



RF Performance Test User Manual

Version: 1.3

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Contents

1	Version record	5
2	Overview	6
3	Programming tool kit	8
4	Program test firmware	9
4.1	Program test firmware to IOT module (with Flash)	9
5	Run test firmware	13
6	Basic configuration	14
7	Single Tone test	19
8	802.15.4 test	20
8.1	802.15.4 TX test	20
8.2	802.15.4 RX test	21
9	BLE test	22
10	HBN/PDS test	25
11	Programming guide for mass production test	26
12	Serial communication commands	29
12.1	Shakehand	29
12.2	Get cap code	29
12.3	Set cap code	29
12.4	Get power	29
12.5	Set power	30
12.6	Set channel	30
12.7	Set TX frequency	30
12.8	Set sequence number	30
12.9	TX	30
12.10	RX	30
12.11	Power Offset	31
12.12	Single Tone	31
12.13	CCA	31
12.14	Active	31
12.15	HBN	31
12.16	PDS	32
12.17	Read memory	32
12.18	Write memory	32
12.19	Write cap code to efuse register	32

12.20 Write power offset to efuse register	32
12.21 Write mac address to efuse register	33
12.22 Read cap code from efuse register	33
12.23 Read power offset from efuse register	33
12.24 Read mac address from efuse register	33
12.25 Program efuse	33
12.26 Get MFG FW version	34
12.27 Get MFG FW build infomation	34
12.28 Get temperature	34
12.29 Get MAC address	34
12.30 Exit MFG FW	34
12.31 Reset chip	34
12.32 BLE Test	34

List of Figures

2.1	Interface of test tool	6
3.1	Programming tool kit	8
4.1	IOT Module Evaluation Kit	9
4.2	Adapter board	10
4.3	Programming interface	11
4.4	Interface of successful programming	12
5.1	Log of successful operation	13
6.1	Get parameters	14
6.2	Set tx power	15
6.3	Set power offset	16
6.4	Update capacitance compensation value	17
6.5	Set active mode	18
7.1	Single Tone test	19
8.1	802.15.4 TX test	20
8.2	802.15.4 RX test	21
9.1	BLE Tx Payload Type	23
9.2	BLE Tx Rate	23
9.3	BLE Rx Rate	24
9.4	BLE Modulation Index	24
10.1	HBN/PDS parameter setting	25
11.1	Modify active entry	27
11.2	Programming interface for mass production test	28

Table 1.1: Version record

Version	Update content
V1.0	Initial release
V1.1	Add content related to power offset and efuse
V1.2	Add programming guide for mass production test
V1.3	Add read/write command for mac address in efuse

The RF performance test tool (RF MFG) is a tool provided by Bouffalo Lab for RF evaluation and testing. It includes two parts: a test tool and a test image (MFG Firmware). The interface of the test tool is shown in the figure below.

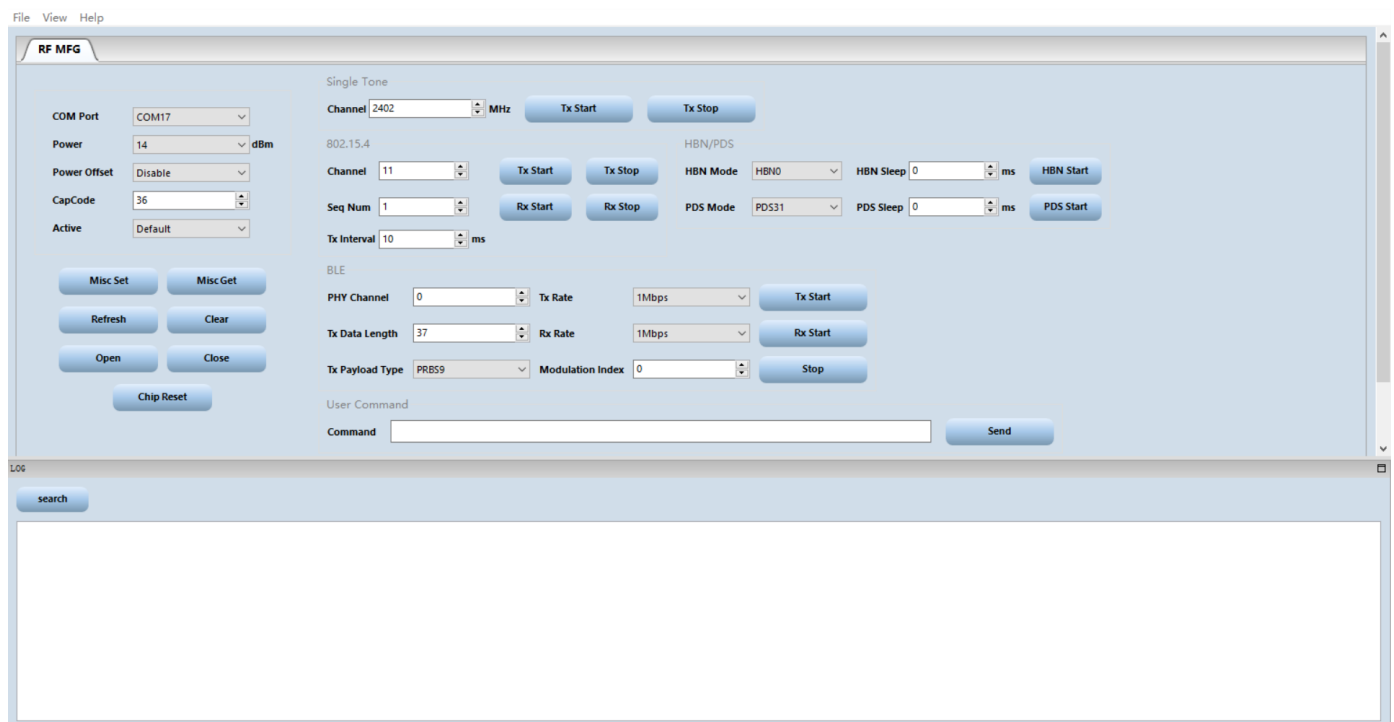


Fig. 2.1: Interface of test tool

The functions that can be performed by the RF performance test tool (RF MFG) include:

- Single Tone test
- 802.15.4 packet transmission
- 802.15.4 packet reception
- BLE packet transmission

- BLE packet reception
- PDS (Power Down Sleep) test
- HBN (Hibernate) test

Programming tool kit

If user does not have the programming tool kit (which is also called Dev Cube), please download it from [Bouffalo Lab Dev Cube](#). It contains the RF test firmware, firmware programming tool, RF test tool, etc. The content of the tool kit is shown in the figure below. It is a tool set used by customers to develop various types of Bouffalo Lab chips.

名称	修改日期	类型	大小
chips	2021/10/14 16:12	文件夹	
docs	2021/10/12 10:20	文件夹	
log	2021/10/21 10:36	文件夹	
utils	2021/10/12 10:20	文件夹	
 BLDevCube.exe	2021/10/19 15:47	应用程序	18,066 KB
 changelog.txt	2021/10/13 14:09	TXT 文件	10 KB
 clear.bat	2021/6/3 9:16	Windows 批处理...	2 KB
 version.txt	2021/10/14 8:32	TXT 文件	1 KB

Fig. 3.1: Programming tool kit

4.1 Program test firmware to IOT module (with Flash)

In the programming tool kit (Bouffalo Lab Dev Cube), the RF test firmware of each chip is included. The following takes BL704 IOT module evaluation kit as an example to introduce the programming process.

