Hi3861 V100 / Hi3861L V100 Demo Board Power Consumption

Test Guide

Issue 01

Date 2020-04-30

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About This Document

Purpose

This document describes how to test the power consumption of Hi3861 V100/ Hi3861L V100 and the precautions during the test.

NOTE

- For details about the power consumption of Hi3861, see the power consumption of Hi3861L. Hi3861 is the same as Hi3861L in terms of the static power consumption (in buck power supply mode). However, only Hi3861L supports an external RTC clock.
- Hi3861 supports the buck power supply mode and LDO power supply mode. The power consumption data of these two modes is different in low-power mode, always TX mode, always RX mode, and deep sleep mode.

Related Versions

The following table lists the product versions related to this document.

Product Name	Version
Hi3861	V100
Hi3861L	V100

Intended Audience

The document is intended for:

- PCB hardware development engineers
- Software engineers
- Technical support engineers

Symbol Conventions

The symbols that may be found in this document are defined as follows.

Symbol	Description
DANGER	Indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	Indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
NOTICE	Indicates a potentially hazardous situation which, if not avoided, could result in equipment damage, data loss, performance deterioration, or unanticipated results. NOTICE is used to address practices not related to personal injury.
NOTE	Supplements the important information in the main text. NOTE is used to address information not related to personal injury, equipment damage, and environment deterioration.

Change History

Issue	Date	Change Description
01	2020-04-30	This issue is the first official release. • In **Purpose** of **About This Document**, the NOTE about power consumption in two different power supply modes for Hi3861, Hi3861L, and Hi3861 is updated. • In **1.1 Environment Preparation**, the description of the test instrument is updated. • In **1.2 Hardware Cable Connection**, the NOTICE descriptions are added to **Step 2** of **Hardware Cable Connections for Deep Sleep and Ultra-Deep Sleep Modes**, **Step 2** of **Hardware Cable Connections for Power-Off Mode**, **Step 2** and **Step 3** of **Hardware Cable Connections for Always TX and RX Modes**. • In **2.3 Test Data**, the description of the ambient temperature is updated. **Table 2-1** is updated. • In **Step 3** of **3.2 Test Method**, the descriptions of J304 and J305 jumper caps are deleted. • In **3.3 Test Data**, the description of the ambient temperature is updated. **Table 3-1** is updated. • In **4.2 Test Data**, the description of the ambient temperature is updated. **Table 4-1** is updated. • **Step 2** of **5.1.2 Test Method** is updated. • **Table 5-1** of **5.1.3 Test Data** is updated. • **Step 2** and **Step 3** of **5.2.2 Test Method** are updated. • **Table 5-2** of **5.2.3 Test Conclusion** is updated. • **6.1 Test Command** is updated. • In **6.2 Test Method**, **Step 3** is updated. The NOICTE about testing the low power consumption of protocols is added. • In **6.3 Test Data**, the description that the beacon interval is set to 100 ms and DTIM is set to 1 on the AP side is deleted. The NOTE about the test environment is updated. **Table 6-1** is updated. • **7 Precautions** is updated.

Issue	Date	Change Description
00B06	2020-04-08	• In **Hardware Cable Connections for Deep Sleep and Ultra-Deep Sleep Modes**, **Hardware Cable Connections for Power-Off Mode**, and **Hardware Cable Connections for Always TX and RX Modes** of **1.2 Hardware Cable Connection**, pin 13 is changed to pin 14. • In **2.2 Test Method**, **Step 3** is updated. • In **4 Power-Off Mode**, the title is updated. • In **6 Lower-Power Mode**, the title is updated. • In **6.1 Test Command**, the command comments are updated. • In **6.2 Test Method**, **Step 1** is updated. • In **6.3 Test Data**, the NOTE about the test environment and AP configuration is updated.
00B05	2020-03-25	• In **1.1 Environment Preparation**, the description of the ambient temperature is added, and in other sections, the description of the normal temperature is deleted. • In **6.2 Test Method**, the description of the beacon period in **Step 1** is updated, and the procedure for testing three chips and obtaining the average value is deleted. • **6.3 Test Data** is added. • In **7 Precautions**, the precautions are added.
00B04	2020-03-06	In **1.2 Hardware Cable Connection**, the description of "floating the pin" in **Hardware Cable Connections for Deep Sleep and Ultra-Deep Sleep Modes**, **Hardware Cable Connections for Power-Off Mode**, and **Hardware Cable Connections for Always TX and RX Modes** is changed to "disconnecting from the mother board".
00B03	2020-02-26	In **7 Precautions**, the precautions for the low power consumption test are added.

