GigaDevice Semiconductor Inc.

GD32W51x Throughput and Power Consumption Test Guide

Application Note
AN085

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1. Introduction

This application note is intended to guide customers to test the transmit and receive throughput of the Wi-Fi development board corresponding to the GD32W51x series devices in signaling mode and power consumption in various scenarios.

This application note is mainly divided into two parts to introduce, the first part of the test system, including the development board hardware and software configuration; The second part is the introduction of test methods, including throughput and power consumption test in various scenarios.

2. Test preparation

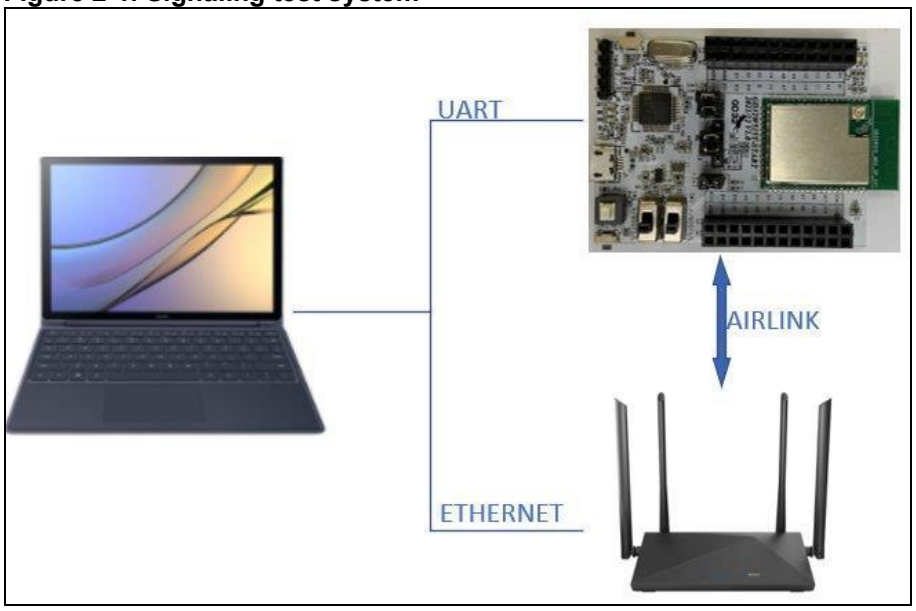
This chapter is the preparation of signaling test, including the construction of test system, hardware and software platform. The section of hardware configuration contains the configuration description of GD32 development board (module).

2.1. System construction

The signaling test system consists of PC, DUT(Device Under Test), and AP (Access Point) (***Figure 2-1. Signaling test system***).

The PC controls the DUT and AP through UART(USB-to-UART) and Ethernet respectively, to test the DUT throughput and scenario power consumption index. The DUT and AP interact wirelessly.

Figure 2-1. Signaling test system



2.2. Hardware configuration

The DUT is the GD32 development board (***Figure 2-2. The GD32 development board reference connection***, baseboard + module):

- UART&SWD function: USB-to-UART communication function and USB-to-SWD burning firmware function through the DAP chip circuit on the baseboard to complete, PC through the USB cable connected to USB interface on the baseboard.
- Serial port connection: To connect the main chip UART PIN to the DAP UART PIN, use the jumper caps to connect pin 1 to pin 2 and pin 3 to pin 4 of J7 on the baseboard, respectively.
- SWD connection: To connect the main chip SWD PIN to the DAP SWD PIN, use the

jumper caps to connect pin 3 and pin 2 of J5 to pin 1 and pin 2 of J4 respectively on the baseboard.

- Main chip mode configuration:

  -- The PIN “BOOT0” must be set to a low level (the boot source is flash memory) and implemented through the dip switch “SW4” on the baseboard.

