ESP32

User Guide of ESP Test Tools

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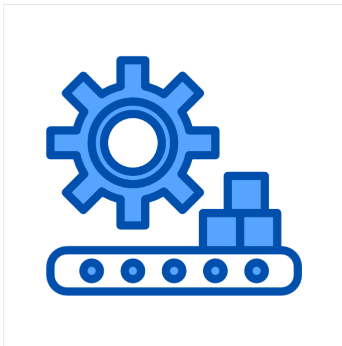
This repository provides comprehensive resources to support the development and production of products based on Espressif chips and modules.

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.

		
RF Test Guide	RF Test Items	Production-stage Tools

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.

Bluetooth Test

- *Bluetooth and Bluetooth LE Non-Signaling Test* controls the device to transmit specific signals without establishing a connection, evaluating performance metrics such as transmit power, spectrum characteristics, and error rate to ensure communication quality.
- *Bluetooth LE DTM Test* evaluates the RF performance of Bluetooth LE devices by directly controlling the device to enter specific transmission or reception modes, accessing key metrics like transmit power, reception sensitivity, and spectrum characteristics.
- *Bluetooth LE Blocking Test* assesses device stability and performance in environments with interference from other wireless signals, ensuring compliance with relevant standards.

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	–	–
Bluetooth and Bluetooth LE Non-Signaling Test	Y	Y	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.

1.4 WFA Certification and Testing Guideline

In addition, this repository also provides *WFA Certification and Testing Guide*, which provides detailed information about the WFA certification process and testing requirements to help you pass the Wi-Fi Alliance certification.

2 EspRFTestTool Toolkit

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

- *EspRFTestTool*: 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: EspRFTestTool toolkit

The zip file not only includes the EspRFTestTool 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 **EspRFTestTool toolkit** refers to the collection of the three tools, while the **EspRFTestTool** refers to this single tool.

2.1 EspRFTestTool

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

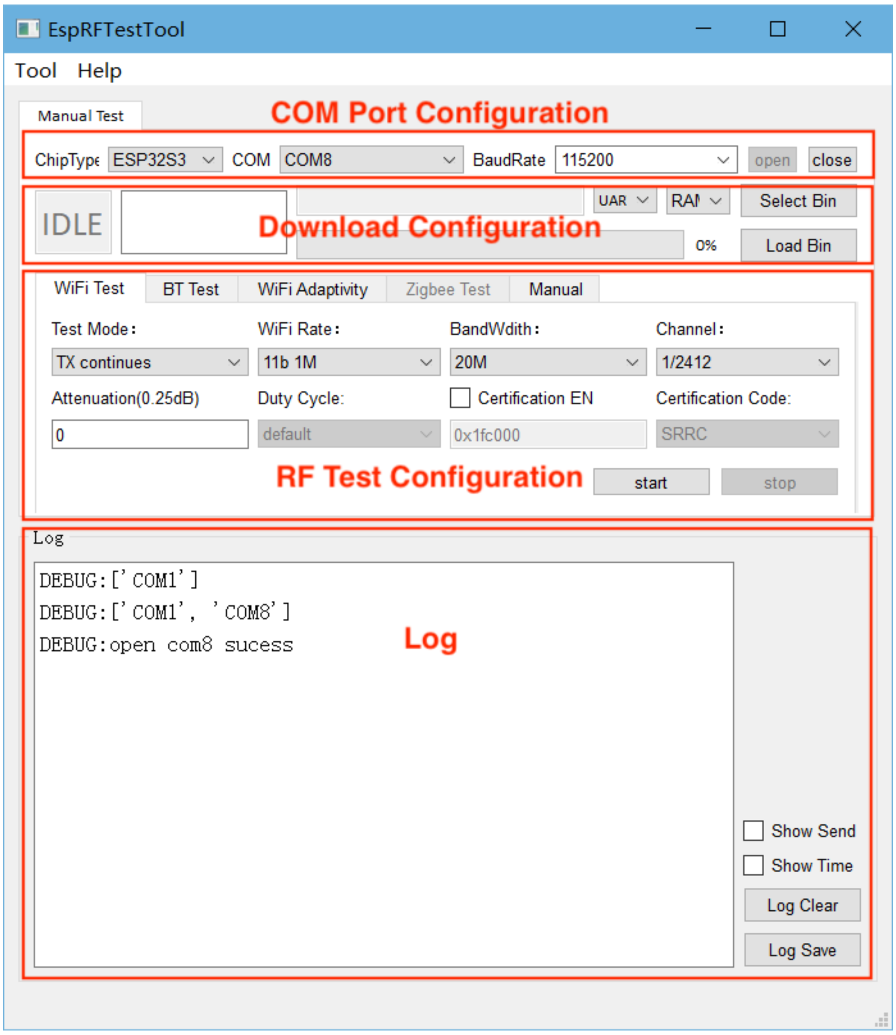


Fig. 1: EspRFTestTool

COM Port Configuration Area

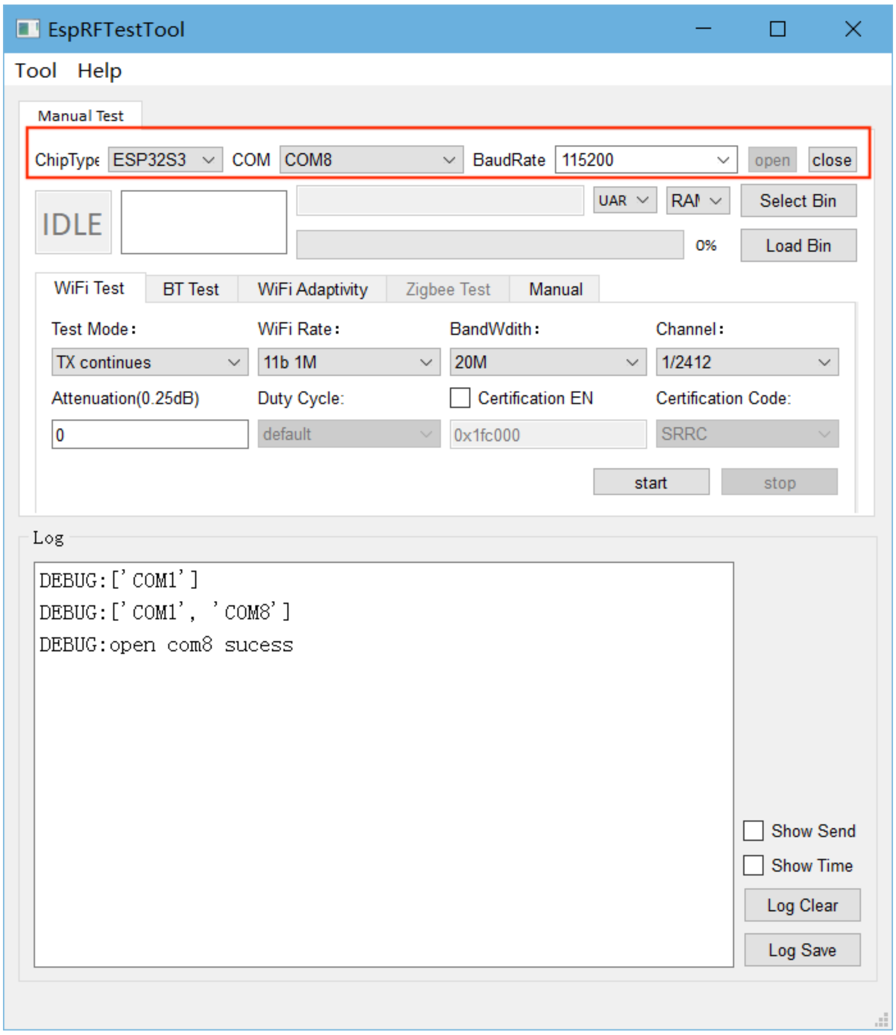


Fig. 2: EspRFTestTool COM Port Configuration Area

- **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

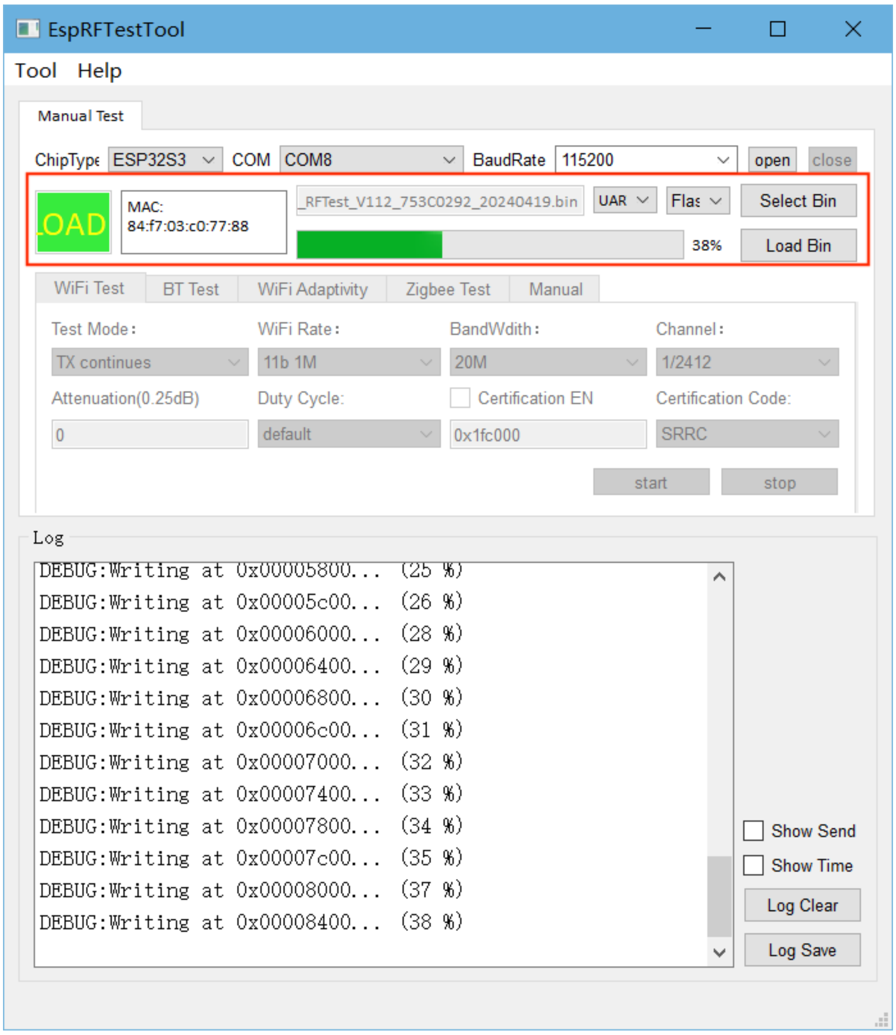


Fig. 3: EspRFTestTool Download Configuration Area

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, EspRFTestTool 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

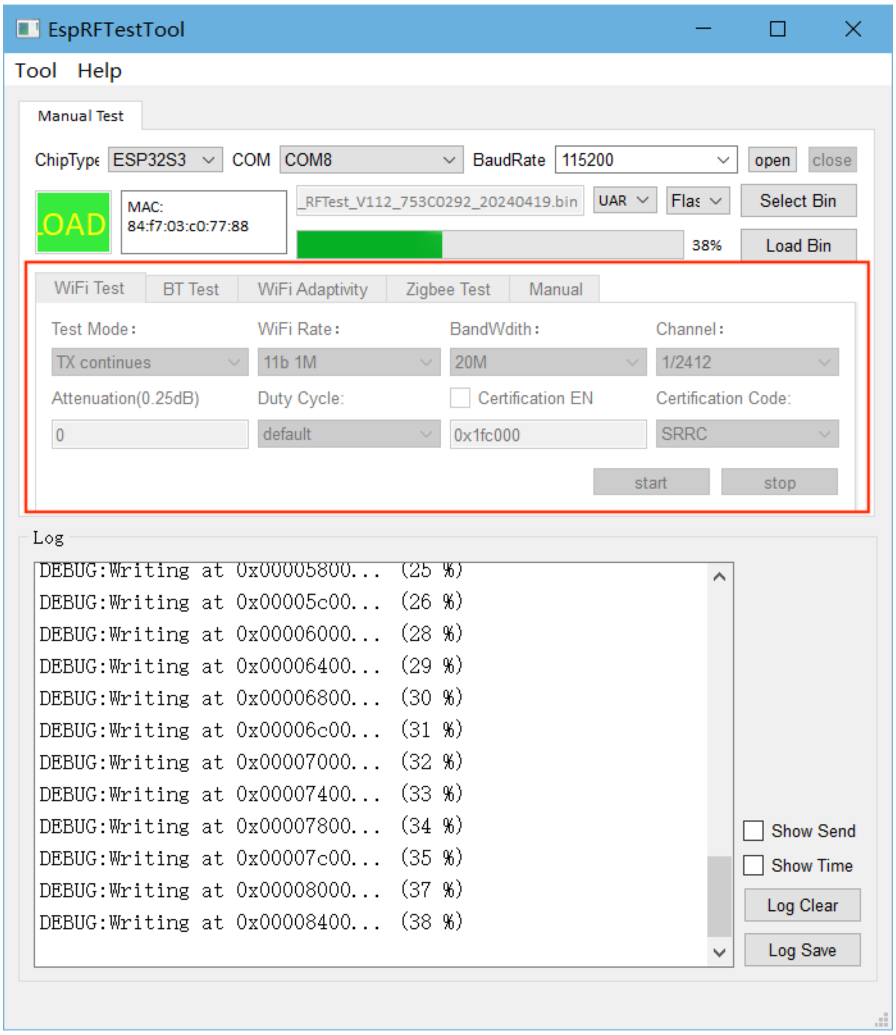


Fig. 4: EspRFTestTool RF Test Configuration Area

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.

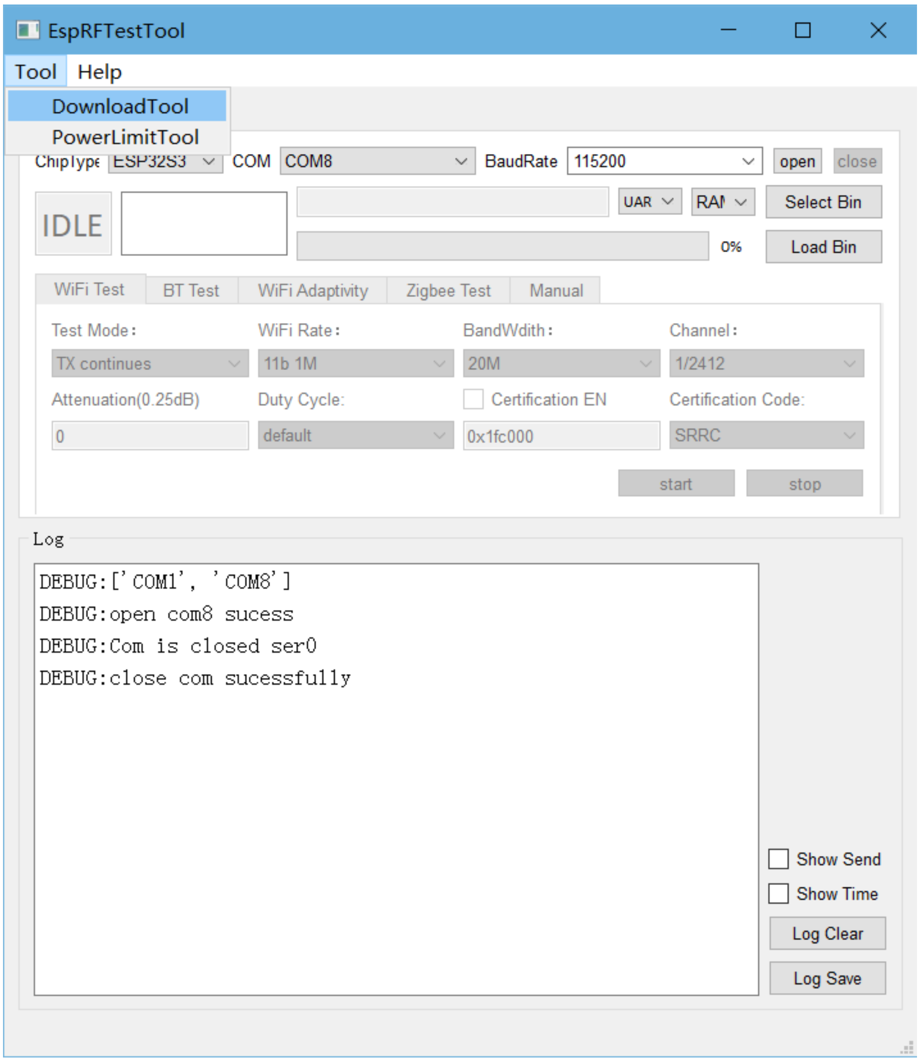


Fig. 5: Entry to DownloadTool

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.

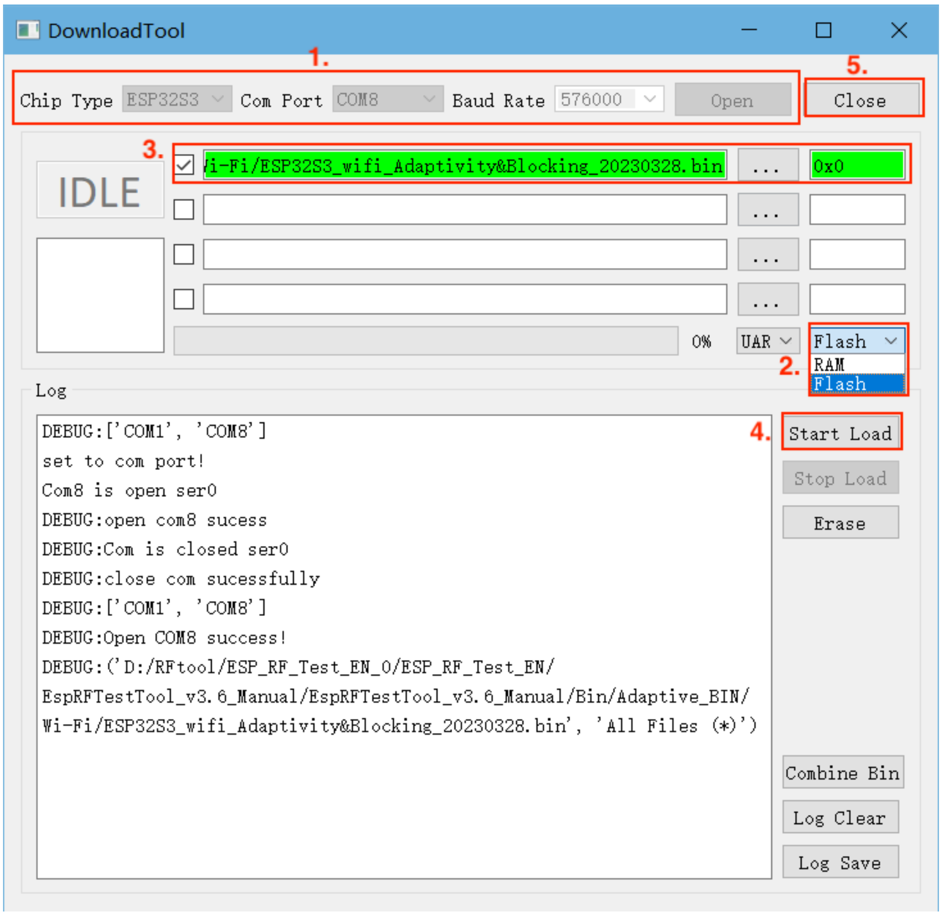


Fig. 6: DownloadTool Interface

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 EspRFTestTool, click `Tool`, and select `PowerLimitTool` from the dropdown box to open PowerLimitTool.

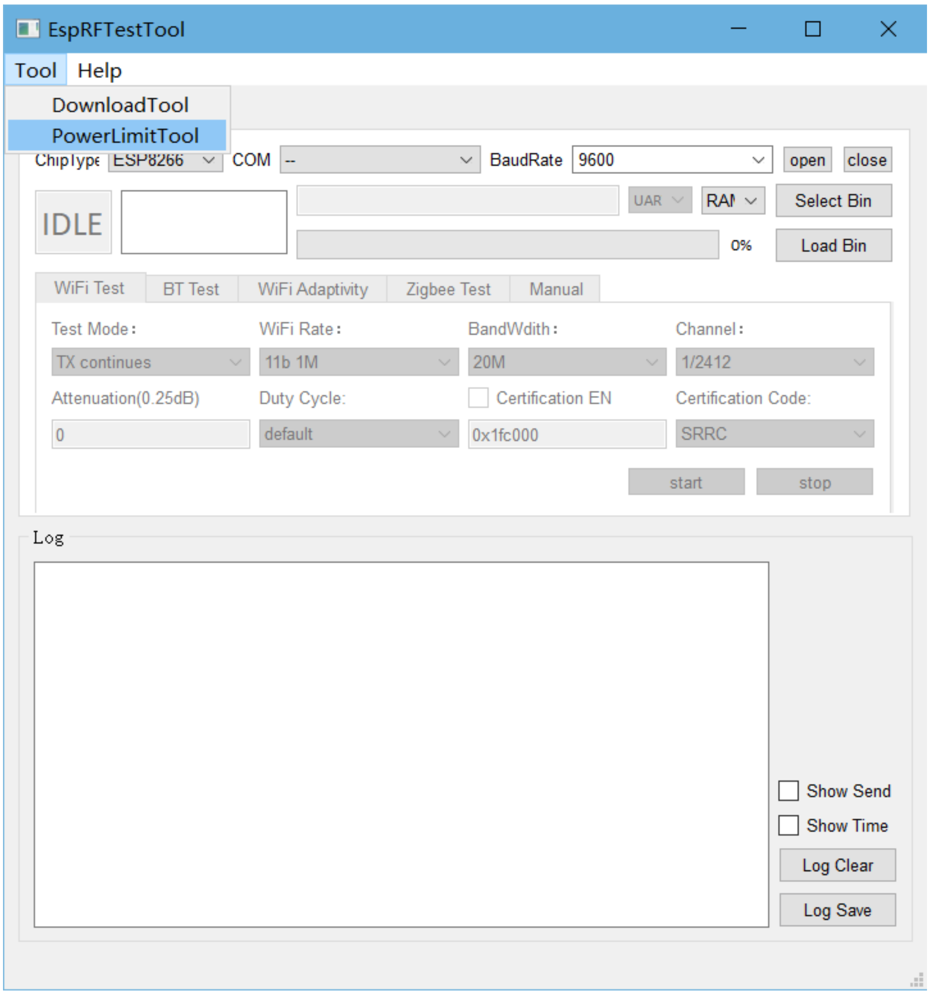


Fig. 7: Entry to PowerLimitTool

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).

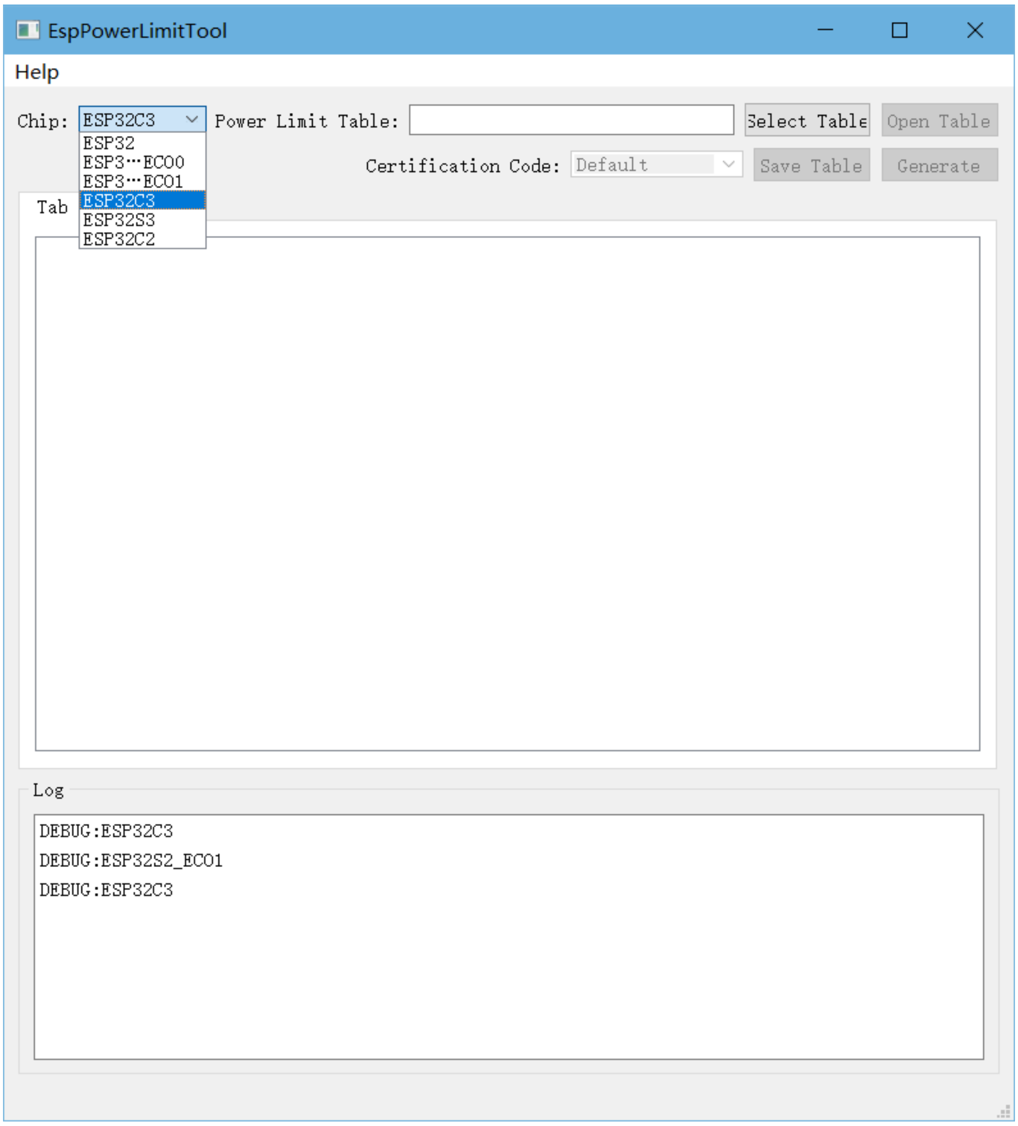


Fig. 8: PowerLimitTool Main Interface

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

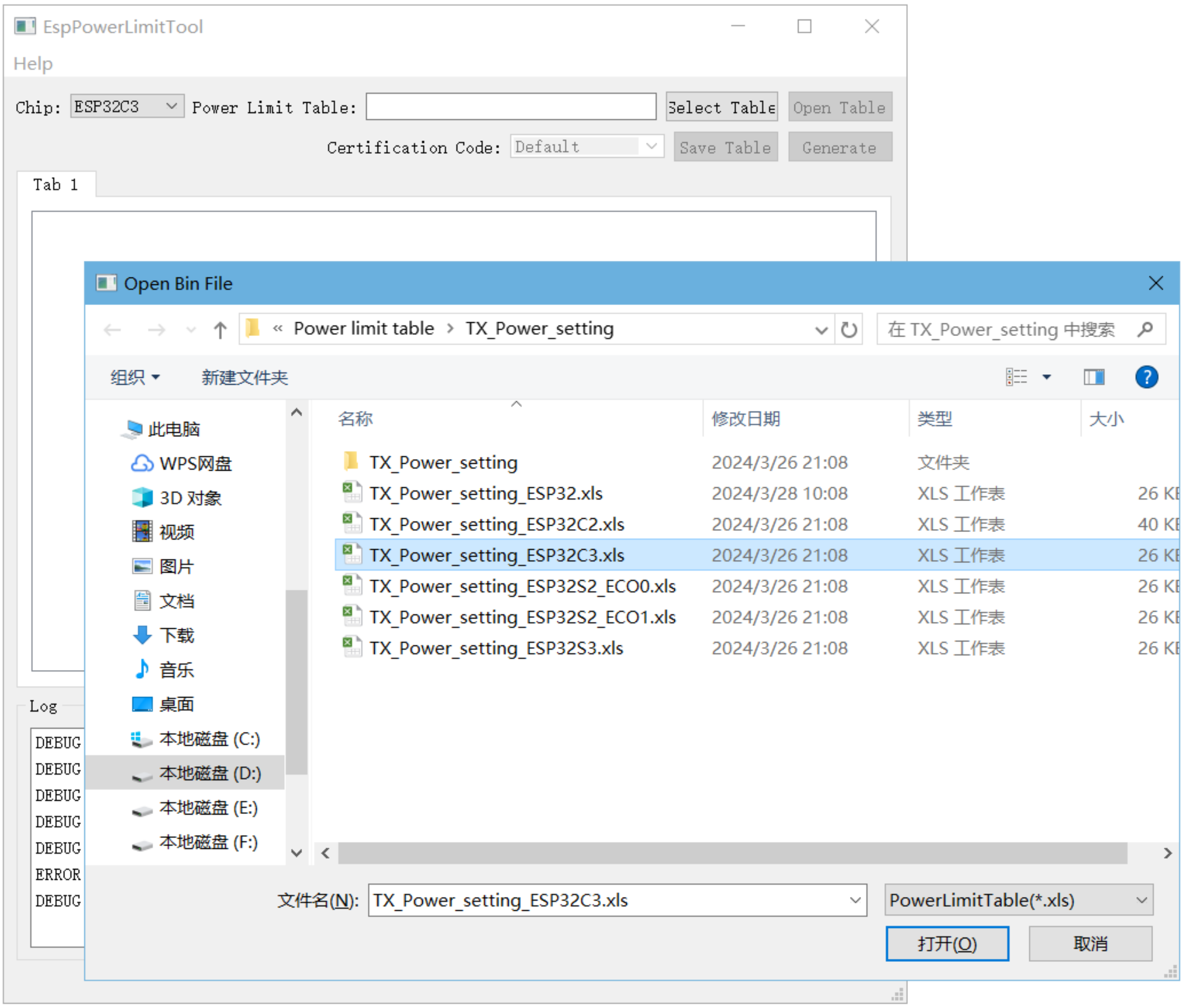


Fig. 9: Importing TX Power Setting Table

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.

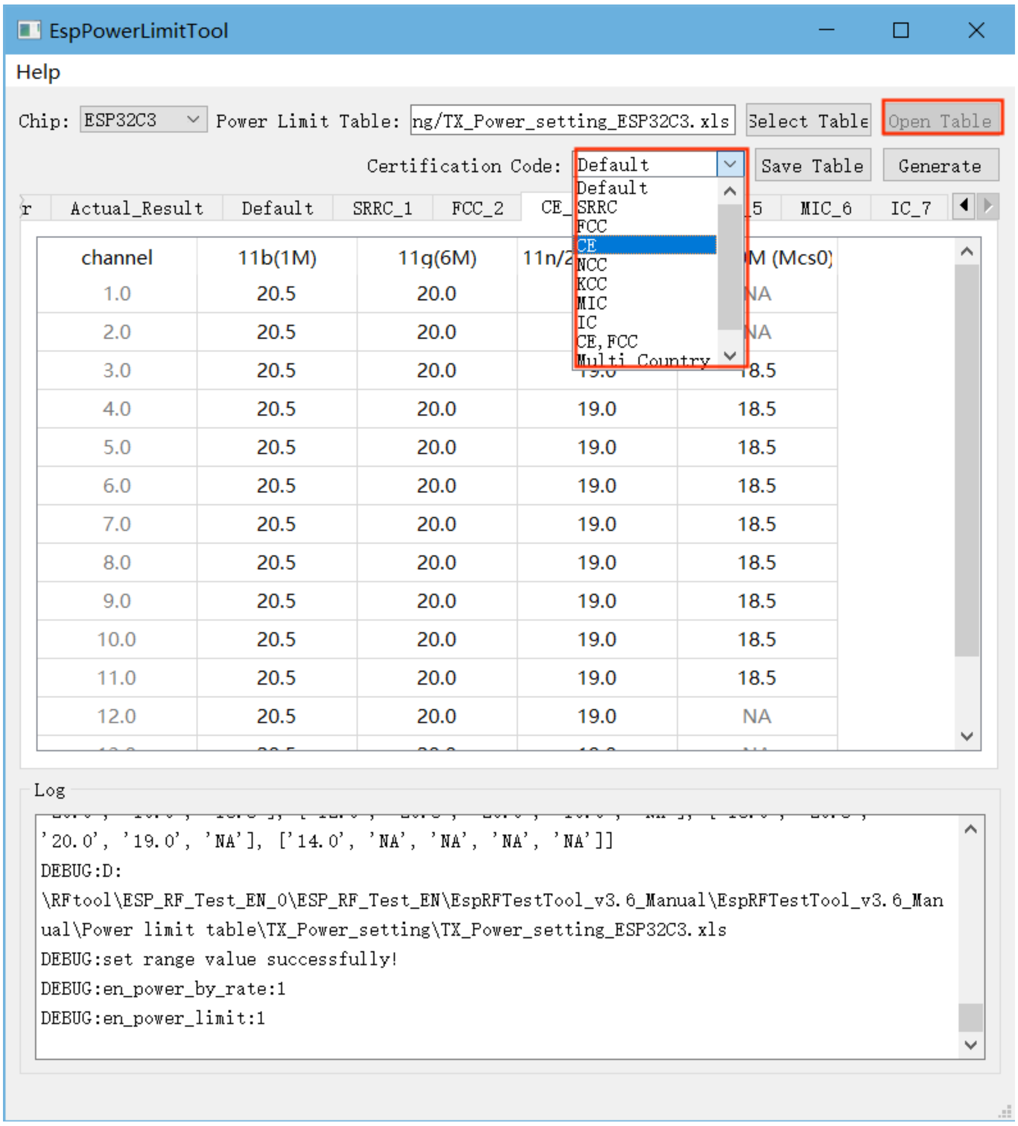


Fig. 10: Modifying TX_Power_Setting

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.

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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.

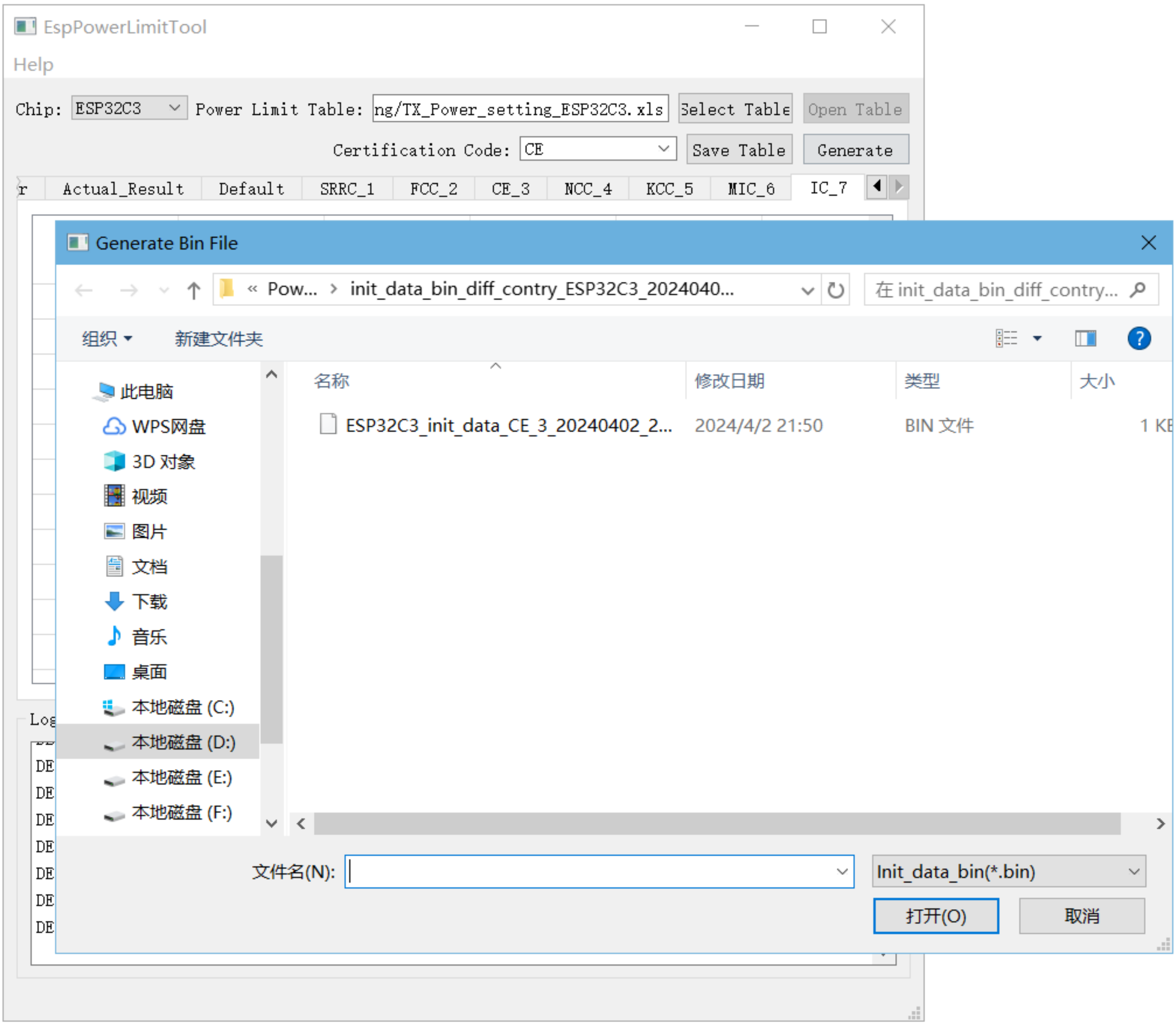

Fig. 11: Generate phy_init_bin File

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 bing 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.