The BL704 IOT module evaluation kit BL704_IoT_DevKit is shown in the figure below.

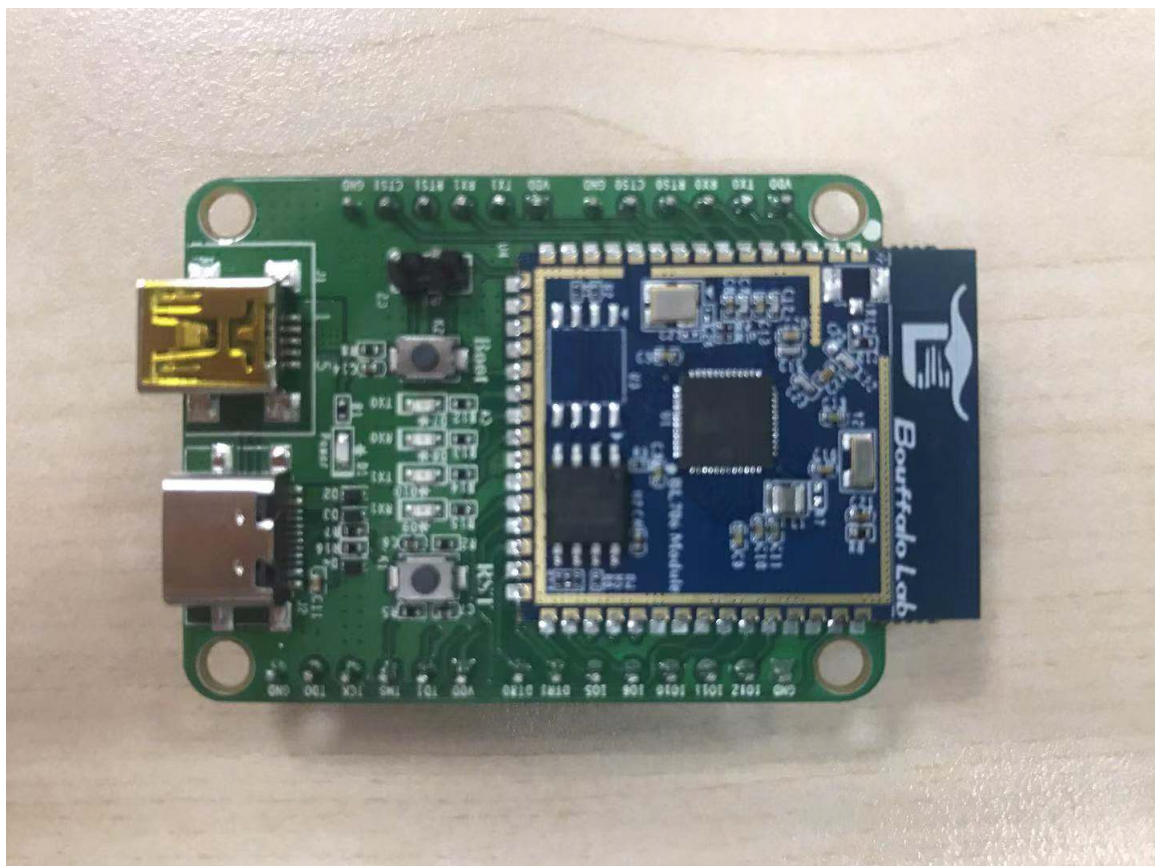


Fig. 4.1: IOT Module Evaluation Kit

The evaluation kit consists of an IOT module and a motherboard. The motherboard uses the USB interface for power supply.

In addition, a USB serial port adapter board is required. The figure below shows one of the adapter boards.

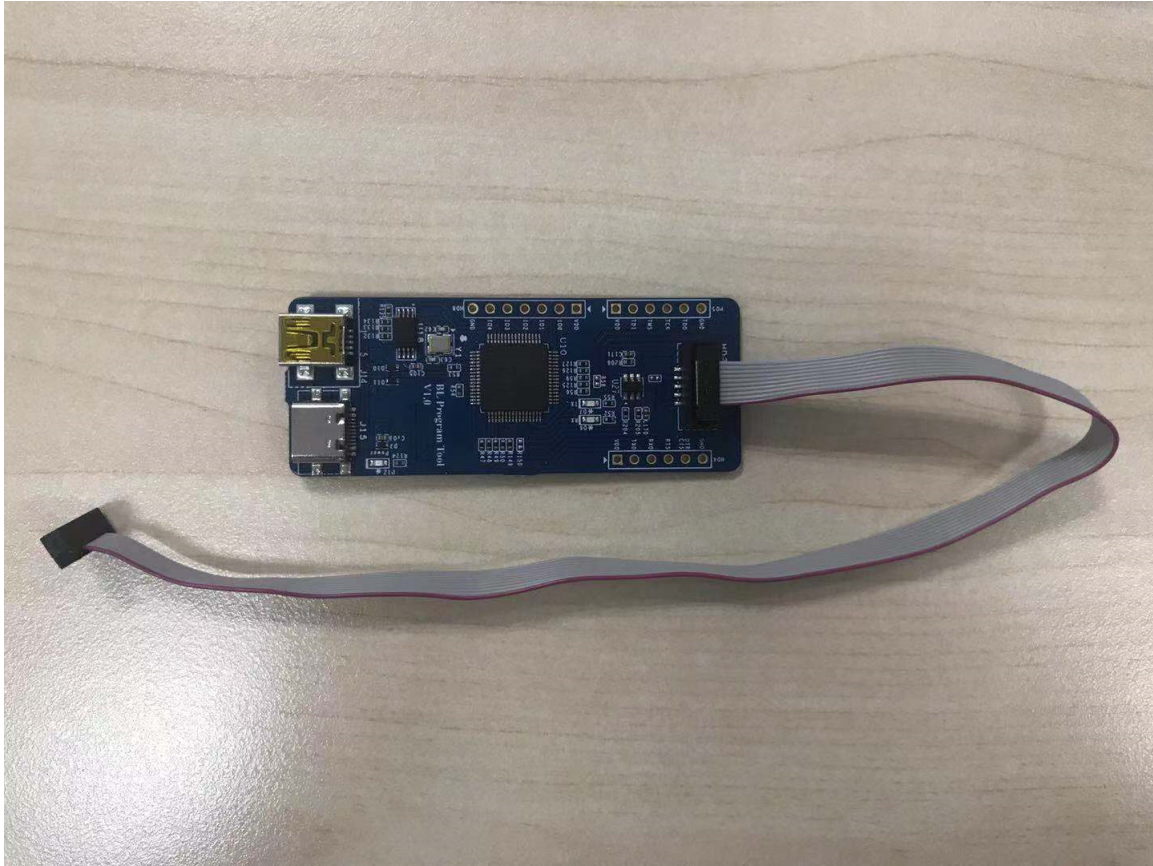


Fig. 4.2: Adapter board

The adapter board uses the USB interface for power supply. After connecting to the evaluation kit, it is used for UART download, UART print and online debug.

When the adapter board is connected to the PC, two serial ports will appear in the PC's device manager. The two COM numbers are adjacent, and the smaller one is connected to the UART of the chip. If the serial port driver is not automatically installed, please go to <https://www.ftdichip.com/Drivers/VCP.htm> to download the driver.

After the adapter board is connected to the evaluation kit, run BLDevCube.exe, select BL702/704/706 in Chip Type, then the following programming interface will be shown.

