

ESP32-S2

User Guide of ESP Test Tools



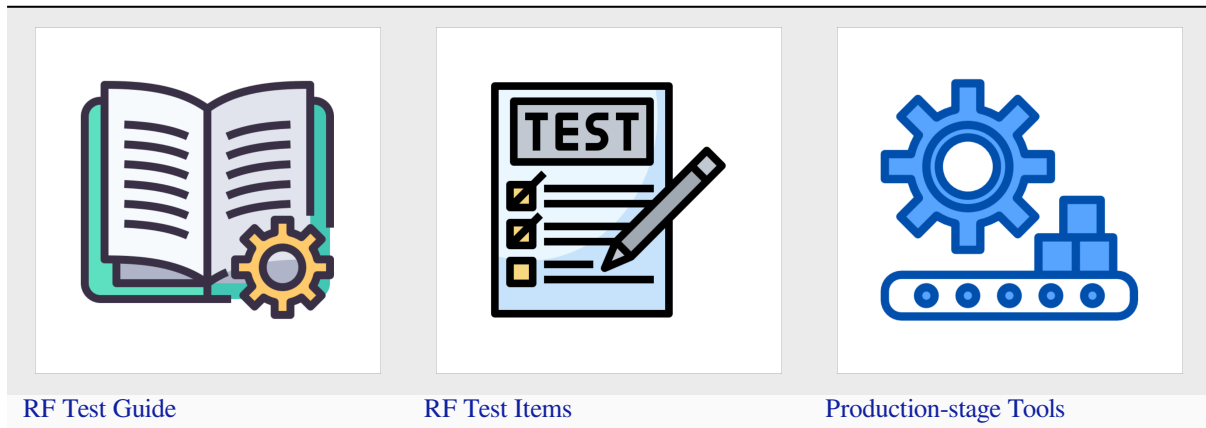
ESPRESSIF

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This repository provides comprehensive resources to support the development and production of products based on [Espressif chips](#) and [modules](#).

For the development stage, it provides an RF testing tool and detailed test guidelines to ensure your product meets the necessary performance and certification standards. Additionally, for the production stage, the repository includes essential tools and instructions to streamline the manufacturing process, ensuring efficient testing, validation, and quality control of your products.



1 Development Stage

To ensure your product meets requirements for related [RF Certifications](#), this repository provides the testing tools and guidelines to facilitate RF testing, ensuring compliance with global standards and industry certifications.

1.1 RF Test Tool

[EspRFTestTool Toolkit](#) is a comprehensive tool that allows you to control devices and evaluate key RF performance metrics. It supports the following [RF Test Items](#).

1.2 RF Test Items

Wi-Fi Test

- [Wi-Fi Non-Signaling Test](#) also known as fixed frequency test, directly controls the device to transmit specific signals without establishing a data connection. It evaluates key RF performance metrics, such as transmit power, spectrum quality, and error rate, ensuring wireless communication quality in various scenarios.
- [Wi-Fi Signaling Test](#) assesses and verifies the Wi-Fi signaling functions of wireless network devices, focusing on stable and reliable communication across different operating scenarios. It evaluates the Over-The-Air (OTA) performance, including Total Radiated Power (TRP) and Total Isotropic Sensitivity (TIS).
- [Wi-Fi Adaptivity Test](#) simulates various network conditions and loads to access device's real-time adjustments in transmission rate, channel selection, and power levels, optimizing overall network performance and stability.
- [Wi-Fi Blocking Test](#) evaluates the device's reception performance in environments with strong interference. By introducing high-intensity interference signals, it measures reception sensitivity and anti-interference capability, ensuring reliable operation in complex wireless environments.

1.3 RF Certifications

The *RF Test Items* outlined above are designed to ensure your product complies with the standards required for the following certifications:

- *CE Certification*: A mandatory certification by the EU, confirming compliance with safety, health, and environmental protection standards.
- *FCC Certification*: A mandatory certification by the U.S. Federal Communications Commission, ensuring compliance with regulations on radio spectrum use, electromagnetic compatibility, and RF radiation.
- *SRRC Certification*: A mandatory certification for radio equipment in China, ensuring compliance with national radio management regulations to avoid electromagnetic interference.

Test items for each certification are listed in the following table.

Table 1: Test Items for RF Certifications

	CE Certification	FCC Certification	SRRC Certification
Wi-Fi Non-Signaling Test	Y	Y	Y
Wi-Fi Adaptivity Test	Y	–	Y
Wi-Fi Blocking Test	Y	–	–

Note: *Wi-Fi Signaling Test* is not typically required for standard RF certifications; it is primarily used to evaluate the OTA performance of devices.

2 EspRFTTestTool Toolkit

The **EspRFTTestTool toolkit** is an RF test tool provided by Espressif. It contains EspRFTTestTool, DownloadTool, and PowerLimitTool.

- *EspRFTTestTool*: Used to perform RF tests
- *DownloadTool*: Used to download the firmware required for RF tests
- *PowerLimitTool*: Used to generate customized phy_init_data firmware

Download Link: `EspRFTTestTool toolkit`

The zip file not only includes the EspRFTTestTool toolkit but also contains all the necessary firmware for *RF Test Items*, allowing users familiar with the testing process to directly use the firmware for testing.

Note: In this document, the **EspRFTTestTool toolkit** refers to the collection of the three tools, while the **EspRFTTestTool** refers to this single tool.

2.1 EspRFTTestTool

The main interface of the EspRFTTestTool toolkit is the EspRFTTestTool, which includes the COM Port Configuration area, the Download Configuration area, the RF Test Configuration area, and the Log window.

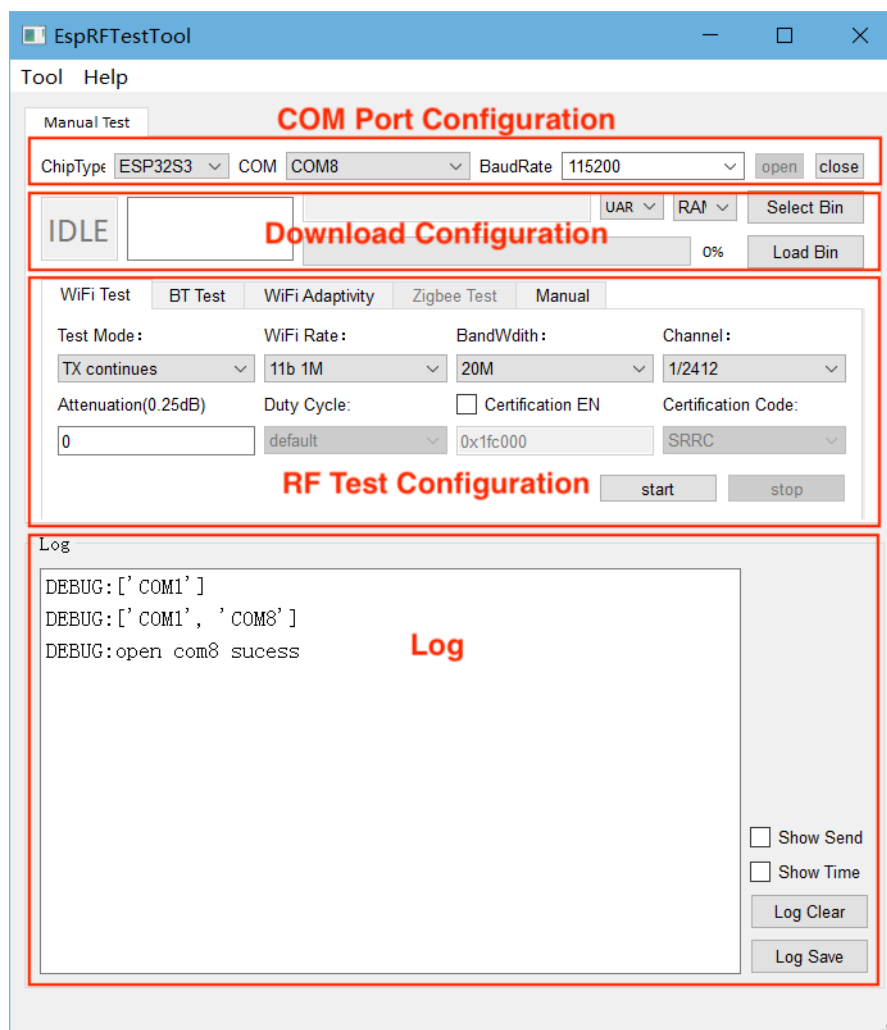


Fig. 1: EspRFTTestTool

COM Port Configuration Area

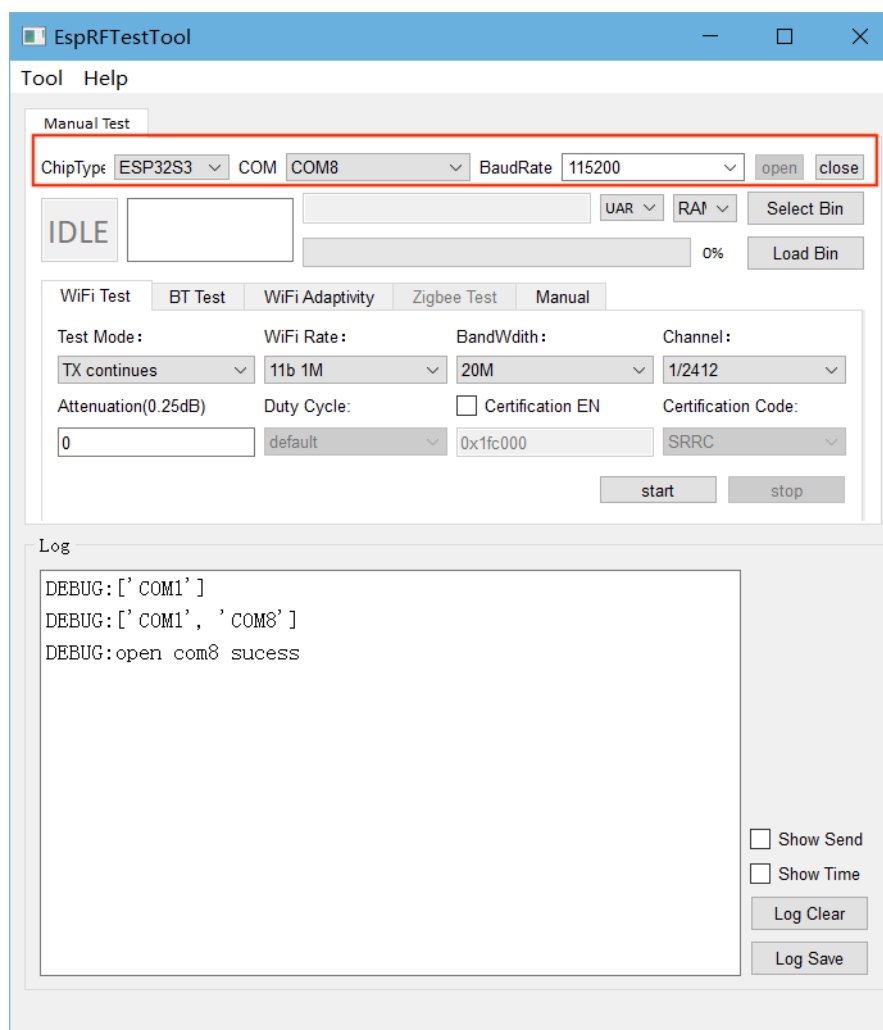


Fig. 2: EspRFTTestTool COM Port Configuration Area

- **ChipType:** Select the chip;
- **COM:** Select the serial port number;
- **BaudRate:** Select the baud rate;
- **Open:** Open the serial port;
- **Close:** Close the serial port.

After configuring the serial port, you can perform quick flashing and RF tests.

Download Configuration Area

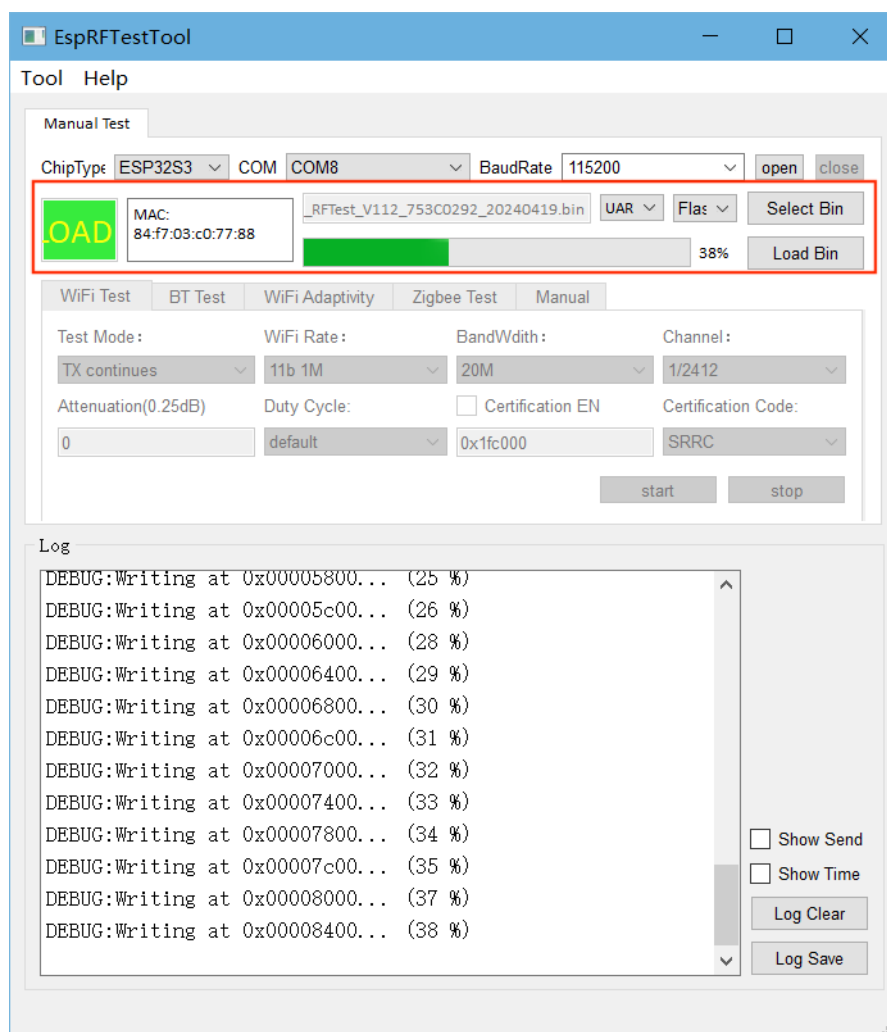


Fig. 3: EspRFTTestTool Download Configuration Area

Generally, the [DownloadTool](#) is used to download the firmware required for RF tests. However, for some simple firmware, such as non-signaling test firmware and adaptivity test firmware, EspRFTTestTool can be used for quick flashing.

- Pull down the Boot pin and re-power the chip to enter download mode;
- By default, flashing is conducted through UART;
- Select flash to download to the flash;
- Click **Select Bin** to select the bin file to be flashed;
- Click **Load Bin** to start flashing;
- After flashing is completed, pull up the Boot pin and re-power the chip to enter operation mode.

RF Test Configuration Area

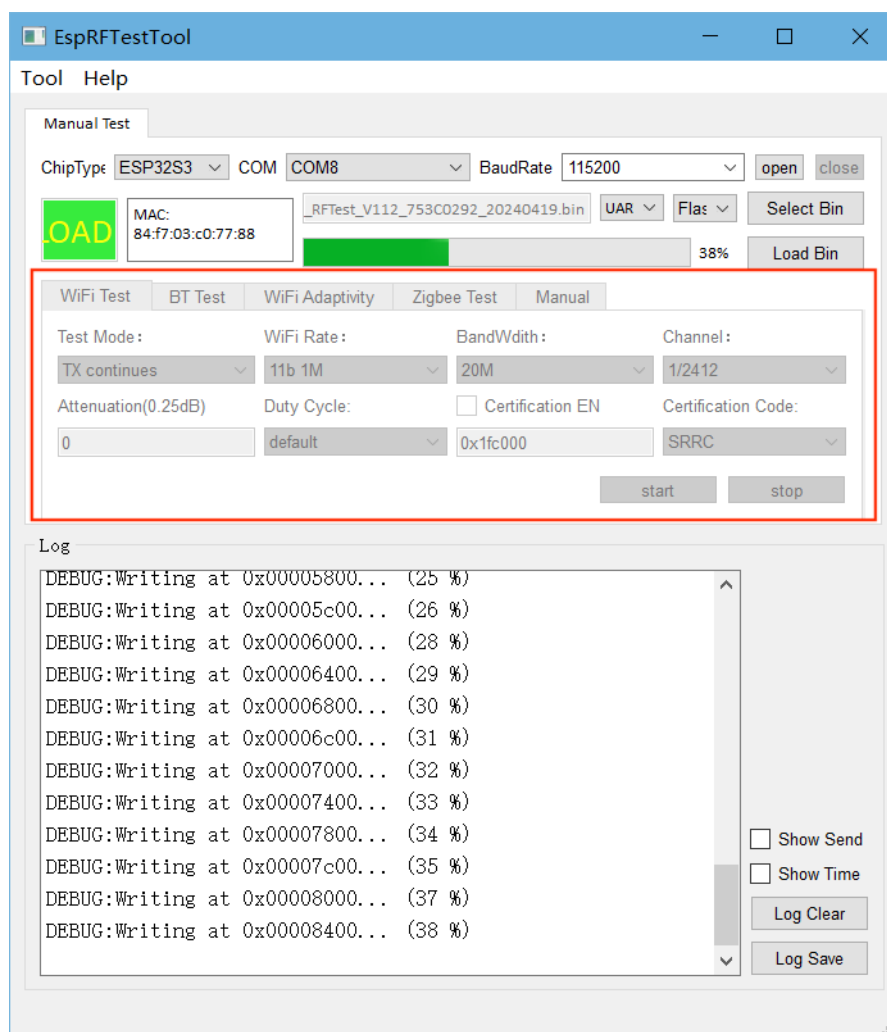


Fig. 4: EspRFTTestTool RF Test Configuration Area

After flashing the firmware, you can perform the corresponding RF tests:

- **Wi-Fi Test:** Used for Wi-Fi Non-Signaling Test;
- **BT Test:** Used for Bluetooth and Bluetooth LE Non-Signaling Test;
- **Wi-Fi Adaptivity:** Used for Wi-Fi Adaptivity Test;
- **Zigbee Test:** Used for 802.15.4 Non-Signaling Test;
- **Manual:** Used to enter serial port commands.

For specific parameter configuration, please refer to the corresponding RF test document.

Log Window

The Log window is used to display the status of the tool. To view the log printed via the chip serial port, please use a general serial port assistant, such as [SerialPortUtility](#).

2.2 DownloadTool

Click **Tool** in the toolbar and select **DownloadTool** to enter the DownloadTool interface.

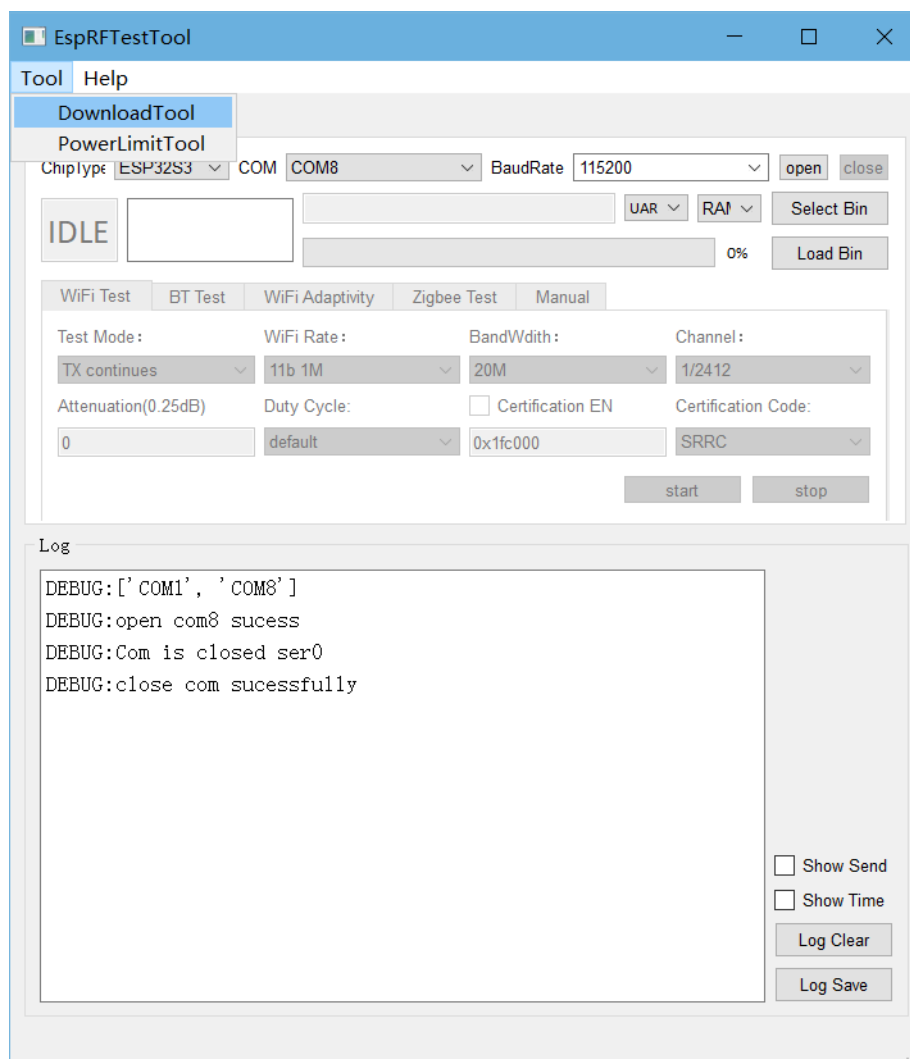


Fig. 5: Entry to DownloadTool

Follow the steps below to flash the firmware:

- Set the Chip Type, COM Port, and Baud Rate. Then, click Open to open the serial port;
- Select flash to download to the flash;
- Select the firmware and flash it to the specified address;
- Check whether the chip has entered download mode. If yes, click Start Load to start flashing. After flashing is completed, the SUCC sign shows up;
- After flashing is completed, click Close to close the serial port.

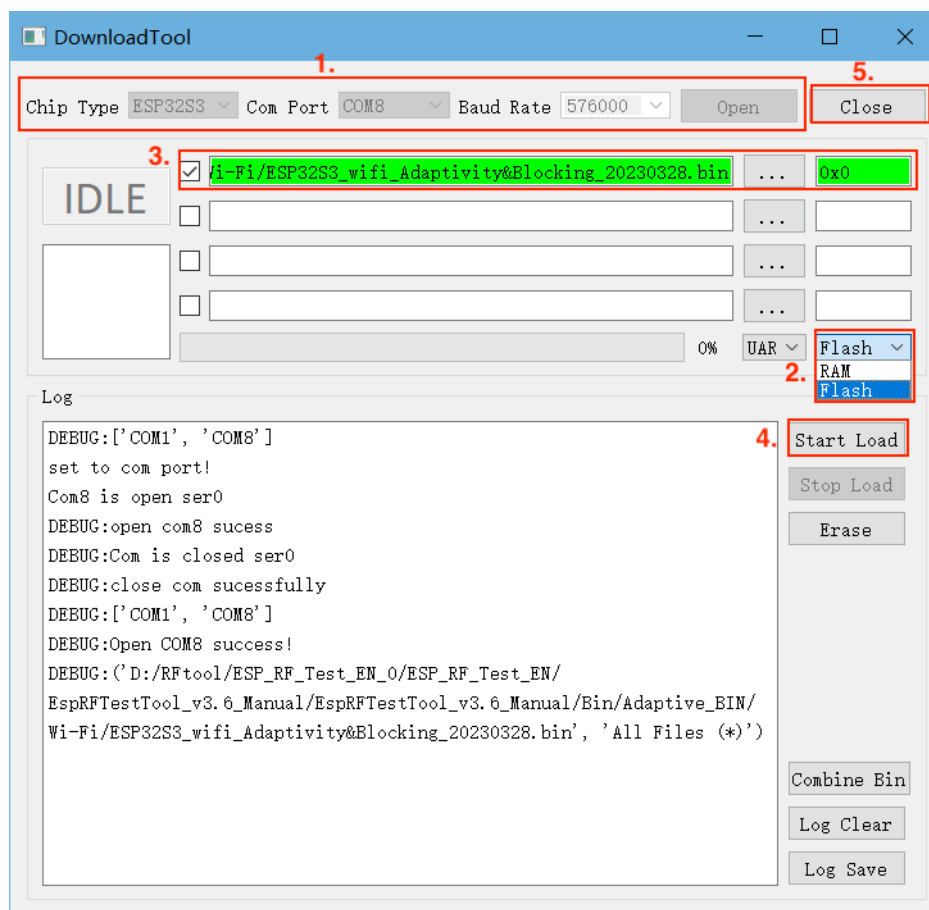


Fig. 6: DownloadTool Interface

Note: How to check whether the chip has entered download mode:

1. Close the serial port of DownloadTool and open a general serial port assistant, such as [SerialPortUtility](#);
2. Configure the serial port number and baud rate, pull down the Boot pin, re-power the chip, and the serial port assistant will print the log like waiting for download;
3. Close the serial port assistant, open DownloadTool, and start flashing;
4. After the flashing is completed, pull up the Boot pin, and re-power the chip to enter operation mode. If there are any abnormal behaviors, use the serial port assistant to check.

Note: By default, DownloadTool flashes to RAM. To specify a flash address, you need to switch to flashing to flash first.

2.3 PowerLimitTool

PowerLimitTool generates single-country and multi-country phy_init_bin files by configuring Wi-Fi output power to ensure your products meet the regulatory requirements of different countries or regions.

Note: The following methods can be used to limit Wi-Fi power. If multiple methods are used together, the minimum power value will be taken:

1. Use the API (`esp_wifi_set_max_tx_power`) to limit the maximum output power.

2. Configure Max Wi-Fi TX Power in Menuconfig, which serves the same function as the API mentioned above and can limit the maximum output power.
3. Use the Phy Init Bin function to modify the phy_init_data.h file in ESP-IDF.
4. Use the Phy Init Bin function to generate the phy_init_data.bin file by referring to the introduction in this document.

Under the main interface of EspRFTTestTool, click Tool, and select PowerLimitTool from the dropdown box to open PowerLimitTool.

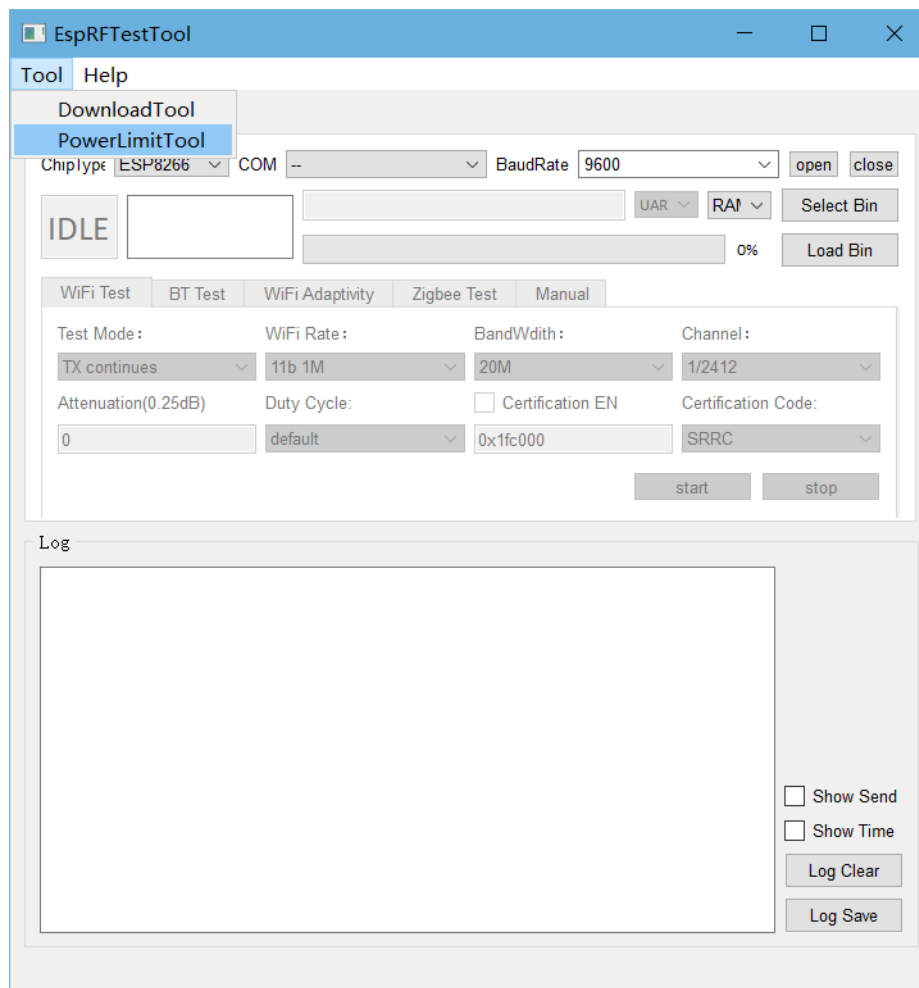


Fig. 7: Entry to PowerLimitTool

1. In the main interface of PowerLimitTool, click the Chip dropdown box to view the chips supported by the tool and select a chip (This section takes ESP32-C3 as an example).