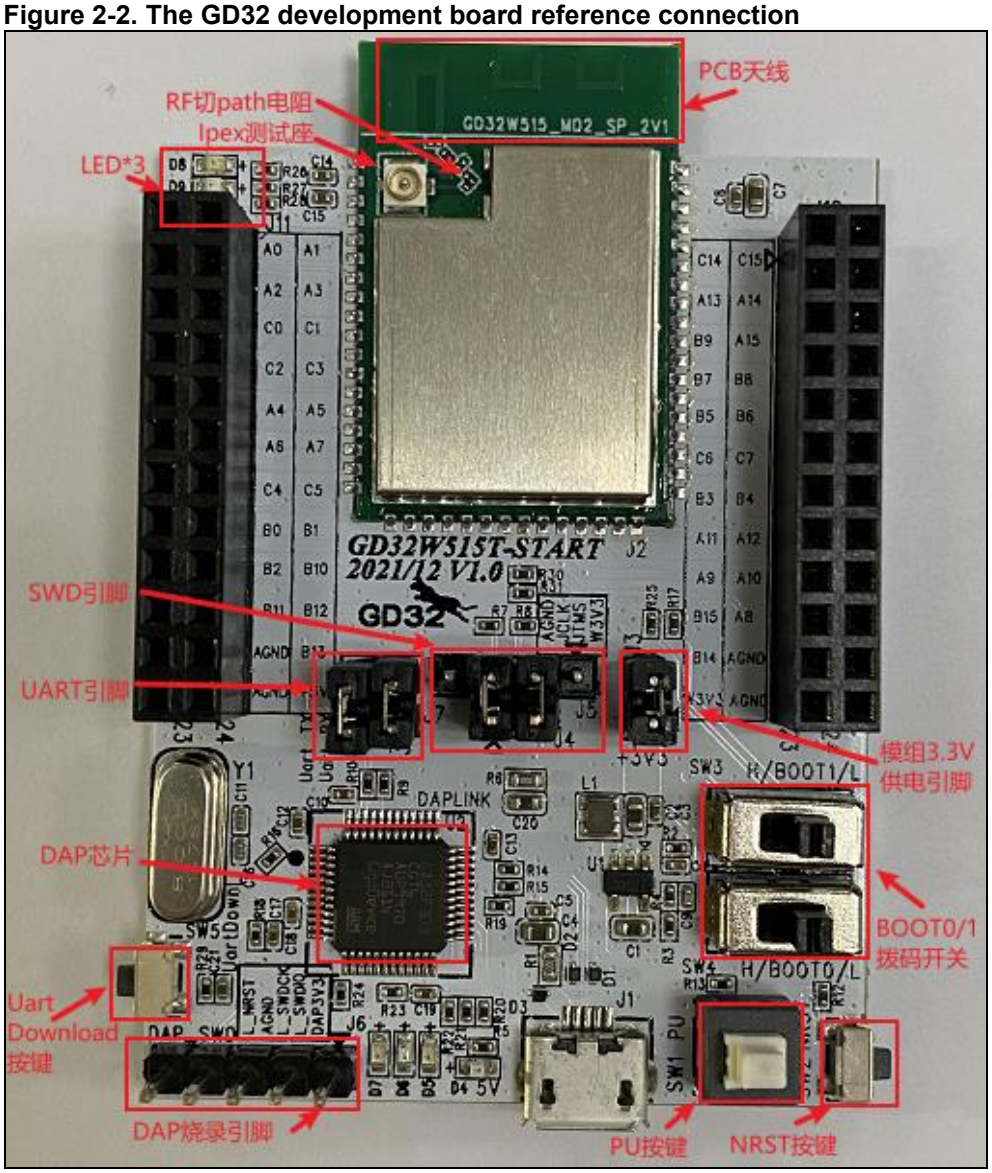
  -- The PIN “PU” must be set to a high level and can be achieved by pressing switch “SW1” on the baseboard.

- Module antenna switching:

  -- Select the DUT RF signal pathway by welding the switching resistance position (***Figure 2-2. The GD32 development board reference connection***): When the resistance left side is upward, the RF path leads to the PCB antenna, which can only be used for radiation test. When the resistance left side is downward, the RF path leads to RF (Ipex) test seat, which can be used for conduction test and external antenna radiation test. This guide focuses on radiation test.

- Module power supply: The DC - DC circuit of the baseboard converts the 5V power supply input by USB interface into 3V3 output, and 3V3 is connected to the module 3V3 solder pad through the jumper cap “J3”. Disconnecting this jumper cap (external supply 3V3 to pin 2 of J3) can be used for the module power consumption test.

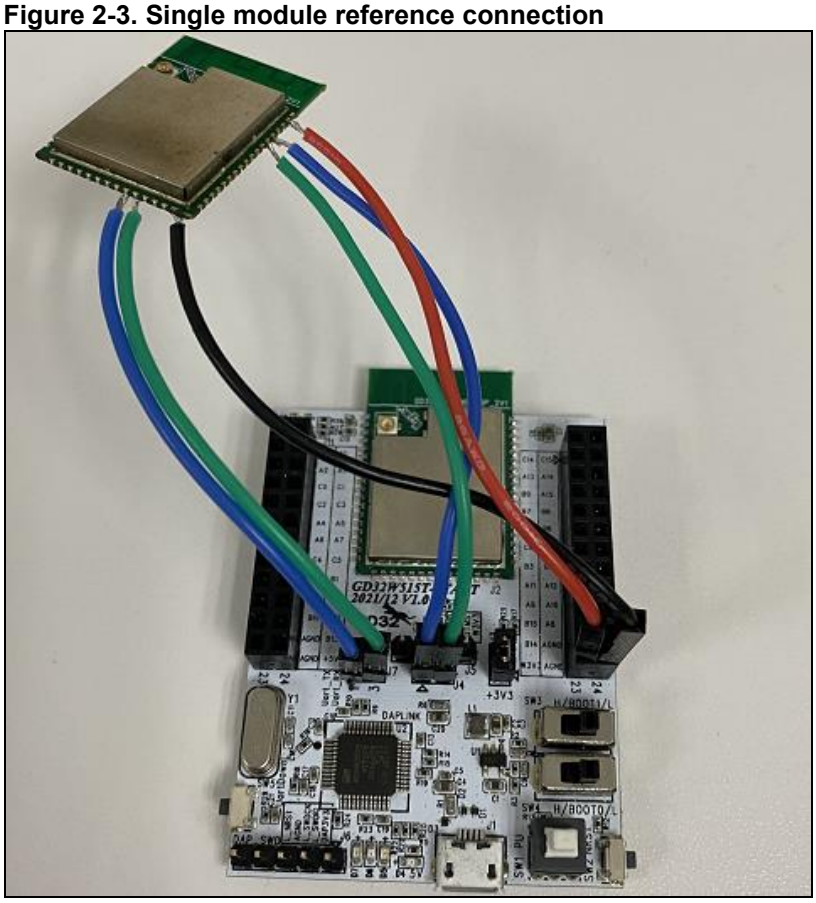
Figure 2-2. The GD32 development board reference connection