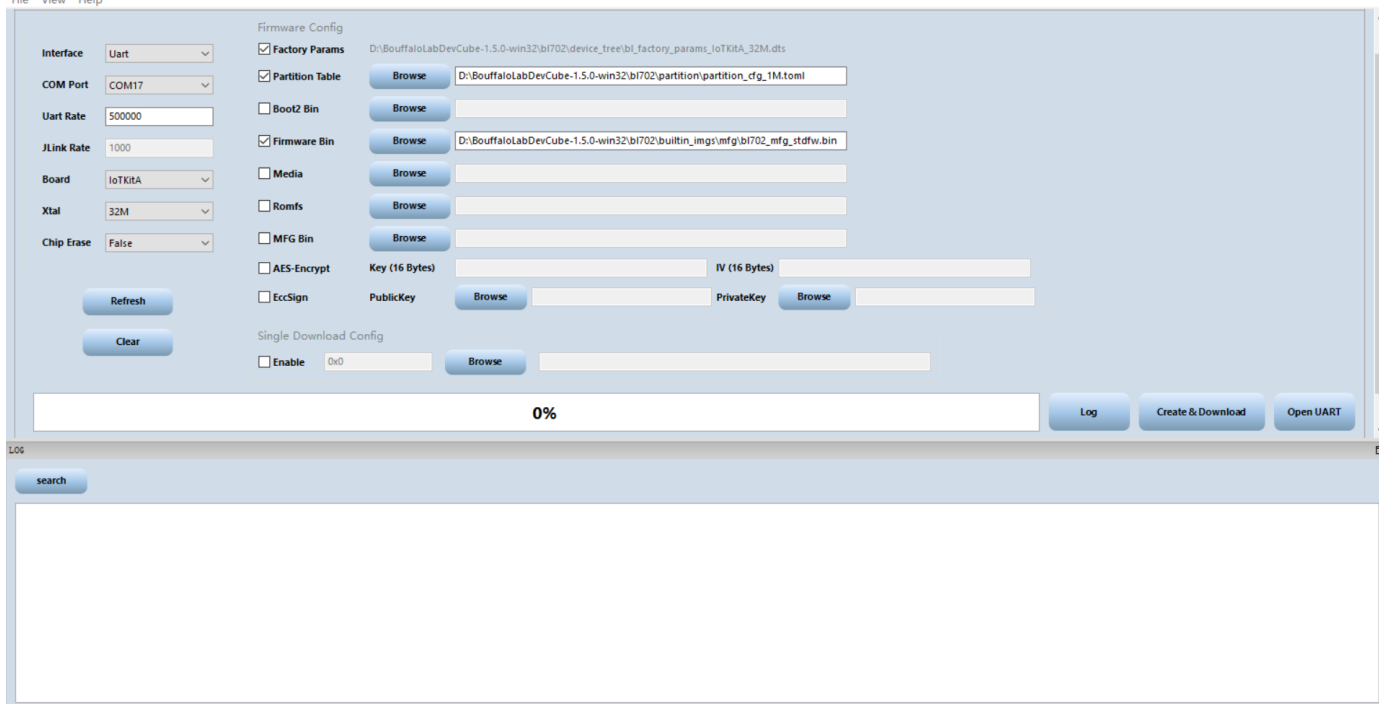


Fig. 4.3: Programming interface

In the communication interface settings on the left:

- Interface: Used to select the communication interface for programming, here select Uart for programming
- COM Port: When selected UART for programming, select the COM port that connects to the chip, and you can click the Refresh button to refresh the COM number
- Uart Rate: When selected UART for programming, fill in the baud rate, 500000 is recommended
- Board: Select the board type you are using, here select IoTKiTA
- Xtal: Used to select the crystal type on the board, here select 32M
- Chip Erase: The default setting is False, which means that full chip Flash will not be erased when programming

Use the default configuration for other items.

In the programming settings on the right, select:

- Partition Table: Use the partition table in the partition directory of the corresponding chip type in the programming tool directory. In this example bl702/partition/partition_cfg_1M.toml
- Firmware Bin: Select the corresponding Flash version firmware in the mfg folder under the builtin_imgs directory of the corresponding chip type in the programming tool directory. In this example bl702/builtin_imgs/mfg/bl702_mfg_stdfw.bin

According to the above configuration, after setting up Dev Cube, configure the chip to UART boot mode, and then

you can start programming.

The method to configure the chip to UART boot mode is as follows:

- Press and hold the Boot button on the module
- Press and release the RST button
- Release the Boot button

After completing the above boot settings, click the Create & Download button to complete the firmware programming.

The indication of successful programming is as follows.

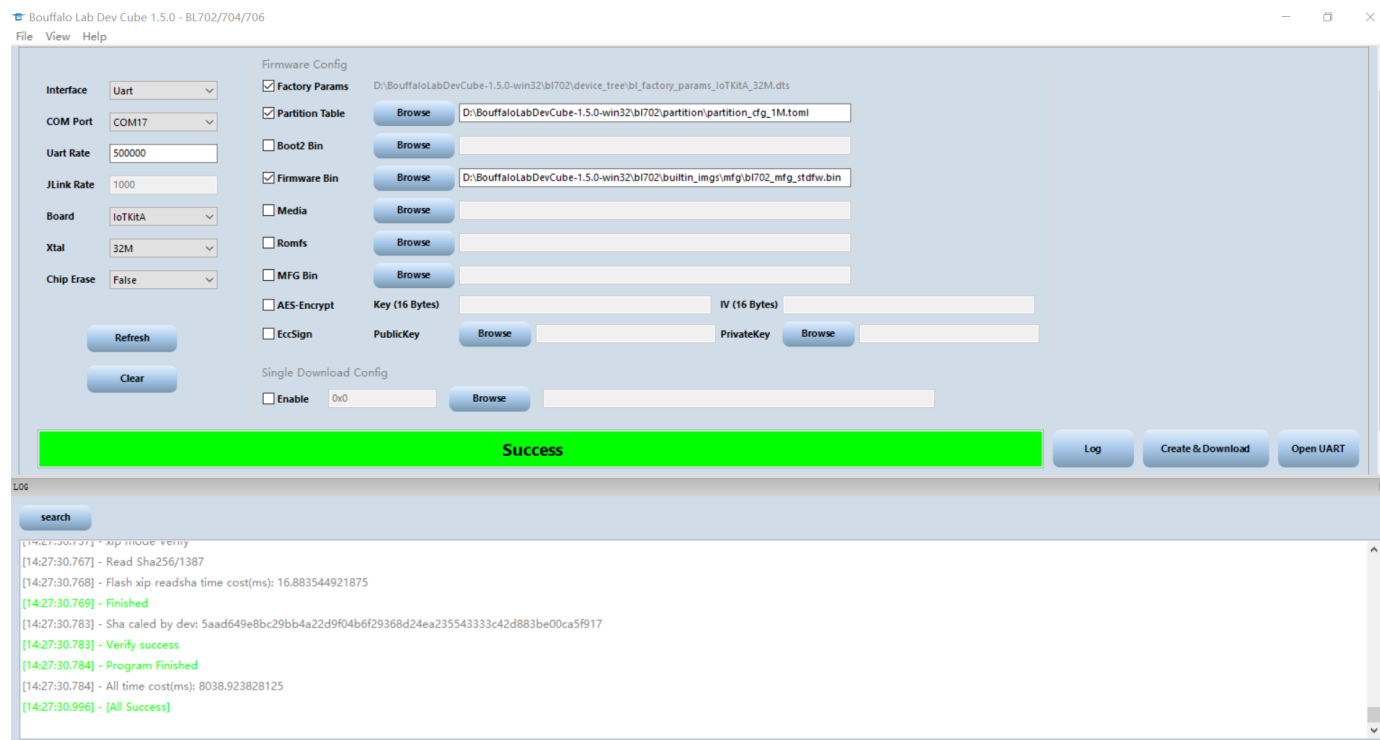


Fig. 4.4: Interface of successful programming

Run test firmware

For the IOT module (with Flash), after downloading the test firmware, press and release the RST button, and the chip can run the RF test firmware.

