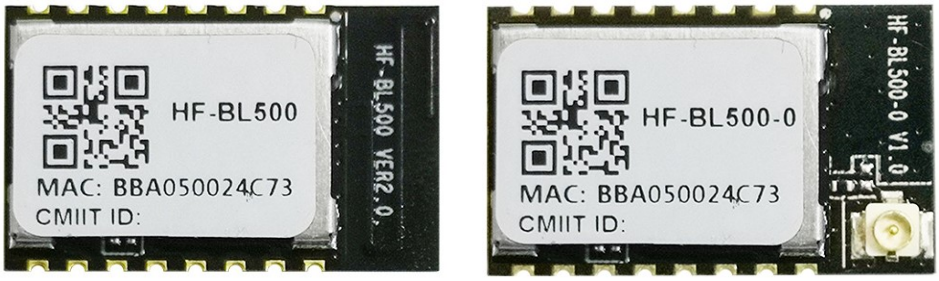
HF-BL500

Bluetooth Low Energy (BLE 5.0) Module

User Manual

V 1.2



Overview of Characteristic

- ✧ **Support BLE5.0 Standard. Max 2Mbps Data Rate**
- ✧ **Integrate RISC MCU, 48MHz CPU, 48KB RAM, 512KB Flash**
- ✧ **Support Wireless OTA Upgrade**
- ✧ **UART Transparent Transmit Module**
- ✧ **Supper Low Sleep Mode, 80uA/1s. Excellence Power Save Scheme Suitable for Battery-Powered Applications**
- ✧ **Support Internal PCB or External IPEX Antenna**
- ✧ **Single 2.5V~4.3V Power Supply**
- ✧ **Size: 22.5mm x 13.5mm x 3mm**

Table of Contents

LIST OF FIGURES

LIST OF TABLES

HISTORY

V 0.1 08-10-2020. First Version

V 0.2 09-02-2020. Update Pin Description

V 1.0 10-19-2020. Add and update AT command(AT:WAC, AT:TPL, AT:ADV)

V 1.1 01-13-2021. Add AT+UIDNW, AT+UIDIW, AT+UIDIR, AT+UIDNR Command

V 1.2 04-16-2021. Add External IPEX module

1. PRODUCT OVERVIEW

1.1. General Description

HF-BL500 Bluetooth Low Energy module is a high performance IOT module designed by High Flying. It provide a solution for connecting things to Bluetooth wireless network and data transmitting via UART interface. With the feature of low power, small size, high anti-interference performance, the module integrates PCB antenna and use open stamp type interface which enable customer have more flexibility on software and product structure , and solve the RF hardware design and debug issue.

The HF-BL500 SOC chip block diagram is as following.

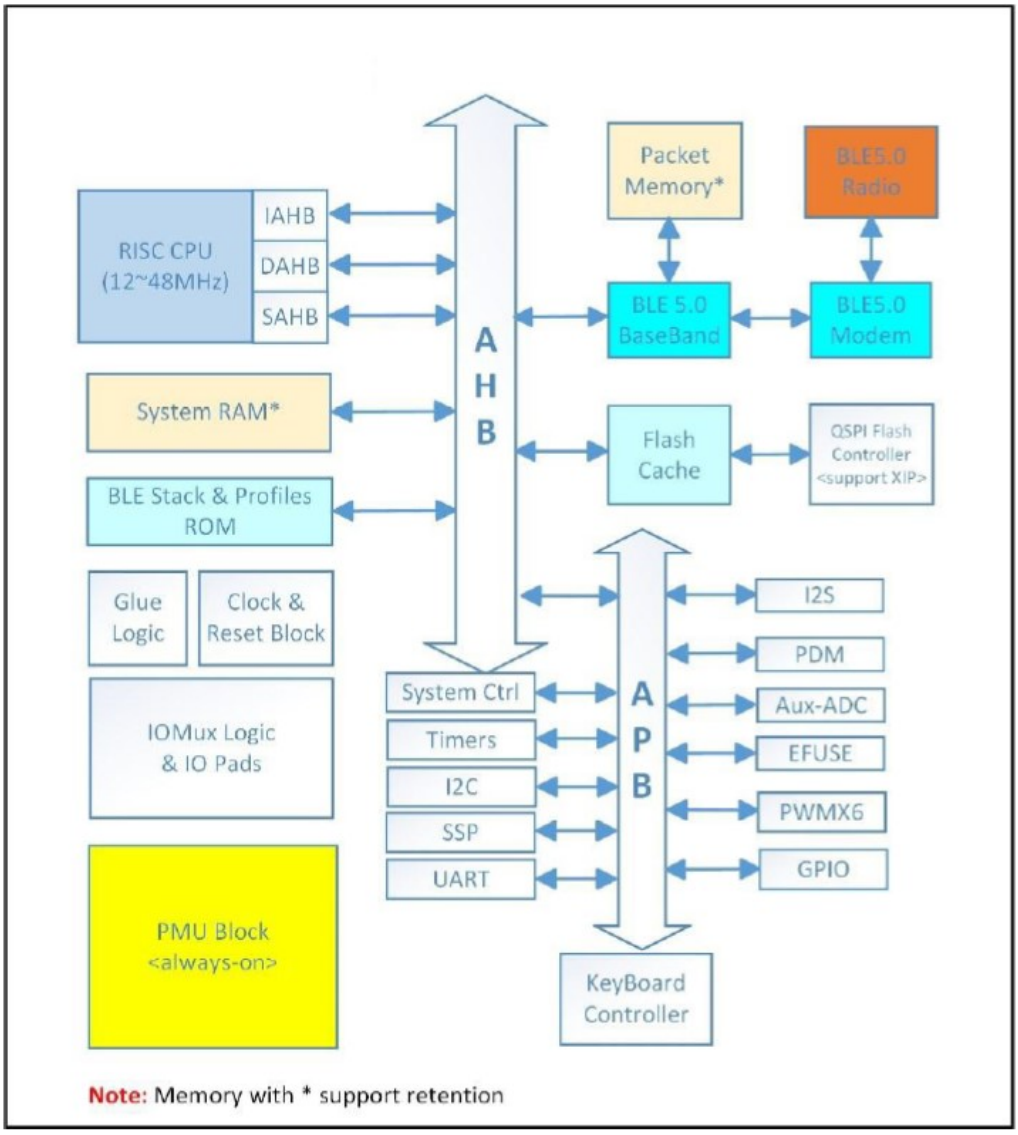


Figure 1. HF-BL500 SOC Block Diagram

1.2. Key Application

- Smart LED lighting
- Smart toy
- Electronic Scale
- Smart Cup
- Smart Home Appliance
- OBD
- IOT, Smart Home Automation
- Sports, fitness, customer electronics products
- Smart instrument, data acquisition sensor
- PC, Tablet peripheral interface

1.3. Device Parameter

Table1. HF-BL500 Module Technique Specification

Class	Item	Condition	Parameter
Wireless parameter	Wireless standard		802.15.1
	Frequency range		2.402GHz-2.480GHz
	Data rate		2Mbps@2.4GHz
	Tx power		Max=+10 dBm,
	Rx sensitivity		-93 dBm
Hardware parameter	Data interface		UART PWM ADC
	Operating voltage		2.5~4.3V
	Average power consumption	20ms broadcast	3.2mA
		1 sec broadcast	80uA
	Distance	Indoor	40 meters(10dBm)
		Outdoor	150 meters(10dBm)
	Work temperature		-40℃- 125℃
	Storage temperature		-45℃- 125℃
	Size		22.5mm x 13.5mm x 3mm

