GigaDevice Semiconductor Inc.

GD32W51x Certification Test Guide

Application Note
AN083

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1. Introduction

This application note is mainly used to guide users to test the GD32W51x series device RF (radio frequency) related certification regulations, which mainly refer to FCC / CE / SRRC, etc. This application note introduces the hardware and software configuration of DUT (device under testing), the method of testing Tx / Rx (transmit / receive) indicators of non-signaling modes in each certification using RF testing tools, and the method of testing "Blocking" and “Adaptivity” indicators of signaling modes in CE certification using serial port command line.

2. Test preparation

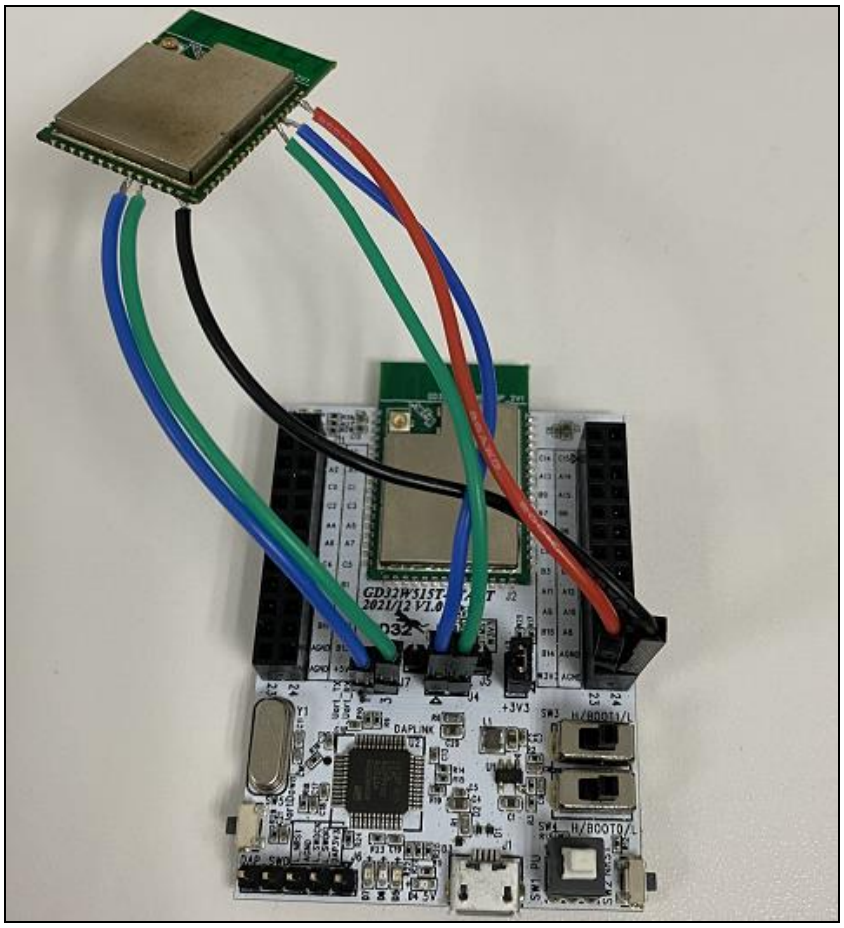
This chapter is about the preparation for the certification test, mainly about the construction of DUT hardware and software platform.

2.1. Hardware configuration

The hardware platform is mainly consists of the serial port bottom board and the DUT (***Figure 2-1. Single module reference connection***, the GD module and development board are used as examples for DUT / serial port bottom board). The DUT requires that the shield be welded to ensure that the certified radiation indicator meets the requirements. The hardware configuration of the DUT is as follows:

- The following PINs of GD module need to be led with DuPont wires: 3V3, GND, PB15 / PA8 (UART Tx / Rx, for serial communication), PA13 / PA14 (SWD_TMS / CLK, for burning firmware), BOOT0, NRST, PU (NRST and PU pins are recommended to reserve a pull-up option on the GD module, then there is no need to pull out the lead).
- Configure chip PIN “BOOT0” = low level (boot mode is flash), “PU” and “NRST” = high level.
- PB15 / PA8, PA13 / PA14, and 3V3 / GND are respectively connected with pin1 / pin3 of J7, pin2 / pin1 of J4, and pin23 / pin24 of J10 on the bottom board of GD development board through DuPont wire.
- Antenna port configuration of GD module: for radiation measurement items, it needs to be connected to the antenna; for conduction measurement items, it needs to be connected to the instrument through RF cable.