On the BLDevCube.exe interface, switch to the RF MFG test interface through View->RF MFG. Select the COM number used and click the Open button to see the log of the test firmware. The example is as follows.

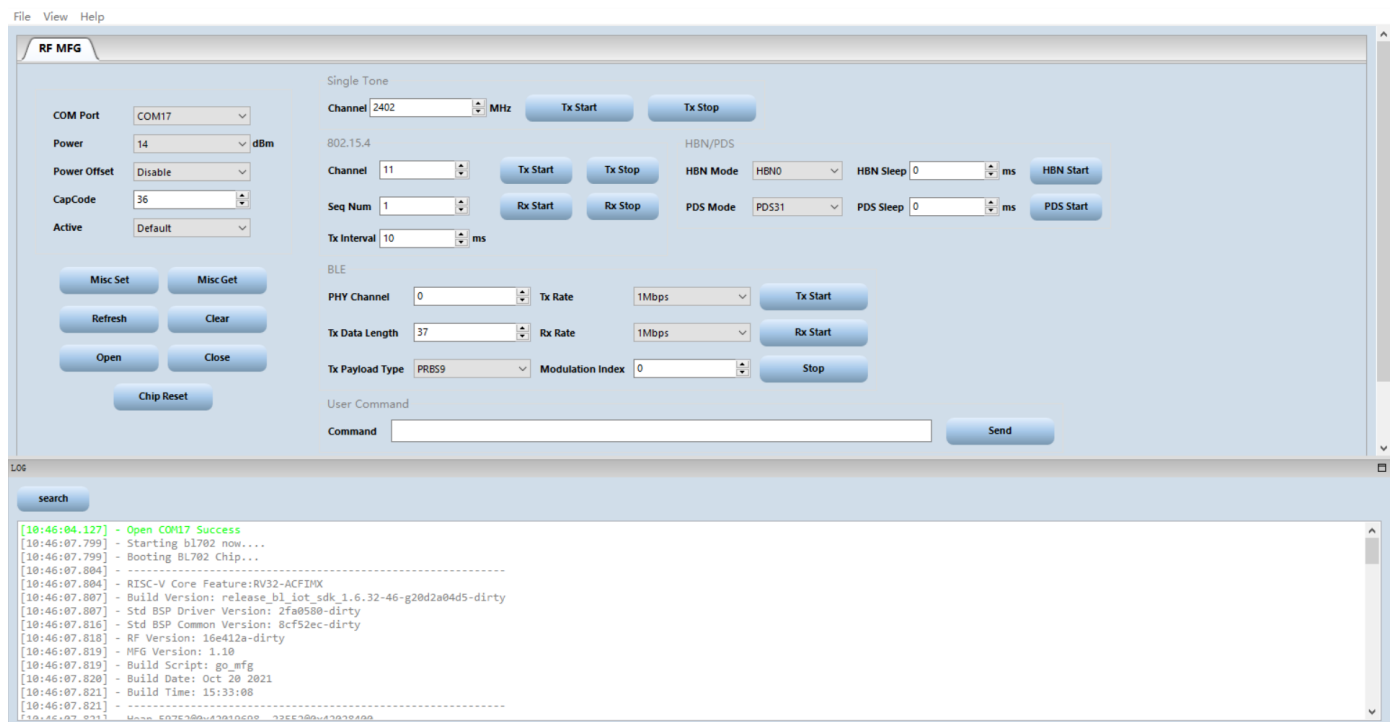
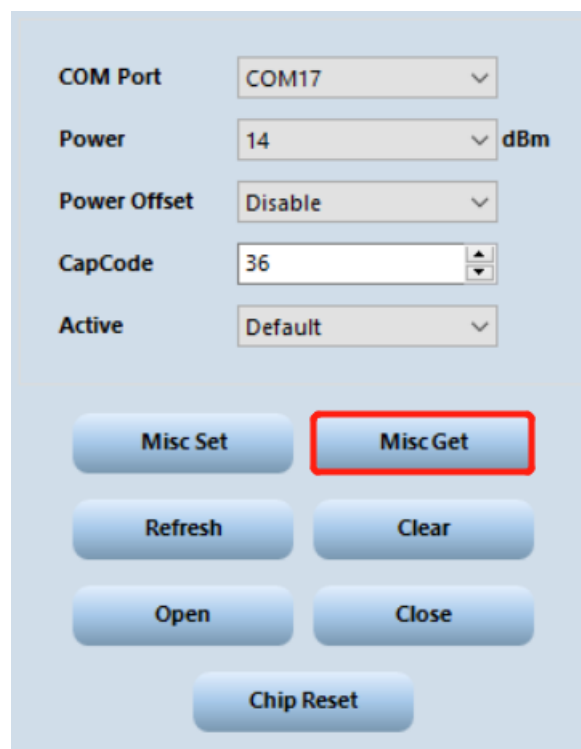


Fig. 5.1: Log of successful operation

The RF test tool running on PC communicates with the test firmware through UART, the baud rate used is 115200, the data bit is 8 bits, and there is no parity.

Basic configuration

Click the Misc Get button to get Power and CapCode parameters currently configured in the chip.

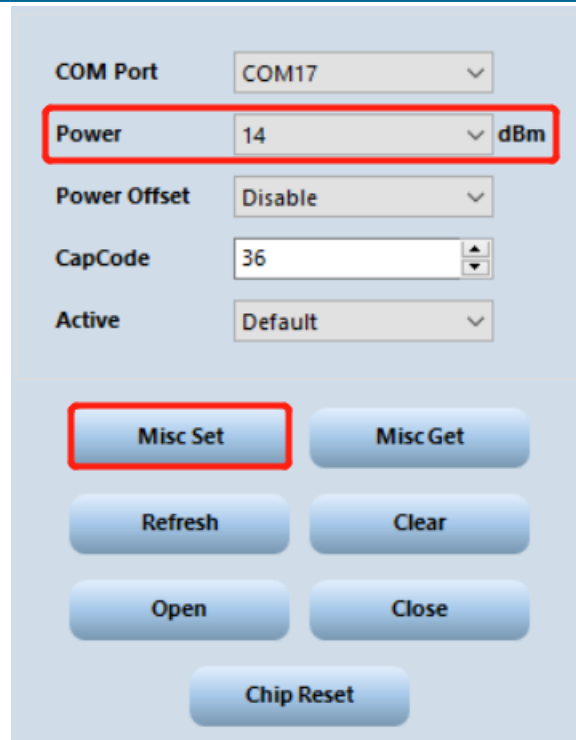


The screenshot displays a configuration window with the following elements:

- COM Port:** A dropdown menu currently set to "COM17".
- Power:** A dropdown menu set to "14" with the unit "dBm" to its right.
- Power Offset:** A dropdown menu set to "Disable".
- CapCode:** A numeric input field containing the value "36".
- Active:** A dropdown menu set to "Default".
- Buttons:** A collection of control buttons including "Misc Set", "Misc Get" (highlighted with a red rectangle), "Refresh", "Clear", "Open", "Close", and "Chip Reset".