1.4. Module Appearance

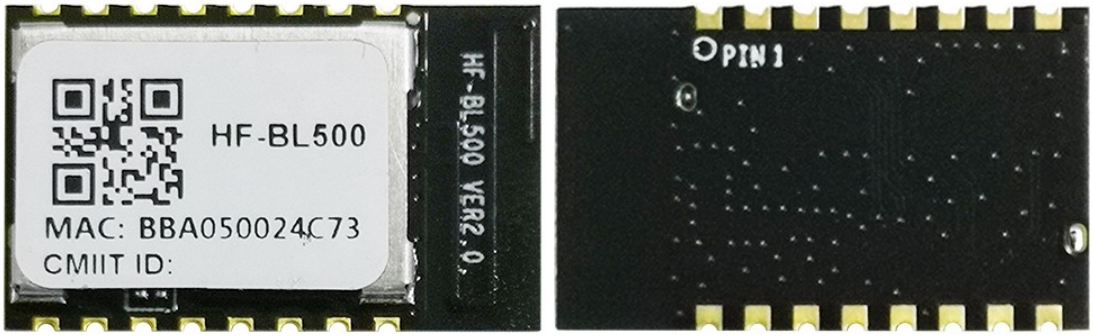


Figure 2. HF-BL500-1 Appearance

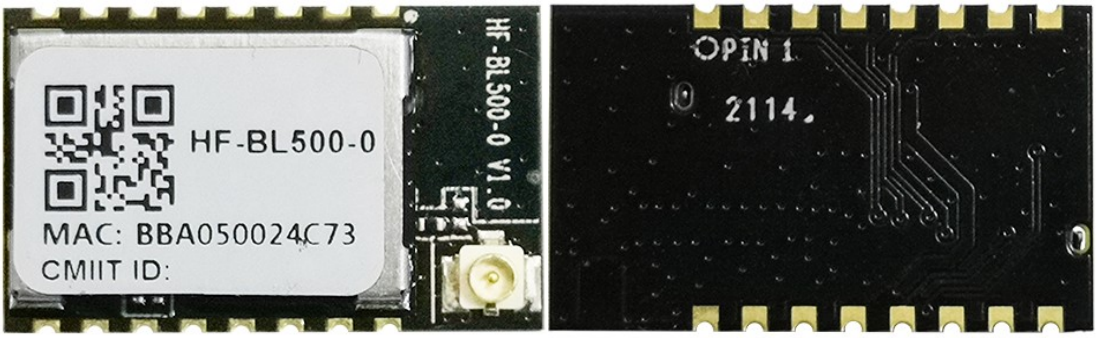


Figure 3. HF-BL500-0 Appearance

2. HARDWARE INTRODUCTION

2.1. Pin Definition

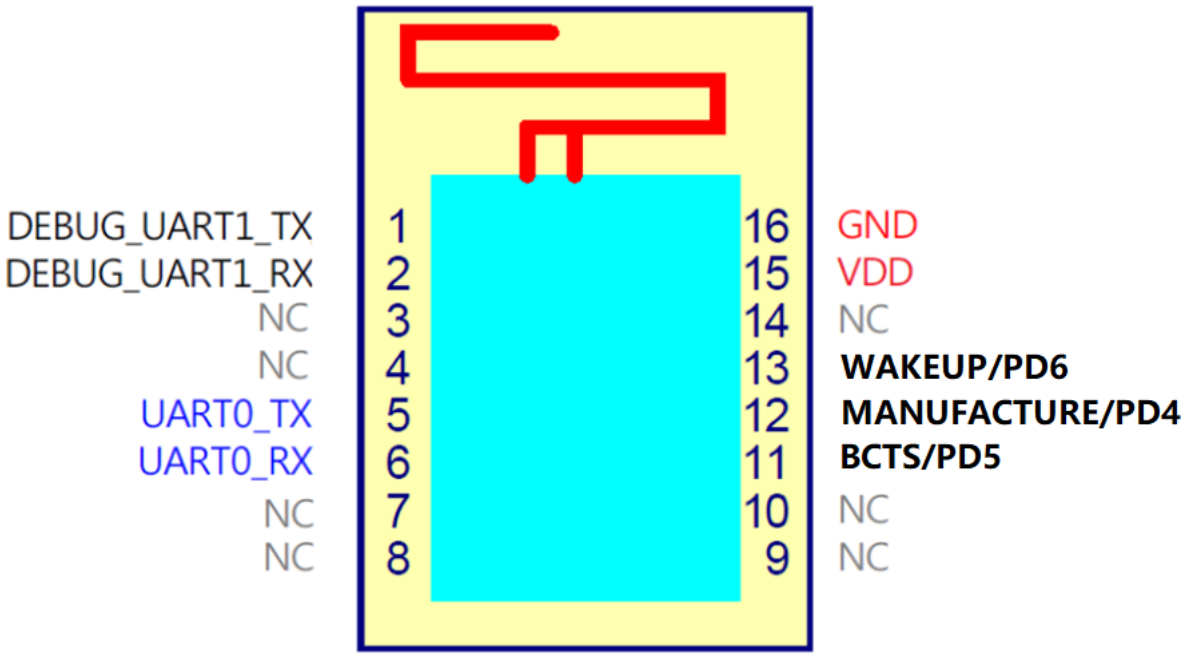


Figure 4. HF-BL500 Pin Definition

Table2. HF-BL500 Pin Function Definition

Pin	Describtion	Net Name	Signal Type	Comments
1	UART1_TX	DEBUG_UART1_TX	O	3.3V TTL Debug UART1 Output PORTA3, PWM3
2	UART1_RX	DEBUG_UART1_RX	I	3.3V TTL Debug UART1 Input PORTA2, PWM2
3		NC		
4		NC		
5	UART0_TX	UART0_TX	O	3.3V TTL UART0 Output PORTC7
6	UART0_RX	UART0_RX	I	3.3V TTL UART0 Input PORTC6
7, 8 9, 10		NC		
11		BCTS	IO	The default output low, high data output is sent, used to wake up the MCU, the data is sent after the output low PORTD5, PWM4/ADC1
12		MANUFACTURE	I/O	Pull Low for more than 5 seconds to restore the factory settings, leave it open if not

				use(internal has low pull-up) PORTD4, PWM5/ADC0
13		WAKEUP	IO	Pull low to wake up module, if does not need power save, direct connect this pin to GND PORTD6, PWM1/ADC2
14		NC		
15	**+3.3V 电源**	**DVDD**	**Power**	
16	**Ground**	**GND**	**Power**	

<Notes>

I — Input；O — Output

PU—Internal Resistor Pull Up； I/O: Digital I/O； Power—Power Supply

PWM function:

PWM1~PWM5 is for LED Mesh application, it direct output PWM, control the LED duty cycle, add transistor or MOSFET to amplify.

2.2. Electrical Specification

Table3. Limited Specification

Parameter	Description	Min Value	Typ. Value	Max value	Unit
VPIN	Pin voltage limit	-0.1	-	VCC	V
T_VRISE	Power up time	5	-	100	mS
ESD_HBM				4000	V
ESD_MM				100	V
ESD_CDM				500	V
Storage temperature range		-50		150	°C

Table4. RF Specification

Parameter	**Min value**	**Typ. Value**	**Max value**	**Unit**
Receiving sensitivity		-93		dBm
Operating frequency range	2400		2483	MHz
Frequency deviation	225	250	275	KHz
Output Power	-20		4	dBm
Frequency tolerance		±50		Ppm
Signal strength accuracy		±5		dBm
Signal accuracy		1		dBm

2.3. Mechanical size

HF-BL500 physical size （unit: mm）as below:

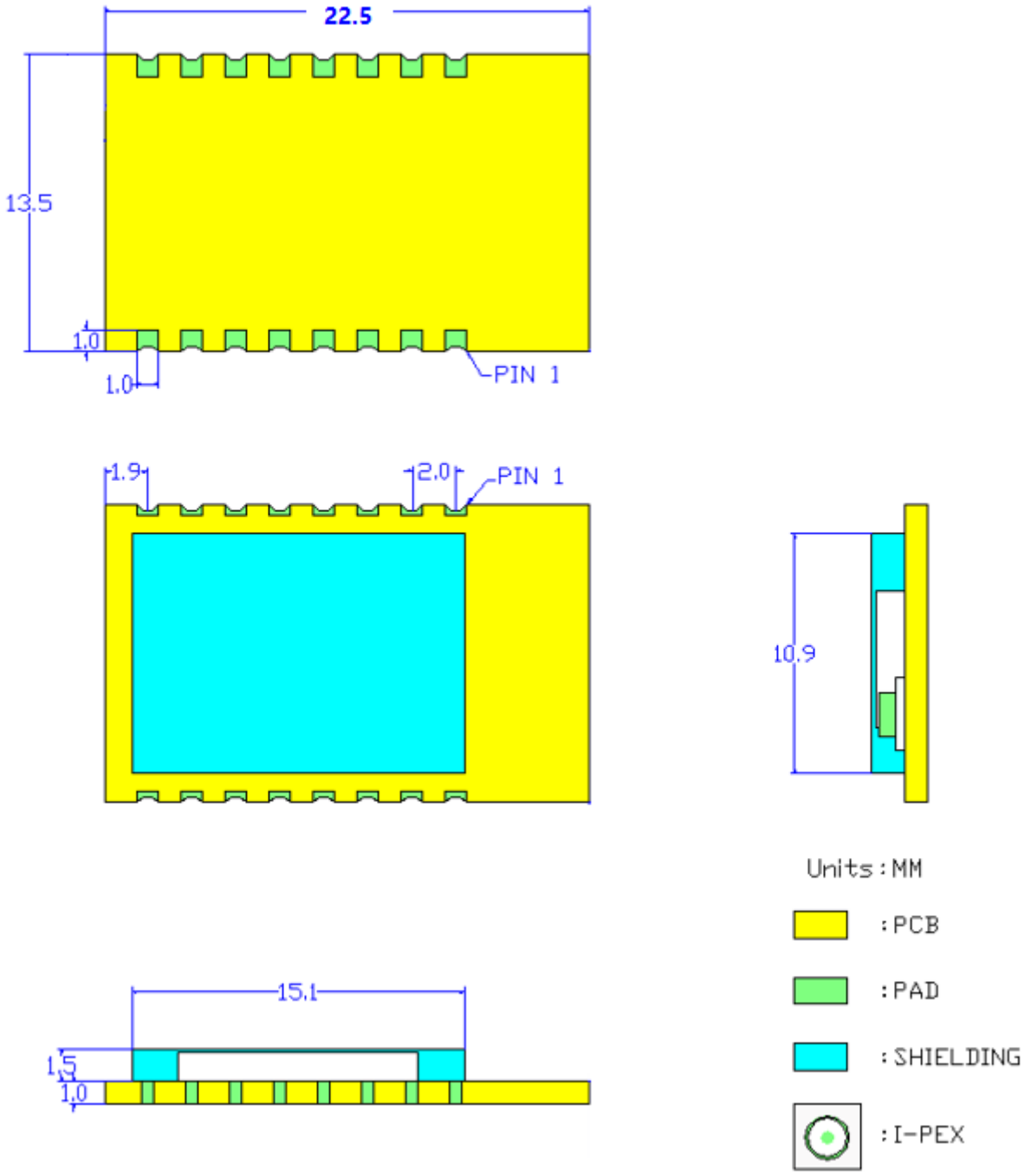


Figure 5. HF-BL500 Mechanical size

2.4. Antenna Layout

HF-BL500 supports internal antenna. Customers need to obey following antenna design rules and module location suggestions:

- For user PCB, place module on the edge area of the PCB as possible, or suspend the antenna area.

- Module antenna correspondent area can't put components or paste GND, the surrounding components or GND should be as far as possible from antenna place.
- Antenna must be away from high components at least 10mm.
- Antenna can't be shielded by any metal enclosure.

High Flying suggests to locate HF-BL500 as following picture to reduce the influence to antenna and wireless signal as much as possible, or contact High Flying technique people for support

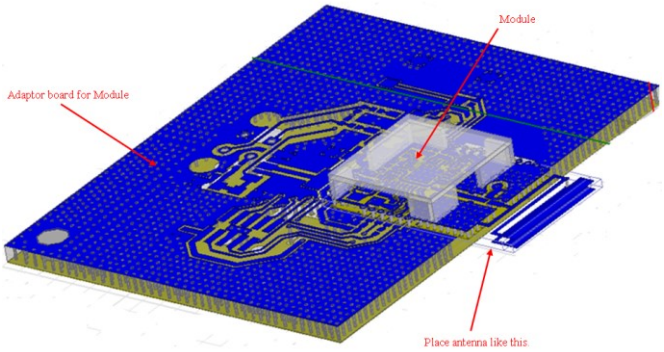


Figure 6. HF-BL500 Module Reference Placement

2.4.1. Order Information

Base on customer detailed requirement, modules provide different variants and physical type for detailed application.

Mark ★ in Red is our main modules									
Type \ Function	Antenna	Footprint	PIN Num	GPIO Num	Size	Power Input	Function	UART	UART Num
★HF-BL500-1	Internal PCB	SMT	16	5	22.5 x 13.5 x 3mm	3.3VDC	BLE	3.3V TTL	1 Comm+1 Debug
HF-BL500-0	External 1st IPEX		16						

Figure 7. Order Information

3. UART TRANSPARENT TRANSMIT MODE

3.1. Transparent Transmit Mode

Transparent Transmit means the bi-direction communication between device and mobile terminal Device can set HF-BL500 parameters (refer to “AT Command” chapter). Target different baud rate and BLE connect interval or different packet sending interval, module would have different data handling capacity. The default baud rate of HF-BL500 is 115200bps, it is recommended to set baud rate at 115200bps when transmitting big data or in highly real-time application. Baud rate support save after power off.

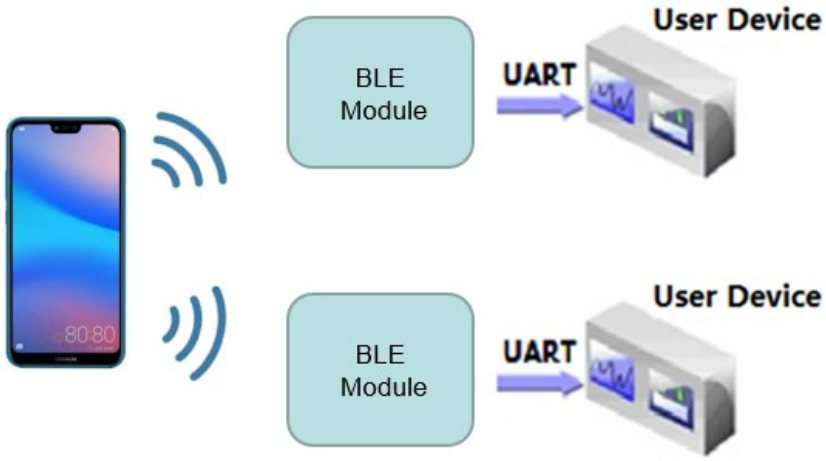


Figure 8. Basic HF-BL500 wireless network structure

Module can receive almost 800 bytes data from serial interface one time. Module will automatically send sub-packet according to data size, each packet limit is 200 bytes. The data packet sending from mobile device to module must be separated to sub-packet(1～200 byte each). After receiving the sub-packets, module will send to MCU in proper order.

Serial hardware protocol: 115200 bps, 8,non-parity, 1 stop bit

After receiving data from MCU serial port, module will judge if it is AT command. If it is, module will execute the command. If not, module will transmit the data to APP under BLE connection and notify mode enabled status.

After module receives APP data, it will output the data to MCU via serial interface.

If module system status changed, module will send status notification character to MCU, such as disconnect, connect, broadcast.

Bluetooth protocol require that the minimum connect interval is 7.5ms. Default connect interval is 20ms (comply with IOS regulation), if it is needed to save power and apply low speed transmit mode. User can adjust connect interval through AT command (the maximum connect interval is 2000ms, comply with IOS regulation)

The calculation of transmit speed: the data packet of each connection interval from APP to module is 1 packet, max 4 packet can be transmitted from module to APP in each interval (the packet is related to module CPU capacity). There is maximum 200 bytes in each packet, if connect interval is T (unit: ms), then max transmit speed V (unit is byte/s) is:

Vmodule = 200*4*1000/T (V only related T)

Vapp=200*1000/T (V only related T)

Vapp: if module connect interval is 20ms, then each interval can transmit max 200 bytes, so theoretically the max speed is 200x50 =10k byte/s. Test shows the transmit from APP to module is stable and reliable.

Vmodule: if module connect interval is 20ms, then each interval can transmit maximum 800 bytes, so theoretically the maximum speed is 800x 50=40k byte/s.

Baud rate also take effect on the communication rate, 115200 speed is about 10KB.

Below is the example of 20ms connect interval communication mode, user can self-configure. The lower the Speed, the lower the packet lost ratio.

Table5. Communication Data Rate

Connect Interval T (ms)	Max Data Rate V V=800*1000/T	UART packet length L	UART packet interval TS(ms) L<800, TS>=T 800<L<160, TS>=2*T 800<L<1000, TS>=3*T	Actual Data Rate V0 V0=L*1000/TS
20	40K	80	TS>T, TS=20ms	80*1000/20=4KB
20	40K	400	TS=20ms	400*1000/20=20KB
20	40K	900	TS=40ms	900*1000/40=36KB

Note:

In IOS, the function is used to call Characteristic is: BCharacteristicWriteWithRespons e parameter: “write with response” mode would lower transmit efficiency to ensure the accuracy of each packet. Using “CBCharacteristicWriteWithoutResponse”; “write without response” mode would promote transmit efficiency, but the accuracy of packet need to be verified by APP up level.

3.2. Transparent Transmit Mode Pin Description

All pins of Transparent Transmit :UART_TX, UART_RX, WAKEUP, BCTS, MANUFACTURE

Min. pins of Transparent Transmit:UART_TX, UART_RX, WAKEUP

Pin	Describtion	Net Name	Signal Type	Comments
2	UART_TX	UART_TX	O	3.3V TTL UART0 Communication Output
3	UART_RX	UART_RX	I	3.3V TTL UART0 Communication Input
6	BCTS	ADC2	I/O	The default output low, high data output is sent, used to wake up the MCU, the data is sent after the output low
7	MANUFACTURE	LED2	I/O	Pull low for more than 5 seconds to restore the factory settings,
8	WAKEUP	LED1	I/O	Pull low to wake up module, if does not need power save, direct connect this pin to GND

WEAKEUP: inside high impedance, pin must be connected. Pull up to stop UART receive function. UART is unable to receive data (UART able to send data). Pull down to enable UART to receive data.
BCTS: In normal time, output low level; BCTS output high level before sending data from module, after sending, BCTS output low level.

