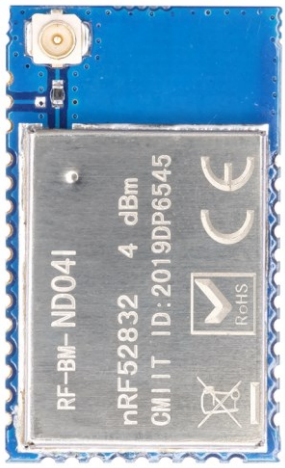
nRF52832 Bluetooth Low Energy 5.0 Master-Slave Module and Protocol

Version: V1.4

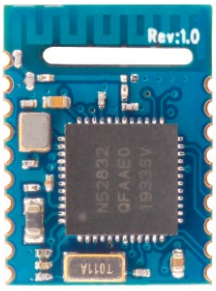
Shenzhen RF-star Technology Co., Ltd.

Jan. 8th, 2021

RF-BM-ND04



RF-BM-ND04I



RF-BM-ND08

Table of Contents

Table of Tables

Table of Figures

1 Summary

RF-BM-ND04(I) and RF-BM-ND08 are RF modules based on Nordic BLE SoC nRF52832 with ARM® Cortex®-M4 32-bit processor. It integrates a 32.768 kHz and a 32 MHz crystal, an LC filter, an antenna matching and a meander line inverted-F PCB antenna / or an IPEX connector. The modules support BLE stack v5.0 including the high-speed 2 Mbps feature and can be preprogrammed with serial interface communication protocols, such as NFC, ANT and 2.4 GHz proprietary for simple programming. The modules also support Bluetooth mesh which can be run concurrently with Bluetooth LE, enabling smartphones to provision, commission, configure and control mesh nodes. The module has NFC-A Tag for use in simplified pairing and payment solutions. It also has numerous digital peripherals and interfaces such as ADC, PDM, PWM, I^2C and I^2S for many applications. It features low power consumption, small size, robust connection distance, and rigid reliability. 1.27-mm pitch stamp stick package for easy assembling and cost-effective PCB design.

RF-star can provide customers with the integration of the entire profiles, applications, radio and BLE protocol stack. With compliance to Bluetooth Low Energy standard, the RF-star's modules enable the creation of a new market for tiny, cost-effective and power-efficient wireless consumer products such as watches, medical sensors, mice, TV remote controls and fitness trainers.

2 Overview

2.1 Introduction

The Bluetooth LE modules which are mentioned in this document can work in bridge mode (transparent transmission mode).

After the module starts to broadcast, a smartphone with a specific APP running will scan and pair with it. When the connection is successful, the smartphone can monitor and control the module through Bluetooth protocol.

In bridge mode, the user CPU can communicate with the mobile device bi-directionally through the serial ports of modules. Users can also manage and control certain communication parameters through specific AT commands of serial ports. The detailed meaning of the user data is defined by the upper applications. Mobile devices can write the module through the APP. And the data are written will be sent to the user CPU through serial ports. Then the module will transmit the data packet from the user CPU to the mobile devices automatically. Under the development in this mode, the user needs to undertake the code design for the master CPU and the APP for mobile devices.

In order to ensure the stability of the firmware, the module will start to work normally after 500 ms of poweron. When transmitting a big size data packet, it is recommended to start working after the module is connected for 6 s. MTU, connection interval, and other operations need to be confirmed when a connection is established. If the high-speed transparent transmission is carried out at this time, packet loss or device jamming is very easy to occur.

2.2 Features

1. Easy to use, no need of any application experience of Bluetooth protocol stack.
2. Support BLE master mode, slave mode, master-slave mode and Beacon mode.
3. Support concurrent slave mode and master, that is, the module can connect to other slave devices when it is connected by one master device.
4. Support multi-connection during master mode and master-slave mode. Under master-slave mode, 7 slave devices can be connected at the same time, and it also can be connected as a slave device by another master device at the same time.
5. Default connection interval of 20 ms, which makes a quick connection and enhances the compatible stability of Android and iOS phones.
6. UART design for user interface, full-duplex bi-directional communication, and support the minimum baud rate of 4800 bps and the maximum baud rate of 460800 bps.
7. Support software reset module by AT command.

8. Support acquire and modify the MAC address (to take effect after resetting) by AT command.
9. Support adjust the Bluetooth connection interval and control different transmit rates (dynamic power consumption adjustment) by AT command.
10. Support adjust the transmit power, modify the broadcast interval, modify the serial port baud rate, modify the module name, by AT commands, please check for details in AT Command.
11. Support modify Service UUID by AT command.
12. AT commands can be sent through APP.
13. High-speed transparent transmission rate and the maximum is 46 kB/s (Use standard hardware flow control).
14. Ultra-low working power consumption, the measured power consumption of the module is as follows:

Table 1. Power Consumption of nRF52832

Event	Average Current	Test Condition / Remark
Sleep	2.76 μA	
Broadcast	76.98 μA	Broadcast interval: 200 ms
Broadcast	32.79 μA	Broadcast interval: 500 ms
Broadcast	17.53 μA	Broadcast interval: 1000 ms
Broadcast	8.90 μA	Broadcast interval: 2000 ms
Broadcast	4.27 μA	Broadcast interval: 5000 ms
Connection	80.35 μA	Connection interval: 45 ms
Connection	27.25 μA	Connection interval: 150 ms

2.3 Supporting Working Mode

The device supports four working modes as below:

1. BLE slave mode
2. BLE master mode
3. BLE master-slave mode
4. Beacon mode

The default role after power-on is the slave mode. The role can be switched to adjust the working mode through the AT command "AT+ROLE". Please check the AT Command in detail. **In the Beacon mode, the serial port is closed, the mode only can be switched through the mobile APP.**

2.4 Default Configuration at Slave Mode

1. Device name: RF-STAR-SMMT.
2. Broadcast interval: 200 ms.

3. Connection interval: 20 ms.
4. 128-bit UUID (by default)
5. Broadcast mode: connectable
6. Device status: transparent transmission

2.5 Default Configuration at Beacon Mode

1. Company ID: 0x0059 (Nordic).
2. Major UUID: 0x0102.
3. Minor UUID: 0x0304.
4. RSSI: -50 dBm.
5. UUID: 0x01, 0x02, 0x03, 0x04, 0x05, 0x06, 0x07, 0x08, 0x09, 0x0A, 0x0B, 0x0C, 0x0D, 0x0E, 0x0F, 0x10.

The serial port is closed and unavailable in this mode.

2.6 Device Status

1. DEVICE START: The device starts to work.
2. S:CONNECTED: BLE slave is successfully connected.
3. S:DISCONNECTED: BLE slave is disconnected.
4. B:CONNECTED: Beacon is successfully connected.
5. B:DISCONNECTED: Beacon is disconnected.
6. "XX:XX:XX:XX:XX:XX CONNEDTED": BLE master is successfully connected (The string in red is the MAC address of the connected slave).
7. "XX:XX:XX:XX:XX:XX DISCONNECTED": BLE master is disconnected (The string in red is the MAC address of the disconnected slave).
8. CONNECT XX:XX:XX:XX:XX:XX TIMEOUT: The time when the BLE master connects to the slave device is overtime (The string in red is the MAC address of the connected slave device). When devices are not found within 5 s after the command is operated, a timeout will be prompted.
9. BUSY...: The device is busy, please wait for the device to finish processing the current task.
10. WAKE UP: Serial port wake up
11. DEVICE ERROR!: An abnormal error occurred in the device. The device will automatically restore factory settings.

The above states can be turned on or off by the AT command. For details, please refer to AT Command.

2.7 Multi-Connection

1. Support multi-connection during master mode and master-slave mode. Under master-slave mode, 7 slave devices can be connected at the same time, and it also can be connected as a slave device by another master device at

the same time.

2. If AT+CONNECT command failed to connect to the device (prompt FAIL), please refer to the command description for the reason.
3. Multi-connection means multiple devices automatically reconnect. When an opposite device disconnects abnormally, the device will initiate reconnection. Please refer to the command description.
4. During multi-connection, the designated data transmission handle function is not saved after power off, and the device will transmit data with the device with a handle value of 0 by default. If the device with the corresponding handle is disconnected, the handle value will be automatically switched to the next effective handle. (The handle can be queried with the command AT+CNT_LIST).
5. The user disconnects the device which is sets as automatic reconnection by AT commands, and the current automatic reconnection of the device will be failed. It will take effect after the next abnormal disconnection.