Fig. 6.1: Get parameters

Through the Power drop-down menu, you can set the tx power of the chip, and click the Misc Set button to take effect.



COM Port COM17

Power 14 dBm

Power Offset Disable

CapCode 36

Active Default

Misc Set Misc Get

Refresh Clear

Open Close

Chip Reset

Fig. 6.2: Set tx power

Through the Power Offset drop-down menu, you can enable or disable power offset function, and click the Misc Set button to take effect. After chip reset, the power offset table will be initialized. Each time you enable power offset function, the power offset table will be updated.

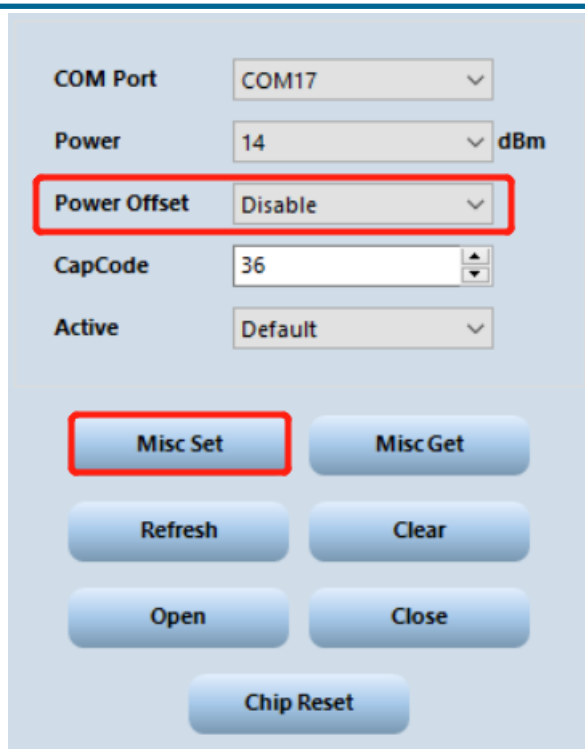


Fig. 6.3: Set power offset

For the load capacitance of the crystal, the BL702 series chip has capacitance compensation inside. Different load capacitance requirements correspond to different capacitance compensation values. The following table provides reference values.

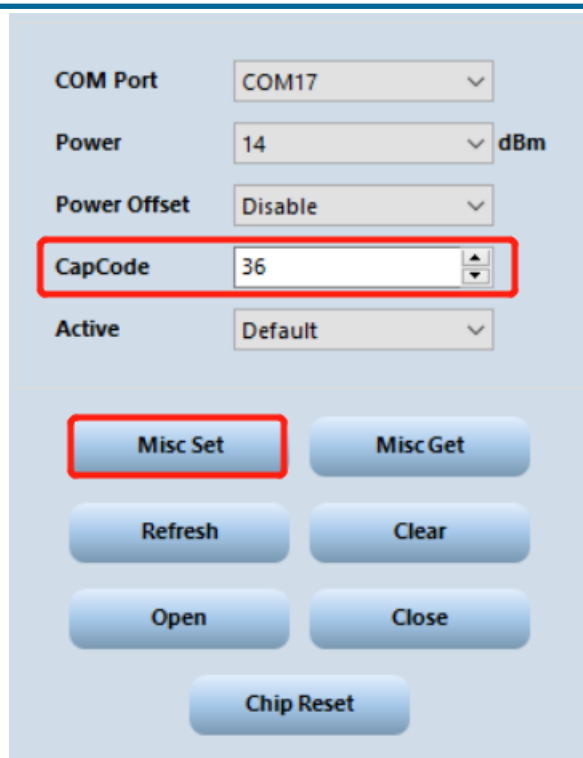
Note: Actual PCB traces also have certain parasitic capacitance, so the best compensation value is still subject to actual test results.

Table 6.1: Capacitance compensation value corresponding to BL702

XTAL Loading Capacity (pF)	Capacity Code
12	32~36

The method of use is as follows:

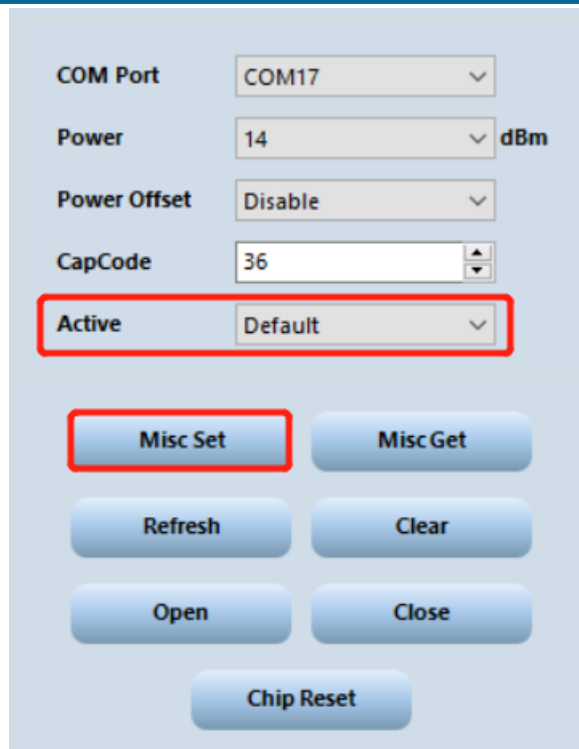
1. Fill in the value to be compensated in the Cap Code.
2. Click the Misc Set button to update the compensation value.



The screenshot displays a configuration window for the RF Performance Test. It features several input fields and buttons. The 'COM Port' is set to 'COM17'. The 'Power' is set to '14 dBm'. The 'Power Offset' is set to 'Disable'. The 'CapCode' field, which is highlighted with a red box, is set to '36'. The 'Active' mode is set to 'Default'. Below the input fields, there are several buttons: 'Misc Set' (highlighted with a red box), 'Misc Get', 'Refresh', 'Clear', 'Open', 'Close', and 'Chip Reset'.

Fig. 6.4: Update capacitance compensation value

Through the Active drop-down menu, you can set the active mode of the chip, and click the Misc Set button to take effect. Among them, Idle mode will turn off more clocks and peripherals to achieve the purpose of reducing active power consumption.



The screenshot displays a configuration window for the RF Performance Test. The window has a light blue background and contains several settings and buttons. The settings are arranged in a vertical list on the left, each with a label and a corresponding input field or dropdown menu. The 'Active' setting is highlighted with a red rectangular box. Below the settings, there are several buttons arranged in a grid. The 'Misc Set' button is also highlighted with a red rectangular box. The other buttons are 'Misc Get', 'Refresh', 'Clear', 'Open', 'Close', and 'Chip Reset'.

COM Port	COM17
Power	14 dBm
Power Offset	Disable
CapCode	36
Active	Default

Misc Set Misc Get

Refresh Clear

Open Close

Chip Reset

Fig. 6.5: Set active mode

Single Tone test

MFG supports Single Tone test mode. After setting the Channel, click Tx Start to start the test, and click Tx Stop to stop the test.

