



RF-B-AR4 BLE Beacon User Guide

Version 0.1.2

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Mar. 22nd, 2021

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1 Device Overview

There are two modes of Beacon broadcasting: connectable mode and unconnectable mode.

Connectable mode: The user can use the APP to connect the Beacon (enter a specific key when user authentication function is enabled). After the connection, a specific command is issued to modify the beacon parameters on the corresponding channel.

Un-connectable mode: The Beacon broadcasts according to the data set by the user. The default is connectable mode, and it can be configured for mode switching through serial AT commands.

Bluetooth Low Energy Beacon can be applied to indoor positioning, activity detection, asset tracking, etc. It can realize remote data management, and It can also configure the Beacon with different parameters through the mobile APP and the serial port respectively, so as to meet different applications.

The Beacon supports a variety of broadcasts, and each broadcast can be individually set for the broadcast period and transmit power. At the same time, the Beacon also has an accelerometer and a temperature and humidity sensor, and the two sensors can set the sampling period and other parameters respectively.



2 Beacon Parameters

Table 1. Table of Parameters

Item	Value	Remarks
Model	RF-B-AR4	White enclosure
BLE version	BLE5.0	Long range supported
Protocol Option	iBeacon	
	Eddystone	UID, URL and TLM
Temperature and Humidity Sensor	SHT20	Optional
Accelerometer Sensor	LIS3DH	Optional
Operating Voltage	1.1 V ~ 3.3 V	
Battery	CR2477	Service life can last for 5 years under 1 s broadcast interval and sensor sampling cycle.
Broadcast Interval	1 s	
TX Power	-20 dBm ~ +4 dBm	0 dBm is by default.
Flash	1 MB	
RAM	128 KB	
ROM	256 KB	
Transmission Distance	50 m	In an open air and sunny weather, @ 0 dBm
Average Power Consumption	20.95 μ A	Under 1 s broadcast interval and sensor sampling cycle.
Diameter	51.0 mm	Tolerance: \pm 0.2 mm
Thickness	21.0 mm	Tolerance: \pm 0.2 mm
Waterproof Level	IP65	Splash-proof
Weight	29.3 g	Including the CR2477 battery
Operating Temperature	-40 $^{\circ}$ C ~ +50 $^{\circ}$ C	Affected by the enclosure
Storage Temperature	-40 $^{\circ}$ C ~ +100 $^{\circ}$ C	Affected by the enclosure
Other Functions	Number of slots	Up to 10 different slots, including iBeacon, UID, URL, TLM.
	OTA	

Power consumption test is shown as below:

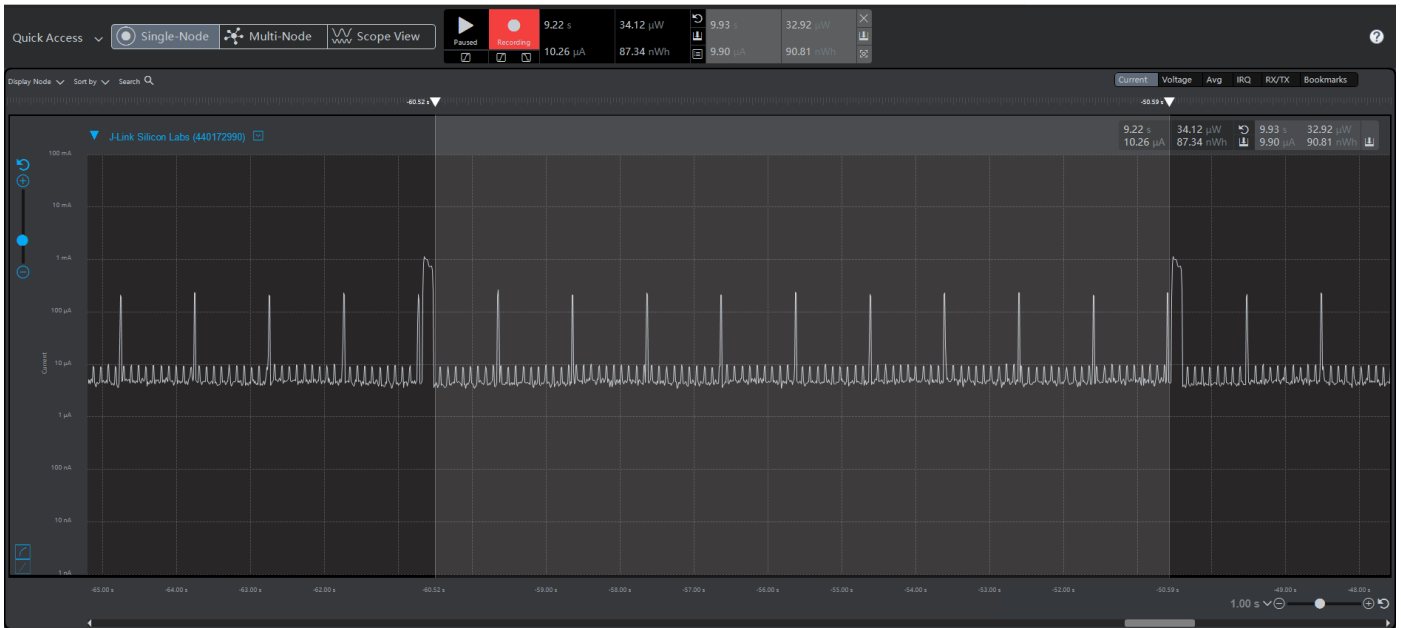


Figure 1. Power Consumption Test

3 LED and Button Specifications

Button	LED	Function	Remark
Press for 1 s under sleep mode	Flash once	Boot up	Sleep mode is default when power-on.
Press for 1 s under working mode	Flash twice	Shut down	
Press for 5 s under working mode	LED on for 2 s	Restore factory parameters	



4 Parameters Configuration

Table 2. Table of Parameter Configuration

Item	Default Settings
UUID (16 Bytes)	0x0112233445566778899AABBCCDDEEFF0
Major (2 Bytes)	1800
Minor (2 Bytes)	1286
Company ID (2 Bytes)	0x4C00
RSSI (2 Bytes)	-48 dBm
TX Power	0 dBm
Broadcast Interval	1 s
Broadcast Name	RFstar_XXXXXX (the suffix XXXXXX is the last three bytes of the MAC address)
Anti-hijacking Key (User Authentication)	Off by default
Connectable Mode	Connectable

5 BLE Protocol Specification (APP Interface)

Service UUID

6E400001B5A3F393E0A9E50E24DCCA9E

Enter Anti-hijacking Key UUID

Characteristics UUID	6E400002B5A3F393E0A9E50E24DCCA9E
Executable operations	Write
Remarks	When the user authentication function is enabled, an anti-hijacking key is required, and there is no return value. If the key is entered incorrectly or no anti-hijacking key is entered and the timeout period is reached, the connection is automatically disconnected. If the key is entered correctly, it will return OK\r\n. The timeout period can be configured by AT command, and the default value is 15 s.

AT Command Operation UUID

Characteristics UUID	6E400004B5A3F393E0A9E50E24DCCA9E
Executable operations	Write / Notify
Remarks	Input AT commands and then receive the command returns through this channel. Support all the commands in the AT command list, and any data without CRLF will be treated as commands.

6 Sensor Data Format

The data sampled by the sensor is placed in the broadcast response packet. Each broadcast has a response packet.

The default data format of the response packet is as follows:

Len	0x0E	Broadcast name length (1 byte)
Type	0x09	Broadcast type (1 byte)
Data	Name Data	Name (13 byte)
Len	0x0D	Self-defined manufacturer data length (1 byte)
Type	0xFF	Manufacturer type (1 byte)
Data	0x5246	Manufacturer ID (2 byte)
	Identification	Connectable identification
	X-axis	Accelerometer sensor data (6 bytes), 2 bytes for each X-axis, Y-axis, Z-axis
	Y-axis	
	Z-axis	
	Temperature	Temperature and humidity sensor data (4 bytes), 2 bytes for each temperature and humidity
Humidity		

Raw data:

```
0x0201061AFF4C000215011223344
5566778899AABBCCDDEEFF007080
506D00E095246737461725F343435
3537360DFF5246C00080FEC0032F0
75715
```