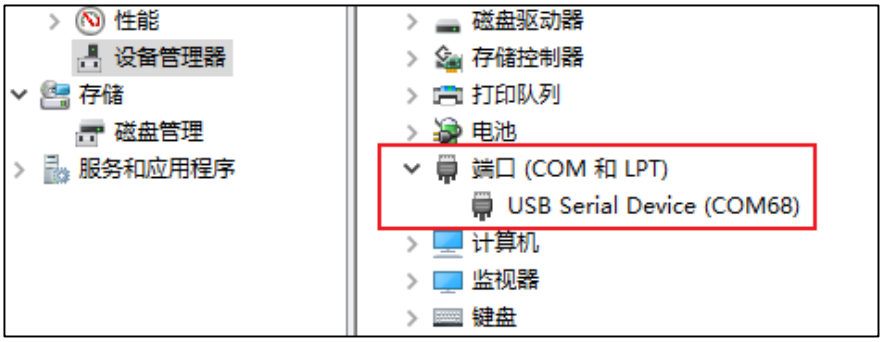
Figure 2-1. Single module reference connection



2.2. Software configuration

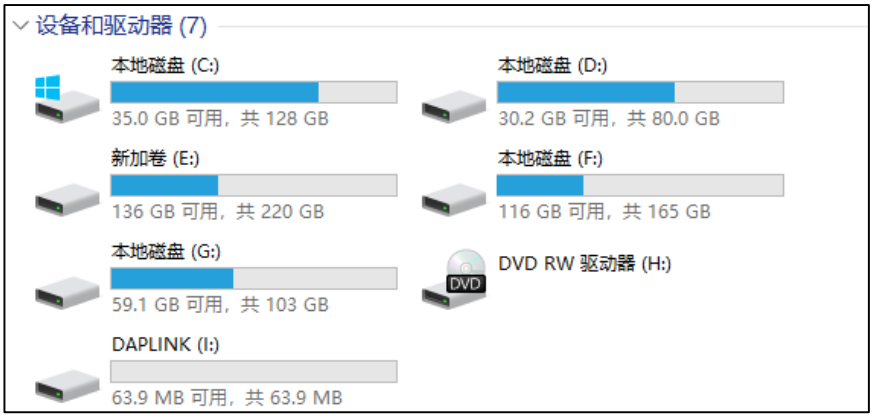
- Driver installation: After the module hardware is configured, connect both ends of the USB cable to the serial port bottom board and PC. Decompress the “mbedWinSerial_16466.rar” file and double-click the .exe file to install the DAPLINK driver on the PC. After the installation is complete, the serial port device and COM number (***Figure 2-2. Serial port driver installation***) are displayed in “Device Manager” on the PC. Windows 10 or Windows 7 is recommended for PC. If the bottom board is not a GD development board, install the serial port tool driver for the bottom board.

Figure 2-2. Serial port driver installation



- Firmware burning: After the DAPLINK driver is installed, the new “DAPLINK” drive letter can be displayed in the PC “Explorer”(*Figure 2-3. DAPLINK drive letter*). Directly drag and drop (or copy and paste) the test firmware to this drive letter and wait for a moment to realize the firmware burning, after completion, press the reset button to restart the chip. It should be noted here that the test firmware corresponding to the non-signaling and signaling mode test items is different and must not be confused. Another burning method is to connect “PA13 / PA14” PINs to J-link tool with DuPont wires (At the same time, another set of “3V3 / GND” DuPont wires should be connected to J-link).

Figure 2-3. DAPLINK drive letter



- Start the test: Use the GD RF test tool or the serial port command line to perform subsequent certification indicator tests.

