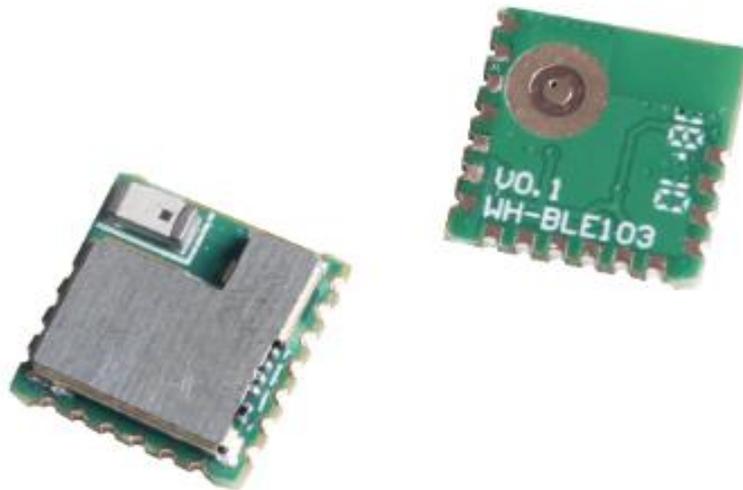


WH-BLE103 User Manual

File Version: V1.0.1



Contents

WH-BLE103 User Manual	1
Features	3
1. Quick Start	4
1.1. Hardware Testing Environment.....	4
1.2. Data transmission test	5
2. Product Overview	7
2.1. Basic Functions	7
2.2. Module basic parameters.....	8
2.3. Hardware Overview.....	9
2.4. Application Area	10
2.5. Module size	10
3. Product function.....	11
3.1. Work mode	12
3.1.1. Host mode	12
3.1.2. Slave mode	13
3.1.3. Broadcasting Mode	13
3.1.4. Mesh Networking.....	14
3.2. Packaging Mechanism.....	15
3.3. iBeacon Protocol	16
3.4. Low Power Mode.....	18
3.5. Password Pairing Verification	18
3.6. Data Transmission Encryption	19
3.7. Auto-connection.....	19
3.8. Indicator Status.....	20
3.9. Setup AT Commands.....	20
3.9.1. Serial Port AT Command.....	20
3.9.2. Transparent AT Command.....	21
3.9.3. Summary Of AT Instruction	21
3.10. AT Commands.....	22
4. Contact Us.....	23
5. Disclaimer.....	24
6. Update History	25

Features

- Compatible with USR-BLE101 in function and encapsulation, add external version and GPIO
- Ultra tiny size 10*10*2mm
- Support BLE4.2 protocol, compatible with low version
- The low power broadcast mode is 300 μ A on average, and the sleep mode is 500nA on average. Multiple wake-up modes
- Master and slave integration. Quick-switch
- A variety of configuration methods, support AT commands
- Support for one to many broadcast mode, built-in iBeacon protocol
- Support Mesh networking and quickly build Bluetooth network.
- Bluetooth to UART data transmission
- 1.7V~3.6V single power supply
- Far transmission distance. Point to point transmission distance up to 60m
- Support 128bit format UUID modification, can communicate with other manufacturers module.

1. Quick Start

WH-BLE103 is low-power BLE module which support BLE4.2 protocol and user can realize communication through simple configuration. The module can be use for point-to-point transparent transmission and encyption transmission. Module can work at master mode or slave mode. User can set one module as master, the other one as slave for transparent transmission. Or develop APP according to standard BLE protocol to communicate with module. BLE103 supports one-to-many broadcast mode and iBeacon protocol. And also support modifying 128bit format UUID to be compatible with other company BLE modules. WH-BLE103 is reliable BLE module with various functions and high compatibility.

This chapter is a quick introduction to WH-BLE103. For functional details, users can check the relevant sections.

The device work as slave mode in this chapter

The test hardware is based on the USR-BLE evaluation board, and the accessories are as follows.



Figure 1 WH-BLE-EVK accessories

Note:

Compatible with USR-BLE101 function and encapsulation, Users do not need to redesign the hardware chassis. In addition, WH-BLE103 add the external antenna and the GPIO.

If you have any question, please submit it back to customer center: <http://h.usriot.com>

1.1. Hardware Testing Environment

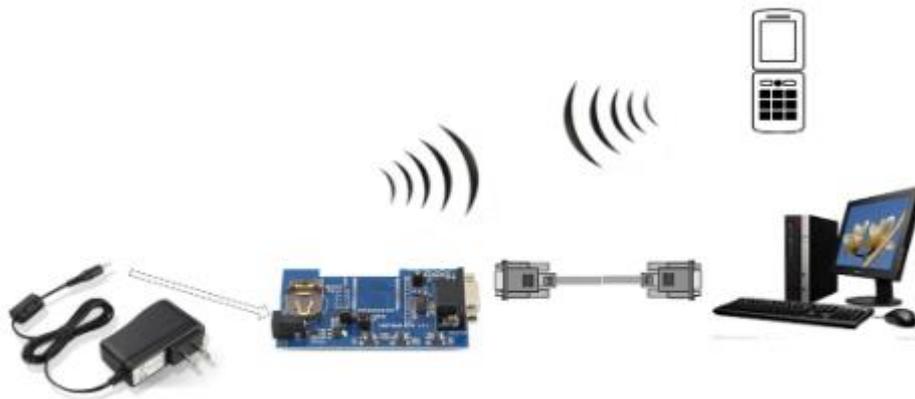


Figure 2 Hardware connection diagram

Normal working condition:

Power light: red , on;

Link light: yellow, twinkle, once a second.