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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 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*.

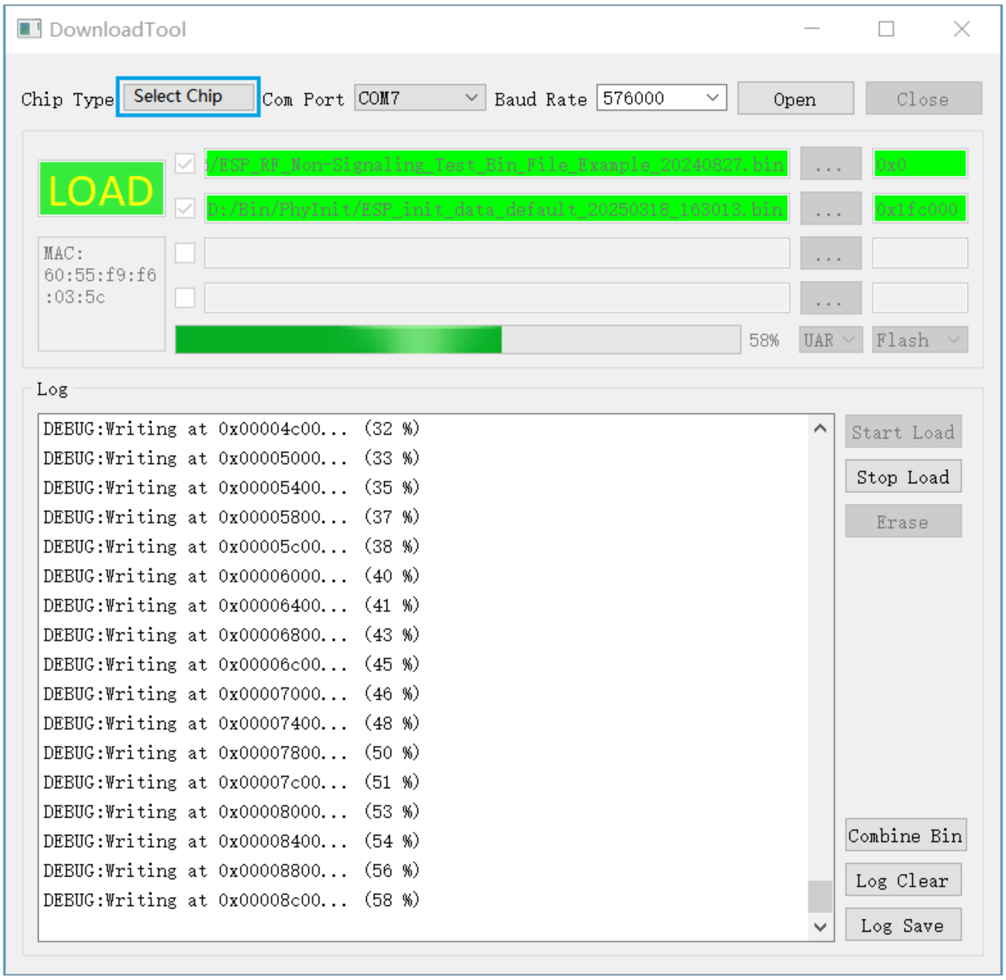


Fig. 12: Flash phy_init_bin File

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`.

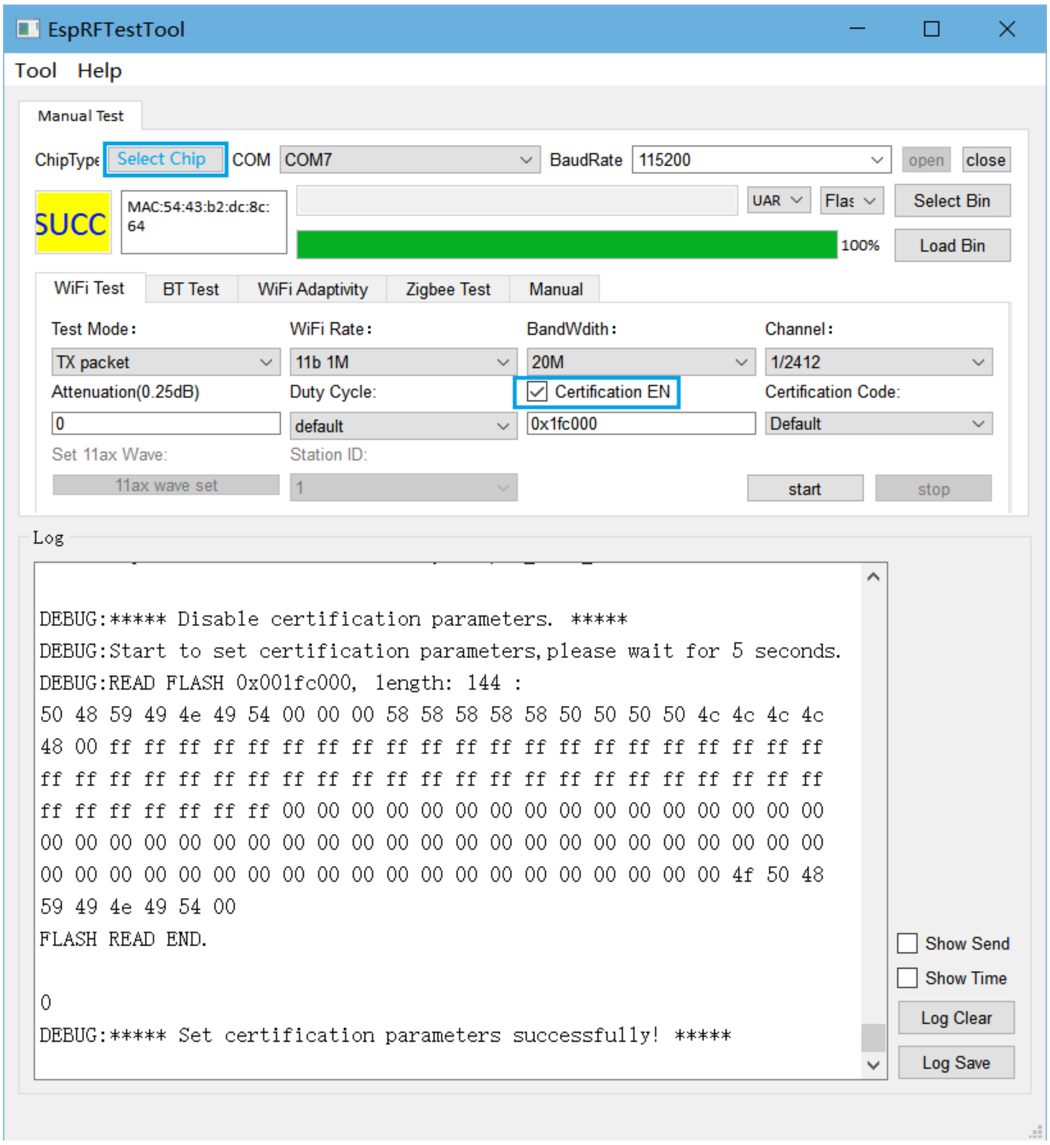


Fig. 13: RF Test Configuration

Typical Average Output power of ESP32

Rates	Typical Average Output power (dBm)
11b 1 Mbps	19.5
11b 11 Mbps	19.5
11g 6 Mbps	18
11g 54 Mbps	14
11n-20 MCS0	18
11n-20 MCS7	13
11n-40 MCS0	18
11n-40 MCS7	13

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.

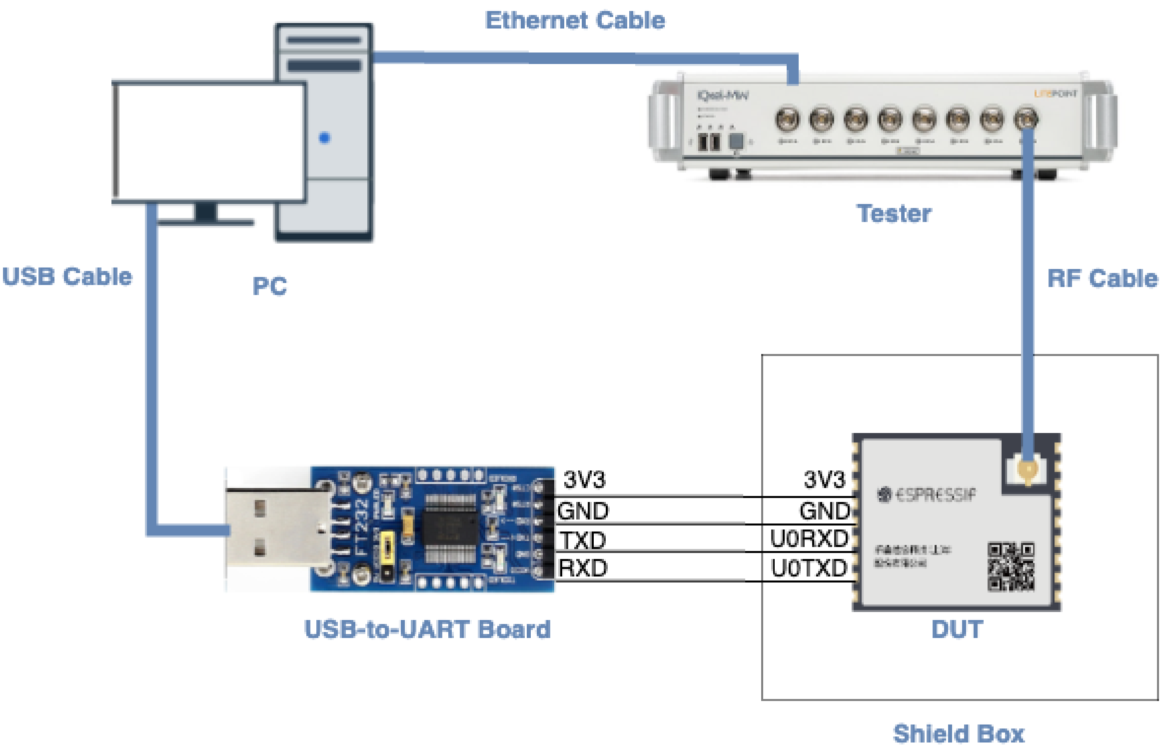


Fig. 14: Test Environment Setup

- **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 EspRFTestTool 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 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 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.

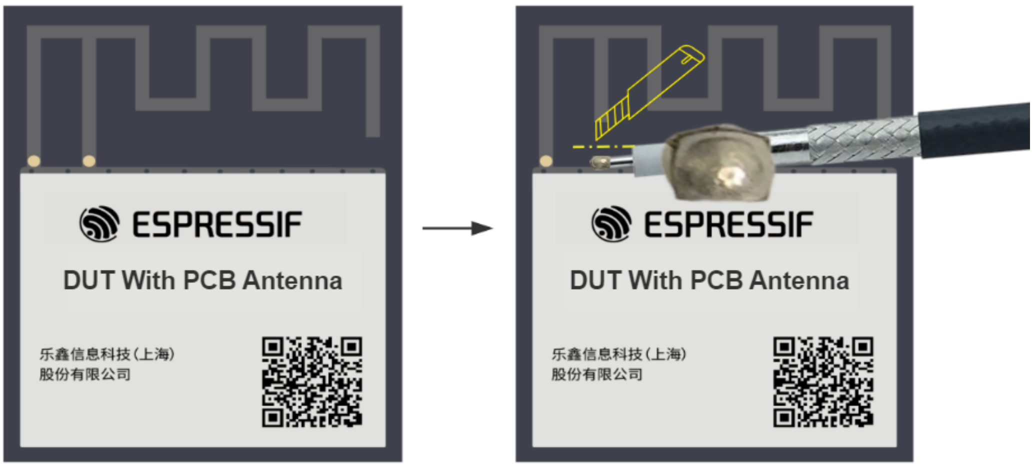


Fig. 15: Soldering RF Connection Cable to Module with Onboard PCB Antenna

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 RF Non-Signaling Test Firmware to `Flash` via `UART`.

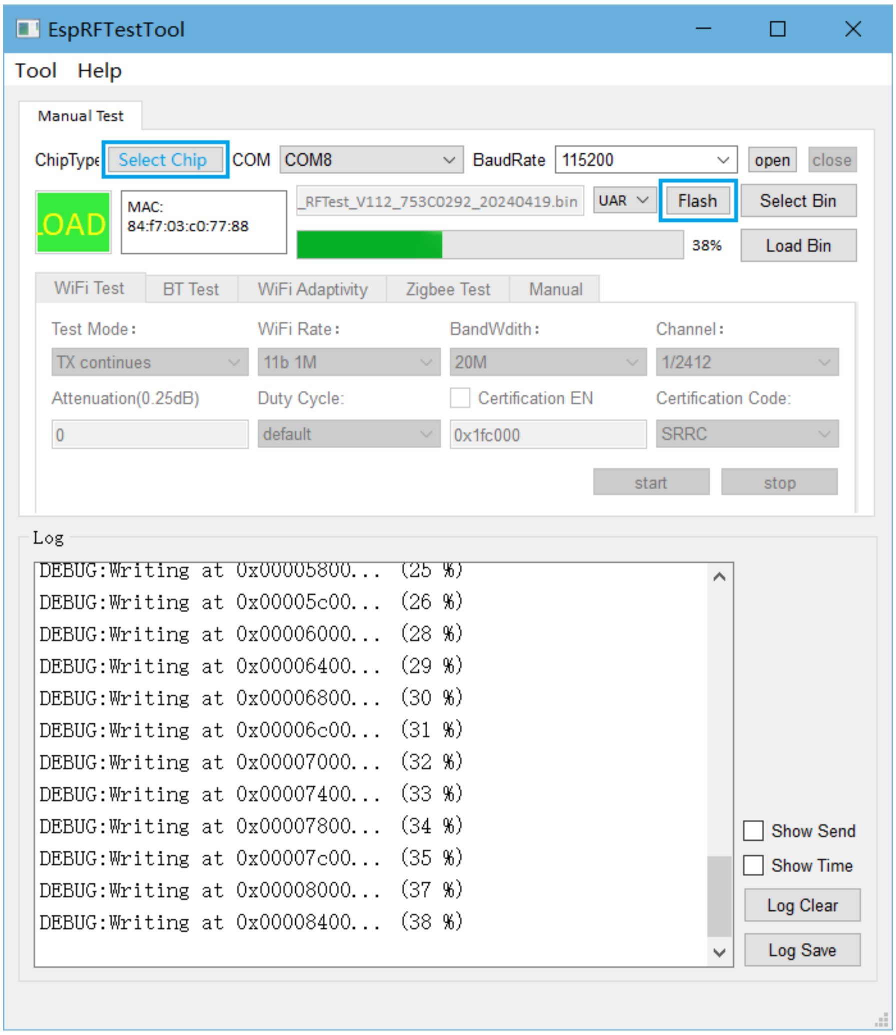


Fig. 16: ESPRFTestTool Configuration

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.

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
- **Atteunuation (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.

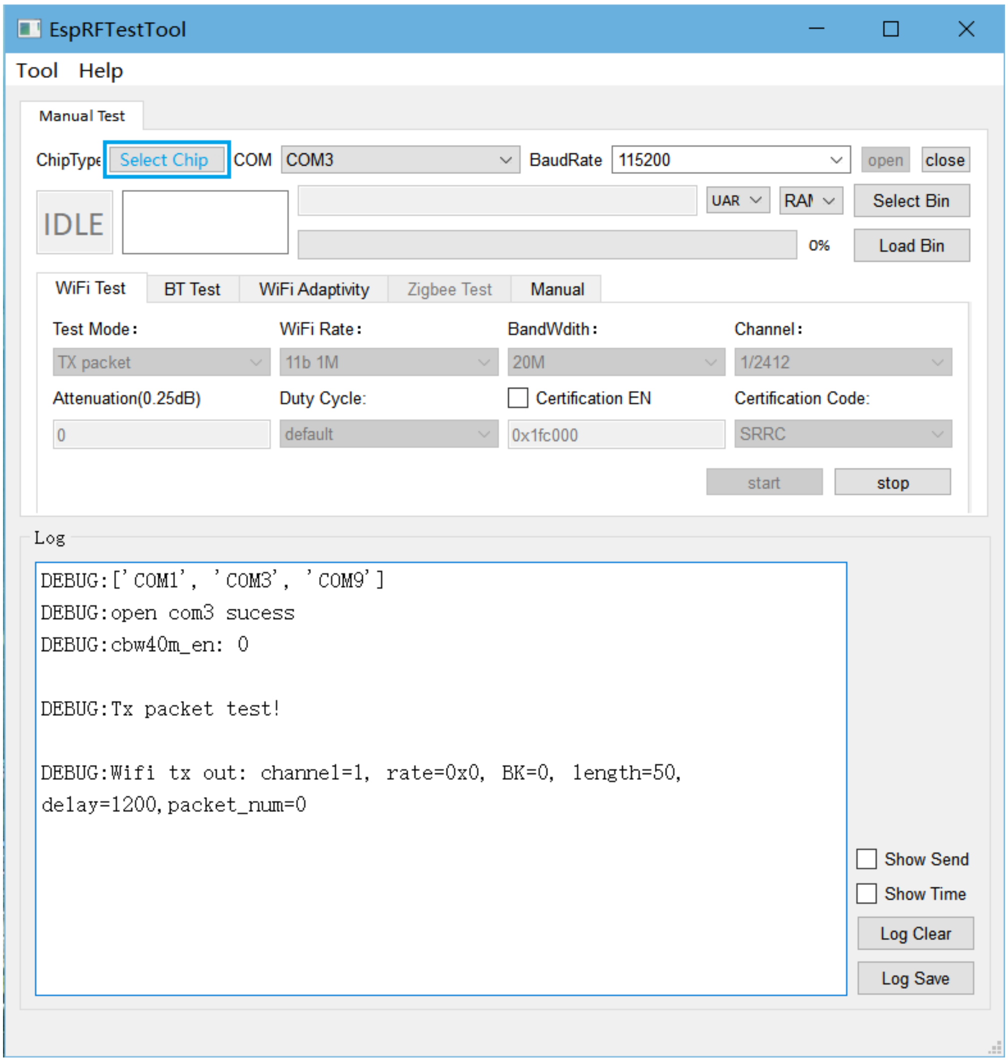


Fig. 17: Wi-Fi TX Performance Test

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.

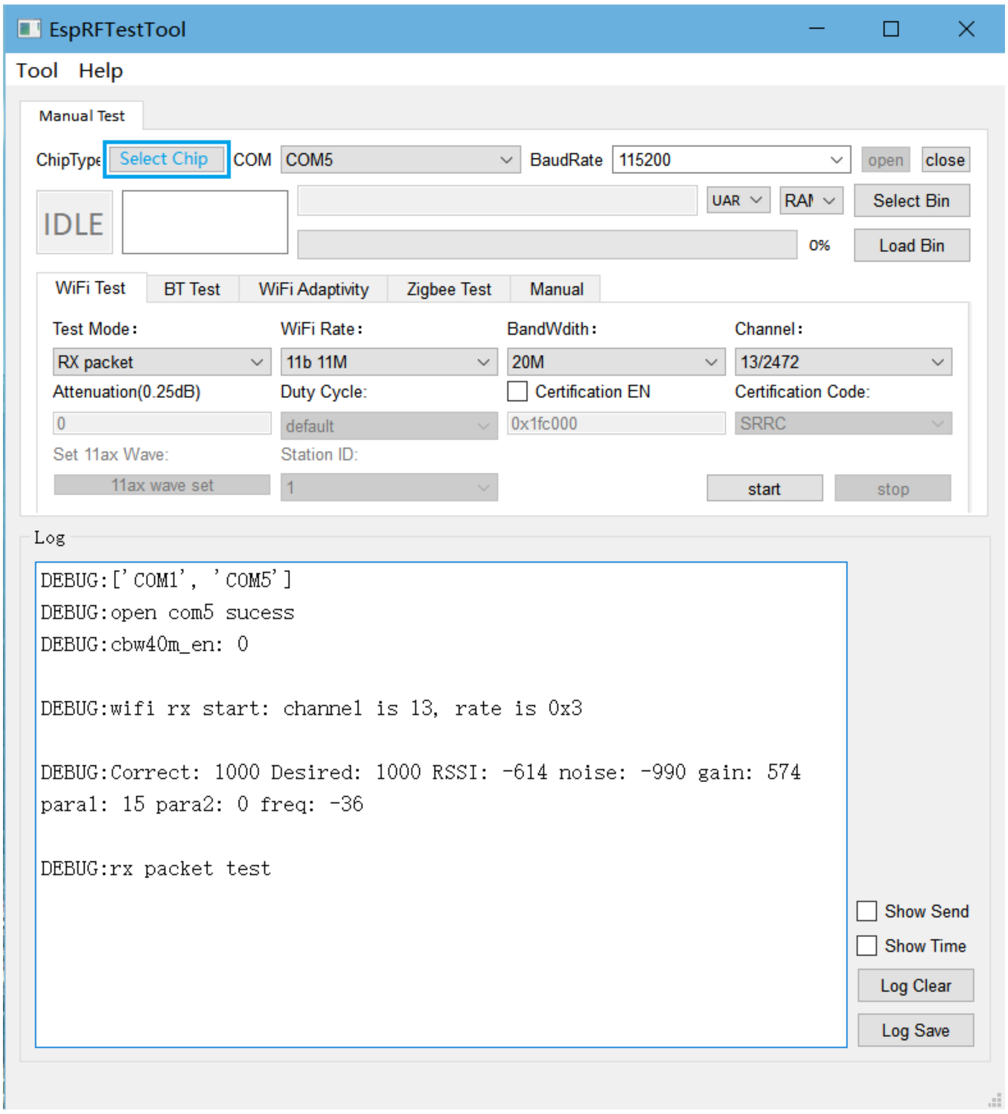


Fig. 18: Wi-Fi RX Performance Test

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 Wi-Fi Target TX Power

Rate	ESP32 Wi-Fi Target Power (dBm)
11b 1M	19.5
11b 11M	19.5
11g 6M	18
11g 54M	14
HT20-11n MCS0	18
HT20-11n MCS7	13
HT40-11n MCS0	18
HT40-11n MCS7	13

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

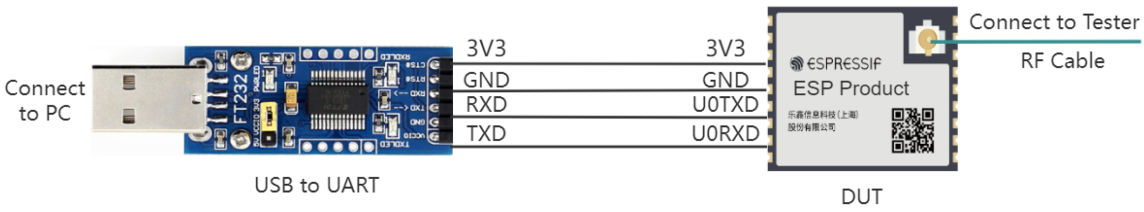


Fig. 19: UART Connection Description

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 `ChipType`, `Com Port` and `Baud Rate`, click `Open`, and select download to `Flash`.
3. ESP32 Wi-Fi Signaling Test Firmware (Single Country) supports a single country code, ESP32 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 Wi-Fi Signaling Test Firmware (Single Country) or ESP32 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

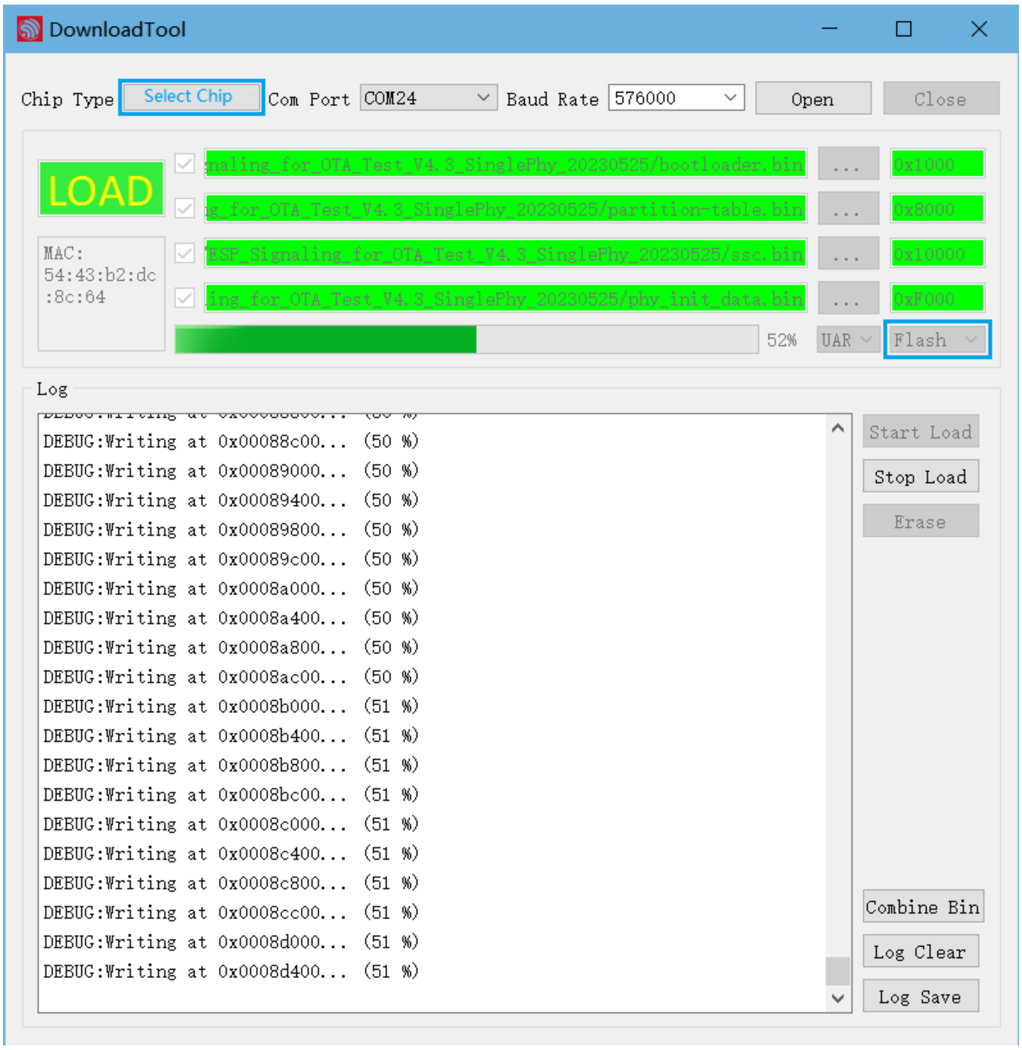
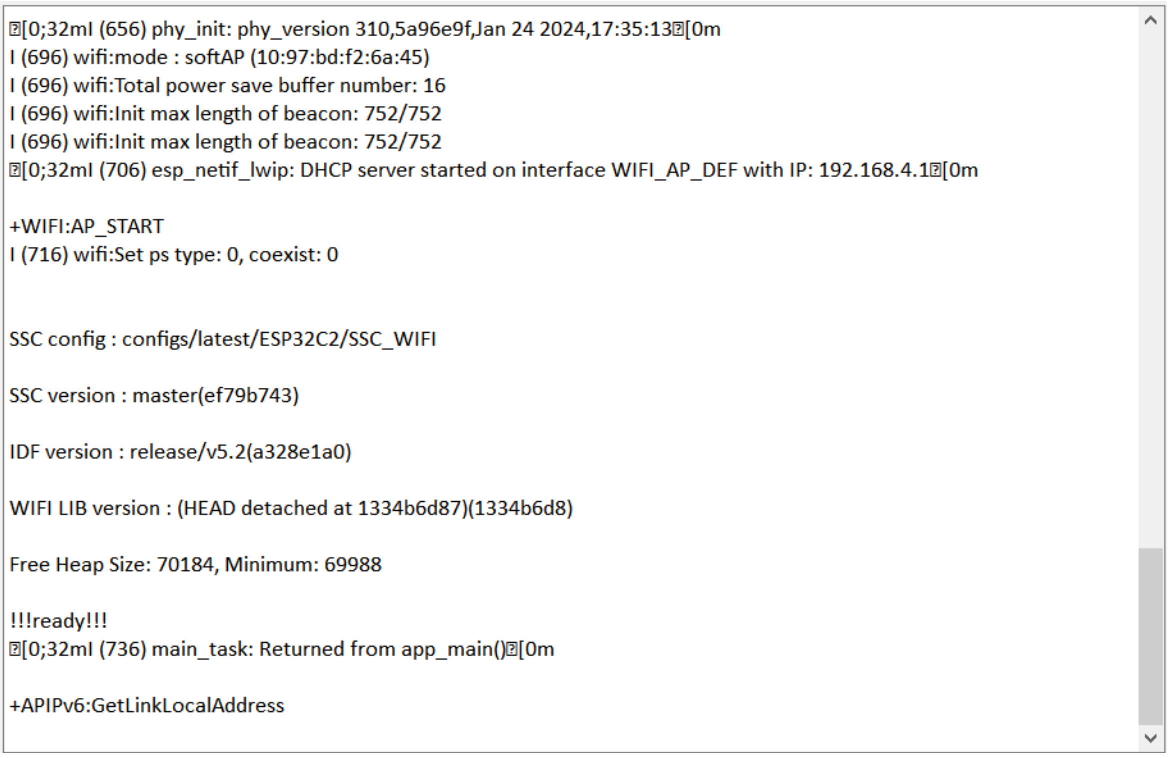


Fig. 20: Firmware Flashing Schematic

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

Start Testing

Check Power-on Log Use a serial communication tool such as Serial Port Utility to configure the port number and set the baud rate to 115200. After the device is powered on again, if the serial port outputs information similar to the following, 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

+APIPv6: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

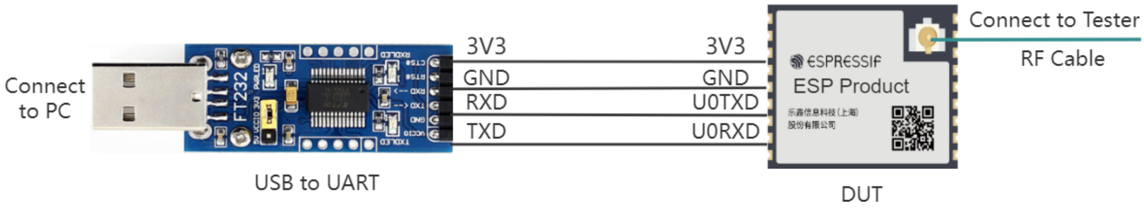


Fig. 23: UART Connection Description

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 Wi-Fi Adaptivity Test/Blocking Test Firmware to 0x1000 via `UART`.

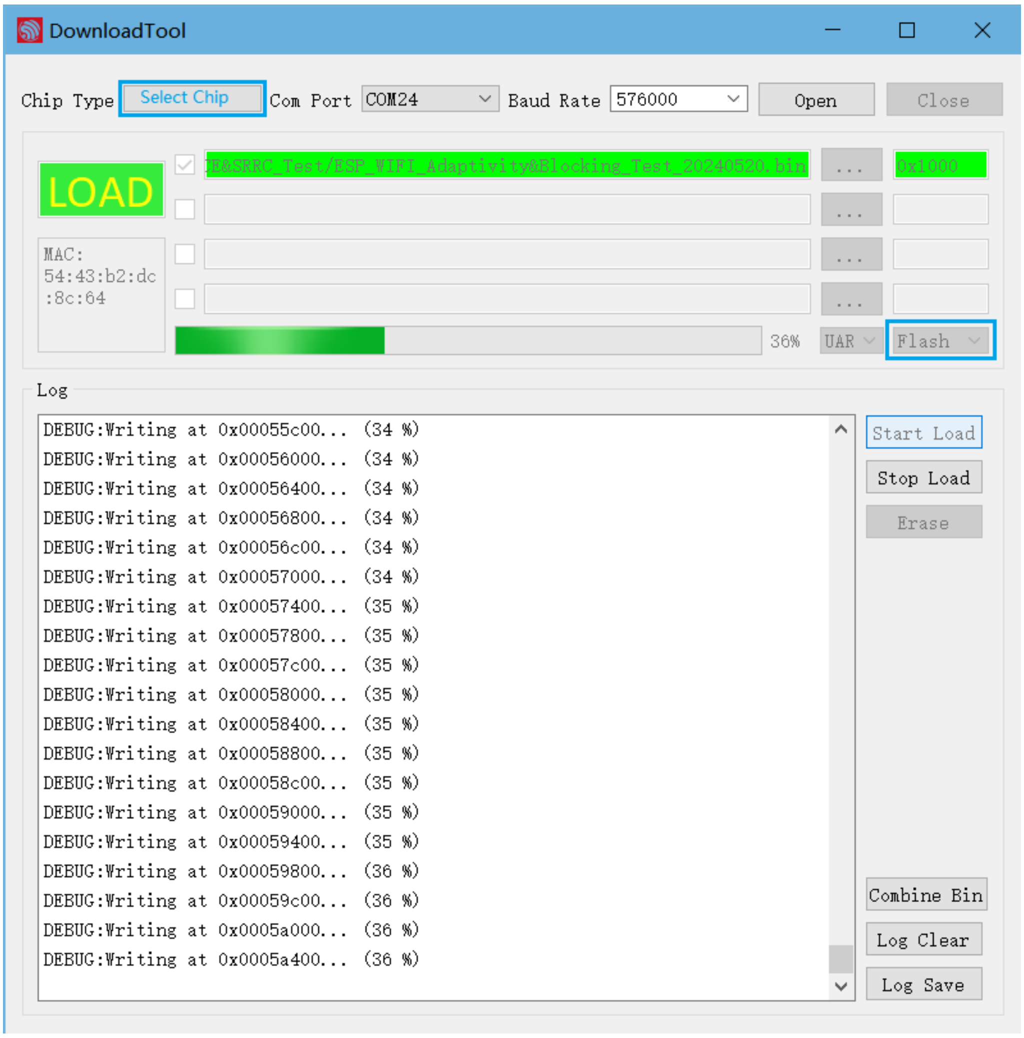


Fig. 24: Flashing Firmware

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

Start Testing

Check Power-on log Use a serial communication tool, such as Friendly Serial Assistant, configure the port number, set the baud rate to 115200, if the serial port prints similar information after the device is 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

+APIPv6: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.

```
+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

+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 200000000000 -j 1
```

Fig. 26: Serial Port Log for Device Provisioning

Test Using EspRFTestTool Tool

- Open the EspRFTestTool toolkit, 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:

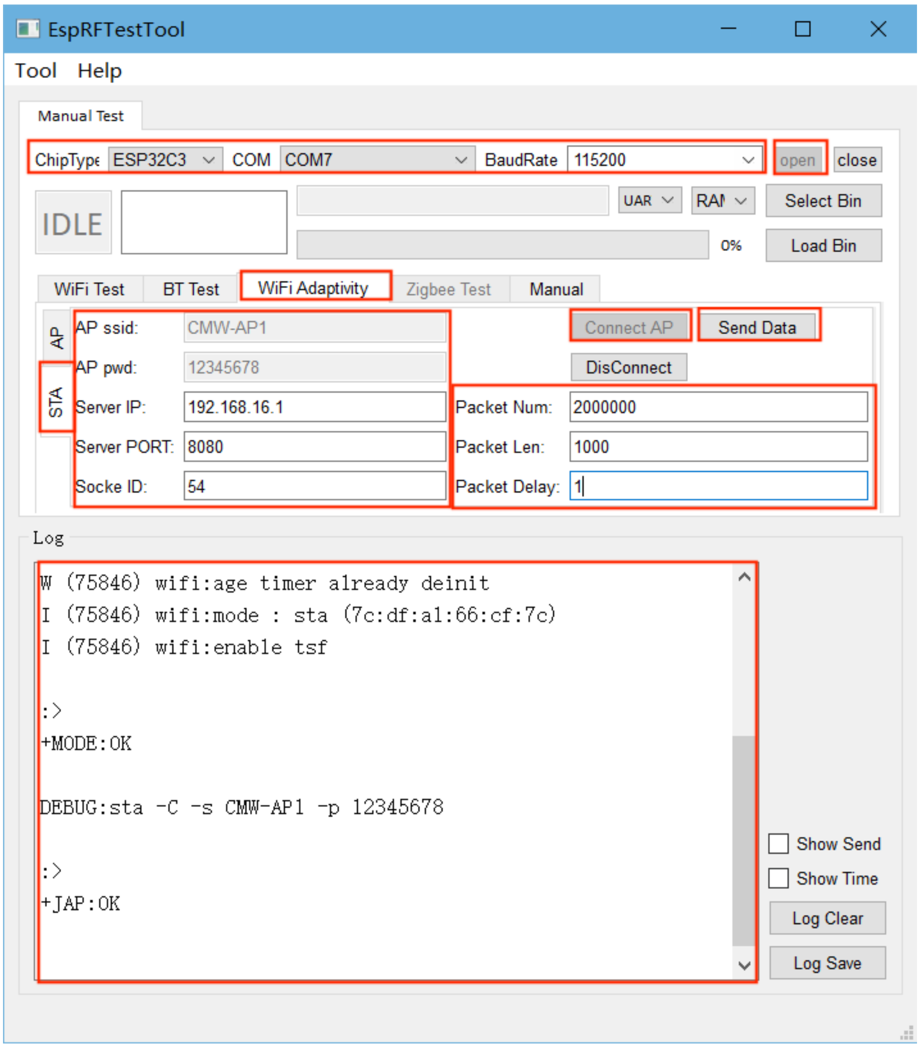


Fig. 27: Device Network Provisioning

- After a successful connection, set `Pakcet 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.