3. Non-signaling indicator test

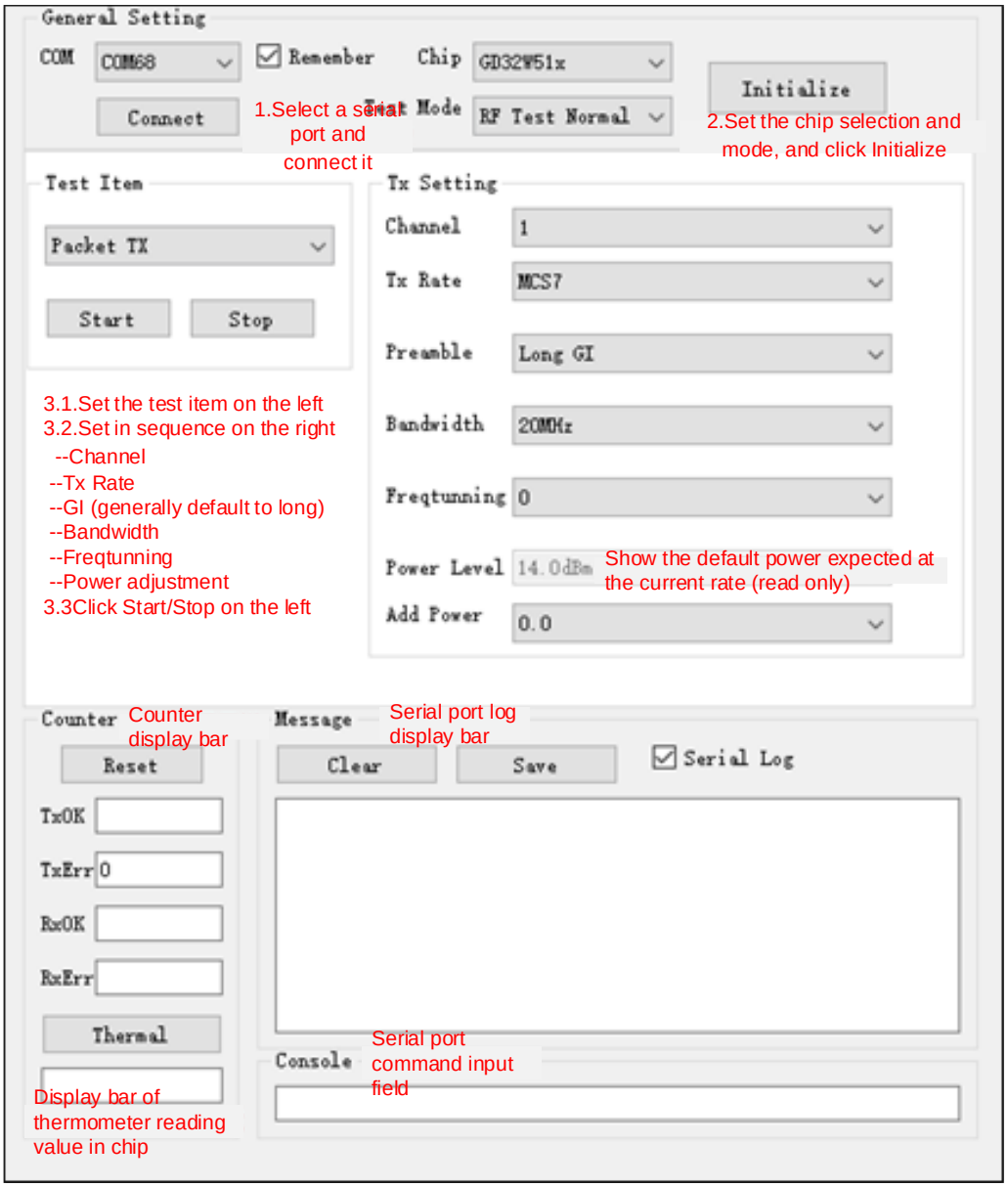
This chapter describes how to use RF test tools provided by GD to test Tx / Rx (transmit / receive) indicator of non-signaling mode in each certification. The following points should be noted:

- The firmware version named "image-all-rf-test.bin" provided by GD needs to be burned for non-signaling RF testing.
- The DUT must be PCB that has passed RF calibration (i.e. RF calibration value and regulatory set value, etc., have been correctly written into the chip Efuse).
- In this chapter, 100% duty cycle is used for Tx / Rx tests, and the default Tx power value is recommended.