Recommendation:

The source of multi-connection data transmission is more complicated, such as the master-slave: the data may come from the following 4 devices, so the data source should be included in the data packet, otherwise, it cannot be identified which device the data came from.

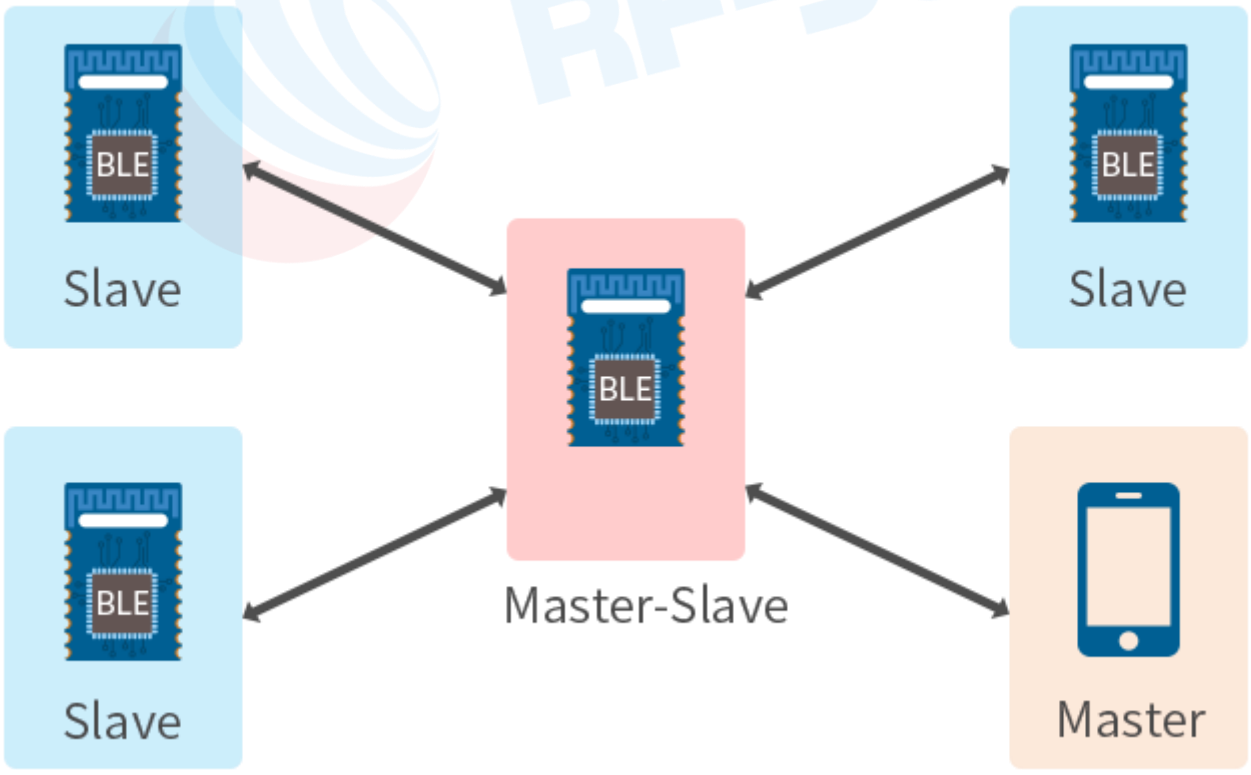


Figure 1. Multi-Connection Diagram

3 Package and Pin Assignment

3.1 RF-BM-ND04(I)

RF-BM-ND04 is pin to pin compatible with and RF-BM-ND04I. The difference is that the antenna of RF-BM-ND04 is PCB type, while RF-BM-ND04I is IPEX type.