Details:

LEN.	TYPE	VALUE
2	0x01	0x06
26	0xFF	0x4C000215011223344556677 8899AABBCCDDEEFF00708050 6D0
14	0x09	0x5246737461725F343435353 736
13	0xFF	0x5246C00080FEC0032F07571 5

LEN. - length of EIR packet (Type + Data) in bytes,
 TYPE - the data type as in <https://www.bluetooth.org/en-us/specification/assigned-numbers/generic-access-profile>

Self-defined Broadcast Data OK

The sensor data field is C00080FEC0032F075715, and the data is low byte first and the high byte after. According to the data format in the above table, it can be parsed as:

X-axis: 00C0

Y-axis: FE80

Z-axis: 03C0 (unit: mg)

The highest bit indicates the sign, that is, when the accelerometer is a negative number, the highest bit is 1, you need to invert the data and add 1 to get the original data.

Temperature: 072F, which is 18.39 degrees Celsius. The highest bit indicates the sign, that is, when the temperature is negative, the highest bit is 1. You need to invert the data and add 1 to get the original data.

Humidity: 1575, which is 54.3%

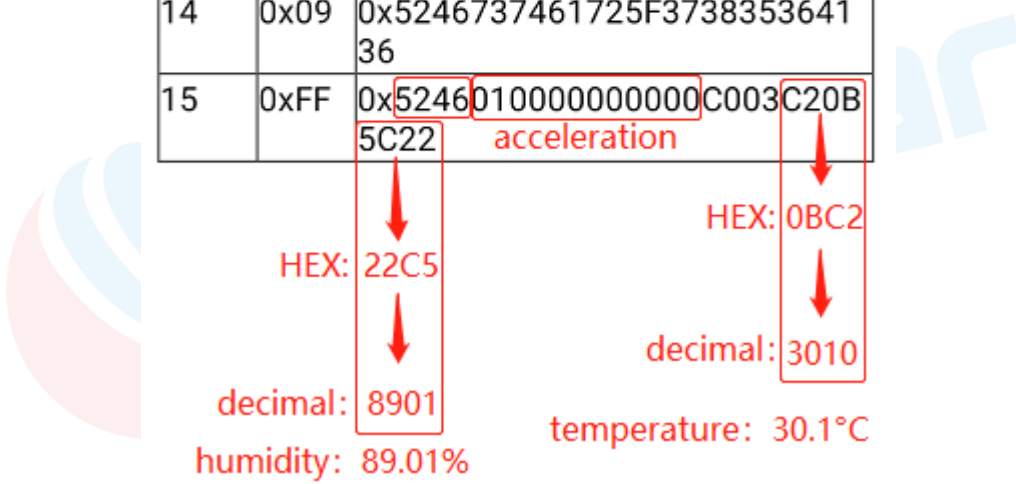
For example:

Raw data:

```
0x0201061AFF4C00021501122334455
66778899AABBCCDDEEFF007080506D
00E095246737461725F373835364136
0FFF5246010000000000C003C20B5C2
2
```

Details:

LEN.	TYPE	VALUE
2	0x01	0x06
26	0xFF	0x4C0002150112233445566778 899AABBCCDDEEFF007080506D 0
14	0x09	0x5246737461725F3738353641 36
15	0xFF	0x5246010000000000C003C20B 5C22 acceleration



7 AT Commands

AT commands can be subdivided into two types:

Type	Command Format	Description
Query command	AT+[x]?	This command is used to query the current value of the returned parameter.
Setting command	AT+[x]=<...>	This command is used to set user-defined parameter value.

Note:

1. This command can be sent through APP.
2. Not every command has the above two types of commands.
3. The AT command must be **capitalized** and no need to be ended with a carriage return and line feed (CRLF).
4. If all parameters of the command are optional parameters, at least one parameter is needed to be filled, otherwise it is also regarded as a command error.

Example: AT+ADS=<0,1>,<0,1>,<10,10240>, you can fill in AT+ADS=,500.