3.1. Tool introduction

Figure 3-1. Tool function description shows the interface and function description of the RF Test Tool “GD RF Test Tool” provided by GD. It is opened for the first time (serial port is not connected & chip is not initialized).

Figure 3-1. Tool function description



3.2. Mode setting

1. The serial port connection: On the tool interface, select the serial port number corresponding to DUT from the “COM” drop-down menu and click “Connect”. Then the text displayed on the button changes to “Disconnect”, indicating that the serial port connection is successful. Then the “freqtunning” field is displayed as the calibrated value. If the serial port connection fails, an error message is displayed in the log window.
2. Mode setting: ***Table 3-1. Test mode*** shows the three test modes. For the test in this chapter, select “RF Test Normal” and click “Initialize”. At this time, the text displayed on the button changes to “De-initialize”, indicating that the RF test Normal mode is entered.
3. If the development board is rebooted or another development board needs to be replaced during the test, repeat steps 1-2. If the buttons show the previous states of “Disconnect”

and “De-initialize”, press them twice in succession to reconnect the serial port and initialize the chip mode.

Table 3-1. Test mode

Test mode	Description	RF calibration compensation value	Temperature compensation mechanism
MP mode	Used for RF calibration test (For the PCB where RF is not calibrated or needs to be recalibrated)	Close	Close
RF Test Normal	Used for RF indicator test at room temperature (For the PCB where RF is calibrated)	Open	Close
RF Test Temp	Used for high and low temperature RF indicator test (For the PCB where RF is calibrated)	Open	Open

3.3. Tx test

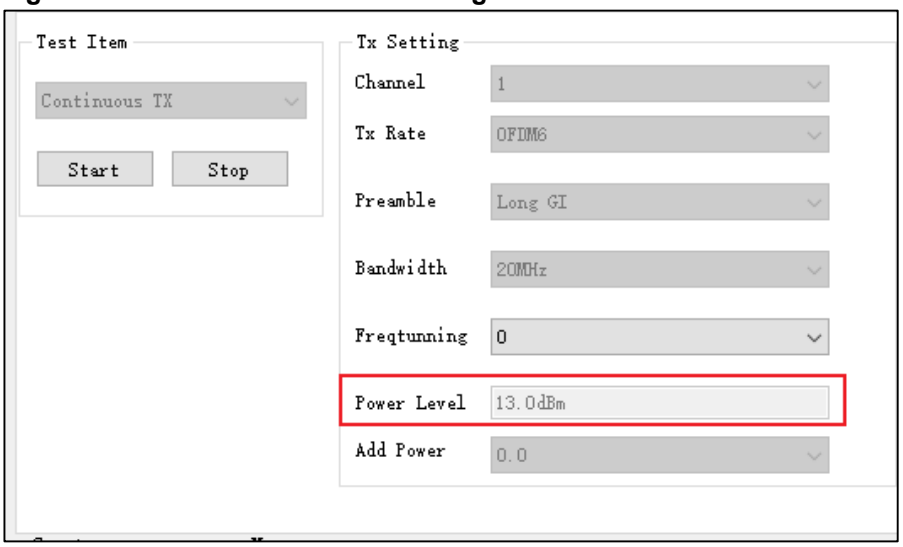
The Tx certification indicators include transmitted power, bandwidth usage, and TX radiation spurious. The Tx test is configured as follows. The Tx duty cycle of the chip is 100%

1. DUT settings: In tool interface, set “Test Item” = “Continuous TX”, set “Channel”, “Rate” and “Bandwidth”, click “Start”, then the chip will start Tx RF signal.
2. Start the certification test, and the peer instrument grabs the required data.
3. Tx adjustment: If the Power needs to be modified, click “Stop” to stop Tx, and then modify the value of “Add Power”, the step unit is 0.25db, and then click “Start”. At this time, the expected power should refer to the following formula:

   Expected power = Default Power (power level) + Power adjustment (Add Power)
4. If the frequency offset needs to be modified, the “Freqtuning” value can be adjusted at the same time. If the frequency offset is positive, the value needs to be increased; If the frequency offset is negative, the value needs to be reduced. The value can be adjusted during Tx test.
5. Temperature test (if necessary): Select “RF Test Temp” and initialize again, repeat steps 1-3. Note that the temperature compensation mechanism takes effect only after the Tx test is stopped and restarted at different ambient temperatures.

As shown in ***Figure 3-2. Continuous Tx Tool setting***, it means FCC certified Tx test, channel = 1(2412MHz), rate = 11G 6M, chip default power = 13dbm, Continuous Tx started.

Figure 3-2. Continuous Tx Tool setting



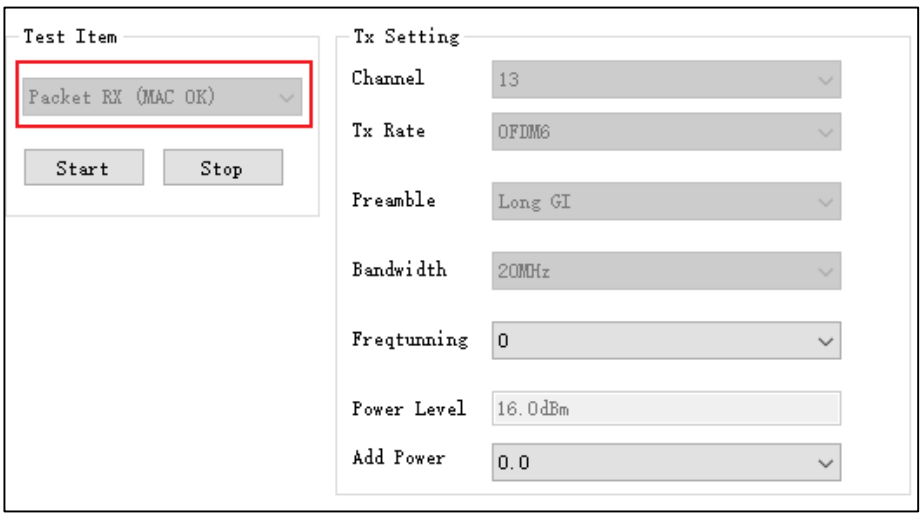
3.4. Rx test

The certified Rx indicator mainly refers to the Rx radiation spurious. The test is configured as follows, and the Rx duty ratio of the chip is 100%.

- Set “Test Item” to “Packet RX”, and set “Channel” and “Bandwidth”.
- Click “Start”. At this time, if the current environment is open, the numbers of RxOK and RxErr counters at the bottom left of the interface will change, indicating that the chip has correctly entered the receiving mode. At this time, the environment can be converted to a shielded environment, click “Reset” to clear the counter.
- Start the certification test, and the peer instrument grabs the required data.

Figure 3-3. Packet Rx Tool setting represents CE certified Rx radiation spurious test, channel = 13 (2472MHz).

Figure 3-3. Packet Rx Tool setting



4. Signaling indicator test

This chapter describes how to test the “Blocking” and “Adaptivity” indicators of CE certification in signaling mode using the serial port command line.

