



# **RF-NBE01 BLE Beacon User Guide**

**Version 1.0**

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## 1 Device Overview

RF-NBE01 is a Bluetooth Beacon that based on Nordic Semiconductor nRF52832. It integrates a three-axis linear accelerometer of LIS3DH and a humidity and temperature sensor of SHT20. The accelerometer has dynamically user-selectable full scales of  $\pm 2\text{ g}$  /  $\pm 4\text{ g}$  /  $\pm 8\text{ g}$  /  $\pm 16\text{ g}$  and is capable of measuring accelerations with output data rates from 1 Hz to 5.3 kHz, at the same time, and the self-test capability allows the user to check the functioning of the sensor in the final application. Meanwhile, the SHT20 contains a capacitive type humidity sensor and a band gap temperature sensor which makes the Beacon is with high accuracy and stability as well as minimal power consumption. RF-NBE01 features with ultra- low power consumption, which can be used for indoor positioning, activity monitoring, asset tracking, etc. In order to achieve remote data management, it can configure Beacon with different parameters through the mobile phone APP to meet different applications. RF-NBE01 can be compatible with nRF52810. Moreover, it is flexible to add or delete the sensors: the accelerometer, the humidity and temperature sensor or both.

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.

**Warning:** Once set to unconnectable mode, the mode cannot be switched again.

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.



## 2 Beacon Parameters

Table 1. Table of Parameters

Item	Value	Remarks
<b>Model</b>	RF-NBE01	
<b>Chip</b>	nRF52832	
<b>Operating Voltage</b>	1.7 V ~ 3.6 V	
<b>Sensor</b>	SHT20	Temperature and humidity sensor
	LIS3DH	Three-axis acceleration sensor
<b>Battery</b>	CR2032	Service life can last for 1 year under 1 s broadcast interval.
<b>Broadcast Interval</b>	1 s	
<b>TX Power</b>	-20 dBm ~ +4 dBm	0 dBm is by default.
<b>Transmission Distance</b>	50 m	In an open air and sunny weather, @ 0 dBm
<b>Average Power Consumption</b>	22.23 $\mu$ A	1 s broadcast interval.
<b>Dimension</b>	30 mm	Diameter
<b>Weight</b>	4.5 g	Including the battery
<b>Operating Temperature</b>	-40 $^{\circ}$ C ~ +85 $^{\circ}$ C	
<b>Storage Temperature</b>	-40 $^{\circ}$ C ~ +125 $^{\circ}$ C	

Power consumption test is shown as below:

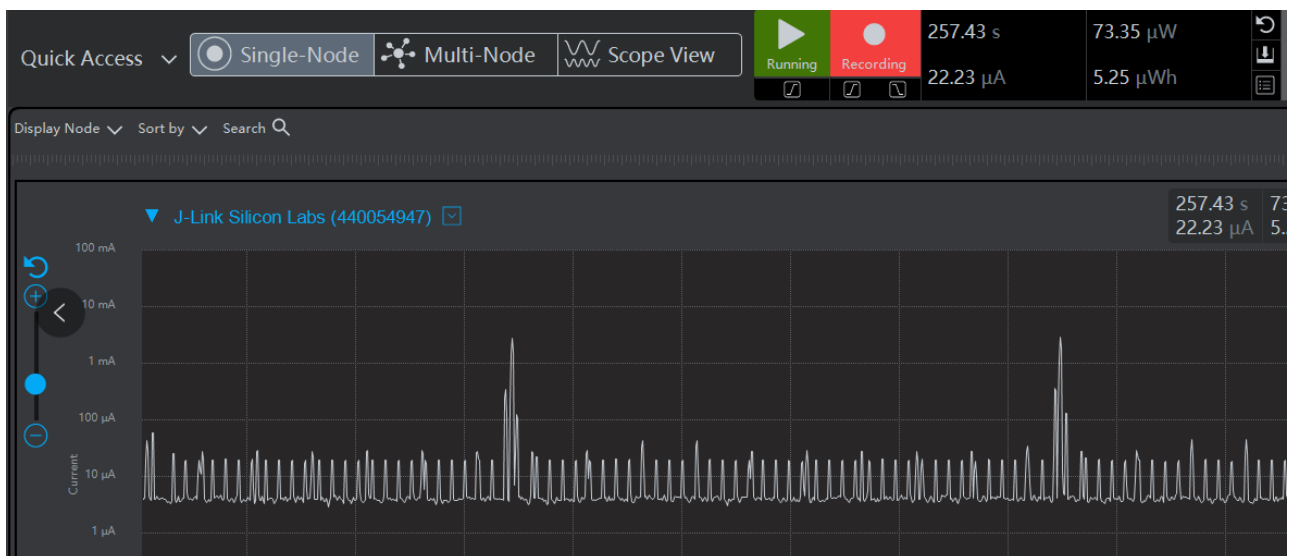


Figure 1. Power Consumption Test

### 3 Parameters Configuration

Table 2. Table of Parameter Configuration

Item	Default Settings
UUID (16 Bytes)	0112233445566778899AABBCCDDEEFF0
Major UUID (2 Bytes)	0708
Minor UUID (2 Bytes)	0506
Company ID (2 Bytes)	4C00
RSSI (2 Bytes)	-48 dBm
TX Power	0 dBm
Broadcast Interval	1 s
Broadcast Name	RFstar_XXXX (the suffix XXXX is the last two bytes of the MAC address)
Anti-hijacking Key (User Authentication)	Off by default
Connectable Mode	Connectable