3.3. Enable Module Deep Sleep

Function: enable module CPU subsystem deep sleep, (BLE subsystem isolate operation), non deep sleep mode module can receive data via UART, under deep sleep module UART function is disabled
Effective time: immediately
Command:
PIN32->WAKEUP: high level ->CPU subsystem enter deep sleep , module UART don't receive data
PIN32->WAKEUP: low level-> CPU is not allowed to enter deep sleep, module UART able to 不允 receive data
Need to pay attention to actual level and data sending sequence, sending data must wait 50 us after set high level to low level, after sending finished, and must waiting another 50 us to set low level to high level

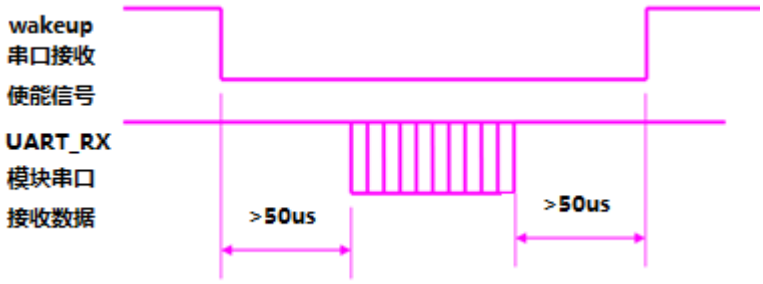


Figure 9. Module UART Receive Enable Signal Map

3.4. Restore Factory Setting via Hardware Method

Function: All changeable parameter restore to factory setting, include baud rate, device name, transmit power, user-define broadcast data, UART data latency data, verify code ,broadcast parameter, connect parameter
Effective time: Immediately
Command:
PIN29->MANUFACTURE:
Feedback:
"AT:RELOAD\r\n" means accept command to restore factory setting

3.5. Factory Default Parameter

3.5.1. Device Name

Device NAME: "HF-BL500"

3.5.2. Broadcast Parameter

Broadcast Min. interval: “0800”, means 500ms

Broadcast Max. interval: “0800”, means 500ms

Broadcast type: “0”, means public

Broadcast channel :“7”,means apply channel index 37 38 39

3.5.3. Transmit Power

Broadcast transmit power : ”8”, means 10dbm

Connect transmit power : ”8” means 10dbm

3.5.4. Connect Parameter

Min interval : ”0016”, means 20ms

Max interval : ”0032”, means 40ms

Slave Latency : ”0”, means 0

Connect timeout : ”0200”, means 2000ms

3.5.5. Baud rate

Baud rate:“115200”

3.5.6. Send Latency Parameter

Serial sending Latency: “01”, means 1ms

4. UART AT COMMAND DEFINITION

4.1. Module Operation Mode Configure

After HF-BL500 power on, module enter transparent transmit mode, default UART configuration parameter is as below:

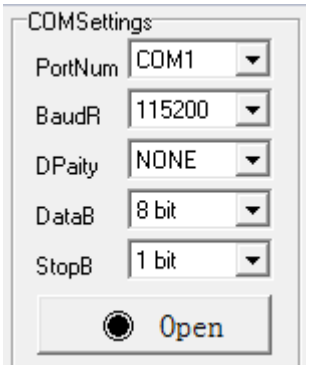


Figure 10. HF-BL500 Default UART Parameter

User can configure the module via AT command through UART or use Evaluation Kit to test.
<Note>: AT command debug tool recommend use “friend serial debug assistant” and SecureCRT tool ,which can be download from company website.

4.2. AT:Command Overview

AT: command can be inputted via serial debug tool or compile as below photo shows, AT:HELP is a help command, list all commands and description.
Remark: the end of each command need add return or line feed character.

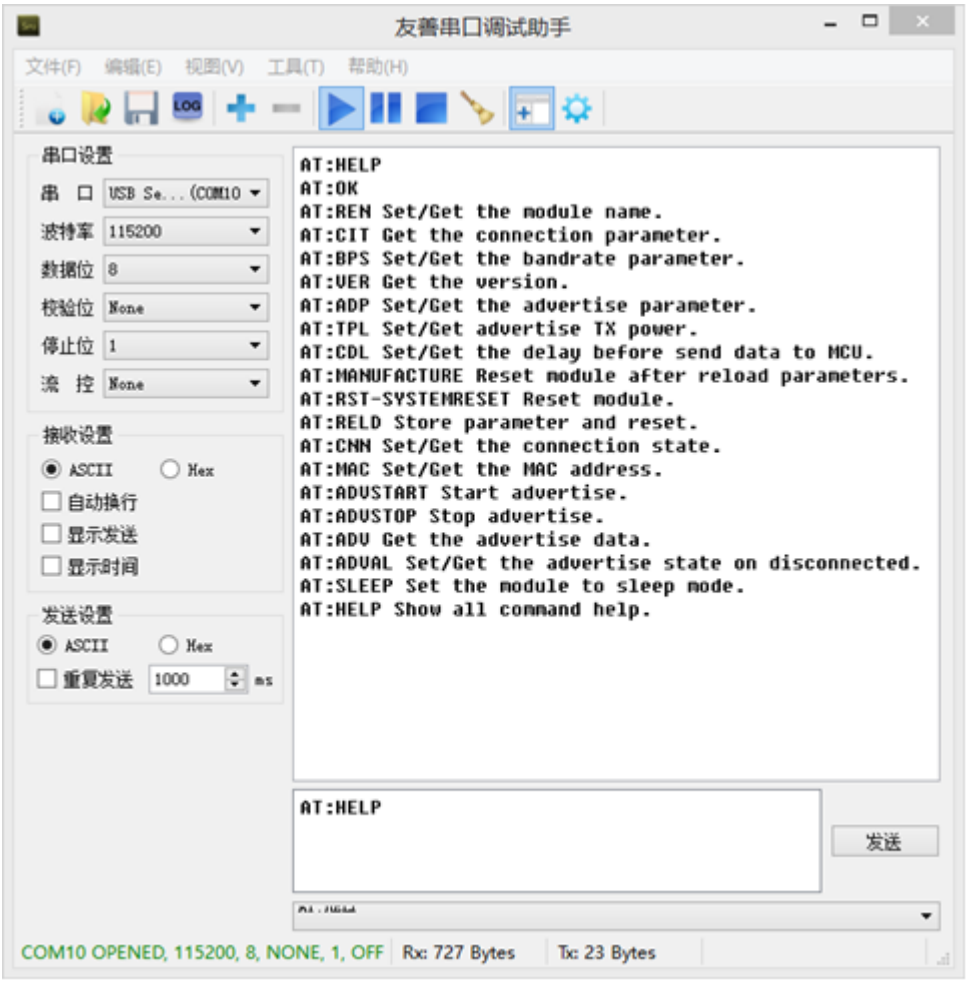


Figure 11. "AT:HELP" list All command

4.2.1. Command Format

AT: command based on ASCII code, format as below:

- Format description
  - **< >**: mean the part must include
  - **[ ]**: mean optional part

- Command message

  AT:<CMD>[op][para-1,para-2,para-3,para-4…]<CR><LF>
  - AT::command message prefix
  - CMD:command character string
  - [op] : command operate character, can be parameter setting or query
    - "-" : means parameter setting
    - "？" :means query
  - [para-n] : parameter setting code, if query, it is not required.
  - <CR>:end ,ASCII code 0x0d；
  - <LF>: return,ASCII code 0x0a

<descritpion>:

When input command,"AT:<CMD>" character is capital word, parameter parts is the same.