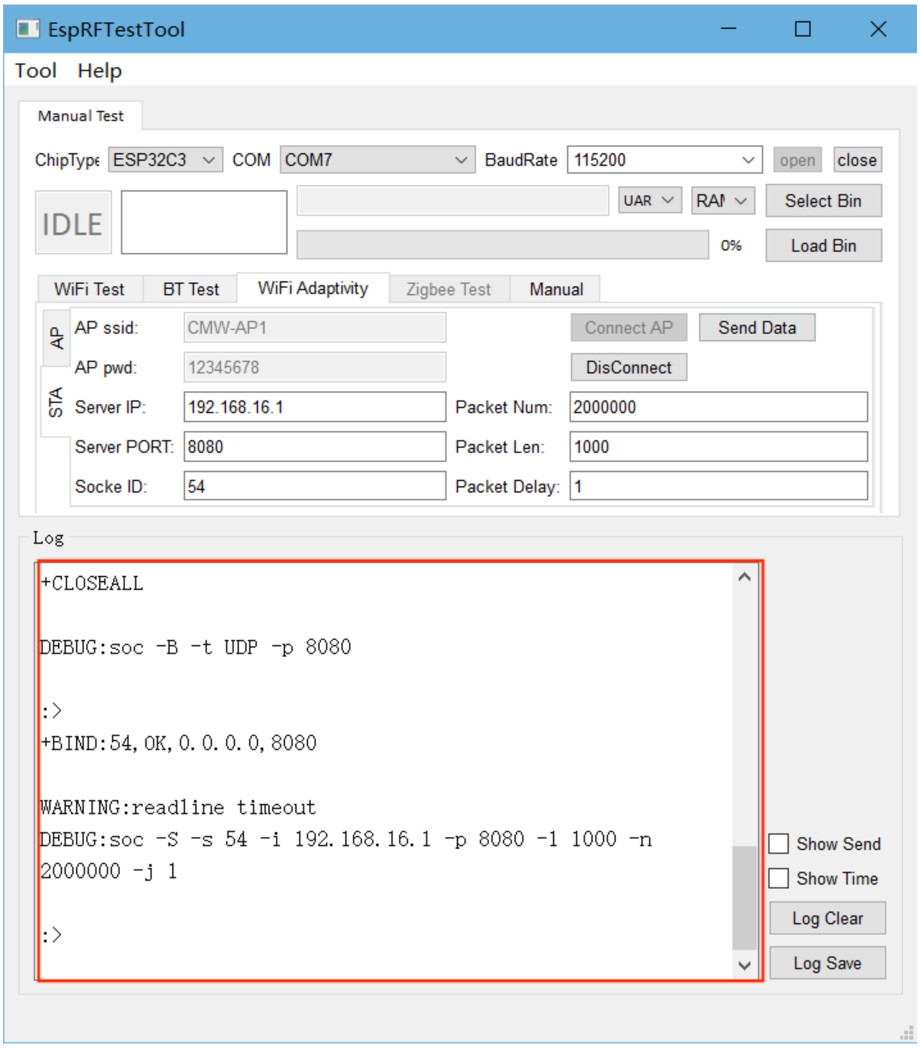


Fig. 28: Wi-Fi Adaptivity Traffic Test

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

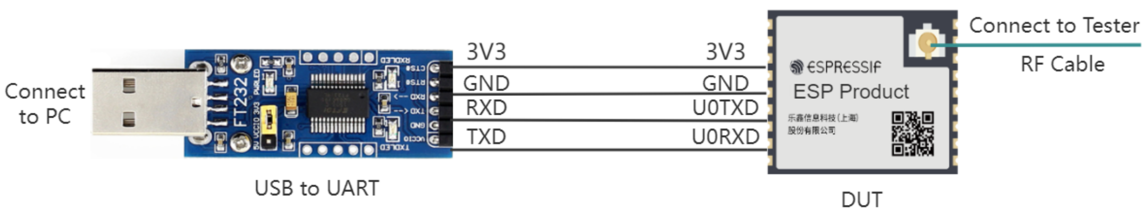


Fig. 29: UART Connection Description

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 Wi-Fi Adaptivity Test/Blocking Test Firmware to 0x1000 via `UART`.

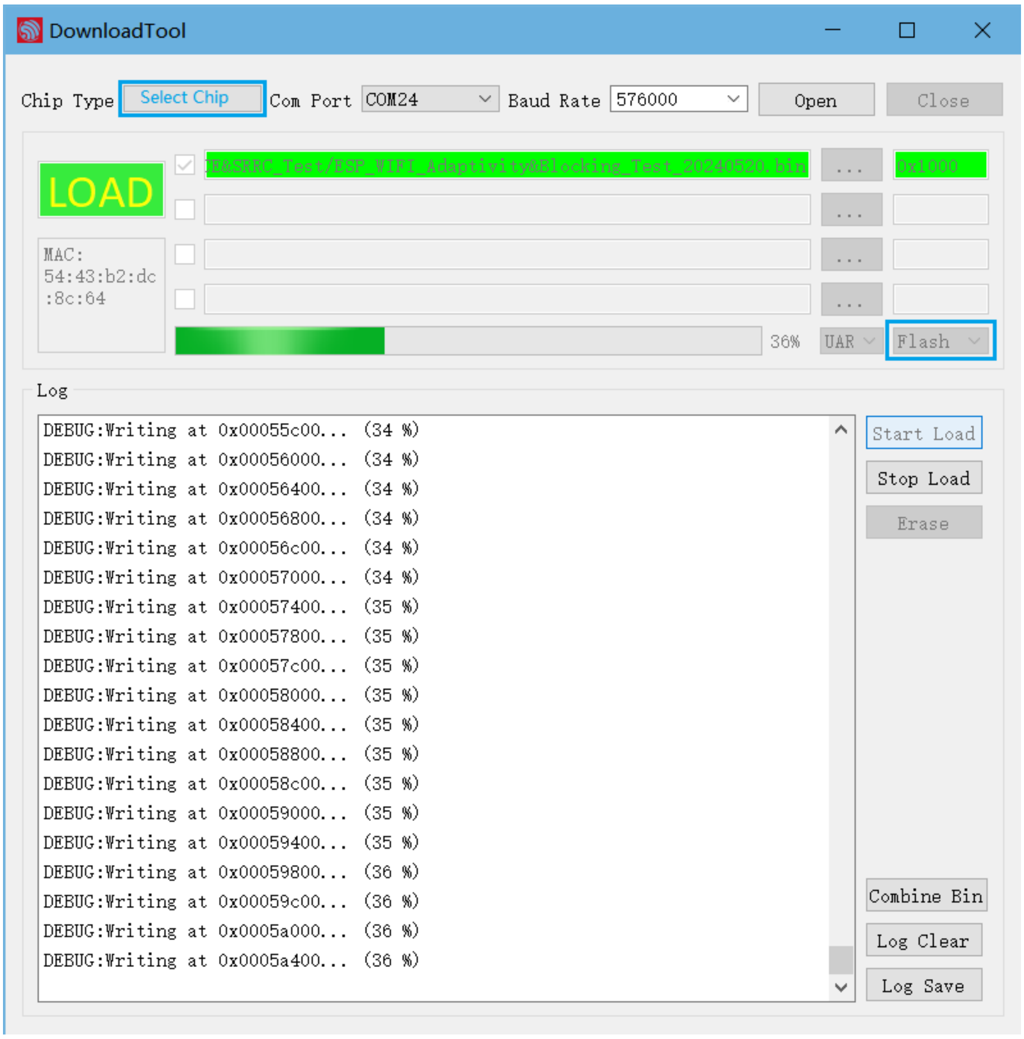


Fig. 30: Flashing Firmware

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

Start Testing

Check Power-on log Use a serial communication tool, such as Friendly Serial Assistant, configure the port number, set the baud rate to 115200, if the serial port prints similar information after the device is powered on again, you can confirm that the test status is OK:

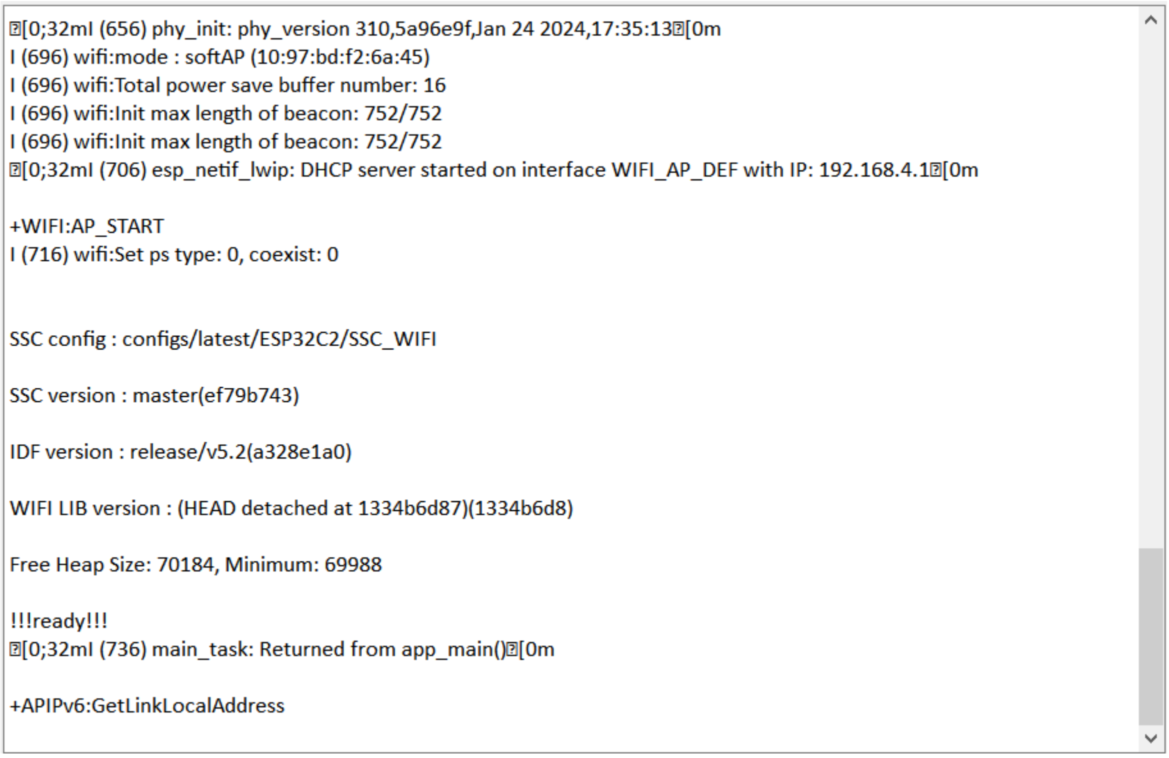


Fig. 31: Device Power-on Serial Port Print Log

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

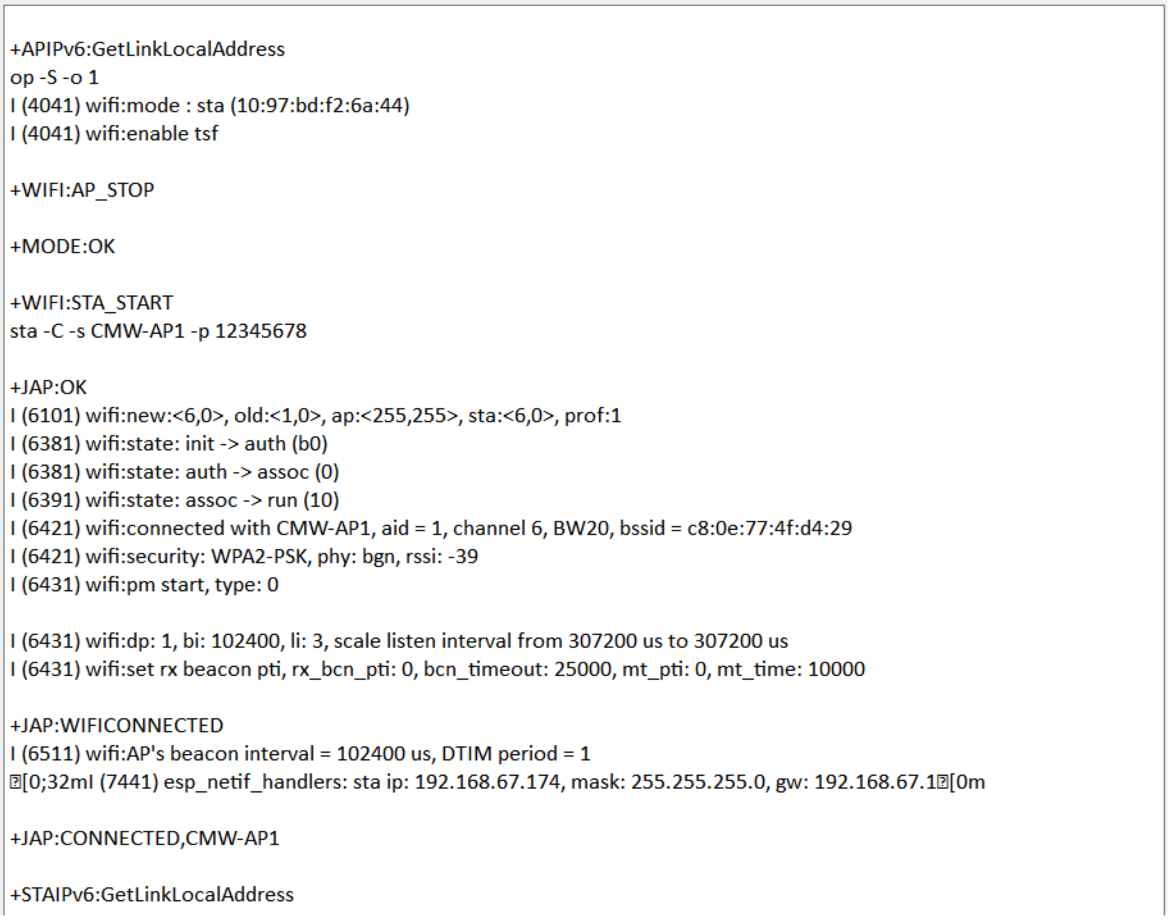
```
//Device Provisioning
//Configure the prototype to enter station mode
op -S -o 1

//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

+STAIPv6:GetLinkLocalAddress
```

Fig. 32: Serial Port Log for Device Provisioning

Test with ESPRFTestTool

- Open the EspRFTestTool 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:

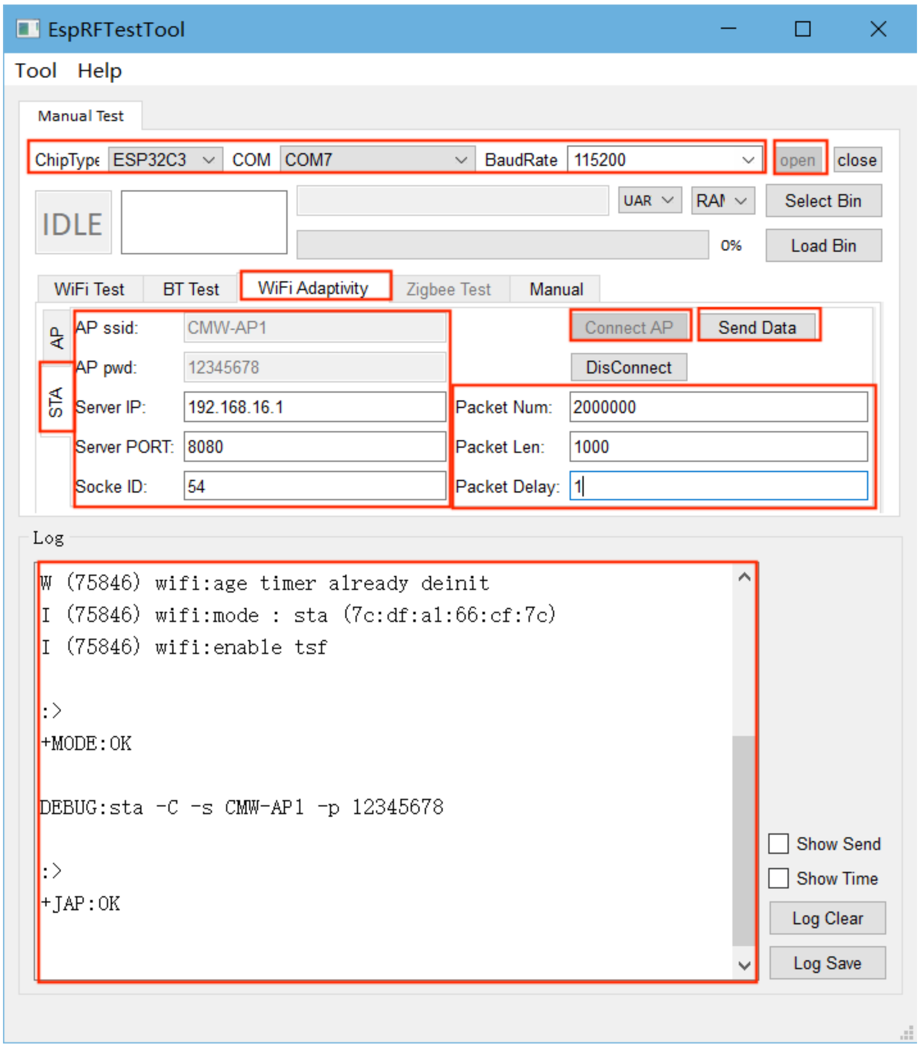


Fig. 33: Serial Port Log for Device Provisioning

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

3.5 Bluetooth and Bluetooth LE Non-Signaling Test

Bluetooth and Bluetooth LE Non-Signaling Test controls the device to transmit specific signals without establishing a connection, evaluating performance metrics such as transmit power, spectrum characteristics, and error rate to ensure communication quality.

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.

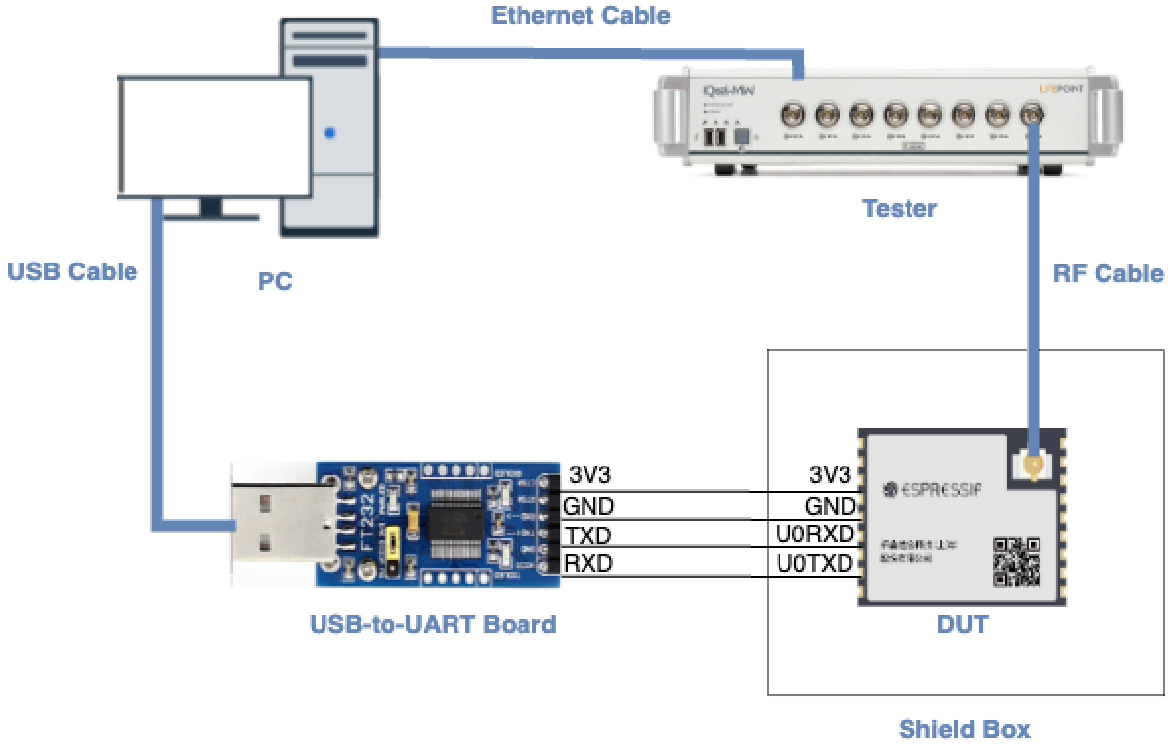


Fig. 34: Test Environment Setup

- **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 EspRFTestTool 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 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 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.

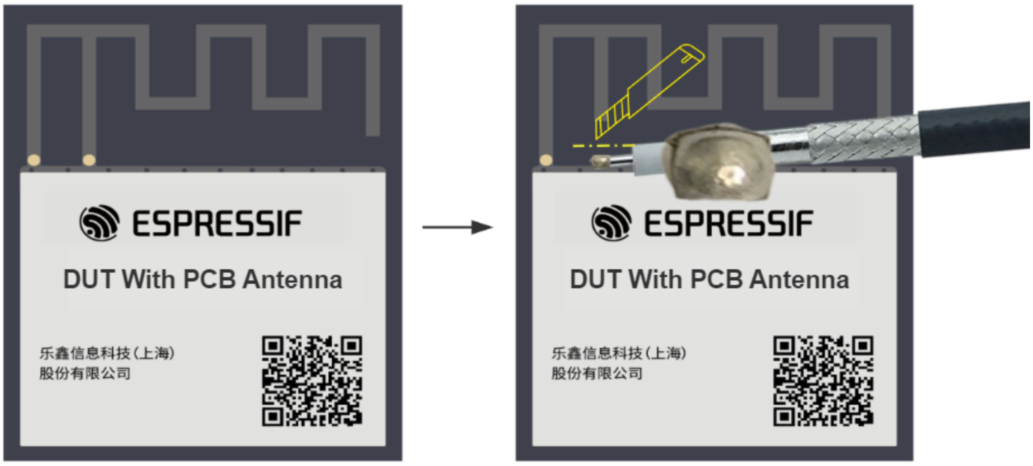


Fig. 35: Soldering RF Connection Cable to Module with Onboard PCB Antenna

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 RF Non-Signaling Test Firmware to `Flash` via `UART`.

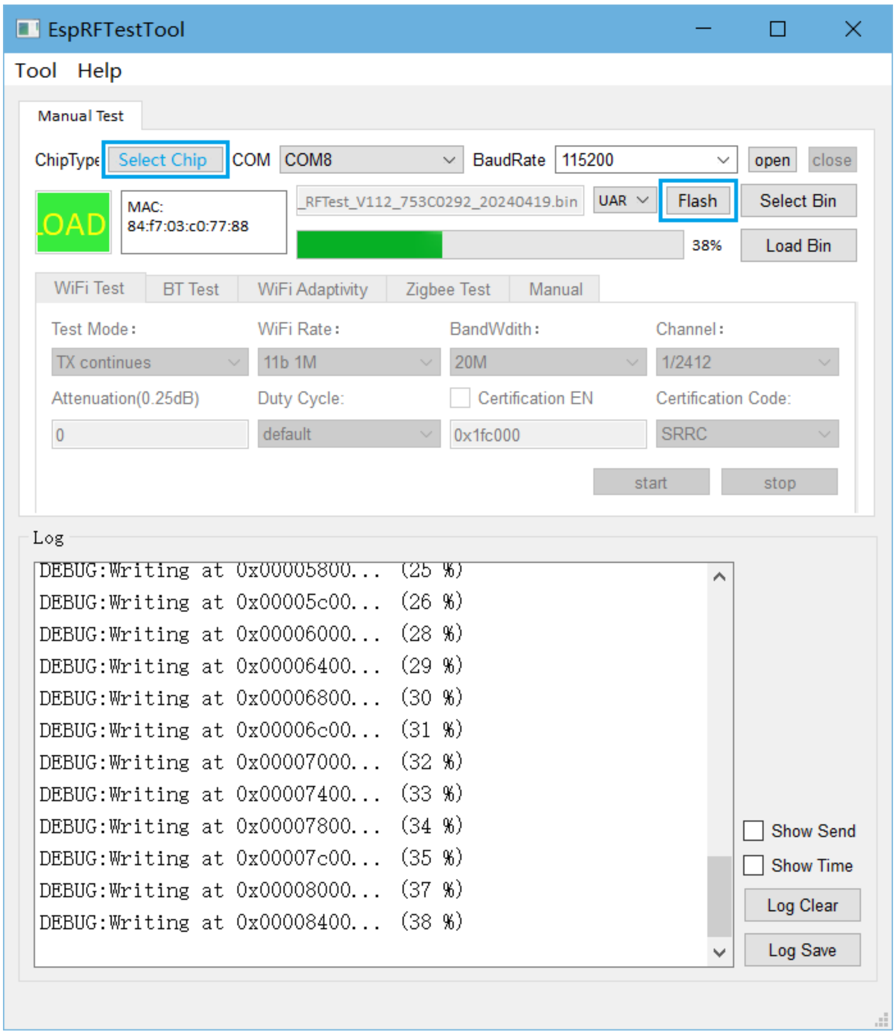


Fig. 36: ESPRFTestTool Configuration

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.

Start Testing

Bluetooth/Bluetooth LE TX Performance Test

- **Test Mode**:
  - BT TX: Used for Bluetooth TX performance tests;
  - BLE TX: Used for Bluetooth LE TX performance tests.
- **Power Level**: Set the Bluetooth power level, supporting 0~7 levels of testing
- **Channel**: Set the Bluetooth test channel
- **Hoppe**: Enable the hopping function. Default: Disabled.
- **Ulap**: Set the Bluetooth address, use the default value, only supported by Bluetooth
- **Itaddr**: Set the logical TX address. Default value is used. Only supported by Bluetooth
- **Syncw**: Set the identity code of the packet file. Default: syncw=0x71764129
- **Payload length**: Set the payload length. Default: 250
- **Data Rate**: Set the packet TX rate and encoding sequence. It supports four rates, including BT 1M, 2M, 3M and BLE 1M. It supports three encoding sequences, including 1010, 11110000, and prbs9

After clicking `start`, the Bluetooth TX parameter description is displayed in the log window, similar to the following:

```
fcc_bt_tx:txpwr=6,hoppe=0,chan=0,rate=1,DH_type=1,data_type=1
```

This indicates that the Bluetooth packet TX is normal, and the TX performance can be tested with the tester.

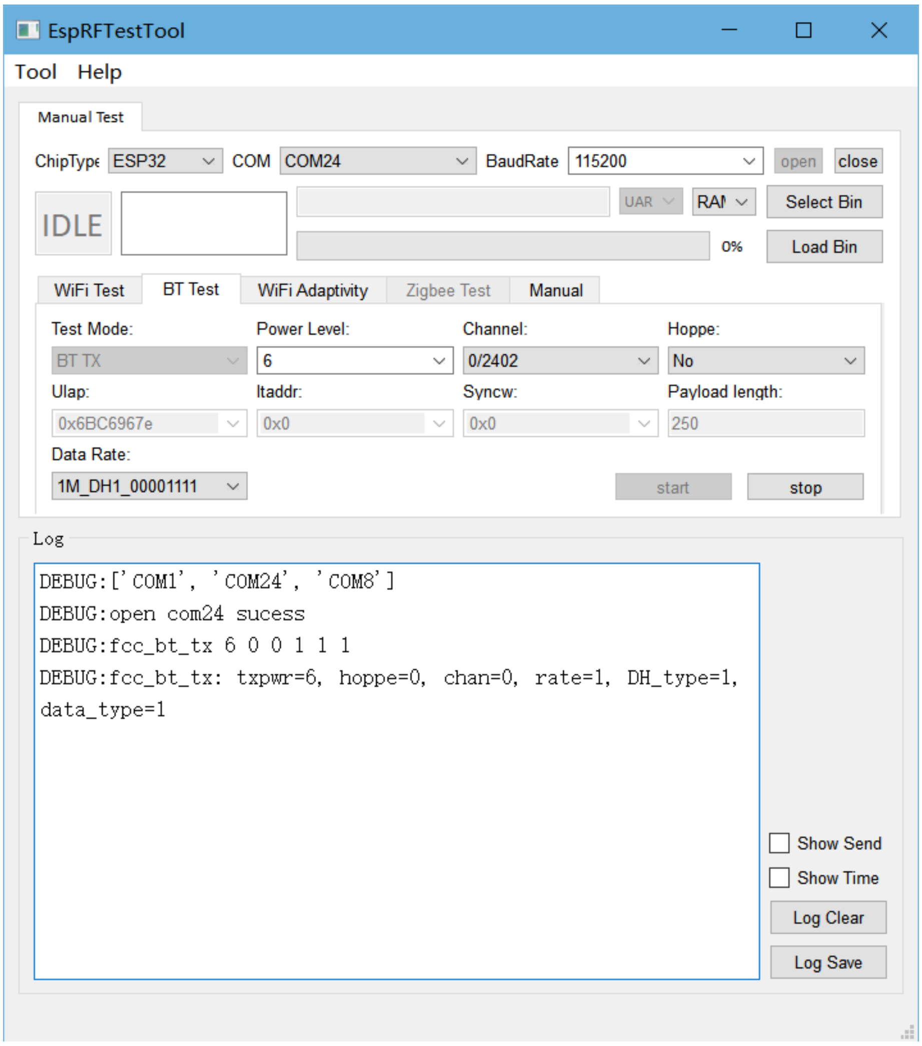


Fig. 37: Bluetooth Transmission Performance

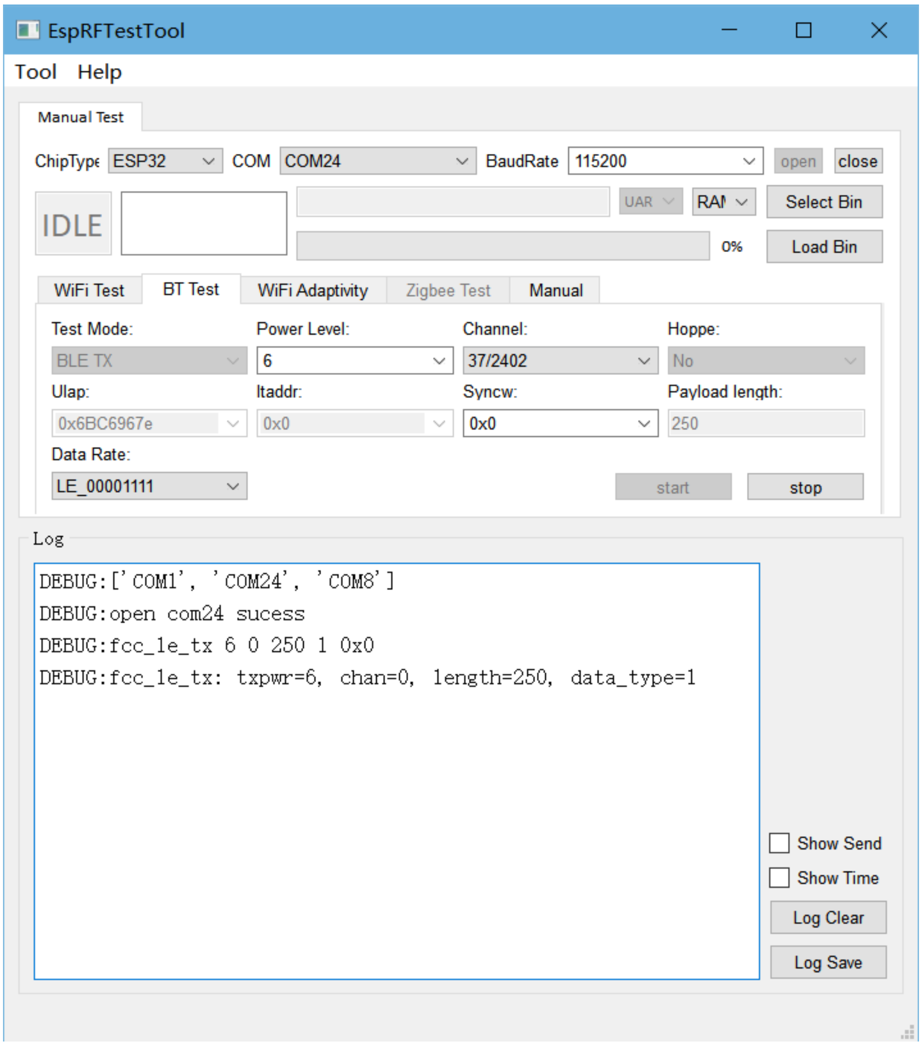


Fig. 38: Bluetooth LE Transmit Performance

Bluetooth RX Performance Test

- **Test Mode**: Set to BT RX for Bluetooth RX performance tests
- **Channel**: Set the Bluetooth test channel
- **Ulap**: Set the Bluetooth address. The default value is used. Only supported by Bluetooth
- **Itaddr**: Set the logical TX address. The default value is used. Only supported by Bluetooth
- **Data Rate**: Set the packet RX rate, supporting BT 1M, 2M, 3M. The default encoding sequence is prbs9

After clicking `start`, use the tester to send packets on the test channel. Click `stop` after completion. The packet RX information is displayed in the log window, similar to the following:

```
3e8 3e8 0 0 0 0 0 0 w 0 0 0 0 0 0 0 0 p 4176 45cf ddfd b 7ca240 0
```

Where:

- The 1st parameter Res[0] (hexadecimal) represents the total number of packets received in this test. In this test, the total number of packets is 3e8.
- The 2nd parameter Res[1] (hexadecimal) represents the number of packets of the corresponding rate received in this test. In this test, the number of packets of the corresponding rate is 3e8.
- The second to last parameter Res[22] (hexadecimal) represents the total number of codes of the corresponding rate received in this test. In this test, the total number of codes of the corresponding rate is 7ca240.
- The last parameter Res[23] (hexadecimal) represents the total number of error codes received in this test. In this test, the number of error codes is 0.