## 4 BLE Protocol Specification (APP Interface)

### Service UUID

6E400001B5A3F393E0A9E50E24DCCA9E

### Enter Anti-hijacking Key UUID

<b>Characteristics UUID</b>	6E400002B5A3F393E0A9E50E24DCCA9E
<b>Executable operations</b>	Write
<b>Remarks</b>	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 the timeout period is reached, the connection is automatically disconnected. If the password is entered correctly, it will return OK\r\n. The timeout period can be configured by AT command, and the default value is 10 s.

### AT Command Operation UUID

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


### Example of sensor data analysis

The sensor data is in the broadcast RSP packet, and the host needs to enable active scanning to receive the scan request packet. The sensor data format is as follows:

Manufacturer ID	Temperature	Humidity	X Axis	Y Axis	Z Axis
2 Byte	2 Byte	2 Byte	2 Byte	2 Byte	2 Byte

The following picture is a screenshot of Nordic's official APP "nRF connect", in which the temperature and humidity data are enlarged by 100 times. When restoring the data, you need to reduce it by 100 times. The sampling frequency of temperature and humidity is once every 30 s.

The data format of the three-axis linear accelerometer sensor is a signed number, and the number with the highest bit of 1 is a negative number. And it needs to be reversed and added 1 to get the original data.



**RFstar\_C107 (Eddy...** OPEN TAB

C1:07:C5:C3:5C:39  
 NOT BONDED ▲ -63 dBm ↔ N/A

Device type: LE only  
 Advertising type: Legacy  
 Flags: GeneralDiscoverable,  
 BrEdrNotSupported  
 Complete list of 16-bit Service UUIDs:  
 0xFEAA  
Eddystone TLM:  
 Frame type: TLM <0x20>  
 Version: 0  
 Battery voltage: 3283 mV  
 Temperature: 26.351562°C  
 Advertisements count: 36  
 Time since power-up: 00:00:47.100  
 Reserved: 0x000000  
Complete Local Name: RFstar\_C107

CLONE RAW MORE

LEN.	TYPE	VALUE
2	0x01	0x04
26	0xFF	0x4C0002150112233445566778899 AABBCCDDEEFF007080506C2
13	0xFF	0x4C000AFF0F43FE30FF603DF0

Manufacturer ID	Temperature	Humidity	X Axis	Y Axis	Z Axis
0x4C00	0x0AFF	0x0F43	0xFE30	0xFF60	0x3DF0

The update period of the three-axis linear accelerometer sensor is 30 s. During the period, if the accelerometer sensor is triggered, it will be broadcasted with the new value for 30 s. If there is a new trigger during the 30 s period, the working mode is as same the same with before.

The default trigger threshold of the accelerometer is 11904 mg. When one of the three-axis (X, Y, Z) exceeds the set threshold, the accelerometer will generate an interrupt signal. When the Beacon device receives this signal, it will trigger to read the three-axis acceleration value of the accelerometer. Currently, the threshold value cannot be changed by command.

## 5 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 only be sent through APP.
2. Not every command has the above two types of commands.
3. The AT command must be **capitalized** and ended with a carriage return and line feed (CRLF).
4. The <> returned in the query AT command indicates the optional parameters, and [] indicates the required parameters. 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.

## AT Command List

Table 3. AT Command List

Command	Function
<u><a href="#">AT+NAME</a></u>	Query / set device name
<u><a href="#">AT+ADS</a></u>	Query / set broadcast parameters
<u><a href="#">AT+MODE</a></u>	Query / set working mode
<u><a href="#">AT+BEACON</a></u>	Query / set beacon related parameters
<u><a href="#">AT+ES</a></u>	Query / set Eddystone related parameters
<u><a href="#">AT+POWER</a></u>	Query / set device transmit power
<u><a href="#">AT+AUTH</a></u>	Query / set user authentication
<u><a href="#">AT+VERSION</a></u>	Query device firmware version number
<u><a href="#">AT+RESET</a></u>	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?	
<b>Function</b>	Query device name.
<b>Example</b>	AT+NAME?
<b>Return Value</b>	AT+NAME=RFstar_XXXX OK
<b>Remark</b>	The command returns the device name correctly, the default is "RFstar_XXXX", XXXX is the last two bytes of the MAC address.

AT+NAME=	
<b>Function</b>	Set device name.
<b>Example</b>	AT+NAME=TEST-NAME
<b>Return Value</b>	OK
<b>Remark</b>	The maximum setting length cannot exceed 11 bytes.