- Feedback message

  AT:<RSP>[op] [para-1,para-2,para-3,para-4…]<CR><LF><CR><LF>

  - AT:: feedback message prefix;
  - RSP: feedback character string, include:
    - “OK” : success
    - “ERP”:failed
    - “DENY”: operation denied
    - <CMD>: original command
  - [op] :-
  - [para-n] : the feedback parameter when query or error code when error happened
  - <CR>:ASCII code 0x0d
  - <LF>:ASCII code 0x0a
- Error code

Table6. Error Code list

Error code	Descritpion
ERP	Invalid command
WRONG	Invalid parameter
DENY	Operation denied

4.2.2. Command List

Table7. AT Command List

Command Type	Data transmit direction	Save or not	Function description
"AT:HELP"	MCU->Module	No	Helo command
" AT:REN-" + Name	MCU->Module	Yes	Set module NAME
" AT:REN？ "	MCU->Module	Query	Query module NAME
"AT+CIT-" +IntervalMin+IntervalMax +Slave Latency+connSupervision Timeout	MCU->Module	Yes	Set connect parameter
"AT+CIT？ "	MCU->Module	Query	Query connect parameter
"AT:BPS-"+baudrate	MCU->Module	Yes	Set baud rate
"AT:BPS？ "	MCU->Module	Query	Query baud rate
"AT:MAC？ "	(APP)MCU->Module	Query	Query MAC
"AT:WAC-"	(APP)MCU->Module	Yes	Set MAC

"AT:VER？"	(APP)MCU->Module	Query	Query software version
"AT:TPL-" +Data0+Data1	MCU->Module	Yes	Set transmit power
"AT:TPL？"	MCU->Module	Query	Query transmit power
"AT:ADP-" +parameters	MCU->Module	Yes	Set broadcast parameter
"AT:ADP？"	MCU->Module	Query	Query broadcast parameter
"AT:ADV-"+ Data	MCU->Module	Yes	Set user-define broadcast data
"AT:ADV？"	MCU->Module	Query	Query user-define broadcast data
"AT:ADVAL"+data	MCU->Module	Yes	Set auto-broadcast switch
"AT:ADVAL？"	MCU->Module	Query	Query auto-broadcast switch
"AT:ADVSTART"	MCU->Module	No	Start broadcast
"AT:ADVSTOP"	MCU->Module	No	Stop broadcast
"AT:CNN-D"	MCU->Module	No	Disconnect
"AT:PID-"+ Data	(APP)MCU->Module	Yes	Ser device verify code
"AT:PID？"	(APP)MCU->Module	Query	Query device verify code
"AT:SAVE"	（APP）MCU->Module	No	Save parameter
"AT:RST"	MCU->Module	No	Restore module
"AT:RELD"	MCU->Module	no	Restore factory setting via AT command
PIN32->WAKEUP high level outside	MCU->module	Notification	Enable module CPU subsystem deep sleep（BLE subsystem isolated operation）
PIN29->MANUFACTURE	MCU->Module	-	Restore factory parameter via hardware

*Note:UART serial interface command must end with <CR><LF>,feedback must end with<CR><LF>

*Note:（APP）means the command is also applicable to APP command,APP command no need <CR><LF>

4.3. AT Command

4.3.1. AT:HELP Help command

Function: display all command description

Effective time:effective immediately

Command:

"AT:HELP"+<CR><LF>

feedback:

"AT:OK" +<CR><LF>+data mean command success, feedback description data

Data: list all command description data

"AT:ERP\r\n" means invalid command, query failed

4.3.2. AT:REN- Set Module NAME

Function: set module name, max length is 11 character

Effective time: effective after re-broadcast

Command:

" AT:REN-" + Name+<CR><LF>

Name : display the name, max 11 character

Feedback:

"AT:OK\r\n" means success

"AT:WRONG\r\n" means invalid parameter, set failed

"AT:ERP\r\n" means invalid command, set failed

4.3.3. AT:REN? Query module Name

Function: query module current Name

Command

"AT:REN？ "+<CR><LF>

'?': means query

Feedback

"AT:REN-"+devicename+<CR><LF> means success

Devicename: device name can be displayed, max 11 character, default factory name is “HF-BL500”

"AT:ERP\r\n\0" means invalid command, failed

4.3.4. AT:CIT- Set Connect Parameter

Function: set BLE connect parameter

Effective time:effect immediately at connection status or effective after connection

Command:

"AT:CIT-"+IntervalMin+IntervalMax+Slave Latency+connSupervision Timeout+<CR><LF>

IntervalMin:4 character means,HighByte |...| LowByte;’0’~’9’ means 0~9,”0200”-> decimal 200*1.25ms

IntervalMax:4 byte means ,HighByte |...| LowByte;’0’~’9’ means 0~9,”1000”-> decimal 1000*1.25ms

Slave Latency:1 character,’0’~’9’ means 0~9,

connSupervision Timeout:4 character means ,HighCharacter|...|LowCharacter,’0’~’9’ means 0~9,”2000”-> decimal 2000*10ms

when connect to IOS APP ,Apple has their own regulation, for parameter must comply :

1. IntervalMax*（Slave Latency+1）《=2 seconds
2. IntervalMin>=20ms
3. IntervalMin +20ms<=IntervalMax
4. Slave Latency<=4
5. connSupervision Timeout<=6 seconds
6. IntervalMax*(Slave Latency+1)*3<connSupervisionTimeout

Feedback:

"AT:WRONG\r\n" means invalid parameter, modify failed

"AT:OK\r\n" means success, run with new connect interval

"AT:ERP\r\n" means invalid command, modify failed

4.3.5. AT:CIT? Query Connect Parameter

Function: Query module connect parameter

Effective time:immediately

Command:

"AT:CIT?"+<CR><LF>

Feedback:

"AT+CIT-"+IntervalMin+IntervalMax+Slave Latency+connSupervision Timeout+<CR><LF>

IntervalMin:4 character means ,HighByte |...| LowByte;'0'~'9' means 0~9,"0200"-> decimal 200*1.25ms

IntervalMax:4 character means,HighByte |...| LowByte;'0'~'9' means 0~9,"1000"-> decimal1000*1.25ms

Slave Latency:1 character,'0'~'9' means 0~9,

connSupervision Timeout:4 character means ,HighByte|...|LowByte,'0'~'9' means 0~9,"2000"-> decimal 2000*10ms

when connect to IOS APP ,Apple has their own regulation, four parameter must comply:

7. IntervalMax*（Slave Latency+1）《=2 seconds
8. IntervalMin>=20ms
9. IntervalMin +20ms<=IntervalMax
10. Slave Latency<=4
11. connSupervision Timeout<=6 seconds
12. IntervalMax*(Slave Latency+1)*3<connSupervisionTimeout

"AT:ERP\r\n" means invalid command, query failed

4.3.6. AT:BPS- Set Baud rate

Function: modify UART Baud rate

Effective time:effective after receiving the success feedback data

Command:

"AT:BPS-"+baud rate+<CR><LF>

Baudrate:6 character,'0'~'9' means 0~9,"115200"-> decimal 115200

Feedback:

"AT:OK\r\n" means success

"AT:WRONG\r\n" means invalid parameter, modify failed

"AT:ERP\r\n" means invalid command, modify failed.

Remark: only apply regular baud rate 4800,9600,19200,38400,57600,115200,230400,921600 other parameter would be consider invalid.

4.3.7. AT:BPS? Query Baud rate

Function: query current baud rate

Effective time:immediately

Command:

"AT:BPS？"+<CR><LF>

Feedback:

"AT:BPS-"+baud rate+<CR><LF> means success

Baudrate:6 character ,'0'~'9' means 0~9,"115200"-> decimal 115200,"038400"-> decimal 38400

"AT:ERP\r\n" means invalid command, query failed

4.3.8. AT:MAC? Get MAC Address

Function: Get Bluetooth MAC

Command:

"AT:MAC?"+<CR><LF>

APP Command do not need <CR><LF>

Feedback:

" AT:MAC-"+MAC+<CR><LF>

MAC: 12 character can represent 6 byte data, each 2 character represent the four bit in high order and the four bit in low order of one byte.

e.g. :"123456789012"->0x12,0x34,0x56,0x78,0x90,0x12, character can only be '0'~'9','A'~'F'

APP Command do not need <CR><LF>

4.3.9. AT:WAC- Set MAC Address

Function: Get Bluetooth MAC

Command:

"AT:WAC-"+MAC+<CR><LF>

APP Command do not need <CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received

MAC: 12 character can represent 6 byte data, each 2 character represent the four bit in high order and the four bit in low order of one byte.

e.g. :“123456789012”->0x12,0x34,0x56,0x78,0x90,0x12, character can only be ’0’~’9’,’A’~’F’

APP Command do not need <CR><LF>

4.3.10. AT:VER? Query Software Version

function:Query device current software version

Effective time:immediately

Command:

"AT:VER？"+<CR><LF>

APP Command do not need <CR><LF>

Feedback:

"AT:VER-"+version+<CR><LF> means query success

APP Command do not need <CR><LF>

Version: character string, e.g. "100-CU-V*.*"

"AT:ERP\r\n" means invalid command, query failed

APP Command do not need "\r\n"