DUT is a single module (*Figure 2-3. Single module reference connection* , take the modules in the above development board as an example):

- The module shall use Dupont wire to lead out the following PIN pins: 3V3、GND、PB15 / PA8 (UART TX / RX, used for serial port communication)、PA13 / PA14 (SWD_TMS / CLK, used to burn firmware)、BOOT0、NRST、PU (The NRST / PU pin is recommended to reserve a pull-up option on the module, so no pull-out of the lead is required).
- Configure chip PIN "BOOT0" = low level (boot mode is flash), "PU" and "NRST" = high level.
- PB15 / PA8, PA13 / PA14, 3V3 and GND are connected with pin 1 and pin3 of J7, pin 2 and pin 1 of J4 and pin 23 and pin 24 of J10 on the baseboard of the GD32 development board respectively through Dupont wires.
- For the antenna configuration of the module, refer to point 5 of the development board configuration above.

Figure 2-3. Single module reference connection



2.3. Software configuration

2.3.1. Driver installation

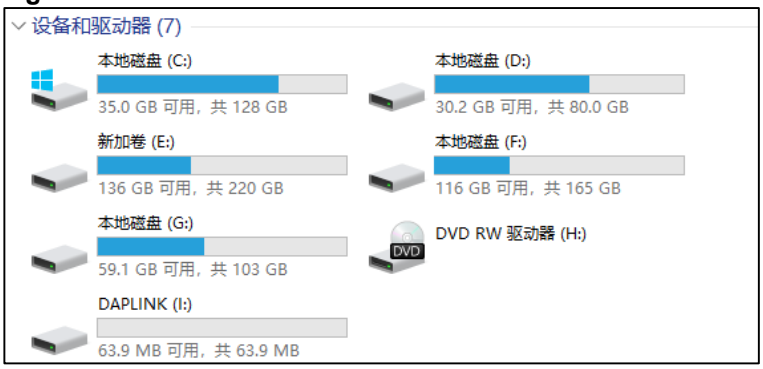
After the development board hardware and test system are set up, the two ends of the USB cable are connected to the development board and the PC respectively. First, install the DAPLINK driver “mbedWinSerial_16466.rar” on the PC terminal. After decompression, double-click the .exe file to start automatic installation. After the installation is complete, the serial port device and COM number can be displayed in the “Device Manager” on the PC (***Figure 2-4. Serial port driver installation***), PC recommended to use WIN10 / WIN7 system. If the baseboard is not a GD32 development board, please install the driver of the corresponding serial port tool.

Figure 2-4. Serial port driver installation

2.3.2. Firmware burning

After the DAPLINK driver is installed, the new "DAPLINK" drive letter can be displayed in PC-"Explorer" (*Figure 2-5. DAPLINK folder*), directly “drag and drop” (or copy and paste) the firmware named “image-all-x.x.x. bin” (“x.x.x” represents the version number) provided by GD32 to this drive letter and wait for a while to realize the firmware burning. After completion, press the “reset” key on the side of the development board to restart the chip. If this method is not used, it can also be burned by connecting the four pins “3V3/TMS/JCLK/GND” of J5 on the baseboard to the Jlink tool through Dupont wire.

Figure 2-5. DAPLINK folder



2.3.3. Start the test

Use the serial port tool and serial port command line to perform subsequent tests.