Through the computer serial port can receive boot printing information, shows AT instructions normal.

If module hardware is normal, it can be searched by mobile phone software.

1.2. Data transmission test

Slave mode support BLE4.2 standard communication protocol, users can develop software independently, make host and module connect and transmit by phone. Testing needs devices support Bluetooth low power.(Android systems 4.3,IOS 7.0 and above)

Test environment: android 7.0

Test software: USR Low Power Bluetooth debugging assistant

Module default baud rate 57600, work at slave mode. Using serial debugging assistant to open serial port, AT commands can change parameters too, details will be intro in AT chapter

Link light twinkle once a second after power on, you can search device named WH-BLE103 by phone.



Figure 3 search Bluetooth by phone

When connected to the device, the Link light is always on.

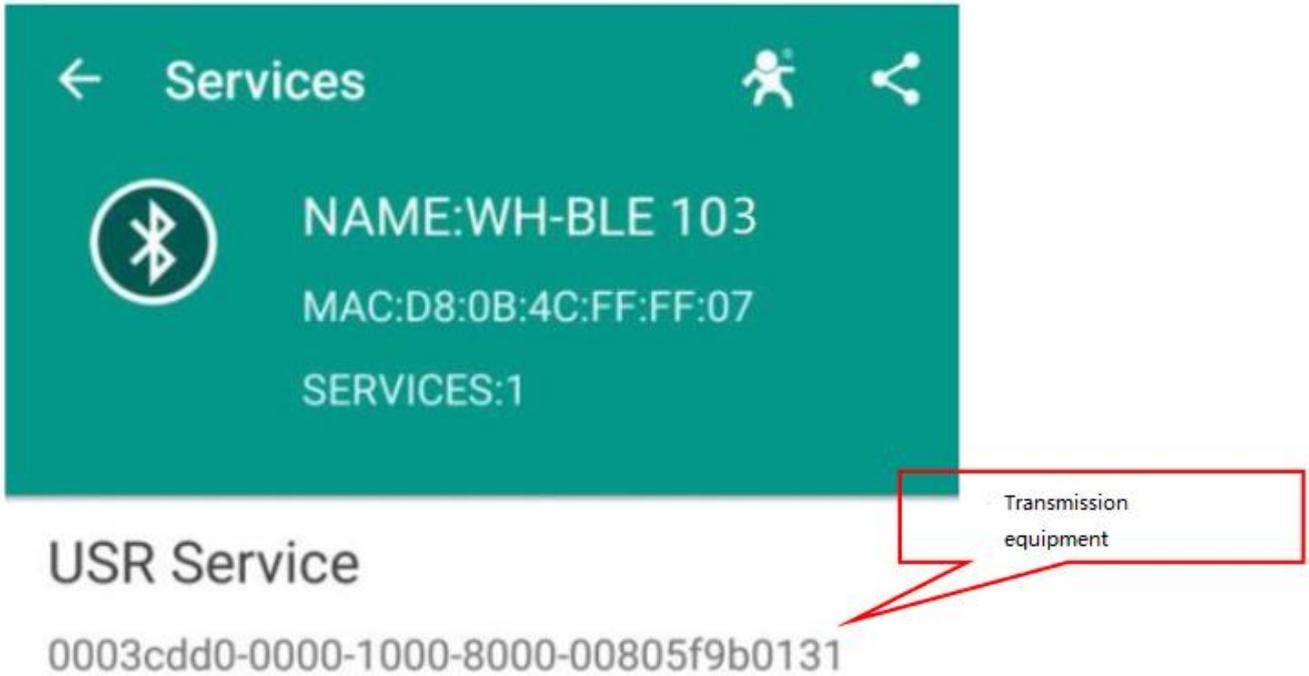


Figure 4 mode service

Click on the first Server, then enter the DEBUG at the bottom, click NOTIFY, make it turn to STOP NOTIFY, now the device work at listening state, click the “↑”, find WRITE, user can send data on this page, and the serial port can receive the data.



Figure 5 read/write mode

Data transmission:



Figure 6 data transmission

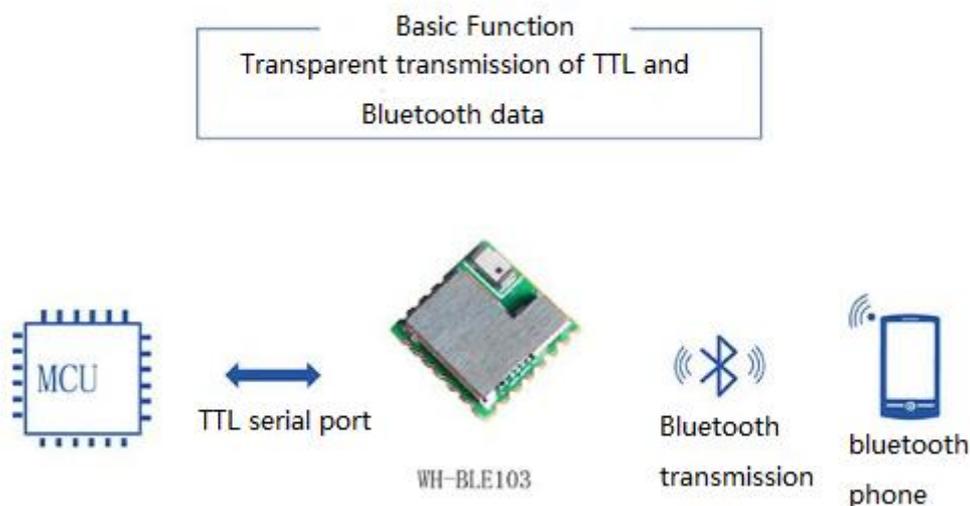
Note:

After test, IOS is better than Android at the support for BLE.