4.3.11. AT:TPL- Set Transmit Power

Function: modify device transmit power, broadcast power and connect power

Effective time:immediately

Command

"AT:TPL-"+Data+<CR><LF>

Data: broadcast and connect power, one character, ’0’~’8’ means 0~8,

0-> -10dbm

1-> -5dbm

2-> -2dbm

3-> 0dbm

4-> 2dbm

5-> 4dbm

6-> 6dbm

7-> 8dbm

8-> 10dbm

Feedback:

"AT:OK\r\n" means command successfully received

"AT:WRONG\r\n" means invalid parameter, modify failed, if not '1'~'8', then it is invalid parameter

"AT:ERP\r\n" means invalid command, modify failed

4.3.12. AT:TPL? Query Transmit Power

Function: query device current transmit power, broadcast power, connect power

Effective time: immediately

Command:

"AT:TPL？"+<CR><LF>

'?': means query command

Feedback:

"AT:TPL-"+Data +<CR><LF>

Data0: broadcast and connect power ,one character, '1'~'8' means 1~8,

0-> -10dbm

1-> -5dbm

2-> -2dbm

3-> 0dbm

4-> 2dbm

5-> 4dbm

6-> 6dbm

7-> 8dbm

8-> 10dbm

"AT:ERP\r\n" means invalid command, query failed

4.3.13. AT:ADP- Set Broadcast Parameter

Function: set broadcast parameter, min. interval/max interval/broadcast type/broadcast channel

Effective time:effect in next broadcast

Command:

"AT:ADP-"+parameters+<CR><LF>

Parameters: includes 13 character, min interval ->4 character, max interval ->4 character,broadcast type->1 character, broadcast channel ->1 character

Min interval:HighByte|...|LowByte,'0'~'9' means 0~9("100"-> decimal 100), unit :0.625ms

Max interval:HighByte|...|LowByte,'0'~'9' means 0~9("1200"-> decimal 1200) ,unit:0.625ms

Broadcast type:'0'~'1' means 0~1,0->public,1->random,only public type available temporarily

Broadcast channel :'1'~'7' means 1~7,the three bit in low order correspond each channel index. bit0->channel37,bit1->channel->38,bit2->channel39 , the setting can be combined

Feedback:

"AT:OK\r\n" means command successful received

"AT:WRONG\r\n" means invalid parameter, change failed

"AT:ERP\r\n" means invalid command, change failed

4.3.14. AT:ADP? Query Broadcast Parameter

Function: query broadcast parameter, min interval/ max interval/ broadcast type/broadcast channel

Effective time:immediately

Command:

"AT:ADP?"+<CR><LF>

Feedback:

"AT:ADP-"+parameters+<CR><LF>

Parameters: include 13 character, min interval ->4 character, max interval->4 character, broadcast type->1 character, broadcast channel ->1 character

Min interval:HighByte|...|LowByte,'0'~'9' means 0~9("100"-> decimal 100) , unit:0.625ms

Max interval:HighByte|...|LowByte,'0'~'9' means 0~9("1200"-> decimal 1200) , unit:0.625ms

Broadcast:'0'~'1' means 0~1,0->public,1->random

Broadcast channel:'1'~'7' means 1~7,the three bit in low order correspond each channel index , bit0->channel37,bit1->channel->38,bit2->channel39, the setting can be combined.

"AT:ERP\r\n" means invalid command, query failed

4.3.15. AT:ADV- Set User-define Broadcast Data

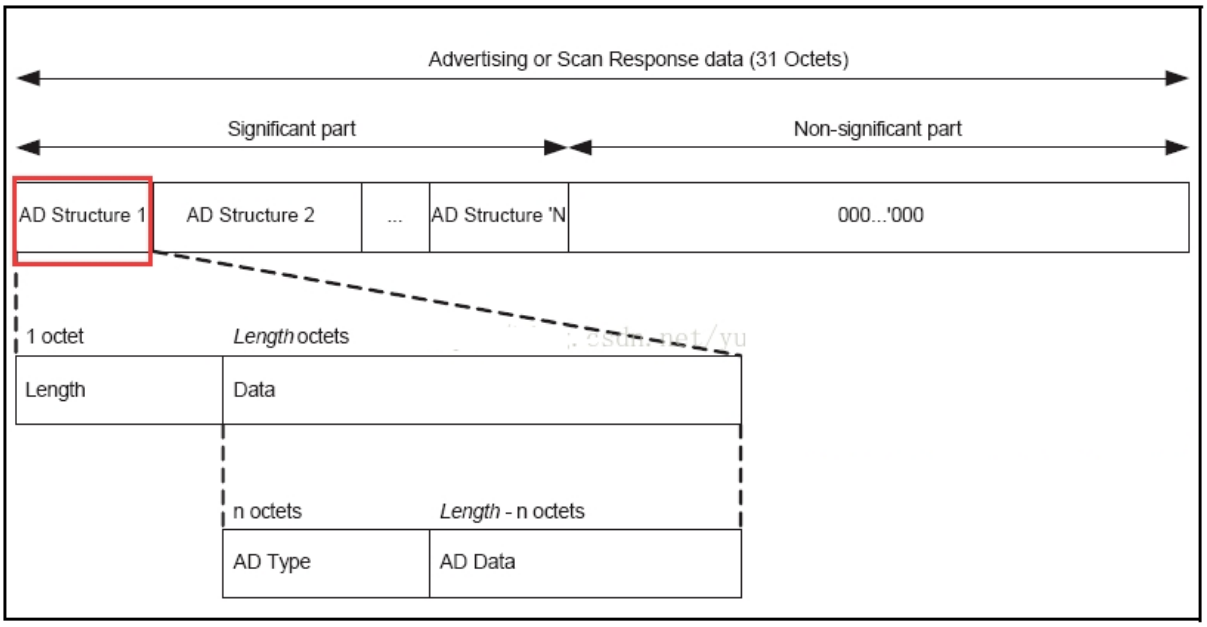
Function: set the user-define data in broadcast, the max data length is 14 bytes

Effective time:effective in next broadcast

Command:

"AT:ADV-"+ Data+<CR><LF>

Data: max length is 11 bytes, data format must follow Bluetooth regulation，command in HEX format example: 41 54 3A 41 44 56 2D 03 09 05 06 0D 0A，value content of 03 （length） 09（AD Type） 05 06（DATA）



Feedback:

"AT:OK\r\n" means command successful received

"AT:WRONG\r\n" means invalid parameter, change failed

"AT:ERP\r\n" means invalid command, change failed

4.3.16. AT:ADV? Query User-define Broadcast Data

Function: query the data in user-define broadcast, max data length is 14 bytes

Effective time:immediately

Command:

"AT:ADV？"+<CR><LF>

Feedback:

"AT:ADV-"+data+<CR><LF> means command successful received and feedback data

Data: max length is 11 bytes, data format must follow Bluetooth regulation

"AT:ERP\r\n" means invalid command, change failed

4.3.17. AT:ADVAL- Set Auto-broadcast Switch

Function: auto start broadcast when module power on and disconnection

Effective time:effective when disconnect

Command:

"AT:ADVAL-"+data+<CR><LF>

Data:'0'->disable,'1'-> means enable

Feedback:

"AT:OK\r

\n" means command successfully received

"AT:WRONG\r\n" means invalid parameter, command failed

"AT:ERP\r\n" means invalid command, command failed

4.3.18. AT:ADVAL? Query Auto-broadcast Switch

Function: query the functions status of auto-broadcast

Effective time:immediately

Command:

"AT:ADVAL？"+<CR><LF>

Feedback:

"AT:ADVAL-"+status+<CR><LF> feedback current auto-broadcast switch function parameter

Status: each character indicate a status

'0'-> disable

'1'-> enable

"AT:WRONG\r\n" means invalid parameter, query failed

"AT:ERP\r\n" means invalid command, query failed

4.3.19. AT:ADVSTART Start Broadcast

Function: device start broadcast

Effective time: do not execute if under broadcast status and connect status, execute immediately under other status

Command:

"AT:ADVSTART"+ <CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received and start broadcast

"AT:ADVSTART-"+status+<CR><LF> means command successfully received, but status incorrect

Status: each character indicate a status

'0'-> CYBLE_CNN_INITIALIZING

'1'-> CYBLE_CNN_ADVERTISING

'2'-> CYBLE_CNN_CONNECTED

'3'-> CYBLE_CNN_DISCONNECTED

'4'-> CYBLE_CNN_STOPPED

'5'-> CYBLE_CNN_CONNECTING

"AT:ERP\r\n" means invalid command, command failed

4.3.20. AT:ADVSTOP Stop Broadcast

Function: stop broadcast

Effective time: execute immediately at broadcast status; do not execute if at other status

Command:

"AT:ADVSTOP"+ <CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received and stop broadcast