3. Throughput test

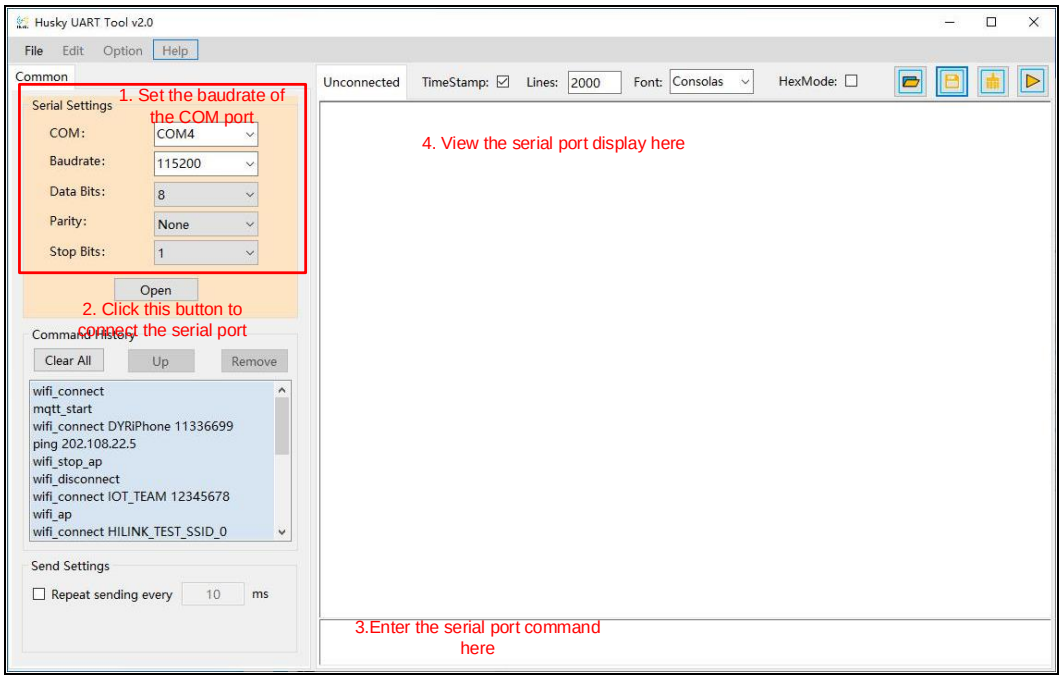
This chapter describes how to test TCP Tx / Rx and UDP Tx / Rx index in signaling mode by using serial port tools and commands. Considering that different degrees of interference in the open environment will affect the test results, the test environment in this chapter is required to be a shielded chamber environment.

The test results in this chapter reflect the throughput performance of the conventional mode of GD32W51x. GD32W51x also supports the mode of high throughput performance. The test results in the shielding chamber show that the UDP throughput is up to 90Mbps, and the TCP throughput is close to 60Mbps. Use the firmware named “image-all-high-performance. Bin” for the test. Refer to the ***Software configuration*** section for the burning method.

3.1. Serial port connection

1. After DUT is connected to the PC, open the UART tool on the PC (it is recommended to use the serial port tool “Husky Uart Tool” provided by GD32), click the “COM” drop-down menu, select the COM port corresponding to DUT, and click the “Open” button below to connect. The serial port configuration and connected status are shown in (***Figure 3-1. GD32 serial port tool)***.

Figure 3-1. GD32 serial port tool



2. If the serial port is connected, briefly press the “reset” button on the side of the DUT development board and release it (that is, the chip “reset” PIN is temporarily lowered). The log information will be displayed in the output box of the serial port as shown in ***Figure 3-2. Serial port startup information***, Click the left mouse button in the input box of the

serial port and press “Enter” on the keyboard. The log shows “#”:

Figure 3-2. Serial port startup information

```
GIGA DEVICE
MBL: Boot from Image 0.
Current image version is 1.0.0.
SDK first message for GDM32W51x
SDK version: v1.0.0
SDK build revision: 2b81f07d375eda26
SDK build date: 2021/11/23 17:49:14

System reset mode: pin,
System clock is 180000000
WiFi SW init OK.
WiFi RF init OK.
WiFi BB config OK.
WiFi RF calibration OK.
WiFi MAC address: 76:ba:ed:1e:00:1e
wifi netlink: device opened!

#
#
```

3.2. Preparatory work

The test from ***iPerf3 TCP Tx test*** to ***iPerf3 UDP Rx test*** requires that the DUT and PC connect to the same AP in wireless and wired mode, respectively. The serial port commands used by DUT to connect to AP are as follows:

1. wifi_scan

Scan for APs in the environment and print AP information, such as SSID and encryption mode, on the serial port tool.

2. wifi_connect <SSID> [PASSWORD]

Connect the DUT to the corresponding AP. In the command, <SSID> is the SSID of the AP, and [PASSWORD] is the password of the AP. If the AP encryption mode is open, the parameter [PASSWORD] does not need to be entered.

3. wifi_status

Query DUT connection information, such as the IP address of the DUT.

The test in the following chapter also requires the iperf3 program installed on the PC, which can be downloaded from the official website: ***https://iperf.fr/iperf-download.php#windows***, please select iPerf 3.1.2 version.

3.3. iPerf3 TCP Tx test

- Run the iperf3 program on the PC, it can use the CMD command line to execute the command:iperf3 -s -p <port> -i <interval>.

- The parameter <port> sets the port on which the Server listens, and the parameter <interval> sets the interval for printing test results (This is the Interval column in ***Figure 3-3. iperf3 TCP Tx***), the unit is second. For example: iperf3 -s -p 5002 -i 1.
- Run the command on the serial port tool: iperf3 -c <ip addr> -l <length> -p <port> -i <interval> -t <time>.
- The parameter <ip addr> indicates the IP address of the PC, the parameter <port> must be the same as parameter of the command on the PC, the parameter <interval> can be different from that on the PC, the parameter <length> indicates the size of the TCP packet sent in byte, in the TCP test ,1460 is recommended for <length>. The parameter <time> indicates the data transmission time. For example: iperf3 -c 192.168.3.12 -l 1460 -p 5002 -i 1 -t 30.