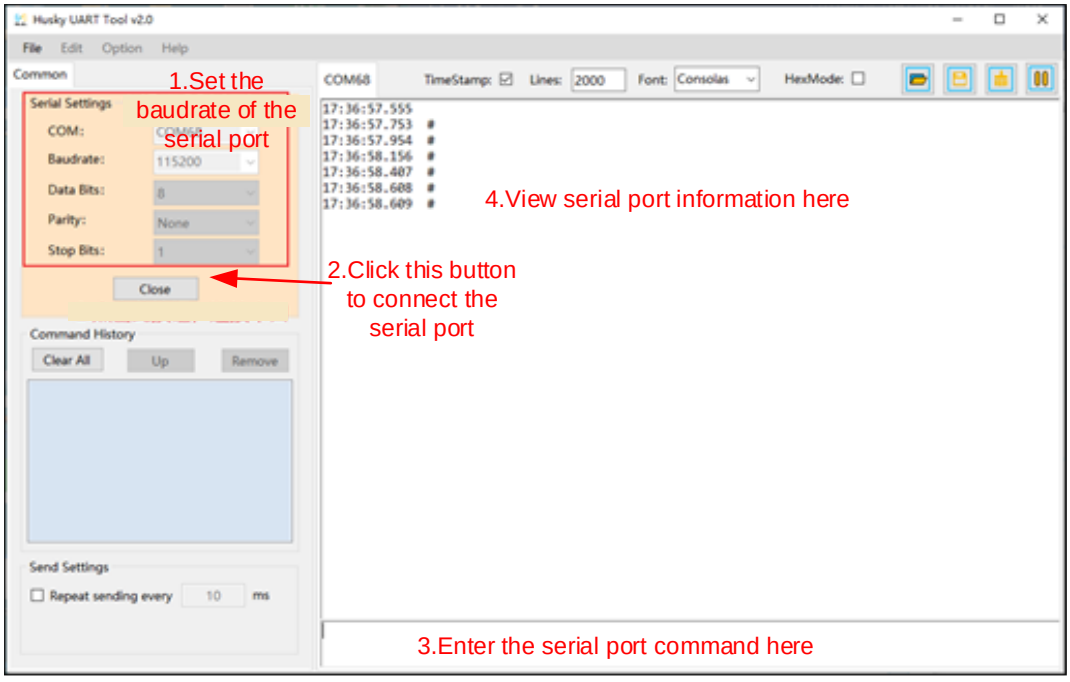
The following points should be noted:

- Burn the test firmware named “image-all-x.x.x.bin”(x.x.x indicates the version) for the connection test.
- The DUT must be PCB that has passed RF calibration (i.e. RF calibration value and regulatory set value, etc., have been correctly written into the chip Efuse).

4.1. Serial port tool

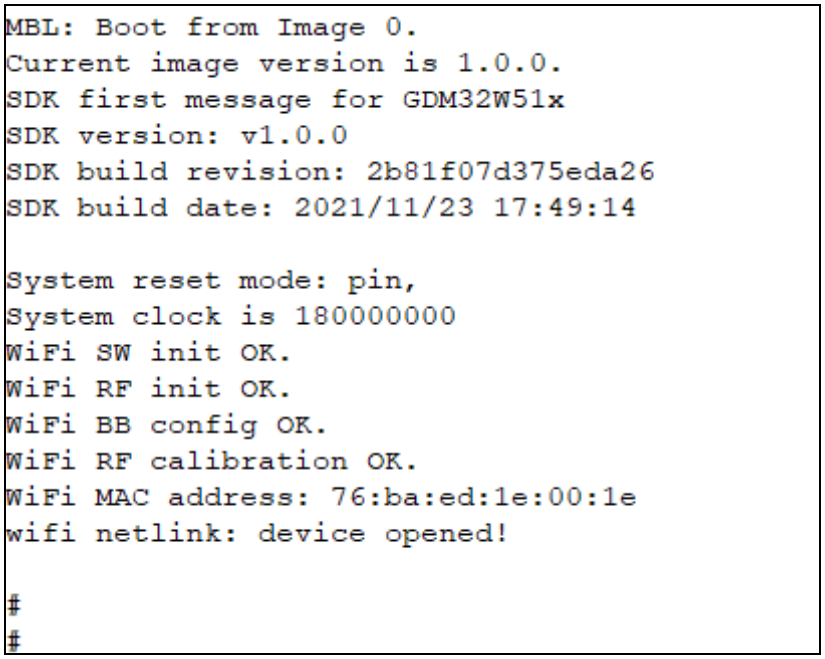
- Open the UART tool (the serial port tool “Husky Uart Tool” provided by GD is recommended) on the PC, click the “COM” menu, and select the COM port corresponding to the DUT. The default serial port configuration is shown in ***Figure 4-1. GD serial port tool***.