Based on the above parameters, you can calculate:

- Bit error rate BT_BER = Res[23]/Res[22]
- BT_RSSI = (-Res[18]]-Res[20])/Res[0]

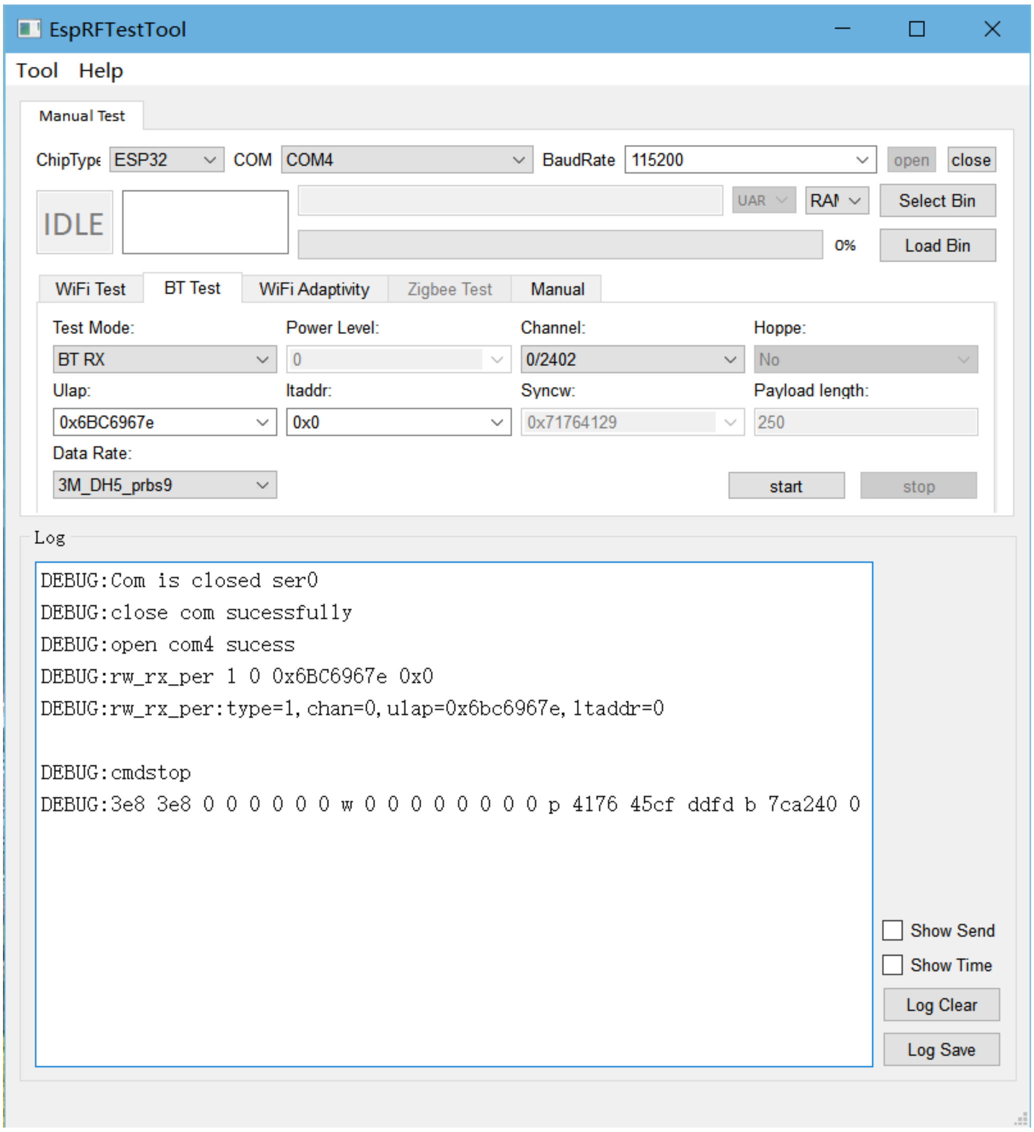


Fig. 39: Bluetooth RX Performance Test

Bluetooth LE RX Performance Test

- **Test Mode**: Select BLE RX for Bluetooth LE RX performance test
- **Channel**: Set the Bluetooth LE test channel
- **Syncw**: Set the identity code of the packet file. Default: syncw=0x71764129
- **Data Rate**: Set the packet RX rate. Default rate: BLE 1M.Default encoding sequence: prbs9

After clicking `start`, use the tester to send packets on the test channel. Click `stop` after completion. The packet RX information is displayed in the log window, similar to the following:

```
3e8 3e8 0 0 0 0 0 0 0 0 w 0 0 0 0 0 0 0 0 p 5b83 58cf 6acb
```

Where:

- The 1st parameter Res[0] (hexadecimal) represents the total number of packets received in this test. In this test, the total number of packets is 3e8.

- The 2nd parameter Res[1] (hexadecimal) represents the number of packets received at the corresponding rate in this test. In this test, the number of packets at the corresponding rate is 3e8.
- The third last parameter Res[20] (hexadecimal) represents the in-band power of all packets in this test. In this test, the in-band power of all packets is 5b83.
- The last parameter Res[22] (hexadecimal) represents the gain of all packets in this test. In this test, the gain of all packets is 6acb.

Based on the above parameters, we can calculate:

- Packet loss rate BLE_PER = [1-(Res[1]/Sent_Packet_Numbers)]*100%<=30.8%
- BLE_RSSI = (-Res[20]-Res[22])/Res[0]

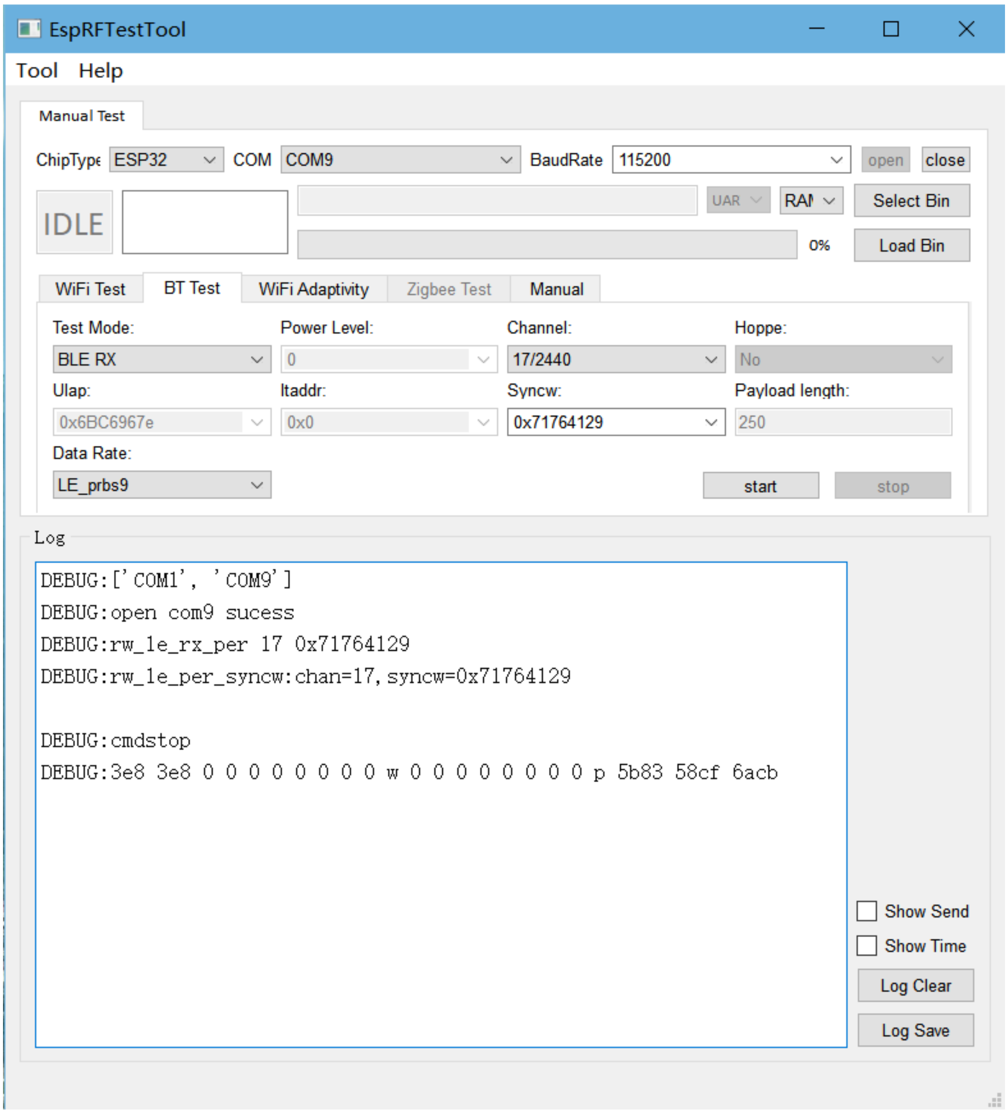


Fig. 40: Bluetooth LE RX Performance Test

Appendix

This appendix is mainly used to explain the power level and corresponding target power of Bluetooth and Bluetooth LE of ESP32, which is used for RF debugging or test reference.

Table 3: ESP32 Bluetooth/Bluetooth LE TX Power Level

Power Level	ESP32 Bluetooth/Bluetooth LE TX Power (dBm)
0	-12
1	-9
2	-6
3	-3
4	0
5	3
6	6
7	9

3.6 Bluetooth LE DTM Test

The Bluetooth LE DTM Test evaluates the RF performance of devices by directly controlling the device to enter specific transmit or receive modes, accessing key metrics like transmit power, reception sensitivity, and spectrum characteristics.

Set Up Test Environment

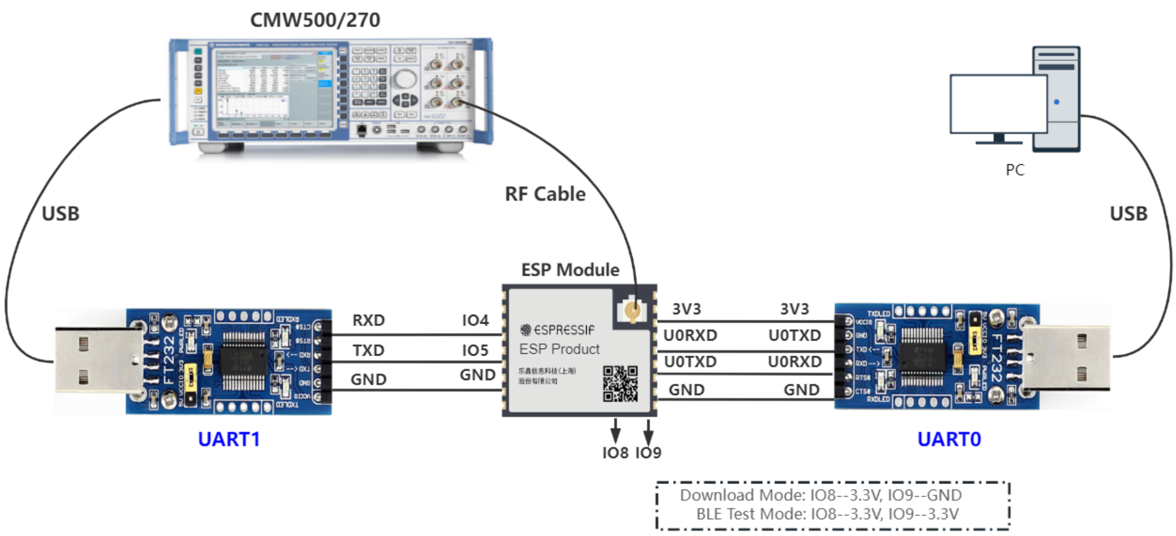


Fig. 41: Test Environment Setup

- **PC** is connected to the USB-to-UART board via USB. The PC needs to have the EspRFTestTool toolkit, tester control software, and the driver for the USB-to-UART board installed.
- **Tester** is used to test the RF performance of the device under test (DUT) in different modes. It connects to DUT via an RF connection cable to transmit RF signals. Typically, it is CMW500, CMW270, or Bluetooth tester CBT.
- **USB-to-UART board** is used to communicate between the computer and the DUT, as well as between the tester and the DUT.
- **Device under test (DUT)** refers to a product designed based on the ESP32 chip or module.

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 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.

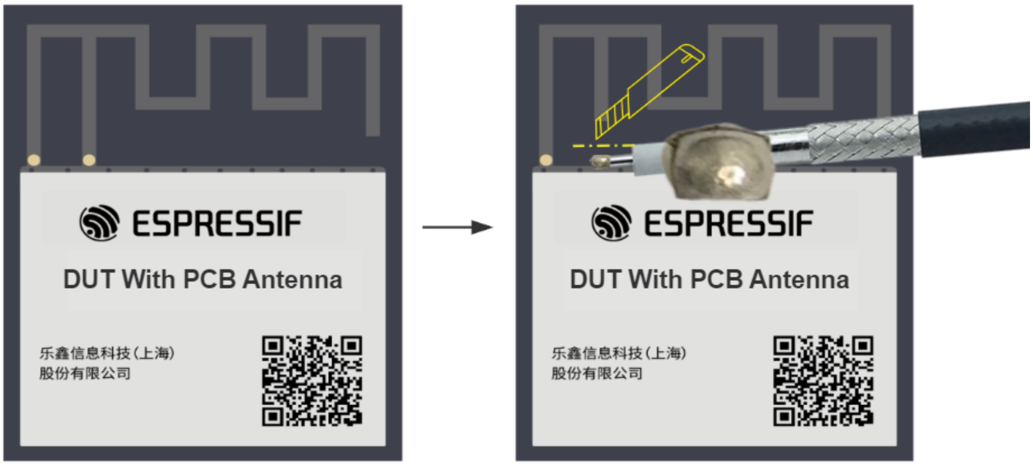


Fig. 42: Soldering RF Connection Cable to Module with Onboard PCB Antenna

Flash Firmware

1. Open *DownloadTool*.
2. Set `ChipType`, `Com Port`, `Baud Rate`, click `Open`, and select to download to `Flash`.
3. Flash the ESP32 Bluetooth LE DTM Test Firmware bin file to the following address via `UART`.

Bin File	Flash Address
ESP32 Bluetooth LE DTM Test Firmware	0x1000

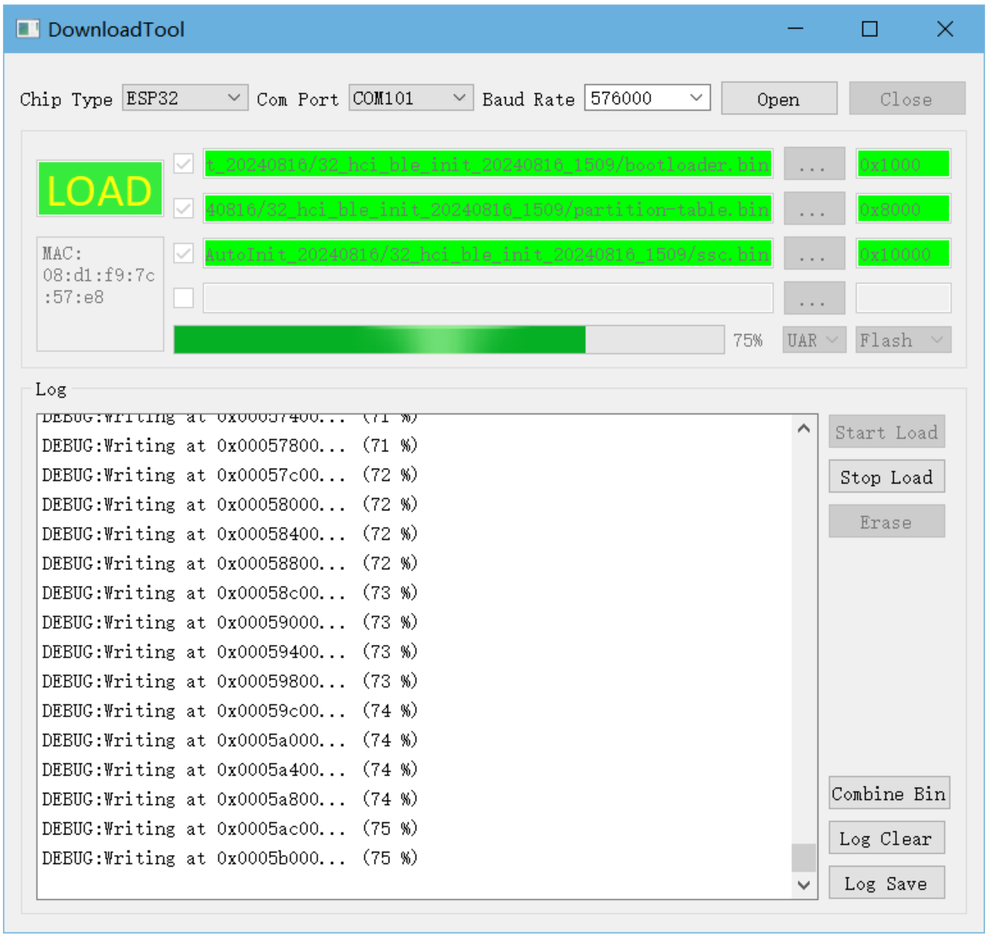


Fig. 43: Flash Firmware

After the flash process is completed, pull up or leave the boot pin unconnected. After the chip restarts and enters the working mode, continue with the following steps for testing.

Start Testing

The connection methods between the DUT and the tester includes HCI and 2-wire, with HCI being the default option.

Based on the hardware connections described above, you can verify whether the firmware flashing was successful by checking the output from the UART0 serial port.

Upon powering on, the device defaults to a power level of 6 dBm, operates without flow control, and uses a baud rate of 115200 for initialization. No commands are required, so you can directly begin the DTM test.

Appendix

This appendix provides the mapping of power levels and target power of ESP32 for RF debugging or testing reference.

Table 4: ESP32 Bluetooth/Bluetooth LE Transmit Power Levels

Power Level	ESP32 Bluetooth/Bluetooth LE Transmit Power (dBm)
0	-12
1	-9
2	-6
3	-3
4	0
5	3
6	6
7	9

3.7 Bluetooth LE Blocking Test

The Bluetooth LE Blocking Test evaluates the stability and performance of a device in environments with interference from other wireless signals. It ensures the device meets relevant standards for interference resistance.

Test Methods for Bluetooth LE Blocking

The test can be performed in two modes:

1. **Non-signaling mode**

In this mode, a fixed frequency is selected to test the device's resistance to interference. For details, please refer to *Bluetooth and Bluetooth LE Non-Signaling Test*.

2. **Direct Test Mode (DTM)**

DTM mode allows low-level control of the device, enabling the introduction of interference signals to access its interference resistance. For details, please refer to *Bluetooth LE DTM 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*

- *Bluetooth and Bluetooth LE Non-Signaling Test*
- *Bluetooth LE DTM Test*
- *Bluetooth LE 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*
- *Bluetooth and Bluetooth LE 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*
- *Bluetooth and Bluetooth LE Non-Signaling Test*

5 WFA Certification and Testing Guide

5.1 Overview

This section provides guidance on obtaining Wi-Fi Alliance (WFA) certification for products based on Espressif chips. It focuses on the QuickTrack process to help you efficiently achieve WFA certification.

Required tools and firmware:

- *Flash Download Tool*
- espsigma tool and firmware

5.2 Introduction to WFA Certification

Certification Process

The WFA certification typically follows these steps:

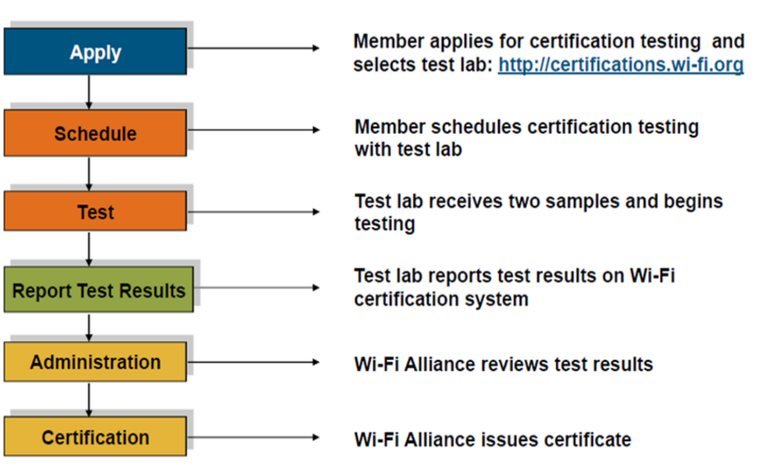


Fig. 44: Standard Process

1. Submit the certification application and choose an Authorized Test Laboratory (ATL), which receives the Certification ID (CID).
2. Send the device to ATL for testing.
3. ATL conducts the necessary test.
4. ATL provides the test results.
5. WFA issues the certification.

Certification Types

1. **New Certification**
   Choose this option if the product has not been Wi-Fi certified before.
2. **Additional Certification**
   Choose this option if the product is already certified but needs to test new features.
3. **Re-Certification**
   If there are changes to the firmware or software that affect Wi-Fi functionality, re-certification is needed, This includes:
   - Small hardware changes or updates to device software (e.g., operating system or drivers)
   - Firmware changes or minor software modifications that affect Wi-Fi operation (even small updates or bug fixes)
   - Changes that don't affect Wi-Fi functionality must be reviewed by ATL to determine if testing is required
4. **Derivative Certification**
   This applies to derivative products based on a source certification. The derivative product must be functionally consistent with the source product, and technical details must be provided to verify eligibility.

Note: WFA certification primarily targets products operating in Wi-Fi 802.11a/b/g/n modes, typically using 2.4 GHz or 5 GHz radio frequency bands. This includes devices like wireless routers, smartphones, home appliances, computers, network infrastructure, and consumer electronics.

5.3 Espressif Product Certification Process

Certification Method

- **Espressif Modules**: Generally, these follow the **New Certification** path.
- **Products based on Espressif Chips**: **QuickTrack** path is recommended.

The relationship between the two is as follows:

Fig. 45: New Certification and QuickTrack

Once an Espressif module completes a new certification, Espressif stores the test data and generates a **Qualified Solution**. You can leverage this solution to streamline your certification process.

New Certification

The test items for Espressif modules are shown in the figure below.

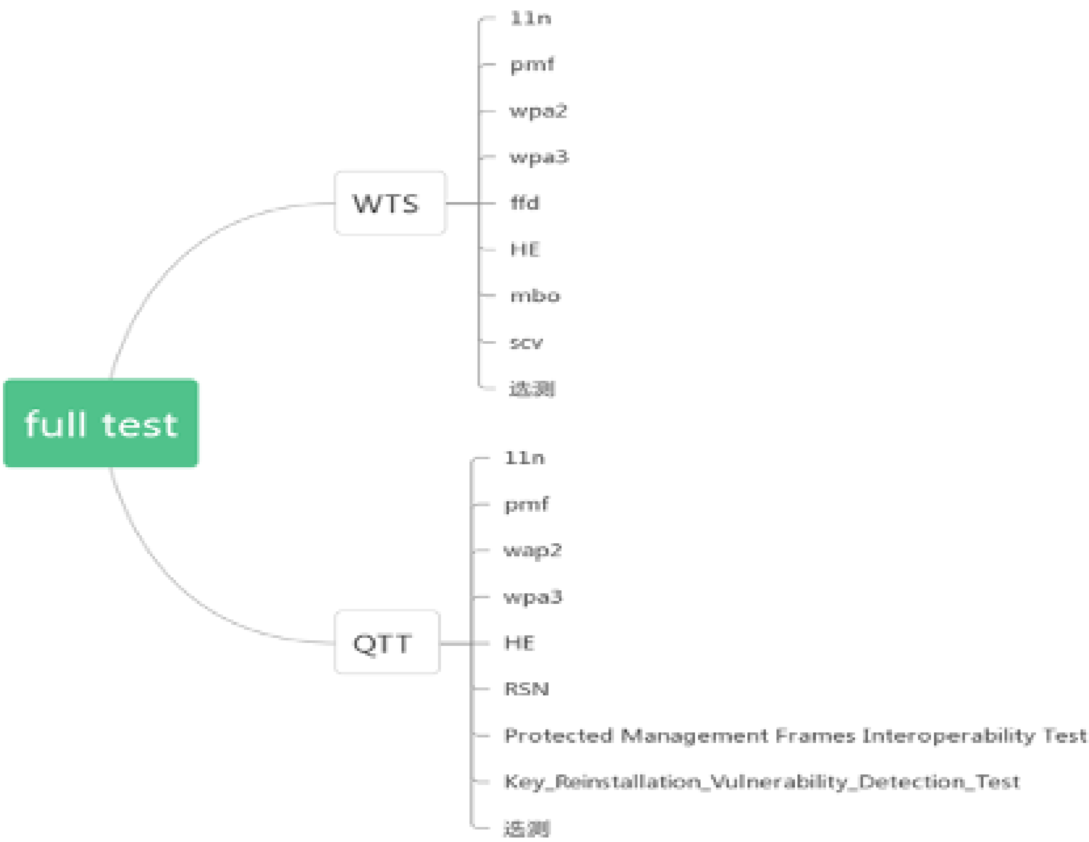


Fig. 46: Full-test Test Items

The WFA testing includes two parts: **WTS (Sigma Tool Test Items)** and **QTT (QuickTrack Test Items)**. While some test items are same, the test cases differ between the two.

QuickTrack

QuickTrack is a streamlined Wi-Fi certification method aimed at reducing testing and certification costs while speeding up the process. This method is designed for products built using a **Qualified Solution**.

To achieve QuickTrack:

1. Select components or solutions from a list of **Qualified Solutions** that meet your product requirements.
2. Perform consistency tests to ensure the components or solutions meet the **Qualified Solution** criteria.
3. Complete testing using tools provided by WFA, either in-house or through ATL.
4. Submit the test results for review by WFA.
5. Once the test results are approved by WFA, the product will receive Wi-Fi certification.

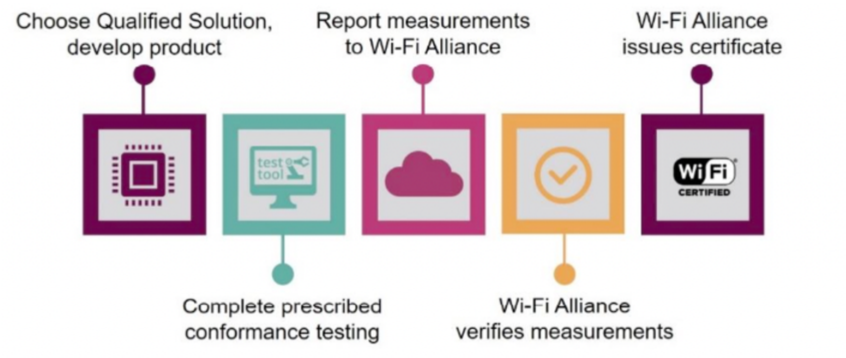


Fig. 47: Quick Certification Process

Advantages of QuickTrack QuickTrack reduces costs and testing time, helping you achieve WFA certification faster. For example, the ESP32-C2 module's full certification test takes about 7.5 days.

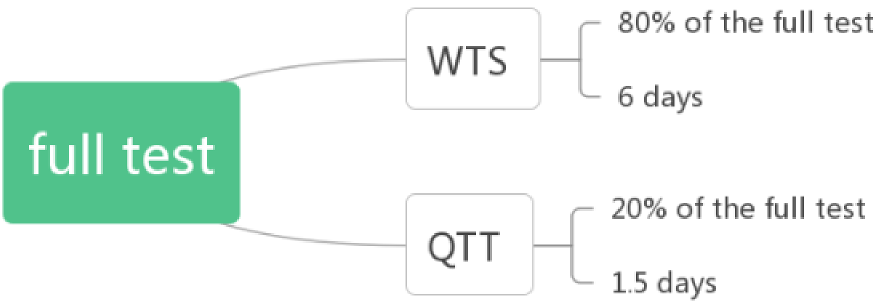


Fig. 48: Full-test Testing Time

If you choose QuickTrack, you must first confirm the product information below:

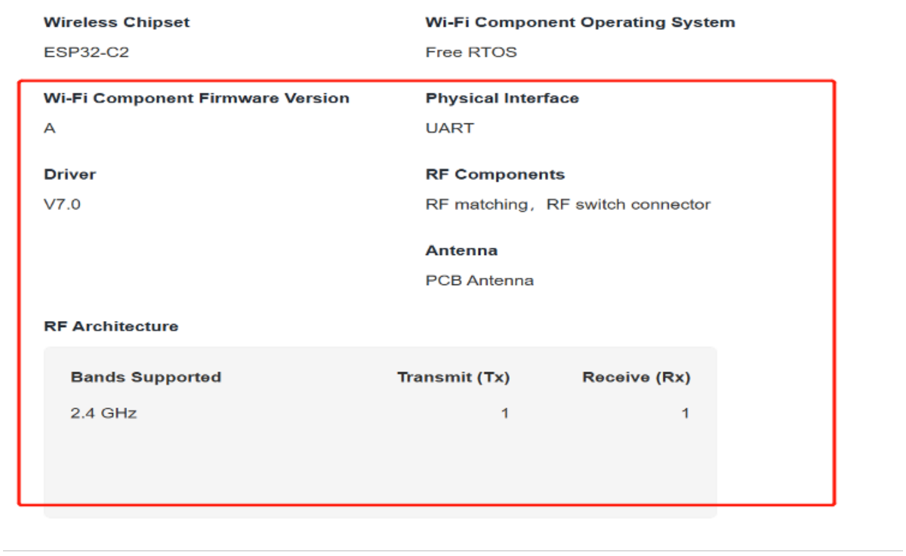


Fig. 49: Product Information

- Using QuickTrack, you need only 1.5 days for QTT testing if your product differs from ESP32-C2.
- If no changes are made, certification can be obtained without further testing by simply paying the certification fee.

The comparison between QuickTrack and the ordinary certification method is as follows:

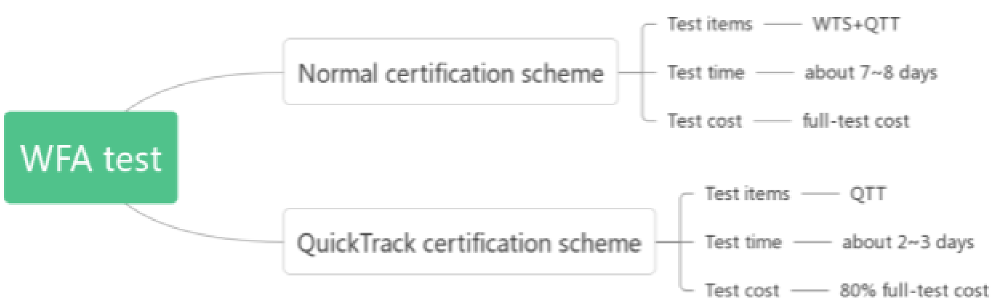


Fig. 50: Comparison Between Ordinary Certification and QuickTrack

Note: The test items mentioned refer only to the testing portion of the certification process. The full WFA certification process, including submission and approval, can take up to 40 days for standard certification. QuickTrack reduces this to approximately 10 days, saving around 70% of the time.

Current QuickTrack Status for Espressif Chips

Currently, both ESP32-C2 and ESP32-C6 have completed QuickTrack **Qualified Solution** certification.

5.4 WFA Testing

1. Submit CID Information

You can fill in CID information according to requirements by referring to Wi-Fi Alliance CID Filling Guide and Espressif Module Filling Method.

2. Flash Firmware

Flashing on Windows

- Open the `flash_download_tool_3.9.2.exe` application.
- Set `chipType` to the corresponding chip name and `workMode` to `develop`, then click `OK`.
- Choose the firmware and specify the flashing address. Select the port number, set `baud` to `115200`, and click `START` to begin flashing.
- Once flashing is complete, `finish` will be displayed.

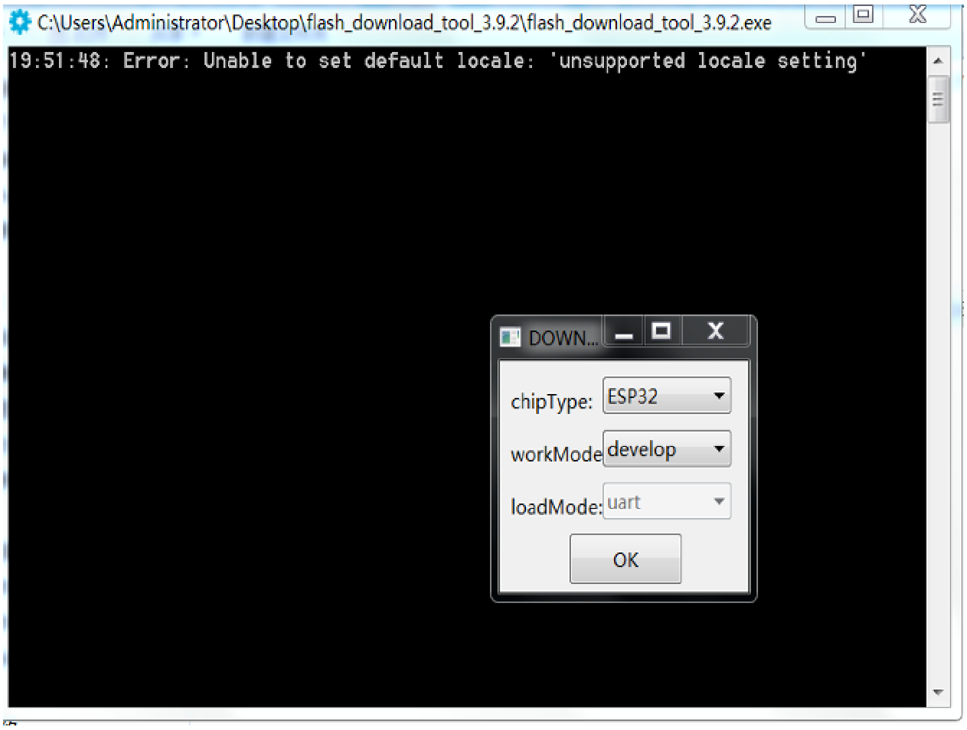


Fig. 51: Flash Configuration

Flash the following firmware to the corresponding address:

- bootloader.bin 0x1000
- espsigma.bin 0x10000
- partition.bin 0x8000

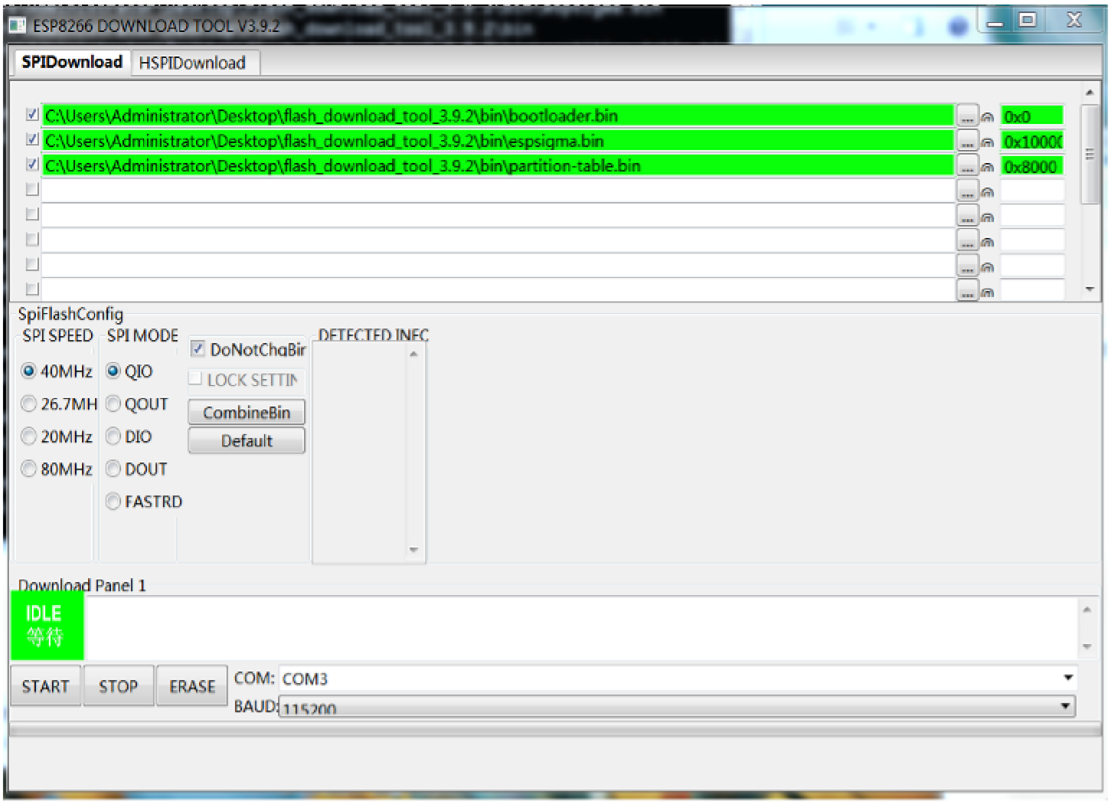


Fig. 52: Flash Firmware

Flashing on Ubuntu

- Install Python 3.7

```
cd espsigma_qt/espsigma
./tools/setup/setup_pyenv_python.sh
source ~/.pyenv/activate
```

- Install the flash tool

```
pip install esptool
```

- Start flashing

```
esptool.py -p /dev/ttyUSB0 --chip=auto write_flash 0x1000 bootloader.bin␣
↪0x8000 partition-table.bin 0x10000 espsigma.bin
```

3. Set Up the Test Environment

- Use Ubuntu 16.04 or higher
- Install Python 3.7

```
cd espsigma_qt/espsigma
./tools/setup/setup_pyenv_python.sh
source ~/.pyenv/activate
```

After installation, you can verify the Python version with `python -v`.

Note: When flashing firmware on a computer with an Ubuntu OS, the Python environment is already installed in the step of flashing firmware, so no further installation is needed. Only computers running Windows require this step to install the Python environment.

Note: The Python version must be 3.7 or higher. If the version displayed in the terminal is incorrect, please the above command.

---

4. Start Testing

Test the WTS Part

- Open a terminal and navigate to the Sigma test tool directory

```
cd /espsigma_qt/espsigma/esp_sigma_ca
```

- Start the test

```
python espsigma.py --dut /dev/ttyUSB*
```

Note: `*` refers to the serial port number.