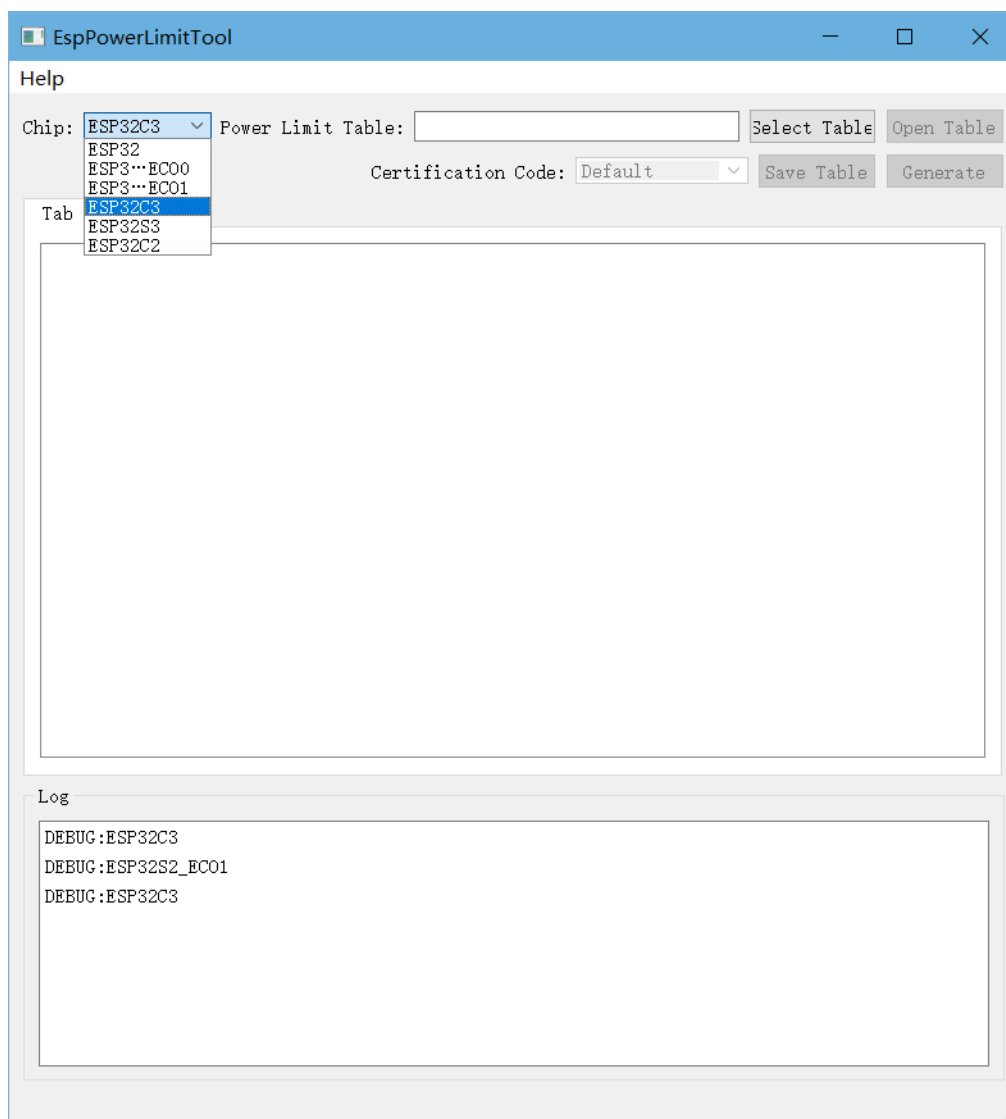


Fig. 8: PowerLimitTool Main Interface

2. Click `Select Table` and select the TX Power Setting table for your chip.

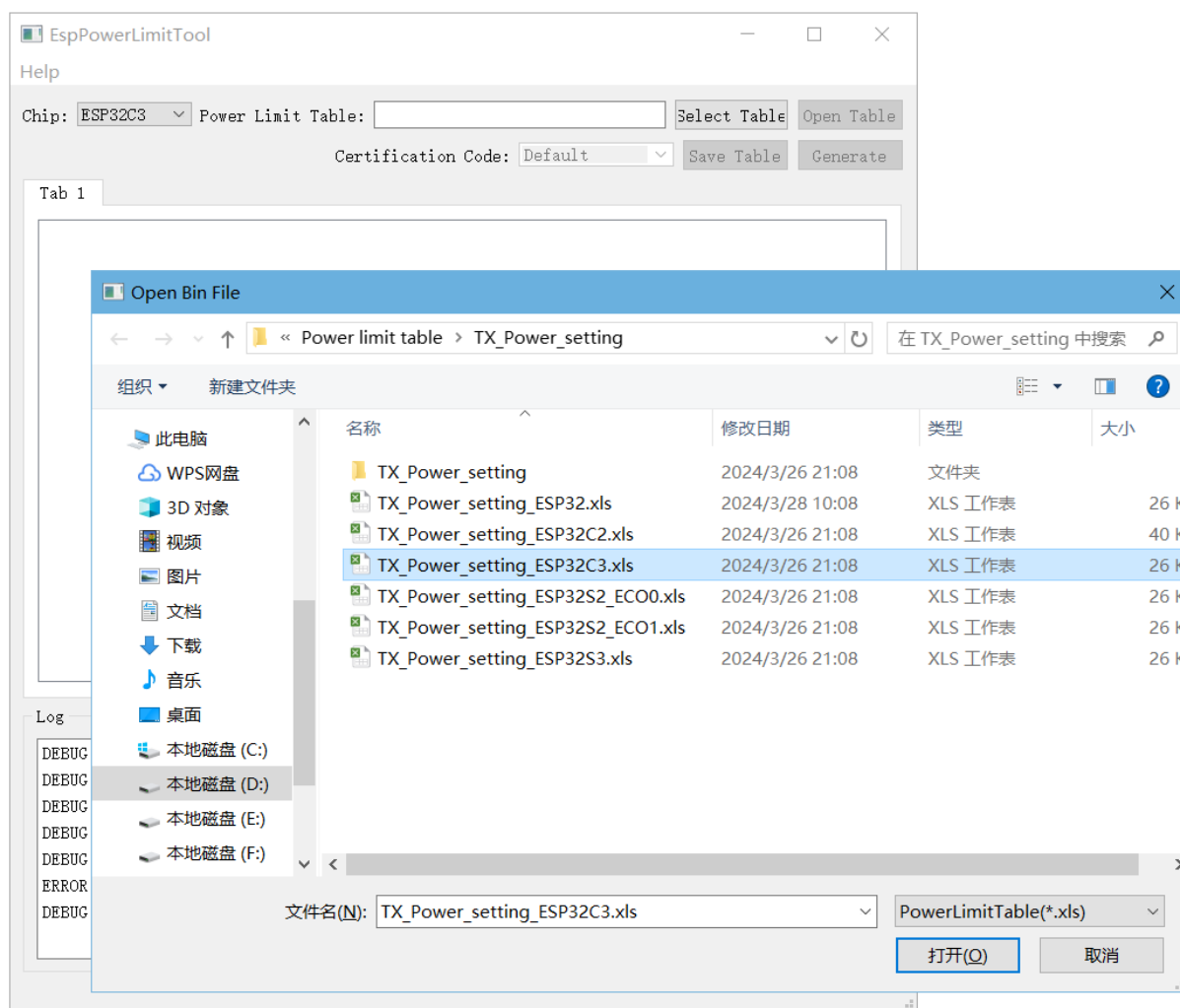


Fig. 9: Importing TX Power Setting Table

3. Click Open Table, modify the power value in the corresponding country code table, and select the desired country code in the Certification Code dropdown box.

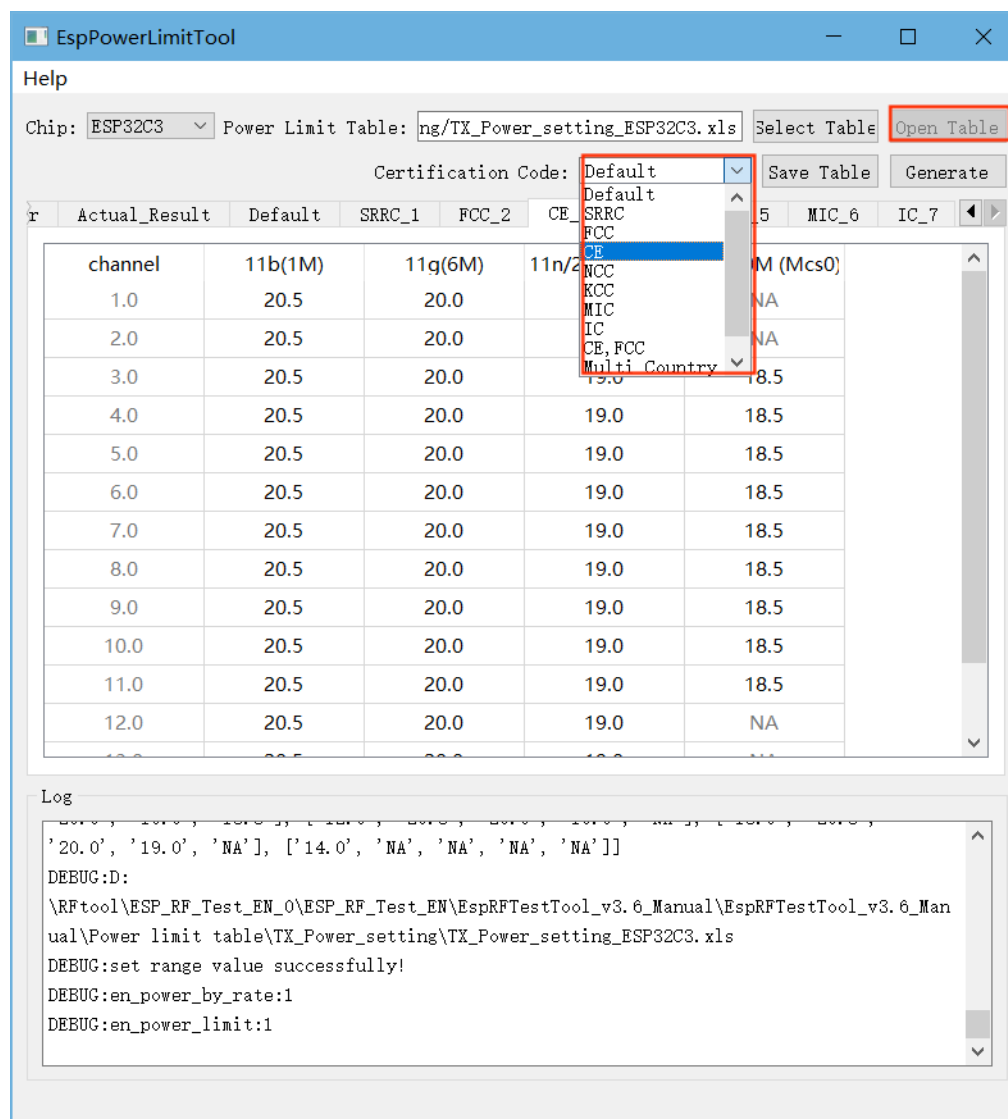


Fig. 10: Modifying TX_Power_Setting

Note: Description of TX Power Setting Table parameters:

1. **Config_Switch:** Enable Power_By_Rate and Power_Limit. Both are set to Yes by default, indicating they can be adjusted.
2. **PowerByRate_TargetPower:** Target power for each rate. It is recommended to keep the default value.
3. **Country_Table:** Currently supported countries (regions). It is extensible.
4. **Actual_Result:** Actual power of the module. The target power is used by default.
5. **Default:** Power configuration in the "Default" country code, usually used to identify the power configuration before setting the country code.
6. **SRRC_1:** Power configuration of the "SRRC" country code, applicable to Mainland China.
7. **FCC_2:** Power configuration of the "FCC" country code, applicable to the United States.
8. **CE_3:** Power configuration of the "CE" country code, applicable to Europe.
9. **NCC_4:** Power configuration of the "NCC" country code, applicable to Taiwan.
10. **KCC_5:** Power configuration of the "KCC" country code, applicable to South Korea.
11. **MIC_6:** Power configuration of the "MIC" country code, applicable to Japan.
12. **IC_7:** Power configuration of the "IC" country code, applicable to Canada.

Note: How to modify power values:

1. Fill in the power value based on the certification result (the certification provides the power attenuation value) (Power value = Target power - Attenuation value/4).
2. If Actual_Result is modified, the Target power in the above formula needs to be changed to Actual_Result.
3. Adding or deleting table content is not allowed. For example, FCC only supports channels 1~11, so it is recommended to keep the power values of channels 12~13 in this table the same as channel 11 instead of deleting them;
4. Except for low and high channels, the power values of other channels should be set to the same as the middle channel;
5. The NA section cannot be modified. If the Certification Code cannot be selected from the dropdown box, it indicates that the table has been modified and needs to be restored.

4. Click Save Table to save the settings. Select the required certification from the Certification Code dropdown, then click Generate to create the phy_init_bin file for the corresponding country code.

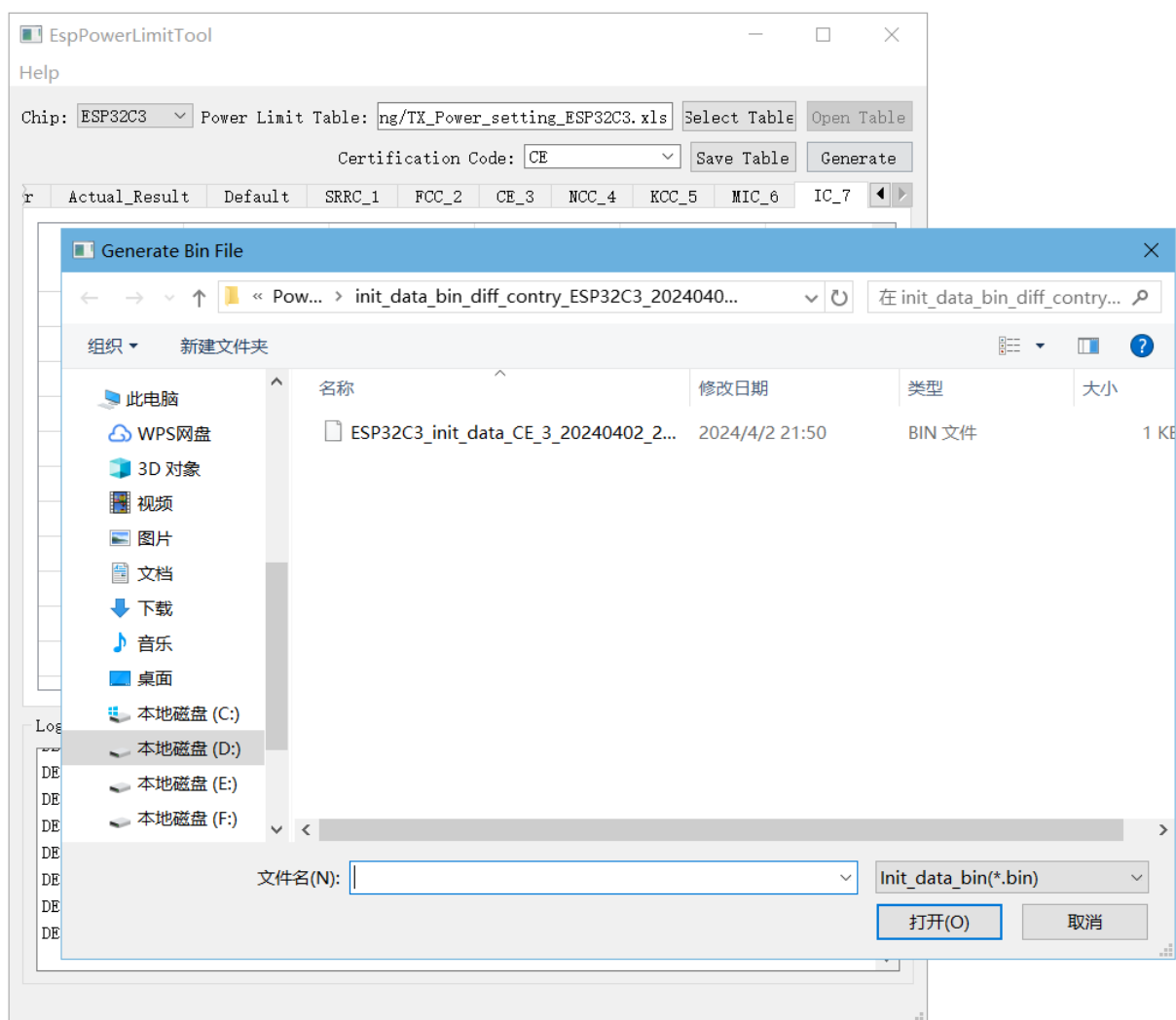


Fig. 11: Generate phy_init_bin File

Note:

1. The dropdown list of *Certification Code* includes options for a single certification, Multiple Country, and Custom.
2. Selecting a single certification will generate a single phy_init_bin file for that certification, which contains a total of 128 bytes except the verification control information.

3. Selecting `Multiple Country` will generate Combined `phy_init_bin` files, including a Default bin file and seven others for SRRC, FCC, CE, NCC, KCC, MIC, and IC. The combined files contain 8*128 bytes.
4. Selecting `Custom` will generate a single or multiple certification bin files based on your choice.

5. Verify whether `phy_init_bin` is effective using Non-Signaling or Signaling Test. Taking Non-Signaling Test as an example, first use the [DownloadTool](#) to download the generated `phy_init_bin` file to the testing product.

- Select `DownloadTool` from `Tool` dropdown list to enter the `DownloadTool` interface.
- Flash the `phy_init_bin` file and corresponding RF test firmware to flash by referring to the instructions stated [DownloadTool](#).
- The flash address for `phy_init_bin` is 0x1fc000 and the flash address for the RF test firmware [ESP32-S2 RF Non-Signaling Test Firmware](#) is 0x1000.

Note: Regarding the Signaling Test, you can simply replace the original `phy_init_bin`. Please refer to the relevant documents in [RF Test Items](#).

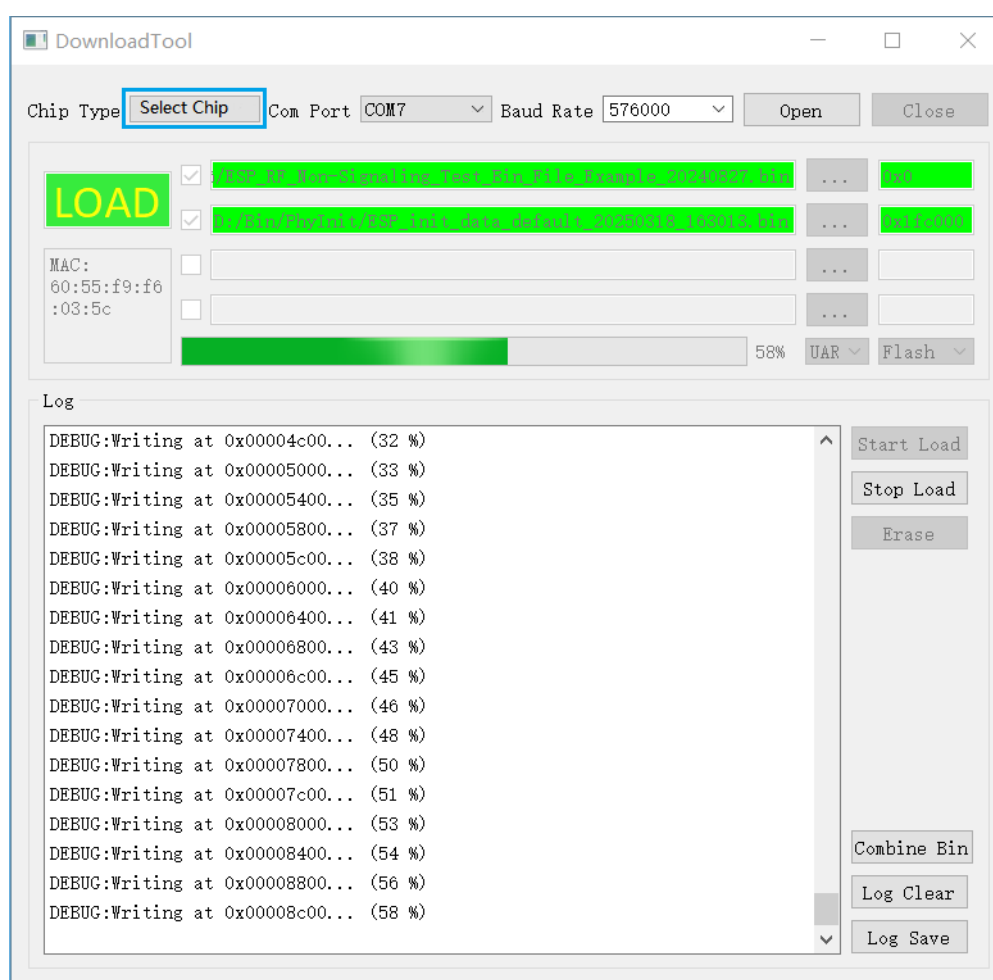


Fig. 12: Flash `phy_init_bin` File

6. Use a Wi-Fi tester to measure the output power and check whether `phy_init_bin` is effective.
 - Open [EspRFTestTool](#).
 - Select corresponding `ChipType`, `COM`, `BaudRate`, and click `Open` to open the serial port.
 - Open the `WiFi Test` tab, and select `Test Mode`, `Rate`, `BandWidth` and `Channel`.
 - Set `Attenuation` to 0, and `Duty Cycle` to 10%.
 - With `Certification EN` unchecked, i.e., `Phy init` not enabled, the tool tests the initial performance of modules.

- With `Certification EN` checked, i.e., Phy init enabled, the tool tests the performance for certification.
- The default address for flashing `phy_init_bin` is `0x1fc000`. If the flashing address changes, update it here.
- For Multiple Country, you can select the certification country codes it includes in the `Certification Code`.

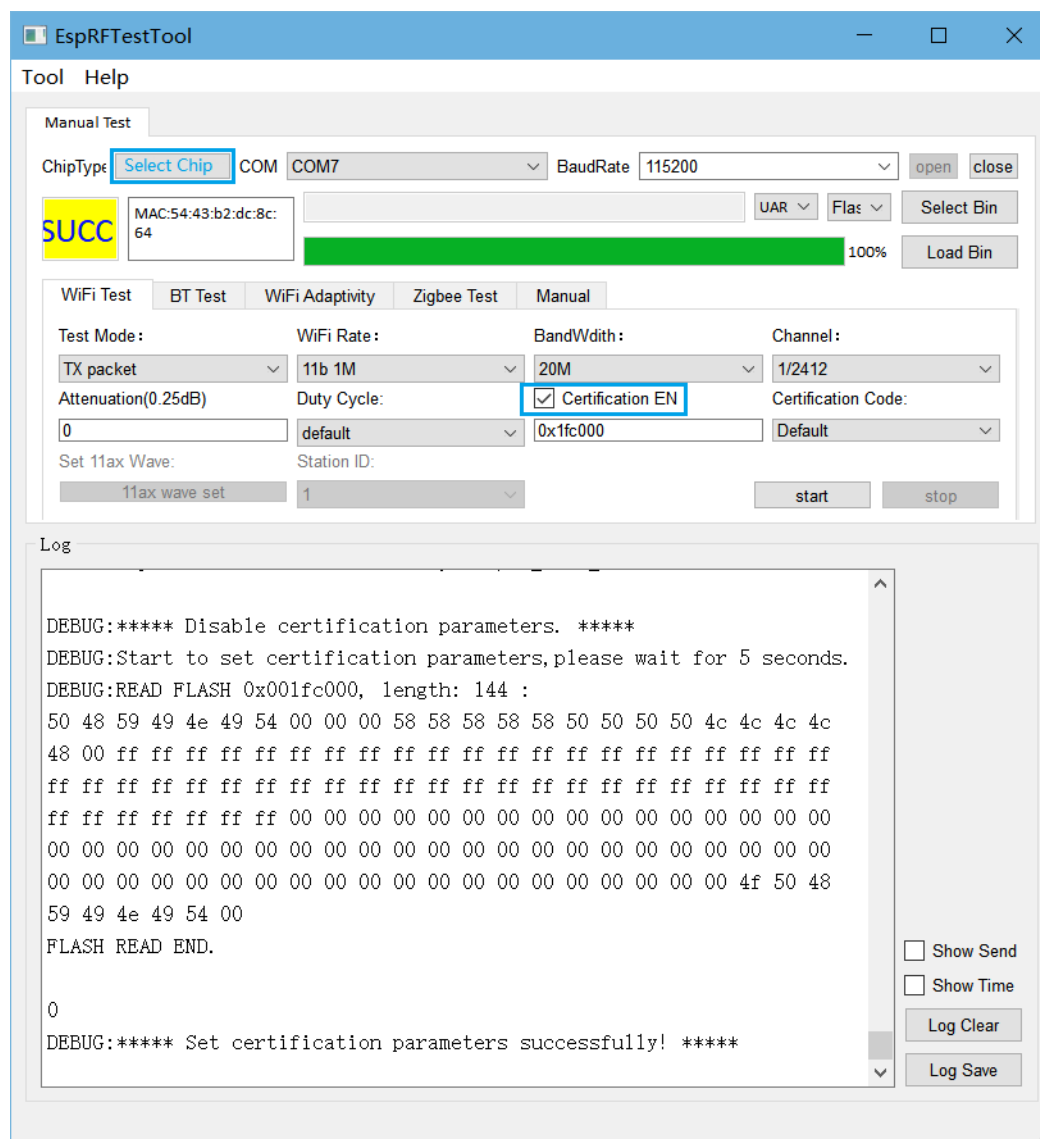


Fig. 13: RF Test Configuration

Typical Average Output Power of ESP32-S2

Rates	Typical Average Output Power (dBm)
11b 1 Mbps	19.5
11b 11 Mbps	19.5
11g 6 Mbps	18
11g 54 Mbps	15
11n-20 MCS0	18
11n-20 MCS7	13.5
11n-40 MCS0	18
11n-40 MCS7	13.5

3 RF Test Items

3.1 Wi-Fi Non-Signaling Test

The Wi-Fi Non-Signaling Test, also known as fixed frequency test, directly controls the device to transmit specific signals without establishing a data connection. It evaluates key RF performance metrics, such as transmit power, spectrum quality, and error rate, ensuring wireless communication quality in various scenarios.

Set Up Test Environment

The RF non-signaling test firmware environment mainly includes a PC, tester, a USB-to-UART board, a device under test (DUT), and a shield box.

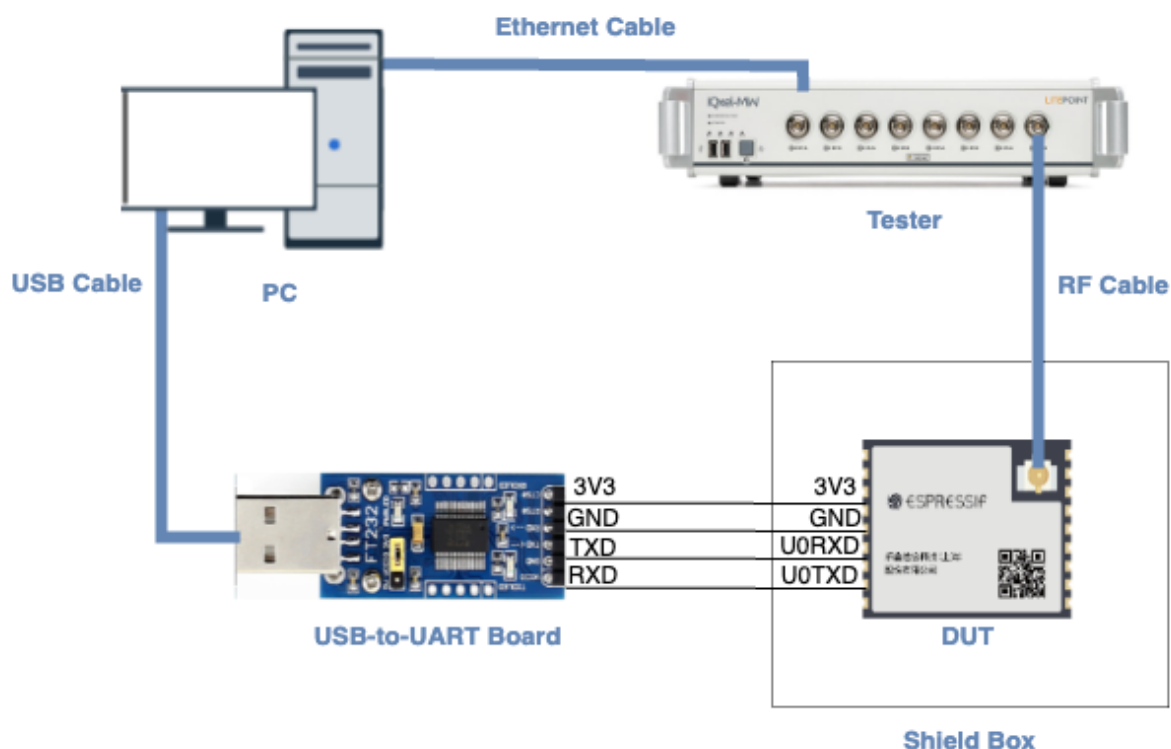


Fig. 14: Test Environment Setup

- **PC** is connected to the USB-to-UART board via USB and to the tester via an Ethernet cable. The PC needs to have the EspRFTTestTool toolkit, tester control software, and the driver for the USB-to-UART board installed.
- **Tester** is used to test the RF performance of the DUT in different modes. Typically, it is the WT-328/IQXel tester.
- **USB-to-UART board** is used to communicate between the PC and the DUT.
- **Device under test (DUT)** refers to a product designed based on the ESP32-S2 chip or module. It is connected to the USB-to-UART board via UART and to the tester via an RF connection cable. The DUT is usually placed inside a shield box.
- **Shield Box** is used to isolate external RF interference and ensure the stability of the test environment.

Note:

- The CHIP_EN pin of the DUT is pulled up by default. If it is not pulled up in the product design, you need to manually connect the CHIP_EN to the 3V3 pin.
 - Some serial communication boards have already swapped RXD and TXD internally, so there is no need to reverse the connection. Adjust the wiring according to the actual situation.
 - ESP32-S2 has a power-on self-calibration feature. The RF connection cable must be connected to the tester before the DUT is powered on for testing.
-

Conduction Test

- For modules without an onboard PCB antenna, the RF connection cable can be directly soldered to the antenna feed point of the module (as shown in the schematic diagram above).
- For modules with an onboard PCB antenna, cut the trace that connects to the PCB antenna feed point and solder the RF connection cable. The RF cable's shielding metal layer must be thoroughly soldered before connecting to the module's GND. The GND soldering point can be either the shield cover or the exposed GND layer on the PCB (after removing the green solder mask). Besides, it should be as close to the feed point as possible.

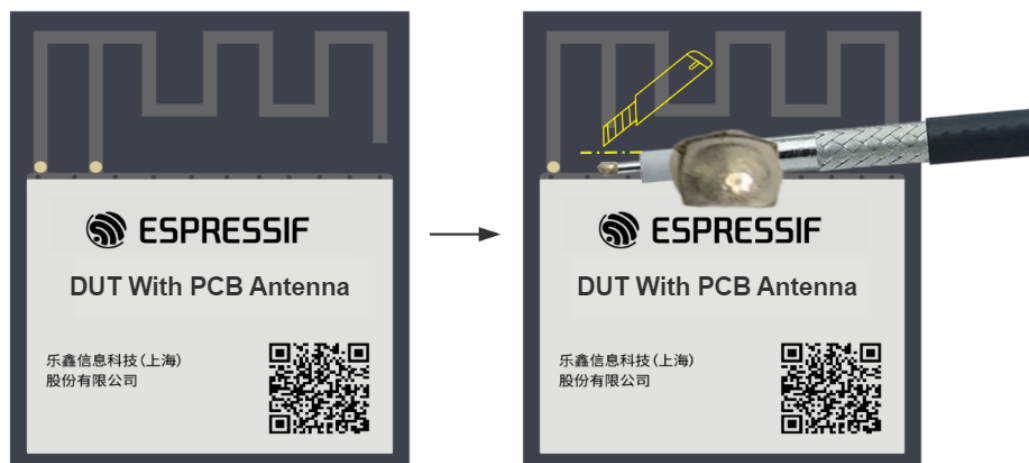


Fig. 15: Soldering RF Connection Cable to Module with Onboard PCB Antenna

Flash Firmware

1. Open [EspRFTestTool](#).
2. Set ChipType, COM, BaudRate, and click Open to open the COM port.

Note: Set BaudRate to 115200

3. Flash [ESP32-S2 RF Non-Signaling Test Firmware](#) to Flash via UART.

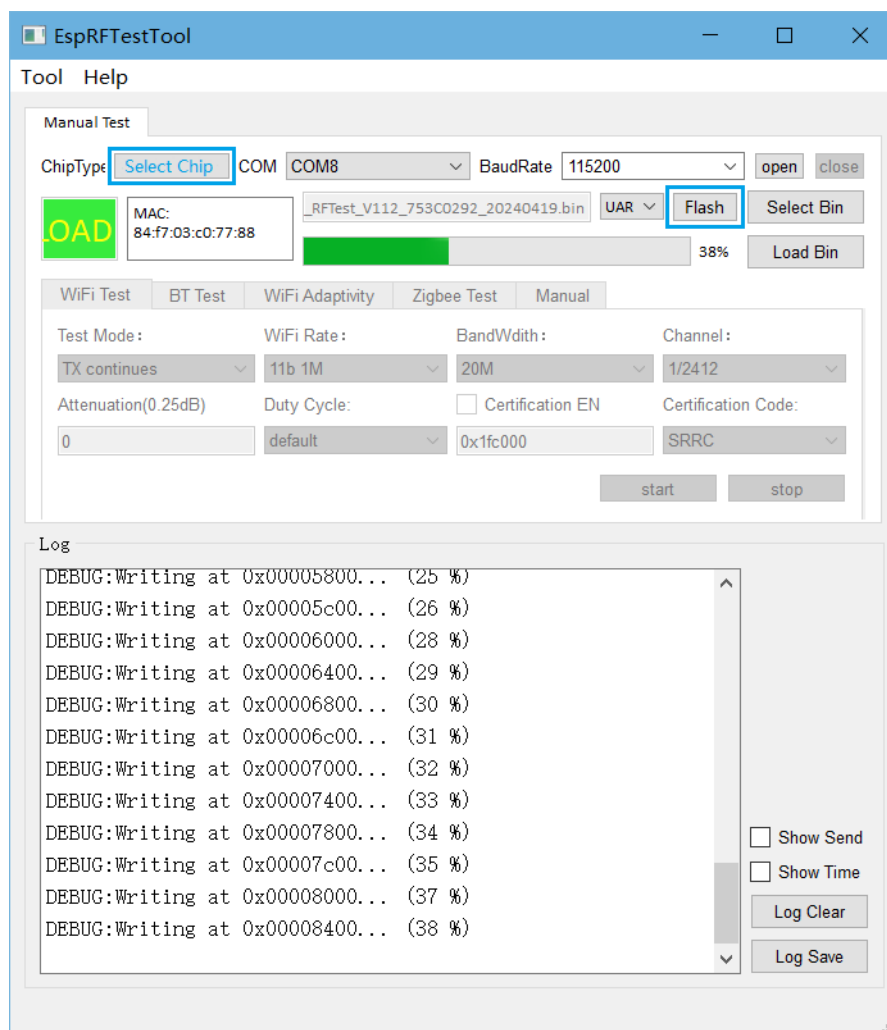


Fig. 16: ESPRFTTestTool Configuration

4. After the firmware flashing is completed, pull the boot pin high or leave it floating. The chip will enter the working mode after power-off restart.