Issue	Date	Change Description
00B02	2020-02-12	• In **About This Document**, the NOTE of "Purpose" is updated. • In **1.1 Environment Preparation**, the test instruments and software are updated. • In **1.2 Hardware Cable Connection**, the cable connection procedures and diagrams in **Hardware Cable Connections for Deep Sleep and Ultra-Deep Sleep Modes**, **Hardware Cable Connections for Power-Off Mode**, and **Hardware Cable Connections for Always TX and RX Modes** are updated. • In **2 Deep Sleep Mode**, the test command, test method, and test data are updated. • In **3 Ultra-Deep Sleep Mode**, the test command, test method, and test data are updated. • In **4 Power-Off Mode**, the test method and test data are updated. • In **5 Always TX and RX Functions**, the test command, test method, and test data are updated. • In **6 Lower-Power Mode**, the test command and test method are added. • In **7 Precautions**, the precautions related to ultra-deep sleep tests are deleted.
00B01	2020-01-15	This issue is the first draft release.

Contents

1 Preparations

1.1 Environment Preparation

- Test instruments: one DC power Keysight N6705C (accurate to μA), one radio communication tester, one router, one Hi3861L_BUCK module (with a mother board), and one Hi3861_BUCK module (with a mother board), one Hi3861_LDO module (with a bottom plate), and one PC
- Test software: HiBurn and UART port debugging tool
- Ambient temperature: 25°C (77°F)

1.2 Hardware Cable Connection

NOTICE

During the test, if the DC power supply has voltage feedback, keep the distance between the feedback point and the test point as short as possible. Ensure that the voltage added to the chip port is the same as the voltage set for the power supply. Otherwise, the test result will be affected.

Hardware Cable Connections for Deep Sleep and Ultra-Deep Sleep Modes

To connect cables for deep sleep and ultra-deep sleep modes, perform the following steps (as shown in **Figure 1-1**):

Step 1 Disconnect pins 1–8, pin 10, and pins 14–15 on the module from the mother board (pins in the black dashed boxes in the following figure). You are advised to use insulation tape between the module and the mother board to ensure complete insulation.

Step 2 Solder the red DuPont cable to pin 1 (3V3), and solder the black DuPont cable to pin 18 (GND). In addition, connect a 330-kilohm resistor between the 3V3 and EN