Figure 4-1. GD serial port tool



- Click the button to connect the serial port. If the "Reset" PIN is pushed down first and then up, the output box of the serial port will display log information, as shown in ***Figure 4-2. Startup information***. At this time, click the left mouse button in the input box of the serial port and press the keyboard "Enter", and "#" will be displayed in the log window.

Figure 4-2. Startup information



4.2. Preparatory work

In the certification indicator test of ***Blocking test*** and ***Adaptivity test***,the DUT must be connected to the AP. Use the following serial port commands:

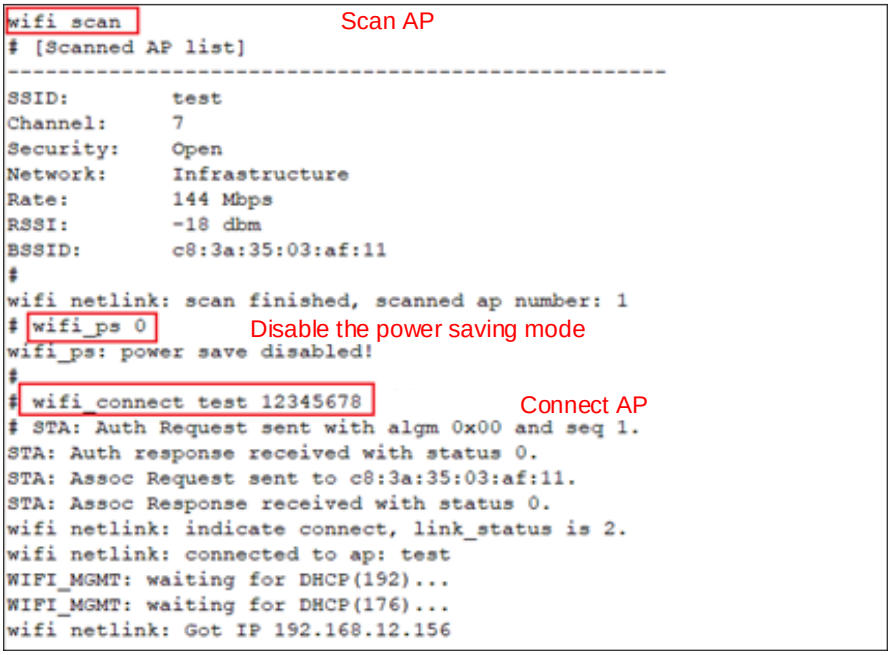
- For Reset chip:
  - reboot
- Scan for aps in the environment and print AP information, such as SSID and encryption mode, on the serial port tool:
  - wifi_scan
- Use to turn off the saving mechanism after connecting to the AP:
  - wifi_ps 0
- Connect the DUT to the AP. <SSID> in the command is the SSID of the AP, and [PASSWORD] is the PASSWORD of the AP. If the AP encryption mode is open, [PASSWORD] is not required:
  - wifi_connect <SSID> [PASSWORD]
- View connection information about the DUT, for example, the IP address of the DUT:
  - wifi_status
- Used for ***Blocking test*** set the chip to start TCP Tx. The parameter <ip addr> indicates the IP address of the Server, the parameter <port> must be the same as that of the command on the Server, the parameter <interval> is used to set the interval for displaying logs, and the parameter <length> indicates the size of TCP packets in byte, 1460 is recommended for TCP testing. <time> Indicates the time of data transmission:
  - iperf3 -c <ip addr> -l <length> -p <port> -i <interval> -t <time>

4.3. Blocking test

This is one of the CE certification indicators. The certification laboratory usually uses signaling comprehensive test instrument such as “CMW500”. The instrument acts as AP, and after connecting the DUT to the instrument, the instrument can control the DUT for Rx test. The steps to set the DUT are as follows:

- Enter the “reboot” command through the serial port to reset the chip.
- Enter the “wifi_scan” command through the serial port to scan for APs.
- Enter the “wifi_ps 0” command through the serial port to disable the power saving mechanism.
- Enter the “wifi_connect <SSID> [PASSWORD]” command through the serial port to connect to the specified AP.
- Enter the “wifi_status” command through the serial port to confirm the cable connection status. The DUT is connected to the AP, as shown in ***Figure 4-3. The DUT connects to the AP***.