Note: The commands on the PC need to be adjusted based on the actual configuration, the following are the same.

After the test starts, the test results can be printed out in the serial port tool. As shown in ***Figure 3-3. iperf3 TCP Tx***.

Figure 3-3. iperf3 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
```

3.4. iPerf3 TCP Rx test

1) Run the command on the serial port tool: iperf3 -s -p <port> -i <interval>,take “<port>=5005,<interval>=1” as an example:iperf3 -s -p 5005 -i 1.
2) Run the iperf3 program on PC and execute the command: iperf3 -c <ip addr> -l 1460 -p <port> -i <interval> -t <time>, <ip addr> indicates the IP address of the DUT, for example: iperf3 -c 192.168.3.11 -l 1460 -p 5005 -i 1 -t 30.

The test result printed by the serial port is shown in ***Figure 3-4. iperf3 TCP Rx***.

Figure 3-4. iperf3 TCP Rx

```
16:22:48.317  iperf3 server:: -----------------------------------------------------------
16:22:48.319  iperf3 server:: Server listening on 5005
16:22:48.321  iperf3 server:: -----------------------------------------------------------
16:23:08.214  iperf3 server:: Accepted connection from 192.168.3.12, port 58982
16:23:08.219  iperf3 server:: [  2] local 192.168.3.11 port 5005 connected to 192.168.3.12 port 58983
16:23:09.213  iperf3 server:: [ ID] Interval           Transfer     Bandwidth
16:23:09.220  iperf3 server:: [  2]   0.00-1.00   sec  2.39 MBytes  20.1 Mbits/sec
16:23:10.274  iperf3 server:: [  2]   1.00-2.00   sec  2.56 MBytes  21.5 Mbits/sec
16:23:11.270  iperf3 server:: [  2]   2.00-3.00   sec  2.57 MBytes  21.5 Mbits/sec
16:23:12.266  iperf3 server:: [  2]   3.00-4.00   sec  2.43 MBytes  20.4 Mbits/sec
16:23:13.257  iperf3 server:: [  2]   4.00-5.00   sec  2.30 MBytes  19.3 Mbits/sec
16:23:14.249  iperf3 server:: [  2]   5.00-6.00   sec  2.29 MBytes  19.2 Mbits/sec
16:23:15.255  iperf3 server:: [  2]   6.00-7.00   sec  2.27 MBytes  19.0 Mbits/sec
16:23:16.308  iperf3 server:: [  2]   7.00-8.00   sec  2.42 MBytes  20.3 Mbits/sec
16:23:17.307  iperf3 server:: [  2]   8.00-9.00   sec  2.58 MBytes  21.7 Mbits/sec
```

3.5. iPerf3 UDP Tx test