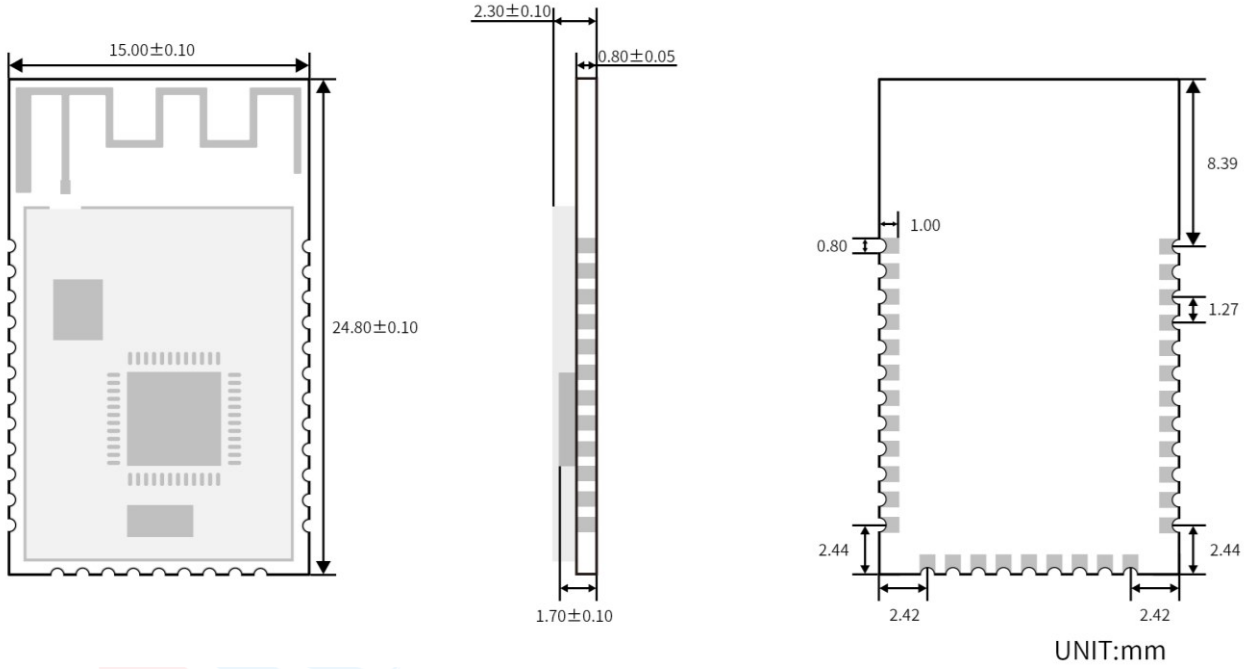


Figure 2. PCB Footprint of RF-BM-ND04

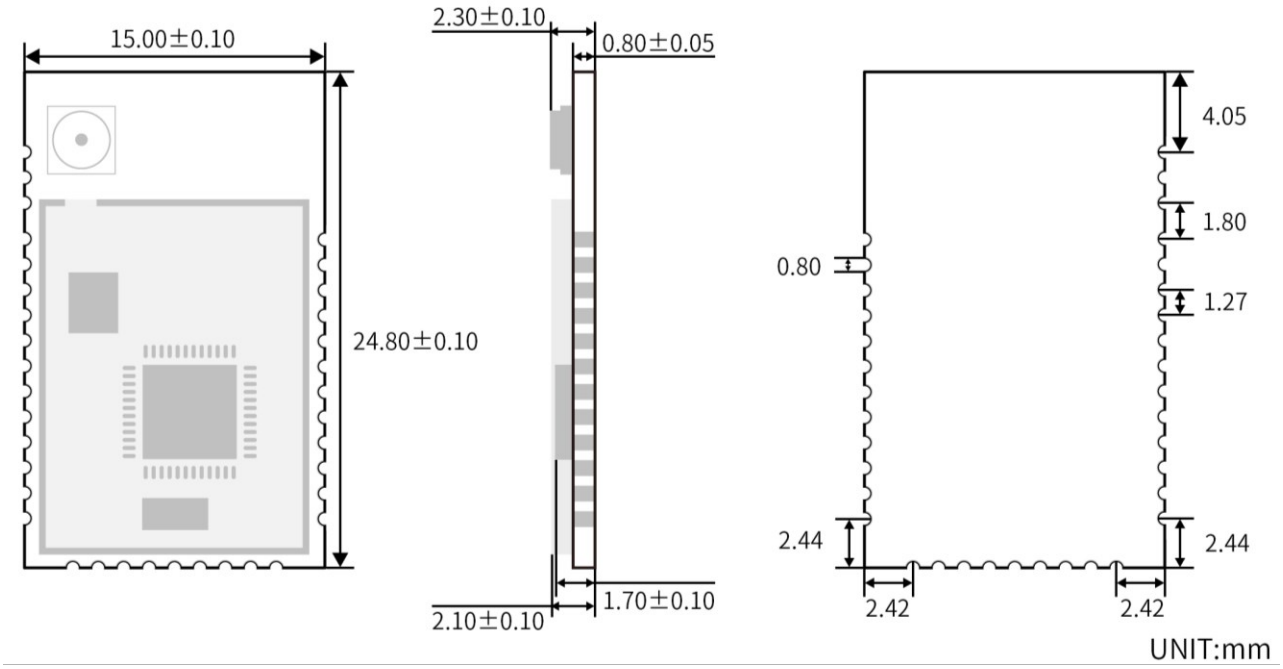


Figure 3. PCB Footprint of RF-BM-ND04I

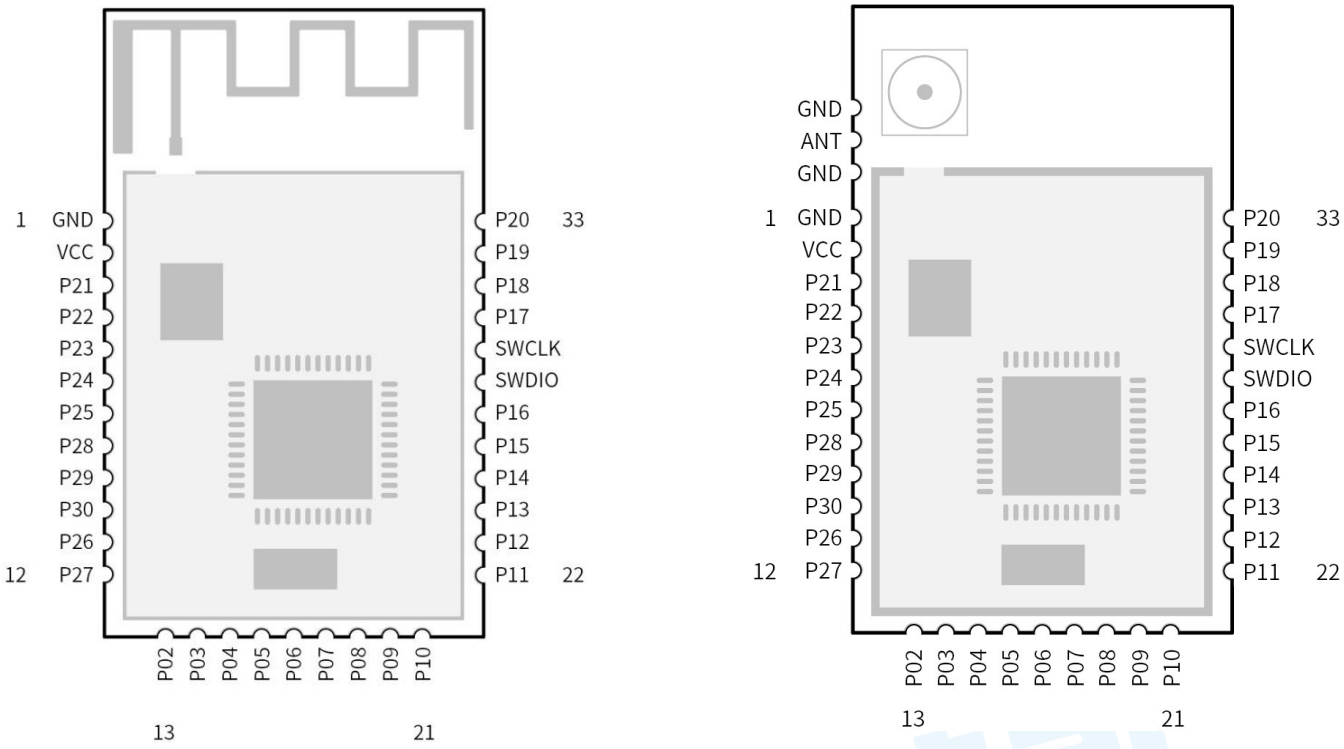


Figure 4. Pin Assignment of RF-BM-ND04(I)

Table 2. Pin Functions of RF-BM-ND04(I)

Pin	Name	Function	Description
1	GND	GND	Ground
2	VCC	VCC	Power supply: 1.7 V ~ 3.6 V. Recommended to 3.3 V.
3	P21 / RST	I/O	Reset, active low.
4	P22	I/O	
5	P23	I/O	
6	P24	I/O	
7	P25	I/O	
8	P28	I/O	
9	P29	I/O	
10	P30	I/O	
11	P26	I/O	
12	P27	I/O	
13	P02	I/O	
14	P03	I/O	
15	P04	I/O	

16	P05	RTS	Module output signal (Standard hardware flow control: Require To Send). When it is at a high level, the module serial port is busy, and the MCU is not allowed to send data to the module serial port. When it is at a low level, the MCU is allowed to send data to the module serial port.
17	P06	TX	Serial port TX
18	P07	CTS	Module input signal (Standard hardware flow control: Clear To Send). When it is at a high level, the MCU serial port is busy, and the module will not send data to the MCU serial port. When it is at a low level, the module will send data to the MCU serial port.
19	P08	RX	Serial port RX
20	P09	I/O	
21	P10	I/O	
22	P11	I/O	
23	P12	I/O	
24	P13	Wakeup IO	When the module is in a sleep state, the module can be awakened through this IO. Active on the falling edge
25	P14	I/O	
26	P15	I/O	
27	P16	I/O	
28	SWDIO	—	Serial Wire Debug I/O for debugging and programming
29	SWCLK	—	Serial wire debug clock input for debugging and programming
30	P17	Status indicator	Slave role (including Beacon) connection status indicator: in low level during connection (LED always on).
31	P18	Status indicator	Master role connection status indicator: in low level during connection (LED always on).
32	P19	RESTORE	All parameters will be reset to factory settings after this pin is set low for 3 s.
33	P20	I/O	

3.2 RF-BM-ND08(I)

RF-BM-ND08 is pin to pin compatible with and RF-BM-ND08I. The difference is that the antenna of RF-BM-ND08 is PCB type, while RF-BM-ND08I is IPEX type. SWD debugging ports are on the bottom side of the module, which is not pulled out in the stamp half hole way, please refer to the module pin diagram for details.