Figure 4-3. The DUT connects to the AP



4.4. Adaptivity test

This is one of the CE certification indicators. The DUT needs to be connected to the test AP of the certification laboratory, and the DUT needs to open TCP Tx. The test steps are as follows:

- Enter the “reboot” command through the serial port to reset the chip.
- Connect the DUT to the specified AP, as in the previous section.
- Run the iperf3 -s -p <port> -i 1 command on the laboratory PC Server. <port> is used to set the port.
- Turn on TCP Tx on the DUT and run the “iperf3 -c 192.168.xx.xx -l 1460 -p <port> -i 1 -t

1000” command through the serial port. “192.168.xx.xx” indicates the IP address of the Server, and <port> must be the same as that of the Server.

DUT starts TCP Tx, as shown in *Figure 4-4. DUT TCP Tx*.

Figure 4-4. DUT TCP Tx

```
16:18:36.097  Iperf3: start iperf3 client!
16:18:36.100  # iperf3 client: Connecting to host 192.168.3.12, port 5002
16:18:36.149  iperf3 client: [  1] local 192.168.3.11 port 59712 connected to 192.168.3.12 port 5002
16:18:37.335  iperf3 client: [ ID] Interval           Transfer     Bandwidth
16:18:37.340  iperf3 client: [  1]   0.00-1.00   sec  2.55 MBytes  21.4 Mbits/sec
16:18:38.329  iperf3 client: [  1]   1.00-2.00   sec  2.75 MBytes  23.0 Mbits/sec
16:18:39.385  iperf3 client: [  1]   2.00-3.00   sec  2.79 MBytes  23.3 Mbits/sec
16:18:40.381  iperf3 client: [  1]   3.00-4.00   sec  2.97 MBytes  25.0 Mbits/sec
16:18:41.374  iperf3 client: [  1]   4.00-5.01   sec  3.29 MBytes  27.4 Mbits/sec
16:18:42.373  iperf3 client: [  1]   5.01-6.00   sec  2.63 MBytes  22.2 Mbits/sec
16:18:43.367  iperf3 client: [  1]   6.00-7.00   sec  2.35 MBytes  19.7 Mbits/sec
16:18:44.424  iperf3 client: [  1]   7.00-8.01   sec  2.85 MBytes  23.7 Mbits/sec
16:18:45.418  iperf3 client: [  1]   8.01-9.00   sec  3.08 MBytes  25.9 Mbits/sec
16:18:46.416  iperf3 client: [  1]   9.00-10.00  sec  3.26 MBytes  27.3 Mbits/sec
16:18:47.409  iperf3 client: [  1]  10.00-11.00  sec  3.31 MBytes  27.9 Mbits/sec
```

5. Q&A

- Q: In non-signaling indicator test, chip initialization failed in RF test tool:
  A: Check whether the firmware version burned in the DUT is the RF test firmware “image-all-rf-test.bin”. Use the Husky Tool to check whether the serial port communication is normal and whether the commands such as input mode setting are valid.

- Q: FCC radiation spurious indicator fail:
  A: Verify that the module has properly welded shields.
  Check whether the chip Efuse regulation settings are consistent with the certification. Otherwise, the default power may be different.
  If it is harmonic fail, confirm whether the module RF output matching circuit has been debugged.

- Q: Low frequency (<1GHz) radiation spurious indicator fail:
  A: Troubleshoot interference in the test environment.
  Check for interference caused by the PC, serial port, power supply baseboard, and USB cable.

- Q: Adaptivity indicator fail:
  A: Check whether the power saving mode of the chip is disabled.
  Adjust the attenuation value added by the AP antenna of the certification laboratory. The attenuation value should not be too large.

6. Revision history

Table 6-1. Revision history

Revision No.	Description	Date
1.0	Initial Release	Jan.06, 2023

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