1) Run the iperf3 program on PC and execute the command: iperf3 -s -p <port> -i <interval>, take “<port>=5002,<interval>=1” as an example: iperf3 -s -p 5002 -i 1.
2) Run the command on the serial port tool: iperf3 -c <ip addr> -l <length> -p <port> -i <interval> -t <time> -u –b <bandwidth>, <ip addr> indicates the IP address of the PC. In the UDP test, 1472 is recommended for <length>. <bandwidth> sets the upper limit of the UDP bandwidth, in bits/ sec. For example: iperf3 -c 192.168.3.12 -l 1472 -p 5002 -i 1 -t 30 -u -b 50M.

3.6. iPerf3 UDP Rx test

1) Run the command on the serial port tool: iperf3 -s -p <port> -i <interval>, take “<port>=5005, <interval>=1” as an example: iperf3 -s -p 5005 -i 1.
2) Run the iperf3 program on PC and execute the command: iperf3 -c <ip addr> -l 1472 -p <port> -i <interval> -t <time> -u –b 50M, <ip addr> indicates the IP address of the DUT. For example: iperf3 -c 192.168.3.11 -l 1472 -p 5005 -i 1 -t 30 -u –b 50M.

4. Scenario power consumption test

This chapter describes how to test power consumption in several typical scenarios in signaling mode. The test scenarios are described as follows:

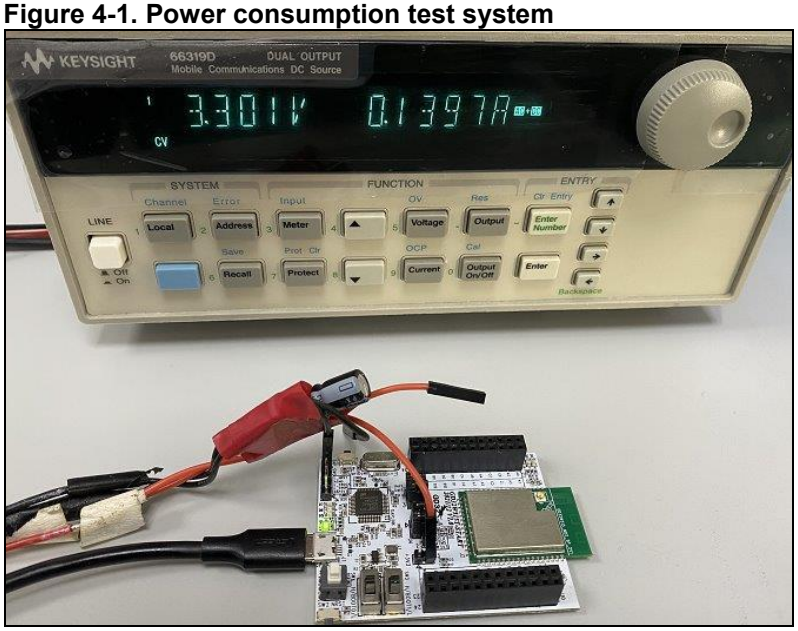
Table 4-1. Test scenarios

Scenario	Description
Wi-Fi is closed	After powering on, the MCU works and Wi-Fi is turned off
Connect the AP + UDP Tx	Connect to the AP, UDP Tx data
Connect the AP + UDP Rx	Connect to the AP, UDP Rx data
Connect the AP + power saving, DTIM = 1	Connect to the AP, enter power saving mode, DTIM = 1

4.1. Test preparation

- Test system: On the basis of ***Figure 2-1. Signaling test system***, an additional DC power is required to supply power to the module and capture current data in real time, such as Keysight 66319D(This instrument will be used in the following power tests).
- Instrument configuration: This is mainly for DC power supply, weld a Dupont wire to the end of the power line for conversion. Considering stable output voltage, it is recommended to weld a large electrolytic capacitor (e.g. 100uF) at the end of the power line. After starting up, first set the output voltage of the instrument to 3.3V, and then set the output state to “OFF”.