"AT:ADVSTOP-"+status+<CR><LF> means command successfully received, but status incorrect

Status: each character indicate a status

'0'-> CYBLE_CNN_INITIALIZING

'1'-> CYBLE_CNN_ADVERTISING

'2'-> CYBLE_CNN_CONNECTED

'3'-> CYBLE_CNN_DISCONNECTED

'4'-> CYBLE_CNN_STOPPED

'5'-> CYBLE_CNN_CONNECTING

"AT:ERP\r\n" means invalid command, command failed

4.3.21. AT:CNN-D Disconnect

Function: device disconnect

Effective time:effective immediately if device at connect status; if at other status, do not execute command

Command:

"AT:CNN-D"+<CR><LF>

Feedback:

"AT:OK\r\n" means command received and executed

"AT:CNN-"+status+<CR><LF> means command received, but not executed because status incorrect

Status: each character indicate a status

'0'-> CYBLE_CNN_INITIALIZING

'1'-> CYBLE_CNN_ADVERTISING

'2'-> CYBLE_CNN_CONNECTED

'3'-> CYBLE_CNN_DISCONNECTED

'4'-> CYBLE_CNN_STOPPED

'5'-> CYBLE_CNN_CONNECTING

"AT:ERP\r\n" means invalid command, change failed

4.3.22. AT:PID- Set Device Verify Code

Function: change device verify code, all "0" means no verify code

Effective time:effective in next Bluetooth connection

Command:

"AT:PID-"+ Data+<CR><LF>

APP command no need <CR><LF>

Data:4 character means 1 hexadecimal data,'0'~'9','A'~'F' means 0~9,A~F（"12AD"-> hexadecimal 0x12AD）

Feedback:

"AT:OK\r\n" means command successfully received.

"AT:WRONG\r\n" means invalid parameter, change failed

"AT:ERP\r\n" means invalid command, change failed

APP command no need "\r\n"

4.3.23. AT:PID? Query Device Verify Code

Function: query device verify code parameter, all ’0’ means no verify code

Effective time:immediately

Command:

"AT:PID？"+<CR><LF>

‘?’: means query command

APP command no need<CR><LF>

Feedback:

"AT:PID-"+ Data+<CR><LF>

APP Command no need<CR><LF>

Data:4 Character means 1 hexadecimal data, ’0’~’9’,’A’~’F’ means 0~9,A~F（“12AD”-> hexadecimal 0x12AD）

"AT:ERP\r\n" means invalid command, query failed

APP Command no need "\r\n"

4.3.24. AT:SAVE Save Parameter

Function: save the changed parameter(the save will stop BLE function and other interrupt, after save, system will restore)

Effective time: immediately, save will stop BLE function and other interrupt, after save, system will restore

Command:

"AT:SAVE"+<CR><LF>

APP command no need <CR><LF>

Feedback:

"AT:OK\r\n" means command correct

"AT:ERP\r\n" means invalid command, command failed

APP Command no need "\r\n"

4.3.25. AT:RST Module Restore

Function: module restore, system software restore

Effective time: stop BLE function ,execute immediately

Command:

"AT:RST"+<CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received

"AT:ERP\r\n" means invalid command, change failed

4.3.26. AT:RELD Restore Factory Setting via At Command

function:all changeable parameter restore to factory setting, include baud rate, device name, transmit power, user-define broadcast data, UART data latency data, verify code ,broadcast parameter, connect parameter

Effective time:immediately,system compulsory restore

Command:

"AT:RELD"+<CR><LF>

Feedback:

"AT:OK\r\n" means command success, system restore

"AT:ERP\r\n" means invalid command, restore failed

4.3.27. AT:UIDS Change Service UUID

Function: Set service UUID

Effective time: Need reboot

Command:

"AT:UIDS"+<CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received

"AT:ERP\r\n" means invalid command, change failed

For APP to change this, does not need “\r\n”

4.3.28. AT:UIDNW Change APP Send notification Channel UUID

Function: Set Send notification Channel UUID

Effective time: Need reboot

Command:

"AT:UIDNW"+<CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received

"AT:ERP\r\n" means invalid command, change failed

For APP to change this, does not need “\r\n”

Ex: AT:UIDNW-0x2B11

4.3.29. AT:UIDIW Change APP Send indication Channel UUID

Function: Set Send Indication Channel UUID

Effective time: Need reboot

Command:

"AT:UIDIW"+<CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received

"AT:ERP\r\n" means invalid command, change failed

For APP to change this, does not need “\r\n”

EX: AT:UIDIW-0x2B12

4.3.30. AT:UIDNR Change APP Receive Notification Channel UUID

Function: Set Receive Notification Channel UUID

Effective time: Need reboot

Command:

"AT:UIDNR"+<CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received

"AT:ERP\r\n" means invalid command, change failed

For APP to change this, does not need “\r\n”

Ex: AT:UIDNR-0x2B10

4.3.31. AT:UIDIR Change APP Receive Indication Channel UUID

Function: Set Receive Indication Channel UUID

Effective time: Need reboot

Command:

"AT:UIDIR"+<CR><LF>

Feedback:

"AT:OK\r\n" means command successfully received

"AT:ERP\r\n" means invalid command, change failed

For APP to change this, does not need “\r\n”

Ex: AT:UIDIR-0x2B13

1. APP COMMAND

1.1. Channel and Data Description

- APP command don't send in groups
- Maxium data of one group command is 20 bytes
- Data Channel:0x2B13 send WriteWithResponse and receive notify

1.2. Data Format

- Bye length （1 byte）+ command type（1 byte）+ command content（max 18 bytes）
- APP-->MODULE

Table8. Command Data from APP to Module

Byte length	Data[0]	1 byte	Include all byte of command type and command content
Command type	Data[1]	1 byte	0x0E: almost 18 bytes in one group AT command 0x0F: send verify code
Command content	Data[2]~data[19]	18 bytes	Details refer to command list (command type)

- APP<--MODULE

Table9. Feedback Data from Module to APP

Byte length	Data[0]	1 byte	Including all bytes from command type and command content
Feedback type	Data[1]	1 byte	0x0E:maxium 18 bytes in one group AT command 0x0F: feedback verify result
Command content	Data[2]~data[19]	18 bytes	Details refer to feedback list（feedback type）

1.3. Command Content

1.3.1. Command Type:0x0E

Command:

Function: data write in the form of 0x2B13 write with response , verify code command refer to AT command 4.3.23 &4.3.24, query version command refer to AT command 4.3.10

Feedback:

Channel:feedback data from 0x2B13 notify

Data content:

verify code command refer to AT command 4.3.23 &4.3.24, query version command refer to AT command 4.3.10

1.3.2. Command Type:0x0F

Command:

Function: send verify code from APP to module, if no verification after connection, module will not execute any other command from APP, if module self verification is null or “0000”, then verify code is no needed.

Verify code have time limit, if no verification within 10 seconds, module will disconnect with APP

Command Content:

Table10. Command Type 0x0F command list

Byte length	Data[0]	1 byte	1~19	Include all bytes from command type and command content
Command type	Data[1]	1 byte	0x0F	Verify code command
Command	Data[2]~data[19]	18 bytes	Data[2]~data[19]	Command content

Feedback:

Channel:feedback data from 0x2B13 notify

Data Content:

Table11. Command Type 0x0F Feedback List

Byte length	Data[0]	1 byte	2	Include all bytes from command type and command content
commandtype	Data[1]	1 byte	0x0F	Verified and feedback

Command content	Data[2]	1 byte	Data[2]	Verification feedback 0x00: success 0x01:failed 0x02: no verify code

2. BASIC COMMUNICATION MECHANISIM

2.1. Application Service Data Channel（user-define application service UUID:0x2B00）

Table12. Description of User-define Service of All Channnel

UUID	Channel attribute	function
0x2B10	Notify/WriteWithResponse	APP send enable command to module via this notify channel
		Under notify enable status, module send data to APP via notify channel
0x2B11	Read/WriteWithoutResponse	APP send data to module
0x2B12	WriteWithResponse	APP send OTA mode switch command
0x2B13	Notify/WriteWithResponse	APP command

2.1.1. Module->APP, UART Data Channel【feature UUID:0x2B10】

Table13. 0x2B10 feature UART Module->APP Channel Description

UUID	Executable operation	Bytes	Default value	Remark
0x2B10	Notify/WriteWithRespons e	20	Null	Module receive data from UART RX,and notify APP via notify channel

Remark: data input from UART and output to Bluetooth. If turn on notify enable switch, outside MCU will send data to module RX via UART, and create a notify event in the channel, APP can directly process in the callback function.