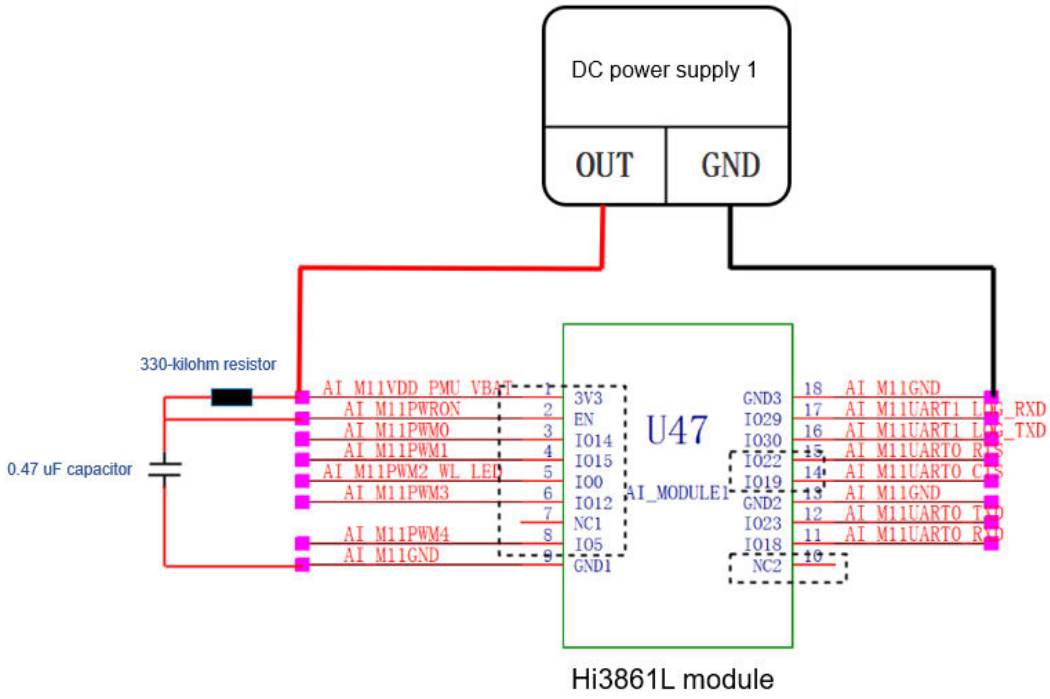
pins, and connect a 0.47 μF capacitor to the EN pin. Use a DC power supply to supply 3.3 V power to the board. (Use a multimeter to measure the voltage of the pin to prevent the voltage of the port connected to the chip from being not 3.3 V due to line loss.)

Note: The purpose of separating the 3.3 V and EN pins from the serial port mother board is to separate this 3.3 V power supply from the 3.3 V power supply of the serial port mother board. Otherwise, the power consumption of the mother board is counted when the chip power consumption is calculated. The purpose of disconnecting the GPIO except the serial port is to prevent the current leakage caused by the loop between the I/O and the mother board.

Step 3 Connect antennas to the board. (Skip this step if you use onboard antennas.)

----End

Figure 1-1 Hardware circuit connections for deep sleep and ultra-deep sleep modes



Hardware Cable Connections for Power-Off Mode

To connect cables for the power-off mode, perform the following steps (as shown in **Figure 1-2**):

Step 1 Disconnect pins 1–8, pin 10, and pins 14–15 on the module from the mother board (pins in the black dashed boxes in the following figure). You are advised to use insulation tape between the module and the mother board to ensure complete insulation.

Step 2 Solder the red DuPont cable to pin 1 (3V3), and solder the black DuPont cable to pin 18 (GND). Connect pin 2 to ground. Use a DC power supply to supply 3.3 V power to the board. (Use a multimeter to measure the voltage of the pin to