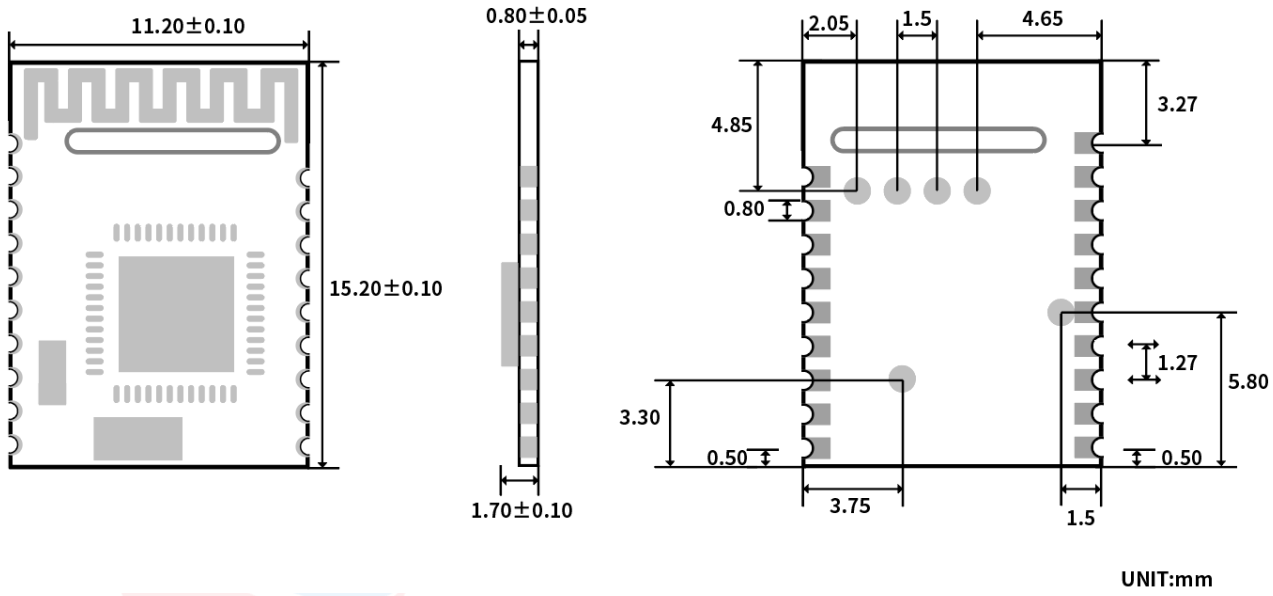


Figure 5. PCB Footprint of RF-BM-ND08

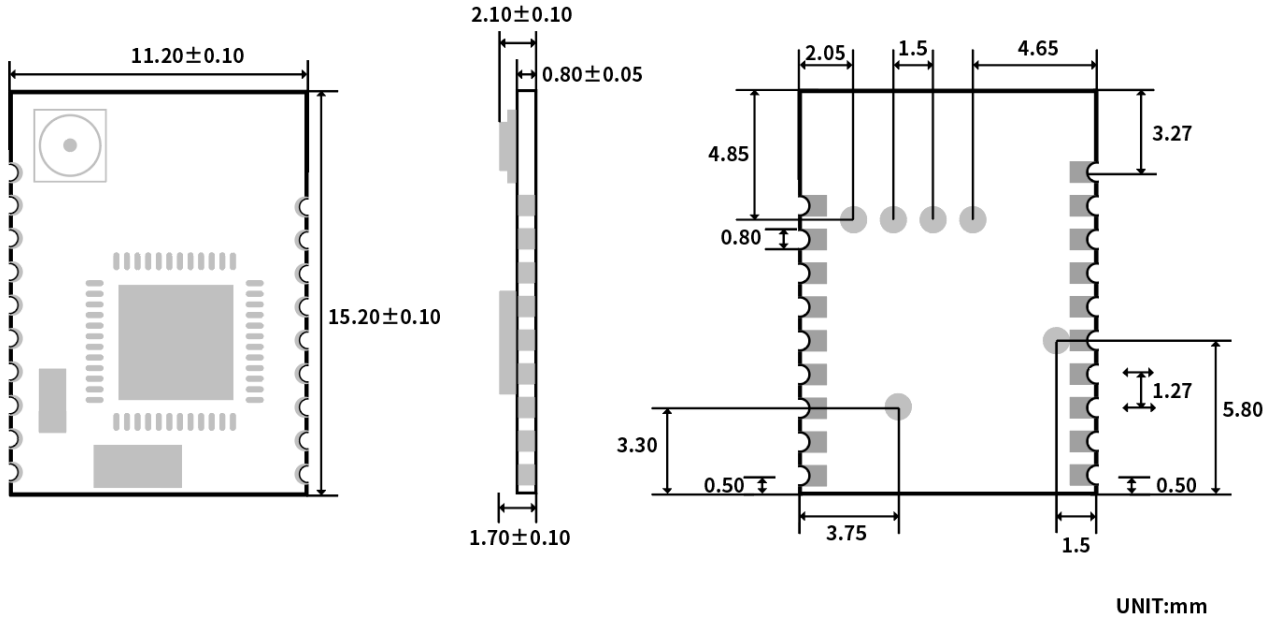


Figure 6. PCB Footprint of RF-BM-ND08I

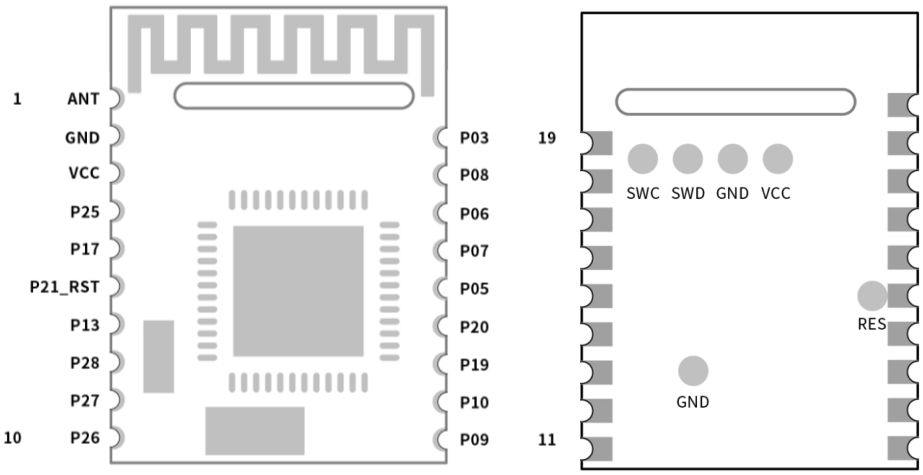


Figure 7. Pin Assignment of RF-BM-ND08(I)

Table 3. Pin Functions of RF-BM-ND08(I)

Pin	Name	Function	Description
1	ANT	—	
2	GND	GND	Ground
3	VCC	VCC	Power supply: 1.7 V ~ 3.6 V. Recommended to 3.3 V.
4	P25	I/O	
5	P17	Status indicator	Slave role (including Beacon) connection status indicator: in low level during connection (LED always on).
6	P21/RST	I/O	Reset, active low.
7	P13	Wakeup IO	When the module is in a sleep state, the module can be awakened through this IO. Active on the falling edge
8	P28	I/O	
9	P27	I/O	
10	P26	I/O	
11	P09	I/O	
12	P10	I/O	
13	P19	RESTORE	All parameters will be reset to factory settings after this pin is set low for 3 s.
14	P20	I/O	
15	P05	RTS	Module output signal (Standard hardware flow control: Require To Send). When it is at a high level, the module serial port is

			busy, and the MCU is not allowed to send data to the module serial port. When it is at a low level, the MCU is allowed to send data to the module serial port.
16	P07	CTS	Module input signal (Standard hardware flow control: Clear To Send). When it is at a high level, the MCU serial port is busy, and the module will not send data to the MCU serial port. When it is at a low level, the module will send data to the MCU serial port.
17	P06	TX	Serial port TX
18	P08	RX	Serial port RX
19	P03	I/O	

4 UART Transparent Transmission Protocol (Bridge Mode)

The bridge mode means to set up a bi-directional communication way between user CPU and mobile devices by the mutual connection between serial port and user CPU. Users can reset serial port baud rate and BLE connection interval by the specified AT commands (see the section "AT Command"). The module will have different data handling capabilities, as per different serial port baud rates and BLE connection intervals.

The hardware protocol of serial port: 115200 bps, 8, no parity, 1 stop bit.

Except for Beacon mode, the serial port is open by default in any mode. If this function needs to be closed, please use the "AT+SLEEP=1" command to close the serial port.

When the module serial port receives data and transmits it to the mobile device, there is no strict requirement for the serial port data packet. When the RTS of the module is set high, it indicates that the receive buffer of the serial port is full (maximum buffer is 3904 bytes), or the serial port is busy.

Data packets from mobile devices to the module must be sub-packed automatically (into 1 ~ 244 bytes per packet) before sending. The module will transmit the packets to the master RXD in turn, after received the packets.

Most serial port tools on PC do not have CTS detection. **For reliable transparent transmission, please use flow control**. It is recommended to use the software SecureCRT.