Note: If you use the flash download tool to flash the firmware, change the flash address of ESP32-S2 to 0x1000.

Start Testing

Wi-Fi TX Performance Test

- **Test Mode:**
 - TX packet: Packet transmission duty cycle less than 50%, used for TX performance tests
 - TX continues: Packet duty cycle close to 100%, used for certification tests;
 - TX tone: Used for single-carrier tests.
- **Wi-Fi Rate:** Set Wi-Fi test rate
- **BandWidth:** Set Wi-Fi test bandwidth
- **Channel:** Set Wi-Fi test channel
- **Attenuation (0.25 dB):** Set power attenuation
 - 0 means no attenuation, which is the default value;
 - 2 means 0.5 dB attenuation;
 - 4 means 1 dB attenuation, and so on.

- **Duty Cycle:** Set the packet duty cycle in TX packet tests. The default duty cycle is around 30%. Supported values: 10%, 50%, 90%.
- **Certification EN:** Not enabled by default. Used only when verifying Power Limit function.
- **Certification Code:** Not enabled by default. Used only when verifying Power Limit function.

After clicking **start**, the log window should print Wi-Fi transmission parameters similar to the following:

```
Wifi tx out: channel=1, rate=0x0, BK=0, length=50, delay=1200, packet_num=0
```

The above parameters indicate that Wi-Fi packet transmission is normal, and the transmission performance can be detected with tester at this time.

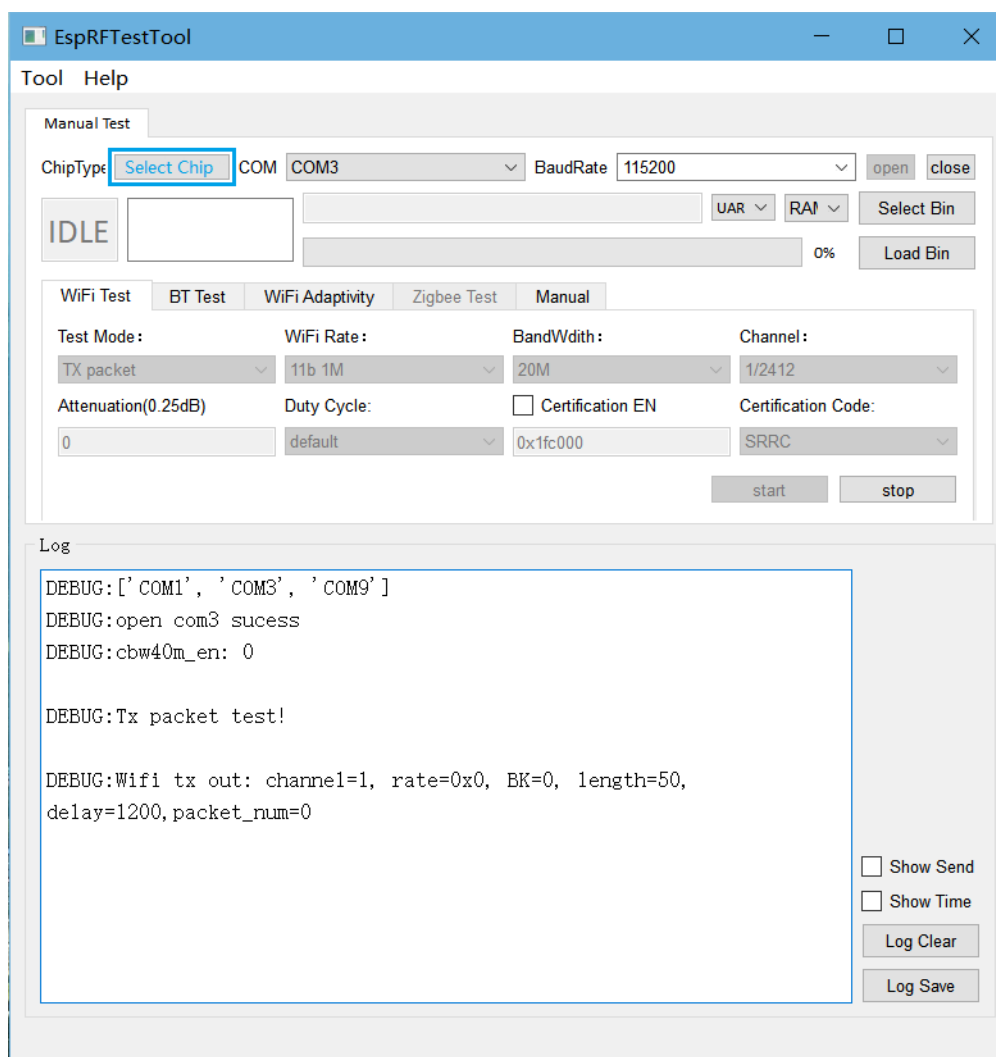


Fig. 17: Wi-Fi TX Performance Test

Wi-Fi RX Performance Test

- **Test Mode:** Set to RX packet for RX performance tests.
- **Wi-Fi Rate:** Set Wi-Fi test rate.
- **BandWidth:** Set Wi-Fi test bandwidth.
- **Channel:** Set Wi-Fi test channel.

After clicking **start**, the tester sends packets on the test channel. Click **stop** after completion. The log window should display packet RX information similar to the following:

```
Correct:1000 Desired:1000 RSSI:-614 noise:-960 gain:0 paral:0 para2:0 freq:0
```

Where:

- **Correct:** The total number of packets received this time.
- **Desired:** The number of packets received at the corresponding rate this time.
- **RSSI:** Represents the average RSSI of the received Desired packets. For example, “RSSI: -614” means the RSSI value is -61.4.

Note:

- If Desired is 0, no packets were received from the tester. Please check the tester's packet settings and packet file to ensure the packet RX link is normal;
- If Desired is not 0 and Correct is greater than Desired, there is interference in the environment. Please retest in a shielded environment;
- Other parameters in the packet RX information are only used for RD debug and have no actual meaning.

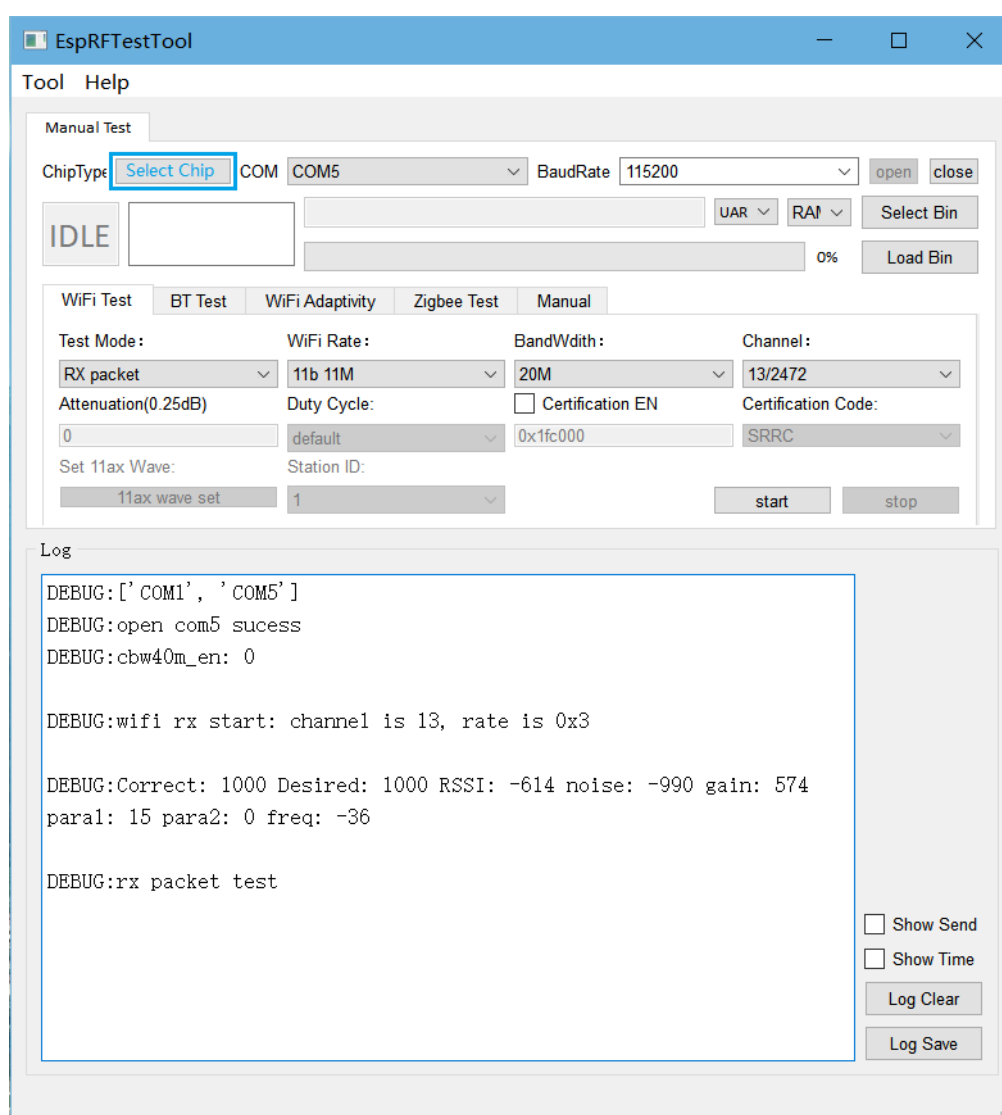


Fig. 18: Wi-Fi RX Performance Test

Appendix

This appendix is mainly used to explain the target output power of the chip's Wi-Fi, which is used for RF debugging or test reference.

Table 2: ESP32-S2 Wi-Fi Target TX Power

Rate	ESP32-S2 Wi-Fi Target Power (dBm)
11b 1M	19.5
11b 11M	19.5
11g 6M	18
11g 54M	18
HT20-11n MCS0	18
HT20-11n MCS7	17
HT40-11n MCS0	18
HT40-11n MCS7	16.5

3.2 Wi-Fi Signaling Test

The Wi-Fi Signaling Test assesses and verifies the Wi-Fi signaling functions of wireless network devices, focusing on stable and reliable communication across varying operating scenarios. It evaluates Over-The-Air (OTA) performance, including Total Radiated Power (TRP) and Total Isotropic Sensitivity (TIS).

Set Up Test Environment

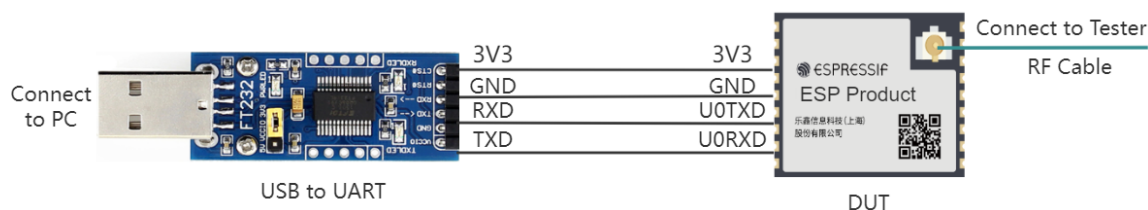


Fig. 19: UART Connection Description

The **Device Under Test (DUT)** is a product designed based on Espressif chips or modules. The device under test is connected to the USB-to-UART adapter board via UART.

Note:

- The CHIP_EN pin of the device under test is pulled up by default. If it is not pulled up in the product design, you need to manually connect the CHIP_EN to the 3V3 pin.
- Some serial communication boards have already swapped RXD and TXD internally, so there is no need to reverse them. The wiring needs to be adjusted according to the actual situation.
- Espressif chips have a power-on self-calibration feature. Therefore, before powering on the device under test, the RF connection cable must be connected to the testing instrument.

Flash Firmware

1. Open [DownloadTool](#).

2. Set Chip Type, Com Port and Baud Rate, click Open, and select download to Flash.
3. [ESP32-S2 Wi-Fi Signaling Test Firmware \(Single Country\)](#) supports a single country code, [ESP32-S2 Wi-Fi Signaling Test Firmware \(Multiple Countries\)](#) supports multiple country codes. They each include 4 bin files, i.e., **bootloader.bin**, **partition-table.bin**, **phy_init_data.bin**, and **ssc.bin**.

After unzipping [ESP32-S2 Wi-Fi Signaling Test Firmware \(Single Country\)](#) or [ESP32-S2 Wi-Fi Signaling Test Firmware \(Multiple Countries\)](#), flash the 4 bin files to the following addresses via UART.

bin file	flashing address
bootloader.bin	0x1000
partition-table.bin	0x8000
phy_init_data.bin	0xF000
ssc.bin	0x10000

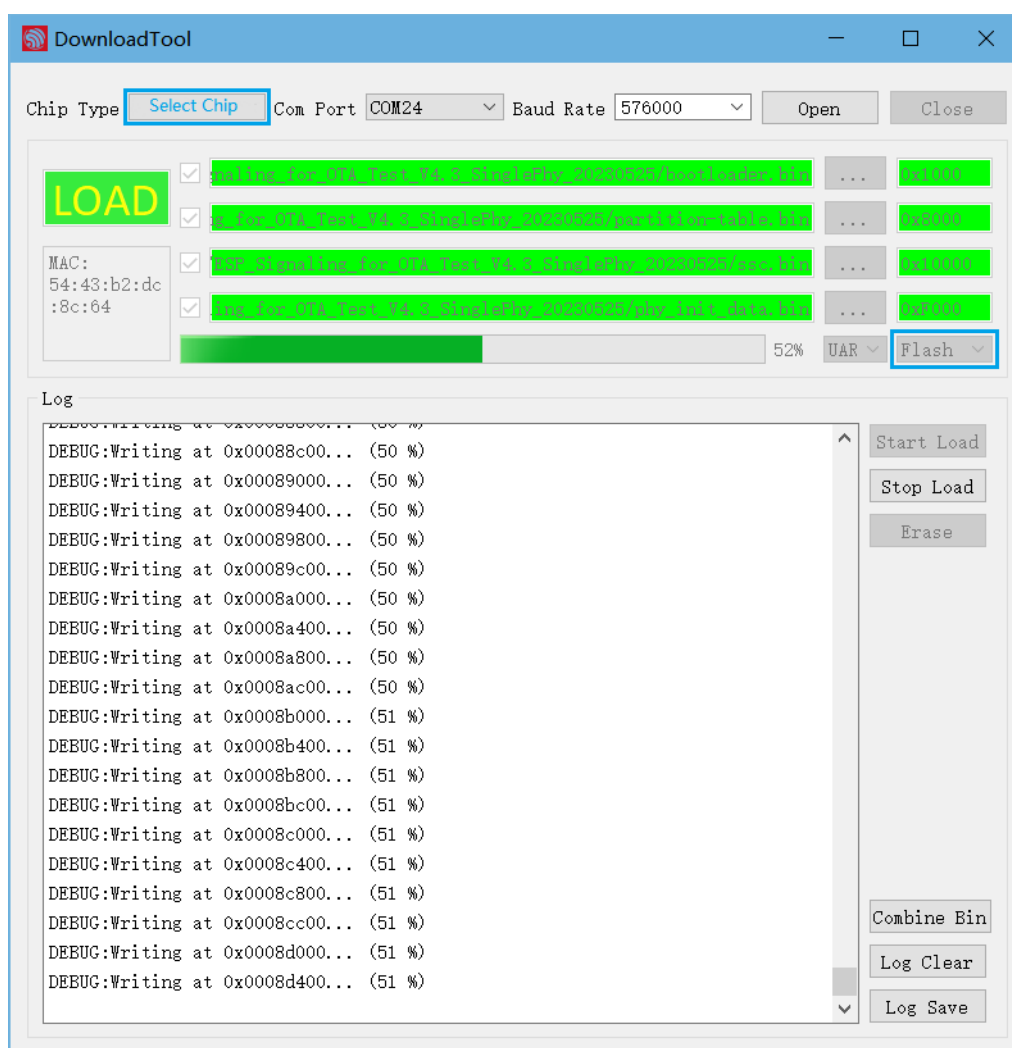


Fig. 20: Firmware Flashing Schematic

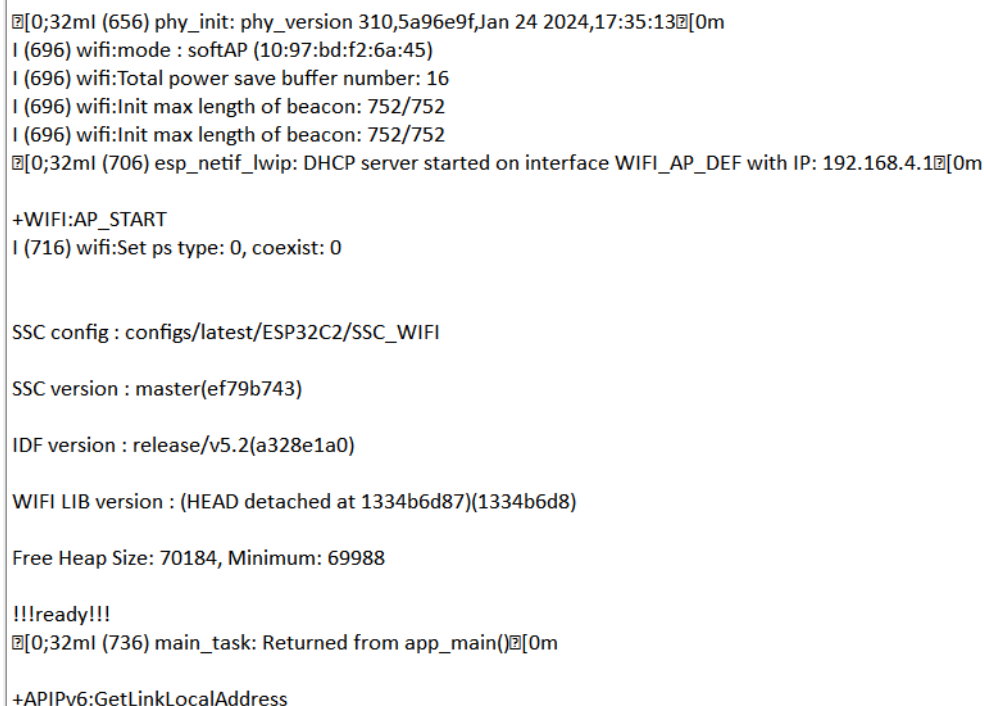
After the flashing is completed, continue with the following steps for signaling testing.

Start Testing

Check Power-on Log

Note: BaudRate is set to 115200.

Use a serial communication tool, such as [Friendly Serial Assistant](#), to configure the port number and baud rate. After the device under test is powered on again, if the serial output is similar to the following information, you can confirm that the test status is normal:



```

[0;32mI (656) phy_init: phy_version 310,5a96e9f,Jan 24 2024,17:35:13[0m
I (696) wifi:mode : softAP (10:97:bd:f2:6a:45)
I (696) wifi:Total power save buffer number: 16
I (696) wifi:Init max length of beacon: 752/752
I (696) wifi:Init max length of beacon: 752/752
[0;32mI (706) esp_netif_lwip: DHCP server started on interface WIFI_AP_DEF with IP: 192.168.4.1[0m

+WIFI:AP_START
I (716) wifi:Set ps type: 0, coexist: 0

SSC config : configs/latest/ESP32C2/SSC_WIFI

SSC version : master(ef79b743)

IDF version : release/v5.2(a328e1a0)

WIFI LIB version : (HEAD detached at 1334b6d87)(1334b6d8)

Free Heap Size: 70184, Minimum: 69988

!!!ready!!!
[0;32mI (736) main_task: Returned from app_main()[0m

+APIv6:GetLinkLocalAddress
  
```

Fig. 21: Serial Port Log for Device Power-on

Device Provisioning Enter the following two commands in the serial port in sequence for network configuration.

```

//Device Provisioning
//Configure the prototype to enter station mode
op -S -o 1

//Connect to AP, SSID is CMW-AP, password is 12345678
sta -C -s CMW-AP -p 12345678
  
```

Note: The `-p` parameter is used to set the AP password. If the AP has no password, this parameter is not needed.

After the station device is assigned an IP address, the Wi-Fi connection is successful, and the following log is printed:

```

I (325546) wifi:new:<1,0>, old:<1,0>, ap:<1,0>, sta:<255,255>, prof:1

+SOFTAP:STADISCONNECTED,42:37:dd:d6:40:44,3
op -S -o 1
I (1407226) wifi:mode : sta (10:97:bd:f2:6a:44)
I (1407226) wifi:enable tsf

+WIFI:AP_STOP

+MODE:OK

+WIFI:STA_START
sta -C -s CMW-AP1 -p 12345678

+JAP:OK
I (1709076) wifi:new:<6,0>, old:<1,0>, ap:<255,255>, sta:<6,0>, prof:1
I (1709356) wifi:state: init -> auth (b0)
I (1709366) wifi:state: auth -> assoc (0)
I (1709366) wifi:state: assoc -> run (10)
I (1709376) wifi:connected with CMW-AP1, aid = 1, channel 6, BW20, bssid = c8:0e:77:4f:d4:29
I (1709376) wifi:security: WPA2-PSK, phy: bgn, rssi: -41
I (1709396) wifi:pm start, type: 0

I (1709396) wifi:dp: 1, bi: 102400, li: 3, scale listen interval from 307200 us to 307200 us
I (1709396) wifi:set rx beacon pti, rx_bcn_pti: 0, bcn_timeout: 25000, mt_pti: 0, mt_time: 10000

+JAP:WIFICONNECTED
I (1709436) wifi:AP's beacon interval = 102400 us, DTIM period = 1

+STAIPv6:GetLinkLocalAddress
[0;32mI (1712406) esp_netif_handlers: sta ip: 192.168.5.8, mask: 255.255.255.0, gw: 192.168.5.1[0m

+JAP:CONNECTED,CMW-AP1

```

Fig. 22: Serial Port Log for Device Provisioning

After the device under test is successfully connected, you can use the RF test instrument for Wi-Fi Signaling Test.

3.3 Wi-Fi Adaptivity Test

The Wi-Fi Adaptivity Test evaluates a device's ability to make real-time adjustments to parameters, such as transmission rate, channel selection, and power levels, by simulating varying network conditions and loads. This test aims to optimize the overall network performance and stability.

Note: If the power spectral density (PSD) of the Wi-Fi signal is higher than 10 dBm/MHz, the adaptivity test should choose the Listen Before Talk (LBT) mechanism based on non-hopping load.

Set Up Test Environment

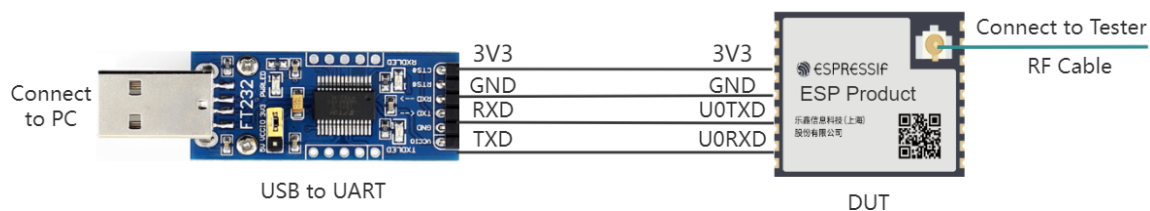


Fig. 23: UART Connection Description

The **Device Under Test (DUT)** is a product designed based on Espressif chips or modules. The DUT is connected to the USB-to-UART adapter board via UART.

Note:

- The CHIP_EN pin of the DUT is pulled up by default. If it is not pulled up in the product design, you need to manually connect the CHIP_EN to the 3V3 pin.
- Some serial communication boards have already swapped RXD and TXD internally, so there is no need to reverse them. The wiring should be adjusted according to the actual situation.
- Espressif chips have a power-on self-calibration function, so the RF connection line must be connected to the test instrument before the DUT is powered on for testing.

Flash Firmware

1. Open [DownloadTool](#).
2. Set ChipType, Com Port, Baud Rate, click Open, select to download to Flash.
3. Flash [ESP32-S2 Wi-Fi Adaptivity Test/Blocking Test Firmware](#) to 0x1000 via UART.

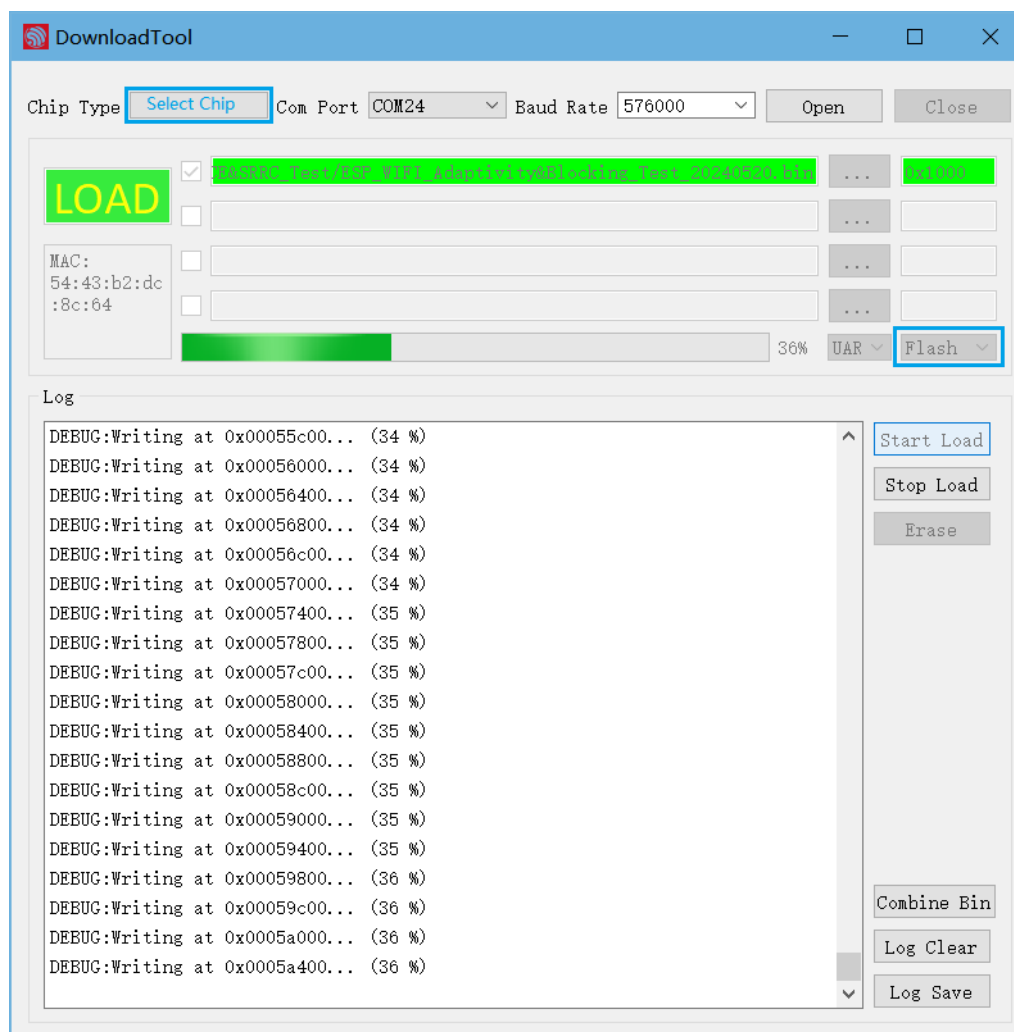


Fig. 24: Flashing Firmware

After the flashing is completed, continue with the following steps for the adaptivity test.

Start Testing

Note: Set BaudRate to 115200.

Check Power-on log Use a serial communication tool, such as [SerialPortUtility](#), and configure the port number and the baud rate. If the device under test prints similar information as below after being powered on again, you can confirm that the test status is OK:

```

[0;32mI (656) phy_init: phy_version 310,5a96e9f,Jan 24 2024,17:35:13[0m
I (696) wifi:mode : softAP (10:97:bd:f2:6a:45)
I (696) wifi:Total power save buffer number: 16
I (696) wifi:Init max length of beacon: 752/752
I (696) wifi:Init max length of beacon: 752/752
[0;32mI (706) esp_netif_lwip: DHCP server started on interface WIFI_AP_DEF with IP: 192.168.4.1[0m

+WIFI:AP_START
I (716) wifi:Set ps type: 0, coexist: 0

SSC config : configs/latest/ESP32C2/SSC_WIFI

SSC version : master(ef79b743)

IDF version : release/v5.2(a328e1a0)

WIFI LIB version : (HEAD detached at 1334b6d87)(1334b6d8)

Free Heap Size: 70184, Minimum: 69988

!!!ready!!!
[0;32mI (736) main_task: Returned from app_main()[0m

+APIv6:GetLinkLocalAddress

```

Fig. 25: Device Power-on Serial Port Print Log

Next, you can choose to [test using serial port commands](#) or [test using EspRFTestTool tool](#).

Test Using Serial Port Commands Enter the following commands in the serial port in sequence for network configuration and traffic testing:

```

//Device provisioning
//Configure the prototype to enter station mode
op -S -o 1

//Connect to AP, SSID is CMW-AP, password is 12345678
sta -C -s CMW-AP -p 12345678

//Traffic test
//Clear socket
soc -T

//Create UDP, port is 8080, default socket ID is 54
soc -B -t UDP -p 8080

//Perform traffic test on AP device with socket ID 54
soc -S -s 54 -i 192.168.1.1 -p 8080 -l 2000 -n 200000000 -j 1

```

Note: The `-p` parameter is used to set the AP password. If the AP has no password, this parameter is not needed.