2. Product Overview

2.1. Basic Functions

WH-BLE103 is low-power BLE module which support BLE4.2 protocol and user can realize communication through simple configuration. The module can be use for point-to-point transparent transmission and encryption transmission. Module can work at master mode or slave mode. User can set one module as master, the other one as slave for transparent transmission. Or develop APP according to standard BLE protocol to communicate with module. BLE103 supports one-to-many broadcast mode and iBeacon protocol. And also support modifying 128bit format UUID to be compatible with other company BLE modules. WH-BLE103 is reliable BLE module with various functions and high compatibility.


Figure 7 base function of device

2.2. Module basic parameters

Table 1 module basic parameters

Wireless parameters	
Wireless standard	802.15.1
Frequency range	2.402GHz—2.480GHz
Transmitting power	-19dBm~+8dBm(Configurable)
Receiving sensitivity	-78dBm
Antenna	Built in: Antenna External: RF pin
Transmission distance	Module to module transmission distance up to 60m (Open area, maximum transmitting power, ceramic antenna)
Hardware parameters	
Working voltage	1.7~3.6V
Working current	Average2.40mA&3.3V Slave machine standby Average4.50mA&3.3V Host standby Average2.40mA&3.3V Broadcasting is not dormant Average0.290mA&3.3V Slave machine deep sleep Average0.290mA&3.3V Broadcasting deep sleep
Size	10*10*2(mm)(L*W*H)
Serial port	
Serial number	TTL*1
Standard	3.3V-TTL
Data bit	5bit,6bit,7bit,8bit
Stop bit	1,2

Check bit	None. even, odd
baud rate	1200bps—1Mbps
Cache	512byte
Flow control	None
Software parameters	
Equipment type	Host/slave machine
Security mechanism	128bit AES
Encryption type	PC1 encryption
Working mode	Main device mode / slave device mode / broadcast mode /Mesh networking mode
Set command	AT + command
User configuration	Serial port AT command, Transparent transmission AT command
Work environment	
Work temperature	-40~85° C
Storage temperature	-40~85° C

2.3. Hardware Overview

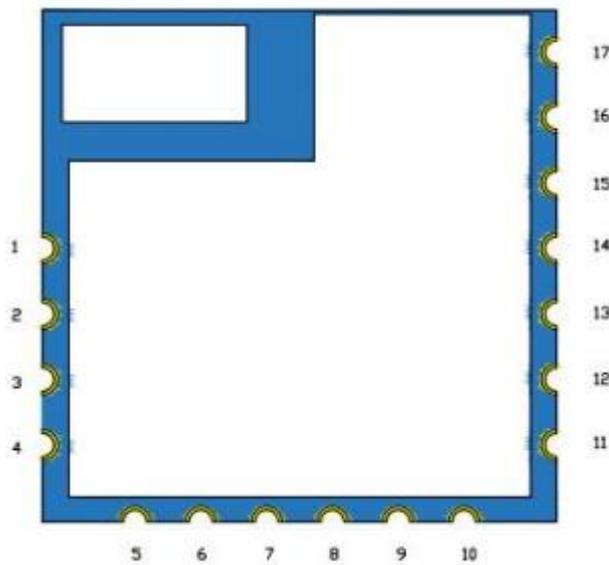


Table 2 module pin function Table

Pin	Name	Signal type	Function
1	nReload	I	Pull down level 3-10s can restore factory settings
2	Wake	I	Wake up module, need pull down level>3s
3	GPIO1	IO	Universally IO1
4	ADC	I	AD acquisition pin
5	GPIO2	IO	Universally IO2
6	VBAT	P	Power input, voltage range:1.7V-3.6V

7	SWCLK	IO	SWD clock pin
8	SWDIO	IO	SWD data pin
9	UART_TX	O	TX signal of UART
10	UART_RX	I	RX signal of UART
11	LINK	O	Connection status indicator pin
12	nReset	I	Module reset, active low
13	GND	P	Power GND
14	VBAT	P	Power input, voltage range:1.7V-3.6V
15	GND	P	Power GND
16	RF	IO	RF pin, external antenna
17	GPIO3	IO	Universally IO3

Illustration:

NC indicates that pins aren't used, users must make Pin vacancy.

P indicates power pin

I indicates input pin

O indicates output pin

I/O indicates Bidirectional data transmission pin

Suggest users use VCC1, VCC2, GND, UART TXD, UART RXD as module min system. Or add REST, LINK, RELOAD, WAKE pin based on requirement. Note that the external antenna version should lead to RE pin.

AD&GPIO as reservation function , users can contact us for Customized.

All the unused pins are suspended in order to reduce power consumption.