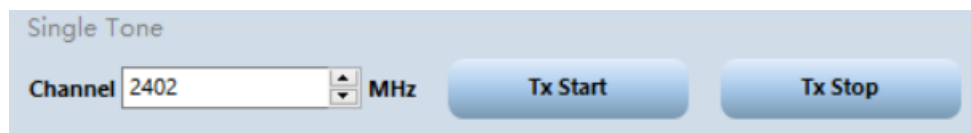


Fig. 7.1: Single Tone test

802.15.4 test

8.1 802.15.4 TX test

Set Channel for transmission channel, Seq Num for sequence number of the packet, and Tx Interval for packets tx interval.

Click Tx Start to start the test, and click Tx Stop to stop the test. After the test is over, the LOG area will show how many packets have been sent.

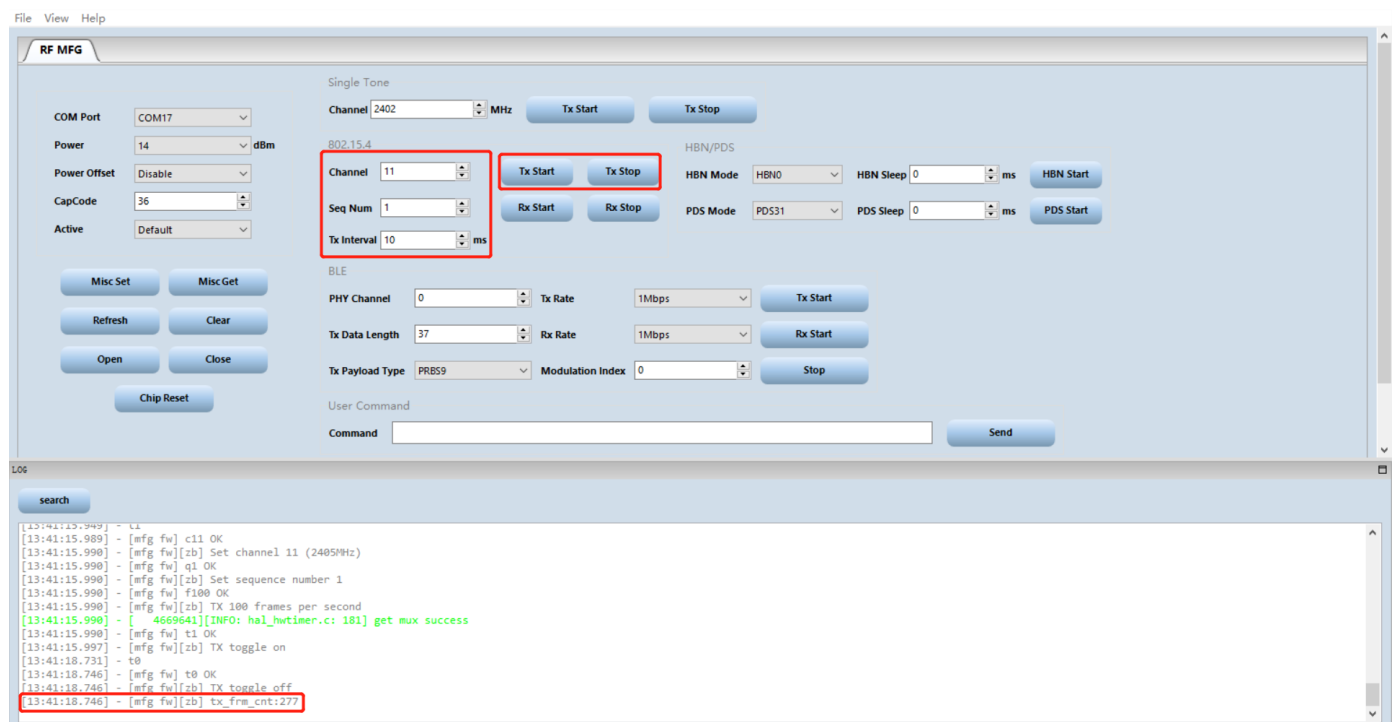


Fig. 8.1: 802.15.4 TX test

8.2 802.15.4 RX test

Set Channel for receiving channel, and Seq Num for sequence number of the packet (only packets with matching sequence number will be received).

Click Rx Start to start the test, and click Rx Stop to stop the test. After the test is over, the LOG area will show how many packets have been received, as well as the average rssi, average frequency offset, and average lqi.

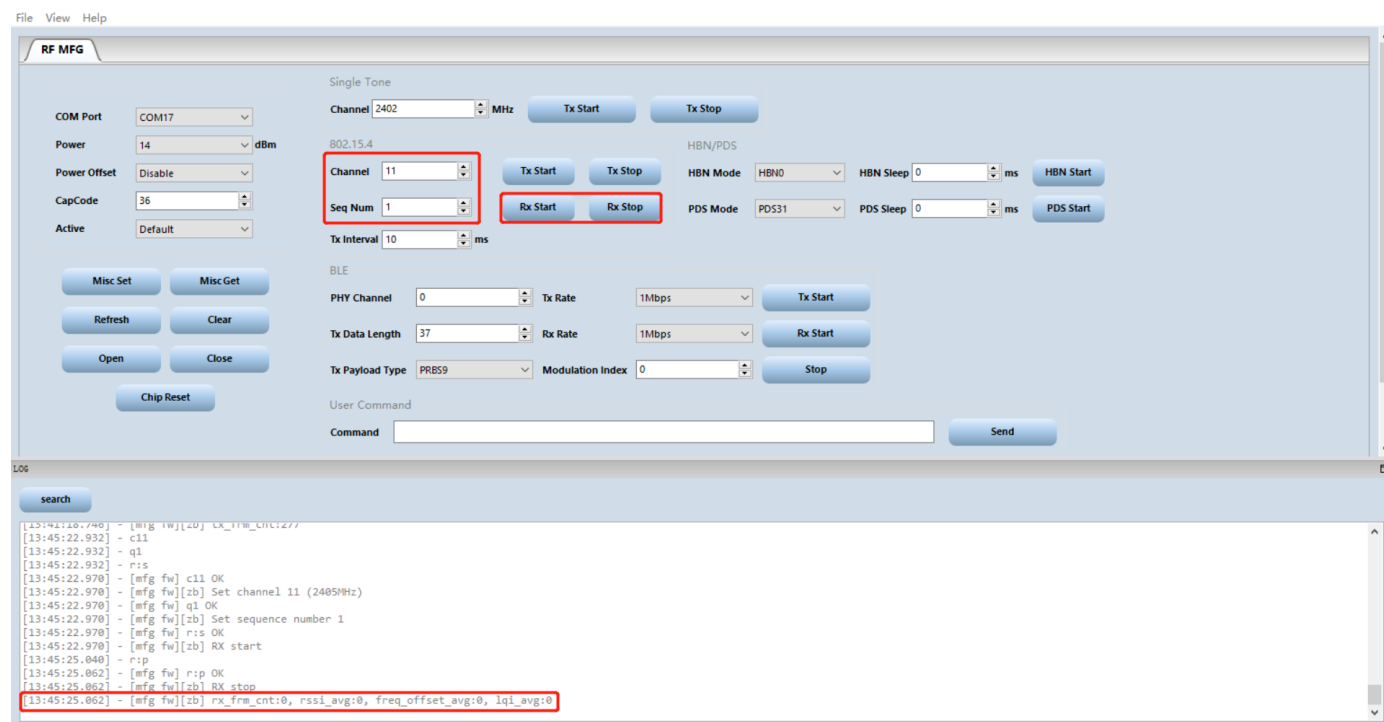


Fig. 8.2: 802.15.4 RX test

RF MFG provides TX and RX testing of BLE.