- Hardware preparation: The GD32 development board is used here to illustrate, refer to ***Figure 2-2. The GD32 development board reference connection***, the baseboard DC-DC circuit converts the 5V power input from the USB interface to 3.3V output, and 3.3V is connected to the 3.3V solder plate of the module through jumper cap “J3”. Disconnect the jumper cap J3 and connect the 3.3V/GND Dupont wire at the DC power output to pin 2 of J3 and any GND pins (jacks), respectively. As shown in ***Figure 4-1. Power consumption test system***, 3.3V/GND Dupont wires are connected to pin 2 of J3 and pin 4 of J6, respectively.
- Software preparation: The test firmware is the same as that used in the previous throughput index test. Please refer to the ***Software configuration*** chapter.
- Power-on sequence: First, change the DC power output status to “ON”, and then the meter current will change. Then connect the baseboard and PC with a USB cable. After the PC “Device Manager” identifies the serial port number, the power test consumption can be started through the serial command line.

Figure 4-1. Power consumption test system

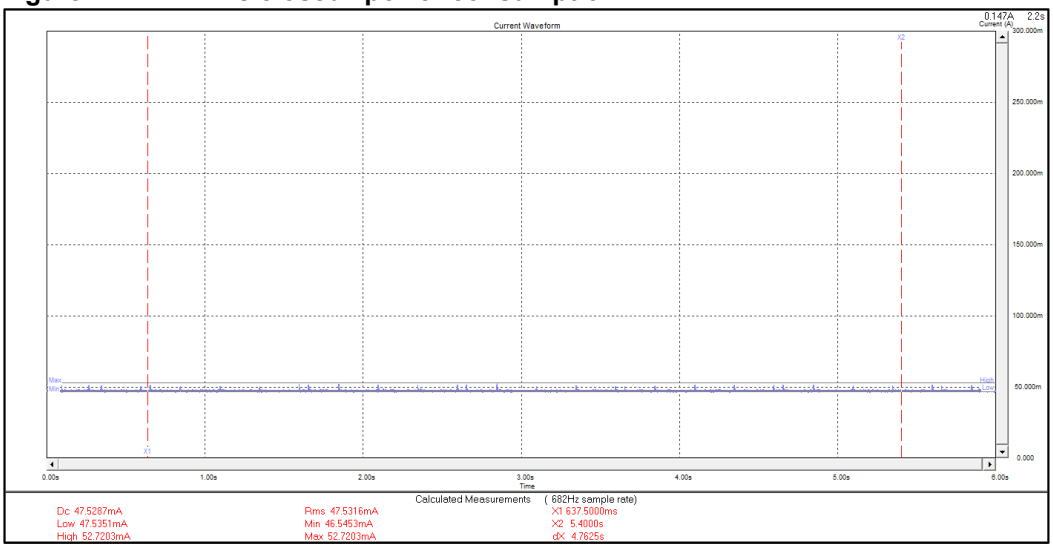


4.2. Wi-Fi is closed

Wi-Fi is opened by default after the chip is powered on. When testing the power consumption in this chapter scenario, Wi-Fi needs to be closed manually. After the test, Wi-Fi needs to be opened manually again to carry out other test items.

- Run the command on the serial port tool to close the Wi-Fi: wifi_close.
- After Wi-Fi is closed, use the DC power supply to capture power consumption data, as shown in ***Figure 4-2. "Wi-Fi is closed" power consumption***, the average power consumption in the captured time window is 47.5mA(the value in the DC column in the lower left of the picture).
- After the power consumption test is complete, run the following command to open Wi-Fi: wifi_open.

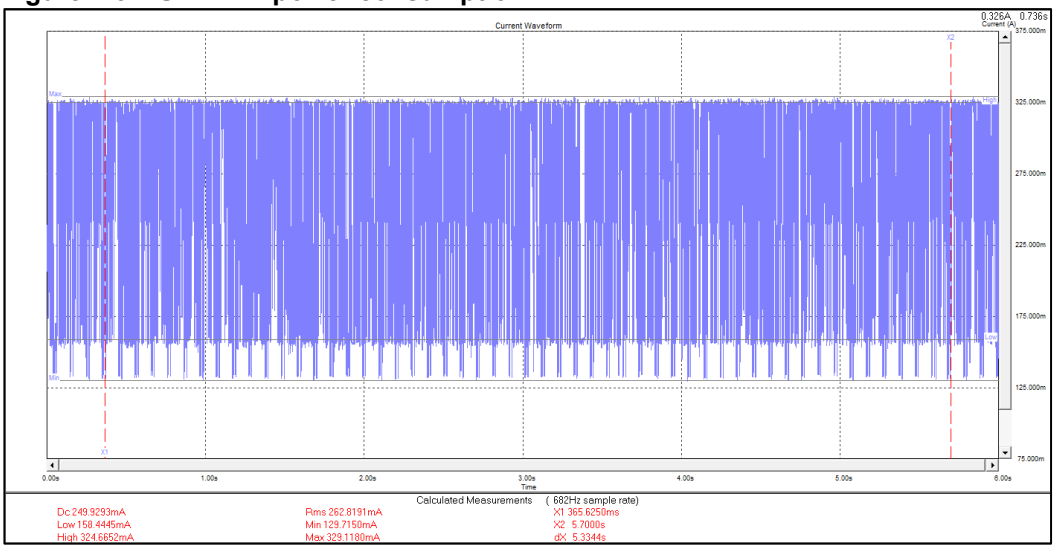
Figure 4-2. "Wi-Fi is closed" power consumption



4.3. Connect the AP+UDP Tx

- Refer to the ***Preparatory work*** chapter steps to connect AP.