If the following similar information is printed in the serial port, it indicates that the traffic has been started and the Wi-Fi Adaptivity Test can be initiated.

```

+APIv6:GetLinkLocalAddress
op -S -o 1
I (4041) wifi:mode : sta (10:97:bd:f2:6a:44)
I (4041) wifi:enable tsf

+WIFI:AP_STOP

+MODE:OK

+WIFI:STA_START
sta -C -s CMW-AP1 -p 12345678

+JAP:OK
I (6101) wifi:new:<6,0>, old:<1,0>, ap:<255,255>, sta:<6,0>, prof:1
I (6381) wifi:state: init -> auth (b0)
I (6381) wifi:state: auth -> assoc (0)
I (6391) wifi:state: assoc -> run (10)
I (6421) wifi:connected with CMW-AP1, aid = 1, channel 6, BW20, bssid = c8:0e:77:4f:d4:29
I (6421) wifi:security: WPA2-PSK, phy: bgn, rssi: -39
I (6431) wifi:pm start, type: 0

I (6431) wifi:dp: 1, bi: 102400, li: 3, scale listen interval from 307200 us to 307200 us
I (6431) wifi:set rx beacon pti, rx_bcn_pti: 0, bcn_timeout: 25000, mt_pti: 0, mt_time: 10000

+JAP:WIFICONNECTED
I (6511) wifi:AP's beacon interval = 102400 us, DTIM period = 1
[0;32mI (7441) esp_netif_handlers: sta ip: 192.168.67.174, mask: 255.255.255.0, gw: 192.168.67.1[0m

+JAP:CONNECTED,CMW-AP1

+STAIPv6:GetLinkLocalAddress
soc -T

+CLOSEALL

soc -B -t UDP -p 8080

+BIND:54,OK,0.0.0.0,8080
soc -S -s 54 -i 192.168.1.1 -p 8080 -l 2000 -n 2000000000000 -j 1

```

Fig. 26: Serial Port Log for Device Provisioning

Test Using EspRFTTestTool Tool

- Open the EspRFTTestTool toolkit, configure ChipType, COM, and BaudRate, open the port, and select the WiFi Adaptivity test interface.
- In STA mode, enter AP ssid and AP pwd, and click Connect AP to connect.
- After successful connection, the following log should be printed:

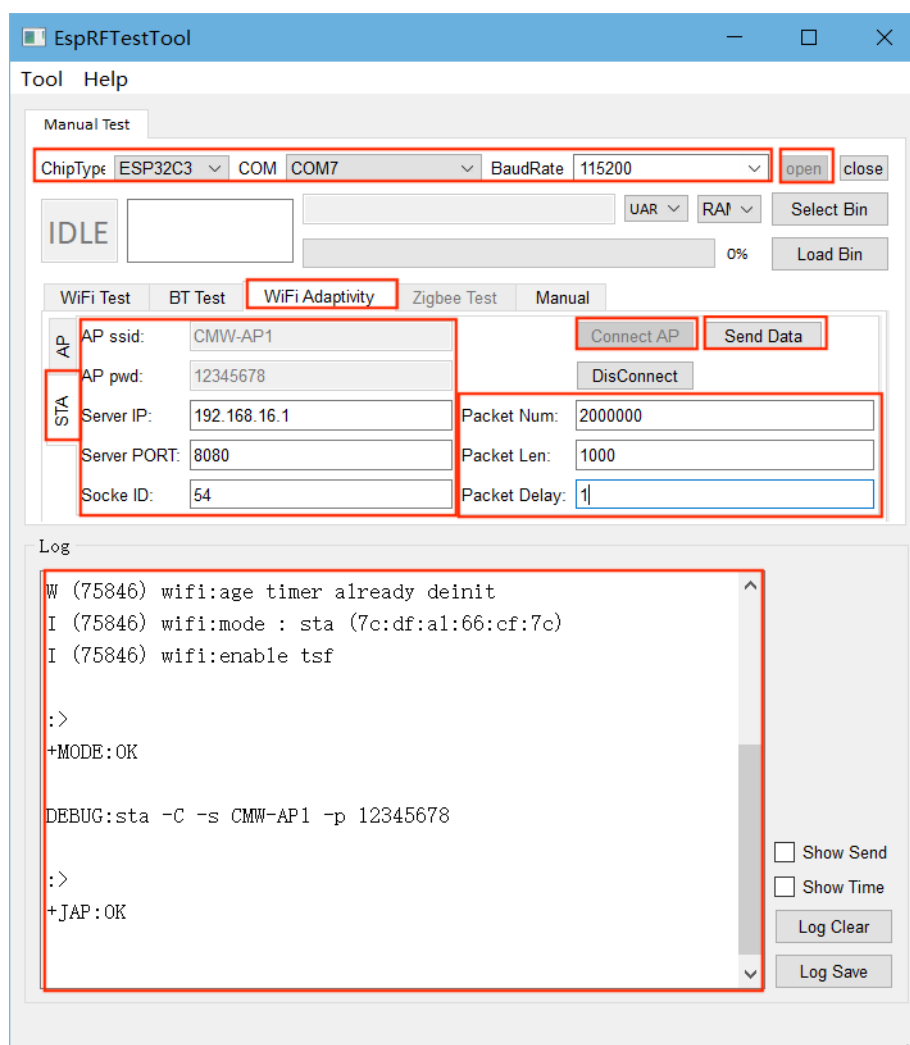


Fig. 27: Device Network Provisioning

- After a successful connection, set `Packet Num` to a sufficiently large value—such as 20000000—to ensure the traffic can run for a long duration.
- Set `Server PORT` to 8080, `Socket ID` to 54, and change `Packet Delay` to 1 to meet certification requirements.
- After the above settings are completed, click `Send Data`. If the log is similar to the figure below, it indicates that the traffic has been started, and the Wi-Fi Adaptivity Test can be initiated.

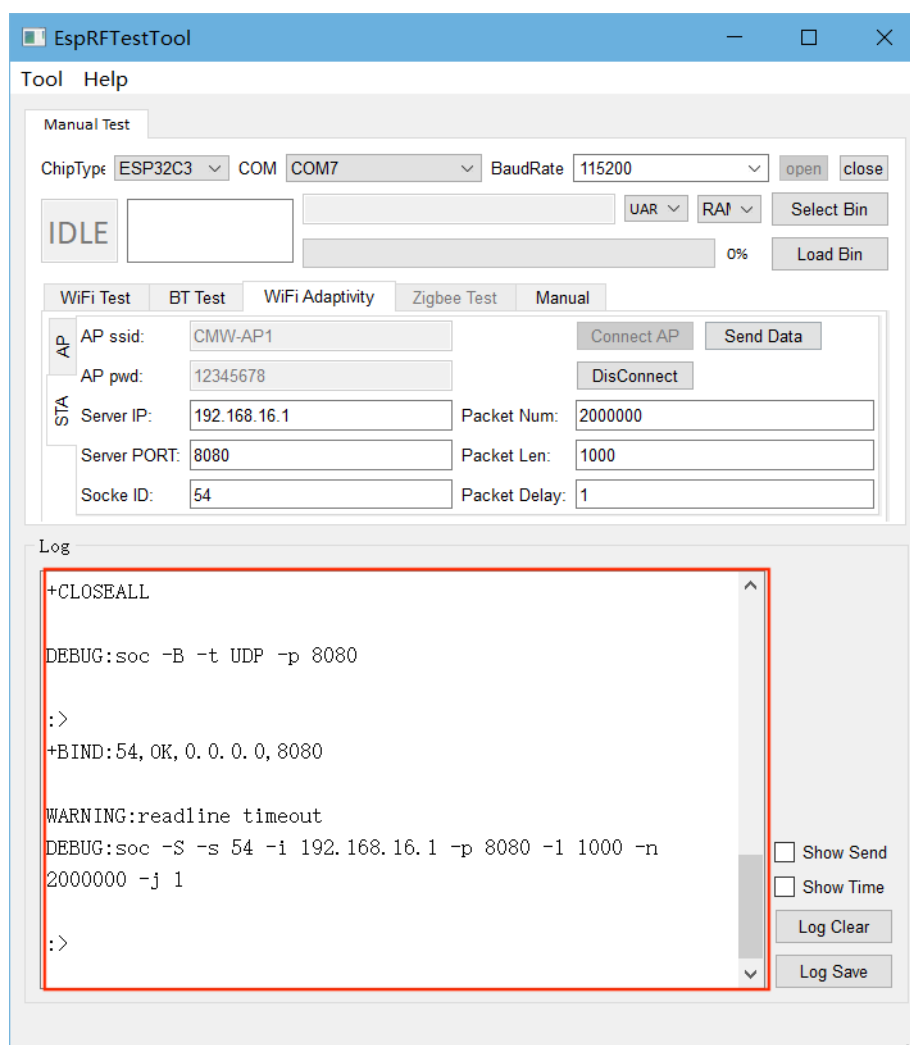


Fig. 28: Wi-Fi Adaptivity Traffic Test

3.4 Wi-Fi Blocking Test

The Wi-Fi Blocking Test evaluates the device's reception performance in environments with strong interference. By introducing high-intensity interference signals, it measures the reception sensitivity and anti-interference capability of a device, ensuring reliable operation in complex wireless environments.

Set Up Test Environment

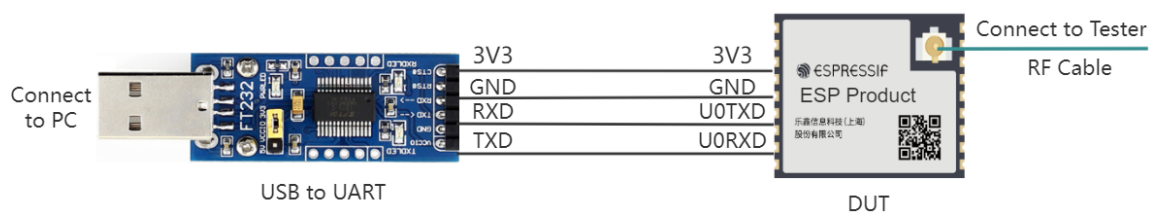


Fig. 29: UART Connection Description

The **Device Under Test (DUT)** is a product designed based on Espressif chips or modules. The DUT is connected to the USB-to-UART adapter board via UART.

Note:

- The CHIP_EN pin of the DUT is pulled up by default. If it is not pulled up in the product design, you need to manually connect the CHIP_EN to the 3V3 pin.
- Some serial communication boards have already swapped RXD and TXD internally, so there is no need to reverse them. The wiring should be adjusted according to the actual situation.
- Espressif chips have a power-on self-calibration function, so the RF connection line must be connected to the test instrument before the DUT is powered on for testing.

Flash Firmware

1. Open [DownloadTool](#).
2. Set ChipType, Com Port, Baud Rate, click Open, select to download to Flash.
3. Flash [ESP32-S2 Wi-Fi Adaptivity Test/Blocking Test Firmware](#) to 0x1000 via UART.

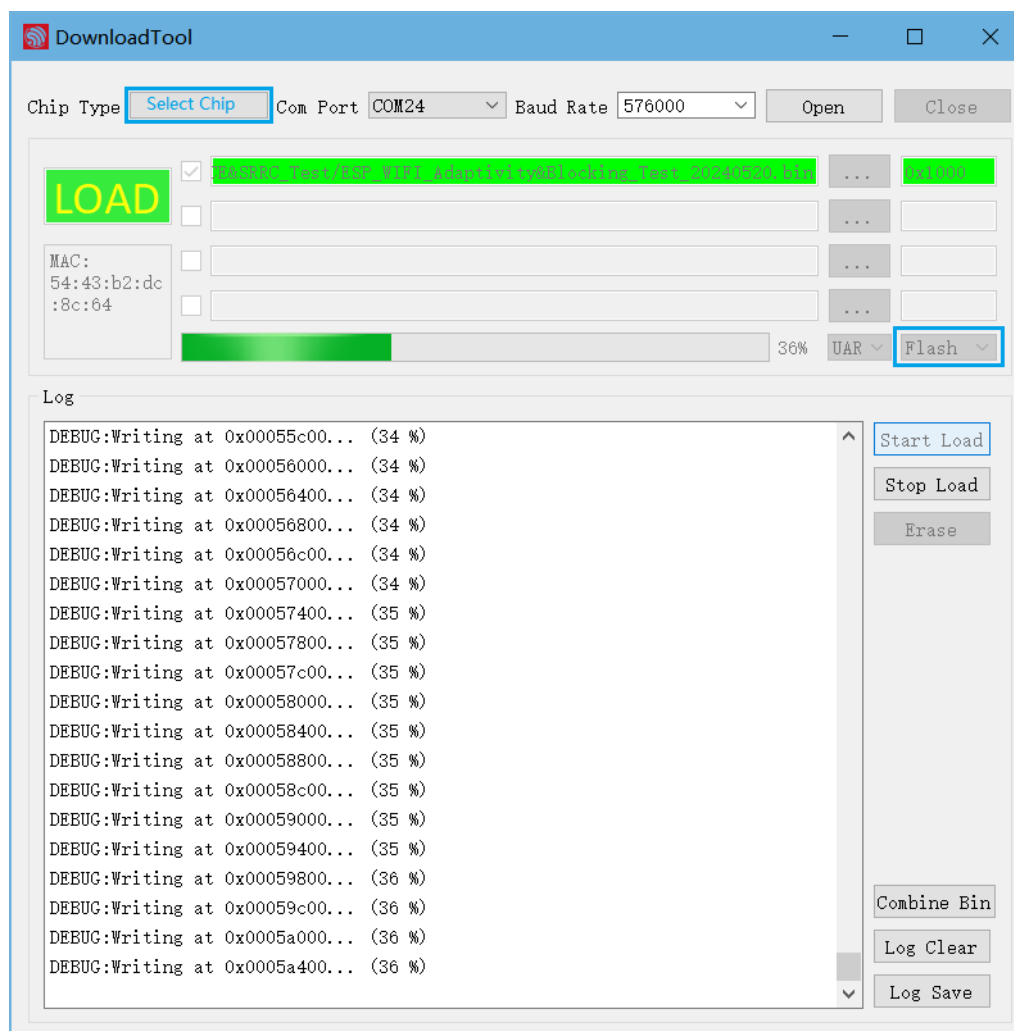


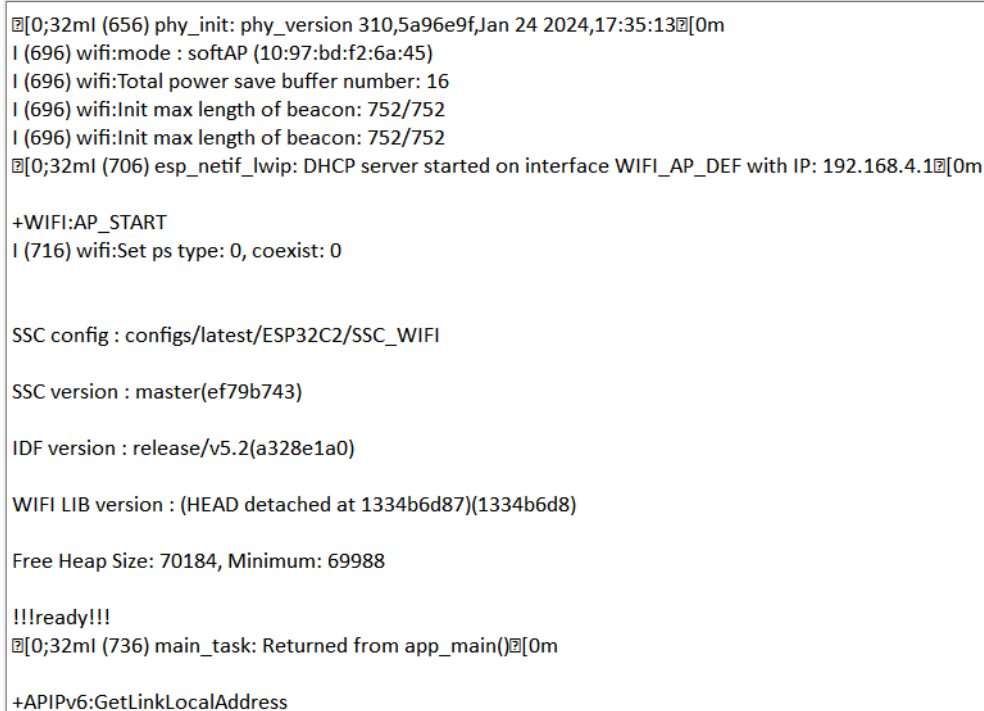
Fig. 30: Flashing Firmware

After the flashing is completed, continue with the following steps for the adaptivity test.

Start Testing

Note: Set BaudRate to 115200.

Check Power-on log Use a serial communication tool, such as [SerialPortUtility](#), and configure the port number and the baud rate. If the device under test prints similar information as below after being powered on again, you can confirm that the test status is OK:



```
[0;32m (656) phy_init: phy_version 310,5a96e9f,Jan 24 2024,17:35:13[0m
I (696) wifi:mode : softAP (10:97:bd:f2:6a:45)
I (696) wifi:Total power save buffer number: 16
I (696) wifi:Init max length of beacon: 752/752
I (696) wifi:Init max length of beacon: 752/752
[0;32m (706) esp_netif_lwip: DHCP server started on interface WIFI_AP_DEF with IP: 192.168.4.1[0m

+WIFI:AP_START
I (716) wifi:Set ps type: 0, coexist: 0

SSC config : configs/latest/ESP32C2/SSC_WIFI

SSC version : master(ef79b743)

IDF version : release/v5.2(a328e1a0)

WIFI LIB version : (HEAD detached at 1334b6d87)(1334b6d8)

Free Heap Size: 70184, Minimum: 69988

!!!ready!!!
[0;32m (736) main_task: Returned from app_main()[0m

+APIv6:GetLinkLocalAddress
```

Fig. 31: Device Power-on Serial Port Print Log

Test with Serial Port Commands Enter the following commands in the serial port in sequence to set up the network:

```
// Device Provisioning
// Configure the prototype to enter station mode
op -S -o 1

// Connect to AP, SSID is CMW-AP, password is 12345678
sta -C -s CMW-AP -p 12345678
```

Note:

- The `-p` parameter is used to set the AP password. If the AP has no password, this parameter is not needed.

If the following information is printed on the serial port, the connection is successful and the Wi-Fi Blocking Test can be performed.


```

+APIPv6:GetLinkLocalAddress
op -S -o 1
I (4041) wifi:mode : sta (10:97:bd:f2:6a:44)
I (4041) wifi:enable tsf

+WIFI:AP_STOP

+MODE:OK

+WIFI:STA_START
sta -C -s CMW-AP1 -p 12345678

+JAP:OK
I (6101) wifi:new:<6,0>, old:<1,0>, ap:<255,255>, sta:<6,0>, prof:1
I (6381) wifi:state: init -> auth (b0)
I (6381) wifi:state: auth -> assoc (0)
I (6391) wifi:state: assoc -> run (10)
I (6421) wifi:connected with CMW-AP1, aid = 1, channel 6, BW20, bssid = c8:0e:77:4f:d4:29
I (6421) wifi:security: WPA2-PSK, phy: bgn, rssi: -39
I (6431) wifi:pm start, type: 0

I (6431) wifi:dp: 1, bi: 102400, li: 3, scale listen interval from 307200 us to 307200 us
I (6431) wifi:set rx beacon pti, rx_bcn_pti: 0, bcn_timeout: 25000, mt_pti: 0, mt_time: 10000

+JAP:WIFICONNECTED
I (6511) wifi:AP's beacon interval = 102400 us, DTIM period = 1
[0;32mI (7441) esp_netif_handlers: sta ip: 192.168.67.174, mask: 255.255.255.0, gw: 192.168.67.1[0m

+JAP:CONNECTED,CMW-AP1

+STAPIPv6:GetLinkLocalAddress

```

Fig. 32: Serial Port Log for Device Provisioning

Test with ESPRFTTestTool

- Open the [EspRFTTestTool package](#), configure ChipType and COM, select 115200 for BaudRate, open the port, and select the WiFi Adaptivity test interface.
- In STA mode, enter AP ssid and AP pwd, and click Connect AP to connect.
- After successful connection, the following log should be printed:

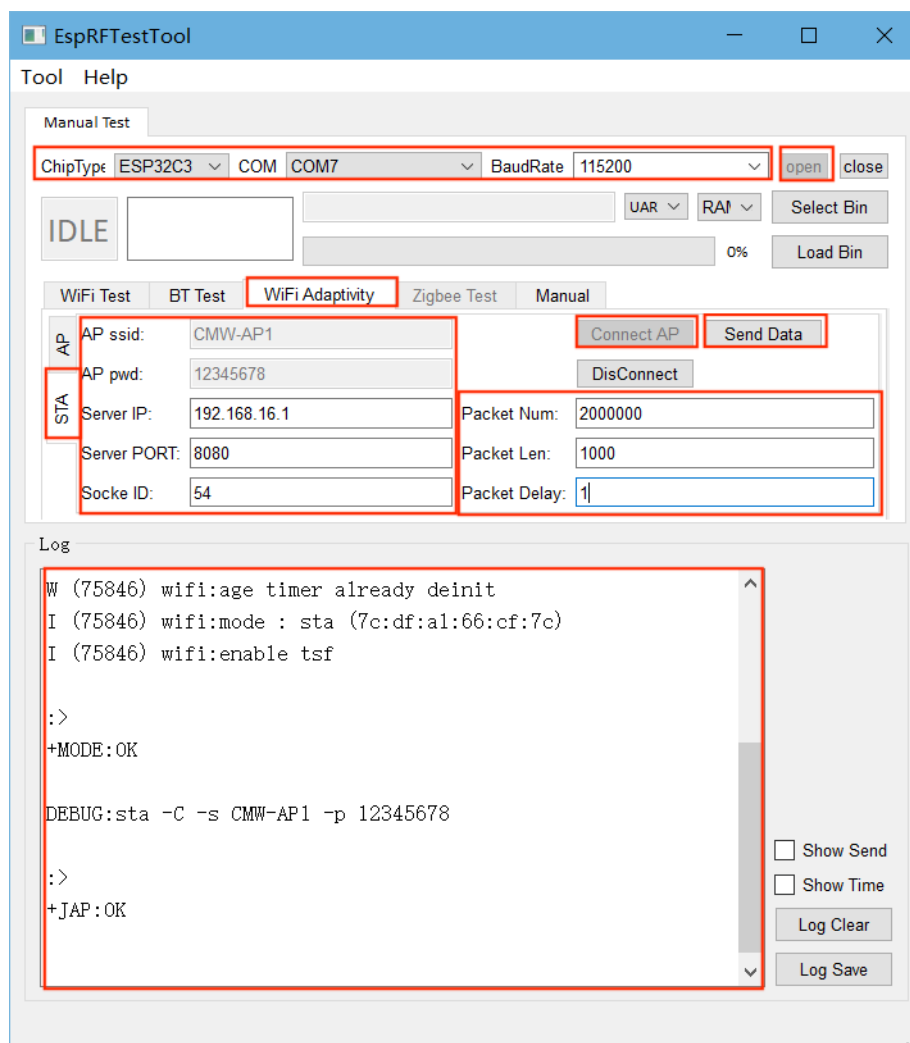


Fig. 33: Serial Port Log for Device Provisioning

After successful connection, you can start the Wi-Fi Blocking Test.

4 RF Test Certification

4.1 CE Certification

CE Certification (Conformité Européene Mark) is a mandatory certification by the EU, confirming compliance with safety, health, and environmental protection standards.

The CE certification of RF products requires non-signaling, adaptivity, and blocking tests:

- *Wi-Fi Non-Signaling Test*
- *Wi-Fi Adaptivity Test*
- *Wi-Fi Blocking Test*

4.2 FCC Certification

FCC Certification (Federal Communications Commission Certification) is a mandatory certification by the U.S. Federal Communications Commission, ensuring compliance with regulations on radio spectrum use, electromagnetic compatibility, and RF radiation.

The FCC certification of RF products requires passing relevant non-signaling tests:

- [Wi-Fi Non-Signaling Test](#)

4.3 SRRC Certification

The SRRC (State Radio Regulatory Commission) Certification is a mandatory certification for radio equipment in China, ensuring compliance with national radio management regulations to avoid electromagnetic interference.

The SRRC certification of RF products requires related non-signaling and adaptivity tests:

- [Wi-Fi Non-Signaling Test](#)
- [Wi-Fi Adaptivity Test](#)

5 Production Stage

For the production stage, this repository provides the following tools and resources designed to streamline the manufacturing process:

- [Flash Download Tool](#) is used to flash firmware onto flash. It supports multiple targets and configurations, enabling users to efficiently update firmware and debug devices.
- [Espressif Production Testing Guide](#) outlines the production testing schemes available for Espressif Wi-Fi products, thus providing reference for testing customer products during manufacturing.
- [Test Fixture Manufacturing Instruction](#) provides guidelines for manufacturing test fixtures used with Espressif's Wi-Fi modules. These standardized fixtures help prevent issues that may arise during production and testing.

6 Flash Download Tool User Guide

6.1 Preparation

The software and hardware resources required for downloading firmware to flash are listed below.

- Hardware:
 - 1 x module to which firmware is downloaded
 - 1 x PC (Windows 7 [64 bits], Windows 10)
- Software:
 - Flash Download Tool

6.2 Tool Overview

User Interface

Open the Flash Download Tool, double-click the .exe file to enter the main interface of the tool, as shown in the figure below:

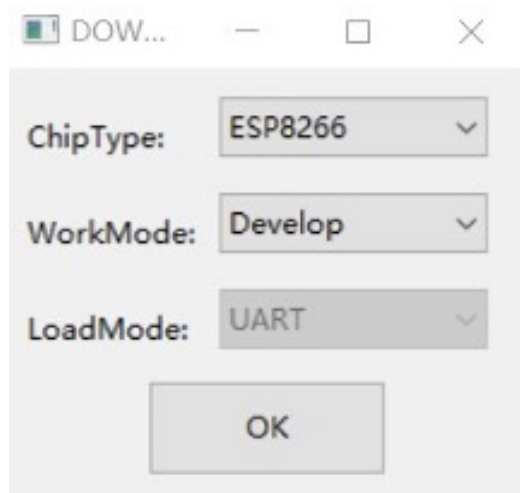


Fig. 34: Flash Download Tool Main Interface

- **ChipType:** Selects the chip type for your product.
- **WorkMode:** Work mode of the tool. Below are the differences between the two modes supported currently, `Develop` and `Factory` modes.
 - `Develop` mode uses the absolute path of the firmware and only allows flashing firmware to one chip at a time.
 - `Factory` mode uses a relative path. It is recommended to place the firmware to be flashed in the bin folder at the same level as the .exe file. It will be automatically saved locally when closed after configuration.
 - Selecting `Factory` mode leads you to a locked interface in order to prevent misoperation by your mouse. Please click the `LockSettings` button to enable editing.
- **LoadMode:** Supports both UART and USB

SPIDownload Tab

Here is the configuration descriptions.

- **Download Path Config** You can configure the firmware loading path and downloading address (in hexadecimal format), such as 0x1000.
- **SPI Flash Config**
 - **SPI SPEED:** SPI boot rate
 - **SPI MODE:** SPI boot mode
 - **DETECTED INFO:** Flash & crystal oscillator information that are detected automatically.
 - **DoNotChgBin:** If it is enabled, the tool flashes the original content of the bin file. If not enabled, the tool updates the firmware according to the SPI SPEED, SPI MODE configuration on the interface before flashing.
 - **CombineBin button:** combines all the selected firmware in Download Path Config into one firmware. If DoNotChgBin is enabled, combine the original firmwares. If DoNotChgBin is not enabled, combine them according to the SPI SPEED and SPI MODE configuration. Any unused areas between firmware files will be filled with 0xff. The combined firmware will be saved as ./combine/target.bin. Each click of this button will overwrite the previous firmware.
 - **Default button:** restores the SPI configuration to the default values.

- Download Panel
 - START: Starts downloading
 - STOP: Stops downloading
 - ERASE: Erases the entire flash
 - COM: Serial port used for downloading
 - BAUD: Baud rate

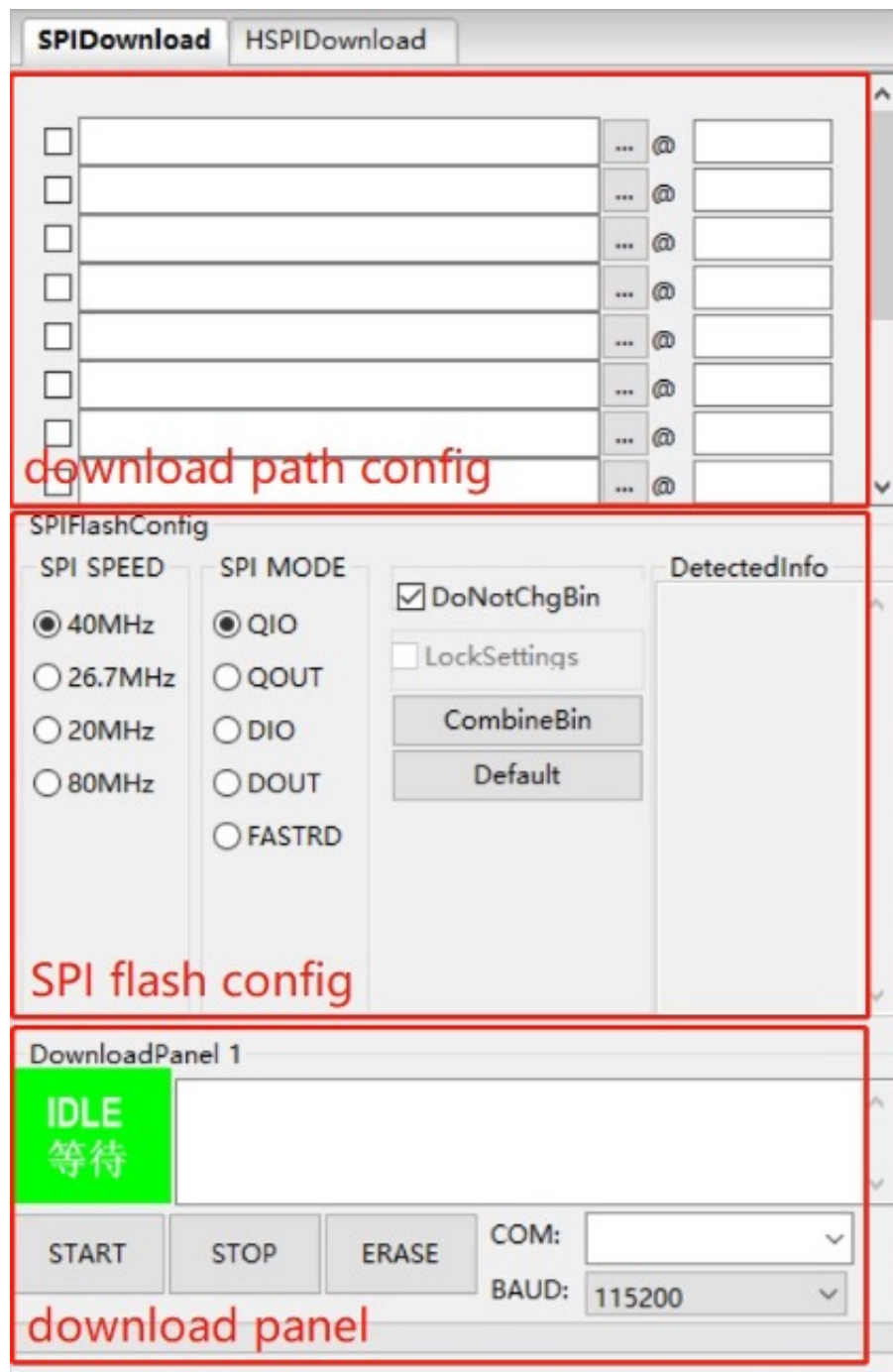


Fig. 35: SPIDownload Tab

FactoryMultiDownload Tab

- Factory mode uses the relative path. By default, the tool loads the firmware from the bin folder of the tool directory. Whereas, Develop mode uses the absolute path. The advantage of the Factory mode is that as

long as the firmware to flash remains in the bin folder of the tool directory, path problems will not occur when the tool package is copied to other factory computers.