### Broadcast Parameter

AT+ADS?	
<b>Function</b>	Query broadcast parameters.
<b>Example</b>	AT+ADS?
<b>Return Value</b>	AT+ADS=,1,200 OK
<b>Remark</b>	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=	
<b>Function</b>	Set broadcast parameters.
<b>Example</b>	AT+ADS=,0,500
<b>Return Value</b>	OK
<b>Remark</b>	Set to enable unconnectable broadcast with 500 ms interval, 1000 ms is by default. <b>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.</b>

### Working Mode

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

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

### Beacon Parameters

AT+BEACON?	
<b>Function</b>	Query Beacon parameters.
<b>Example</b>	AT+BEACON?
<b>Return Value</b>	AT+BEACON=4C00,0708,0506,D0,0112233445566778899AABBCCDDEEFF0 OK
<b>Remark</b>	Parameter 1: Company ID

	Parameter 2: Major Parameter 3: Minor Parameter 4: Reference RSSI of 1 m. This value is a signed type, and the negative values can be restored correctly by adding 1 after the reverse. Parameter 5: User-defined UUID data
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<b>AT+BEACON=</b>	
<b>Function</b>	Set Beacon parameters.
<b>Example</b>	AT+BEACON=4546,0102,0304,C2,0102030405060708090A0B0C0D0EF010
<b>Return Value</b>	OK
<b>Remark</b>	Parameter 1: Set Company ID to 4546 Parameter 2: Set Major to 0102 Parameter 3: Set Minor to 0304 Parameter 4: Reference RSSI at 1 m is -62 dBm Parameter 5: User-defined UUID data is 0102030405060708090A0B0C0D0EF010 Note: The zero parameter cannot be omitted. For example, Major is set to 1, "1" or "01" cannot be filled in, but "0001", otherwise ERROR will be returned.

### Eddystone Parameters

<b>AT+ES?</b>	
<b>Function</b>	Query Eddystone parameters.
<b>Example</b>	AT+ES?
<b>Return Value</b>	<p><b>UID Type:</b></p> AT+ES=00,D0,11223344556677889900112233445566,0000 OK <p><b>URL Type:</b></p> AT+ES=10,C2,01,baidu,00 OK <p><b>TLM Type:</b></p> AT+ES=20,00,0D08,1AC0,0000003E,0000023A OK

<b>Remark</b>	<p>Eddystone's three frame formats have different returns. For details, see the following analysis:</p> <p><b>UID Type:</b></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><b>URL Type:</b></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><b>TLM Type:</b></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>
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<b>AT+ES=</b>	
<b>Function</b>	Set Eddystone parameters.
<b>Example</b>	Different frame types of Eddystone have different formats, which are divided into the following three types: <b>UID Type:</b> AT+ES=00,D0,11223344556677889900112233445566,FF <b>URL Type:</b> AT+ES=10,D0,01,baidu,00 <b>TLM Type:</b> AT+ES=20,00,0EC4,00,0A5A
<b>Return Value</b>	OK
<b>Remark</b>	<p><b>UID Type:</b></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.</p> <p><b>URL Type:</b></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 URL encoding table as below.  <a href="https://github.com/google/eddystone/tree/master/eddystone-url">https://github.com/google/eddystone/tree/master/eddystone-url</a></p> <p><b>TLM Type:</b></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.</p> <p><b>Note:</b></p> <ol style="list-style-type: none"> <li>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.</li> <li>2. The zero parameter cannot be omitted. For example, set the reserved byte of the UID frame to 000A, and "0A" or "A" cannot be filled in, but "000A", and the device must be in Eddystone mode to query, otherwise it will return ERROR.</li> </ol>

**TX Power**

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

AT+POWER=	
<b>Function</b>	Set transmit power.
<b>Example</b>	AT+POWER=-12
<b>Return Value</b>	OK
<b>Remark</b>	The current transmit power of the device is -12 dBm. The device only supports following 9 levels of transmit power: [-40, -20, -16, -12, -8, -4, 0, 3, 4]. The default transmit power is <b>0 dBm</b> .

**User Authentication**

AT+AUTH?	
<b>Function</b>	Query the current status of the user authentication function.
<b>Example</b>	AT+AUTH?
<b>Return Value</b>	AT+AUTH=0,0000,10 OK
<b>Remark</b>	Parameter 1: Enable / disable the user authentication function. 0, disabled. 1, enabled. Parameter 2: Key, the key length cannot exceed 16 bytes. The default is "0000". Parameter 3: Authentication valid time (in s), 10 s is by default. <b>Note:</b> 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.

<b>AT+AUTH=</b>	
<b>Function</b>	Set user authentication function.
<b>Example</b>	AT+AUTH=1,123456,10
<b>Return Value</b>	OK
<b>Remark</b>	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.

### Firmware Version Number

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

### Restore Factory Settings

<b>AT+RESET</b>	
<b>Function</b>	Restore factory settings.
<b>Example</b>	AT+RESET
<b>Return Value</b>	OK
<b>Remark</b>	The device restarts immediately after the setting is successful.

## 6 Revision History

Date	Version No.	Description
2020.07.21	V1.0	The initial version is released.

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](http://www.szrfstar.com).





## 7 Contact Us

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