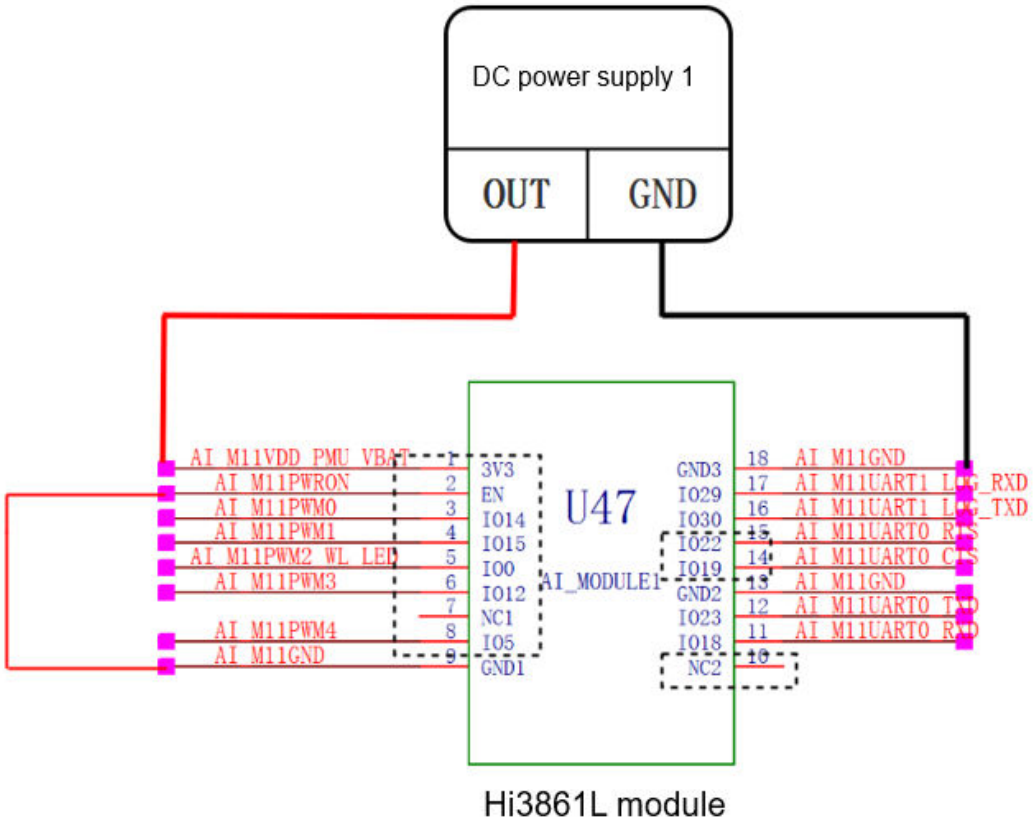
prevent the voltage of the port connected to the chip from being not 3.3 V due to line loss.)

Note: The purpose of separating the 3.3 V and EN pins from the serial port mother board is to separate this 3.3 V power supply from the 3.3 V power supply of the serial port mother board. Otherwise, the power consumption of the mother board is counted when the chip power consumption is calculated. The purpose of disconnecting the GPIO except the serial port is to prevent the current leakage caused by the loop between the I/O and the mother board.

Step 3 Connect antennas to the board. (Skip this step if you use onboard antennas.)

----End

Figure 1-2 Hardware cable connections for power-off mode



Hardware Cable Connections for Always TX and RX Modes

To connect cables for the always TX and RX modes, perform the following steps (as shown in **Figure 1-3**):

Step 1 Disconnect pins 1–8, pin 10, and pins 14–15 on the module from the mother board (pins in the black dashed boxes in the following figure). You are advised to use insulation tape between the module and the mother board to ensure complete insulation.

Step 2 Solder the red DuPont cable to pin 1 (3V3), and solder the black DuPont cable to pin 18 (GND). In addition, connect a 330-kilohm resistor between the 3V3 and EN pins, and connect a 0.47 μF capacitor to the EN pin. Use a DC power supply to

supply 3.3 V power to the board. (Use a multimeter to measure the voltage of the pin to prevent the voltage of the port connected to the chip from being not 3.3 V due to line loss.)