2.4. Application Area

- Wearable smart device
- Industrial data acquisition
- Intelligent instrument
- Sports intelligent equipment
- Medical intelligent equipment
- Intelligent mobile terminal
- Indoor positioning
- Information identification
- iBeacon
- Homckit

2.5. Module size

Unit: mm

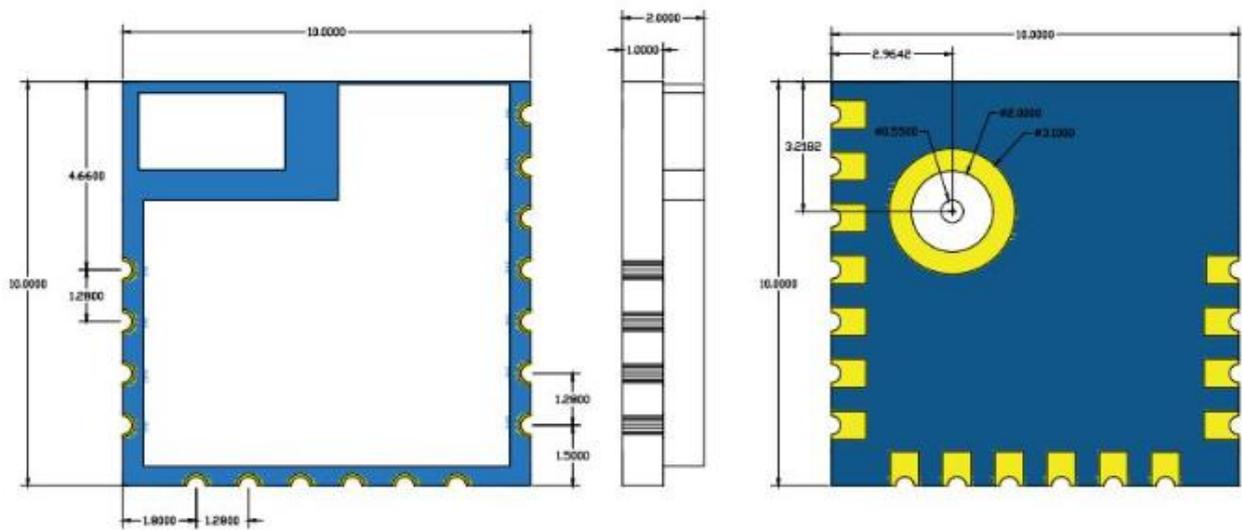


Figure 8 WH-BLE103 module size

3. Product function

This chapter intro the function of WH-BLE103, the overall framework of module functions as follow picture.

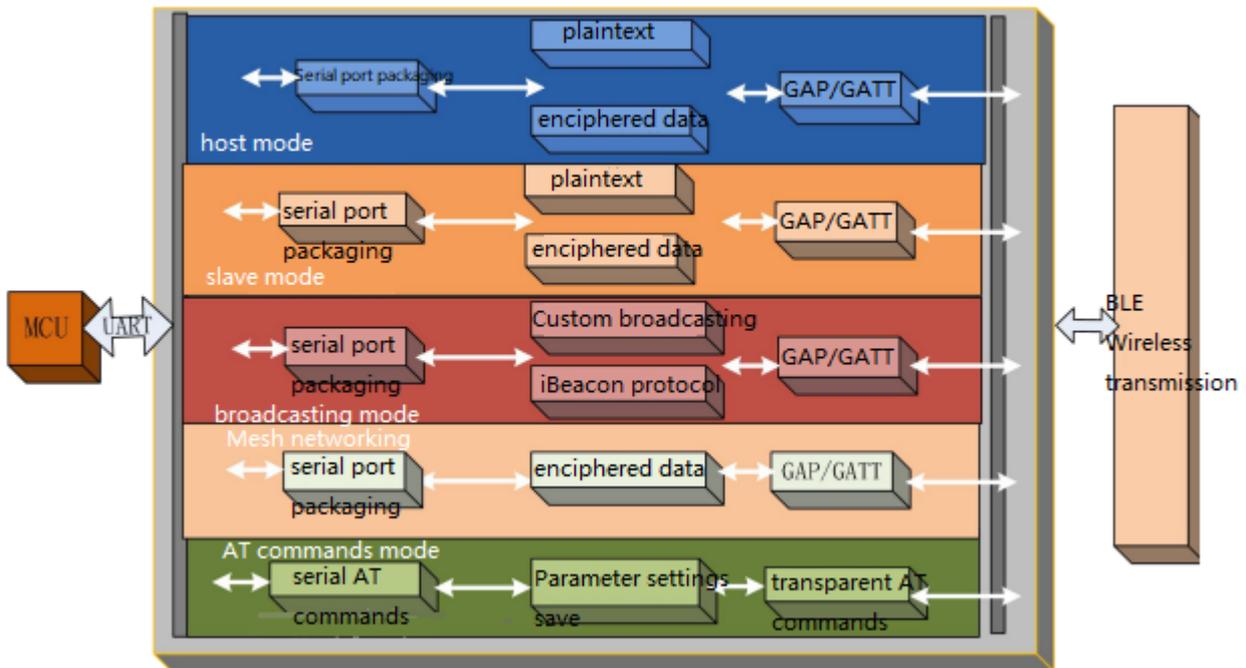


Figure 9 WH-BLE103 module function

3.1. Work mode

There four work modes of WH-BLE103:

- Host mode
- Slave mode
- Broadcasting mode
- Mesh networking mode

Illustration:

Device default slave mode, users can search it directly.

3.1.1.Host mode

WH-BLE103support host work mode, it can connect with slave device. WH-BLE103 can search around device and connect with the slave device when work as host. Also it can setup the MAC address of default slave device, ensure that it can search and connect with the slave device.