- Refer to the ***iPerf3 UDP Tx test*** chapter steps to start iPerf3 UDP Tx test.
- In the process of UDP Tx test, DC power supply is used to capture power consumption data. Refer to ***Figure 4-3. "UDP Tx" power consumption***, the average power consumption is about 249.9mA(the value of "DC" column in the lower left of the picture).

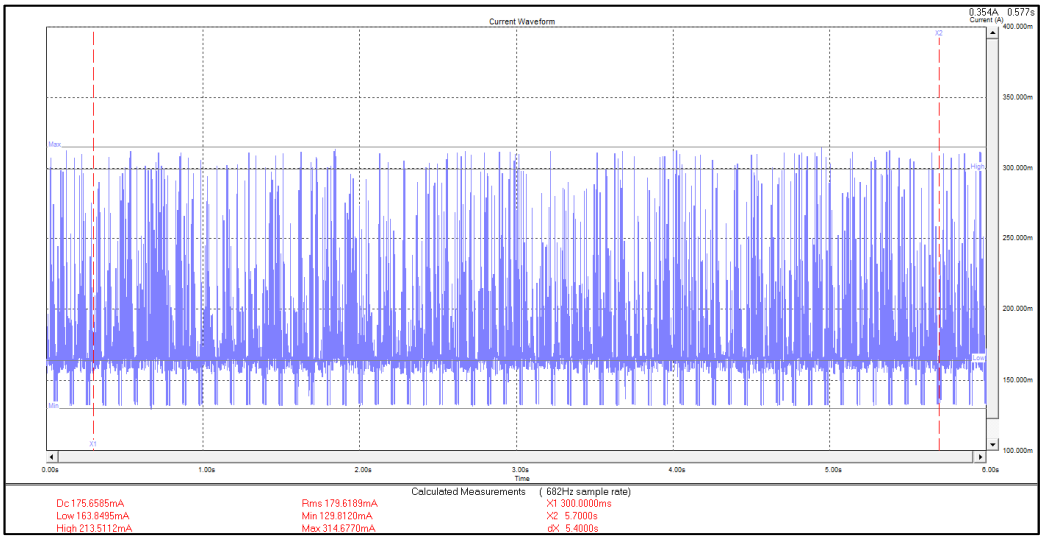
Figure 4-3. "UDP Tx" power consumption



4.4. Connect AP+UDP Rx

- Refer to the Preparatory work chapter steps to connect AP.
- Refer to the iPerf3 UDP Rx test chapter steps to start iPerf3 UDP Rx test.
- In the process of UDP Rx test, DC power supply is used to capture power consumption data., Refer to ***Figure 4-4. "UDP Rx" power consumption***, the average power consumption is about 175.7mA (the value of "DC" column in the lower left of the picture).

Figure 4-4. "UDP Rx" power consumption



4.5. Connect the AP+power saving, DTIM = 1

- The default value of the parameter DTIM of AP on the current market is 1, if not, please modify it on the configuration interface, as shown in ***Figure 4-5. Modify DTIM***.
- Refer to the ***Preparatory work*** chapter steps to connect AP.
- Run the following serial port command to set the chip to power saving mode: wifi_ps 2.
- After entering the power saving mode, use the DC power supply to capture the power consumption data, refer to ***Figure 4-6. "DTIM = 1"power consumption***, the average power consumption is about 1.45mA(the value of "DC" column in the lower left of the picture).

Figure 4-5. Modify DTIM

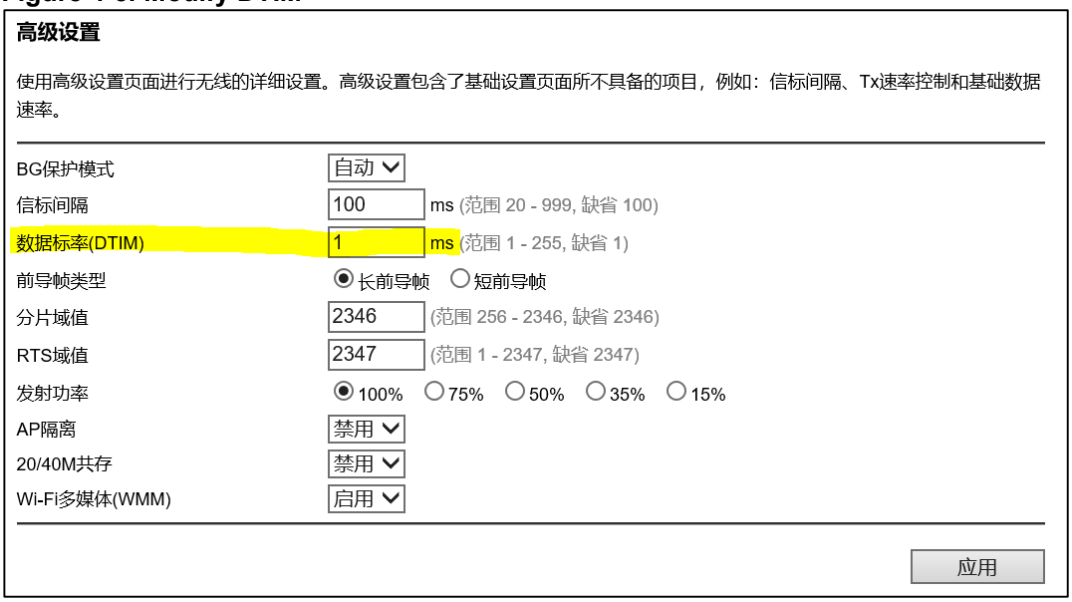
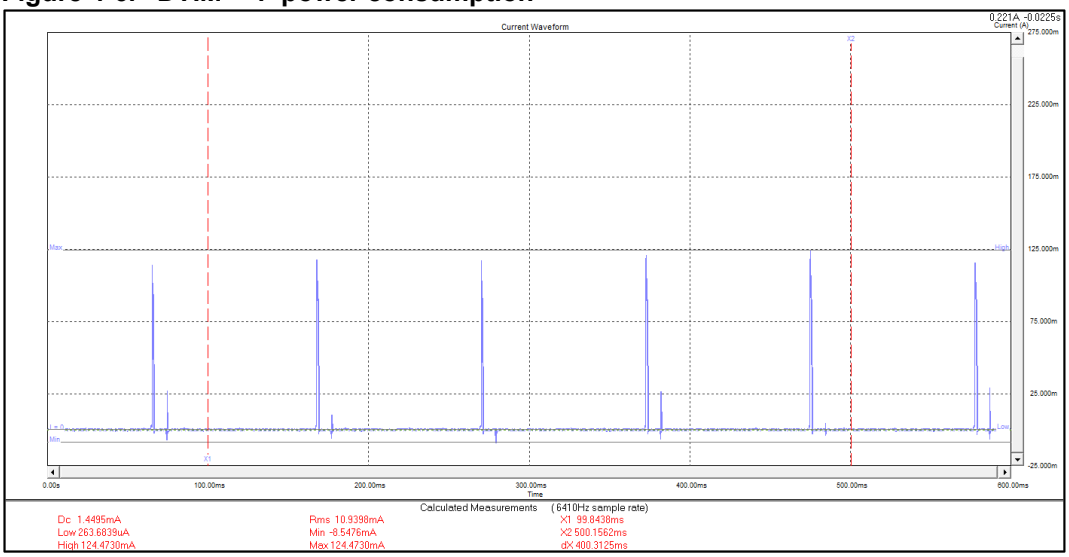


Figure 4-6. “DTIM = 1”power consumption



5. Q&A

Q: When using the serial port command to do the test, no log is returned after running the serial port command.

A: Try closing and opening the serial port tool.
Check that DUT hardware configuration and PIN (UART, NRST, PU, BOOT, 3V3, GND) connections are correct.

6. Revision history

Table 6-1. Revision history

Revision No.	Description	Date
1.0	Initial Release	Nov.23, 2021

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