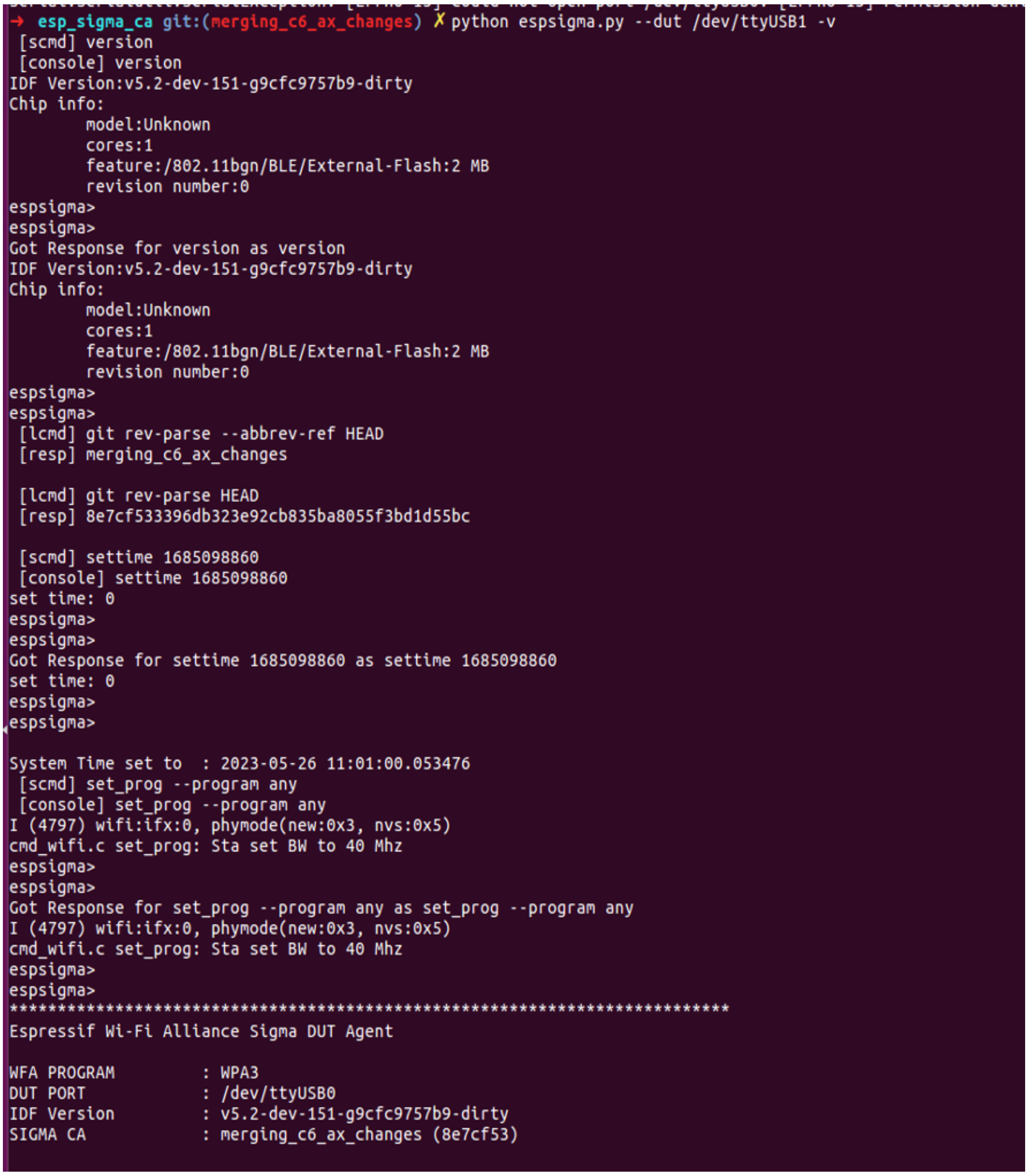


Fig. 53: WTS Test

Test the QuickTrack Part

- Open a terminal and navigate to the Sigma test tool directory

```
cd /espsigma_qt/espsigma/esp_sigma_ca
```

- Start the test

```
python espsigma.py --quicktrack --dut/dev/ttyUSB *
```

Note: `*` refers to the serial port number.

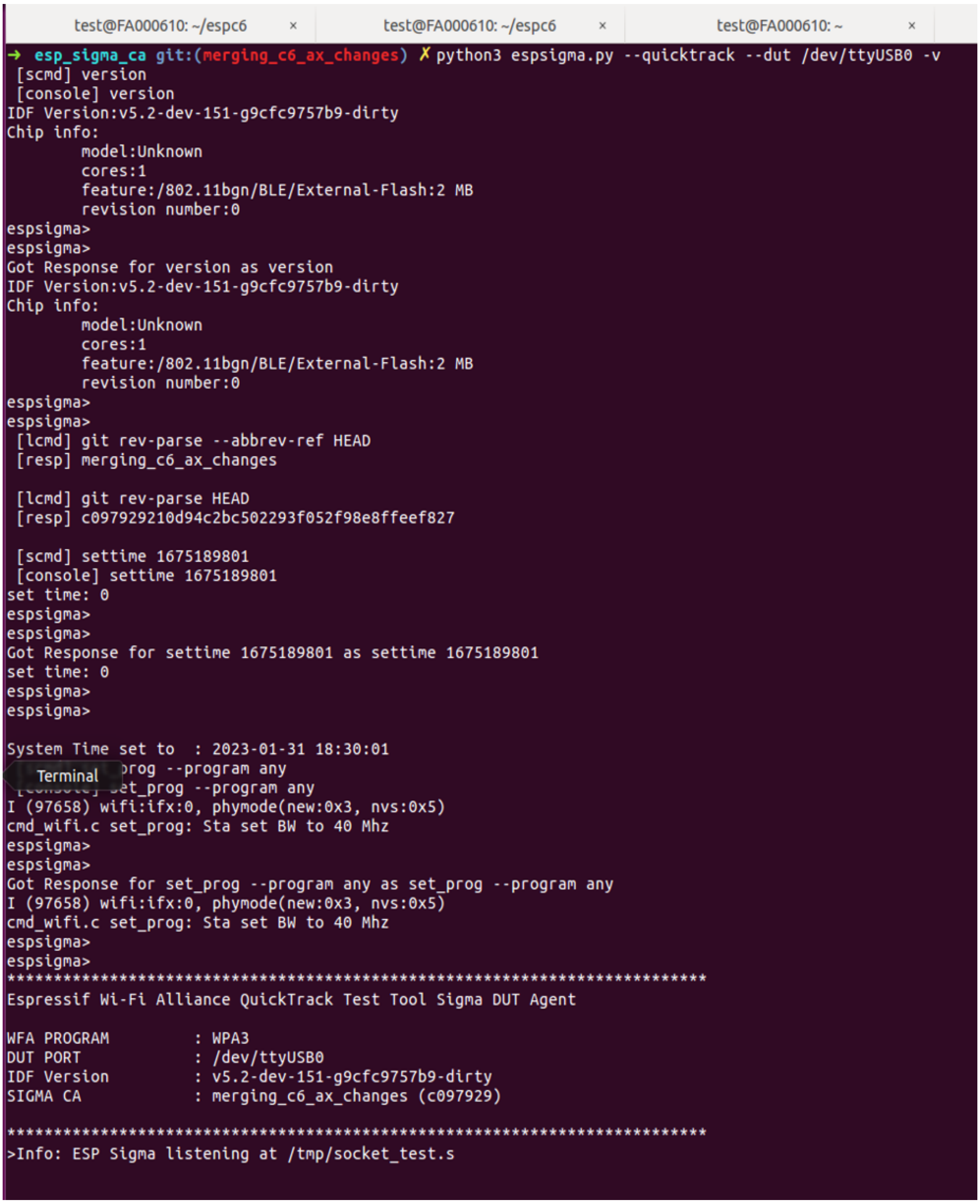


Fig. 54: QuickTrack Test-1

- Open another terminal and navigate to the control app directory

```
cd /espsigma_qt/controlappc-2.0.0.9
```

- Start the control app

```
./app -p *
```

Note: * refers to the QuickTrack Test (QTT) port, e.g., 9005.

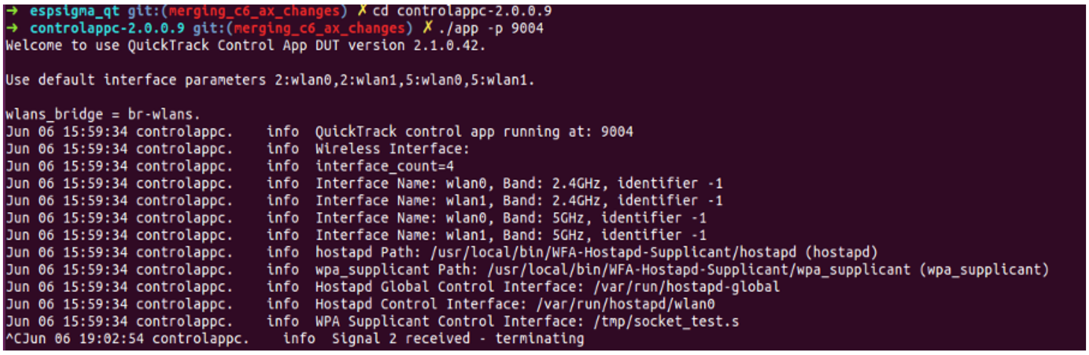


Fig. 55: QuickTrack Test-2

Please refer to the pictures for Quicktrack page settings

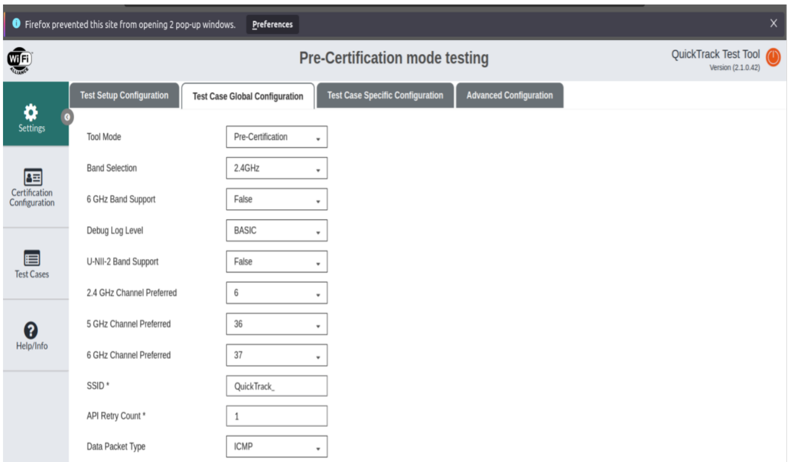


Fig. 56: QuickTrack Settings-1

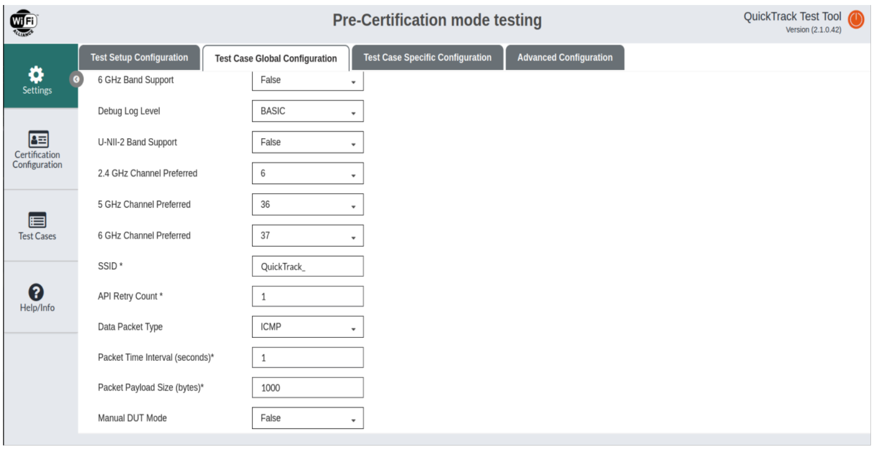


Fig. 57: QuickTrack Settings-2

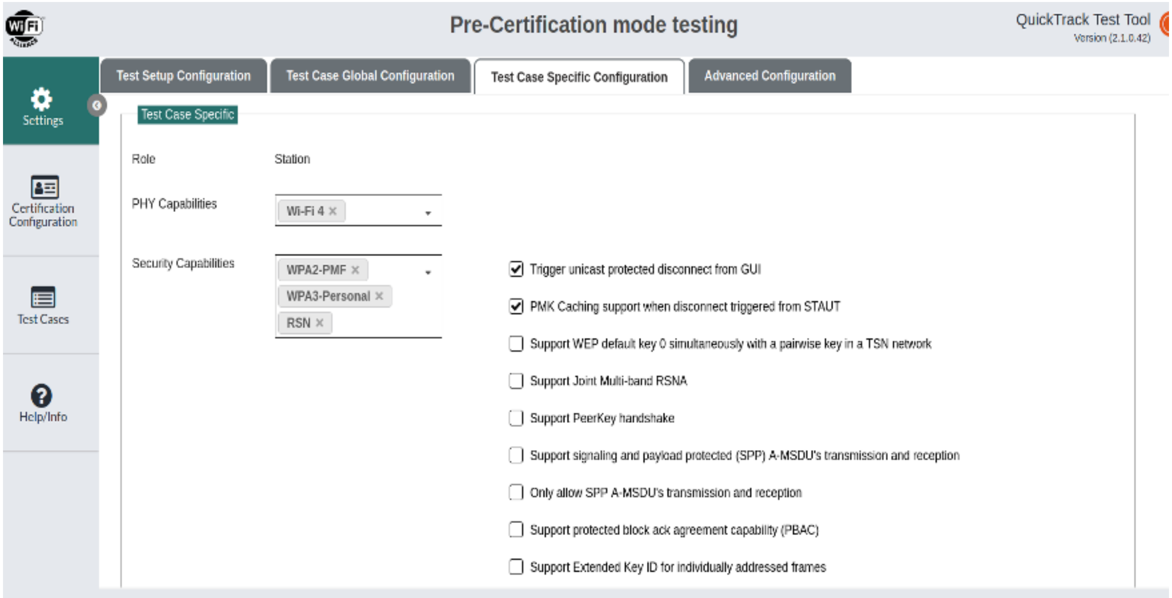


Fig. 58: QuickTrack Settings-3

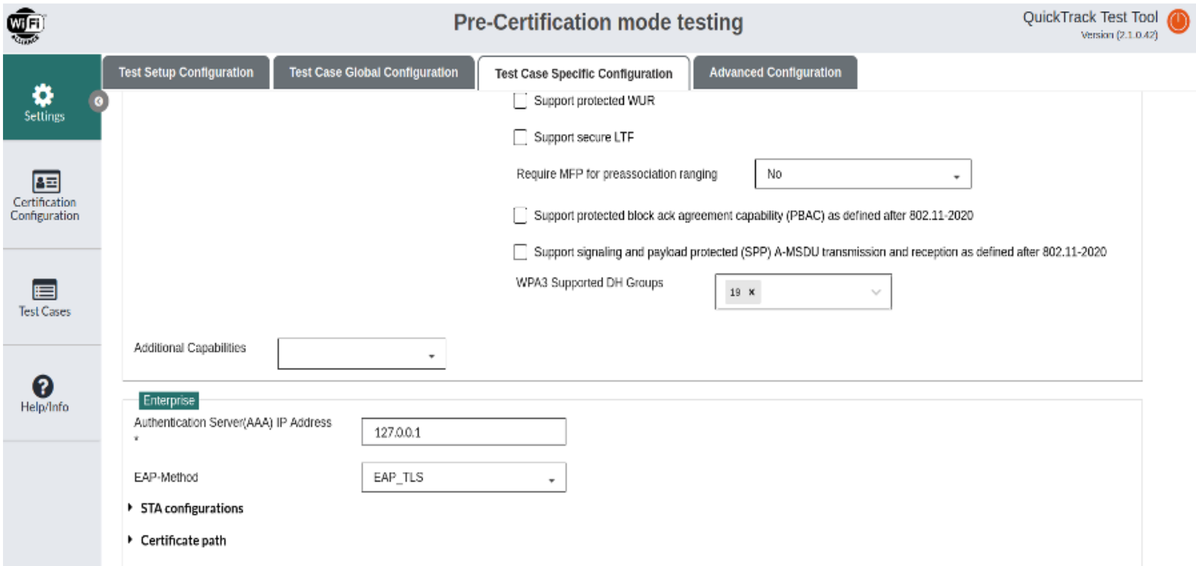


Fig. 59: QuickTrack Settings-4

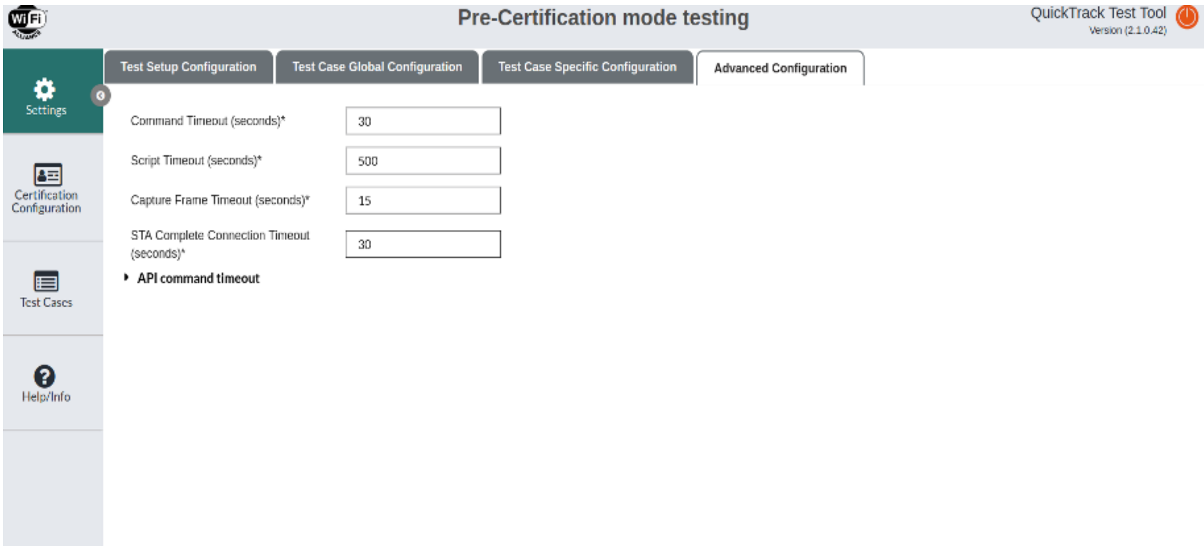


Fig. 60: QuickTrack Settings-5

6 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.
- *Matter QR Code Generator* generates QR codes for Matter devices. It allows users to connect devices to their smart home network by simply scanning the code, simplifying the device setup and connection process.

7 Flash Download Tool User Guide

7.1 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

7.2 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:

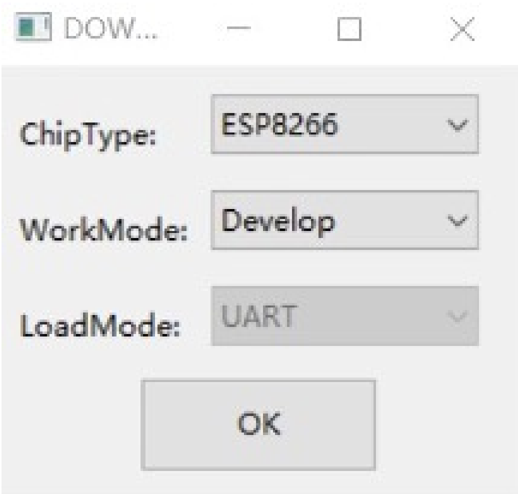


Fig. 61: Flash Download Tool Main Interface

- 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: Only supports UART

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

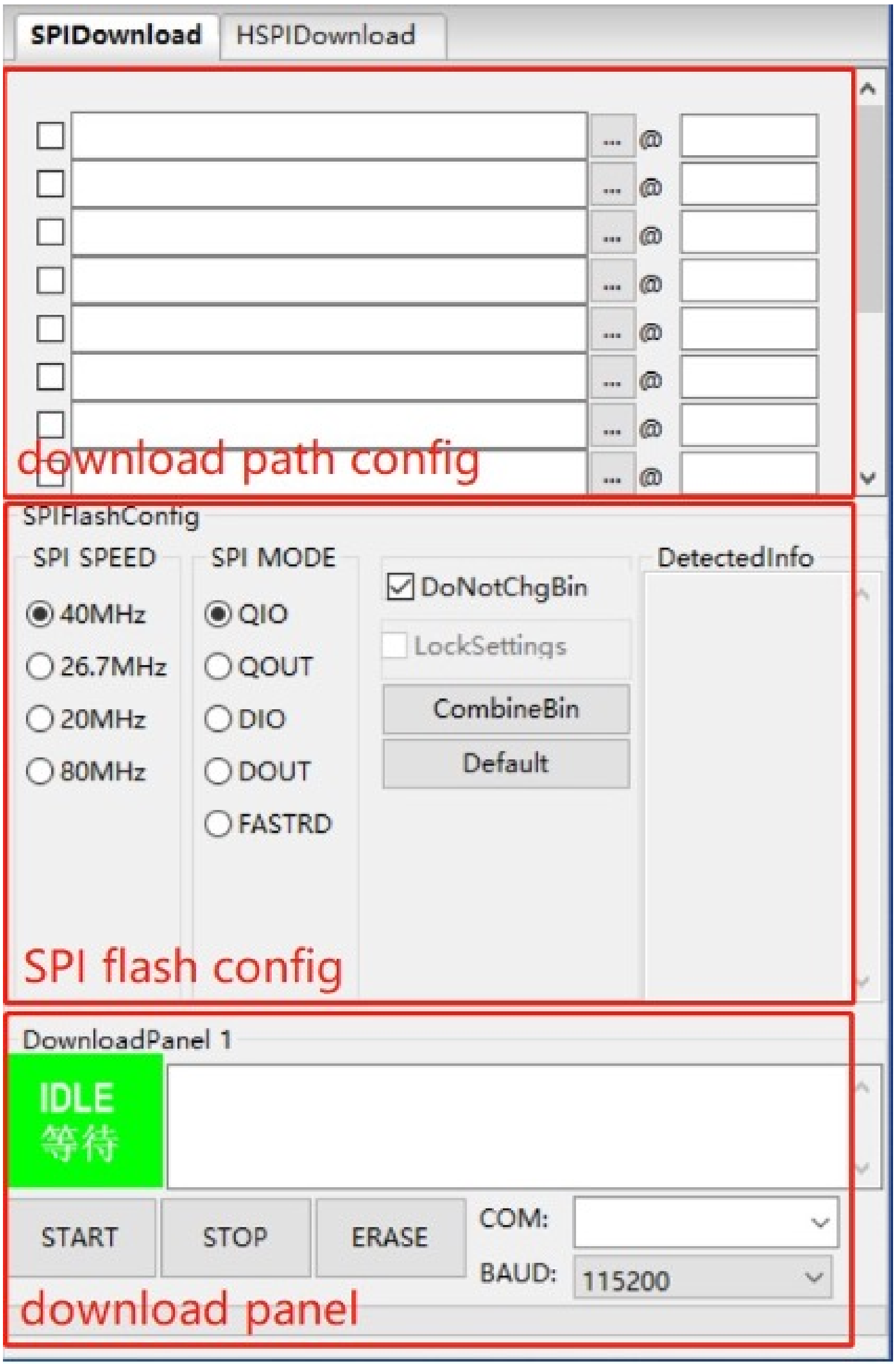


Fig. 62: SPIDownload Tab

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.)

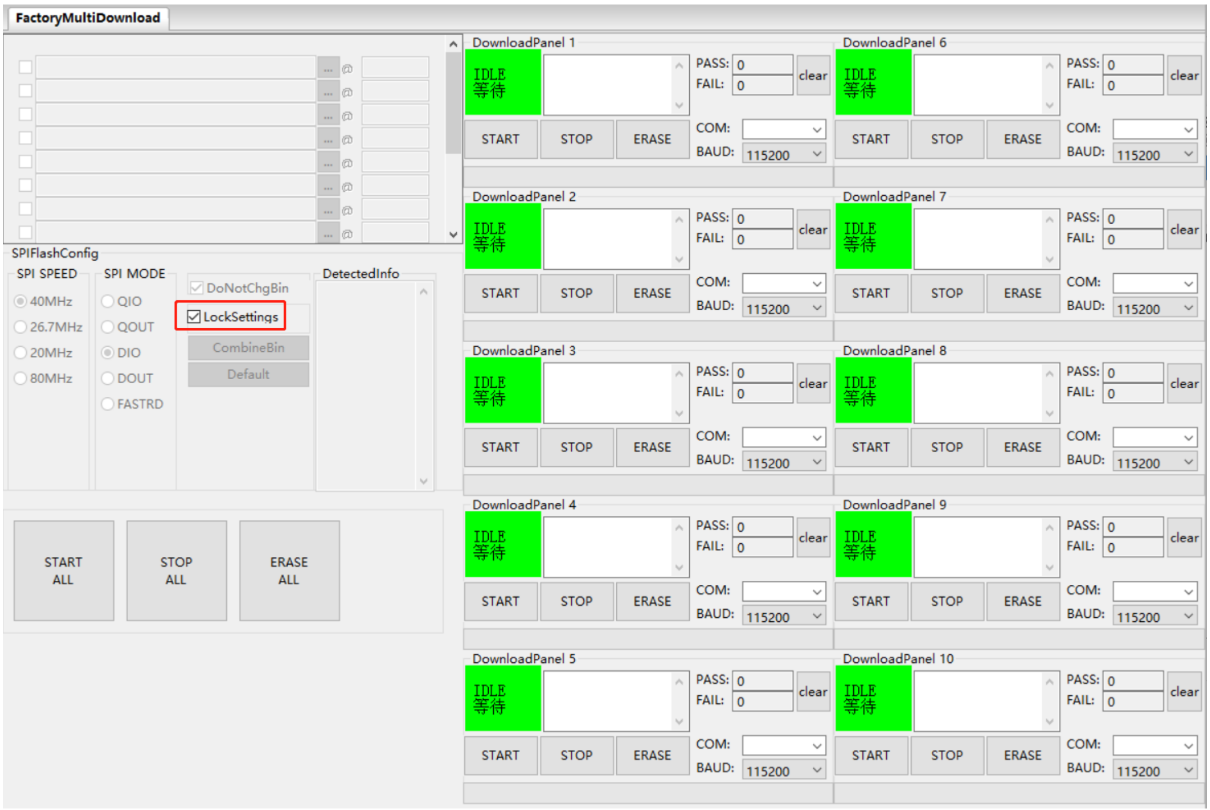


Fig. 63: FactoryMultiDownload Tab

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.

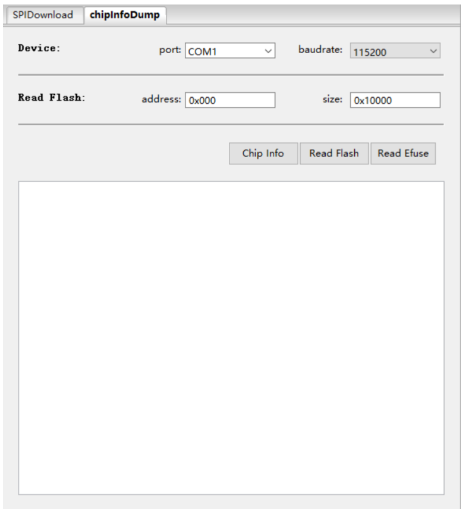


Fig. 64: chipInfoDump Tab

- 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 >= 3.9.8

7.3 Download Example

This section takes ESP32 as an example to demonstrate how to perform both regular and encrypted download operations. ESP32 supports regular and encrypted download.

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`

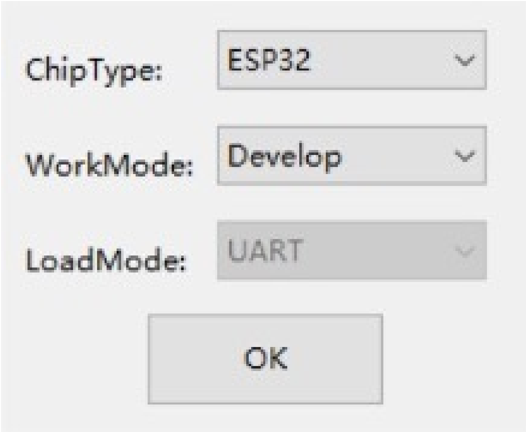


Fig. 65: Selecting Device —ESP32 Download Tool

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.

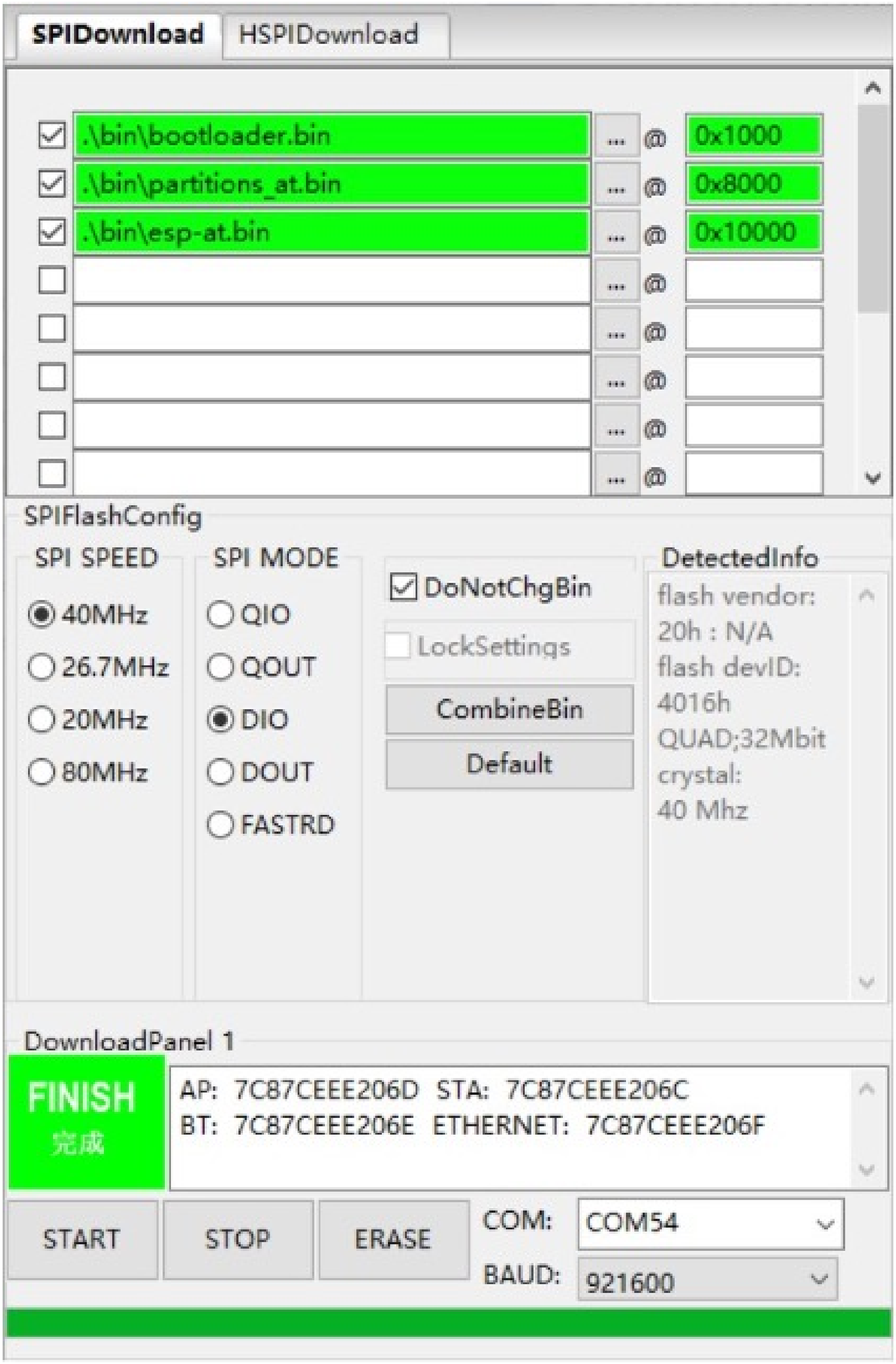


Fig. 66: Download Completed

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)
  - **secure_boot_version = 1** (Selects secure boot version)
  - **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)

- **[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 5: [ESP32 DISABLE FUNC] Config Option

[ESP32 DISABLE FUNC] Config Option	Description
dl_encrypt_disable = False	Configures whether to disable encryption
dl_decrypt_disable = False	Configures whether to disable decryption
dl_cache_disable = False	Configures whether to disable cache
jtag_disable = False	Configures whether to disable JTAG

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:

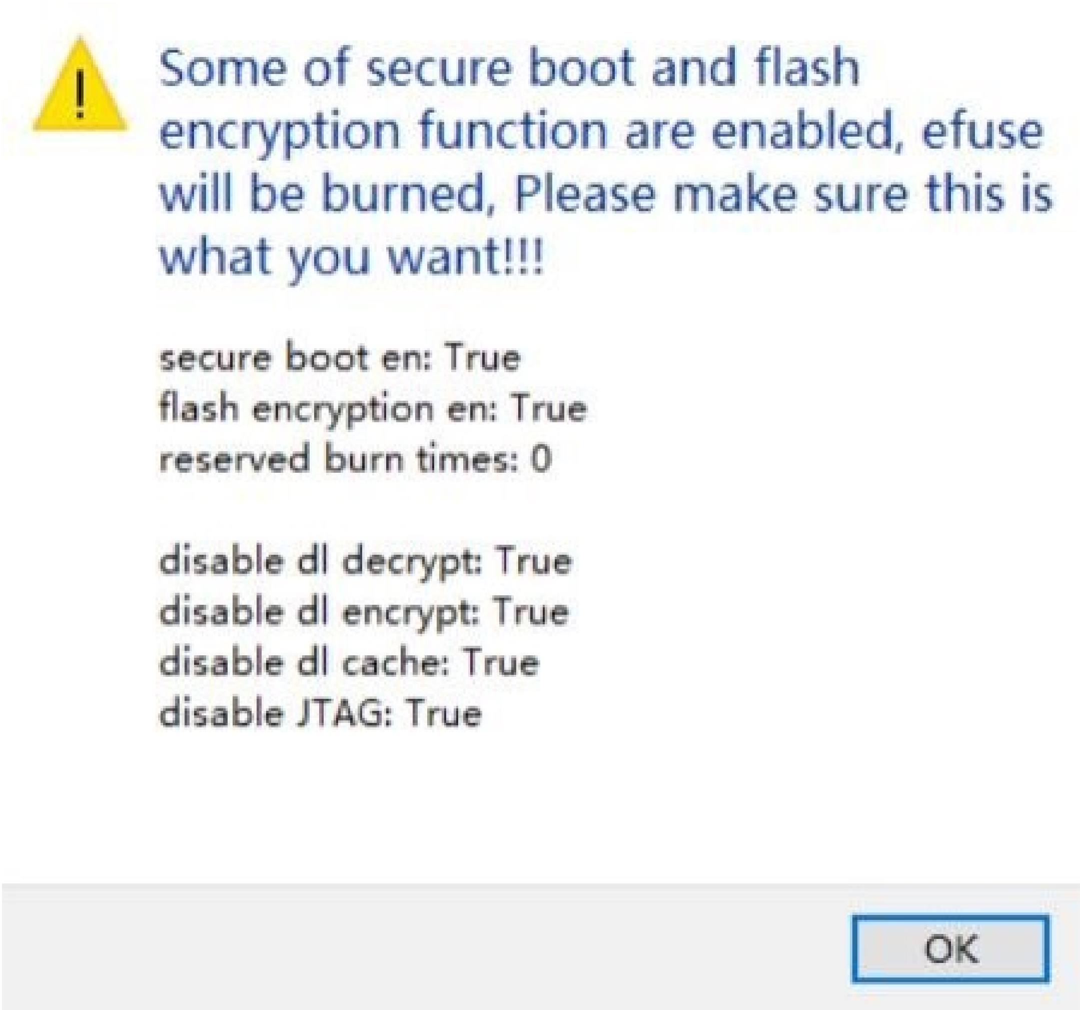


Fig. 67: ESP32 Prompt Message of Enabling Flash Encryption and Secure Boot

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.

8 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.

8.1 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:

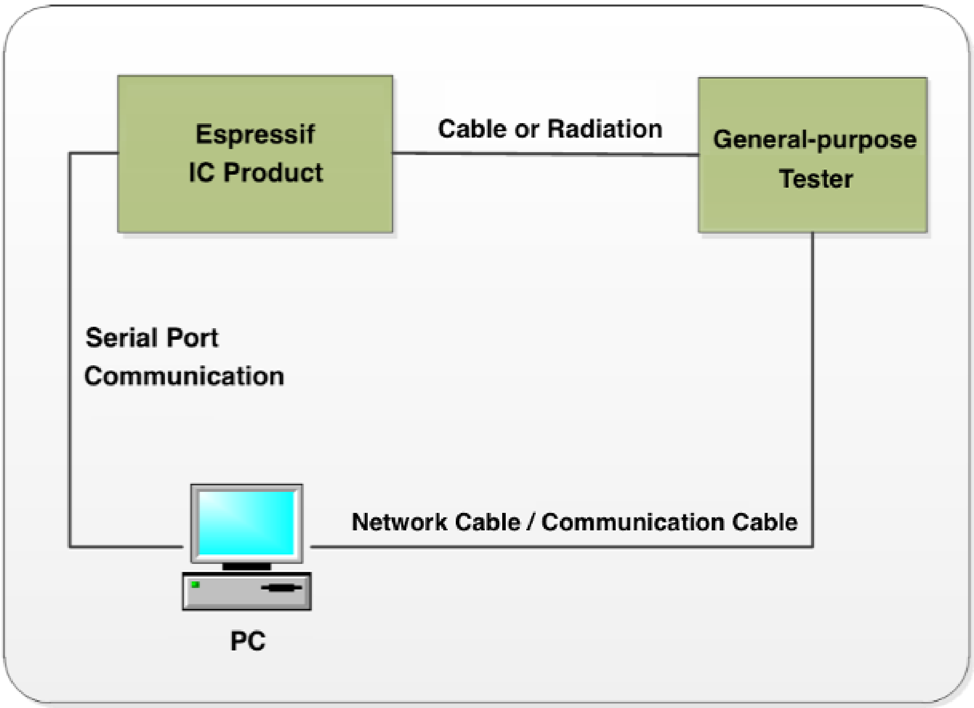


Fig. 68: Diagram of the Tester Scheme

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 t**
    - 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.