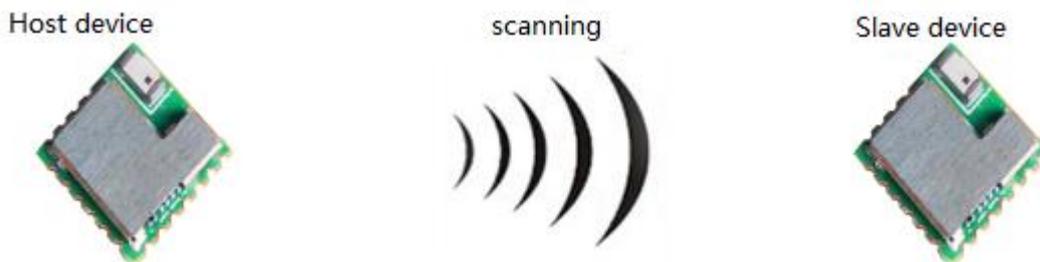


Figure 10 host device scanning slave device



Figure 11 default connect MAC address

Table 3 host mode command list

	Command	Intro
1	AT+MODE	Setup work mode
2	AT+SCAN	Open search mode
3	AT+CONN	Connect device
4	AT+CONNADD	Setup default connect address
5	AT+Z	Reload module

Illustration:

If users want one to one transparent transmission, users need our host device to connect our slave device when BLE103 work at factory setting. If users want to connect other slave device, must know the UUID of slave device, and should setup the UUID of host device(only support 128bit if users need setup UUID), after matching, it can communicate. But our slave device support standard BLE protocol, users can develop.

Illustration:

Firmware only support UUID modification in 128bit format now. If users need UUID modification in 16bit or 32bit format, can contact us for customized.

3.1.2. Slave mode

WH-BLE103 support slave mode, under this work mode, the device support BLE4.2 protocol and 4.0 protocol, users can develop APP according to standard BLE protocol to communicate with module. It includes a server which has one serial port send/receive data, users can found it by UUID, two channels inside include read and write. Users can transmission data through channels.

If the host and slave device are all WH-BLE103, they can transparent data transmission by serial port directly.



Figure 12 slave device can be scanned

Table 4 slave mode command list

	Command	Intro
1	AT+MODE	Setup work mode
2	AT+LINK	Current status of module
3	AT+DISCONN	Disconnect
4	AT+ADP	Enable/close broadcast data

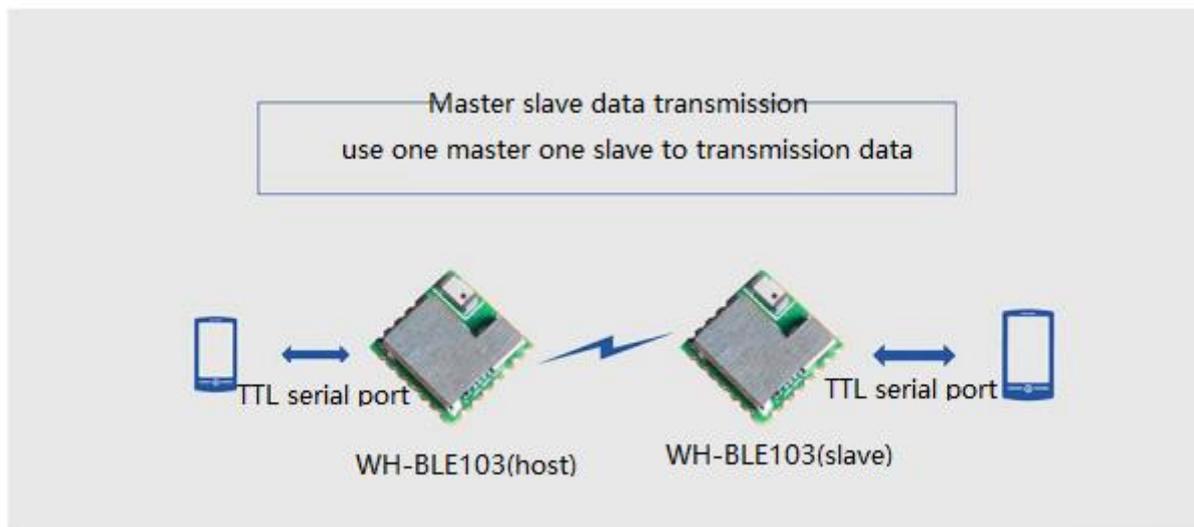


Figure 13 host slave data transmission

3.1.3. Broadcasting Mode

WH-BLE103 support broadcasting mode, it could one-to-many broadcasting when work at broadcasting mode. Users can set module broadcasting data by AT commands, module can continuous broadcasting at low power mode, this mode can be applied to extremely low power consumption, small amount of data, one-way transmission, for example,

wireless meter reading, indoor positioning, etc.. Module is work as transmitting terminal. If you want it work as receiving terminal, you can contact us for customization.

```

缓存区:  文本模式  HEX 模式  自动换行 清空接收

+iBeacon:
UUID:B9407F30-F5F8-466E-AFF9-25556B57FE6D
Major:12 Minor:6 Rssi:56
OK
    
```

Figure 14 set broadcast data

```

Raw Data
02:01:04:1A:FF:4C:00:02:15:B9:40:7F:30:F5:F8:46:6E:AF:F9:25:55:6B:57:FE:6D:00:0C:00:06:C8
    
```

Figure 15 software monitoring broadcast data

Table 5 broadcast mode command list

	Command	Intro
1	AT+MODE	Setup work mode
2	AT+IBEACON	Setup broadcast data packet

Illustration:

Module built-in iBeacon protocol, users only need to use a power supply or a button battery. Module can become a iBeacon device set by AT commands.



Figure 16 one to many broadcast

3.1.4.Mesh Networking

WH-BLE103 support Mesh networking, it can adding multiple modules to the network simply. Using star network and relay technology, each net can connect up to 65000 node, they can connect to each other, finally many Bluetooth modules can be interconnected or manipulated directly through mobile phones, tablet computers or PC. No gateway is required, and if a device fails, you can skip it and select the nearest device for transmission. Modules can be networked only by electrifying.