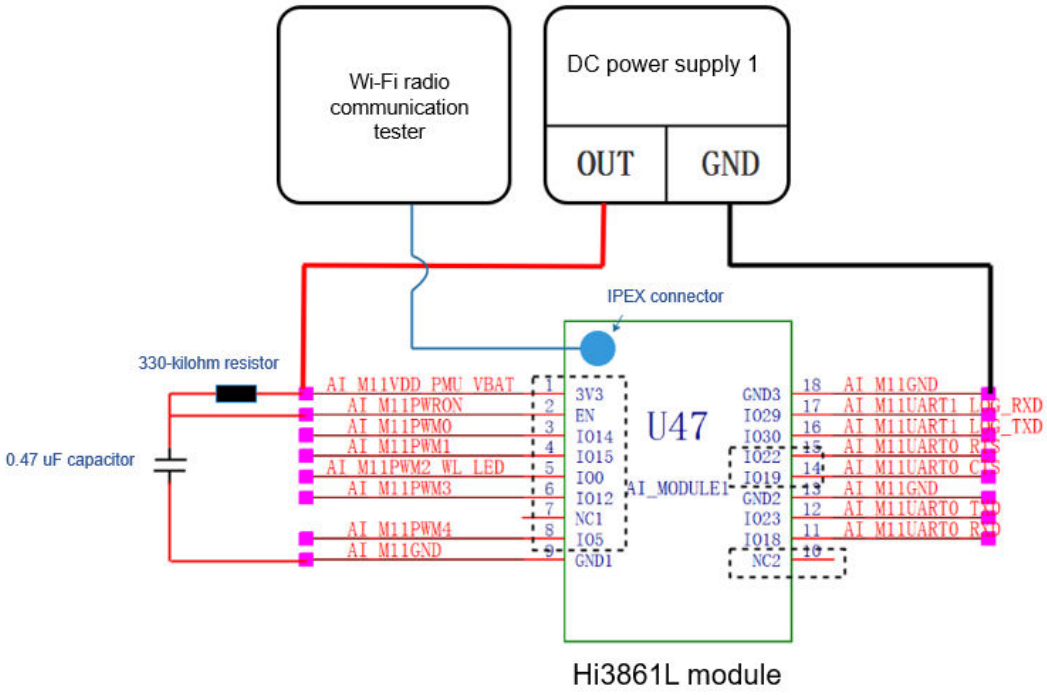
Note: The purpose of separating the 3.3 V and EN pins from the serial port mother board is to separate this 3.3 V power supply from the 3.3 V power supply of the serial port mother board. Otherwise, the power consumption of the mother board is counted when the chip power consumption is calculated. The purpose of disconnecting the GPIO except the serial port is to prevent the current leakage caused by the loop between the I/O and the mother board.

Step 3 Connect the IPEX connector on the board to the radio communication tester.

Note: Because the conducted power needs to be tested in this step, use an external antenna rather than an onboard antenna.

----End

Figure 1-3 Hardware cable connections for always TX and RX modes



2 Deep Sleep Mode

2.1 Test Command

```
AT+SLP=2
AT+PS=1
```

2.2 Test Method

Step 1 Connect cables according to **Figure 1-1** and set the DC voltage to 3.3 V.

Step 2 Burn the software by using HiBurn.

Step 3 In the assistant software for serial port debugging, send the script commands according to **2.1 Test Command** to enable the chip to enter the deep sleep mode.

Step 4 Record the current of the DC power supply.

Step 5 Repeat steps **Step 1**–**Step 4** to test three chips and calculate the average value.

----End

2.3 Test Data

At the ambient temperature of 25°C, use the test script described in **2.1 Test Command**. **Table 2-1** shows the power consumption result in deep sleep mode which is obtained according to **2.2 Test Method**.

Table 2-1 Test result of the deep sleep mode

Chip	Power Voltage (V)	Average Current (μA)
Hi3861L&Hi3861_BUCK	3.3	45
Hi3861_LDO	3.3	326.725

3 Ultra-Deep Sleep Mode

3.1 Test Command

```
AT+USLP=3
```

3.2 Test Method

Step 1 Connect cables according to **Figure 1-1** and set the DC voltage to 3.3 V.

Step 2 Burn the software by using HiBurn.

Step 3 In the serial port debugging tool, send the AT commands according to **3.1 Test Command** to enable the chip to enter the ultra-deep sleep mode.

Step 4 Record the current of the DC power supply.

Step 5 Repeat steps **Step 1**–**Step 4** to test three chips and calculate the average value.

----End

3.3 Test Data

At the ambient temperature of 25°C, use the test script described in **3.1 Test Command**. **Table 3-1** shows the power consumption result in deep sleep mode which is obtained according to **3.2 Test Method**.