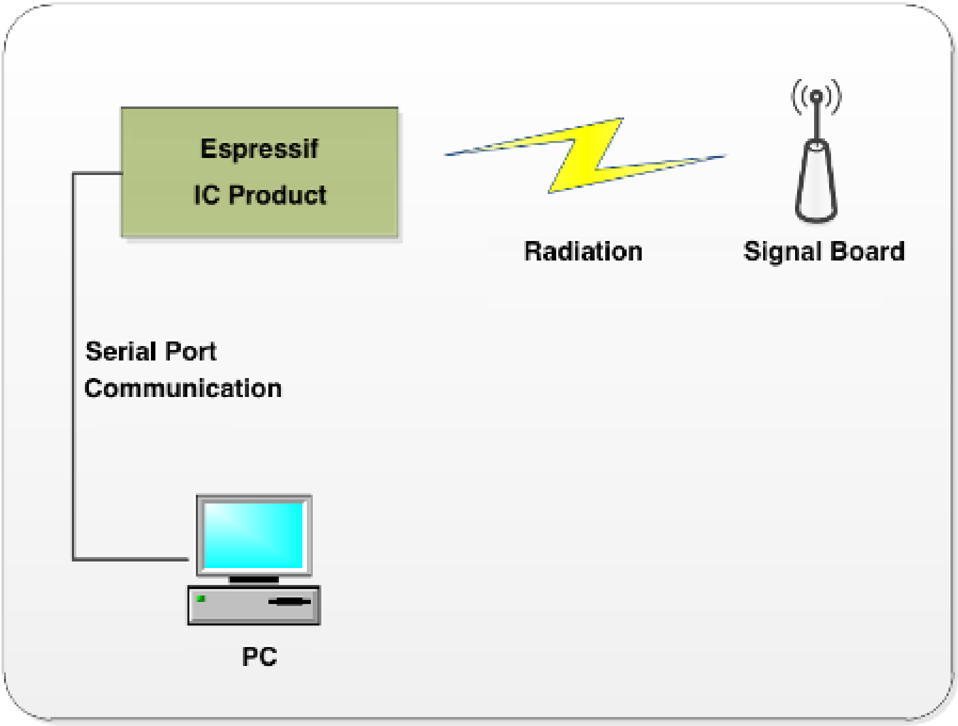


Fig. 69: Diagram of Signal Board Scheme

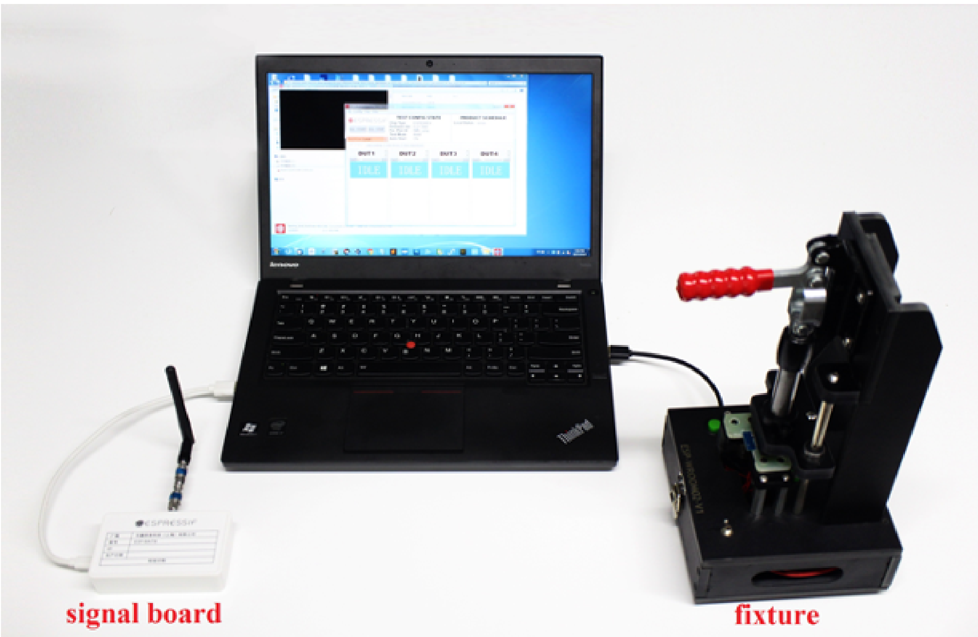


Fig. 70: Hardware Connection for Signal Board Scheme

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

Production Testing Process

1. Please find the followings 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 Equipments 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.

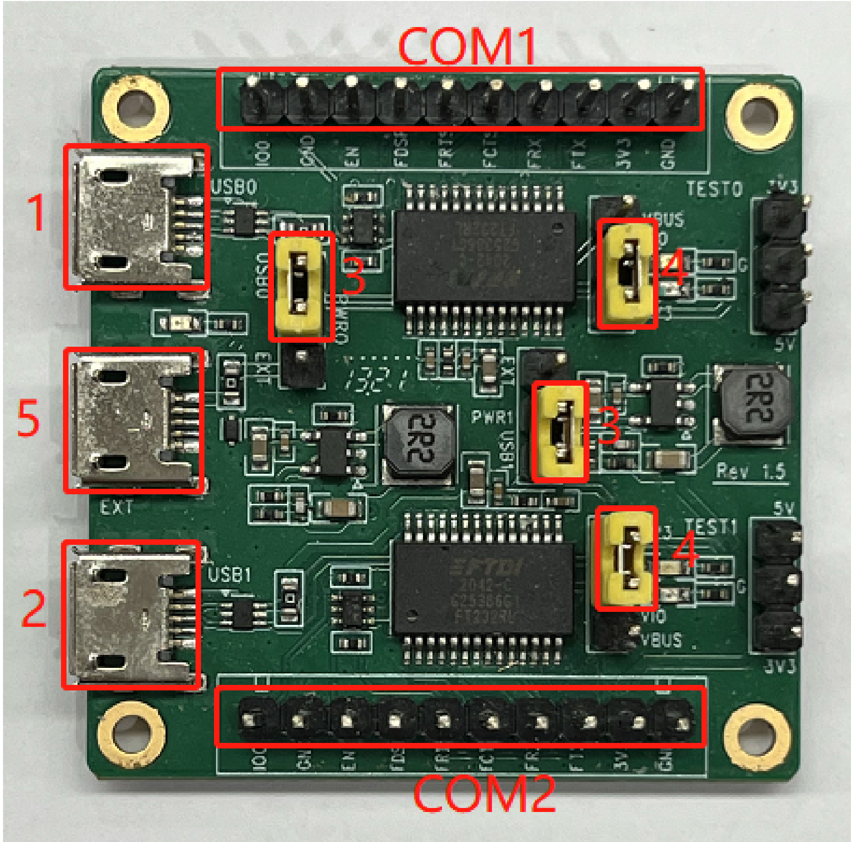


Fig. 71: Serial Port Board

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 Making 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 equipments, 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.

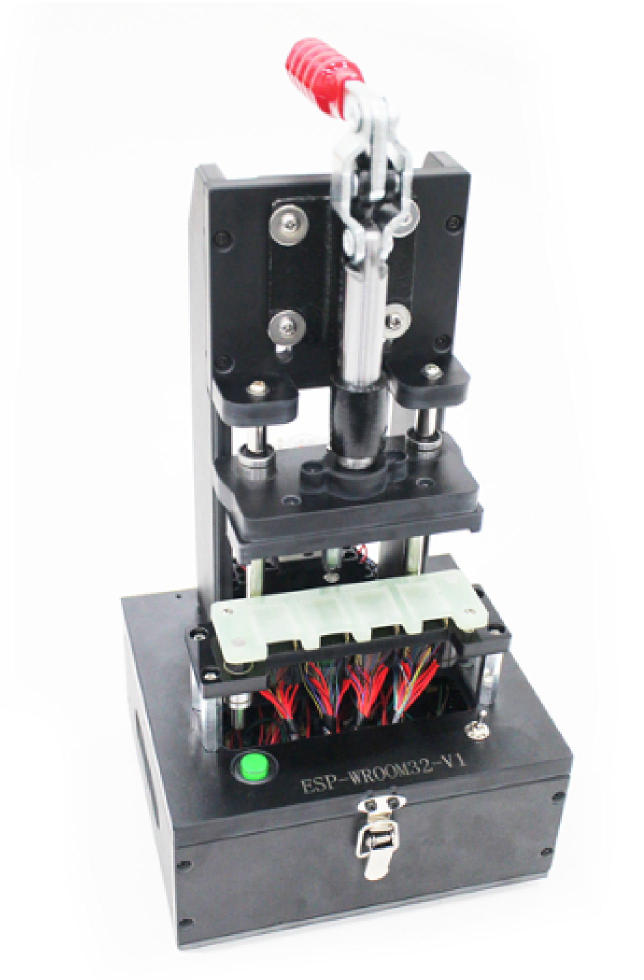


Fig. 72: A Typical Module Fixture

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

Table 6: 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 7: Signal Boards

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

Fig. 73: 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 8: 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.
Tester Scheme	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.

8.2 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 9: Production Testing Package

Production Testing Package	Component	Quantity	Remark
ESP32 / ESP32-S	ESP-BAT32	1	ESP32 signal board
	ESP-FactoryTB2	2	UART base board
	ESP32-WROOM-32D / ESP32-S2-WROOM	2	Espressif modules ESP32-WROOM-32D / Espressif modules 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.

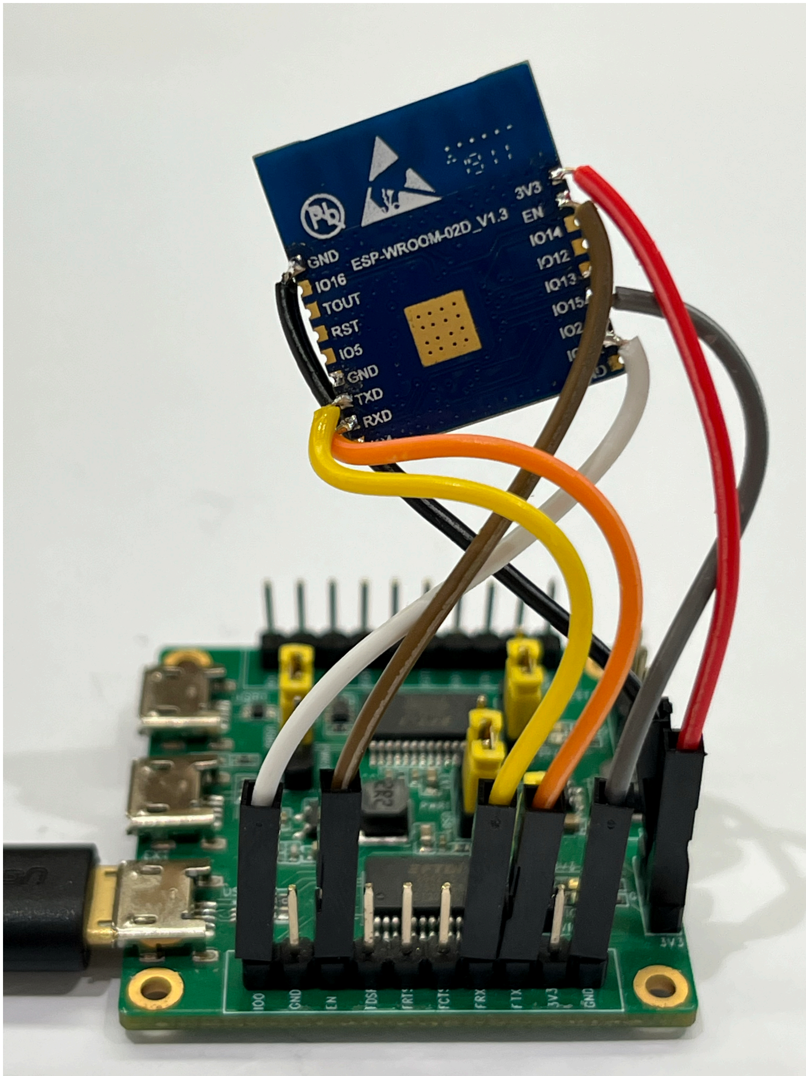


Fig. 74: Wiring for ESP32-WROOM-32D

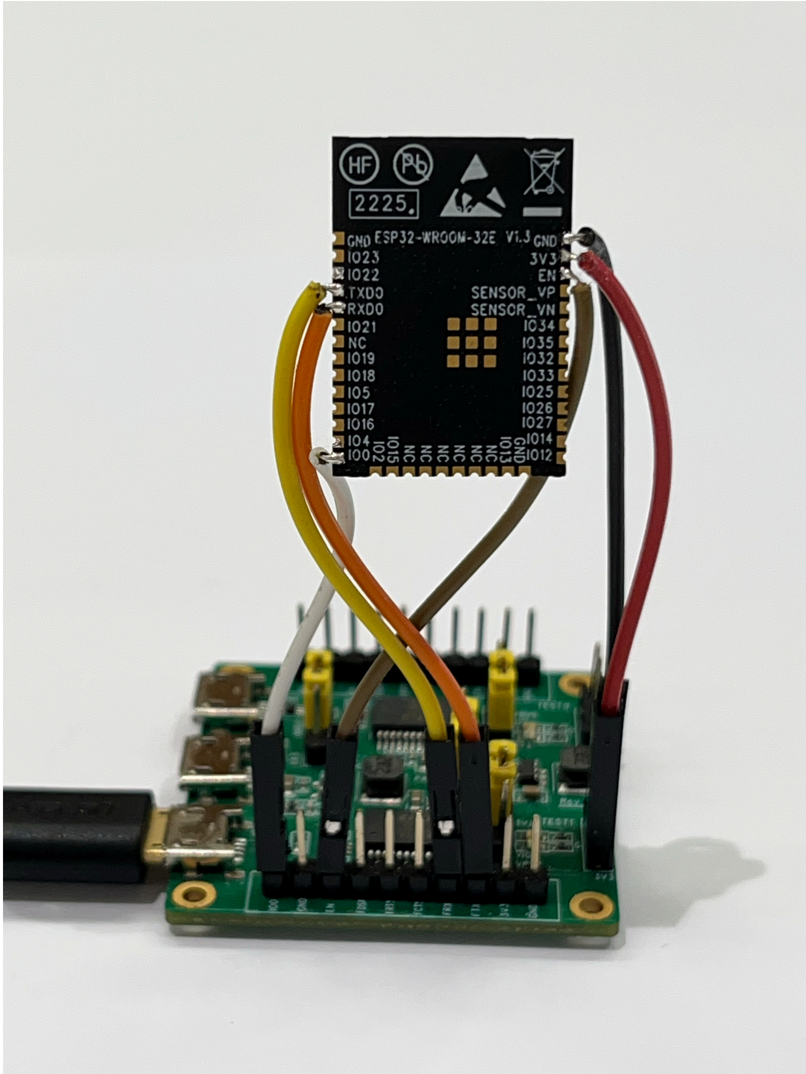
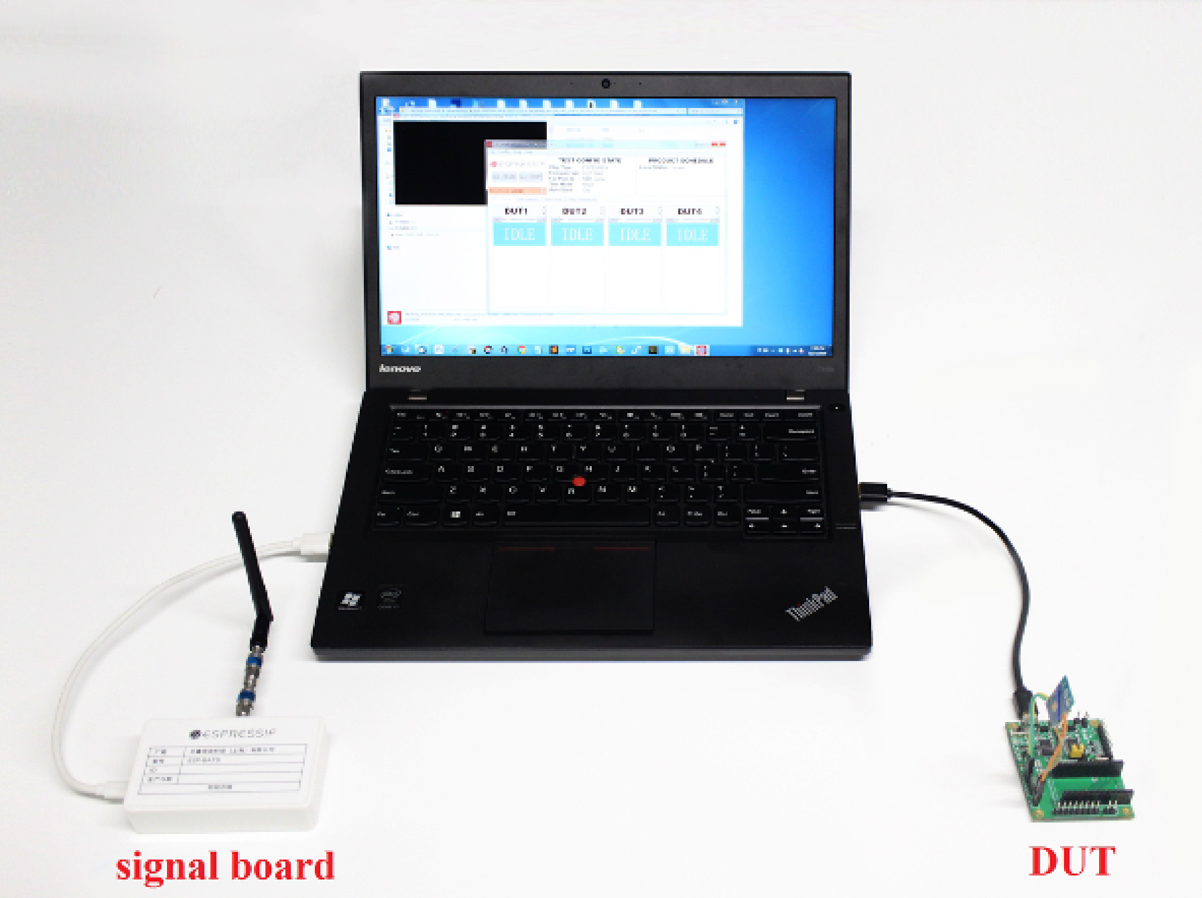


Fig. 75: Wiring for ESP32-WROOM-32E

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.

8.3 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

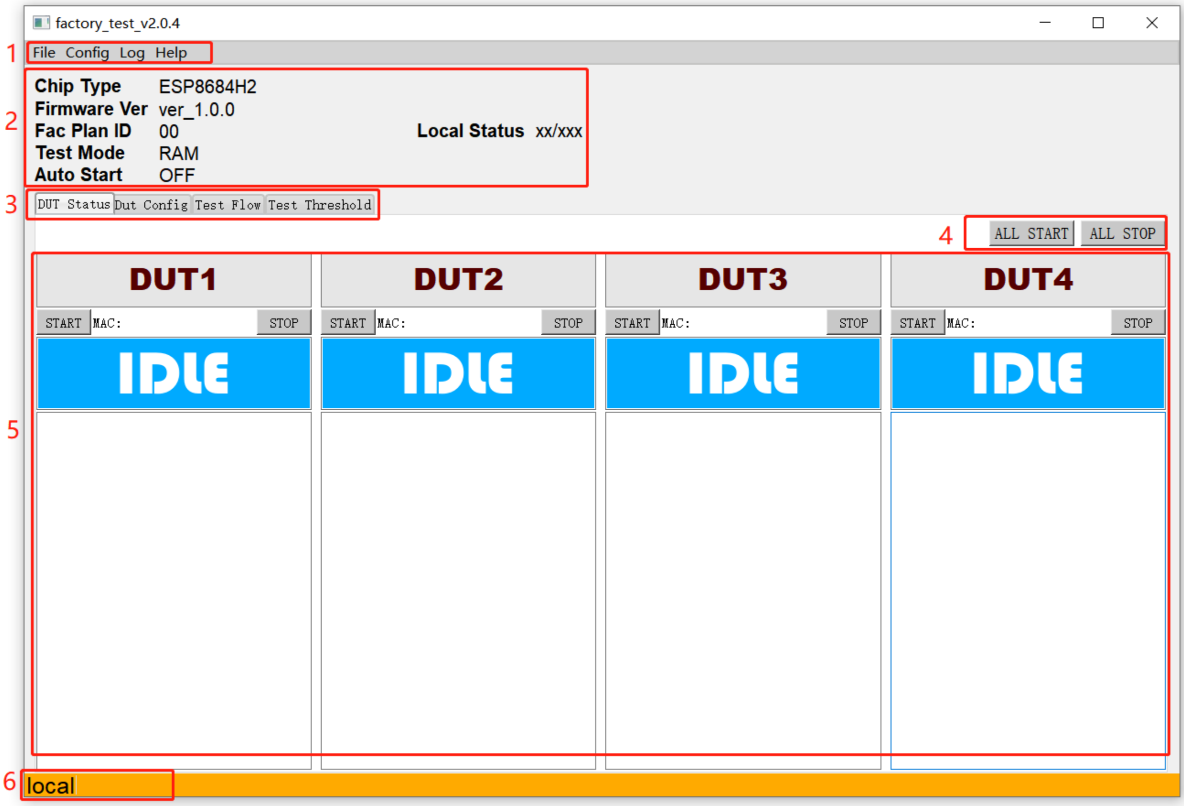


Fig. 76: Main Interface

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

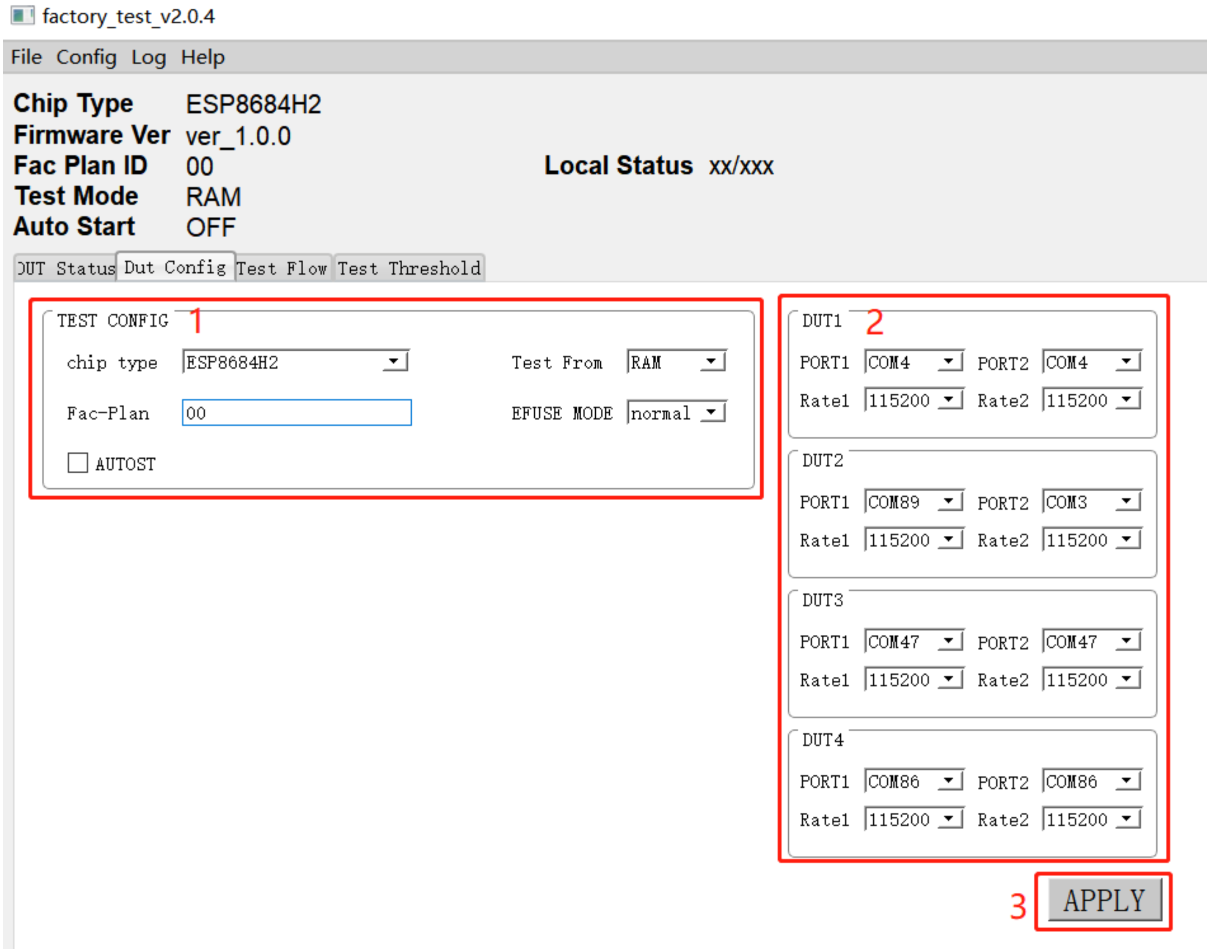


Fig. 77: DUT Config

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

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

TEST CONFIG

Table 10: 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 *custom* option should be selected here. Otherwise, use *normal*.

DUT CONFIG

Table 11: 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`.

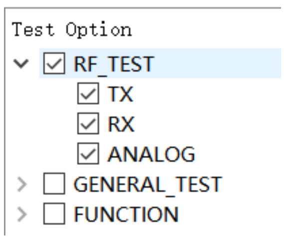


Fig. 78: RF Test

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*.

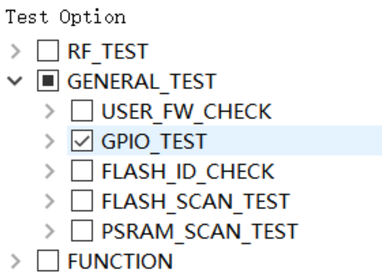


Fig. 79: GPIO Conductivity Test

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.

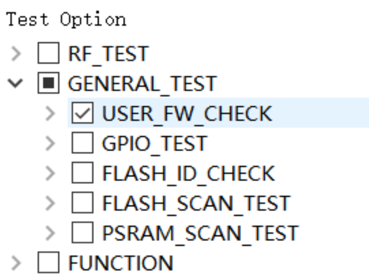


Fig. 80: Firmware Version Verification Test

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.

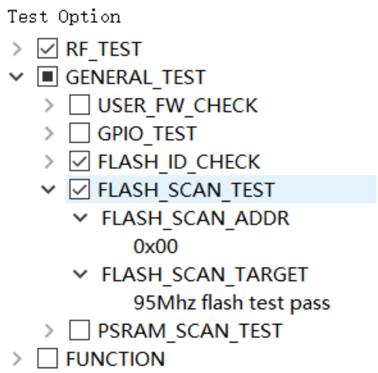


Fig. 81: Flash-related Test

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.

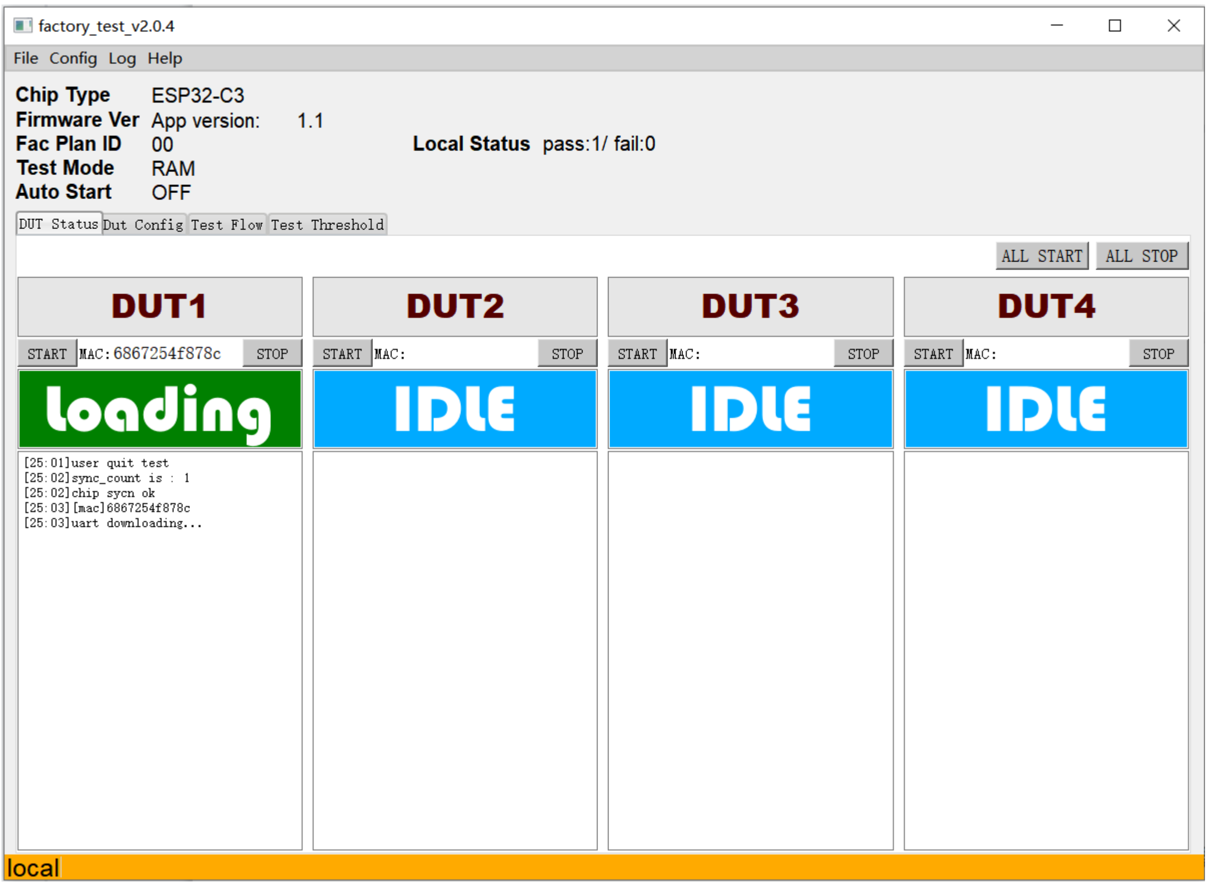


Fig. 82: Synchronization

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

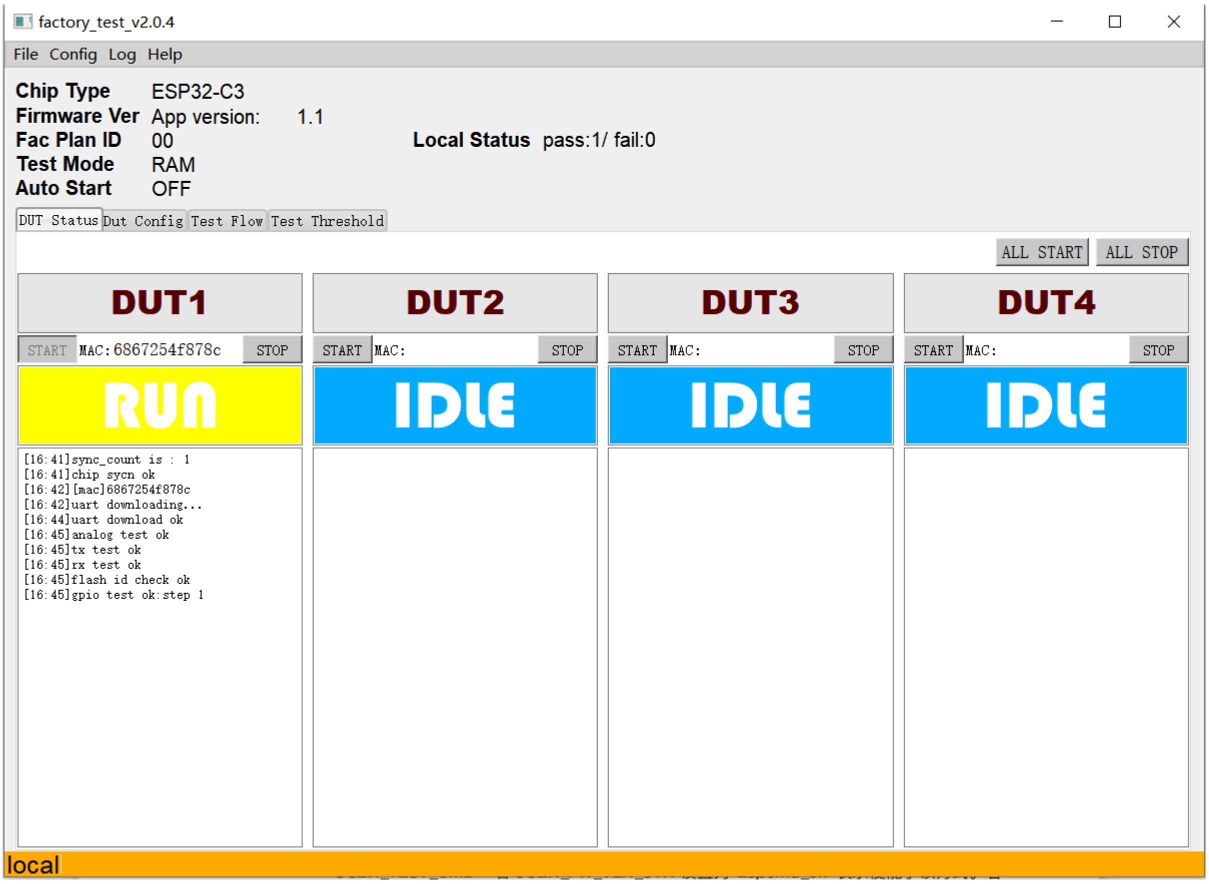


Fig. 83: Running

3. The tool displays test results.

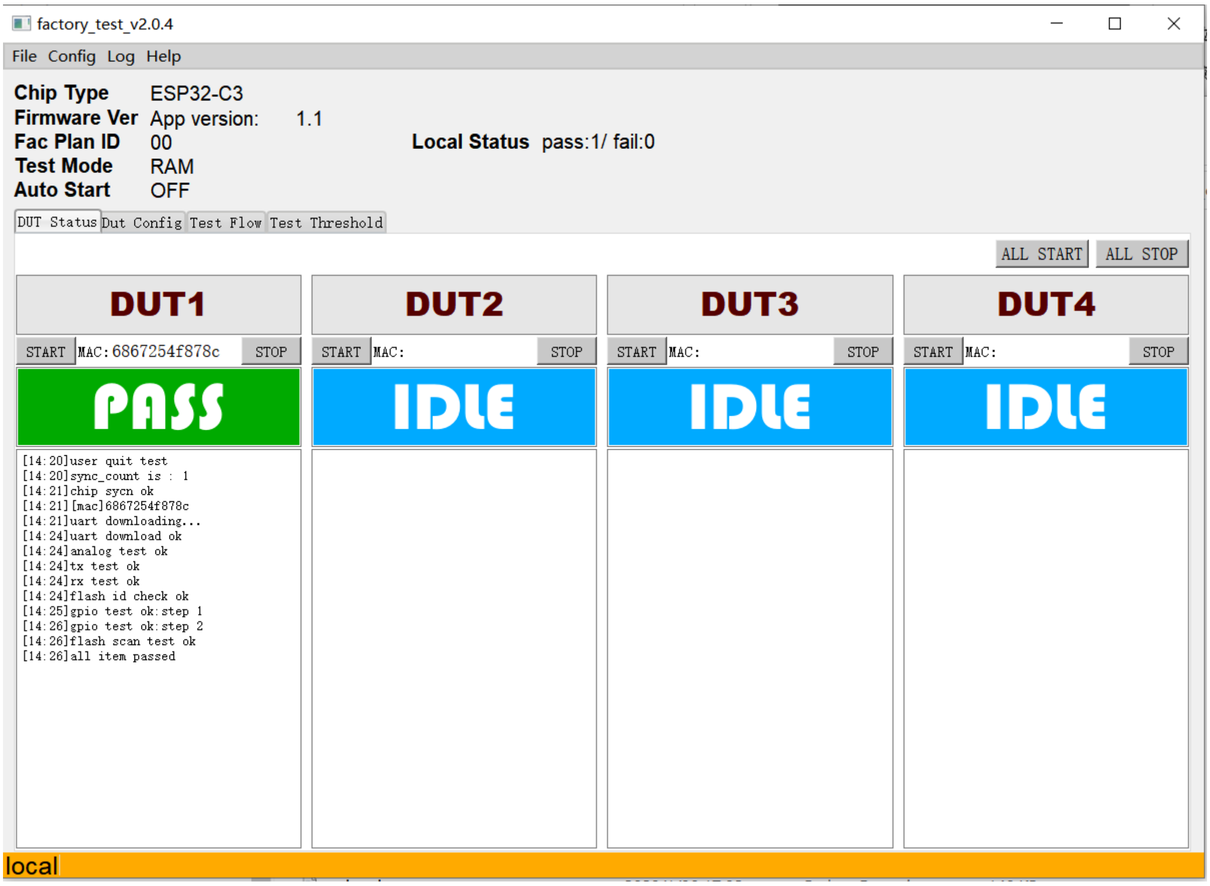


Fig. 84: Finish

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.