5 BLE Protocol Specification (APP Interface)

UART Service UUID

6E400001B5A3F393E0A9E50E24DCCA9E

BLE Data Receiving UUID (RX Characteristic)

Characteristics UUID	6E400002B5A3F393E0A9E50E24DCCA9E
Executable operations	WRITE, WRITE NO RESPONSE
Remarks	The BLE input is transmitted to the serial port output: After APP writes to this channel through the BLE API interface, the data will be output from the serial port TX.

BLE Data Transmitting UUID (TX Characteristic)

Characteristics UUID	6E400003B5A3F393E0A9E50E24DCCA9E
Executable operations	Notify
Remarks	The serial port input is transmitted to the BLE output, and the data input from the serial port RX will be notified in this channel and sent to the mobile device.

AT Command Operation UUID

Characteristics UUID	6E400004B5A3F393E0A9E50E24DCCA9E
Executable operations	NOTIFY, WRITE, WRITE NO RESPONSE
Remarks	Supports all commands in the command list, any data will be processed as commands (do not use +++ to enter the command mode), and users can operate without sending carriage returns and line feeds (CRLF). The serial port must end with a CRLF. The master needs to open notify to receive the data sent by the module.

Device Information UUID: 0x180A

Manufacturer Name

Characteristics UUID	0x2A29
Executable operations	READ
Remarks	RF-STAR-SMMT (Shenzhen RF-star Technology Co., Ltd. Transparent transmission module working as master and slave at the same time)

Hardware Revision

Characteristics UUID	0x2A27
Executable operations	READ
Remarks	Module hardware version reading channel. The module hardware version can be obtained by reading the channel. Such as RF-BM-ND04 / RF-BM-ND08, which indicates that this firmware is suitable for the corresponding model of the module.

Firmware Revision

Characteristics UUID	0x2A26
Executable operations	READ
Remarks	Module firmware version reading channel. The module firmware version can be obtained by reading the channel. The format is v0.2.5, Dec 28 2020,17:58:32, it Indicates the firmware version V0.2.5 generated at 17:58:32 on December 28th, 2020.

System ID

Characteristics UUID	0x2A23
Executable operations	READ
Remarks	Module information acquisition channel. The module ID can be obtained by reading this channel. The format is as xxxxxx0000xxxxxx, and xx is the physical address of the module chip MAC, six bytes, low byte first.

Generic Access UUID: 0x1800

Device Name

Characteristics UUID	0x2A00
Executable operations	READ
Remarks	The default is RF-STAR-SMMT, and it will be updated synchronously after modification with the command "AT+NAME=". Note: It is not recommended to modify the device name through the write attribute under this UUID

Device Appearance

Characteristics UUID	0x2A01
Executable operations	READ
Remarks	The external appearance of the device. It is undefined.

Peripheral Preferred Connection Parameters

Characteristics UUID	0x2A04
Executable operations	READ
Remarks	The 1st, 2nd bytes are the minimum coordinated connection interval. The 3rd, 4th bytes are the maximum coordinated connection interval. The 5th, 6th bytes are Slave Latency. The 7th, 8th bytes are Supervision Timeout Multiplier.

Central Address Resolution

Characteristics UUID	0x2AA6
Executable operations	READ
Remarks	Whether this module supports address resolution can be obtained by reading this channel. If the module supports address resolution {Value: (0x01)}, the directional broadcast function can be used. **Note: Directional broadcast function needs to be customized.**

6 AT Command

6.1 AT Command Format

Table 4. AT Command Format Table

Type	Command Format	Description
Test Command	AT+[x]=?	This command is used to query the parameters and value range of the setting commands.
Query Command	AT+[x]?	This command returns the current value of the parameter.
Configure Command	AT+[x]=<…>	This command is used to set user-defined parameter values.
Execute Command	AT+[x]	This command is used to perform the function of immutable parameters.

Note:

1. This command can be sent through APP and serial port.
2. The default baud rate of the serial port is 115200, 8-bit data bit, 1 stop bit, no parity.
3. Not every command has the above four types of commands.
4. The AT command must be **capitalized** and ended with a carriage return and line feed (CRLF).
5. 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.
6. The parameter positions that are not filled in the optional parameter command must **be reserved**. Refer to the previous example.
7. The parameters in any command cannot contain invisible characters such as spaces and tabs.
8. The value range of the parameters cannot be exceeded when setting parameters.

6.2 AT Command List

Table 5. AT Command List

AT Command	Function	Remark
+++	Enter AT command mode.	
AT+EXIT	Exit AT command mode.	Take effect immediately.
AT+NAME	Query/set device name.	Take effect after restart, save after power off.
AT+MAC	Query/set MAC address.	Take effect after restart, save after power off.
AT+ECHO	Query/set whether the serial port is echoed.	Take effect immediately, do not save after power off.
AT+STATUS	Query/set whether to display the device status.	Take effect immediately, do not save after power off.
AT+ROLE	Query/set device role.	Take effect after restart, save after power off.
AT+ADS	Query/set broadcast parameters under slave mode.	Take effect after restart, save after power off.
AT+CON_INTERVAL	Query/set connection interval.	Take effect after restart, save after power off.
AT+SERVICE	Query/set BLE service-related parameters.	Take effect after restart, save after power off.
AT+SCAN	Scan device	Only effective in master mode and master-slave mode.
AT+CONNECT	Connect devices.	Only effective in master mode and master-slave mode.
AT+DISCONNECT	Disconnect the connected device.	Take effect immediately, do not save after power off.
AT+AUTO_CNT	Automatically reconnect slave devices.	Only effective in master mode and master-slave mode. Take effect immediately, save after power off.
AT+TTM_ROLE	Define the default transparent transmission role.	Only effective in master-slave mode. Take effect immediately, save after power off.
AT+CNT_LIST	Query the connected slave device list of the current device.	Only effective in master mode and master-slave mode.
AT+TTM_HANDLE	Designate the transparent transmission handle during multi-connection. AT+CNT_LIST views the handle of the	Only effective in master mode and master-slave mode. Take effect immediately, do not save after

	connected device.	power off.
AT+DEV_DEL	Delete the saved slave devices.	Take effect immediately, save after power off.
AT+OBSERVER	Enable/disable observer mode.	Only effective in master mode and master-slave mode.
AT+BEACON	Query/set Beacon-related parameters.	Take effect after restart, save after power off.
AT+POWER	Query/set device power.	Take effect after restart, save after power off.
AT+SLEEP	Query/set sleep status (single effective).	Take effect immediately, do not save after power off.
AT+UART	Query/set baud rate.	Take effect after restart, save after power off.
AT+AUTH	Query/set user authentication.	Take effect after restart, save after power off.
AT+RESTART	Restart the device.	Take effect immediately.
AT+RESET	Device parameters restore factory settings and restart.	Take effect immediately.
AT+VERSION	Query firmware version.	
Return Value of AT Command		
OK	Successful operation.	
FAIL	Failed operation.	
ERROR	Error operation.	
BUSY	The operation is busy, please wait for the fulfillment of the previous operation.	

6.3 Detailed AT Command

- **Enter AT Command Mode**

+++	
Function	Enter AT command mode.
Example	+++
Return Value	OK.
Remark	Need to exit AT command mode to switch to transparent transmission mode.

- **Exit AT Command Mode**

AT+EXIT	
Function	Exit AT command mode.
Example	AT+EXIT
Return Value	OK
Remark	

- **Device Name**

AT+NAME?	
Function	Query device name.
Example	AT+NAME?
Return Value	AT+NAME=RF-STAR-SMMT OK.
Remark	The command returns the device name correctly.

AT+NAME=	
Function	Set device name.
Example	AT+NAME=TEST-NAME
Return Value	OK.
Remark	Take effect after restart, save after power off. The maximum setting length is 17 bytes.

- **MAC Address**

AT+MAC?	
Function	Query device MAC address.
Example	AT+MAC?
Return Value	AT+MAC=8A:E5:84:7A:E7:C9 OK
Remark	MAC address is in hexadecimal.

AT+MAC=	
Function	Set device MAC address.
Example	AT+MAC=F1:F2:F3:F4:F5:F6
Return Value	OK
Remark	Take effect after restart, save after power off.

- **Serial Port Echo**

AT+ECHO=?	
Function	Query parameter range of this command.
Example	AT+ECHO=?
Return Value	AT+ECHO=[0,1] OK
Remark	0: Disable echo. 1: Enable echo.