For TX test, you can set the PHY Channel, Tx Data Length, Tx Payload Type and Tx Rate, and then click the Tx Start button to start the test.

For RX test, you can set the PHY Channel, Rx Rate and Modulation Index, and then click the Rx Start button to start the test.

The test can be stopped by the Stop button.

Note: The MFG firmware supports standard HCI command. Instruments that supports HCI command (e.g. R&S CMW500) can be connected for test.

The Tx Payload Type is shown in the figure below.

Value	Parameter Description
0x00	PRBS9 sequence '11111111100000111101...' (in transmission order) as described in [Vol 6] Part F, Section 4.1.5
0x01	Repeated '11110000' (in transmission order) sequence as described in [Vol 6] Part F, Section 4.1.5
0x02	Repeated '10101010' (in transmission order) sequence as described in [Vol 6] Part F, Section 4.1.5
0x03	PRBS15 sequence as described in [Vol 6] Part F, Section 4.1.5
0x04	Repeated '11111111' (in transmission order) sequence
0x05	Repeated '00000000' (in transmission order) sequence
0x06	Repeated '00001111' (in transmission order) sequence
0x07	Repeated '01010101' (in transmission order) sequence

Fig. 9.1: BLE Tx Payload Type

The Tx Rate is shown in the figure below.

PHY:

Size: 1 octet

Value	Parameter Description
0x01	Transmitter set to use the LE 1M PHY
0x02	Transmitter set to use the LE 2M PHY
0x03	Transmitter set to use the LE Coded PHY with S=8 data coding
0x04	Transmitter set to use the LE Coded PHY with S=2 data coding
All other values	Reserved for future use

Fig. 9.2: BLE Tx Rate

The Rx Rate is shown in the figure below.

*PHY:**Size: 1 octet*

Value	Parameter Description
0x01	Receiver set to use the LE 1M PHY
0x02	Receiver set to use the LE 2M PHY
0x03	Receiver set to use the LE Coded PHY
All other values	Reserved for future use

Fig. 9.3: BLE Rx Rate

The Modulation Index is shown in the figure below.

*Modulation_Index:**Size: 1 octet*

Value	Parameter Description
0x00	Assume transmitter will have a standard modulation index
0x01	Assume transmitter will have a stable modulation index
All other values	Reserved for future use

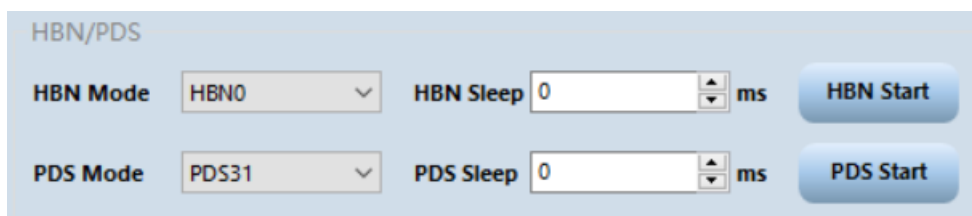
Fig. 9.4: BLE Modulation Index

The HBN/PDS test allows the chip to enter a low power mode. In HBN mode, only a small part of the circuit is kept in working state, while the power supply of other circuits is turned off, thus the power consumption reaches the lowest level.

The chip can be waken up from HBN/PDS mode, and the chip will restart after waken up. The current test tool only supports RTC wakeup.

After setting the HBN/PDS sleep time, click the corresponding Start button to let the chip enter the HBN/PDS mode. After the sleep time expires, the chip will restart.

If the sleep time is set to 0, it means permanent sleep.



HBN/PDS				
HBN Mode	HBN0	HBN Sleep	0 ms	HBN Start
PDS Mode	PDS31	PDS Sleep	0 ms	PDS Start

Fig. 10.1: HBN/PDS parameter setting

Programming guide for mass production test

For mass production test, both RF test firmware and user firmware may need programming. After programming, the RF test firmware will run after chip reset, and instruments (e.g. iTest) can be connected for mass production test. After mass production test completes, the user firmware will run after chip reset. If mass production fails, the RF test firmware will still run after chip reset.

The programming procedure is as follow:

1. Select a partition table file which is used for IOT downloading interface, e.g. `partition_cfg_1M.toml`, then modify the “activeindex” of FW entry to 1, which means booting from FW1, namely booting from mfg, because FW1 and mfg are of the same entry.

```
[pt_table]
#partition table is 4K in size
address0 = 0x1000
address1 = 0x2000

[[pt_entry]]
type = 0
name = "FW"
device = 0
address0 = 0x3000
size0 = 0x90000
address1 = 0x93000
size1 = 0x66000
# compressed image must set len,normal image can left it to 0
len = 0
activeindex = 0    0 -> 1
age = 0

[[pt_entry]]
type = 1
name = "mfg"
device = 0
address0 = 0x93000
size0 = 0x66000
address1 = 0
size1 = 0
# compressed image must set len,normal image can left it to 0
len = 0
activeindex = 0
age = 0
```

Fig. 11.1: Modify active entry

2. In IOT downloading interface, select the partition table file modified in the previous step as Partition Table, select a user firmware as Firmware Bin, select the RF test firmware as MFG Bin, and keep others unchanged.