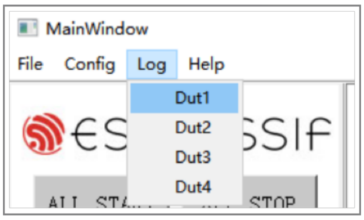


Fig. 85: Check Test Record

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.

8.4 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.

Test Configuration

Please see the followings to configure the GPIO conductivity test for ESP32-WROOM-32D module.

Pin wiring:

- IO23–>IO34
- IO22–>IO35
- IO15–>IO32
- IO02–>IO33
- IO19–>IO25
- IO18–>IO26
- IO05–>IO12
- IO13–>IO27
- IO21–>IO14

Configuration on the host computer:

<GPIO34,GPIO23,0>;<GPIO35,GPIO22,1>;<GPIO32,GPIO15,0>;<GPIO33,GPIO2,1>;<GPIO25,GPIO19,0>;<GPIO26,GPIO18,

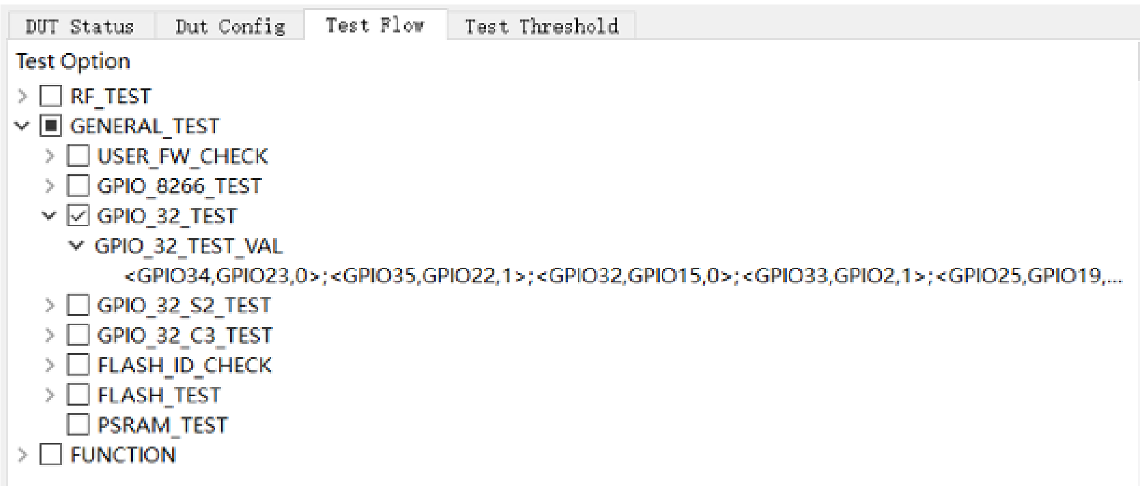


Fig. 86: ESP32 Series Test Option

Serial Command

- **Serial port command: ESP_TEST_GPIO** <Parameter1> <Parameter2> <Parameter3>

Input	ESP_TEST_GPIO 0xD9000C20 0x0054ECE0 0x00000055
Expected Input Result	0x33000000 0x00AC0000 0x000000BB

- **Command Description:** The states of a GPIO are represented with a 2-bit character. Each GPIO has four states:
  - 00: the default mode;
  - 01: INPUT;

  - 10: the OUTPUT level is low;
  - 11: the OUTPUT level is high.
- **Parameter description:**
  - <Parameter1>: 32-bit character, which represents the states of the range from GPIO0 to GPIO15. To be more specific, bit [1:0] represents the states of GPIO0, bit [3:2] represents the states of GPIO1,···bit [30:31] represents the states of GPIO15.
  - <Parameter2>: 32-bit character, which represents the states of the range from GPIO16 to GPIO31. To be more specific, bit [1:0] represents the states of GPIO16, bit [3:2] represents the states of GPIO17,··· bit [30:31] represents the states of GPIO31.
  - <Parameter3>: 32-bit character, which represents the states of the range from GPIO32 to GPIO47. To be more specific, bit [1:0] represents the states of GPIO32, bit [3:2] represents the states of GPIO33,··· bit [30:31] represents the states of GPIO47.
- **Result:**
  - **Input result:** <Parameter1> <Parameter2> <Parameter3>
  - **Description:** A 2-bit character is used to represent a GPIO as input result, in which the higher bit indicates whether the input is valid, while the lower bit represents the input level. Each GPIO as INPUT has four results in total:
    * 00: this GPIO does not work as INPUT;
    * 10: the OUTPUT level is low;
    * 11: the INPUT level is high;
    * 01: no significant meaning.
  - **Parameter description:**
    * <Parameter1>: 32-bit character, which represents the input results of the range from GPIO0 to GPIO15. To be more specific, bit [1:0] represents the input results of GPIO0, bit [3:2] represents the input results of GPIO17,···bit [30:31] represents the input results of GPIO15.
    * <Parameter2>: 32-bit character, which represents the input results of the range from GPIO16 to GPIO31. To be more specific, bit [1:0] represents the input results of GPIO16, bit [3:2] represents the input results of GPIO17,···bit [30:31] represents the input results of GPIO31.
    * <Parameter3>: 32-bit character, which represents the input results of the range from GPIO32 to GPIO47. To be more specific, bit [1:0] represents the input results of GPIO32, bit [3:2] represents the input results of GPIO33,···bit [30:31] represents the input results of GPIO47.

Note: ESP32 has 34 GPIOs, of which:

- GPIO20, GPIO24, and GPIO28 to GPIO31 are not available for state configuration;
- GPIO1/U0RXD and GPIO3/U0TXD are used to send/receive commands, thus cannot be used for IO tests (Therefore, the test results are considered invalid);
- GPIO34 to GPIO39 only work as INPUT only.

8.5 Appendix C: Firmware Version Verification Test

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

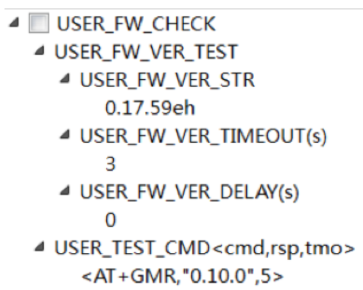


Fig. 87: Detailed Configuration

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`.

8.6 Certification

Download certificates for Espressif products from Certificates.

9 Test Fixture Manufacturing Instruction

9.1 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.

9.2 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:

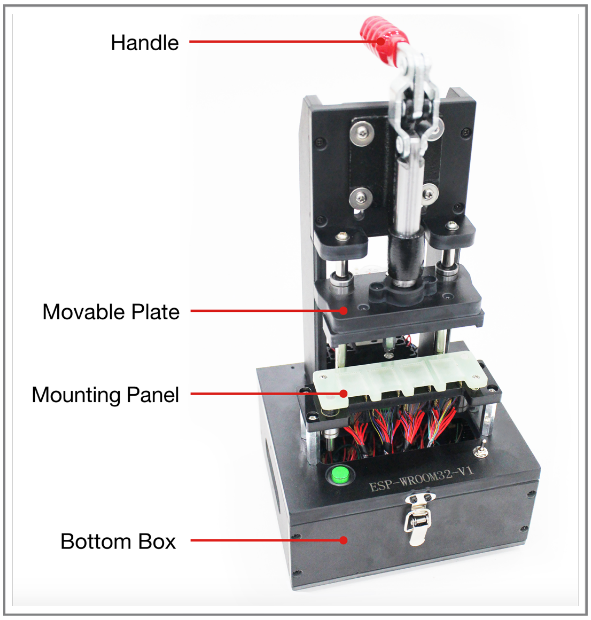


Fig. 88: The Structure of a Typical Test Fixture (ESP-WROVER)

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 12: The Primary Structure of a Typical Test Fixture

Part	Description
Handle	It is used to power on or power off the module: • 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.

9.3 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:

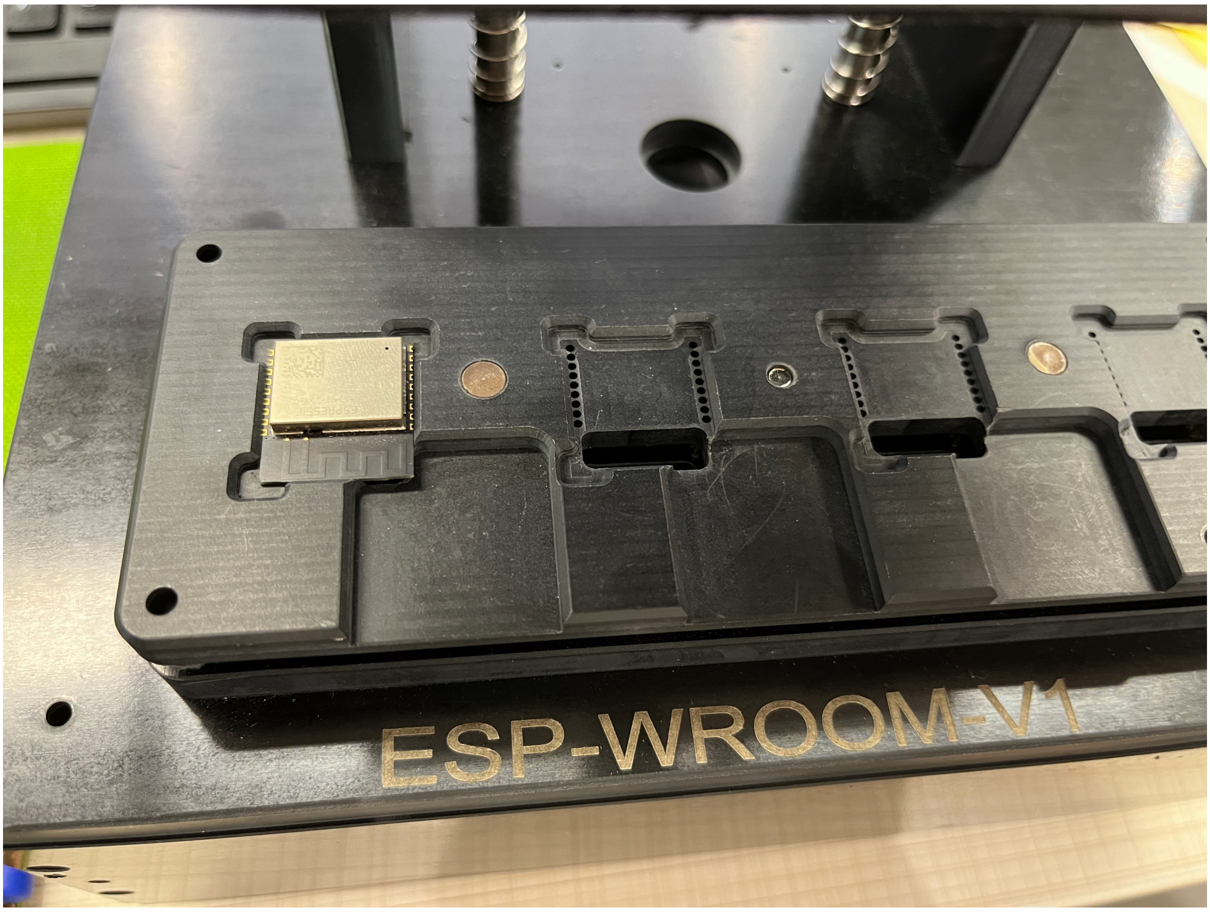


Fig. 89: The Mounting Panel for the ESP-WROVER Test Fixture

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.

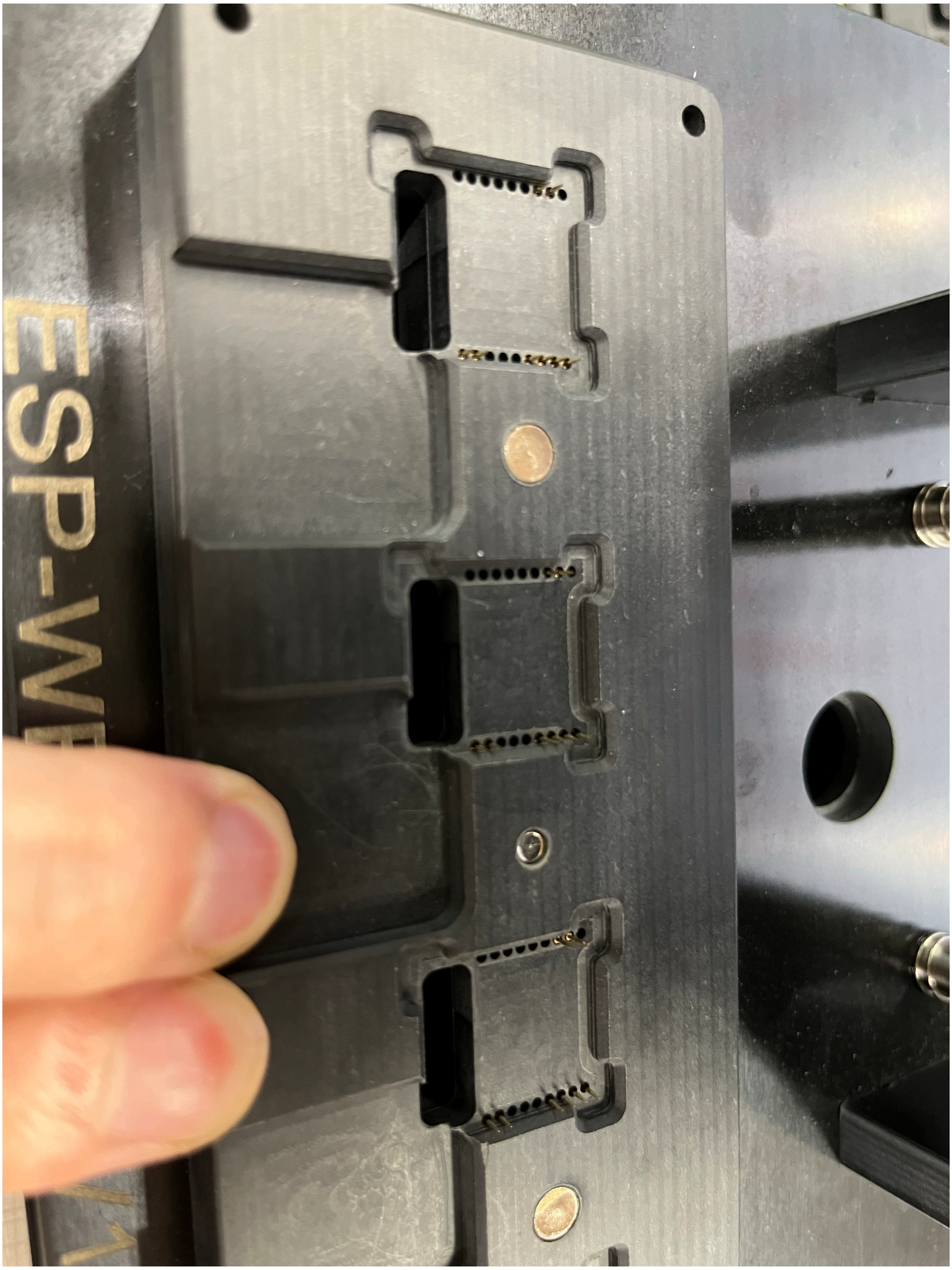


Fig. 90: The Metal Probes (the handle is pressed)

- 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:

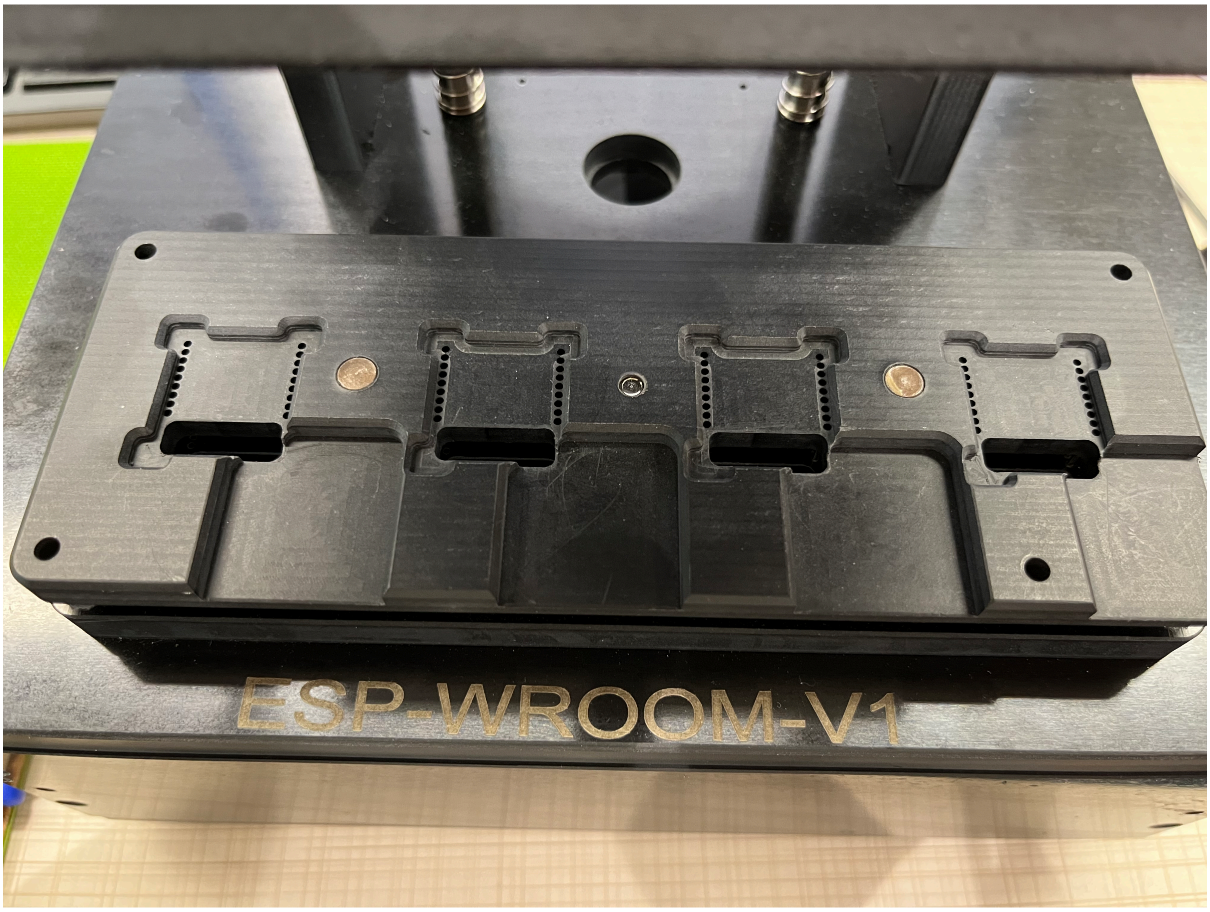


Fig. 91: The Metal Probes (the handle is lifted)

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:

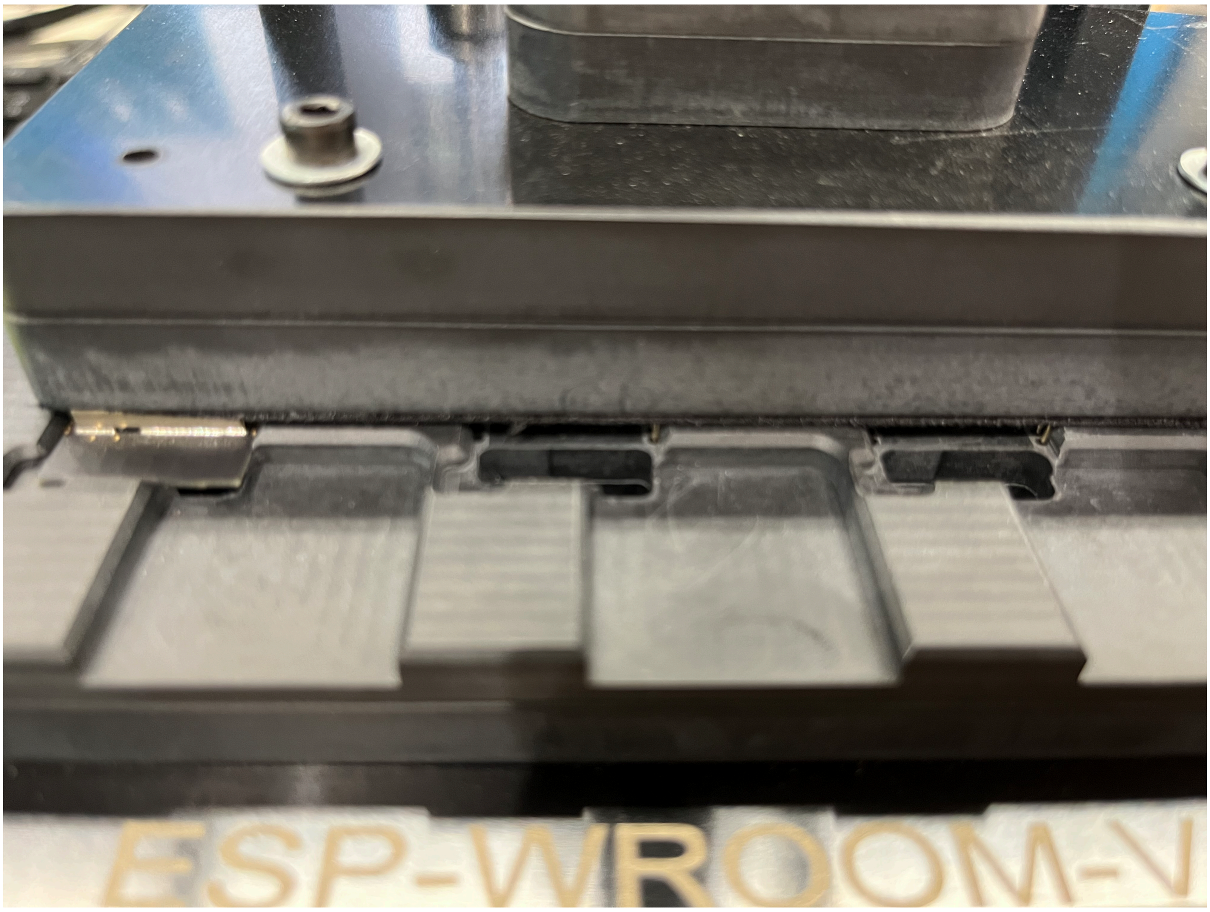


Fig. 92: The Movable Plate and the Mounting Panel

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:

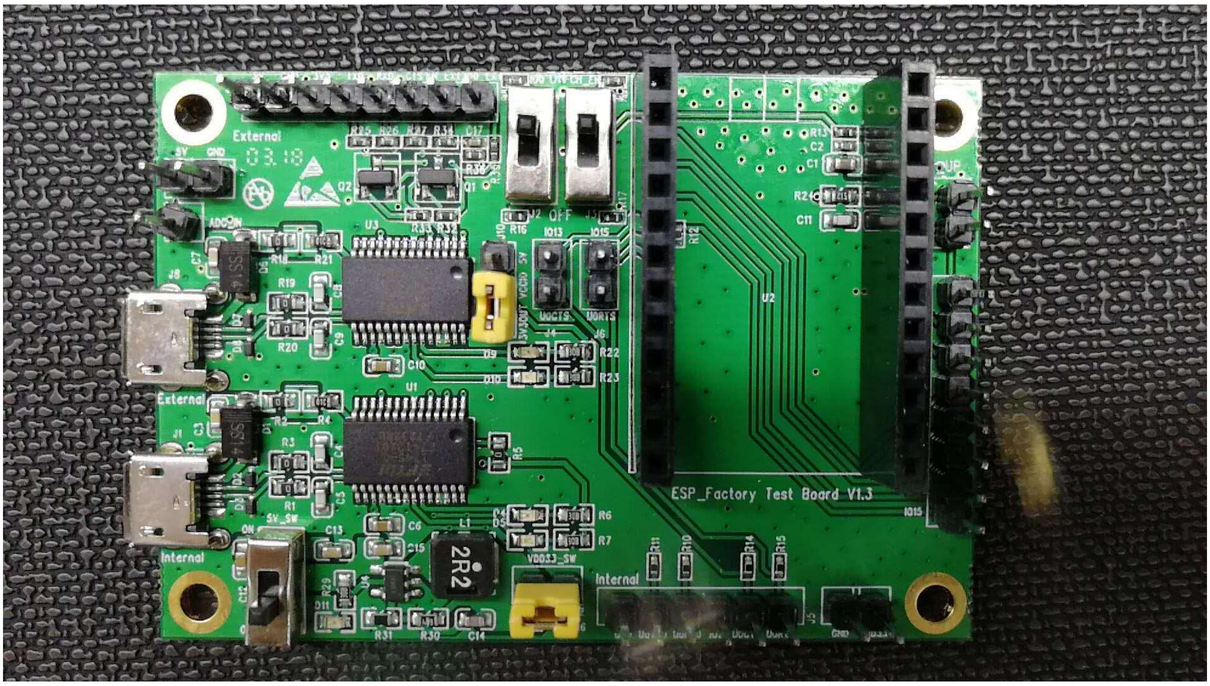


Fig. 93: A Typical Serial Port Board (ESP_Factory Test Board V1.3)

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 13: The classification of the marks

Module Type	Mark
• ESP-WROOM-02 • ESP-WROOM-02D • ESP-WROOM-02DC	ESP-WROOM-02/02D-V1
• ESP-WROOM-02U • ESP-WROOM-02UC	ESP-WROOM-02U-V3*
• ESP32-WROOM-32 • ESP32-WROOM-32D • ESP32-WROOM-32DC • ESP32-SOLO-1 • ESP32-SOLO-1C	ESP32-WROOM-32/32D-V1
• ESP32-WROOM-32U • ESP32-WROOM-32UC	PESP32-WROOM-32U-V3*
• ESP32-WROVER (PCB) • ESP32-WROVER-B (PCB) • ESP32-WROVER-BC (PCB)	ESP32-WROVER-V1
• 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 14: 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**: 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).	1. Press the handle, so that the switch located in positions 1 and 2 is turned on and the serial port boards are powered on; 2. The DIP switch located in position 3 and 4 is used to control the conductivity of the wiring, and therefore the working modes.
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.	–

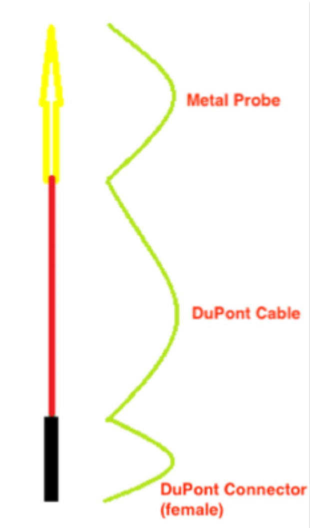


Fig. 94: A Diagram Showing How to Connect the Red Wires

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

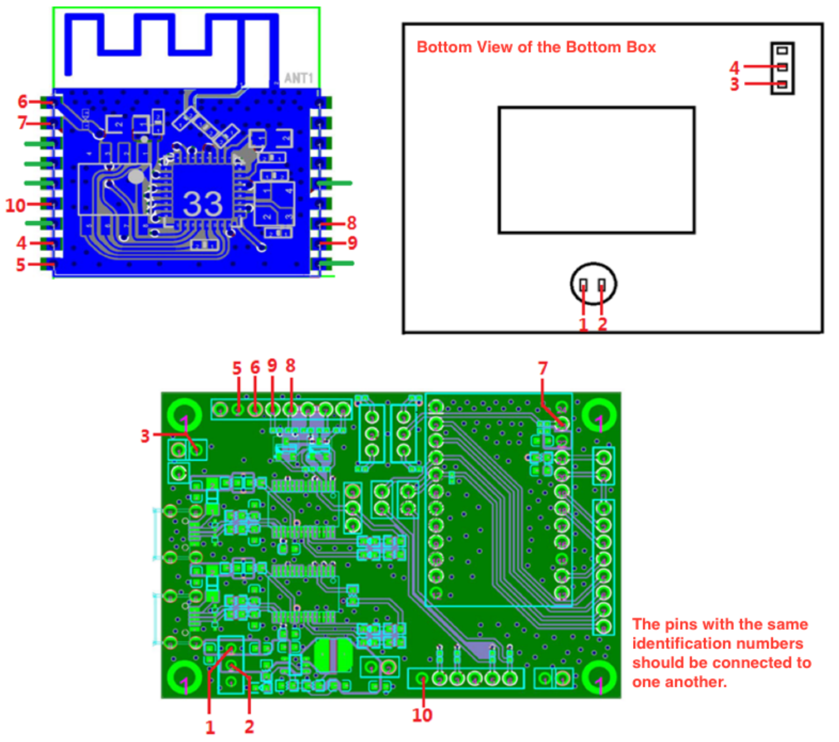


Fig. 95: The Wiring of the ESP-WROOM-02 Fixture

2. ESP-WROOM-32

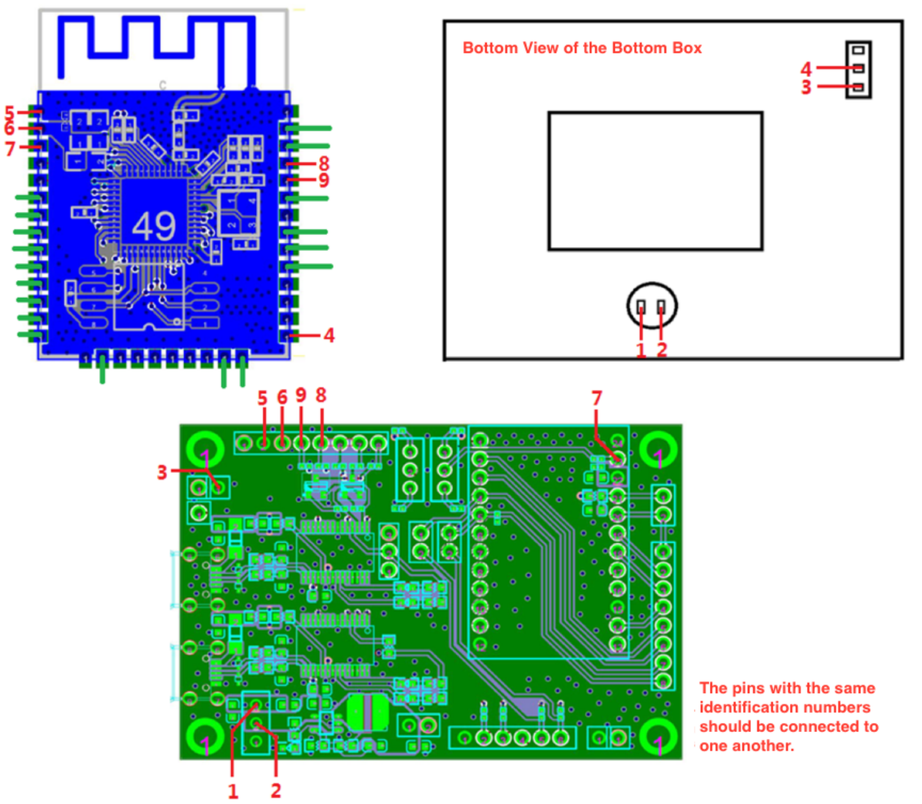


Fig. 96: The Wiring of the ESP32-WROOM-32 Fixture

3. ESP-WROVER

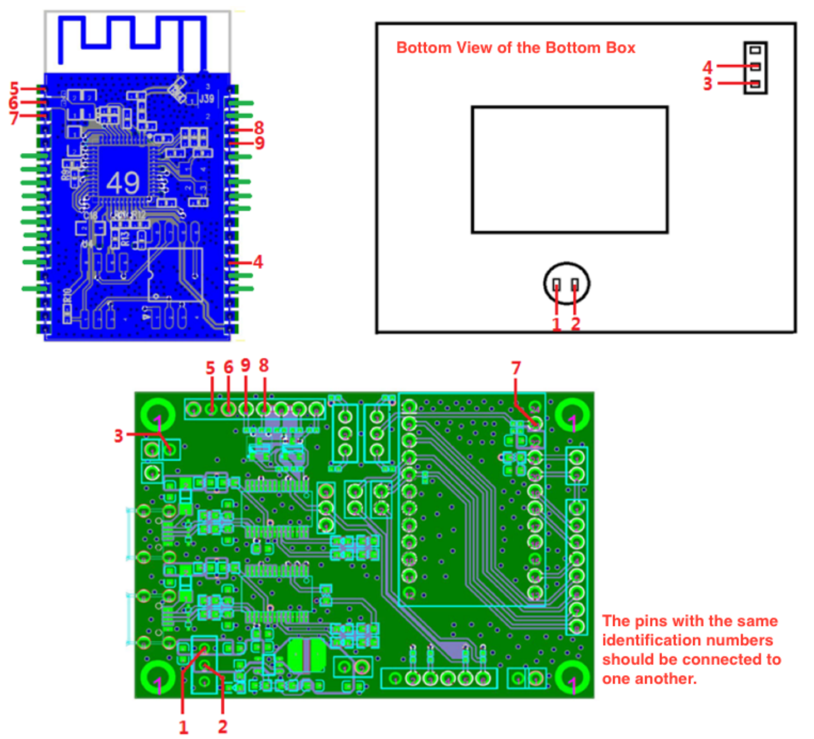


Fig. 97: The Wiring of the ESP-WROVER Fixture

When the Automatic Mode Switching on the Tool Side is supported

1. ESP-WROOM-02

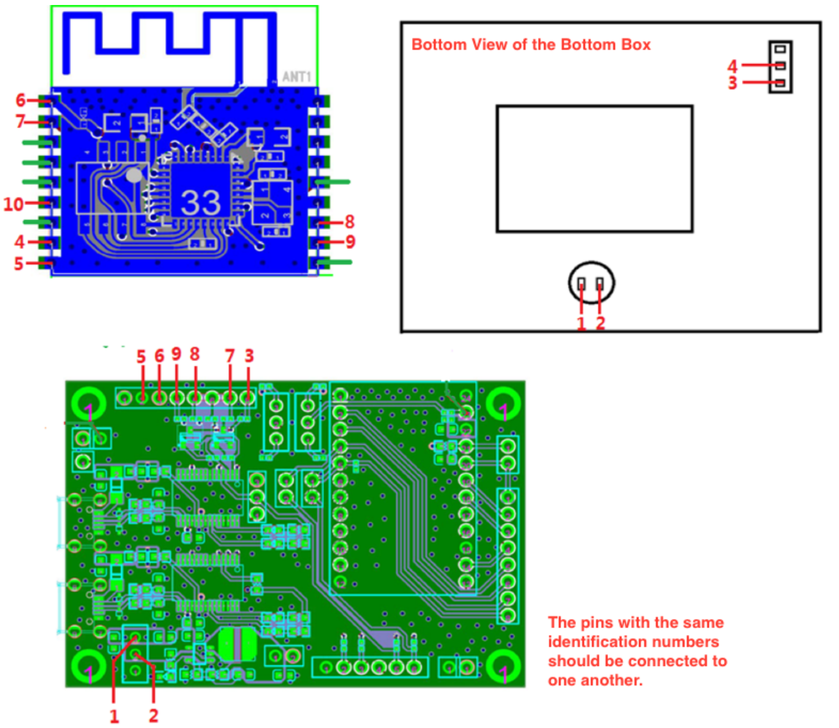


Fig. 98: The Wiring of the ESP-WROOM-02 Fixture

2. ESP32-WROOM-32

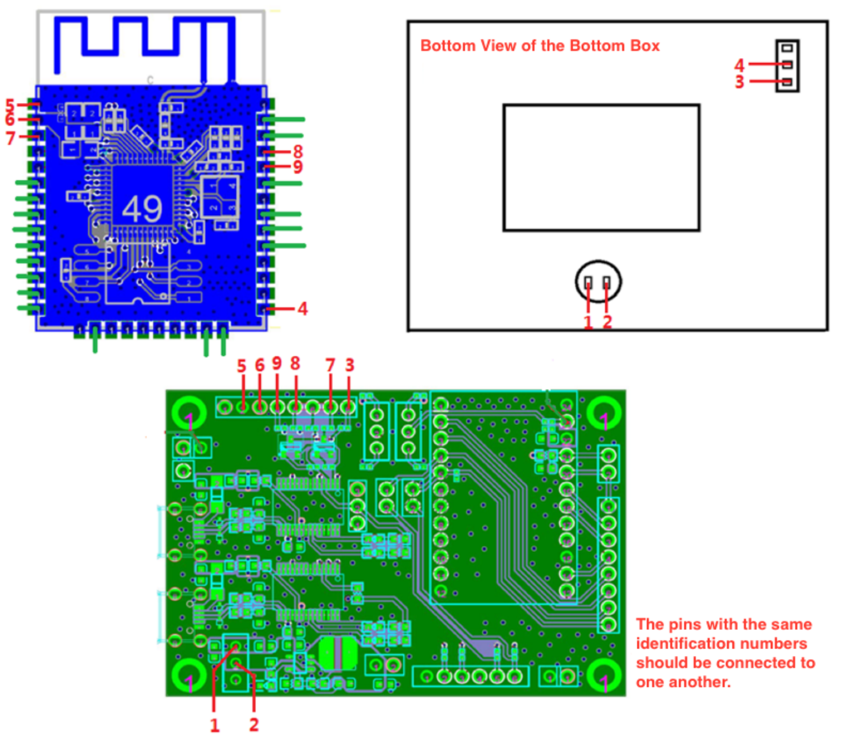


Fig. 99: The Wiring of the ESP-WROOM-32 Fixture

3. ESP-WROVER

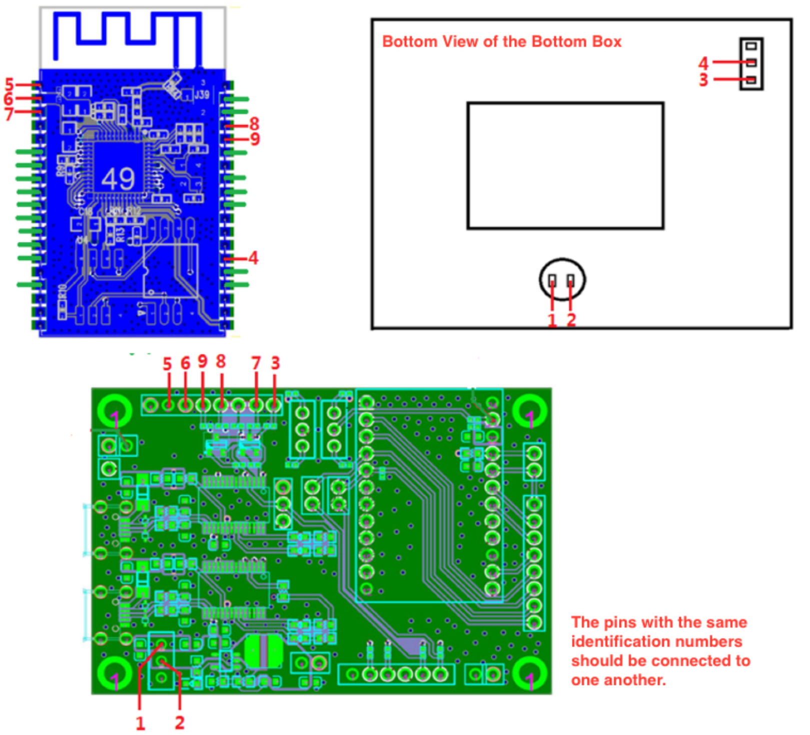


Fig. 100: The Wiring of the ESP-WROVER Fixture

9.4 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.