AT+ECHO?	
Function	Query serial port echo.
Example	AT+ECHO?
Return Value	AT+ECHO=0 OK
Remark	0: Disable echo. (Disable by default). 1: Enable echo.

AT+ECHO=	
Function	Set serial port echo.

Example	AT+ECHO=1
Return Value	OK
Remark	Enable echo. Take effect immediately, do not save after power off.

- **Device Status Display**

AT+STATUS=?	
Function	Query parameter range of this command.
Example	AT+STATUS=?
Return Value	AT+STATUS=[0,1] OK
Remark	0: Disable device status display function. 1: Enable device status display function (enable by default).

AT+STATUS?	
Function	Query the current display state of device status.
Example	AT+STATUS?
Return Value	AT+STATUS=1 OK

AT+STATUS=	
Function	Set display state of device status.
Example	AT+STATUS=0
Return Value	OK
Remark	Disable device status display. Take effect immediately, do not save after power off.

- **Device Role**

AT+ROLE=?	
Function	Query parameter range of this command.
Example	AT+ROLE=?
Return Value	AT+ROLE=[0,1,2,3] OK
Remark	0: Salve (by default) 1: Master 2: Master-slave 3: Beacon, connectable. (The serial port is closed under this mode, and no name.)

AT+ROLE?	
Function	Query the current role.
Example	AT+ROLE?
Return Value	AT+ROLE=0 OK
Remark	The current role of the device is slave.

AT+ROLE=	
Function	Set device role.
Example	AT+ROLE=1
Return Value	OK
Remark	The device will work in master mode. Take effect after restart, save after power off.

- **Slave Role Broadcast Parameters**

AT+ADS=?	
Function	Query parameter range of this command.
Example	AT+ADS=?
Return Value	AT+ADS=<0,1>,<0,1>,<20,10240> OK
Remark	This command has three parameters. Parameter 1: Set broadcast status (0: Disable. 1: Enable, take effect immediately). Parameter 2: Set broadcast mode (0: Non-connectable. 1: Connectable, take effect after restart). Parameter 3: Set broadcast interval (in ms, take effect after restart).

AT+ADS?	
Function	Query broadcast parameters.
Example	AT+ADS?
Return Value	AT+ADS=1,1,200 OK
Remark	Parameter 1: Broadcasting Parameter 2: Connectable broadcast Parameter 3: The broadcast interval is 200 ms.

AT+ADS=	
Function	Set broadcast parameters.
Example	AT+ADS=1, 0, 500
Return Value	OK
Remark	Enable unconnectable broadcast with 500 ms broadcast interval. Take effect after restart, save after power off.

- **Connection Interval**

AT+CNT_INTERVAL=?	
Function	Query parameter range of this command.
Example	AT+CNT_INTERVAL=?
Return Value	AT+CNT_INTERVAL=<8~4000> OK
Remark	The connection interval range is from 8 ms to 4000 ms. 20 ms is by default.

AT+CNT_INTERVAL?	
Function	Query the connection interval of the device.
Example	AT+CNT_INTERVAL?
Return Value	AT+CNT_INTERVAL=20 OK
Remark	The connection interval of the device is 20 ms.

AT+CNT_INTERVAL=	
Function	Set device connection interval.
Example	AT+CNT_INTERVAL=20
Return Value	OK
Remark	1. The connection interval is set as 20 ms. Take effect after restart, save after power off. 2. After the connection interval is set, it will only take effect when the device is initialized, which is equivalent to restarting. 3. The connection interval can reach less than 20 ms (minimum 8 ms), when the Bluetooth module is worked as the master role 4. Due to system problems in general mobile phones, the minimum connection interval can only be 20 ms. 5. After the connection interval takes effect, the connection interval will be coordinated according to different mobile phones. The maximum coordination to " connection interval to be set + 55 ms", For example, if the connection interval is set to 10 ms through the command, the maximum coordinated connection interval is 65 ms.

- **Slave Service**

AT+SERVICE=?	
Function	Query parameter range of this command.
Example	AT+SERVICE=?
Return Value	AT+SERVICE=<0,1>,<0-FFFF>,<0-FFFF>,<0-FFFF>,<0-FFFF>,<0-FF...> OK
Remark	Parameter 1: 128-bit UUID function (0: 16-bit; 1: 128-bit, take effect after restart). Parameter 2: Device service UUID (the3rd and 4th byte). Parameter 3: Device receiving channel UUID (the 3rd and 4th byte in 128-bit mode). Parameter 4: Device transmitting channel UUID (the 3rd and 4th byte in 128-bit mode). Parameter 5: Device AT command channel UUID (the 3rd and 4th byte in 128-bit mode). Parameter 6: 128-bit basic UUID values (the 3rd and 4th bytes of the basic UUID are replaced with the UUID of the above parameters to constitute the actual 128-bit UUID of the device). Note: The base UUID of 0000xxxx-0000-1000-8000-00805F9B34FB cannot be used. This command is only effective in the slave mode.

AT+SERVICE?	
Function	Query the setting parameters of the current service.
Example	AT+SERVICE?
Return Value	AT+SERVICE=1,0001,0002,0003,0004,9ECADC240EE5A9E093F3A3B50000406E OK
Remark	

AT+SERVICE=	
Function	Set the related parameters of device service.
Example	AT+SERVICE=0, FFF0, FFFF1, FFF2, FFF3
Return Value	OK
Remark	The device is 16-bit UUID mode. UUID is FFF0, FFFF1, FFF2, FFF3 respectively. Take effect after restart, save after power off.

- **Master Scan**

AT+SCAN=?	
Function	Query parameter range of this command.
Example	AT+SCAN=?
Return Value	AT+SCAN=[0,1],<1-65535>,<0,1> OK
Remark	Parameter 1: Scan status of the current device. 0: Stop scanning. 1. Scanning. Parameter 2: Timeout time (in s). Parameter 3: Whether to enable the display name function, 1: displays the name, 0: does not display the name (the default is 1)

AT+SCAN?	
Function	Query the scan status and timeout time settings.
Example	AT+SCAN?
Return Value	AT+SCAN=0, 10, 1 OK
Remark	Parameter 1: 0: the current device scan status is stopped. Parameter 2: Indicates that the current scan timeout time is 10 s. Parameter 3: 1: Display device name

AT+SCAN	
Function	Scan the surrounding devices.
Example	AT+SCAN
Return Value	OK 0 53:60:52:A4:3E:66 -67 RF-STAR-SMMT 1 43:D5:CF:24:60:94 -58 RF-STAR-ABCD 2 21:DD:7C:E3:99:B5 -71 RFstar_99B5 3 5D:61:9B:78:2E:5E -83 RFstar_2E5E ……
Remark	Scan immediately (stop scanning after the number of devices reaches 20 or the scan time reaches 20 s), and print the MAC address, RSSI value, and device name of the slave device, where "0, 1, 2, 3..." is the serial number of the scanned devices (Scan for devices with name by default).

AT+SCAN=	
Function	Regularly scan surrounding slave devices.
Example	AT+SCAN=1, 10
Return Value	OK 0 53:60:52:A4:3E:66 -67 RF-STAR-SMMT 1 43:D5:CF:24:60:94 -58 RF-STAR-ABCD 2 21:DD:7C:E3:99:B5 -71 RFstar_99B5 3 5D:61:9B:78:2E:5E -83 RFstar_2E5E ……
Remark	Parameter 1: 1 means to start scanning Parameter 2: 10 means that the current scan timeout is 10 s. Note: Automatically stop scanning after the number of devices reaches 20 or the scan time reaches the set time 10 s.