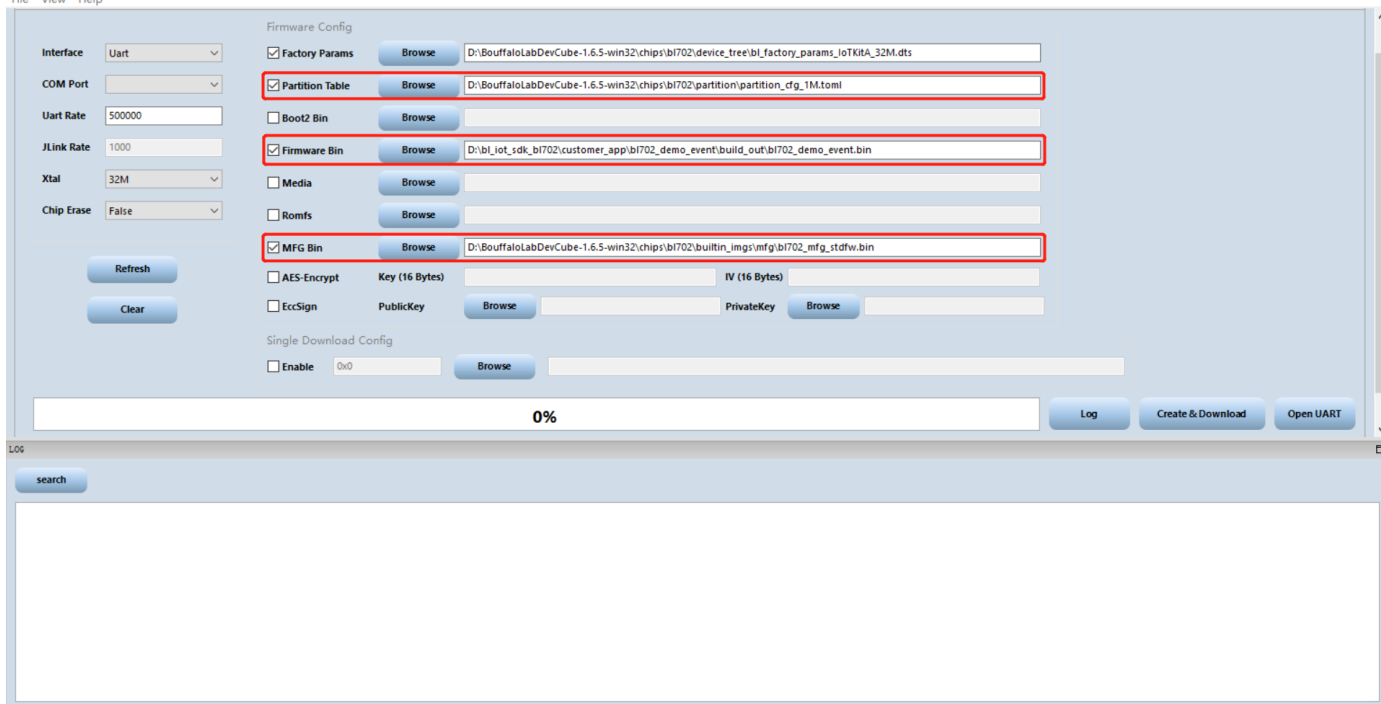


Fig. 11.2: Programming interface for mass production test

To exit mass production test:

1. The host send the ATSC command to set user firmware entry as active entry. If the user firmware is not programmed, the ATSC command will return an error.
2. The host send the Reset command to reset the chip. After chip reset, the user firmware will run.

All commands are of string type.

12.1 Shakehand

- Command: H
- Return: mfg

12.2 Get cap code

- Command: x
- Return: Get cap code [cap code]

12.3 Set cap code

- Command: x[cap code]

cap code: [0, 63]; default: 36

12.4 Get power

- Command: p
- Return: Get tx power [power dbm]dBm

12.5 Set power

- Command: `p[power dbm]`

power dbm: [0, 14]; default: 14

12.6 Set channel

- Command: `c[channel]`

For single tone test, channel is the channel frequency - channel: [2402, 2480]; default: 2402

For 802.15.4 test, channel is the channel index number - channel: [11, 26]; default: 11

12.7 Set TX frequency

- Command: `f[freq]`

freq is the number of packets sent per second

freq: [1, 1000]; default: 100

12.8 Set sequence number

- Command: `q[seq num]`

seq num: [0, 255]; default: 1

12.9 TX

1. Tx Start: `t1`

2. Tx Stop: `t0`

- Return: `tx_frm_cnt:[tx_frm_cnt]`

12.10 RX

1. Rx Start: `r:s`

2. Rx Stop: `r:p`

- Return: `rx_frm_cnt:[rx_frm_cnt], rssi_avg:[rssi_avg], freq_offset_avg:[freq_offset_avg], lqi_avg:[lqi_avg]`

12.11 Power Offset

1. Enable: V1
2. Disable: V0

12.12 Single Tone

1. Tx Start: m1
2. Tx Stop: m0

12.13 CCA

1. set ed threshold: C:T[ed threshold]
2. run cca: C:M[cca mode]
 - Return: channel_busy:[channel_busy], rssi:[rssi], ed:[ed]

ed threshold: [-122, -71]; default: -71

cca mode: [0, 3]; default: 2

12.14 Active

1. Default: i0
2. Idle: i1

12.15 HBN

1. set hbn level: h1[hbn level]
2. set hbn wakeup pin: hp[wakeup pin]
3. enter hbn mode: ht[sleep time ms]

hbn level: [0, 3]; default: 0

wakeup pin: 0, 10, 11, 12, 13; default: 0(none)

sleep time ms: [0, 131071999]; default: 0(sleep forever)

12.16 PDS

1. set pds level: sl[pds level]

2. enter pds mode: st[sleep time ms]

pds level: 0, 1, 2, 3, 4, 5, 6, 7, 31; default: 31

sleep time ms: [0, 131071999]; default: 0(sleep forever)

12.17 Read memory

- Command: RM0x[addr]
- Return: Read memory: 0x[addr] = 0x[val]

12.18 Write memory

- Command: SM0x[addr]=0x[val]
- Return: Write memory: 0x[addr] = 0x[val]

12.19 Write cap code to efuse register

- Command: ewx[cap code]
- Return: Write cap code [cap code] to efuse register

cap code: [0, 63]

Note: The ewx command will first reload all data from efuse to corresponding efuse registers, then write cap code to corresponding efuse register, without limit of write times.

12.20 Write power offset to efuse register

- Command: ewp[power offset low],[power offset high]
- Return: Write power offset [power offset low],[power offset high] to efuse register

power offset low: [-8, 7]

power offset high: [-8, 7]

Note: The ewp command will first reload all data from efuse to corresponding efuse registers, then write power offset

to corresponding efuse register, without limit of write times.

12.21 Write mac address to efuse register

- Command: `ewm[mac0]:[mac1]:[mac2]:[mac3]:[mac4]:[mac5]:[mac6]:[mac7]`
- Return: Write mac [mac0]:[mac1]:[mac2]:[mac3]:[mac4]:[mac5]:[mac6]:[mac7] to efuse register

Example: `ewm00:00:75:09:00:42:E8:B4`

Note: The `ewm` command will first reload all data from efuse to corresponding efuse registers, then write mac address to corresponding efuse register, without limit of write times.

12.22 Read cap code from efuse register

- Command: `erx`
- Return: Read cap code [cap code] from efuse register

12.23 Read power offset from efuse register

- Command: `erp`
- Return: Read power offset [power offset low],[power offset high] from efuse register

12.24 Read mac address from efuse register

- Command: `erm`
- Return: Read mac [mac0]:[mac1]:[mac2]:[mac3]:[mac4]:[mac5]:[mac6]:[mac7] from efuse register

12.25 Program efuse

- Command: `ep`

Note: The `ep` command will write all data in efuse registers to efuse permanently, i.e. `ewx+ep` will write cap code to efuse, `ewp+ep` will write power offset to efuse, and `ewm+ep` will write mac address to efuse. There are only three times for each chip to write cap code, power offset and mac address to efuse respectively.

12.26 Get MFG FW version

- Command: y:v
- Return: MFG Version: [version]

12.27 Get MFG FW build information

- Command: y:d
- Return: Build Data: [build date] Build Time: [build time]

12.28 Get temperature

- Command: y:T
- Return: Temperature: [temperature]

12.29 Get MAC address

- Command: y:m
- Return: MAC Address: [mac address]

12.30 Exit MFG FW

- 命令: ATSC

Note: The ATSC command will set user firmware entry as active entry. After next chip reset, the user firmware will run. If the user firmware is not programmed, the ATSC command will return an error.

12.31 Reset chip

- Command: Reset

12.32 BLE Test

12.32.1 BLE TX

- Command: ETE[channel][tx data length][tx payload type][tx rate]

All parameters are of hex string type.

Example: ETE00250001

channel: 0x00

tx data length: 0x25

tx payload type: 0x00(PRBS9)

tx rate: 0x01(1Mbps)

12.32.2 BLE RX

- Command: ERE[channel][rx rate][modulation index]

All parameters are of hex string type.

Example: ERE000100

channel: 0x00

rx rate: 0x01(1Mbps)

modulation index: 0x00

12.32.3 BLE test stop

- Command: EE