5. The parameter positions that are not filled in the optional parameter command must **be reserved**. Refer to the previous example.
6. Except for the user authentication function, all other setting commands are effective immediately and saved after power-off.
7. **The master end must make MTU bigger than 128 bytes, otherwise, the commands cannot be set normally.**

AT Command List

Table 3. AT Command List

Command	Function
AT+NAME	Query/setdevice name
AT+ADS	Query/setbroadcast parameters
AT+ENCRTPT	Query/setbroadcast encryption
AT+MODE	Query/setworking mode
AT+CYCLE?	Enable numbers of broadcast slots.
AT+CLR_CYCLE=1	Clear numbers of broadcast slots.
AT+DATA_CYCLE=1	Query numbers of broadcast slots.
AT+BEACON	Query/setbeacon related parameters
AT+ES	Query/setEddystone related parameters

AT+POWER	Query/setdevice transmit power
AT+AUTH	Query/setuser authentication
AT+GSENSOR	Query/setaccelerometer sensor parameters
AT+THINFO	Query/set temperature and humidity sensor parameters
AT+VERSION	Query device firmware version number
AT+RESET	Restore device parameters to factory settings and restart
Command Return Value	
OK	Successful command
FAIL	Failed command
ERROR	Error command
BUSY	Busy command, please wait for the previous operation



Device Name

AT+NAME?	
Function	Query device name.
Example	AT+NAME?
Return Value	AT+NAME=RFstar_XXXXXX OK
Remark	The command returns the device name correctly, the default is "RFstar_XXXXXX", XXXXXX is the last three bytes of the MAC address.

AT+NAME=	
Function	Set device name.
Example	AT+NAME=TEST-NAME
Return Value	OK
Remark	The maximum setting length cannot exceed 14 bytes.

Broadcast Parameter

AT+ADS?	
Function	Query broadcast parameters.
Example	AT+ADS?
Return Value	AT+ADS=,1,200 OK
Remark	Parameter 1: Reserved Parameter 2: Device broadcast mode setting (0, un-connectable. 1, connectable). Parameter 3: Device broadcast interval in ms, the setting range: 100 ms ~ 10240 ms.

AT+ADS=	
Function	Set broadcast parameters.
Example	AT+ADS=,0,500
Return Value	OK
Remark	Set to enable unconnectable broadcast with 500 ms interval, 1000 ms is by default. Note: Please be sure to set this parameter carefully, once it is set to un-connectable mode broadcast, any parameter is not allowed to be modified.

Broadcast Data Encryption

AT+ENCRYPT?	
Function	Query broadcast data encryption.
Example	AT+ENCRYPT?
Return Value	AT+ENCRYPT=0,11223344556677889911223344556677 OK
Remark	Parameter 1: 0: Disable broadcast data encryption. 1: Enable broadcast data encryption. Parameter 2: AES key (16 bytes).

AT+ENCRYPT=	
Function	Query broadcast data encryption.
Example	AT+ENCRYPT=1,11223344556677889911223344556677
Return Value	OK
Remark	Enable broadcast data encryption and set the AES key to "11223344556677889911223344556677", the key must be 16 bytes. This encryption only encrypts data in iBeacon mode or UID. If enable encryption and then set TLM or URL, the Beacon will feedback FAIL. The range of Beacon broadcast encryption includes UUID, Major, Minor, and with a total of 20 bytes, the first 16 bytes are encrypted by AES128, and the last 4 bytes are encrypted by XOR (the value of XOR is the last byte of MAC). The UID encrypted content includes 16 bytes of Namespace and Instance, which are encrypted by AES128.

Working Mode

AT+MODE?	
Function	Query working mode.
Example	AT+MODE?
Return Value	AT+MODE=0 OK
Remark	0: iBeacon mode. 1: Eddystone mode.

AT+MODE=	
Function	Set working mode.
Example	AT+MODE=1
Return Value	OK
Remark	Set the broadcast to Eddystone mode, iBeacon mode is by default.

Enable Numbers of Broadcast Slots

AT+CYCLE?	
Function	Query the state of numbers of broadcast slots.
Example	AT+CYCLE?
Return Value	AT+CYCLE=0 OK
Remark	0: Disable numbers of broadcast slots. 1: Enable numbers of broadcast slots.