Table 6 Mesh networking mode command list

	Command	Intro
1	AT+MODE	Setup work mode
2	AT+PASS	Setup communication password
3	AT+Z	Reload module

Illustration:

This mode will be limited because of the networking principle, first of all, because the module needs to switch mode constantly during the transmission process, resulting in the amount of data transmitted is 20 bytes each time, and a few seconds of delay, similar to UDP mode, it can't guarantee that data will be delivered to the module, in order to ensure that data is delivered, the module adopts Retransmission mechanism.

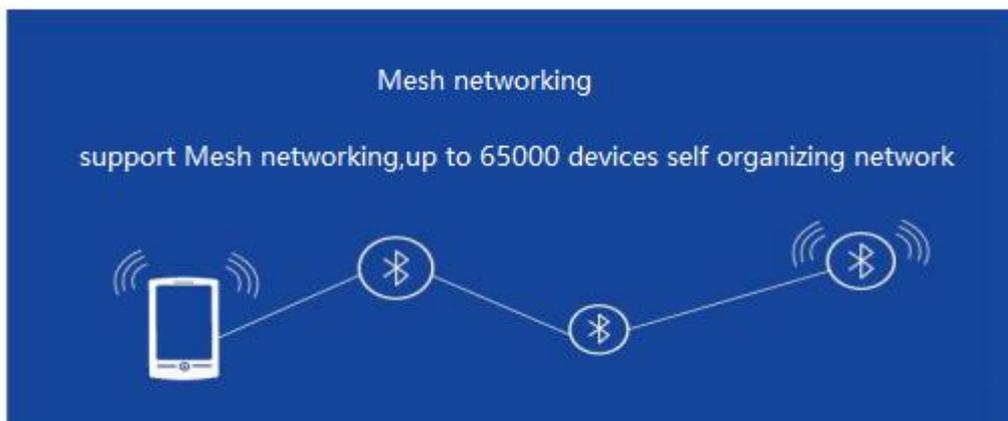


Figure 17 Mesh networking

3.2. Packaging Mechanism

Low power Bluetooth positioning for small data transmission. Modules have different data throughput capabilities for different serial baud rates, BLE connection intervals, and different packet intervals. The forwarding rate will not exceed 4K byte/s, and the test shows that the probability of packet leakage is low when the rate is below 1.5K byte/s. For safety consideration, it is recommended to do check retransmission on the upper level.

Serial port of WH-BLE103 receives up to 512 bytes of packets at a time, and the module automatically sub packs and sends packets according to the size of the packets, with each packet up to 20 bytes. Packets sent by mobile devices must be sent separately(1-20 byte/s). After receiving the wireless packet, the module will be forwarded to the serial port of the module in turn.

There are two kinds of package mechanism inside the module, one is the standard 20 bytes per packet, the other is 100 bytes per packet, the latter can only be used for a master-slave data transmission. If you use APP to communicate with the slave, the rate should be 20 bytes per packet with AT instructions.

For the serial port, the packaging speed can also be set by AT instruction, with a default of 100 milliseconds. Reasonable packing speed can reduce package overlap.

Table 7 packaging mechanism command list

	Command	Intro
1	AT+MAXPUT	Enable / close maximum output
2	AT+UARTIM	Set the speed of the serial port package.

Illustration:

The default packaging mechanism is 20 bytes per packet.

When the serial port packet is between 100 byte and 512 byte, the serial port data can be received at one time, but it

needs to reserve the time for the module to send data through Bluetooth, otherwise there will be data overlap.

The version under Android 5 limits the packet to 20 bytes per packet, other versions can send more than 20 bytes per packet. If the user develops APP, you can contact technical support for Android source code.

IOS limits the maximum transmission capacity of 182 bytes per packet.

3.3. iBeacon Protocol

WH-BLE103 uses BLE broadcast technology to send its own unique ID around, and applications that receive the ID do some work based on that ID. For example, in a store, the iBeacon module tells the server to send discounts to customers via the iPhone or iPad. In addition, when the appliance fails or stops working, it sends messages through iBeacon to APP.

The iBeacon protocol has four parameters, namely UUID, Major, Minor, TX power.

UUID can distinguish beacon from different devices. For example, a certain area of a shop is distributed by a network of beason. It is used to provide specific services to customers. The beason in the network has the same UUID.

Major number: used to identify related beacon as a group. For example, beason in same shop will have same major number.

Major grade: used to identify specific beason devices. In this way, you will know where the customer is in the store.

TX power: used to determine the distance between you and beason, which is the signal intensity value (RSSI) measured from the device 1m. The received signal becomes weaker, that is, the distance is far away. According to the RSSI distance of 1 meters and the current RSSI, the distance can be calculated.

WH-BLE103 can be set with very simple commands.

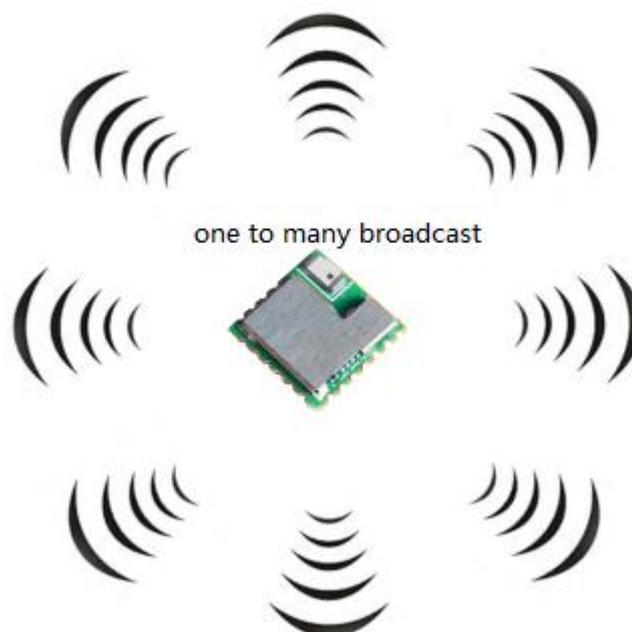


Figure 18 Divergent one to many broadcasting

- 1) We use a generic APP for simple testing, using the IOS system, testing software: Locate Beacon. First open bluetooth of mobile phone, then open APP.