- In Factory mode, the tool enables LockSettings by default. When LockSettings is enabled, firmware download path config and SPI flash config cannot be configured. This is to prevent production line workers from accidentally clicking and causing errors. (When factory managers need to configure these settings, they can click LockSettings to unlock.)

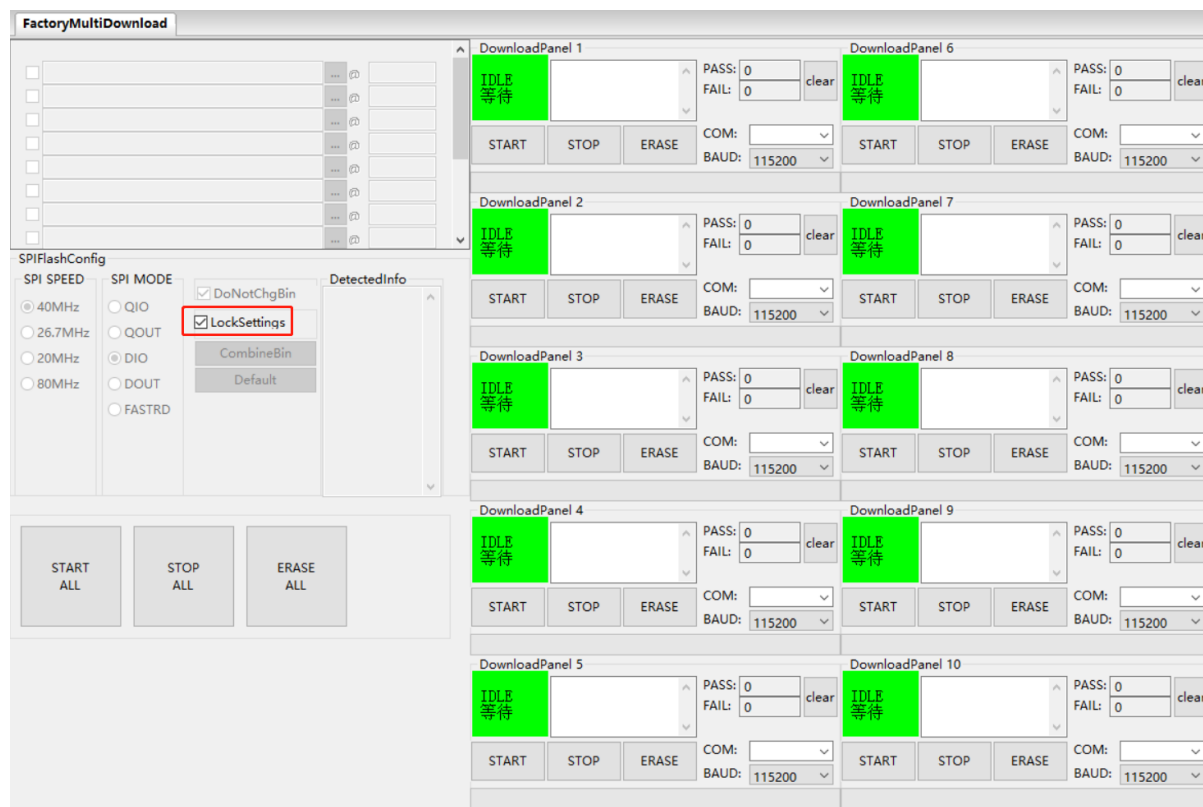


Fig. 36: FactoryMultiDownload Tab

The download path config and SPI flash config section on the FactoryMultiDownload Tab are basically the same as those on the SPIDownload tab. Please refer to [SPIDownload Tab](#) for descriptions. Do not forget to configure the serial port number and baud rate of each download panel.

chipInfoDump Tab

- Device: Selects the device's serial port number and communication baud rate.
- Read Flash: Specifies the start address and size of the content to be read from the flash. This setting is only required when reading flash.

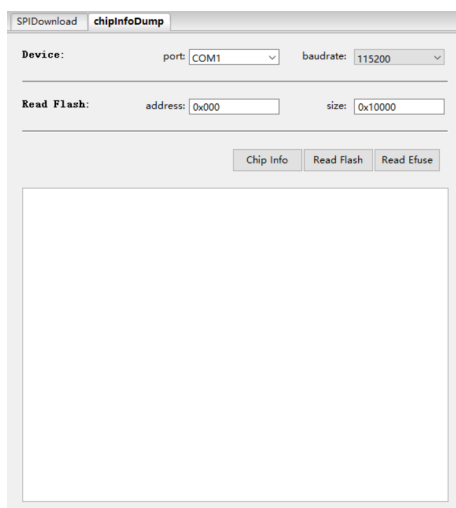


Fig. 37: chipInfoDump Tab

- **Function Description**
 - **Chip Info:** Reads the chip model, flash ID, and flash status register values. The read content is displayed directly in the tab.
 - **Read Flash:** Reads data stored in the flash. The read content is saved in a generated bin file, which is named in the format “Chip MAC + Start Address of Reading + Data Length of Reading + Reading Time” .
 - **Read Efuse:** Reads the chip’ s eFuse content, with functionality identical to *esptool summary*. The read content is stored in a generated text file, named in the format “Chip MAC + Reading Time” .

Note:

- To use the above reading functions, the product should enter download mode after startup.
 - Tool version $\geq 3.9.8$
-

6.3 Download Example

This section takes the ESP32 series as an example to demonstrate how to perform both regular and encrypted download operations. At present, ESP32-S2 only supports regular download, and will support encrypted download later.

Regular Download

1. Pull GPIO0 low to enter the download mode.
2. Open the download tool, set **ChipType** to **ESP32**, **WorkMode** to **Develop**, and **LoadMode** to **UART** as shown in the figure below. Then, click **OK**

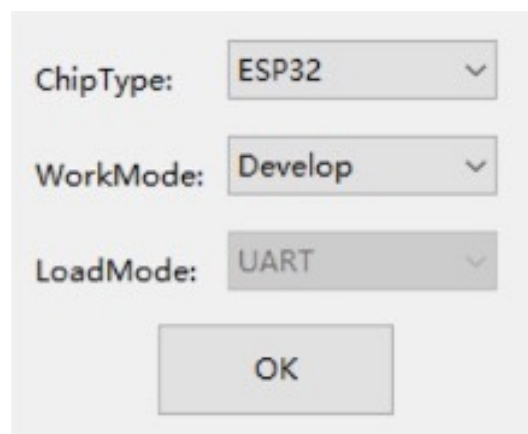


Fig. 38: Selecting Device —ESP32 Download Tool

3. In the appeared download page, enter the path to the bin file and the address where it should be downloaded, check the box before the path, and select SPI SPEED, SPI MODE, COM, and BAUD according to your requirements.
4. Click **START** to start downloading. During the download process, the tool will read the flash information and the chip's MAC address.
5. After the download is complete, the tool interface is shown in the following figure.

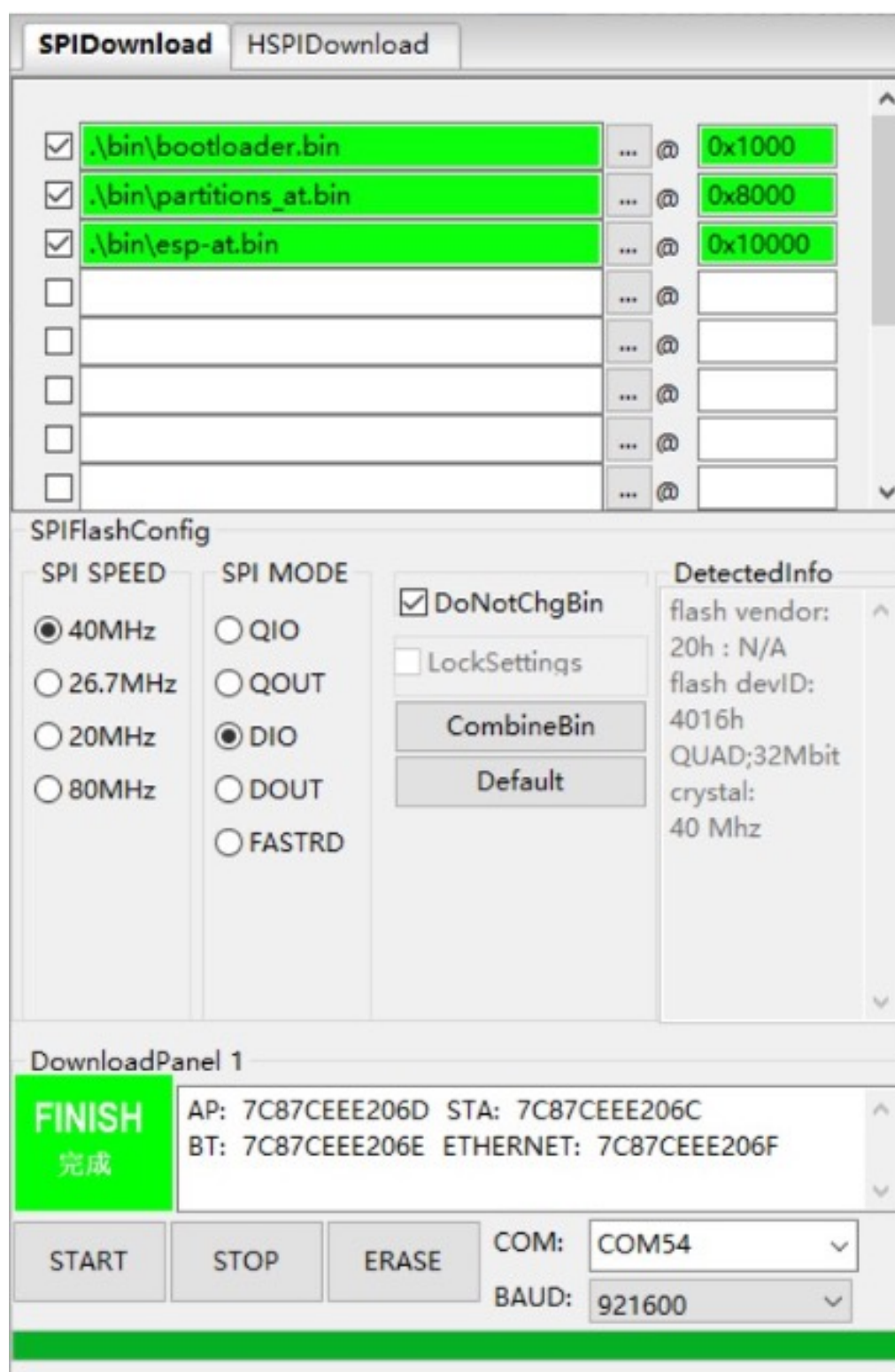


Fig. 39: Download Completed

Encrypted Download

The encrypted firmware downloading process is as follows:

- Flash Download Tool downloads the plaintext firmware to the chip.
- The chip uses the key in its eFuse to encrypt the firmware and write it to the flash.

- If there is no such key in the eFuse, the tool will automatically generate a random one and flash it to eFuse. You can also prepare your own encryption key. If there is, the tool skips the key generation and flashing process.

To configure the encryption function, follow the steps below:

- Open the configuration file `./configure/esp32/security.conf`. If there is no such file, for example, when you open the tool for the first time, restart the tool.
- Update the configuration options as needed.

Below are the configuration options. The equal sign is followed by the default value of the option. `True` means enabling the option; `False` means disabling it.

- **[SECURE BOOT]** Secure boot related configurations:
 - **secure_boot_en = False** (Configures whether to enable secure boot)
 - **public_key_digest_path = .securepublic_key_digest.bin** (Path to the public key digest file. This file is generated using the command `espsecure digest_sbv2_public_key -k pem.pem -o public_key_digest.bin`. The `.pem` file is the private key file specified during compilation.)
 - **public_key_digest_block_index = 0** (Index of the eFuse block where the public key digest file is stored. Default: 0.)
- **[FLASH ENCRYPTION]** Flash encryption related configurations:
 - **flash_encryption_en = False** (Configures whether to enable flash encryption)
 - **reserved_burn_times = 3** (Configures how many times [3 in this case] are reserved for the flashing operation)
 - **flash_encrypt_key_block_index = 0** (Configures the index of the encryption key in the block_key. Default: 0. Range: 0~4. For more information, refer to [Technical Reference Manual \(PDF\)](#) > Chapter eFuse Controller.)
- **[SECURE OTHER CONFIG]** Other security configurations:
 - **flash_encryption_use_customer_key_enable = False** (Configures whether to enable a customer-specified encryption key)
 - **flash_encryption_use_customer_key_path = .secureflash_encrypt_key.bin** (If using a customer-specified key, the key path needs to be specified here.)
 - **flash_force_write_enable = False** (Configures whether to skip encryption and secure boot checks during flashing. If it is set to False (default), an error message may pop up when attempting to flash products with enabled flash encryption or secure boot.)
- **[FLASH ENCRYPTION KEYS LOCAL SAVE]** Determines whether to store the encryption key file locally. Default: False.
- **keys_save_enable = False** (Configures whether to save the key.)
- **encrypt_keys_enable = False** (Configure whether to encrypt the locally stored key.)
- **encrypt_keys_aeskey_path =** (If you encrypt the locally stored key, please fill in the key file here, such as `./my_aeskey.bin`)
- **[ESP32* EFUSE BIT CONFIG]** Determines whether to set encryption items when flash encryption is enabled. Default: False.

Table 3: [ESP32-S* DISABLE FUNC] Config Option

[ESP32-S* DISABLE FUNC] Config Option	Description
<code>dis_usb_jtag = False</code>	Configures whether to disable USB JTAG
<code>hard_dis_jtag = False</code>	Configures whether to hard-disable JTAG
<code>soft_dis_jtag = 7</code>	Configures whether to soft-disable JTAG
<code>dis_usb_otg_download_mode = False</code>	Configures whether to disable USB OTG download
<code>dis_direct_boot = False</code>	Configures whether to disable direct boot
<code>dis_download_icache = False</code>	Configures whether to disable instruction cache in the Download mode
<code>dis_download_dcache = False</code>	Configures whether to disable data cache in the Download mode

There will be a prompt message (shown below) when the tool is running. Check if the message is correct. The figure below shows the prompt message of enabling both flash encryption and secure boot:

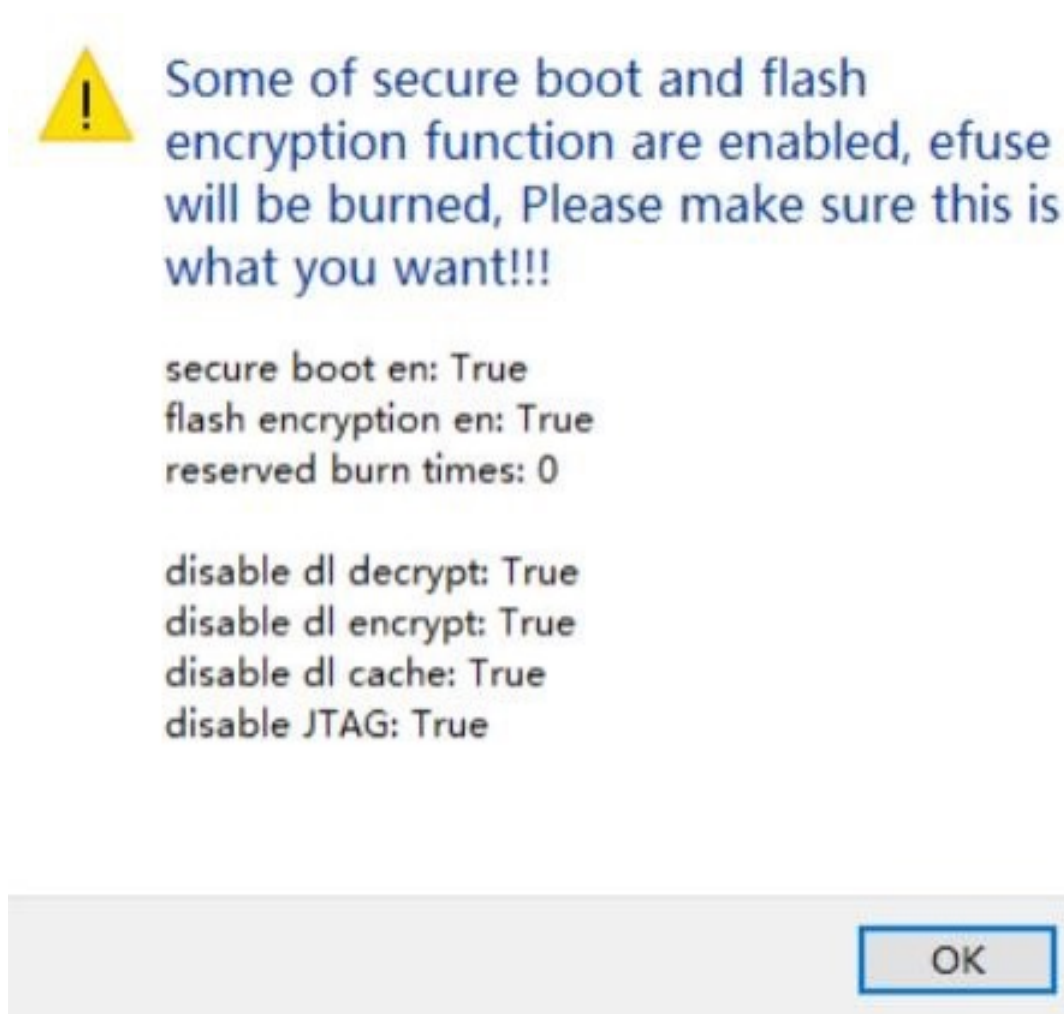


Fig. 40: ESP32 Prompt Message of Enabling Flash Encryption and Secure Boot

During the firmware flashing process, the key and other information will be flashed into the chip's eFuse. After the flashing process is completed, `FINISH/完成` will be displayed.

Note: Prior to downloading, the tool verifies flash encryption and secure boot information in the eFuse, so as to prevent re-downloading to and damaging the encrypted module.

7 Espressif Production Testing Guide

This guide mainly describes the production testing schemes available for Espressif Wi-Fi products (Wi-Fi module/Chip Onboard), thus providing reference for the production testing of customer products.

7.1 Introduction

Generally, there are two production testing schemes available to test the RF performance of the Wi-Fi products based on Espressif IC:

- RF General-purpose Tester Scheme (general standard in the industry);
- Signal Board Scheme (ESP enterprise standard).

RF General-purpose Tester Scheme

The tester scheme is widely used for the production testing of Wi-Fi products. Espressif provides the necessary serial port commands and firmware, so the customers can easily use this scheme for testing.

The testing steps can be found below, which are also demonstrated in the figure below:

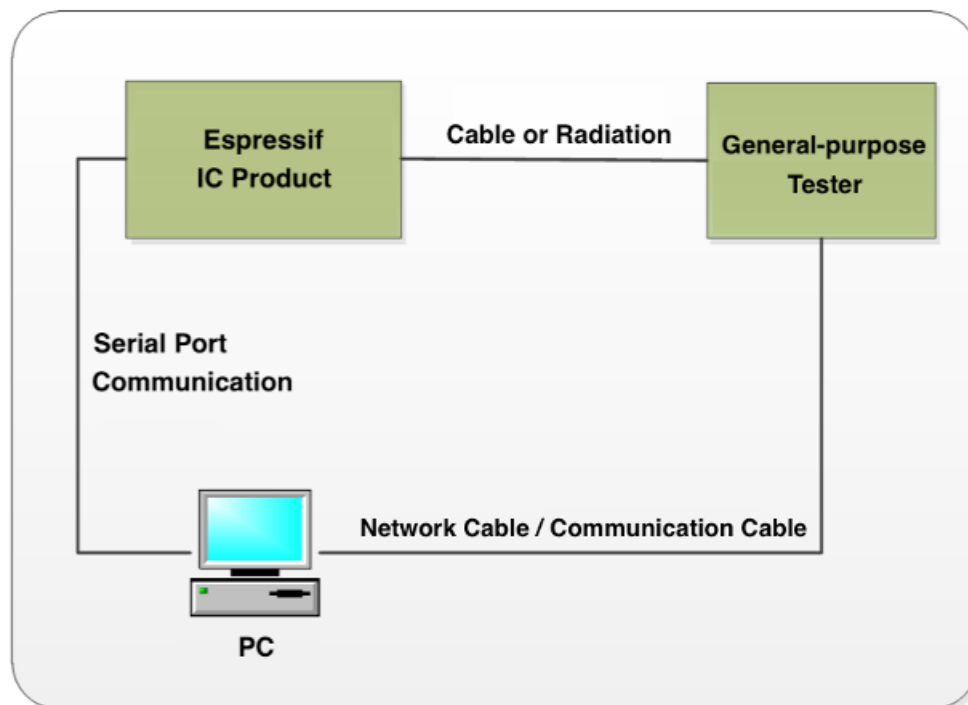


Fig. 41: Diagram of the Tester Scheme

1. Download `RF_Test_FW.bin` to ESP IC RAM;
2. Run the Test Tool that corresponds with the RF tester on the PC, and send the serial port commands to the modules for sending/receiving packets in different modes;
3. The RF tester analyzes the RF related parameters in each specific mode.

Note:

- For this scheme, the mass production testing tool provided by the tester supplier should be adaptable with the Espressif IC products;
 - **If the supplier is unable to provide this kind of test tool, customers can alternatively make the tool adaptable by using the tester's available interfaces. Meanwhile, customers can use esptool to download `RF_Test_FW.bin`:**
 - esptool can be downloaded from [here](#). For related commands, refer to the [documentation](#);
 - For the manual testing of ESP products' RF performance, please refer to [RF Test Items](#).
 - The test above must be performed in a shielded enclosure.
-

Signal Board Scheme

The signal board scheme is specially designed by Espressif, which can effectively test the RF performance of the mass-produced Wi-Fi products, and therefore guarantee the RF quality. This scheme features low cost of hardwares and easy environment setup for factories.

As demonstrated in the figure below, the signal board can be used as a standard device to interact with and test the DUT (Device Under Test) by analyzing the communication data.

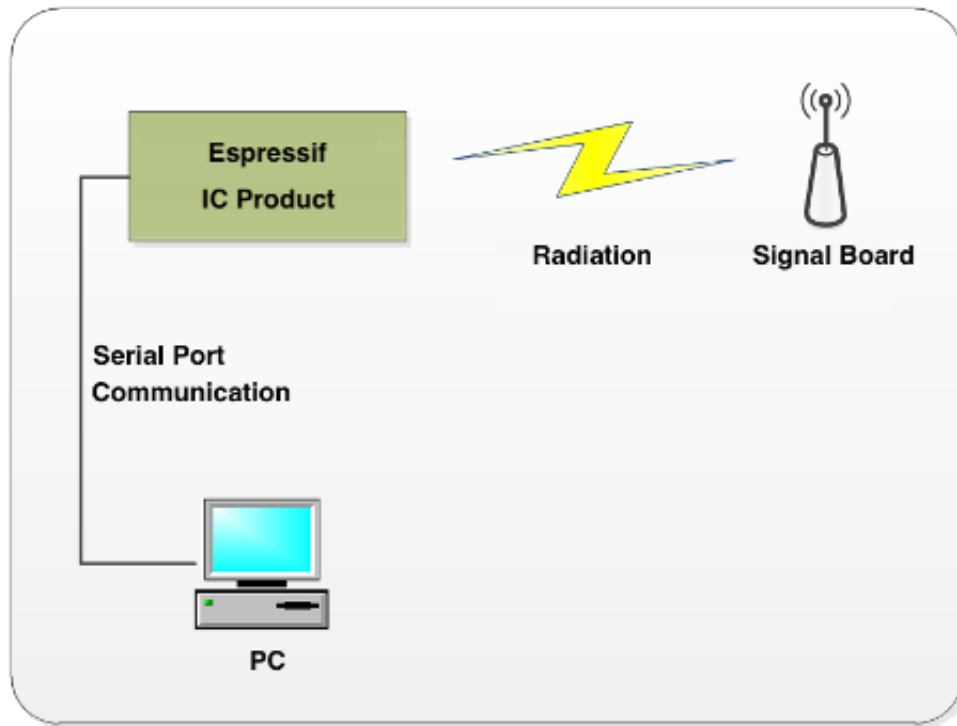


Fig. 42: Diagram of Signal Board Scheme

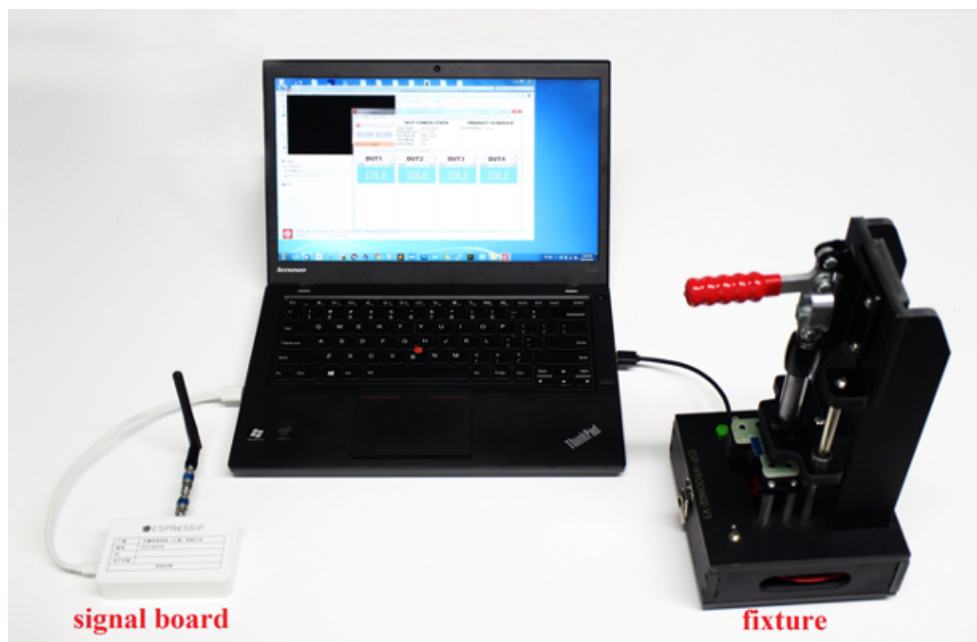


Fig. 43: Hardware Connection for Signal Board Scheme

Note: The test above must be performed in a shielded enclosure.

Production Testing Process

1. Please find the following test points that need to be tested, and connect the DUT accordingly to conduct the test:

Test Points	Download Mode	Flash Operation Mode
V33, GND, RXD, TXD, EN, GPIO0	GPIO0 connected to low level	GPIO0 connected to high level

Note:

- Download mode: for downloading bin files and is the main mode used for production testing.
- Flash operation mode: for checking the log info.

-
2. Connect the DUT to the serial port board by using the test fixture, and enter the DUT into the download mode via the production testing tool. If your serial port board does not support flow control, connect the corresponding GPIO(s) to low level directly, so DUT enters the download mode after powering up automatically.
 3. Start the production testing tool on your PC, and follow the instruction provided in [Production Testing Tool](#).

Note:

- To enhance production efficiency, test fixtures are typically designed for one-to-multiple configurations. For instance, a common set-up is one-to-four, where a single fixture can accommodate and test four devices simultaneously.
- For more details about the test fixture manufacturing instruction, please refer to [Test Fixture Manufacturing Instruction](#).
- Connect the serial port board (which is placed inside the bottom box of the fixture) to the PC with a USB cable, and install the corresponding driver to ensure the serial port can be successfully identified.

Related Equipment for Production Testing

Serial Port Board The serial port board is mainly used as a USB converter. You may use other similar boards. However, considering some of them might have unstable performance, it is recommended to purchase what is shown below. If you want to purchase from Espressif, please [contact us](#).

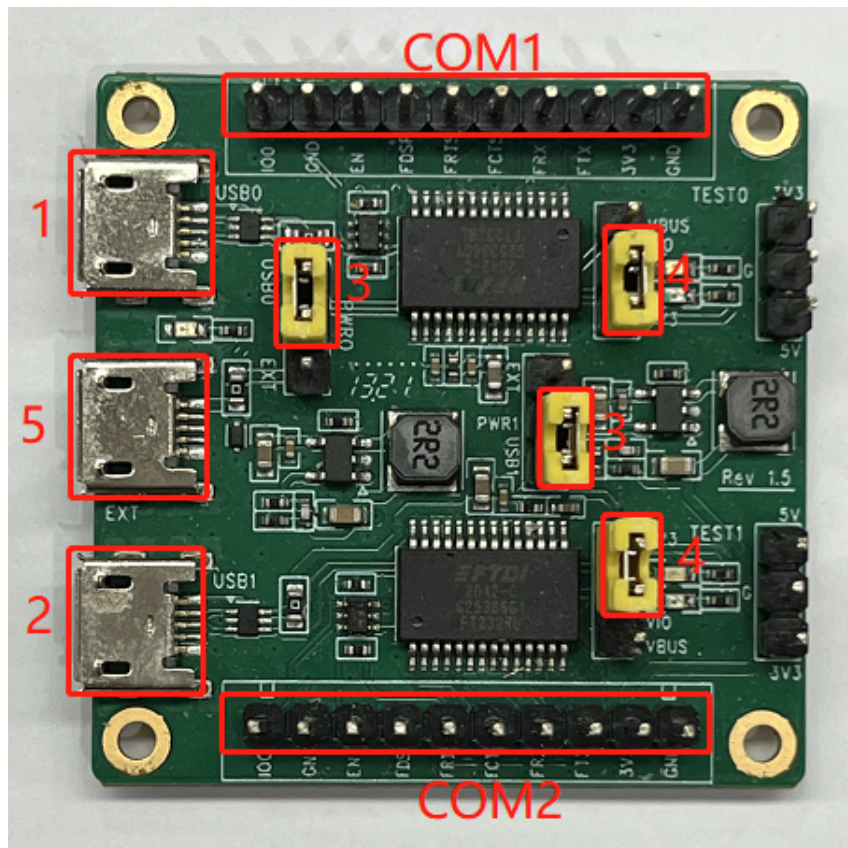


Fig. 44: Serial Port Board

Please check the board you purchased against the following requirements to make sure the switches and shorting jumpers are in the correct positions:

- Marking COM1 and Marking COM2: the serial ports used for the communication with the PC. Marking 1 and Marking 2 are the two independent serial ports, corresponding to TX/RX/FRTS/FCTS.
- Marking 3: selects powering the device through the USB port or an external power supply.
- Marking 4: selects 3.3 V or 5 V serial voltage level.
- Marking 5: for connecting external power supply, not used, so no need to configure.

Test Fixture The test fixture is an important equipment to execute the DUT in test mode. Specifically, you can put the module on the fixture and bring the module pins into contact with the fixture probes by pressing the fixture handle. When the test is finished, lift the handle to separate the module pins from the probes (for other similar equipment, customers may think of it as a reference or directly lead out the corresponding pins that are assigned to what you want to test).