Table 3-1 Test result of the ultra-deep sleep mode

Chip	Power Voltage (V)	Average Current (μA)
Hi3861L&Hi3861_BUCK	3.3	2.9731

Chip	Power Voltage (V)	Average Current (μA)
Hi3861_LDO	3.3	3.462

4 Power-Off Mode

4.1 Test Method

Step 1 Connect cables according to **Figure 1-2**.

Step 2 Connect the power-on pin to ground so that the chip enters the power-off state. No configuration script needs to be sent. Set the output voltage of the DC power supply to 3.3 V.

Step 3 Record the current of the DC power supply.

Step 4 Repeat steps **Step 1**–**Step 3** to obtain the average value.

----End

4.2 Test Data

Table 4-1 shows the power consumption result of the power-off mode at the ambient temperature of 25°C according to **4.1 Test Method**.

Table 4-1 Power-off test result

Chip	Power Voltage (V)	Average Current (μA)
Hi3861L&Hi3861_BUCK	3.3	0.3671
Hi3861_LDO	3.3	0.487

5 Always TX and RX Functions

5.1 Always TX

5.1.1 Test Command

NOTE

For details, see the *Hi3861 V100/Hi3861L V100 AT Commands User Guide*.

```
AT+STARTSTA
AT+IFCFG=wlan0,down
AT+ALTX=1,2,20,1,7
AT+IFCFG=wlan0,up
```

5.1.2 Test Method

Step 1 Connect the PC to the UART of the chip by using the USB-to-UART chip, and set the voltage of the DC power supply to 3.3 V. For details about the cable connection, see **Figure 1-3**.

Step 2 Connect the IPEX connector to the RF port of the Wi-Fi communication tester through the IPEX cable.

Step 3 Connect the UART port of the chip by using the UART port tool of the PC (IPOP is used in the current test), and press the reset button to initialize the system.

Step 4 Send the TX configuration commands in **5.1.1 Test Command** in sequence to enable the chip to enter the always TX state.

Step 5 Record the current of the DC power supply.

----End

5.1.3 Test Data

Table 5-1 describes the TX power consumption tested by using the method in 5.1.2 Test Method.

Table 5-1 Test result for TX power consumption

Chip	TX Power Consumption@3.3 V and 25°C											
	802.11b_23dBm_20M_11Mbps Duty cycle: 98%		802.11b_18dBm_20M_11Mbps Duty cycle: 97%		802.11g_16dBm_20M_54Mbps Duty cycle: 87%		802.11n_18dBm_20M_MCS7 Duty cycle: 87%		802.11n_20dBm_20M_MCS7 Duty cycle: 87%		802.11n_18dBm_5M(narrowband)_MCS7 Duty cycle: 88%	
Current Unit (mA)	High-Level Current	Total Current in the Period	High-Level Current	Total Current in the Period	High-Level Current	Total Current in the Period	High-Level Current	Total Current in the Period	High-Level Current	Total Current in the Period	High-Level Current	Total Current in the Period
Hi3861L	422.25	415	278.32	274.44	269.78	247.2	290.9	263.72	324.99	293.87	286.05	259.84
Hi3861_BUCK	404.92	396.5	288.57	284.02	279.03	256.52	292.35	265.13	338.22	304.97	307.58	279.64
Hi3861_LDO	438.87	431.1	325.59	321.33	324.03	300.97	345.44	317.6	382.83	349.5	355.72	327.31

5.2 Always RX

5.2.1 Configuration Command

NOTE

- For details, see the *Hi3861 V100/Hi3861L V100 AT Commands User Guide*.
- The MAC address is not fixed.

```
AT+MAC=00:E0:52:22:22:14
AT+STARTSTA
AT+IFCFG=wlan0,down
AT+ALRX=1,0,20,1
AT+IFCFG=wlan0,up
AT+RXINFO            /* Check the number of packets received by the chip.
```

5.2.2 Test Method

Step 1 Connect the PC to the UART of the chip by using the USB-to-UART chip, and set the voltage of the DC power supply to 3.3 V. For details about the cable connection, see **Figure 1-3**.