- **Master Connection**

AT+CONNECT=	
Function	Connect to the specified device according to the serial number or MAC address returned by "AT+SCAN" command.
Example 1	AT+CONNECT=1
Return Value	OK 43:D5:CF:24:60:94 CONNECTED
Remark	Connect to the slave device with the serial number of 1 in the list returned by "AT+SCAN" command, effective once. To connect again, the command needs to be reused to scan and acquires the serial number, otherwise, an abnormal error will occur.
Example 2	AT+CONNECT=,F1:F2:F3:F4:F5:F6
Return Value	OK F1:F2:F3:F4:F5:F6 CONNECTED
Remark	Connect the device with the specified MAC address. Parameter 1 is omitted, only need to fill in the MAC address to be connected. The connected device may have timed out and failed to connect. The connection timeout period is 10 s, and the timeout prompt: "CONNECT F1:F2:F3:F4:F5:F6 TIMEOUT". **Note: When the command returns "FAIL", there are two possible reasons:** 1. The number of connected devices has reached 7. And one of the connected devices needs to be disconnected before connecting the new device again. 2. There are 7 devices in the list stored. The command “AT+DEV_DEL=?” can be used to query the stored devices, and then the command “AT+DEV_DEL=xx:xx:xx:xx:xx:xx” can delete the stored devices. After deleting, the new device can be connected again. When the current number of connections and device list stored both reach 7, the disconnection and deletion of the stored device need to be performed by steps 1 and 2, before the new device can be connected. Please do not try to connect to a broadcast device that is set as unconnectable.

- **Disconnect**

AT+DISCONNECT=?	
Function	Query parameter range of this command.
Example	AT+DISCONNECT=?
Return Value	AT+DISCONNECT=<0,1,2>,<0-x> OK
Remark	This command has two parameters: Parameter 1: 0: Disconnect slave devices. 1: Disconnect master devices. 2: Disconnect master-slave mode devices. Parameter 2: The handle value of the current connection can be queried by the command "AT+CNT_LIST". **Note: Parameter 2 must be used in the correct role (that is, parameter 1 must be the role of the current device).** For example: If the device is in master role with two slave devices connected, and "AT+DISCONNECT=1,1" means to disconnect the slave device with handle 1 from the master role.

AT+DISCONNECT	
Function	Disconnect all the current connected devices.
Example	AT+DISCONNECT
Return Value	OK F1:F2:F3:F4:F5:F6 DISCONNECTED
Remark	Take effect immediately, do not save after power off.

- **Automatically Reconnection**

AT+AUTO_CNT=?	
Function	Query parameter range of this command.
Example	AT+AUTO_CNT=?
Return Value	AT+AUTO_CNT=[0, 1],<FF:FF:FF:FF:FF:FF:FF> OK
Remark	Parameter 1: 0: Disable automatic reconnection **(Only take effect on the connected device)**. 1: Enable automatic reconnection **(Only take effect on the connected device. After setting, the automatic reconnection function is disabled for the new connected device by default)**. Parameter 2: Optional parameters. Device MAC address that has been added to the list of connected devices. If this parameter is set, the automatic reconnection function of the specified MAC address is enabled or disabled according to parameter 1, at the same time, the automatic reconnection function of other devices is not influenced by this command. Parameter 1 and parameter 2 affect each other. When only parameter 1 is set, the automatic reconnection function takes effect on all connected devices. When there are parameters 1 and 2, the automatic reconnection function takes effect on the specified MAC address device, and other devices maintain the original status. **Note: The device with automatic reconnection will not automatically connect to the slave device in the following cases:** 1. Use "AT+DISCONNECT" command to connect the disconnected slave device, the automatic reconnection function will not work at this time. The following conditions can restore the automatic reconnection function. a) Use the command again to connect the slave device. b) Restart the device c) Disable the BLE function of this device and then enable the BLE function (Use the command “AT+SLEEP=,0” to disable the BLE function, and then use the command “AT+SLEEP=,1” to enable the BLE function). 2. After using the command "AT+SLEEP=,0" to disable the BLE function, the device will not automatically reconnect. When BLE is enabled again, the device will automatically reconnect.

AT+AUTO_CNT?	
Function	Query the automatic reconnection status of the current device.
Example	AT+AUTO_CNT?

Return Value	AT+AUTO_CNT= 1,FF:1C:2B:D1:4C:BD 0,EB:71:5B:DE:08:87 OK
Remark	Device FF:1C:2B:D1:4C:BD enable the automatic reconnection function (Take effect after power off). Device EB:71:5B:DE:08:87 disable automatic reconnection function.

AT+AUTO_CNT=	
Function	Set automatic reconnection function.
Example	AT+AUTO_CNT=1
Return Value	OK
Remark	Take effect immediately, save after power off.

AT+AUTO_CNT=	
Function	Set automatic reconnection function for the device with specified MAC address.
Example	AT+AUTO_CNT=0, EB:71:5B:DE:08:87
Return Value	OK
Remark	Automatic reconnection function of the device with MAC address EB:71:5B:DE:08:87 is disabled. Take effect after restart, save after power off.

- **Designate Role Who Sends Data (Master-Slave at the Same Time)**

AT+TTM_ROLE=?	
Function	Query parameter range of this command.
Example	AT+TTM_ROLE=?
Return Value	AT+TTM_ROLE=[0,1] OK
Remark	0: Slave role transmits data. 1: Master role transmits data.

AT+TTM_ROLE?	
Function	Query which role transmits data.
Example	AT+TTM_ROLE?
Return Value	AT+TTM_ROLE=0 OK
Remark	The salve role transmits data.

AT+TTM_ROLE=	
Function	Set slave role or master role to transmit data in the master-slave mode.
Example	AT+TTM_ROLE=0
Return Value	OK
Remark	The device transmits data in slave mode. Take effect immediately, do not save after power off.

- **Display Current Connected Devices**

AT+CNT_LIST	
Function	Display currently connected devices.
Example	AT+CNT_LIST
Return Value	AT+CNT_LIST= 0 (FF:1C:2B:D1:4C:BD) 1 (EB:71:5B:DE:08:87) OK
Remark	The string in red is the connected handle, and the string in the bracket is the device MAC address corresponding to the handle.

	This command is used with AT+TTM_HANDLE. For example: AT+TTM_HANDLE=0 means that the master role transparently transmits the data value to the FF:1C:2B:D1:4C:BD device.

- **Designate Transmission Device**

AT+TTM_HANDLE=?	
Function	Query available handle value
Example	AT+TTM_HANDLE=?
Return Value	AT+TTM_HANDLE=[0,1] OK
Remark	There are 2 handle values available currently: 0 and 1. This handle value is allocated by the system. Note: There are at most 7 values, which means that the master role is connected to 8 slave devices at the same time, and each handle corresponds to a slave device.

AT+TTM_HANDLE?	
Function	Query current handle.
Example	AT+TTM_HANDLE?
Return Value	AT+TTM_HANDLE=1 OK

AT+TTM_HANDLE=	
Function	Designate the slave role for data transmission under multi-connection.
Example	AT+TTM_HANDLE=0
Return Value	OK
Remark	Set the slave device that the handle value is 0 to transmit data. Use with AT+CNT_LIST. Take effect immediately, do not save after power off.

- **Delete Device**

AT+DEV_DEL=?	
Function	Query the deletable device list which has been saved.
Example	AT+DEV_DEL=?
Return Value	AT+DEV_DEL= FF:1C:2B:D1:4C:BD EB:71:5B:DE:08:87 OK
Remark	The deletable device MAC address list.

AT+DEV_DEL=	
Function	Delete the saved devices.
Example	AT+DEV_DEL=FF:1C:2B:D1:4C:BD
Return Value	OK
Remark	Delete the device with MAC address FF:1C:2B:D1:4C:BD. Take effect immediately, save after power off. Note: Delete device operation will not actively disconnect the device. For example: FF:1C:2B:D1:4C:BD device is connected. After using this command, only the saved information is cleared, and the connection with the device will not be actively disconnected.