2.1.2. APP->Module,UART Data Channel【feature UUID:0x2B11】

Table14. 0x2B11 Feature UART APP->Module Channel Description

Feature value UUID	Executable operation	Byte	Default value	remark
0x2B11	Read/WriteWithout Response	20	null	APP write data to module via “write” channel, module output data via UART

Description :input from Bluetooth and output via UART. APP write data via ”Write” channel, the data will output via UART TX.

2.1.3. APP->Module,OTA Mode Switch【Feature UUID:0x2B12】

Table15. 0x2B12 Feature OTA Mode Switch Channel Description

Feature value UUID	Executable operation	Byte	Default value	remark
0x2B12	WriteWithoutResponse	20	Null	Mode switch: switch from application mode to OTA status, command data is :“bootloader”

2.1.4. APP->Module,APP Command Channel【Feature UUID:0x2B13】

Table16. 0x2B13 Feature APP Command Channel Description

Feature value UUID	Executable operation	Byte	Default value	remark
0x2B13	Notify/WriteWithResponse	20	null	APP command, details refer to AT command :4.3.9、4.3.10、4.3.23、4.3.24 Note:APP do not need to add the "AT:" prefix for AT comamnd

2.2. Battery Service Data Channel

Battery service UUID: 0x180F

Table17. Description of Battery Service of All Channel

UUID	Channel attribute	function
0x2A19	read	Read electricity

2.2.1. APP->Module,Battery Data Channel 【Feature UUID:0x2A19】

Table18. 0x2A19 Feature Battery Power Channel Feature Description

Feature value UUID	Executable operation	byte	Default value	remark
0x2A19	Read	1	null	Unit is 20mV

2.3. OTA Service Data Channel

OTA service UUID:00060000-F8CE-11E4-ABF4-0002A5D5C51B

Table19. Description of OTA Service of All Channel

UUID	Channel arritbute	function
00060001-F8CE-11E4-ABF4-0002A5D5C51B	WriteWithResponse	OTA data transmit

2.3.1. APP->Module,OTA Data Channel

Table20. Feature OTA Data Channel Feature Description

Feature value UUID	Executable operation	byte	Default value	remark
00060001-F8CE-11E4-ABF4-0002A5D5C51B	WriteWithResponse	20	null	OTA data under ”bootloader” mode, OTA mode receive program data and cover FLASH relative area

3. PACKAGE INFORMATION

3.1. Reflow Soldering Profile

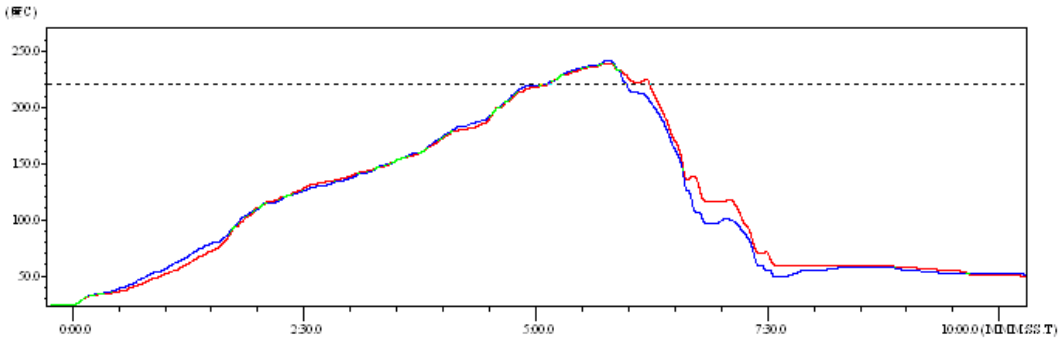


Figure 12. Reflow Soldering Profile

Table21. Reflow Soldering Specification

Number	Item	Temp (℃)	Time(s)
1	Reflow time	220 ℃ above	35~55 s
2	Peak temp	Max 260℃	

Remark: 1. Recommend to supply N2 for reflow oven
2. O2 content lower than 300ppm；

3.2. Handling Instruction

1. Shelf life in sealed bag: 12 months at <30℃, <60% humidity。
2. After bag opened, device need to be re-baked if window time over 168 hours
3. Recommended to over bake with N2 supplied
4. Recommended to reflow oven with N2 supplied
5. Bake required with 24 hours at 125+-5℃,
6. Recommended to store at ≦10% RH with vacuum packing
7. If SMT process needs twice reflow
   (1) TOP side (2) BOT side

Case 1: BLE module mounted on PCB TOP, need to bake TOP side after BOT side processed 168 hours (window time)

Case 2: BLE module mounted on PCB BOT side ,follow normal bake rule.

Remark: window time means it is been 168 hours since last bake to next flow.

APPENDIX A: UART TRANSPARENT TRANSMIT TYPICAL APPLICATION

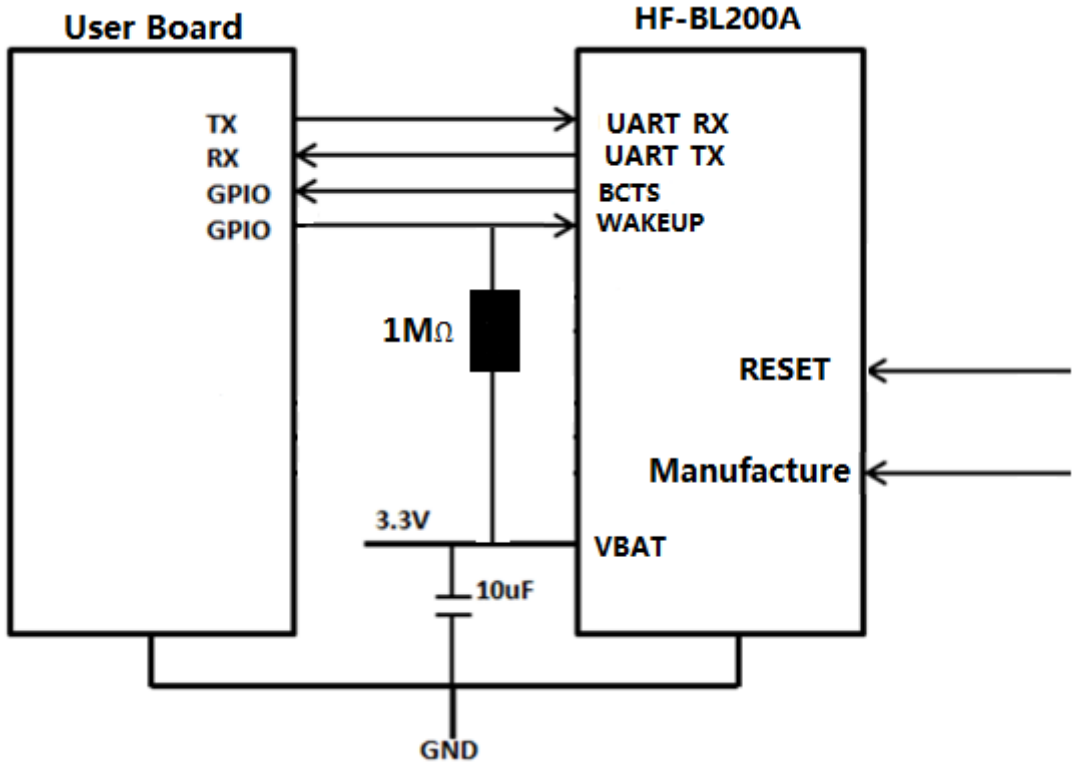


Figure 13. UART Transparent Transmit Typical Application

BCTS------ Module UART output notify signal, output （wakeup external MCU, remind MCU there is data output）

Module will pull down BCTS, and delay Xms before output data; X set by external MCU via At command, in default there is no latency. After sending data, BCTS pull-up, if there is new data sending BCTS will pull-up after sending all the new data. .

WAKEUP------ UART wakeup enable, Stop Mode Wakeup,(recommend to add external Pull-up resistor)

Pin Mode: WAKEUP pin is high resistor input. Can't be suspended, can be controller by pull-up or pull down or external MCU

UART Wakeup Enable: when WAKEUP is pull-up, all system enter into DEEPSLEEP ; when WAKEUP is pull-down, system enter into SLEEP mode. When sending data from external MCU to module, need to pull-down WAKEUP pin, after sending finished, pull-up WAKEUP to lower the power.

There must be a latency from WAKEUP pull-down to MCU sending data, the time is no less 拉低 than 2ms。

Stop Mode Wakeup:WAKEUP pull-down, AT command send out Stop command, when system enter into STOP mode, can be wakeup through pull-up WAKEUP.

UART_TX/RX------UART data send/receive signal。

Manufacture------restore factory setting via hardware method: keep low level at least 5 second when power on or restore

APPENDIX B: CONTACT INFORMATION

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