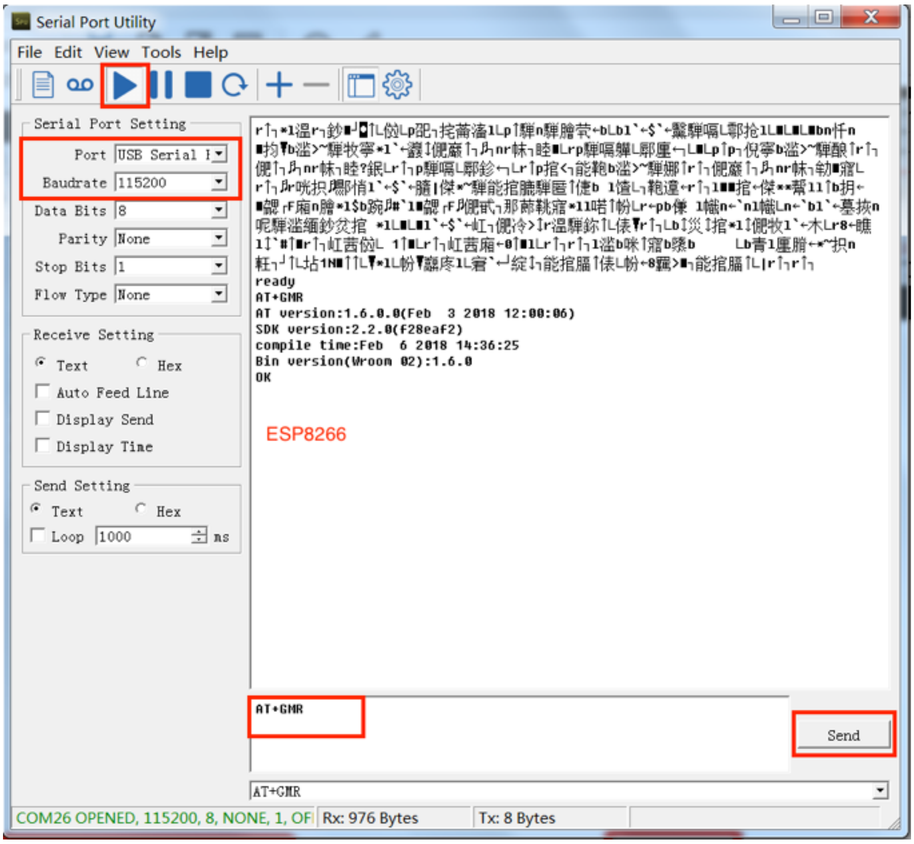


Fig. 101: AT Command Test

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.

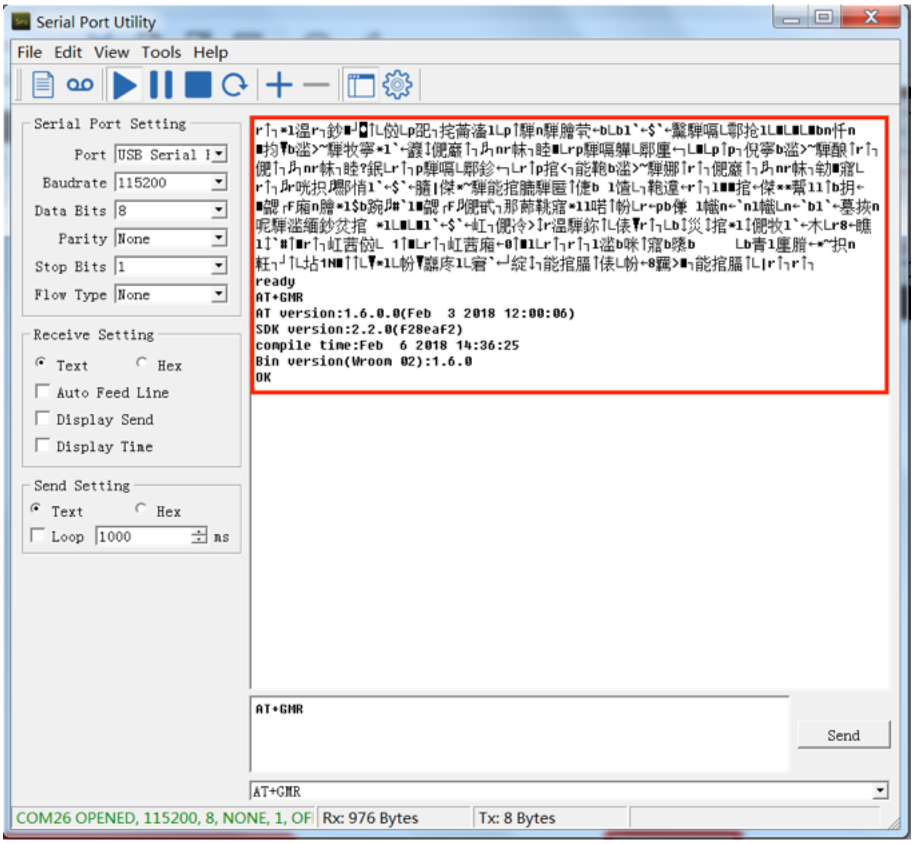


Fig. 102: Expected Result of AT Test - ESP8266 Series

- 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.

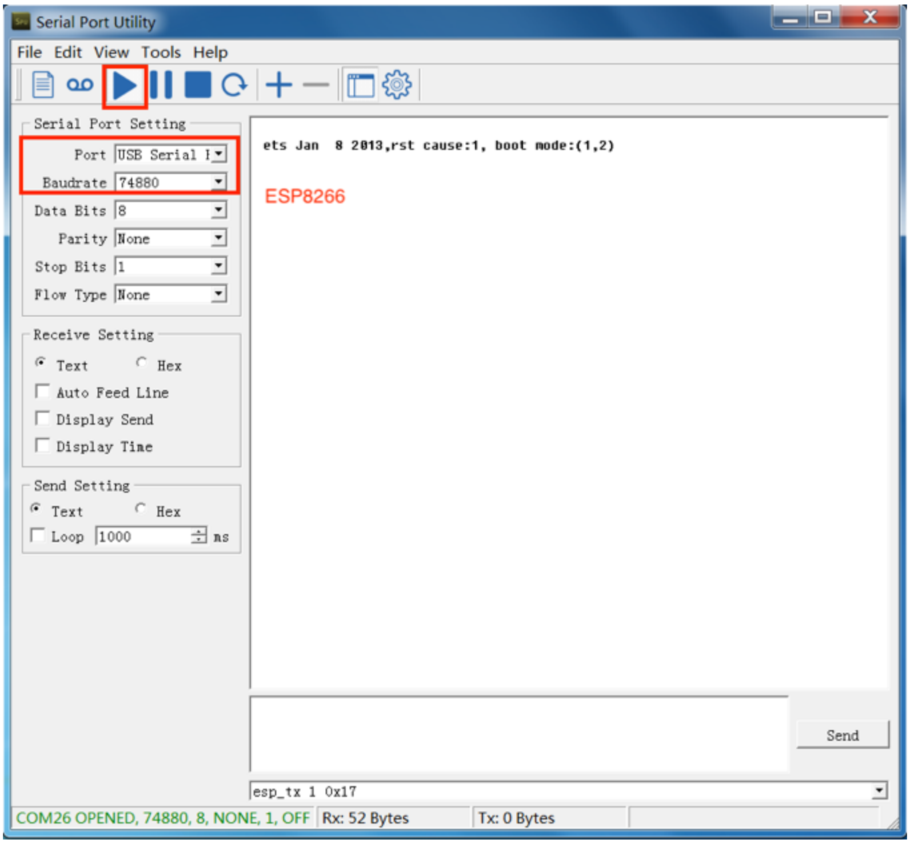


Fig. 103: Expected Result - ESP8266 Series

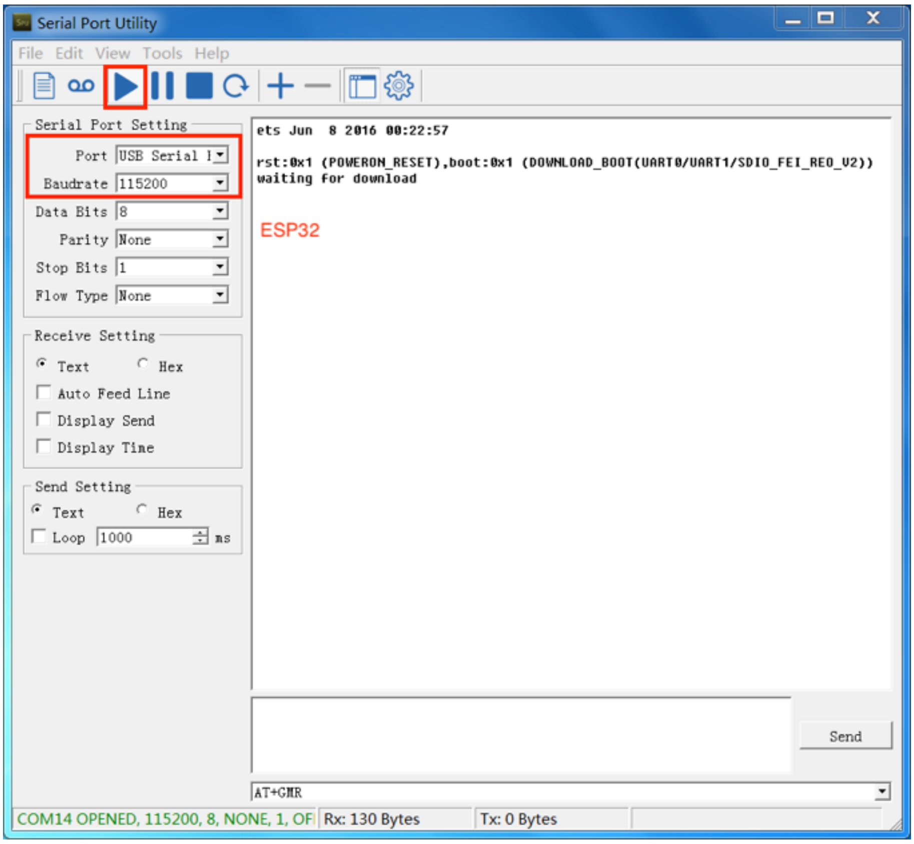


Fig. 104: Expected Result - ESP32 Series

- 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.

9.5 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 15: 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 16: Deliverables

Deliverables	Description
Fixture Set	Fixture + serial ports + complete wiring. **Notices:** 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.

10 Matter QR Code Generator

Matter QR Code Generator is used to generate QR codes that are used for provisioning Espressif's Matter devices. Integrated with BarTender, the generator enables label design and printing. With Matter QR Code Generator, you can configure label templates, select printers, and define data sources flexibly, meeting various QR code generation and printing needs in different scenarios. The generator also supports laser engraving machines over LAN for easier integration.

Download Link: Matter QR Code Generator

10.1 Software Directory

The directory structure of the Matter QR code generator is as follows:

- `bartender`: stores library dependency files
- `configure`: stores configuration files
- `data_output`: stores temporary output files
- `data_source`: stores files for local printing
- `files`: stores printing template files and scanning board firmware
- `esp_printer_main.exe`: the main executable file

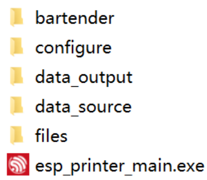


Fig. 105: QR code generator main interface (click to enlarge)

10.2 Get Started

Install BarTender

BarTender is the middleware of Espressif's Matter QR code Generator. Currently, Matter QR code Generator only supports BarTender 2022 and 2016 64-bit versions. During installation, make sure to choose the default path. You can select just the BarTender Designer module.

Fig. 106: Module selection (click to enlarge)

For more details about the installation process, refer to *Appendix II: BarTender (2022) Installation Process*.

Edit Label Template

The label template defines the content and format of printed labels, and it can be edited using BarTender. The generator uses a default label template located in the the `\\files\\matter` directory. You may also customize this template to adjust the font, label size, or layout.

Note:

- Do not modify the label template filename.
- You can add or delete elements that are not bound to the data source, such as images, boxes, etc.
- Do not add or delete named data sources.

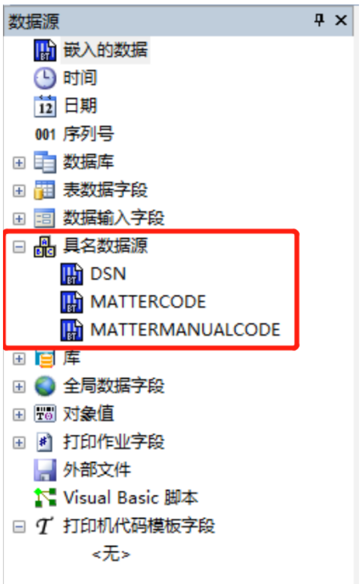


Fig. 107: Named data sources in the template (click to enlarge)

- The examples shown in the print interface are just static images. Your changes will not appear in the interface.

Tool Configuration

The configuration files are located in the directory `configure/config.conf`. You can open and edit them with Notepad.

Main Config	Subitem	Optional Value	Description
facConfig	rssiLimit	Recommended range: -30 ~ -80	The signal strength threshold that must be reached for surrounding products to be scanned before printing
	getMacType	[devboard, scan]	**Provides two ways to enter device informat** • devboard: Obtain MAC by receiving Bluetooth broadcasts via the scanning board • scan: Directly obtain device information using a barcode scanner
	print_enable	[0, 1]	**Controls the printer's enabled status:** • 0: Only retrieve information; printing is disabled • 1: Enables printing
SerialConfig	devPort	COM*	Scanning board serial port number
	devBaud	115200	Scanning board baud rate
v2_scanboard (only for V2 scanning boards)	scan_timeout	Default: 10	Scan timeout
	case_command	2	Fixed value
bartender	version	[2022, 2016]	BarTender Software Version[1]

10.3 Start Printing

[1] Currently, only version 2016 and 2022 are supported.

Interface

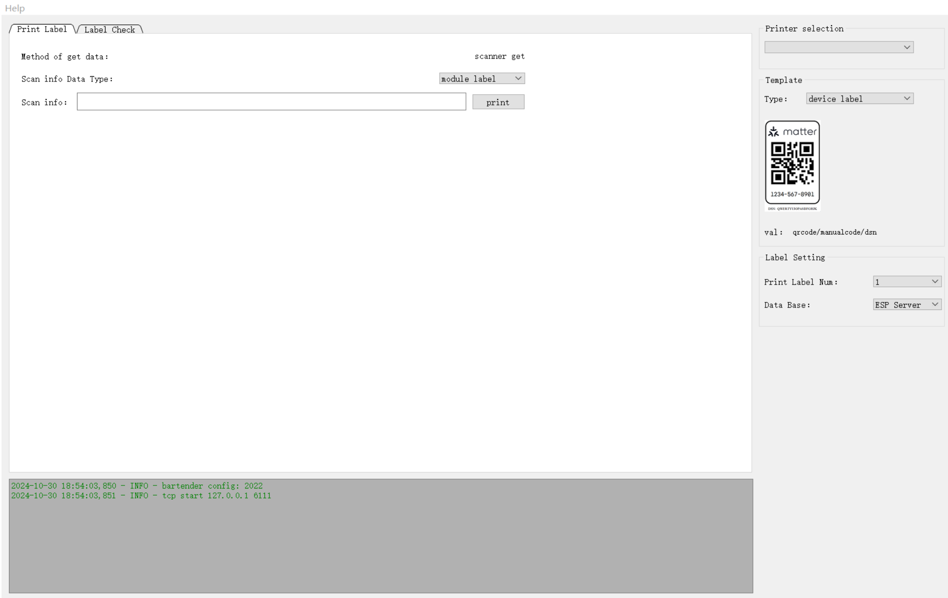


Fig. 108: Advanced Options (click to enlarge)

Interface Configuration

- `Printer selection`: The system printer is displayed by default. You can select a printer as needed
- `Template`: Choose the template file used for printing
- `Method of get data`: The method to get device information
  - `Scanner get`: Use a barcode scanner
    - `Scan info Data Type`: The format of the content scanned by the barcode scanner
      - `Module label`: QR code on the Espressif module shield
      - `Device label`: The already printed device label
      - `MAC`: MAC address of Espressif products
  - `BLE Broadcast`: Use a scanning board
- `Print Label Num`: The number of labels to print. The maximum is currently 6
- `Data Base`: Data source
  - `ESP Server`: Retrieve QR code data from Espressif server
  - `Local excel`: Query data from a local table and copy it to `data_source/matter_qrcode_data.xlsx` in the required format:

说明: MAC列存放12个字符长度的MAC地址		
MAC	QR Payload	manual code
744DBDFBCC0C	MT:CWBA00QV173O303K400	32861103440

Fig. 109: Data storage format

  - `Scanner data`: Retrieve information from scanned data (Currently only supported by Cyprus, as its device broadcast comes with MAC and QR code information).

Common Printing Methods

- Printing by scanning the shield QR code:

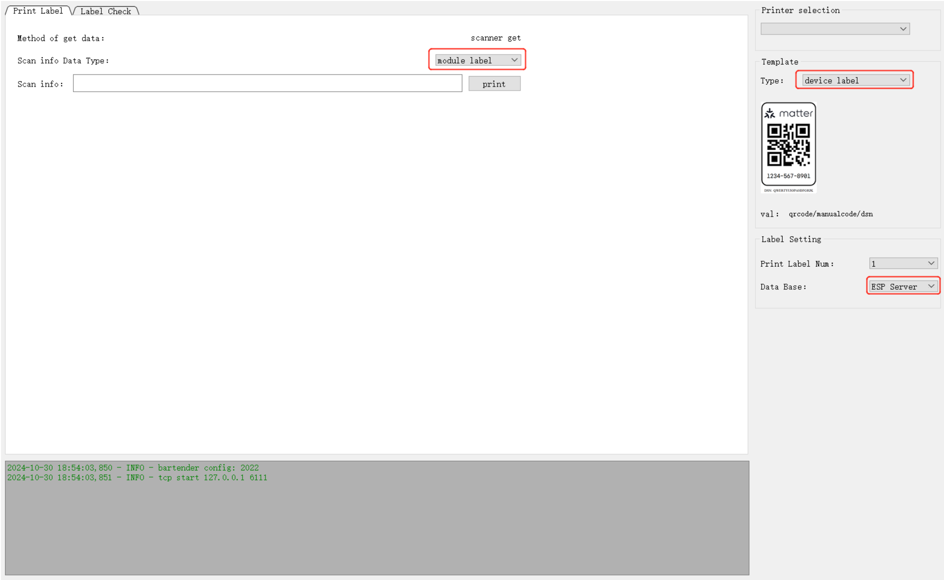


Fig. 110: Print by scanning the shield QR code (click to enlarge)

- Printing by scanning a printed label:

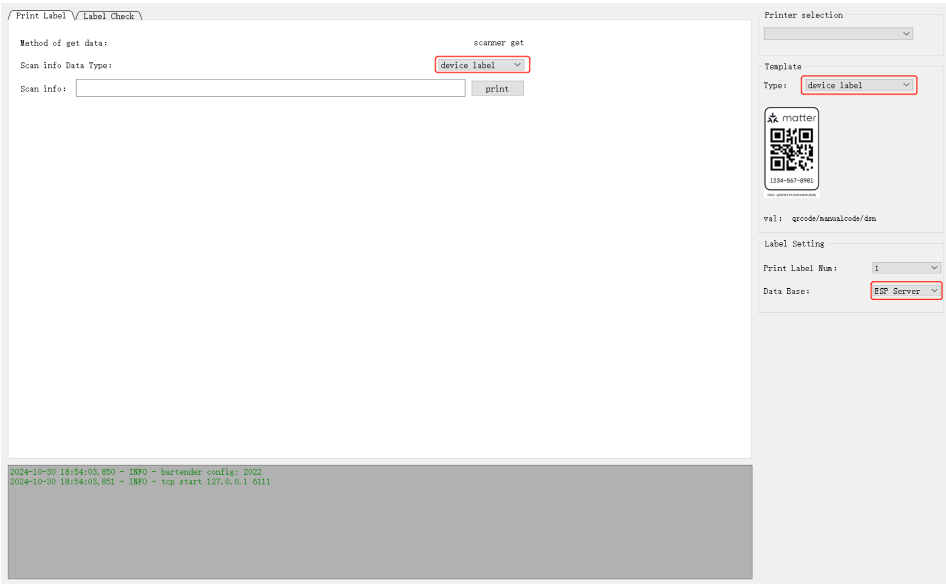


Fig. 111: Print by scanning a printed label (click to enlarge)

10.4 Check Printed Labels

The purpose of checking printed labels is to ensure that the device information matches the printed QR code. To do this, a scanning board is required to scan the device's Bluetooth broadcast signal.

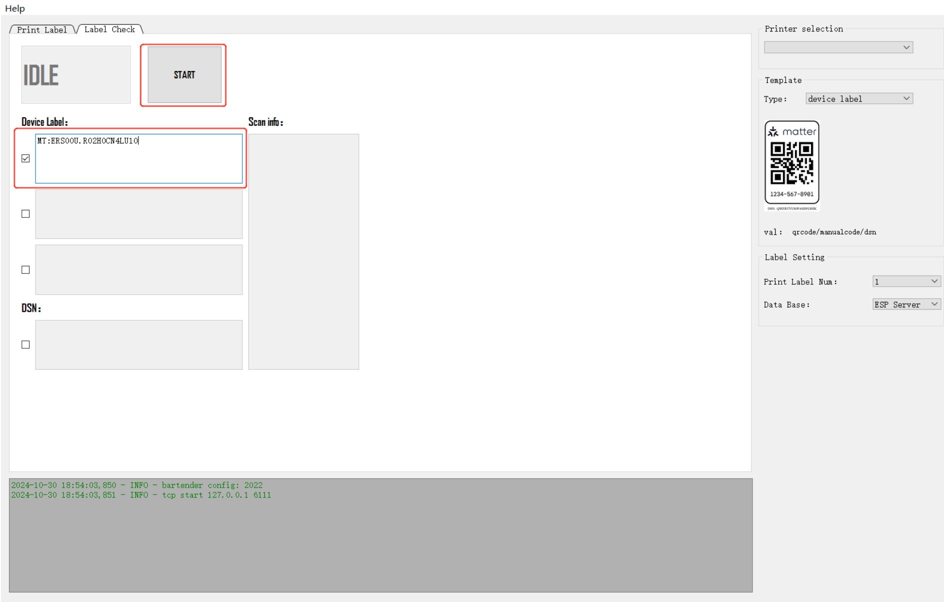


Fig. 112: QR code check (click to enlarge)

- To check the QR code, you need to use the configuration method of the scanning board, which corresponds to the `Method of get data: BLE boardcase` in the `Print Label` interface.
  - In the configuration file `facConfig`, set `getMacType = devboard`.
- Check the checkbox based on the number of device codes to be checked, so as to enable the corresponding number of device labels.
- To perform a DSN check (only applicable for Cyprus), check the checkbox to enable this feature.

10.5 Integrate Laser Marking

Currently, the QR code can be obtained over LAN, enabling integration with the laser marking machine.

Configuration

Table 17: TCPserverConfig

Configuration Item	Configuration Value	Description
server_enable	1	Enable LAN for QR code retrieval
ip	127.0.0.1	LAN address. If the laser marking host and this host are on the same PC, the loopback address can be used
port	6000	TCP communication port
qr_req_string	get_qrcode	The command to request QR code. This can be adjusted based on the configuration of the laser marking machine
manual_req_string	get_manualcode	The command to request manual code. This can be adjusted based on the configuration of the laser marking machine
dsn_req_string	get_dsncode	The command to request dsn code. This can be adjusted based on the configuration of the laser marking machine

10.6 Appendix I: Flash Scan Board Firmware

- To flash the scanning board firmware, the ESP32-C3 series development boards are required. Select the development board based on your needs.
- bin file path: `./files`
- Flash address: `0x0`

Flash tool download: Click here to download the flash tool

10.7 Appendix II: BarTender (2022) Installation Process

The following figures show the whole process of BarTender installation (Take BarTender 2022 as an example):

1. Check the advanced installation option checkbox.

Fig. 113: Choose advanced installation options (click to enlarge)

2. Use the default installation path.

Fig. 114: Default installation path (click to enlarge)

3. The installation process is as follows.

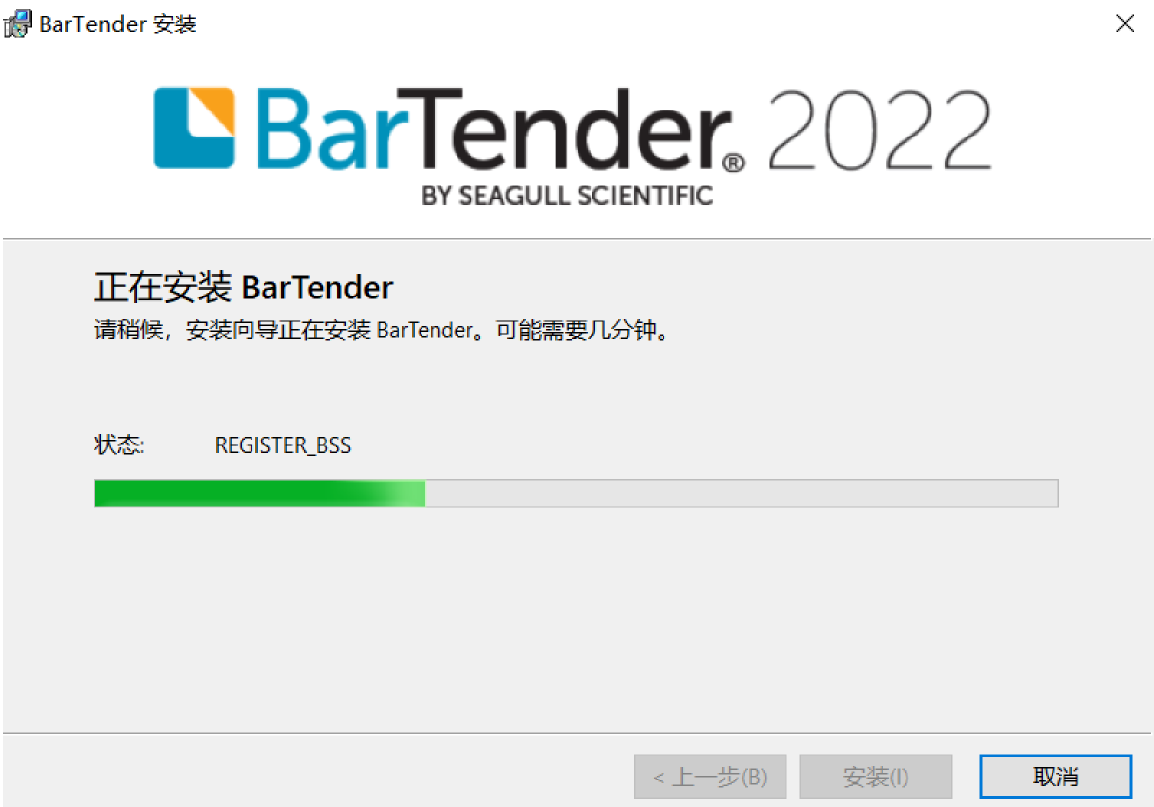


Fig. 115: BarTender Installing (click to enlarge)

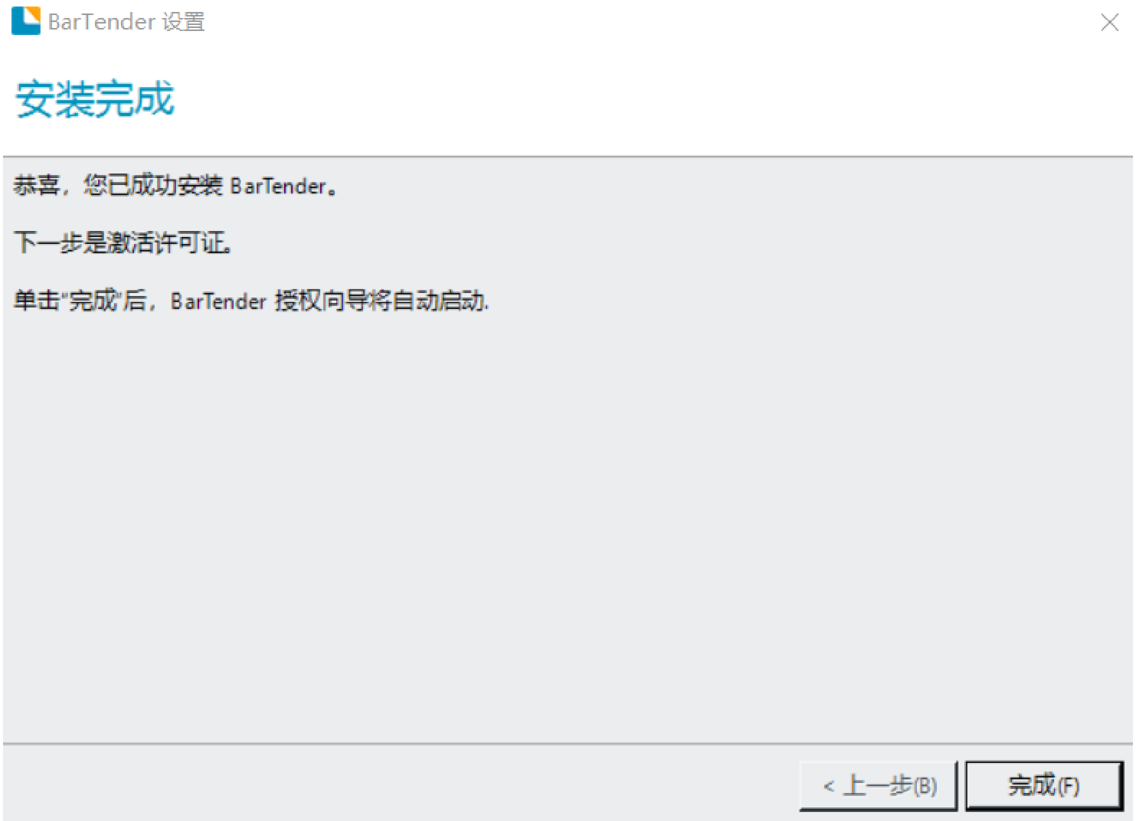


Fig. 116: Installation completed (click to enlarge)

4. Enter the serial number to activate BarTender.

Fig. 117: Enter serial number (click to enlarge)

11 FAQ

- *RF Testing FAQs* offers answers to common questions about *EspRFTestTool Toolkit* and *RF Test Items*.
- *WFA Certification Test FAQs* address common questions regarding the *WFA Certification and Testing Guide*.
- *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*.

11.1 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.

11.2 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.

11.3 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:

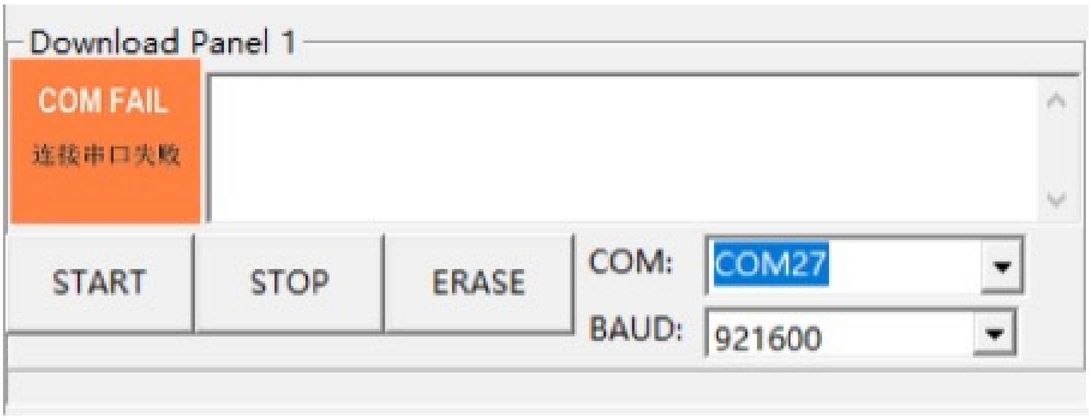


Fig. 118: Connection Failure of Serial Port

- 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?

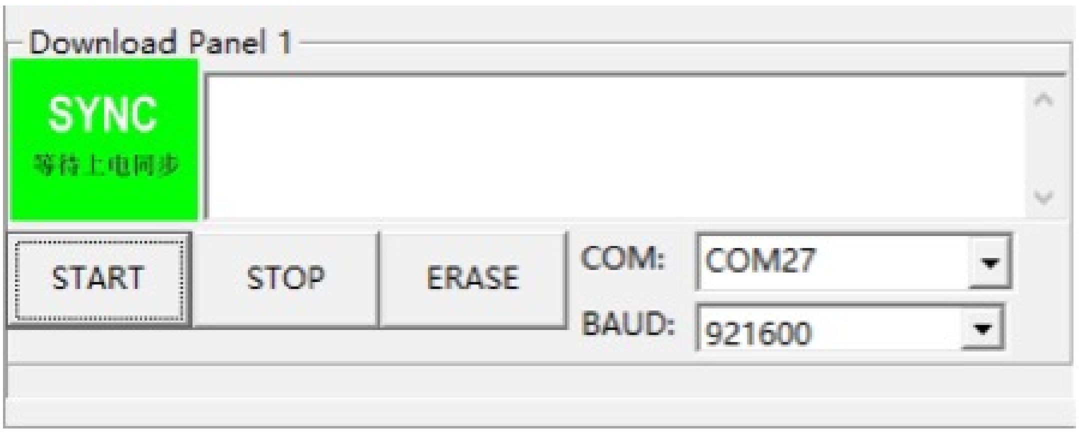


Fig. 119: Download Panel

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. 120: 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.

11.4 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.

12 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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