For the production testing of Wi-Fi modules, the module pins must be led out and connected to the base board, so as to communicate with the serial ports of the PC. To achieve this, a fixture can be used. The figures below show the overall appearance of a typical fixture.

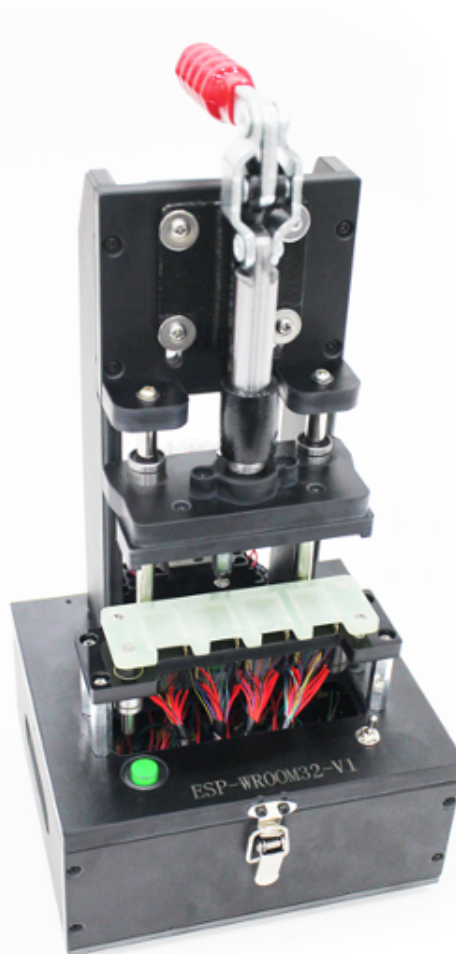


Fig. 45: A Typical Module Fixture

The primary structure of a typical module fixture can be seen in the table below (take Espressif test fixture as an example).

Table 4: The Primary Structure of a Typical Test Fixture

Part	Description
Handle	When users lift the handle, the module is separated from the metal probes at the bottom and gets disconnected from the power supply. When users press the handle, the module comes into contact with the metal probes and starts the testing procedure.
Mounting Panel	It is used for placing and holding the module.
Bottom box	It is used to place serial port board(s), enabling the module to communicate with the PC via USB.

Signal Board The signal board can be used a standard device to interact with the DUT during the production testing.

Table 5: Signal Boards

Board Name	Description
ESP-BAT32	For ESP32/ESP32-S/ESP32-C series



Fig. 46: A Typical ESP-BAT32 Signal Board

For the purchase of Espressif signal board, please [contact us](#).

Note:

- Only one signal board should be used within the same network coverage. Otherwise, signal interference will occur.
- If more than one signal board are used for mass testing, please conduct in a shielded room or with a shielded box.
- The above table is also applicable to ESP8684/ESP8585.

Scheme Comparison

The comparison between the signal board scheme and the tester scheme is shown in the table below. You can choose from these two schemes according to your actual requirements.

Table 6: Scheme Comparison

Scheme	Test Item	Description
Signal Board Scheme	RF Test	Tests the supply voltage of the chip and its fluctuation, and the frequency offset against the signal board, etc.
	Packet Sending/Receiving Test	Tests the packet sending/receiving between the DUT and the signal board.
	GPIO Conductivity Test	Identifies IC soldering defects, if there are any.
	Firmware Version Verification Test	Verifies the version information of the firmware that has been downloaded to flash.
	Flash RW Test	Verifies the RW operation of flash.
	EVM Test	Tests the TX Power, and EVM performance of the DUT during the packet sending.
	Frequency Offset Test	Tests the frequency of the DUT during the packet sending.
	TX Power Test	Tests the TX power of the DUT during the packet sending.
	RX Sensitivity Test	Tests RX sensitivity of the DUT (This test must be performed in an RF shielded environment).
	GPIO Conductivity Test	See above in this table.
	Flash RW Test	See above in this table.

Note:

1. The signal board scheme has applied Espressif's internal standards and can effectively ensure the quality of RF products, provided that the RF matching of the module is qualified and the production materials are consistent with those specified in the production processes.
2. To ensure the overall quality of the mass production of modules, the customers may use the signal board scheme for full inspection and the tester scheme for sampling inspection.
3. You cannot directly test the RF performance parameters of a DUT, such as TX, RX, EVM, and FREQ, with the signal board scheme. Therefore, a general-purpose Wi-Fi tester can be used as a supplement to the signal board scheme.

The signal board scheme features low cost and easy environment setup, making it a popular solution that has long been widely used by the customers. Therefore, this guide will mainly focus on this scheme, and demonstrate it with the use of Espressif modules. Customers may follow this guide to set up the testing environment for their own Wi-Fi products.

7.2 Environment Setup

In order to show the customers the effectiveness of our signal board scheme, Espressif provides a complete testing package. Our testing package introduces the customers to the overall process of the production testing. Note that an Espressif module is used in the package as an example, so that the customers can simply replace this module with their Wi-Fi products (of ESP32-C/ESP32/ESP32-S/ESP8266 series) in their own production testing.

Testing Package

The production testing package has the following key components:

Table 7: Production Testing Package

Production Test- ing Package	Component	Quan- tity	Remark
ESP32 / ESP32-S	ESP-BAT32	1	ESP32 signal board
	ESP-FactoryTB2	2	UART base board
	ESP32-WROOM-32D	/ 2	Espressif modules ESP32-WROOM-32D / Espressif modules ESP32-S2-WROOM
	ESP32-S2-WROOM		

Test Step

Please connect your DUT to the production testing base board as shown in the following figures, depending on the product series (ESP32-C/ESP32/ESP32-S/ESP8266) your DUT belongs to; then, connect the serial port board, signal board and your PC together; then, open the production testing software tool on your PC.

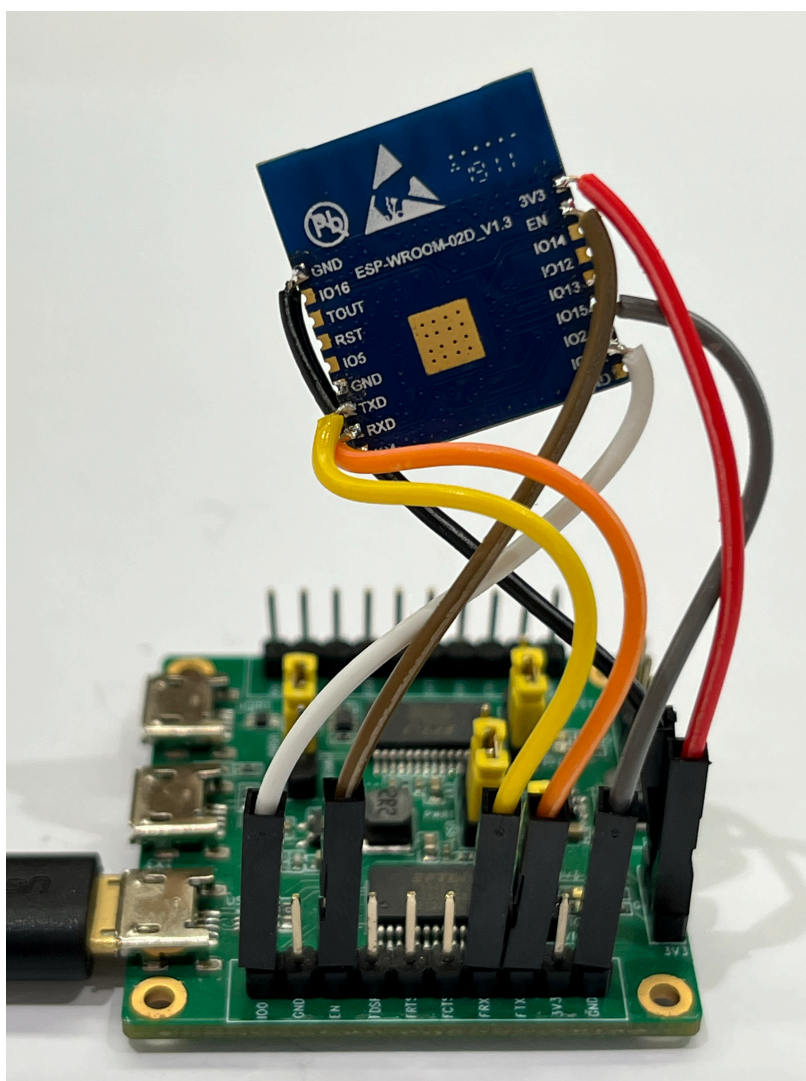


Fig. 47: Wiring for ESP32-WROOM-32D

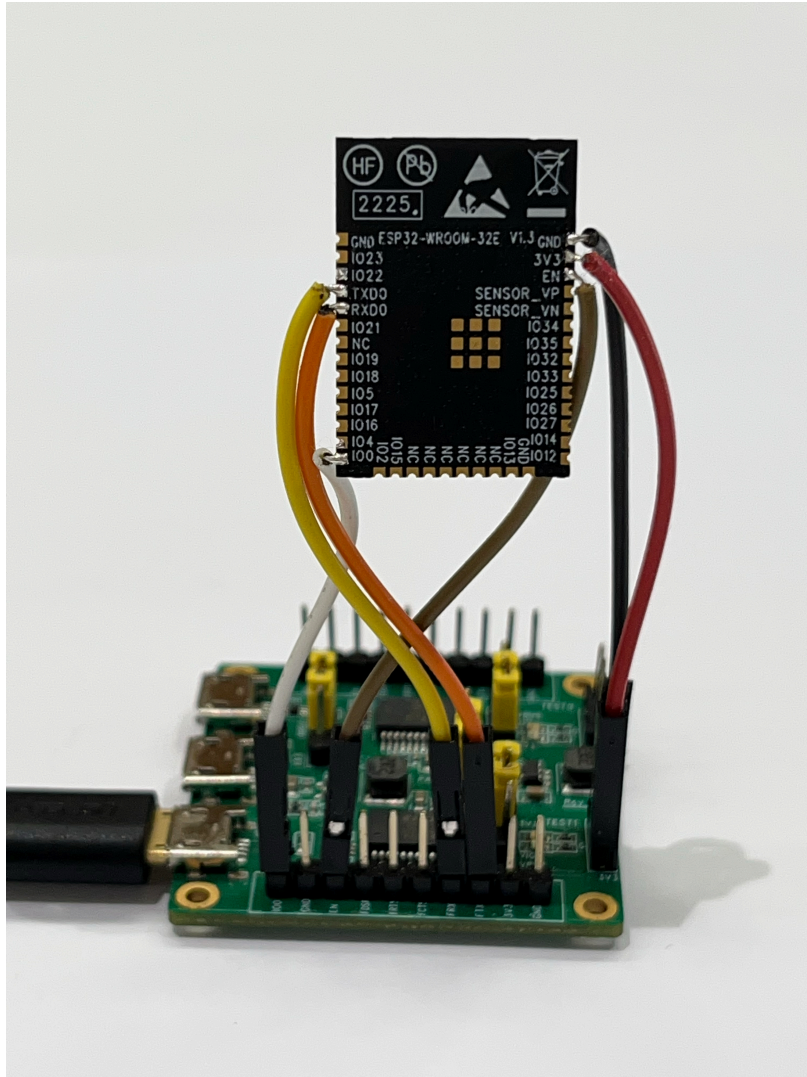
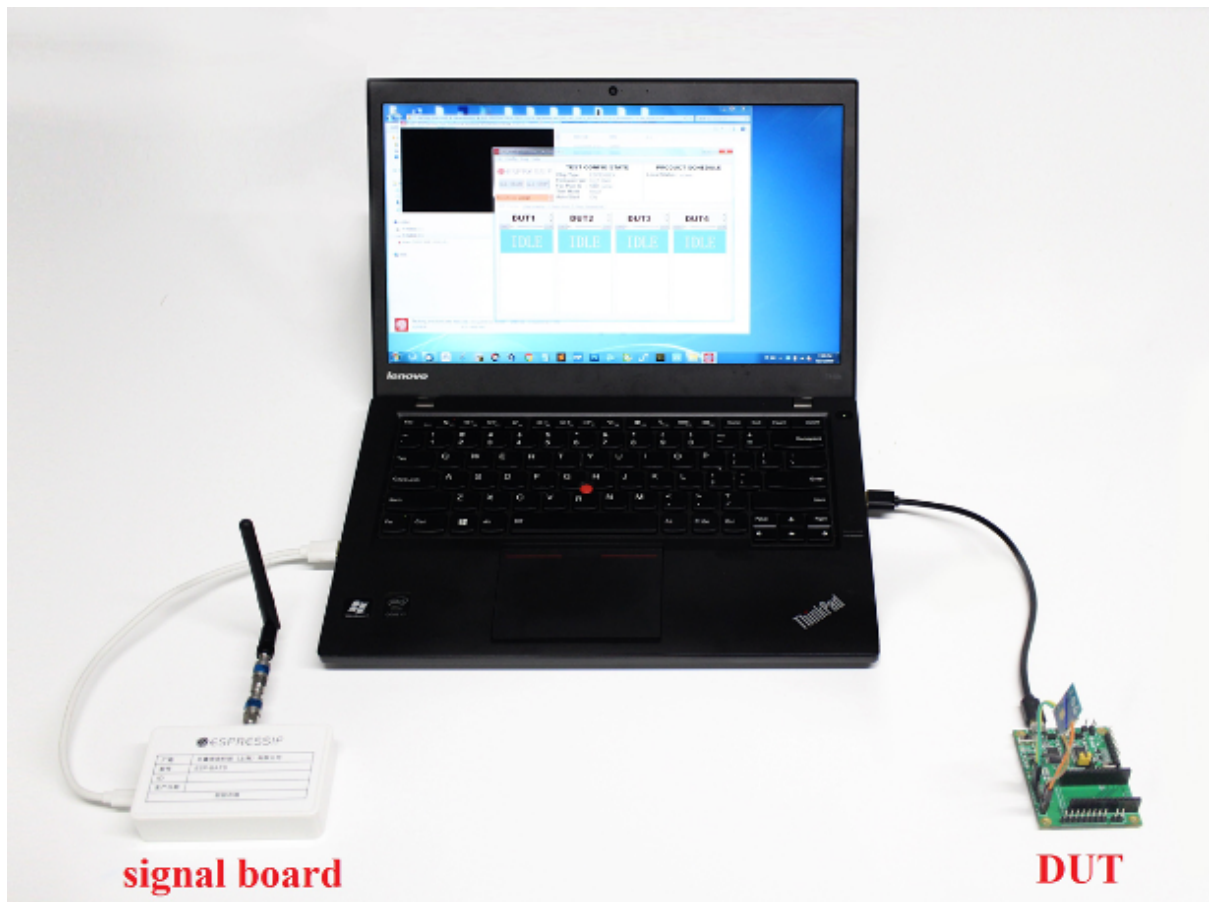


Fig. 48: Wiring for ESP32-WROOM-32E

1. The DUT communicates with the signal board at a rate of around 1 to 2 M. Configure the DUT to download mode and power up the serial port board.



2. Open the production testing software tool and complete the corresponding configuration based on which product series your DUT belongs to. For details, please refer to Section [Tool Configuration](#) below.
3. Click START button to start the test. During the testing, Parameter `fb_rssi` in the Log must be kept at around -50.
4. Troubleshoot based on the test results.

7.3 Production Testing Tool

Tool Introduction

Download Link

Directory

- `factory_test_ui_tool`: the main directory
 - `factory_test_cus_v1.0.exe`: the executable file
 - `config`: the configuration files run by the tool
 - * `.sys_config/.bin`: stores the test bin files for different chips
 - * `.sys_config/.spec_file`: stores the threshold files for different chips
 - * `.sys_config/.sys_settings.conf`: configures the current test bin file and threshold file
 - `logs`: stores test logs for each DUT

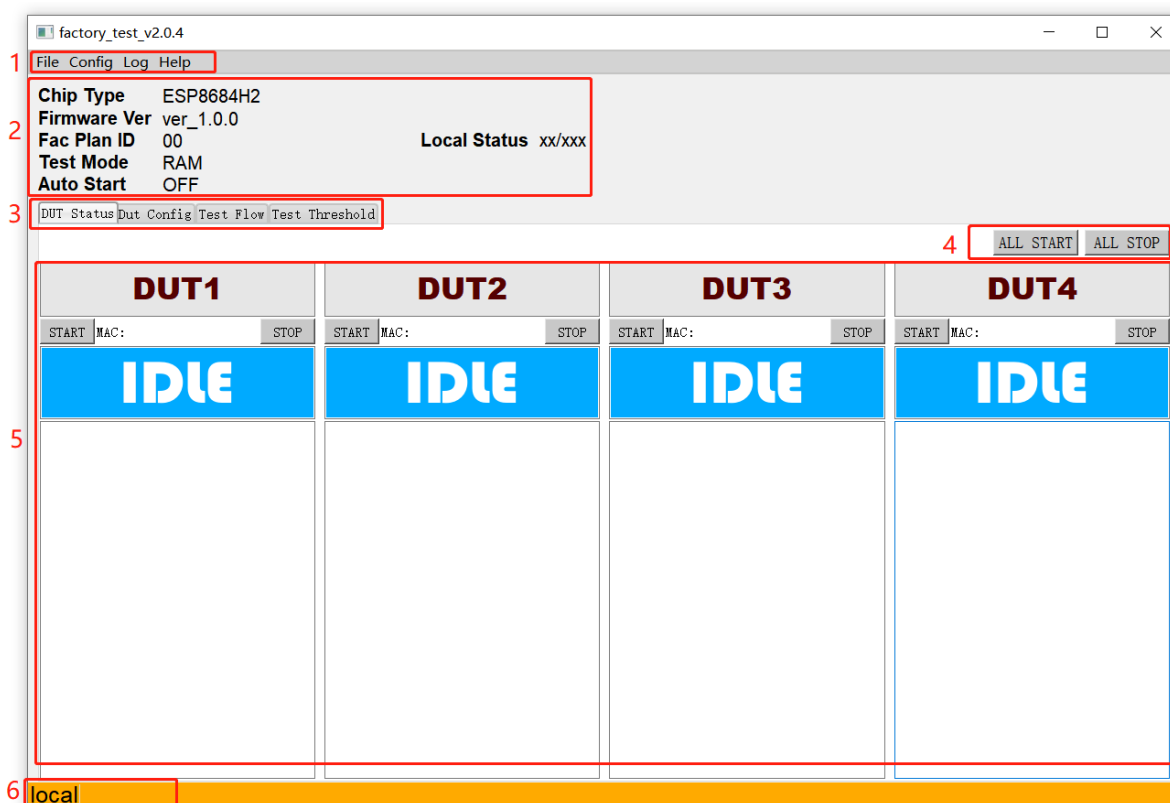


Fig. 49: Main Interface

Interface The MainWindows of the tool, as shown in the figure above, can be divided into six main parts:

1. Menu Bar:

- **Config** button can be used to switch between Local Mode and Cloud Mode (Cloud Mode is currently not supported);
- **Log** button can be used to select and open log files;
- **Help** button can be used to find help files.

2. Test Configuration Info:

- **left** section shows test configuration information such as Chip Type;
- **right** section shows the summary of all historical tests till now (the numbers of passed and failed tests).

3. Interface Tab Bar switches between different interfaces for testing or configuration.

4. ALL START/ALL STOP: Start/Stop all operations.

5. Testing Interface: the default testing interface after configuration. Here, you can see four DUT blocks, because a one-to-four fixture is used. Testing for different DUTs is independent from each other while the configuration of those is not.

6. Position displays if Local Mode or Cloud Mode is enabled.

Test Mode The current testing tool only supports 1 type of testing:

- **RAM Test:** Before testing, make sure the DUT is in download mode. During testing, the host computer downloads the firmware for testing to the RAM of the DUT, and runs it.

Tool Configuration

factory_test_v2.0.4

File Config Log Help

Chip Type ESP8684H2
Firmware Ver ver_1.0.0
Fac Plan ID 00
Test Mode RAM
Auto Start OFF

Local Status xx/xxx

DUT Status DUT Config Test Flow Test Threshold

TEST CONFIG 1

chip type ESP8684H2 Test From RAM
 Fac-Plan 00 EFUSE MODE normal
☐ AUTOST

DUT1 2

PORT1 COM4 PORT2 COM4
 Rate1 115200 Rate2 115200

DUT2

PORT1 COM89 PORT2 COM3
 Rate1 115200 Rate2 115200

DUT3

PORT1 COM47 PORT2 COM47
 Rate1 115200 Rate2 115200

DUT4

PORT1 COM86 PORT2 COM86
 Rate1 115200 Rate2 115200

3 APPLY

Fig. 50: DUT Config

Interface As shown in the figure above, the DUT Config tab can be divided into three major blocks:

- 1. TEST CONFIG: Test-related configuration
- 2. DUT: DUT-related configuration
- 3. APPLY: apply the configuration

TEST CONFIG

Table 8: TEST CONFIG

Parameter	Description	Notes
Test From	Location from which the program starts to run	RAM: The test bin to be downloaded must be selected.
Fac-Plan	Test record code	The MAC list stored in the form of code + test result .
AUTOST	Automatic test switch	If this option is checked, a new test will start automatically when the current test finishes.
EFUSE MODE	Detection method of eFuse	If a customized MAC address is used, the <i>custom</i> option should be selected here. Otherwise, use <i>normal</i> .

DUT CONFIG

Table 9: DUT CONFIG

Parameter	Description	Notes
Port	Serial port number	Serial port configuration of the DUT, including the serial port for normal test and the serial port for firmware test. The configuration of these two serial ports can be the same or not, depending on the customers' actual requirements.
Rate	Baud rate	Baud rate of the serial port.
APPLY	Confirms all the modification that has been made	Any modification to the configuration on the interface takes effect only after clicking the APPLY button and passing the verification by entering the correct verification code. The verification code depends on the date and time of performing the test (the sum of the values of year, month, day and hour). For example, assuming the test is performed at 12 o'clock on March 1st, 2018, the verification code is the sum of 2018 (year), 03 (month), 01 (date) and 15 (hour), i.e. 2037.

Test Flow

In addition to some basic RF performance tests, the production testing scheme can also be used to evaluate the overall quality of the DUT through a variety of other tests, including but not limited to the RF Test (customizing commands is allowed), GPIO Conductivity Test, Firmware Version Verification Test, and Flash RW Test.

RF Test

- **Test Objective:** RF performance tests must be conducted during the production testing to ensure that the DUT can send/receive packets as expected.
- **Test Method:** Send/Receive packets back and forth between the signal board and the DUT through radiation. The DUT sends the test results to the host computer via the serial port. Then, the host computer provides conclusions by analyzing the test results.
- **Test Steps:** DUT runs with the testing firmware. The test starts after the host computer sends the serial port commands. Initially, the DUT obtains the RF performance information by reading registers, including the voltage fluctuations; then the DUT sends/receives a certain number of packets to/from the signal board; upon completion, the host computer determines if the DUT has passed the tests by checking the log information against the set thresholds.
- **Configuration Interface:** To enable this test, go to the `Test Flow` tab and check `RF_TEST`.

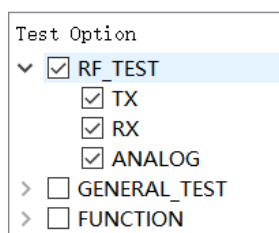


Fig. 51: RF Test

GPIO Conductivity Test

- **Test Objective:** This test can be performed to check the conductivity of GPIOs. It can help identify if there are any soldering problems, such as insufficient wetting or solder bridges.
- **Test Method:** After the corresponding pins of the fixture and DUT are shortened, the pin levels are set and obtained with the serial port commands, thus identifying any existing soldering problems.

- **Test Steps:** After the RF test is completed, a series of serial port commands are sent to perform the GPIO conductivity test. The serial port commands have been integrated in the host computer, so the customers can easily perform the GPIO Conductivity Test by enabling this function.
- **Configuration Interface:** As shown in the figure below, you can enable this test in the GENERAL_TEST sub-list on the Test Flow tab. For details, please refer to [Appendix B: GPIO Conductivity Test Configuration](#).

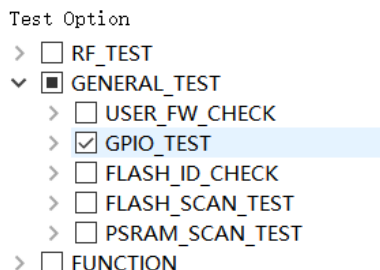


Fig. 52: GPIO Conductivity Test

Firmware Version Verification Test

- **Test Objective:** This test can be performed to verify the correctness of the firmware version downloaded to flash.
- **Test Method:** Check against the target firmware by comparing a “certain verification string” or “version number” in the serial port log. Therefore, this verification string must distinguish itself from those of other firmware.
- **Test Steps:** After the RF test, the host computer configures the serial port board to flow control mode, so the DUT boots from flash, and check the string in the log against the target string. You can easily verify the firmware version by enabling this function.
- **Configuration Interface:** You can enable this test in the GENERAL_TEST sub-list on the Test Flow tab.

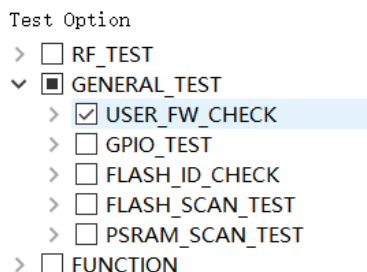


Fig. 53: Firmware Version Verification Test

Flash-related Test

- **Test Objective:** Flash ID Verification Test and Flash RW Test can be performed to verify the correctness of the flash model and the ability of the flash to read/write respectively.
- **Test Method:** These tests are performed with serial port commands, and the test results are returned to the host computer via the serial port.
- **Test Steps:** After the RF test is completed, the host computer provides a conclusion by checking the test results.
- **Configuration Interface:** You can enable these tests in the GENERAL_TEST sub-list on the Test Flow tab. FLASH_SCAN_ADDR is the starting address of this test item (only requiring a 0x1000 sector size), while FLASH_SCAN_TARGET is the target test value. The target value varies for different chips.

```

Test Option
> ☒ RF_TEST
v ☒ GENERAL_TEST
  > ☐ USER_FW_CHECK
  > ☐ GPIO_TEST
  > ☒ FLASH_ID_CHECK
  v ☒ FLASH_SCAN_TEST
    v FLASH_SCAN_ADDR
      0x00
    v FLASH_SCAN_TARGET
      95Mhz flash test pass
  > ☐ PSRAM_SCAN_TEST
> ☐ FUNCTION

```

Fig. 54: Flash-related Test

Tool Operation

Two different test modes are supported in the signal board scheme: the Single-DUT mode and the Four-DUT mode. The configuration below is applicable to both of these two test modes. The operation process is as follows:

1. After setting up the environment, click **START** button (or **ALL START**) to begin synchronization and downloading.

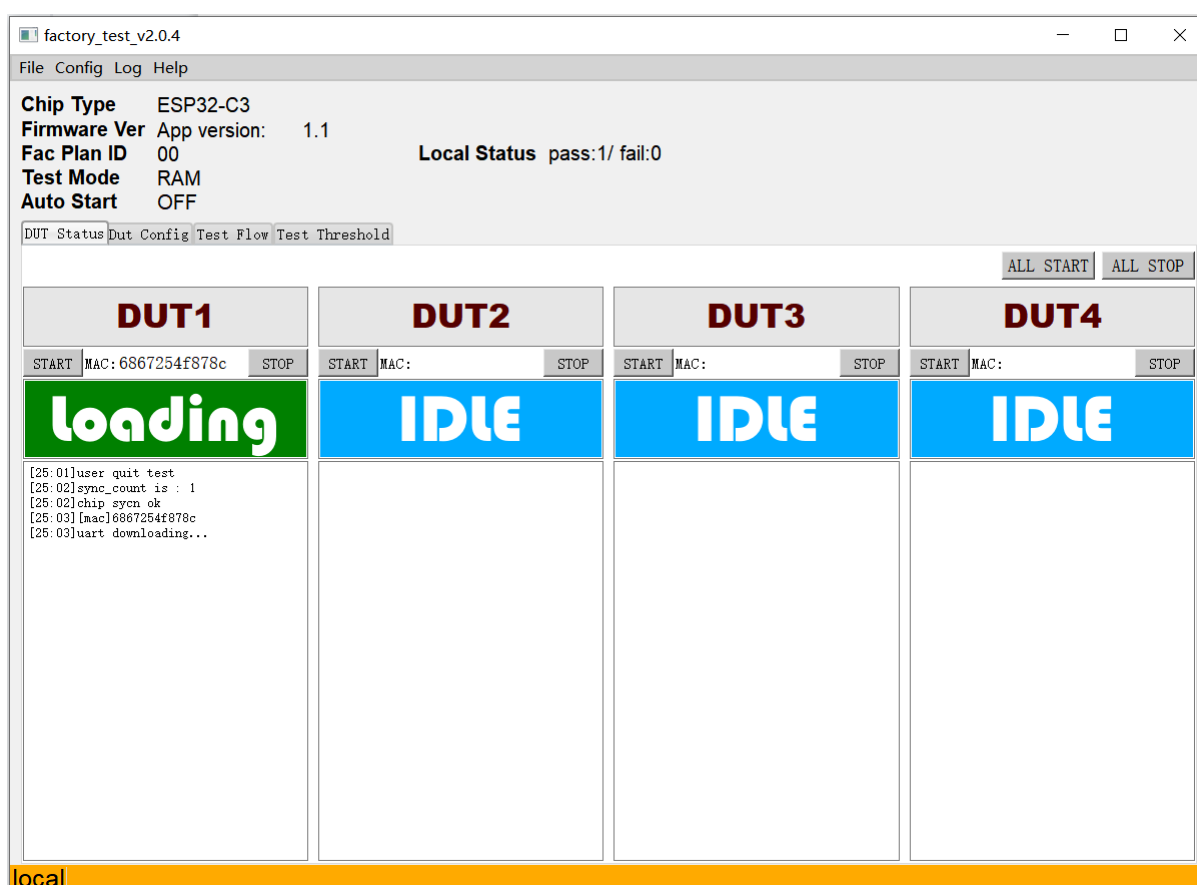


Fig. 55: Synchronization

2. After downloading is finished, the tool displays testing progress (RUN). Wait for test results.

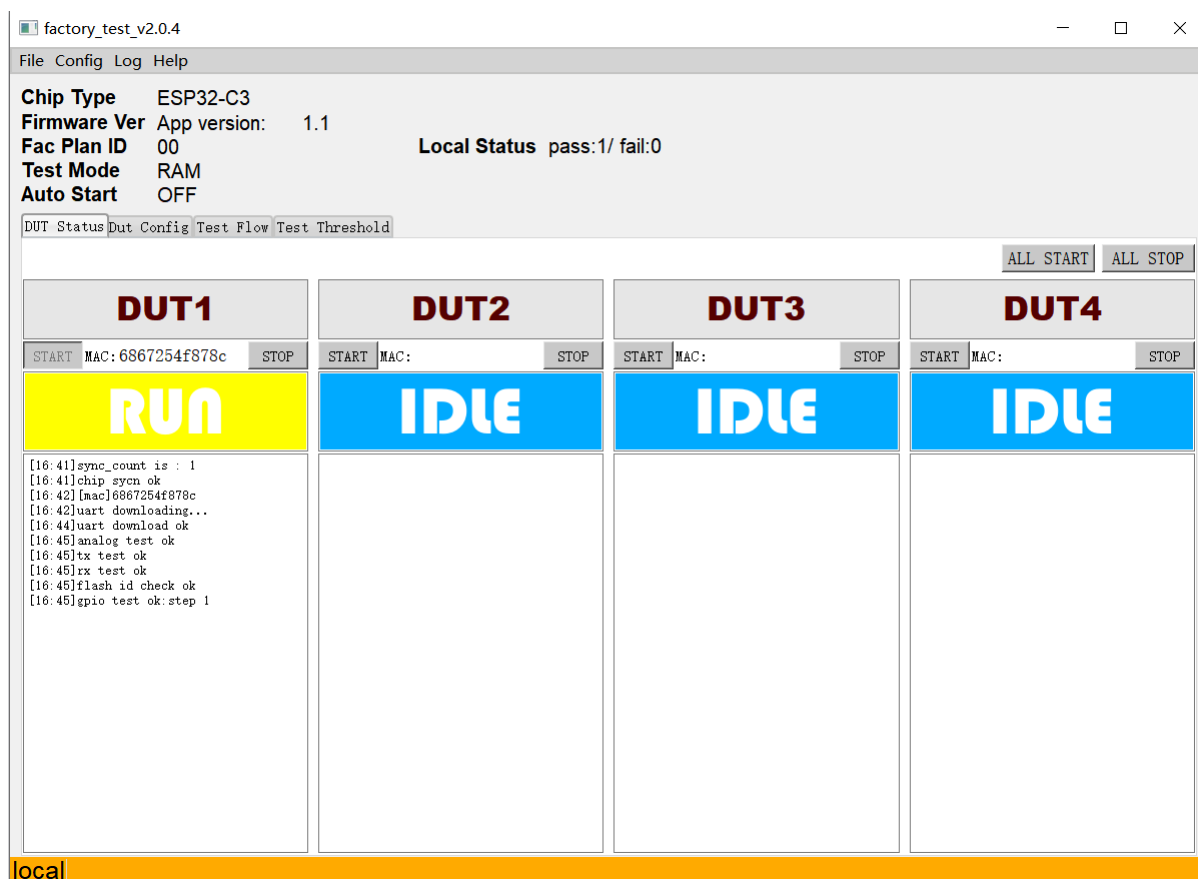


Fig. 56: Running

3. The tool displays test results.

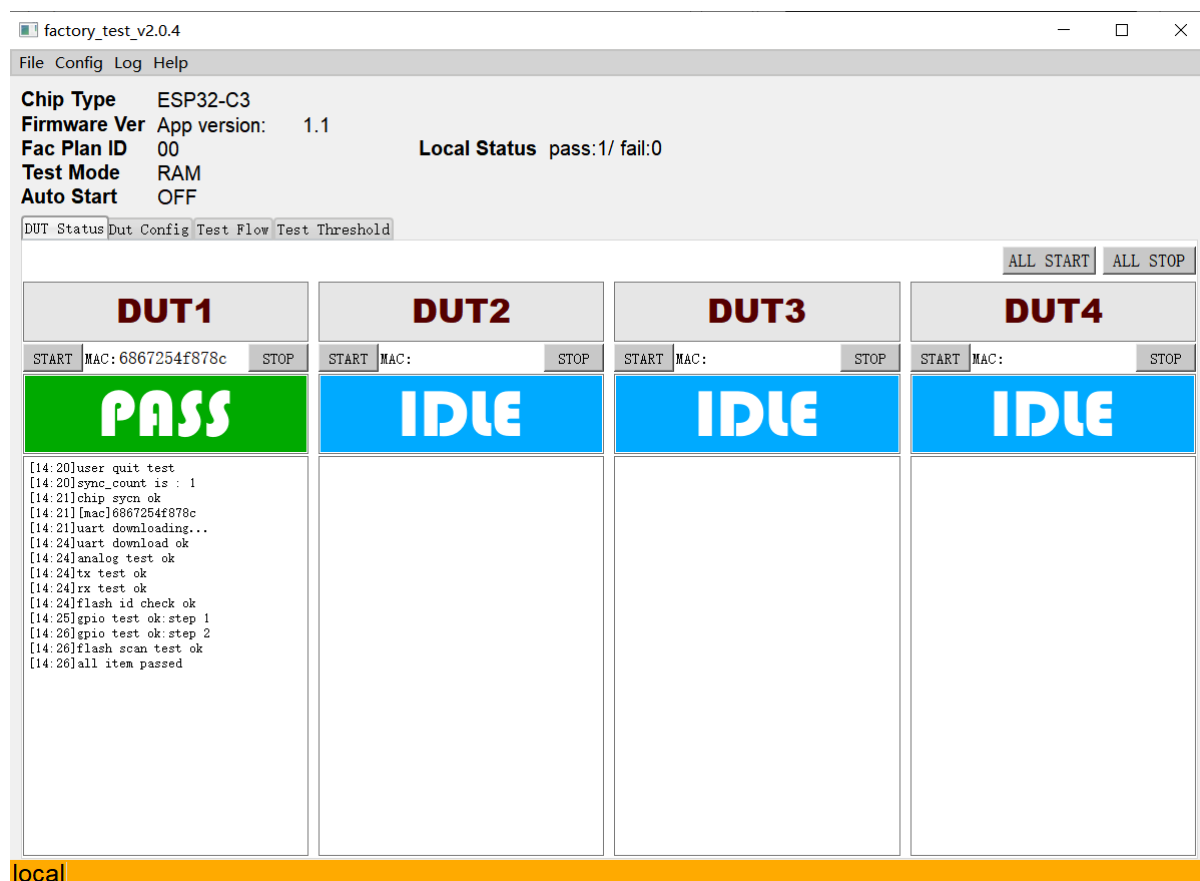


Fig. 57: Finish

The tool displays **FAIL** if any test item fails. The status block lists the detailed results of each test, to help you identify the reasons.

4. Check the detailed test records.

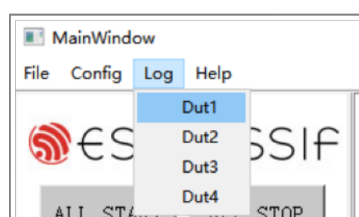


Fig. 58: Check Test Record

The test results of each production test will be saved in a separated log. The name of each log follows the pattern of "DUT MAC + date". Click the **Log** button to bring up the log file of the last test for the corresponding DUT. If there is no test history for this workstation, open the **Logs** folder to access available logs.

7.4 Appendix B: GPIO Conductivity Test Configuration

During the GPIO Conductivity Test, the pins (GPIOx, GPIOy) to be tested should be connected with each other as instructed below. One pin works as an output for a signal ($n = 0$ or 1), while the other one works as an input and reads the current signal.

Note on <GPIOx, GPIOy, n>:

1. GPIOx is the input pin, and GPIOy is the output pin.

2. n can be 0 or 1. 0: low level; 1: high level.

To make sure both high and low levels of all the pins can be tested. Once configured, this GPIO conductivity test is always performed twice:

1. First time with the configured n, and
2. Second time with the inverted n.

For example, if n is configured to 1, then the test will run with n = 1 for the first time, and then run again with n = 0 for the second time.

7.5 Appendix C: Firmware Version Verification Test

The detailed configuration of the firmware version verification test is shown below:

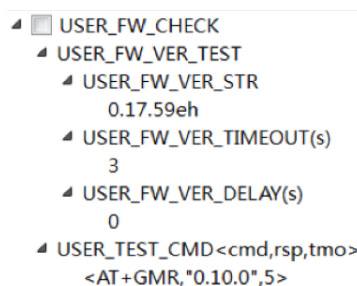


Fig. 59: Detailed Configuration

The firmware version verification test is enabled if the option `USER_FW_CHECK` is checked. Here, two test modes are available:

- `USER_FW_VER_TEST`: If the `USER_FW_VER_STR` is set to `Espcmd_en`, the `USER_TEST_CMD` is enabled. Otherwise, `USER_FW_VER_TEST` is enabled, in which a string is used to verify the firmware version number, such as the `0.17.59eh` in the figure above.
- `USER_TEST_CMD`: If the `USER_FW_VER_STR` is set to `Espcmd_en`, the `USER_TEST_CMD` is enabled. You can verify the firmware version number with your customized commands. For example, the value `<AT+GMR, "0.10.0",5>` in the figure above indicates that after sending the command `AT+GMR`, the serial port should return a character string that contains `0.10.0`.

7.6 Certification

Download certificates for Espressif products from [Certificates](#).

8 Test Fixture Manufacturing Instruction

8.1 About This Instruction

This document provides instructions on the manufacturing of the test fixtures for Espressif's Wi-Fi modules, in an effort to avoid problems caused by the lack of standardized fixtures during the module production and testing.

8.2 Overview

Module fixtures have different structures based on their types and usage. The structure of an ESP-WROVER fixture is shown in the following figure:

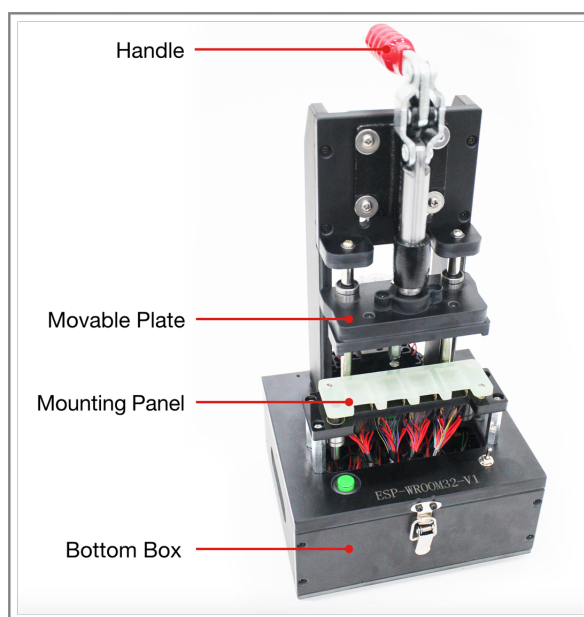


Fig. 60: The Structure of a Typical Test Fixture (ESP-WROVER)

The structure of other module fixtures are similar to that of ESP-WROVER. The primary structure of a typical module fixture consists of the following parts, which may differ only on the details:

Table 10: The Primary Structure of a Typical Test Fixture

Part	Description
Handle	It is used to power on or power off the module: <ul style="list-style-type: none"> When users lift the handle, the module is separated from the metal probes at the bottom and gets disconnected from the power supply. When users press the handle, the module comes into contact with the metal probes and starts the testing procedure.
Mounting Panel	It is used for placing and holding the module.
Bottom box	It is used to place serial port board(s), enabling the module to communicate with the PC
Switch	It is installed on the bottom box to control the power supply to the serial port board and the working modes.

8.3 The Main Structure of a Typical Module Fixture

Mounting Panel

The items needing attention during the manufacturing of mounting panels are listed below.

Antenna The antenna area should be completely exposed, keeping the antenna connection point over the line at the left end of the mounting panel or aligned with the left end of the mounting panel, which can be seen in the figure below. The mounting panel should not be made of metal, and the use of metal components should be minimized around the antenna:

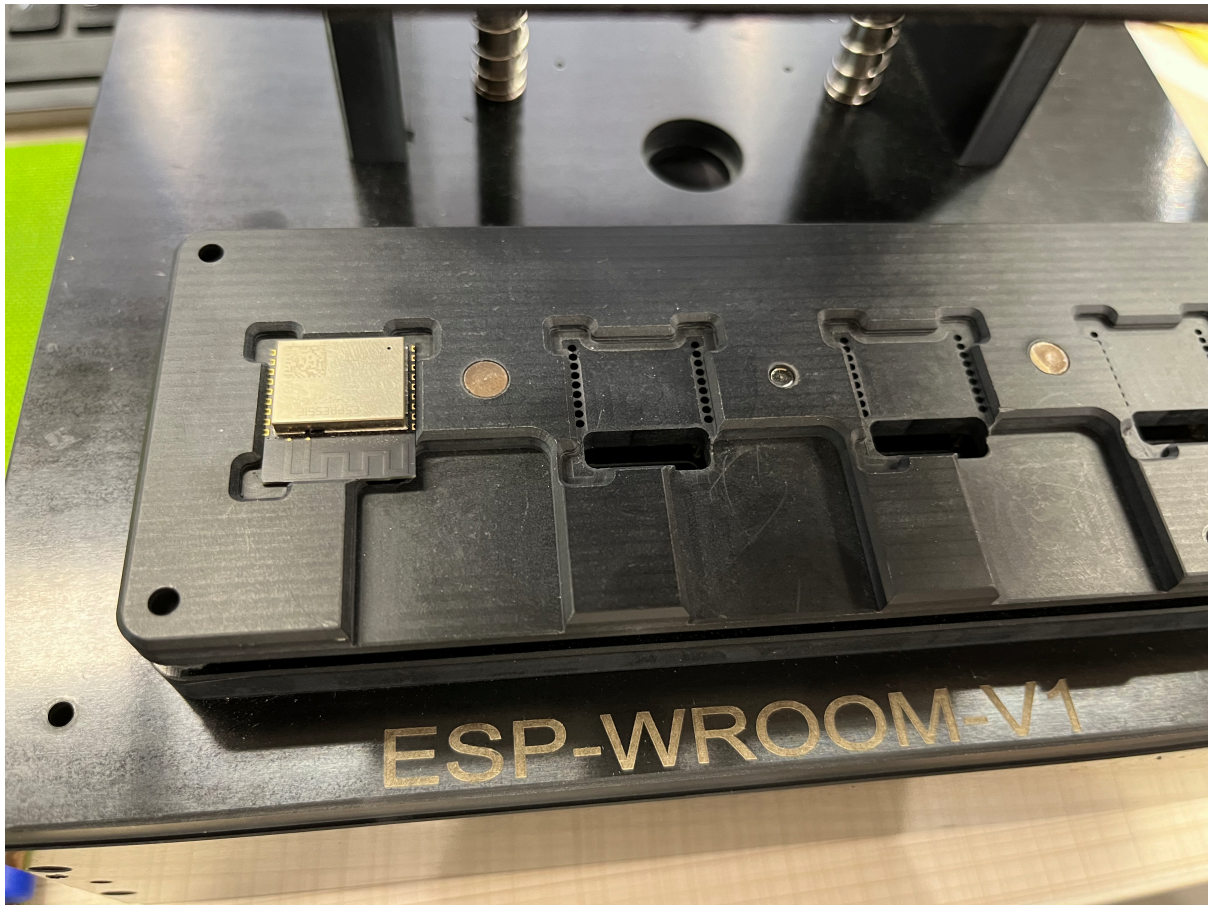


Fig. 61: The Mounting Panel for the ESP-WROVER Test Fixture

Handle

- When users press the handle, they must ensure that the metal probes under the mounting panel are attached to all the pins of the module.

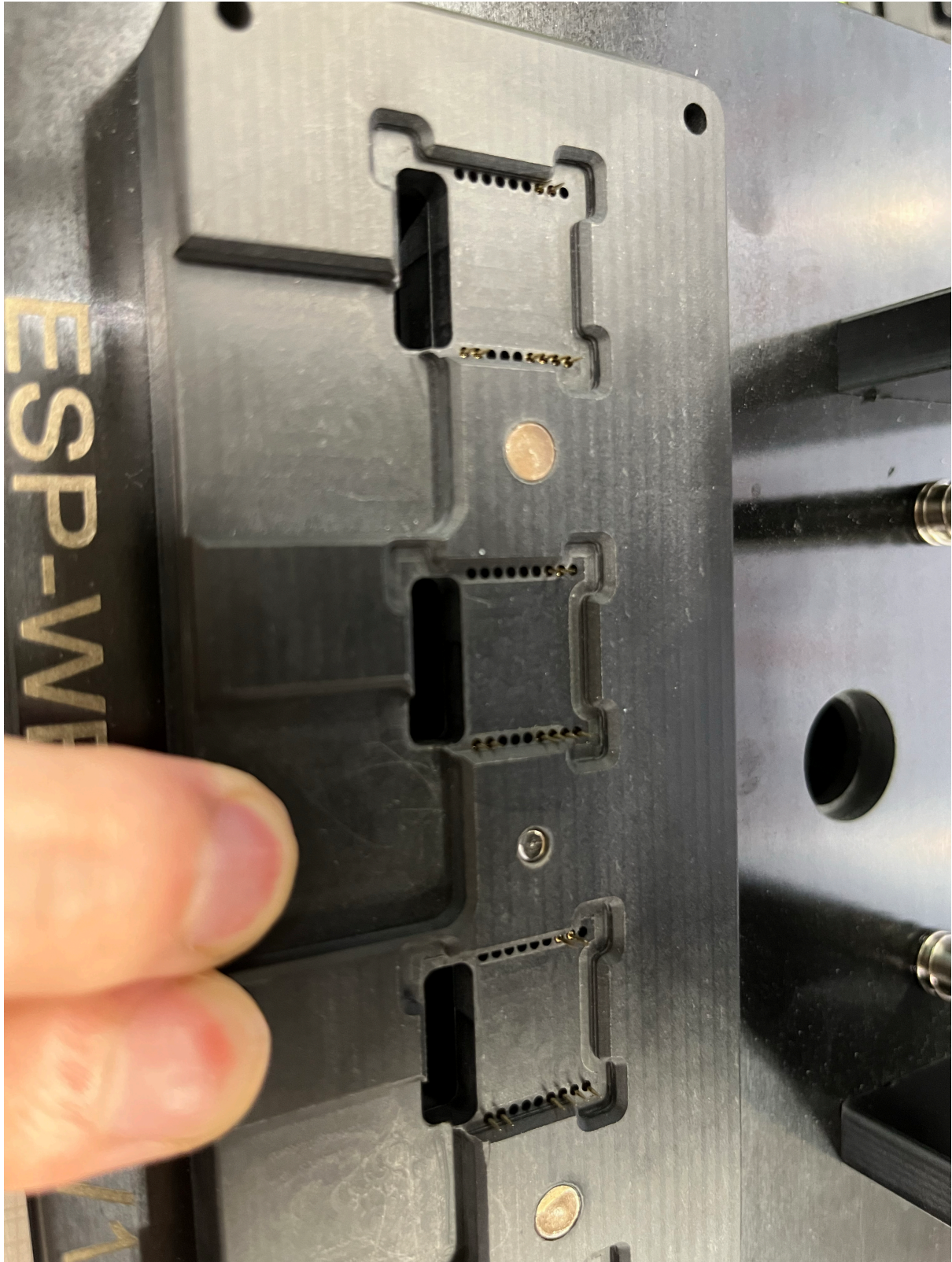


Fig. 62: The Metal Probes (the handle is pressed)

- When users lift the handle, they must ensure that the metal probes under the mounting panel are completely detached from all the pins of the module, which can be seen in the figure below:



Fig. 63: The Metal Probes (the handle is lifted)

When users press the handle, they should leave a suitable distance between the movable plate and the mounting panel. The aim is to ensure that the probes are in touch with all the pins of the module, yet without crushing the module and its shield cover. Please see the figure below:

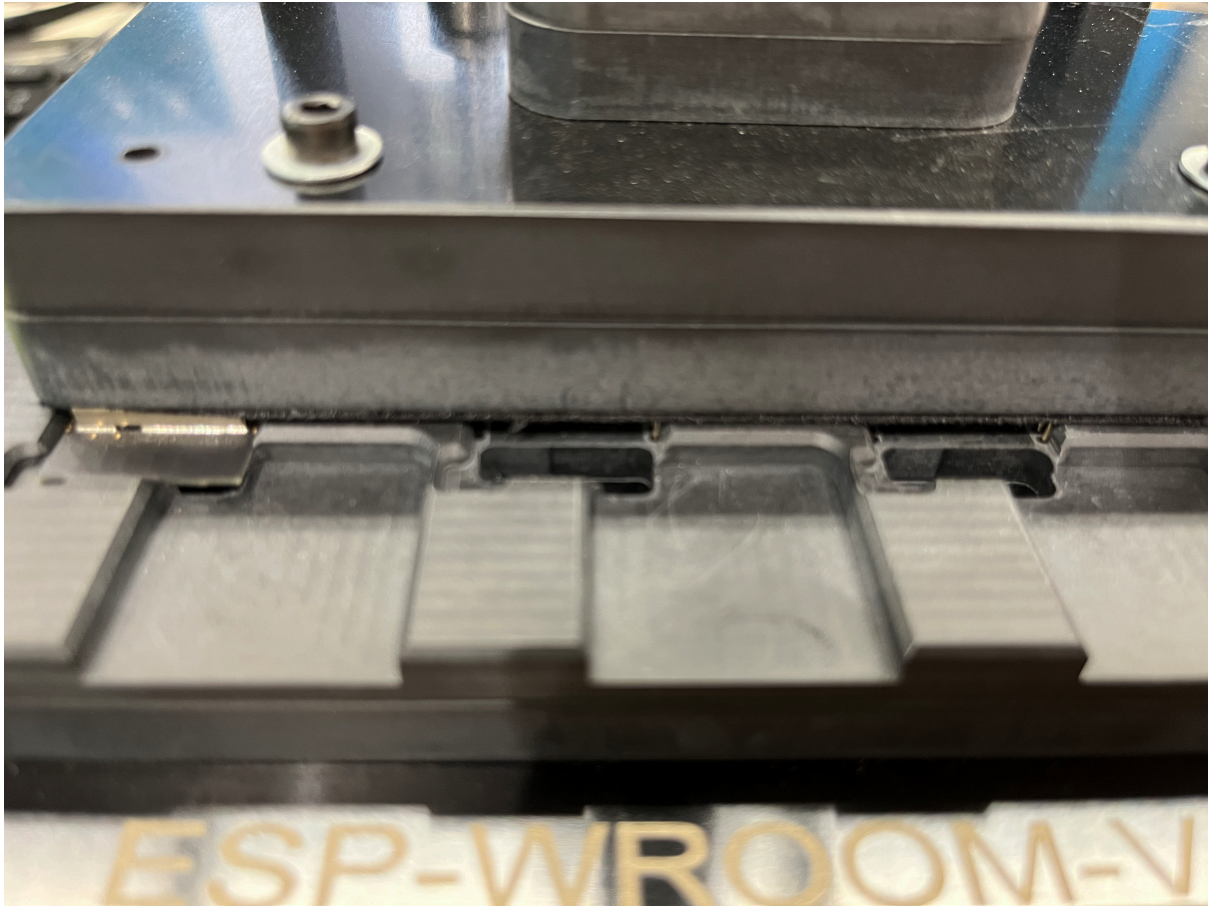


Fig. 64: The Movable Plate and the Mounting Panel

Bottom Box

Serial Port Board Two serial port boards (ESP_Factory Test Boards V1.3) are placed inside the bottom box, which can be seen in the figure below:

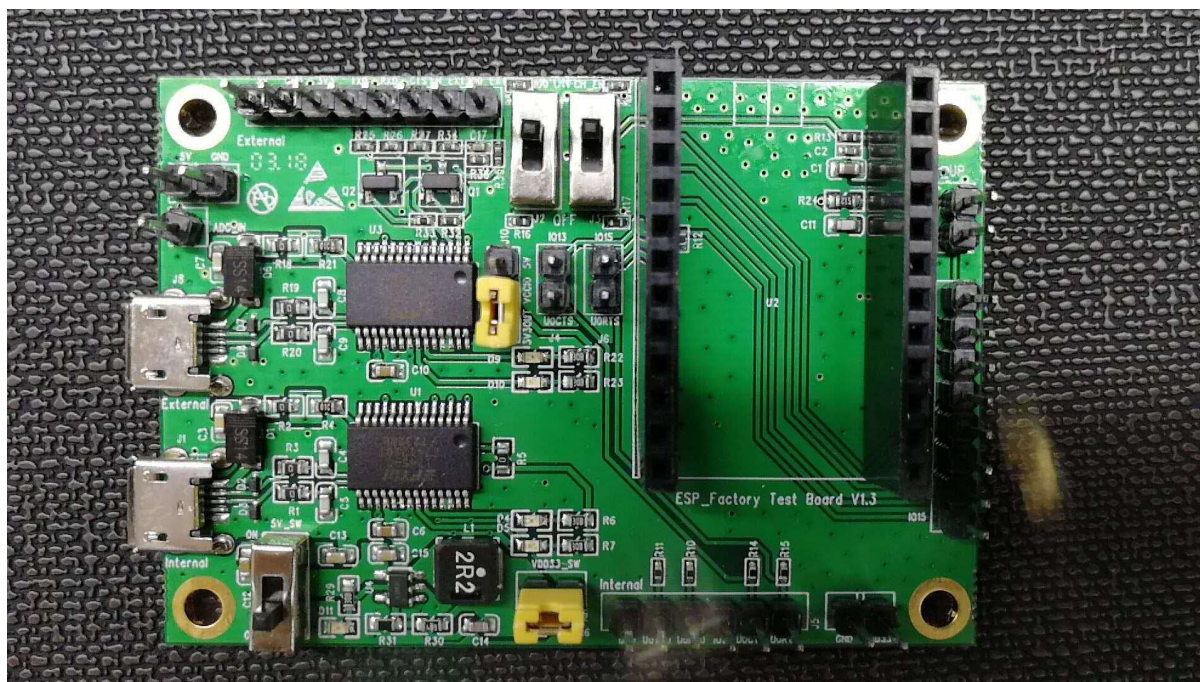


Fig. 65: A Typical Serial Port Board (ESP_Factory Test Board V1.3)

This serial port board, which has two serial-port chips, is placed inside the bottom box. Users should place as many serial port boards as necessary for the specific type of module fixture in operation. For example, the one-to-four module fixture requires four serial port boards.

It is required that the serial port boards be screwed onto the bottom box so as to keep them stable and prevent any short-circuit in the boards. The serial port boards are fixed by using screws in the four pass-through holes of the boards. In addition, when multiple serial ports are used to connect the HUB, the HUB should be provided with an external power supply to avoid a series of problems caused by insufficient power supply to the serial ports.

The Mark on the Bottom Box To facilitate the identification of the fixtures, it is required that the logo be printed on the surface of the bottom box. The classification of such marks is shown in the table below, where V* indicates the version of the fixture.

Table 11: The classification of the marks

Module Type	Mark
<ul style="list-style-type: none"> • ESP-WROOM-02 • ESP-WROOM-02D • ESP-WROOM-02DC 	ESP-WROOM-02/02D-V1
<ul style="list-style-type: none"> • ESP-WROOM-02U • ESP-WROOM-02UC 	ESP-WROOM-02U-V3*
<ul style="list-style-type: none"> • ESP32-WROOM-32 • ESP32-WROOM-32D • ESP32-WROOM-32DC • ESP32-SOLO-1 • ESP32-SOLO-1C 	ESP32-WROOM-32/32D-V1
<ul style="list-style-type: none"> • ESP32-WROOM-32U • ESP32-WROOM-32UC 	PESP32-WROOM-32U-V3*
<ul style="list-style-type: none"> • ESP32-WROVER (PCB) • ESP32-WROVER-B (PCB) • ESP32-WROVER-BC (PCB) 	ESP32-WROVER-V1
<ul style="list-style-type: none"> • ESP32-WROVER (IPEX) • ESP32-WROVER-B (IPEX) • ESP32-WROVER-BC (IPEX) 	ESP32-WROVER-I-V2*

Note:

1. Jumper caps in *The Movable Plate and the Mounting Panel* should be plugged in the yellow shorting plugs.
2. This guide is not applicable to ESP-WROOM-02U-V3, ESP32-WROOM-32U-V3 and ESP32-WROVER-I-V2.

The Wiring of the Mounting Panel Please see the rules in the table below, and connect the red and green wires as requested, while leaving the rest of the wires unconnected.

Table 12: Wiring Requirements

Components	Functions	Requirements	Remarks
Red wire	The red wires coming out of the probe	Connect the DuPont cables coming out of the probe to the serial boards. The pins with the same identification numbers should be connected to one another (see the following figures).	Notices : <ol style="list-style-type: none"> 1. Users should use standard DuPont cables, and the length of the cables should be kept as short as possible. 2. For the pins on the serial board that are not led-out, please solder the cables directly to the tin spots at the back of the serial boards.
	The red wires coming out of the switch	Connect the DuPont cables coming out of the switch to the serial boards. The pins with the same identification numbers should be connected to one another (see the following figures).	
Green wire	—	No need to connect the green wires to the serial port board.	—
Switch	One to one	One-channel side switch	—
	One to four	A four-channel side switch that controls four circuits.	—

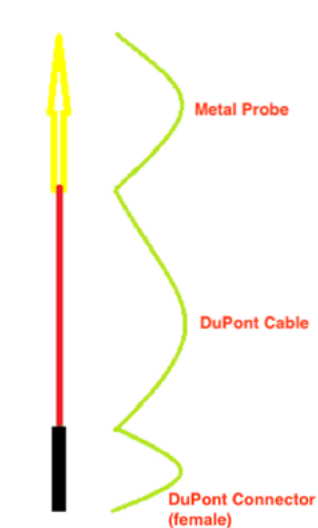


Fig. 66: A Diagram Showing How to Connect the Red Wires

The Wiring of the Fixture The fixture can enable or disable the **Automatic Mode Switching** on the Tool Side, by using the different wirings which can be seen in the following figures.

Note: By default, the Automatic Mode Switching on the Tool Side is not enabled.