Figure 19 Locate Beacon Operating interface

- 2) Opening the first function, APP displays the specific information and the current distance of the module , if the module works properly.



Figure 20 Locate Beacon Operating interface

- 3) The changes in distance between the phone and the module are displayed in real time, and push is received when leaving or entering the recognition range.
- 4) This software is just a debugging tool, and users can develop according to their own needs.

Illustration:

For some reasons, iBeacon can 't measure distances very accurately. The data provided by Apple find that the location is more accurate within 3 meters.



Figure 21 iBeason protocol

3.4. Low Power Mode

WH-BLE103 has a variety of low power mode, which can provide longer battery life for battery powered users.

- 1) Autosleep mode, using AT command setup the sleep time, when without connection, serial port has no data, or after reaching the set time, the module automatically enters sleep mode. In this mode, the normal broadcasting of Bluetooth can be connected, and the serial data can be waken up at any time.
- 2) Deepsleep mode, enter by AT command, the module can be broadcasted and connected in this mode. The connection or wake up pins can be used to wake up the module. The power consumption of this mode is 300uA, and most slave machines work in this mode.
- 3) Hibernate mode, enter by AT command, module will not work in this mode, wake up pins can be used to wake up the modules.

Table 8 low power mode command list

	Command	Intro
1	AT+AUTOSLEEP	Set autosleep mode
2	AT+DEEPSLEEP	Set deepsleep mode
3	AT+HIBERNATE	Set hibernate mode

Illustration:

Low power mode only applies to slave or broadcast mode, the host has no low power mode, when the host does not work can stop running, when used can restart the module.

The DEEPSLEEP mode uses a broadcast interval of 100 ms. The longer the broadcast interval, the lower the power consumption. The time interval is set by AT + ADPTIM.

3.5. Password Pairing Verification

In order to ensure the safety of the device, the module provides a password pairing mechanism, and uses the AT command to enter. With this feature, it takes 10 seconds to write a 6-bit password to maintain the connection and data transfer between the phone and the module. Password error or timeout will disconnect. If both the master and slave devices are USR-BLE103, the master only needs to send a 6-bit password to the slave device after establishing the connection.

AT command: AT+PASSEN=ON

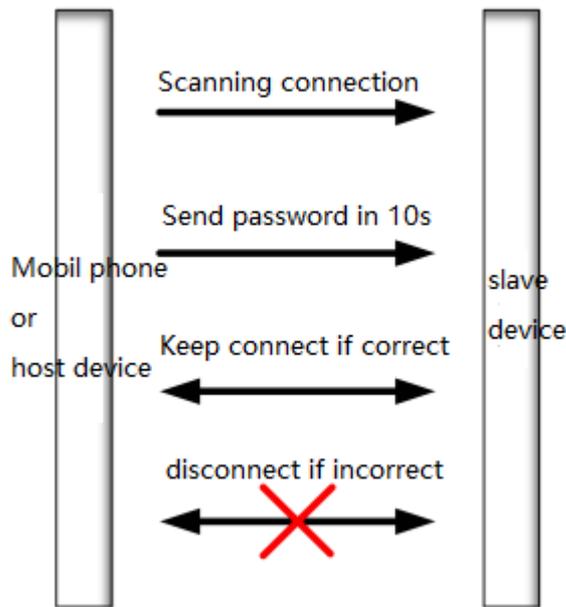


Figure 22 Password pairing verification

3.6. Data Transmission Encryption

For the security of data transmission, data can be chosen for plaintext transmission and encrypted transmission. Enter by AT command, serial data will be encrypted by PCI, the module receives data with the same password can decrypt the data, ensure the security of data transmission.

The module uses standard PCI encryption, users can develop their own APP to encryption transmission, users can ask technical support for related development files.

Table 9 data transmission encryption command list

	Command	Intro
1	AT+TRENC	Enable/close data encryption
2	AT+PASS	Set transmission password

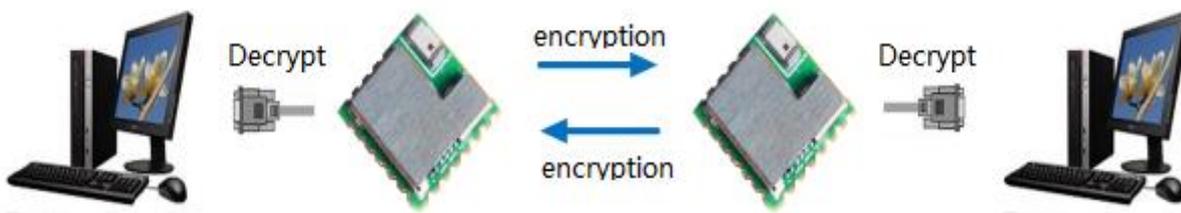


Figure 23 data transmission encryption

3.7. Auto-connection

WH-BLE103 support autoconnection for ensure stability of connections, enter by AT command, when power failure or signal interference leads to disconnection, the external environment returns to normal, the host will automatically search the slave for connection, reduce data loss, improve stability.