AT+CYCLE=1	
Function	Set numbers of broadcast slots function.
Example	AT+CYCLE=1
Return Value	OK
Remark	Enable numbers of broadcast slots function. Default is disabled. After it is enabled, numbers of broadcast slots can be preset through the commands "AT+BEACON" and "AT+ES" (up to 10 preset broadcast slots can be supported), and each broadcast slot will be set according to the preset broadcast cycle and transmit power.

Clear Numbers of Broadcast Slots

AT+CLR_CYCLE	
Function	Clear numbers of broadcast slots.
Example	AT+CLR_CYCLE=1
Return Value	OK
Remark	All broadcast slots are cleared. The numbers of broadcast slots function is disabled. Meanwhile, the device is back to the normal Beacon mode.

Query Numbers of Broadcast Slots

AT+DATA_CYCLE?	
Function	Query numbers of broadcast slots data.
Example	AT+DATA_CYCLE?
Return Value	AT+ DATA_CYCLE=2 OK
Remark	Query the number of broadcast slots. If 2 is returned, it means there are two slots. And use "AT+DATA_CYCLE=" to query the data.

AT+DATA_CYCLE=1	
Function	Query broadcast slots data.
Example	AT+DATA_CYCLE=1
Return Value	AT+DATA_CYCLE=1,020106.....,0,1000 OK
Remark	The data returned with the following format: Parameter 1: The serial number of the data returned. 1 means the first broadcast slot. Use "AT+DATA_CYCLE?" to query the number of slots in total. (Range: 1~10) Parameter 2: Slot data. Parameter 3: The current TX power of this slot. 0 dBm for the example data. Parameter 4: The broadcast interval of this slot. 1000 ms for the example data.

Beacon Parameters

AT+BEACON?	
Function	Query Beacon parameters.
Example	AT+BEACON?
Return Value	AT+BEACON=4C00,0708,0506,D0,0112233445566778899AABBCCDDEEFF0,0,1000 OK
Remark	Parameter 1: Company ID Parameter 2: Major Parameter 3: Minor Parameter 4: Reference RSSI at 1 m. This value is a signed type, and the negative values can

	<p>be restored correctly by adding 1 after the reverse.</p> <p>Parameter 5: User-defined UUID data.</p> <p>Parameter 6: The transmit power of this broadcast packet, if not set, the system parameters will be used by default.</p> <p>Parameter 7: The broadcast cycle of this broadcast packet, if not set, the system parameters will be used by default.</p>
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AT+BEACON=	
Function	Set Beacon parameters.
Example	AT+BEACON=4546,0102,0304,C2,0102030405060708090A0B0C0D0EF010,0,1000
Return Value	OK
Remark	<p>Parameter 1: Set Company ID to 4546</p> <p>Parameter 2: Set Major to 0102</p> <p>Parameter 3: Set Minor to 0304</p> <p>Parameter 4: Reference RSSI at 1 m is -62 dBm</p> <p>Parameter 5: User-defined UUID data is 0102030405060708090A0B0C0D0EF010</p> <p>Parameter 6: Set the transmit power to 0 dBm.</p> <p>Parameter 7: Set the broadcast cycle to 1000 ms.</p> <p>Note: The zero parameter cannot be omitted. For example, if you set Major to 1, you cannot fill in "1" or "01", but you should fill in "0001", otherwise ERROR will be returned.</p>

Eddystone Parameters

AT+ES?	
Function	Query Eddystone parameters.
Example	AT+ES?
Return Value	<p>UID Type:</p> <p>AT+ES=00,D0,11223344556677889900112233445566,0000,0,1000</p> <p>OK</p> <p>URL Type:</p> <p>AT+ES=10,C2,01,baidu,00,0,1000</p> <p>OK</p>

