s esp_ap1 -p 12345678` Notes: esp_ap1 is AP's SSID, 12345678 is AP's password.
4	IP address configuration	`ip -S -o 1 -i xxx.xxx.xxx.xxx`	For example: `ip -S -o 1 -i 192.168.1.100`
5	IP address inquiry	`ip`	-

⚠ ***Notice:***

If the encryption type for AP is open, then you just have to input `sta -C -s <AP SSID>`.

5. Enterprise-level Encryption Test

To conduct enterprise-level encryption test on ESP32, you will need to import ***ca.pem***, ***client.key*** and ***client.crt*** into the test module (for the format of these files, please refer to the .zip file provided on Espressif's official website). The specific steps are as the following:

1. Put the three files mentioned above into ***cert_file*** folder, rename them as ***ca_pem.bin***, ***client_crt.bin*** and ***client_key.bin*** respectively.

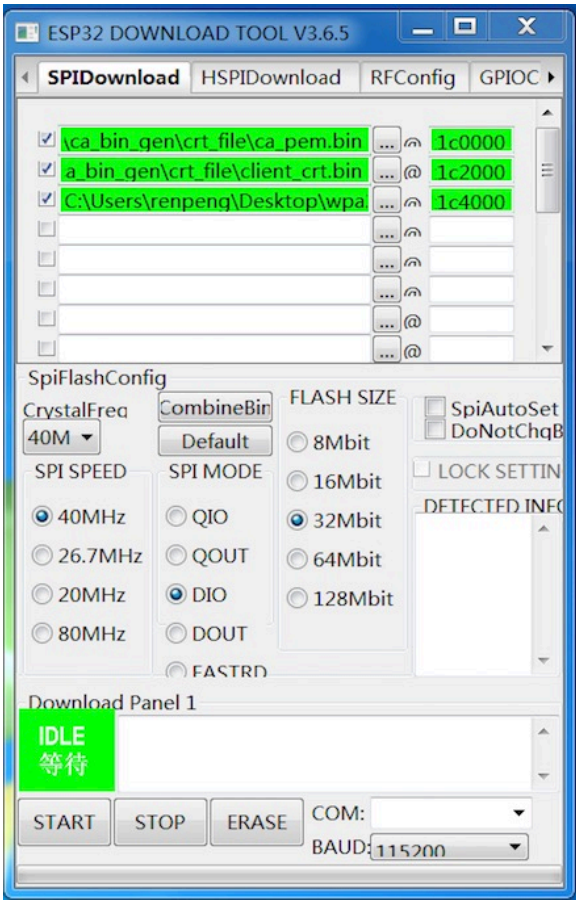
   The flash address for each is:

   client_crt.bin: 0x1c0000

   client_key.bin: 0x1c4000

   ca_pem.bin: 0x1c8000

2. Flash above bin files into the defined address by using the flash tool, as shown in figure 5-1:



ESP32 DOWNLOAD TOOL V3.6.5

☑ \ca_bin_gen\crt_file\ca_pem.bin @ 1c0000
☑ a_bin_gen\crt_file\client_crt.bin @ 1c2000
☑ C:\Users\renpeng\Desktop\wpa @ 1c4000

CrystalFreq: 40M
SPI SPEED: ● 40MHz
SPI MODE: ● DIO
FLASH SIZE: ● 32Mbit
BAUD: 115200

Figure 5-1. Flash Download Tool

3. Use enterprise-level encryption to connect AP (three types of encryption as PEAP0, TTLS and TLS are supported by now).
   - Steps of using PEAP0 and TTLS encryption to connect AP are shown in table 5-1:

Table 5-1. PEAP0 and TTLS Encryption Connection Steps

Steps		ssc Command	Notes
1	Configure the module into STA mode	`op -S -o 1`	-
2	Disable enterprise-level encryption function	`wpa2 -D`	-
3	Install the client certificate	`wpa2 -I -c 2`	-
4	Install the CA certificate	`wpa2 -I -c 1`	-
5	Set username and password	`wpa2 -S -u <username> -p <password>`	For example: `wpa2 -S -u esp -p 12345678`
6	Enable enterprise-level encryption	`wpa2 -E`	-
7	Set up connection between the module and AP	`sta -C -s <AP_SSID> -p <AP_Password>`	For example: `sta -C -s esp_ap1 -p 12345678` Note: esp_ap1 is AP's SSID, 12345678 is AP's password.

   - Steps of using TLS encryption to connect AP are shown in table 5-2:

Table 5-2. TLS Encryption Connection Steps

Steps		SSC Command	Notes
1	Configure the module into STA mode	`op -S -o 1`	-
2	Disable enterprise-level encryption function	`wpa2 -D`	-
3	Install the client certificate	`wpa2 -I -c 2`	-
4	Install the CA certificate	`wpa2 -I -c 1`	-
5	Enable enterprise-level encryption	`wpa2 -E`	-
6	Set up connection between the module and AP	`sta -C -s <AP_SSID> -p <AP_Password>`	For example: `sta -C -s esp_ap1 -p 12345678` Note: esp_ap1 is AP's SSID, 12345678 is AP's password.