Table 10 disconnection reconnection command list

	Command	Intro
1	AT+AUTOCONN	Enable/close auto connection

3.8. Indicator Status

The status information of module indicator is shown in table.

Table 11 indicator status

Module status	Indicator status
Host search	Twinkle three times a second
Slave broadcasting	Twinkle one times a second
Connection	on
Low power mode	off

Note:

The link lamp is active low, “on” means the pin is low level.

3.9. Setup AT Commands

After the module is started successfully, the module can be set by UART.

UART parameters: baud rate 57600, parity bit none, data bit 8, stop bit 1.

3.9.1. Serial Port AT Command

WH-BLE103 support many work modes, users can use serial port command make the module work at AT command mode.

Steps to switch from other modes to command mode:

1. send +++ from serial port to module, when module receive +++, it will return “a”;
2. after serial port receive a ,send another “a” to module,module will return”+OK”when receive,then enter AT command mode.

Users can send”+++a”,when module return”+OK”,it work at AT command mode.


Figure 24 data return from module

Illustration:

Send +++ and “a” need finish in time:

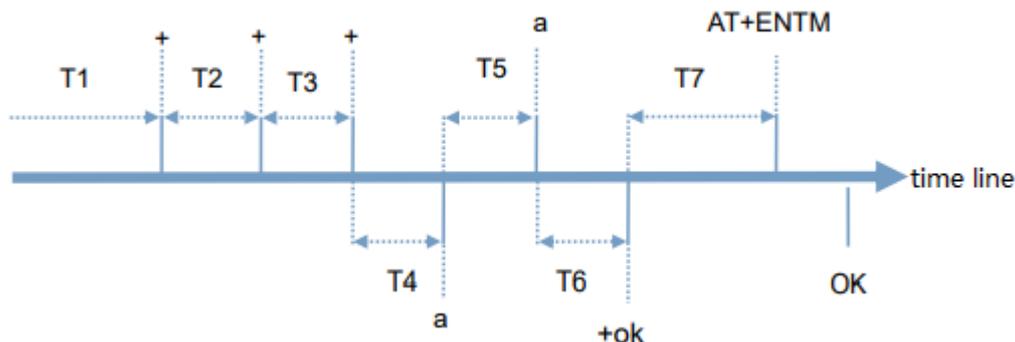


Figure 25 +++a time sequence diagram

Requirement: $T1 > \text{packing interval}$, $T2, T3 \leq 300\text{ms}$, $T5 \leq 3\text{s}$

You can switch from command mode to transparent mode when you enter AT+ENTM and “enter key” in command mode.

3.9.2. Transparent AT Command

WH-BLE103 support transparent AT command mode, in this mode, you can use phone APP or connection module to set parameters, add 6 bit cipher and instruction to the module. e.g. 000000, AT+CIVER? Enter, You can set up and query parameters without entering the instruction mode.

3.9.3. Summary Of AT Instruction

The AT instruction can be input directly through serial port debugger such as CRT, can also be input through programmed.

The AT command uses the command line based on ASCII code. The format is as follows:

1. Format Description

< > Indicate the part that must be included.

[] Indicate optional parts

2. Command Message

AT+<CMD>[op][para-1,para-2,para-3,para-4...]<CR>

AT+ Command message prefix

[op] The instruction operator is specified as parameter setting or query.

‘=’ Means setup parameter

‘NULL’ Means query parameter

[para-n] Used only when parameters are set, indicating input.

<CR> Terminator, carriage return, ASCII code 0x0D

3. Response Message

<CR><LF>+<RSP>[op][[para-1,para-2,para-3,para-4...]<CR><LF>

+ Response message prefix

RSP Response string

‘OK’ Means success

‘ERR’ Means fail

[para-n] Returns a parameter or error code when querying.

<CR> ASCII code 0x0d

<LF> ASCII code 0x0a

4. Error Code

Table 12 error code list

Error code	Intro
1	Invalid command format
2	Invalid parameters
NO ATCMD	Invalid command

3.10. AT Commands

Table 13 AT commands list

Command	Intro
Universal command	
NAME	Query / set module name
MODE	Query / set module mode
MAC	Query module MAC address
CIVER	Query software version
TPL	Query / set module transmit power
PASS	Query / set module password
PASSEN	Set / query pairing validation
UART	Set / query module serial port parameters
UARTTM	Setting / querying serial port packing time
AUTOSLEEP	Set / query auto-sleep
DEEPSLEEP	Set / query deep sleep
HIBERNATE	Set / query hibernate
HELLO	Set / query boot welcome
ENTM	Exit command mode
RELOAD	Restore factory settings
Z	Control module restart
Bridging order	
LINK	Query module connection state
SCAN	Search slave around
CONN	Quick connection by search index number
CONNADD	Setup / query devices connect to MAC address by default.
DISCONN	Setting off the current connection
ADP	Set / query module broadcast or not
ADPTIM	Set / query module custom broadcast speed
AUTOCONN	Setup / query module auto connect
Characteristic function	
MAXPUT	Enable / disable maximum output
TRENC	Enabling / disabling PC1 encrypted transmission
IBEACON	Set / query iBeacon function
UUID	Query / modify UUID

4. Contact Us

Company: Jinan USR IOT Technology Limited

Address: Floor 11, Building 1, No. 1166 Xinluo Street, Gaoxin District, Jinan, Shandong, 250101, China

Web: www.usriot.com

Support: h.usriot.com

Email: sales@usr.cn

Tel: 86-531-88826739/86-531-55507297

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6. Update History

2018-04-11 V1.0.0 Established.

2018-08-28 V1.0.1 Modify partial parameter values