	<p>TLM Type:</p> <p>AT+ES=20,00,0D08,1AC0,0000003E,0000023A,0,1000</p> <p>OK</p>
<p>Remark</p>	<p>Eddystone's three frame formats have different returns. For details, see the following analysis:</p> <p>UID Type:</p> <p>Parameter 1: UID frame fixed value, 0x00</p> <p>Parameter 2: The reference RSSI at 1 m, which has been compensated by -41 dBm based on the RSSI at 0 m, range: -100 dBm ~ -7 dBm. This value is a signed type, and the negative values can be restored correctly by adding 1 after the reverse.</p> <p>Parameter 3: 16-byte UUID (Namespace + Instance) value</p> <p>Parameter 4: Reserved bytes, user can modify it.</p> <p>Parameter 5: Set the transmit power to 0 dBm.</p> <p>Parameter 6: Set the broadcast cycle to 1000 ms.</p> <p>URL Type:</p> <p>Parameter 1: URL frame fixed value, 0x10</p> <p>Parameter 2: The reference RSSI at 1 m, which has been compensated by -41 dBm based on the RSSI at 0 m, range: -100 dBm ~ -7 dBm. This value is a signed type, and the negative values can be restored correctly by adding 1 after the reverse.</p> <p>Parameter 3: URL prefix range 0x00 ~ 0x03</p> <p>Parameter 4: URL content, users can directly access the URL by broadcasting the URL in a specific APP.</p> <p>Parameter 5: URL suffix, range 0x00 ~ 0x0D</p> <p>Parameter 6: Set the transmit power to 0 dBm.</p> <p>Parameter 7: Set the broadcast cycle to 1000 ms.</p> <p>TLM Type:</p> <p>Parameter 1: TLM frame fixed value, 0x20</p> <p>Parameter 2: Version number, must be 0x00</p> <p>Parameter 3: Voltage data, the default is automatically obtained by the device, the unit is mv (when it is 0, it means that the voltage data is automatically obtained by the device; when it is 1, it means that the voltage is user-defined data).</p> <p>Parameter 4: Temperature data, in °C (when it is 0, the temperature data is automatically obtained by the device, if it does not support the value, it is 0x8000; when it is 1, it means that the temperature is user-defined data).</p>

	<p>Parameter 5: Broadcast count value, counting starts after power on, reset can restore the count value.</p> <p>Parameter 6: Time counting since power on, resolving power is 100 ms, when the device is switched from the default iBeacon mode to Eddystone mode, the device will start counting from zero. Reset can restore the count value.</p> <p>Parameter 7: Set the transmit power to 0 dBm.</p> <p>Parameter 8: Set the broadcast cycle to 1000 ms.</p>
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AT+ES=	
Function	Set Eddystone parameters.
Example	<p>Different frame types of Eddystone have different formats, which are divided into the following three types:</p> <p>UID Type: AT+ES=00,D0,11223344556677889900112233445566,FF,0,1000</p> <p>URL Type: AT+ES=10,D0,01,baidu,00,0,1000</p> <p>TLM Type: AT+ES=20,00,0EC4,00,0A5A,0,1000</p>
Return Value	OK
Remark	<p>UID Type:</p> <p>Set the RSSI reference value of the UID frame to -48 dBm, the Namespace ID and Instance ID are set together, and set the reserved value to 0xFF. Set transmit power to 0 dBm and the broadcast cycle to 1000 ms.</p> <p>URL Type:</p> <p>Set the RSSI reference value of the URL frame to -48 dBm, the URL prefix is 0x01, baidu is the set URL content, and 00 is the URL suffix, which can be encoded as .com/. For other suffix format codes and prefix codes, please see the official below URL encoding table. Set transmit power to 0 dBm and the broadcast cycle to 1000 ms.</p> <p>https://github.com/google/eddystone/tree/master/eddystone-url</p> <p>TLM Type:</p> <p>Parameter 2: "00" means that the voltage parameter of the TLM frame is automatically obtained by the device, then the parameter 0EC4 is considered invalid</p> <p>Parameter 4: "01" means setting the temperature data as user-defined data, then parameter 0A5A is considered valid. The parameter 0A5A is the parameter after 100 times magnification, so 26.50 °C is the user-defined temperature. Set transmit power to 0 dBm and the broadcast cycle to 1000 ms.</p>

	<p>Note: 1. You can switch between the three Eddystone modes only by setting the frame type, for example: Send the command "AT+ES=20,,,,," can directly switch to TLM mode, and send the command "AT+ES=00,,,,," can directly switch to UID mode.</p> <p>2.The zero parameter cannot be omitted. For example, set the reserved byte of the UID frame to 000A, and you cannot fill in "0A" or "A", but should fill in "000A", and the device must be in Eddystone mode to query, otherwise it will return ERROR.</p>
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TX Power

AT+POWER?	
Function	Query current transmit power.
Example	AT+POWER?
Return Value	AT+POWER=4 OK
Remark	The current transmit power of the device is 4 dBm.