A. Appendix – SSC Instruction Set

When using SSC instruction set, the compilation process will be based on SDK and IDF. Thus, enter the SSC instructions you need directly in the serial port tool will work.

1. reboot - reboot module

reboot - reboot module	
Test Instruction	`reboot`
Response	`!!!ready!!!`

2. restore - restore module

restore - restore module	
Test Instruction	`restore`
Response	`!!!ready!!!`

3. op -S -o 1/2/3 - operation mode configuration

op -S -o 1/2/3 - operation mode configuration	
Test Instruction	`op -S -o 1/2/3`
Response	`+MODE:OK`
Description	1: station mode 2: softap mode 3: softap + station mode

4. sta -C - connect AP

sta -C -s <ap_ssid> -p <ap_password> - connect AP	
Test Instruction	`sta -C -s <ap_ssid> -p <ap_password>`
Response	`+JAP:CONNECTED`
Description	<ap_ssid>: AP's SSID <ap_password>: AP's password
Example	`sta -C -s esp -p 12345678`

5. sta -D - disconnect AP

sta -D - disconnect AP	
Test Instruction	`sta -D`
Response	`+JAP:DISCONNECTED`

6. ip - inquire ip address

ip - inquire ip address	
Test Instruction	`ip`
Response	`+STAIP:xxx.xxx.xxx.xxx`

7. dhcp -E - disable dhcp

dhcp -E - disable dhcp	
Test Instruction	`dhcp -E`
Response	`+DHCP:STA,OK`

8. dhcp -S - enable dhcp

dhcp -S - enable dhcp	
Test Instruction	`dhcp -S`
Response	`+DHCP:STA,OK`

9. ip -S - static ip address configuration

ip -S - static ip address configuration	
Test Instruction	`ip -S -o 1 -i <ip_addr>`
Response	`+IP:OK`
Description	<ip_addr>: static ip address
Example	`ip -S -o 1 -i 192.168.0.100`

10. wps -E - configure WPS mode

wps -E - configure WPS mode

Test Instruction	`wps -E -t 1/2`
Response	`+WPS:OK`
Description	1: PBC mode 2: PIN mode
Example	`wps -E -t 1`

11. wps -S - enable WPS to connect AP

wps -S - enable WPS to connect AP	
Test Instruction	`wps -S`
Response	`+WPS:OK`

12. wps -D - disable WPS

wps -D - disable WPS	
Test Instruction	`wps -D`
Response	`+WPS:OK`

13. wpa2 -D - disable enterprise-level encryption

wpa2 -D - disable enterprise-level encryption	
Test Instruction	`wpa2 -D`
Response	`+WPA2:Disable`

14. wpa2 -E - enable enterprise-level encryption

wpa2 -E - enable enterprise-level encryption	
Test Instruction	`wpa2 -E`
Response	`+WPA2:Enable`

15. wpa2 -I - upload enterprise-level certificate

wpa2 -I -c 1/2 - upload enterprise-level certificate	
Test Instruction	`wpa2 -I -c 1/2`
Response	`+WPA2:SetCA / +WPA2:SetClient`

Description	1: upload CA certificate 2: upload client certificate
Example	`wpa2 -I -c 1`

16. wpa2 -S - set enterprise-level username and password

wpa2 -S -u <user_name> -p <password> - set enterprise-level username and password	
Test Instruction	`wpa2 -S -u <user_name> -p <password>`
Response	`+WPA2:SetUsername` `+WPA2:SetPassword`
Description	<user_name>: username <password>: password
Example	`wpa2 -S -u esp -p 12345678`

17. dht2040 -S -e 1 - ht2040 coexistence

dht2040 -S -e 1 -ht2040 coexistence	
Test Instruction	`dht2040 -S -e 1`
Response	set ht2040 enable:ok

Note: this instruction should be used before the device being connected to AP, and this is specific to the WFA 11N Certification Test item 5.2.48.

18. ampdu - ampdu ban

ampdu -T Tx AMPDU function ban	
Test Instruction	`ampdu -T`
Response	+AMPDU: OK

Note: this instruction is specific to the WFA 11N Certification Test item 5.2.28. After the AMPDU being banned, Wi-Fi will be re-enabled, please connect AP again.

19. ping -i <ip address> -l <packet length> -c <ping count> - ping instruction

ping -S -t <ip address> -w <timeout> -l <packet length> -v <qos value> - ping instruction	
Test Instruction	`ping -i <ip address> -l <packet length> -c <ping count>`
Response	`+PING:byte = 64, time = xxxms OK`
Description	

Example	`ping -i 192.168.0.1 -l 1000 -c 100`

Espressif IoT Team

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