When the Automatic Mode Switching on the Tool Side is not supported

1. ESP-WROOM-02

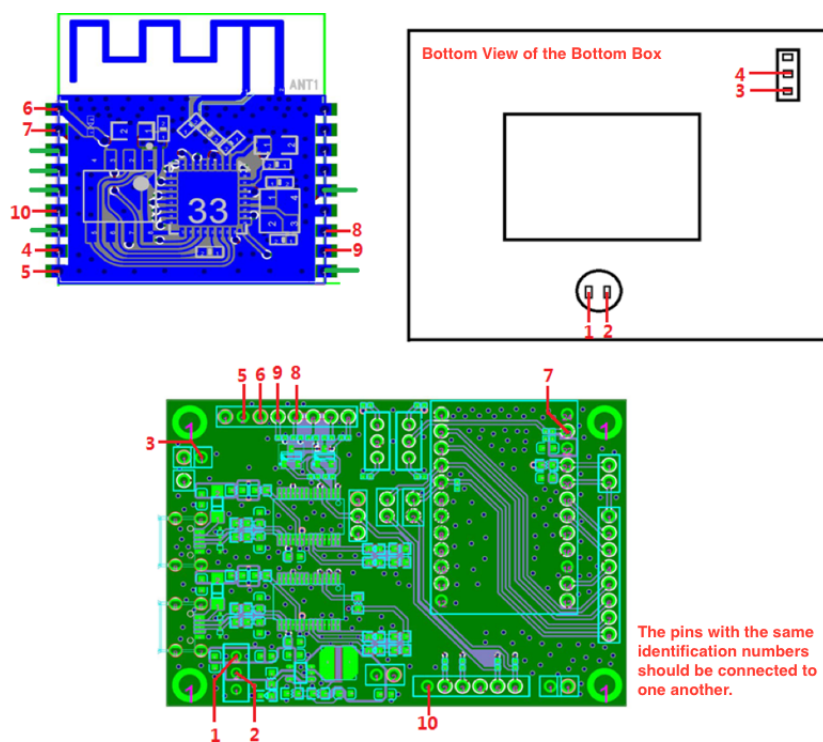


Fig. 67: The Wiring of the ESP-WROOM-02 Fixture

2. ESP-WROOM-32

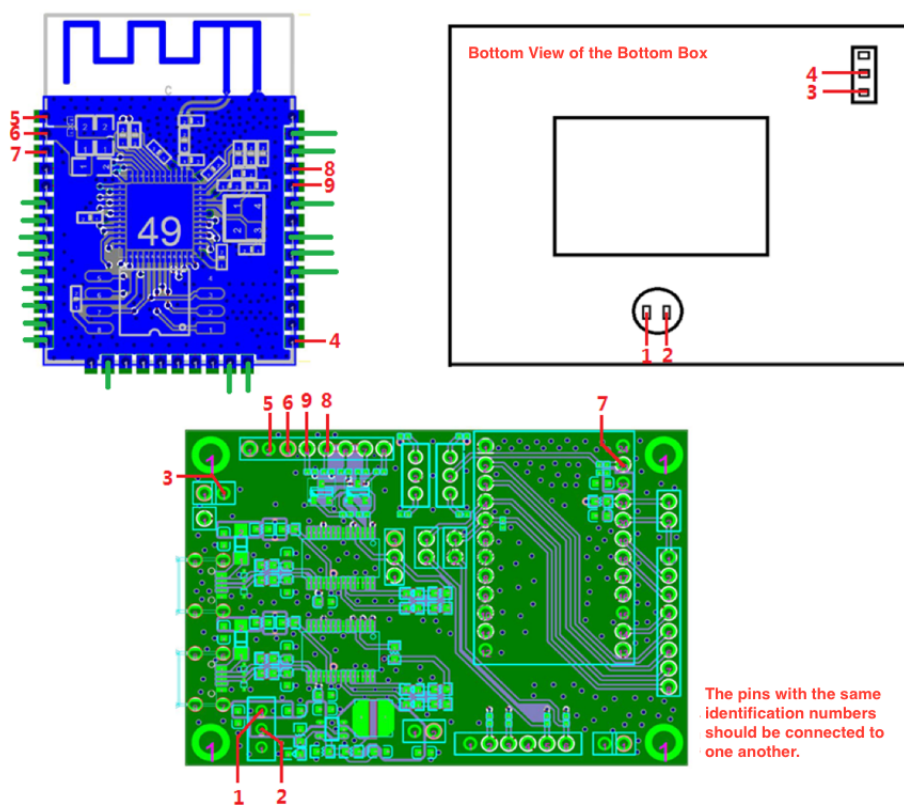


Fig. 68: The Wiring of the ESP32-WROOM-32 Fixture

3. ESP-WROVER

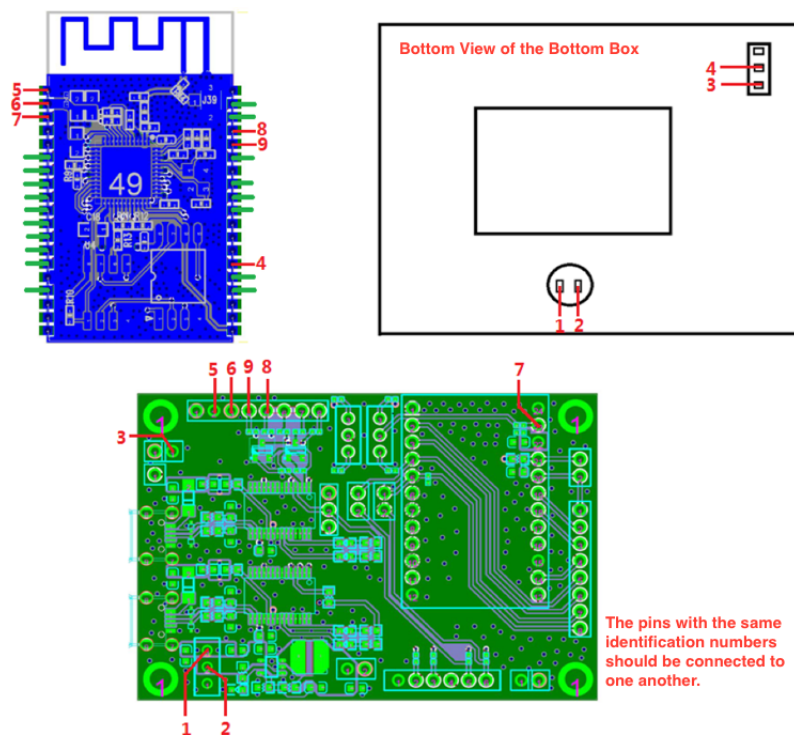


Fig. 69: The Wiring of the ESP-WROVER Fixture

When the Automatic Mode Switching on the Tool Side is supported

1. ESP-WROOM-02

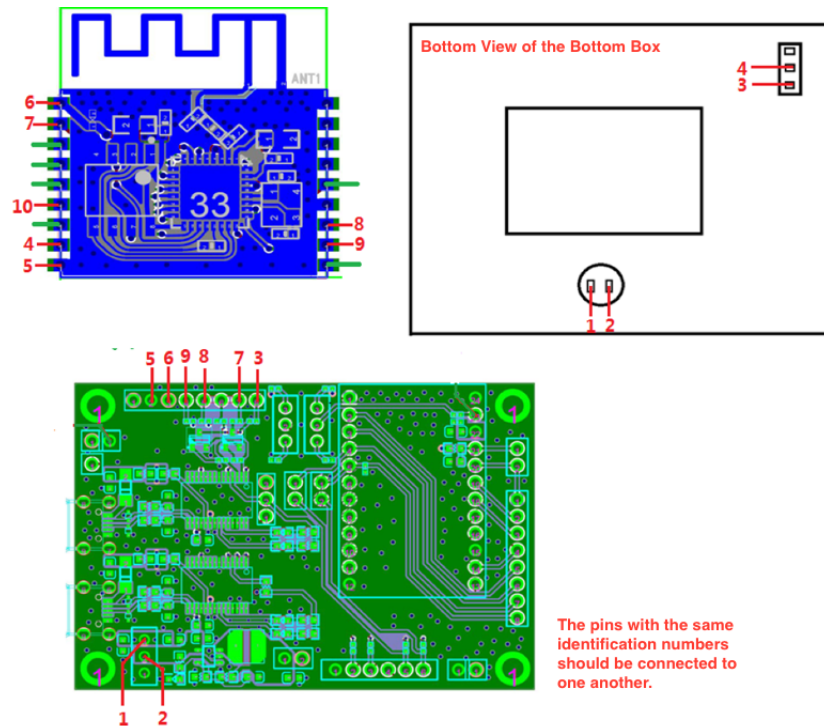


Fig. 70: The Wiring of the ESP-WROOM-02 Fixture

2. ESP32-WROOM-32

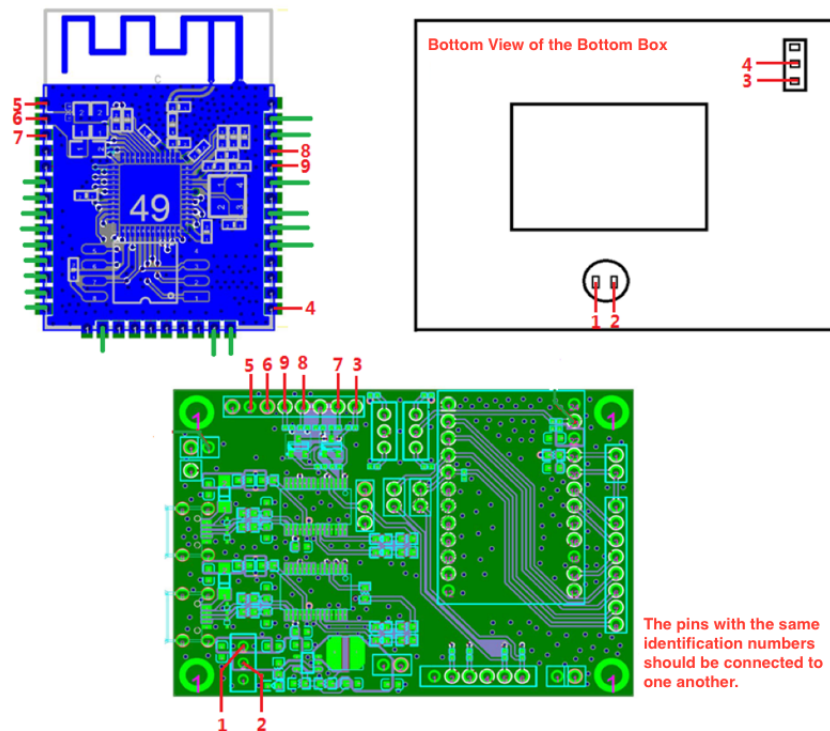


Fig. 71: The Wiring of the ESP-WROOM-32 Fixture

3. ESP-WROVER

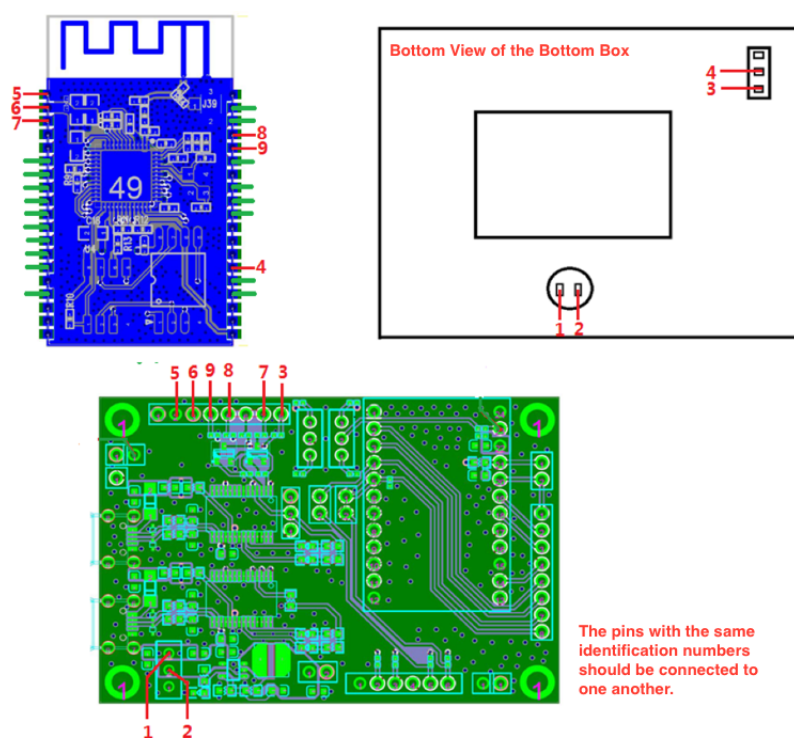


Fig. 72: The Wiring of the ESP-WROVER Fixture

8.4 Fixture Testing

Wiring Conductivity Test

To ensure that all the materials used for the wiring are functional, a conductivity test should be performed after the wiring is completed. Users can choose test tools, such as a multimeter, a simple LED circuit and so on.

Working Mode Verification Test

Please follow the steps below to verify the working modes of the module.

Operation Mode (currently only for ESP-WROOM-02 series modules)

1. After the wiring conductivity test, open a communication software for serial ports on the PC. (The **Serial Port Utility** is recommended here).
2. Select the corresponding port and baud rate (ESP8266/ESP32: 115200), and start the communication.
3. Use the switch located in positions 3 and 4 and toggle it towards position 3, so that you configure the module to the operation mode.
4. Press the handle.
5. Enter the command **AT+GMR**, and click Send.

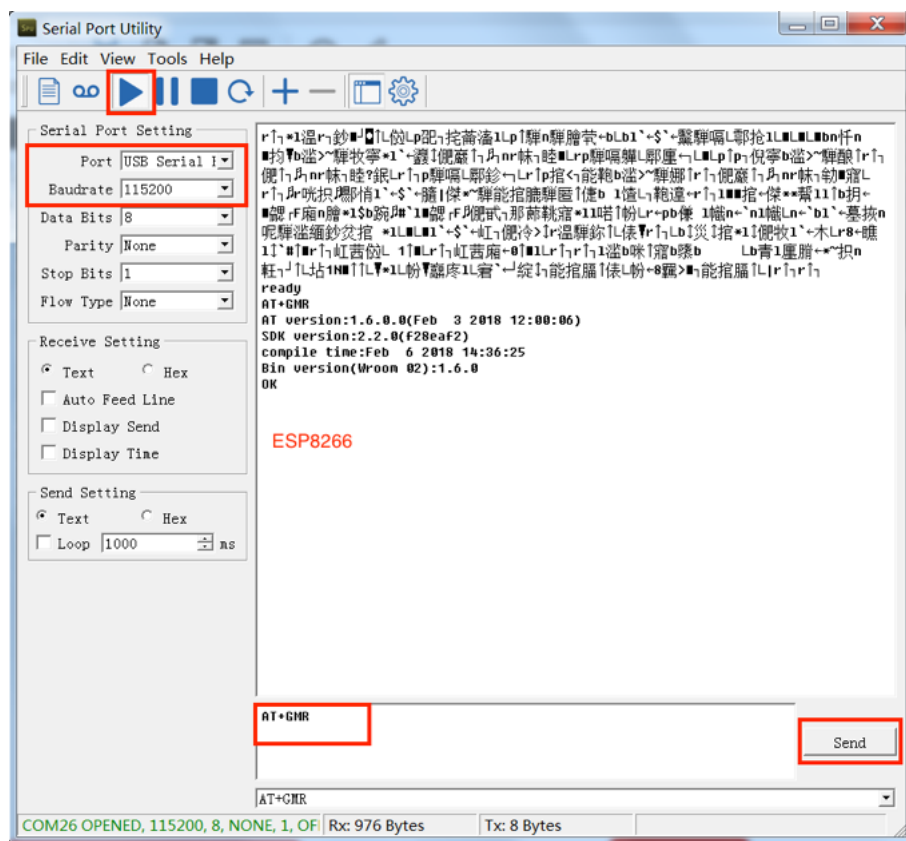


Fig. 73: AT Command Test

Note: Before clicking the Send button, users should press the **Enter** button after typing in the **AT+GMR** command.

6. Check the serial debugging tool window.

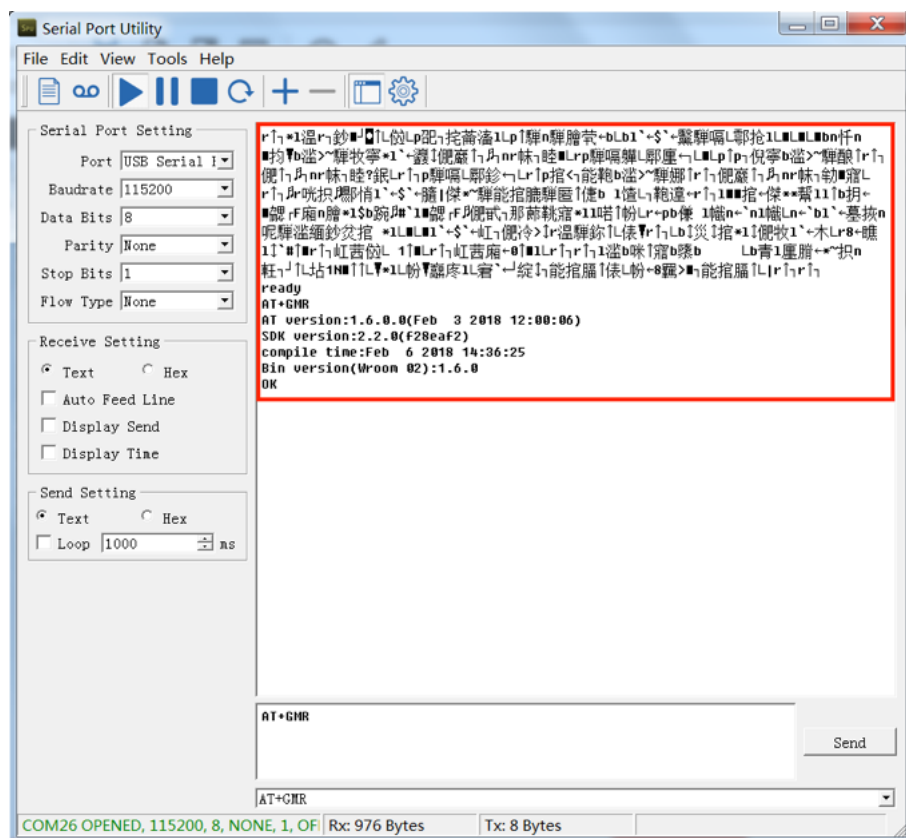


Fig. 74: Expected Result of AT Test - ESP8266 Series

- If the test result is as expected, which means the test was successful, users should save a screenshot of the test result.
- If the test result is not as expected, which means the test was not successful, users should perform the conductivity test again and ensure that the wiring is correct.

Download Mode

1. After the verification test of the operation mode, users should perform a verification test of the download mode, using the same serial port debugging tool.
2. Select the corresponding port and baud rate (ESP8266: 74880; ESP32: 115200), and start the debugging.
3. Use the switch located in positions 3 and 4 and toggle it towards position 4, so that you configure the module to the operation mode.
4. Press the handle.
5. Check the serial debugging tool window.

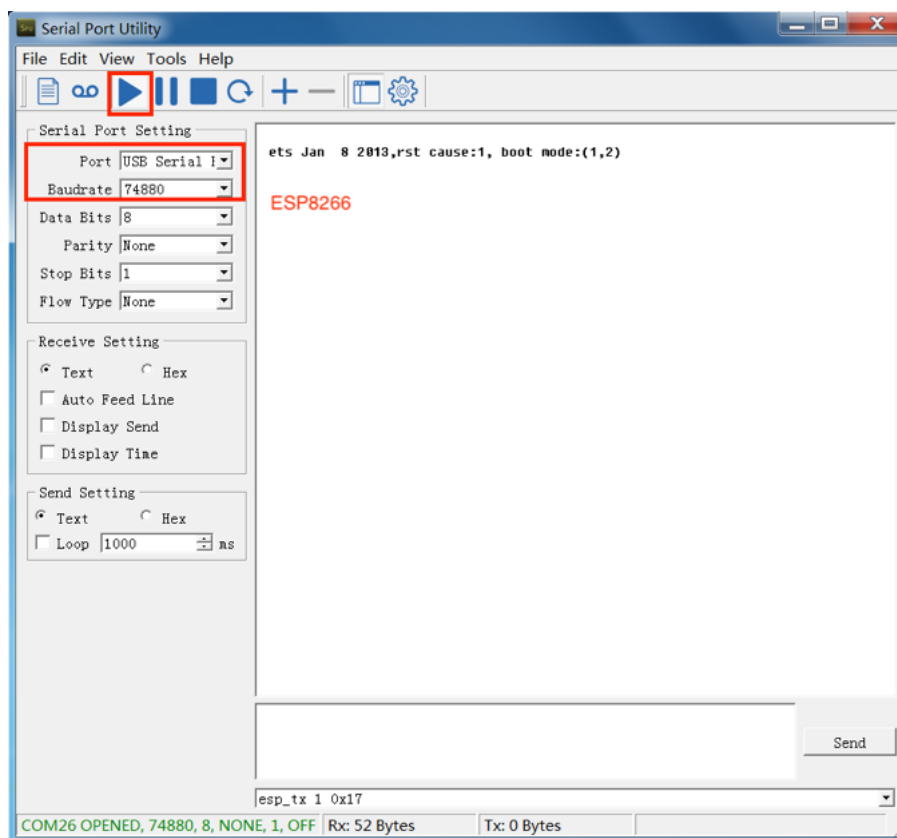


Fig. 75: Expected Result - ESP8266 Series

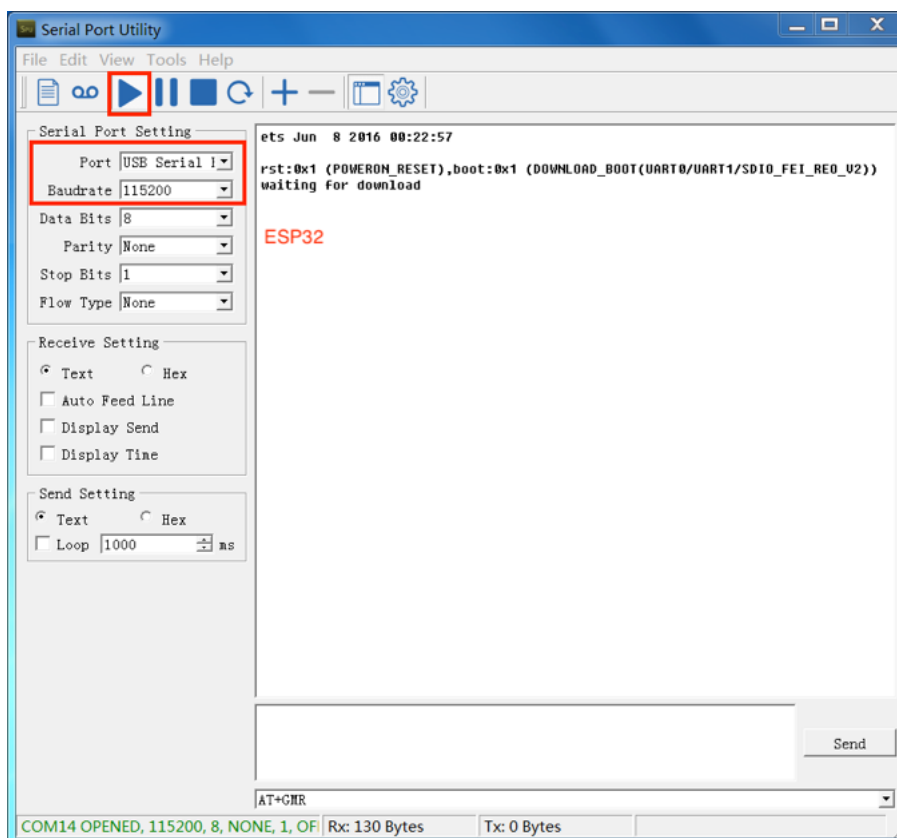


Fig. 76: Expected Result - ESP32 Series

- If the test result is as expected, which means the test was successful, users should save a screenshot of the test result.
- If the test result is not as expected, which means the test was not successful, users should perform the conductivity test again and ensure that the wiring is correct.

Test Report

Fixture manufacturers must perform the above-mentioned tests, and provide test reports or screenshots reflecting the results of these tests.

8.5 Appendix

Materials to Apply Fixtures

To accelerate the fixture manufacturing process, please provide the fixture manufacturers with the materials listed in the table below:

Table 13: Materials to apply fixtures

Material	Description
Module Gerber	Gerber files provide detailed information about the dimensions and positioning holes of the module.
Sample modules (for AT firmware downloading)	Sample modules can be useful for fixture manufacturers' testing. Please provide them on demand.
Serial Port Board	Please provide as many serial port boards as you actually need. For example, you should provide four serial port boards if you want to use a one-to-four fixture. (The serial board is ESP_Factory_Test_board V1.3.)
Wiring mode	Please inform the fixture manufactures whether you want to enable the Automatic Mode Switching or not. (By default, the Automatic Mode Switching on the Tool Side is not supported.)

Deliverable Items

The fixture manufacturers should deliver both of the items listed below:

Table 14: Deliverables

Deliverables	Description
Fixture Set	Fixture + serial ports + complete wiring. Notices: <ol style="list-style-type: none"> 1. If a one-to-four fixture is used, then there should be four serial boards in the bottom box, with complete wiring. 2. The serial board is ESP_Factory_Test_board V1.3.
Test Report	Test reports or screenshots reflecting the results of these tests.

Certification

Download certificates for Espressif products from [Certificates](#).

9 FAQ

- [RF Testing FAQs](#) offers answers to common questions about [EspRFTestTool Toolkit](#) and [RF Test Items](#).
- [Flash Download Tool FAQs](#) cover common questions about the [Flash Download Tool User Guide](#).
- [Espressif Production Testing Guide FAQs](#) provide answers to common questions about the [Espressif Production Testing Guide](#).

9.1 RF Testing

1. What should I do if the EspRFTestTool Toolkit fails to flash?

The chip might not have entered download mode correctly. Follow these steps to troubleshoot:

- Check the log: Use a serial tool (such as `sscom`, [Serial Port Utility](#)), select the correct baud rate, and check the log after powering up the chip.
- Confirm download mode: When the chip enters download mode, it typically displays “wait for download.”
- Check the connections: If no log is printed, ensure that the power supply and UART connections are functioning properly.

2. How can I confirm whether the firmware was successfully flashed?

Even if the flashing tool indicates success, the firmware might not have been flashed correctly. Follow these steps to verify:

- Check the log: Close the serial port used by the flashing tool, open a serial tool (such as `sscom`, [Serial Port Utility](#)), select the correct baud rate, and check the log.
- Enter working mode: Pull up the Boot pin and re-power the chip to enter working mode.
- Confirm flash success: Check if the log shows continuous reboots or matches the expected behavior based on the firmware documentation to confirm if the flashing was successful.

3. What should I do if the running traffic fails in the Wi-Fi Adaptivity Test?

If running traffic fails, consider the following possible causes and solutions:

- Firmware issues: Ensure that the firmware was flashed successfully.
- Network issues: Check whether the router (AP) network is stable and connections are smooth.
- Connection delays: If the connection is slow, wait a few seconds and restart running traffic.
- Serial testing: If the issue persists, consider testing via serial commands.

9.2 WFA Certification Test

1. How can I get the USB port name of the device?

Run the command `ls /dev/ttyUSB*` in the terminal to see the USB port name.

2. How can I get the MAC address of the DUT?

- Open `minicom` with the command `minicom -D /dev/ttyUSB*`;
- Type `query` and the MAC address of the DUT will be shown as `dut_mac`.

3. How do I flash the enterprise certificate?

The certificate is already included in the firmware, so you do not need to flash it separately.

4. Why isn't the tool starting?

Check the Python version and ensure the toolchain is fully installed.

5. Why is the tool script not detecting UCC commands after starting?

Ensure that the IP address is correctly configured on your computer.

6. What should I do if the DUT shows garbled output and is unresponsive to read/write commands?

Confirm that the DUT is flashed with the correct bin files and check that the power supply is working properly.

9.3 Flash Download Tool

1. I cannot find the serial port in the COM drop-down menu of the Flash Download Tool.

First, check the Device Manager to ensure the serial port is properly installed. If not, check the driver for any issues.

2. I got a “COM FAIL” error, as shown below:

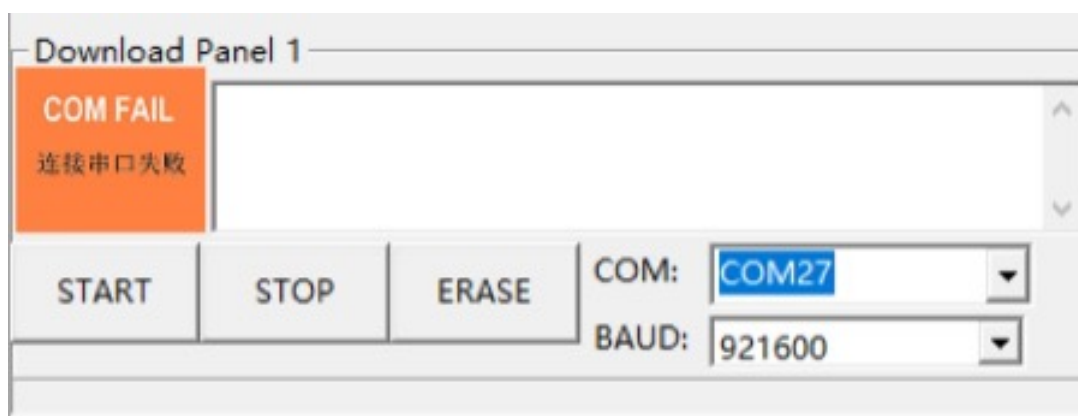


Fig. 77: Connection Failure of Serial Port

- Make sure the correct COM port is selected
- Verify that the COM port isn't being used by another thread.

3. The Flash Download Tool is stuck, as shown in the figure below. How can I fix this?

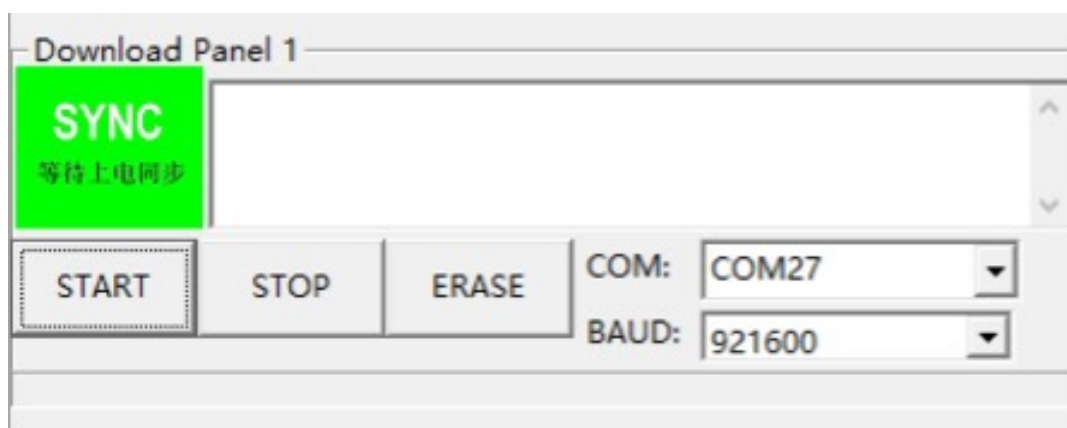


Fig. 78: Download Panel

This issue may occur due to:

- Hardware: The module is not in download mode.

- Software: The module selected in the tool isn't the one you are using.

4. I clicked the START button and got the error shown below.



Fig. 79: eFuse Error

The ESP8266 Chip efuse check error `esp_check_mac_and_efuse` message indicates an issue with the eFuse. Possible causes include:

- The eFuse is fine, but the wrong module is selected in the tool. In this case, select the correct module based on your setup.
- There is a problem with the module's eFuse. In this case, contact Espressif for esptool.exe and instructions, and send the eFuse data to Espressif for further debugging.

5. Errors occur during downloading.

Check the following:

- Ensure the module's TX/RX pins are not used by other software.
- Make sure the module's flash size is no less than the firmware size.
- If you encounter an MD5 verification error, erase the entire flash and try downloading again.

6. The module crashes when powered on again after downloading the firmware.

If the firmware works correctly, check the following:

- The module selected in the tool matches the one you are using.
- The correct flash boot mode is selected.
- The correct flash download mode is selected.

9.4 Espressif Production Testing Guide

1. Why it is necessary to set up an evaluating environment?

To ensure smooth mass production testing, the test environment must be evaluated beforehand. This is to confirm several aspects: stable power supply (including power to the DUT and the signal board), that the signal board and production test baseboard meet requirements, and to eliminate potential interference from the surrounding environment.

2. What should be done if RX FAIL occurs after testing and `fb_rssi` and `dut_rssi` are outside the normal range?

If RX FAIL occurs after testing and `fb_rssi` and `dut_rssi` are greater than 60 or less than -30, the following measures can be taken: increase the distance between the signal board and the module under test, or add a 30 dB attenuator on the signal board side.

3. How often does the signal board need to be calibrated? How can interference between signal boards be avoided?

The MAC address and production date of the board are given at the back of the signal board. Note that the signal board must be recalibrated every year, because the long operating time of components, such as crystal oscillators, may lead to measurement deviations. Only ONE signal board must be used in an independent environment or RF-shielded environment to avoid interference.

10 Related Documentation and Resources

- [Chip Datasheet \(PDF\)](#)
- [Technical Reference Manual \(PDF\)](#)
- [Chip Errata \(PDF\)](#)
- [Chip Variants](#)
- [Modules](#)
- [Development Boards](#)
- [ESP Product Selector](#)
- [Regulatory Certificates](#)
- [User Forum \(Hardware\)](#)
- [Technical Support](#)

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