AT+POWER=	
Function	Set transmit power.
Example	AT+POWER=-12
Return Value	OK
Remark	The current transmit power of the device is -12 dBm. The device only supports following 8 levels of transmit power: [-20, -10, -6, -4, -2, 0, 2, 4]. The default transmit power is 0 dBm .

User Authentication

AT+AUTH?	
Function	Query the current status of the user authentication function.
Example	AT+AUTH?
Return Value	AT+AUTH=0,0000,10 OK
Remark	Parameter 1: Enable / disable the user authentication function. 0, disabled. 1, enabled.

	<p>Parameter 2: Key, the key length cannot exceed 16 bytes. The default is "0000".</p> <p>Parameter 3: Authentication valid time (in s), 10 s is by default.</p> <p>Note:</p> <p>It will take effect after disconnection when enabled, and Bluetooth will be automatically disconnected if the authentication key is not received within the valid time. When the authentication takes effect, the password needs to be filled in for verification after each connection.</p>
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AT+AUTH=	
Function	Set user authentication function.
Example	AT+AUTH=1,123456,10
Return Value	OK
Remark	<p>Enable user authentication function, set the key to "123456", and the effective time is 10 s. The setting range of the valid time is 1 s ~ 65535 s. The serial port setting takes effect immediately, and the APP setting takes effect after disconnection. Once the user authentication is enabled, a key is required for each connection, otherwise, the user authentication fails and all commands are invalid, FAIL information prompt will be returned. The recommended value should be 10 s or more, otherwise, it will cause the authentication time to be too short to cause authentication failure.</p>

Accelerometer Sensor Parameter

AT+GSENSOR?	
Function	Query the accelerometer sensor parameters.
Example	AT+GSENSOR?
Return Value	AT+GSENSOR=2000,20,2 OK
Remark	<p>Parameter 1: Accelerometer trigger threshold.</p> <p>Parameter 2: Accelerometer sensor sampling cycle.</p> <p>Parameter 3: High-density broadcast duration.</p> <p>The trigger threshold is set to 2000 mg, sampling cycle to 20 s, and high-density broadcast duration to 2 s.</p>

AT+GSENSOR=	
Function	Set the accelerometer sensor parameters.
Example	AT+GSENSOR=2000,30,3
Return Value	OK
Remark	Set the trigger threshold to 2000 mg, sampling cycle to 30 s, and high-density broadcast duration to 3 s when the accelerometer is triggered.

Temperature and Humidity Sensor Parameter

AT+THINFO?	
Function	Query the temperature and humidity sensor parameters.
Example	AT+THINFO?
Return Value	AT+THINFO=10 OK
Remark	Temperature and humidity sensor sampling cycle is 10 s.

AT+THINFO=	
Function	Set the temperature and humidity sensor parameters.
Example	AT+THINFO=60
Return Value	OK
Remark	Set the temperature and humidity sensor sampling cycle to 60 s.

Firmware Version Number

AT+VERSION	
Function	Query firmware version number.
Example	AT+VERSION?
Return Value	AT+VERSION=V0.1.0 OK

Restore Factory Settings

AT+RESET	
Function	Restore factory settings.
Example	AT+RESET

Return Value	OK
Remark	The device restarts immediately after the setting is successful.



8 Revision History

Date	Version No.	Description
2020.07.21	V0.1.0	The initial version is released.
2021.01.05	V0.1.1	Add related AT commands of sensor and broadcast cycle.
2021.04.27	V0.1.2	Add button function sprcification, modify the numbers of slots part.

Note:

1. The document will be optimized and updated from time to time. Before using this document, please make sure it is the latest version.
2. To obtain the latest document, please download it from the official website: www.szrfstar.com.



9 Contact Us

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