Step 2 Connect the UART port of the chip by using the UART port tool of the PC, and send the RX configuration commands in **5.1.1 Test Command** in sequence to enable the chip to enter the always RX state. Send the **AT+RXINFO** command in the serial port tool to check whether data packets are received and whether the chip enters the always RX state.

Step 3 If the chip has entered the always RX state, record the current of the DC power supply.

Step 4 Repeat steps **Step 1**–**Step 3** to test three chips and calculate the average value.

----End

5.2.3 Test Conclusion

Table 5-2 Test result for RX power consumption

Test Chip	Power Voltage	Average Current@20 MHz Bandwidth	Average Current @5 MHz Bandwidth
Hi3861L&Hi3861_BUCK	3.3 V	45.078 mA	42.653 mA
Hi3861_LDO	3.3 V	95.265 mA	84.3 mA

6 Lower-Power Mode

6.1 Test Command

```
AT+STARTSTA
AT+SCAN
AT+SCANRESULT
AT+CONN="router_ssid",,0  /* "ssid",bssid,auth_type,"passwd" (changed according to router attributes)*/
AT+DHCP=wlan0,1          /* Obtain the IP address through DHCP.*/
AT+IFCFG                 /* Ensure that the IP address is obtained before sending any of the following commands:*/
AT+SLP=2                 /* Set the deep sleep mode.*/
AT+PS=1                  /* Enable the low-power mode of the Wi-Fi subsystem. The default sleep time is the same as that on the AP side.*/

AT+PS=1,300              /* Set the expected sleep time to 300 ms and DTIM to 3.*/
AT+PS=1,500              /* Set the expected sleep time to 500 ms and DTIM to 5.*/
AT+PS=1,1000             /* Set the expected sleep time to 1000 ms and DTIM to 10.*/
AT+PS=1,3000             /* Set the expected sleep time to 3000 ms and DTIM to 30.*/
```

6.2 Test Method

Step 1 Connect cables according to **Figure 1-1**, enable the AP, and set the beacon interval.

Step 2 Connect the UART port by using the UART port debugging tool, and send the commands listed in **6.1 Test Command** in sequence.

Step 3 Enable the current curve recording function of the DC power analyzer to obtain the current curve of the output end. Select the average power consumption data in different periods according to different modes, and record the low power consumption data of the system. For example, DTIM1 records the power consumption data in a period of 100 ms.

----End

NOTICE

When the system power consumption is tested, the longer the current curve sampling period is, the more serious the curve distortion is. It is recommended that the current curve sampling period be less than or equal to 0.2 ms. In addition, the current curve shows that the beacon duration is 1 ms. Otherwise, the tested power consumption may be greater than the actual power consumption.

6.3 Test Data

NOTE

The following test is performed in a shielded environment where the ambient temperature is 25°C, the STA is enabled with the RX function, the beacon duration on the AP is 1 ms, and the test voltage is 3.6 V.

Table 6-1 Low-power test data for the system

Test Chip	DTIM=1	DTIM=3	DTIM=5	DTIM=10	DTIM=30
Hi3861L	0.975 mA	0.363 mA	0.244 mA	0.149 mA	0.089 mA
Hi3861_BUCK	1.270 mA	0.523 mA	0.342 mA	0.233 mA	0.171 mA
Hi3861_LDO	2.252 mA	0.961 mA	0.734 mA	0.621 mA	0.529 mA

7 Precautions

- The output power cable of the DC power supply has certain voltage attenuation. During the test, ensure that the voltage added to the chip port is the same as the configured voltage. For example, you can use the voltage compensation function of the instrument to compensate for the voltage loss caused by the line loss. Otherwise, the test power consumption may be high.
- If a peak current occurs during sleep, increase the capacitance of the VBAT filter capacitor.
- If the sleep current is too high, it may be affected by the ambient temperature.
- Unless otherwise stated, all the tests are performed at the ambient temperature of 25°C.
- All the tests are performed when all GPIOs except the serial port have no load.