- **Observer**

AT+OBSERVER=	
Function	Turn on/off the observer function to scan and print the slave devices.
Example	AT+OBSERVER=1
Return Value	OK MAC: CE:BE:B6:B1:88:9A rssi: -82 adv pk: 0201061AFF4C000215FDA50693A4E24FB1AFCFC6EB0764782500010002D8 rsp pk: 0A0954656D70547261636B1016031819564D00010002CEBEB6B1889A
Remark	Turn on the observer function, and always scan and print the slave devices. Stop scanning by sending "AT+OBSERVER=0". Among them, "adv pk" is the broadcast packet data, and "rsp pk" is the response packet

- **Beacon**

AT+BEACON=?	
Function	Query parameter range of this command.
Example	AT+BEACON=?
Return Value	AT+BEACON=<0-FFFF>,<0-FFFF>,<0-FFFF>,<-90-4>,<0-FF...> OK
Remark	This command has five parameters: Parameter 1: Company ID. Parameter 2: Major UUID. Parameter 3: Minor UUID. Parameter 4: Reference RSSI at 1 m. Parameter 5: User-defined UUID. **Note: In this mode, the serial port is closed and unavailable.**

AT+BEACON?	
Function	Query the set parameters of Beacon.
Example	AT+BEACON?
Return Value	AT+BEACON=0059,0102,0304,-50,0102030405060708090A0B0C0D0E0F10 OK
Remark	

AT+BEACON=	
Function	Set Beacon parameters.
Example	AT+BEACON=F1F2,,,-60,
Return Value	OK
Remark	Set Beacon company ID: F1F2. Set reference RSSI: -60. Take effect after restart, save after power off.

- **Tx Power**

AT+POWER=?	
Function	Query parameter range of this command.
Example	AT+POWER=?
Return Value	AT+POWER=[-40,-20,-16,-12,-8,-4,0,3,4] OK
Remark	Tx power can be set as -40 dBm, -20 dBm, -16 dBm, -12 dBm, -8 dBm, -4 dBm, 0 dBm, 3 dBm, 4 dBm. 9 levels in total.

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

AT+POWER=	
Function	Set Tx power.
Example	AT+POWER=-12
Return Value	OK
Remark	Tx power is set as -12 dBm. Take effect after restart, save after power off.

- **Sleep Mode**

AT+SLEEP=?	
Function	Query parameter range of this command.
Example	AT+SLEEP=?
Return Value	AT+SLEEP=<0,1>,<0,1>,<0,1> OK
Remark	This command has three parameters: Parameter 1: Serial port function switch (0: disable. 1: enable). Parameter 2: BLE function switch (0: disable. 1: enable). Parameter 3: Serial port wake-up function switch (0: disable. 1: enable). Note: Use parameter 2 to disable the BLE function. If the device is connected, disconnect all connections with the device and disable the broadcast. If the device is in the broadcast status, disable the broadcast. When the device is in the master role (in the master and master-slave mode), and the currently connected devices enable the function of automatic reconnection, the device will not automatically reconnect after turning off BLE. When the BLE function is turned on again, the device will resume automatic reconnection. Disable the BLE function will not prohibit the use of the AT command of the corresponding role, but just let the module's Bluetooth enter the idle status and keep it, and any BLE-related operations are valid.

AT+SLEEP?	
Function	Query current sleep status of the device.
Example	AT+SLEEP?
Return Value	AT+SLEEP=1,1,1 OK
Remark	Parameter 1: Enable serial port function. Parameter 2: Enable BLE function. Parameter 3: Enable serial port wake-up function. When the parameter is set to 1, if the device is in sleep status, the serial port will be reopened no matter what data it receives, and print the "WAKE UP" string. (It is recommended to use data other than 0xFF, 0x00, and longer than 3 bytes to wake up the serial port)

AT+SLEEP=	
Function	Set the sleep status of the device.
Example	AT+SLEEP=0,0,0
Return Value	OK
Remark	Turn off the BLE function, if the device is connected, it will immediately disconnect the current connection. Take effect immediately, do not save after power off.

- **Baud Rate**

AT+UART=?	
Function	Query parameter range of this command.
Example	AT+UART=?
Return Value	AT+UART=[4800,9600,38400,57600,115200,230400,250000,460800] OK
Remark	The baud rate can be 4800, 9600, 38400, 57600, 115200, 230400, 250000, 460800. 8 levels in total.

AT+UART?	
Function	Query current baud rate of the device.
Example	AT+UART?
Return Value	AT+UART=115200 OK
Remark	The current baud rate is 115200 bps.

AT+UART=	
Function	Set the baud rate of the device.
Example	AT+UART=9600
Return Value	OK
Remark	Set the baud rate to 9600 bps. Take effect after restart, save after power off.

- **User Authentication**

AT+AUTH=?	
Function	Query parameter range of this command.
Example	AT+AUTH=?
Return Value	AT+AUTH=<0,1>,<******>,<1-65535> OK
Remark	This command has three parameters: Parameter 1: Disable/enable user authentication function. Parameter 2: Key, up to 16 bytes of any visible character except ‘,’ ‘?’ ‘”’ ‘=’. **This parameter cannot be empty when authentication is enabled.** Parameter 3: Valid time (in s) of authentication. Note: Take effect after restart. The slave has disconnected automatically after the master authentication key is not sent within the valid time. (Data transmission characteristic value sends the authentication key.)

AT+AUTH?	
Function	Query the current status of the authentication.
Example	AT+AUTH?
Return Value	AT+AUTH=1,12GH**__)),15 OK
Remark	Parameter 1: 1, enable user authentication function. Parameter 2: Key is 12GH**__)). Parameter 3: Valid time of user authentication is 15 s.

AT+AUTH=	
Function	Set user authentication.
Example	AT+AUTH=1,12GH**__)),10
Return Value	OK
Remark	Enable authentication. Set the key as “12GH**__)). The valid time of user authentication is 10 s. Take effect after restart, save after power off.

- **Restart Device**

AT+RESTART	
Function	Restart the device.
Example	AT+RESTART
Return Value	OK
Remark	Restart the device. Take effect immediately.

- **Reset Device**

AT+RESET	
Function	Reset device.
Example	AT+RESET
Return Value	OK
Remark	Restart the device. Take effect immediately.

- **Firmware Version**

AT+VERSION	
Function	Query device firmware version.
Example	AT+VERSION
Return Value	AT+VERSION=v1.0.0, Dec 13 2019,17:40:42 OK
Remark	Query the firmware version information and the date.

7 Transparent Transmission Test

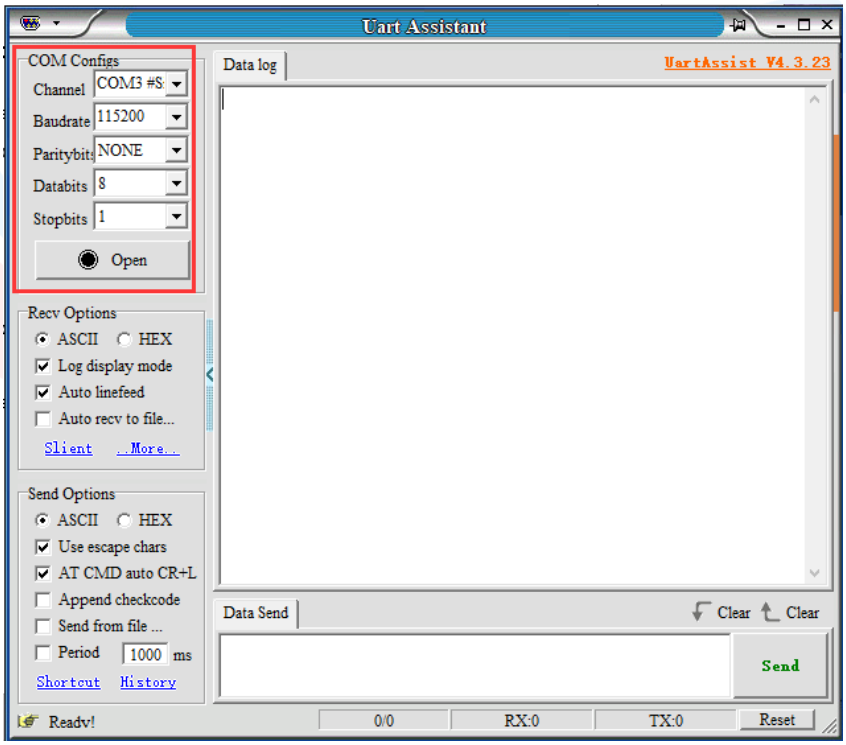
7.1 Test by APP (Android)

1. Turn on cellphone Bluetooth, and install APP “nRF Connect” (this APP can be found in the APP store): The usage method of iOS version APP is similar to Android.

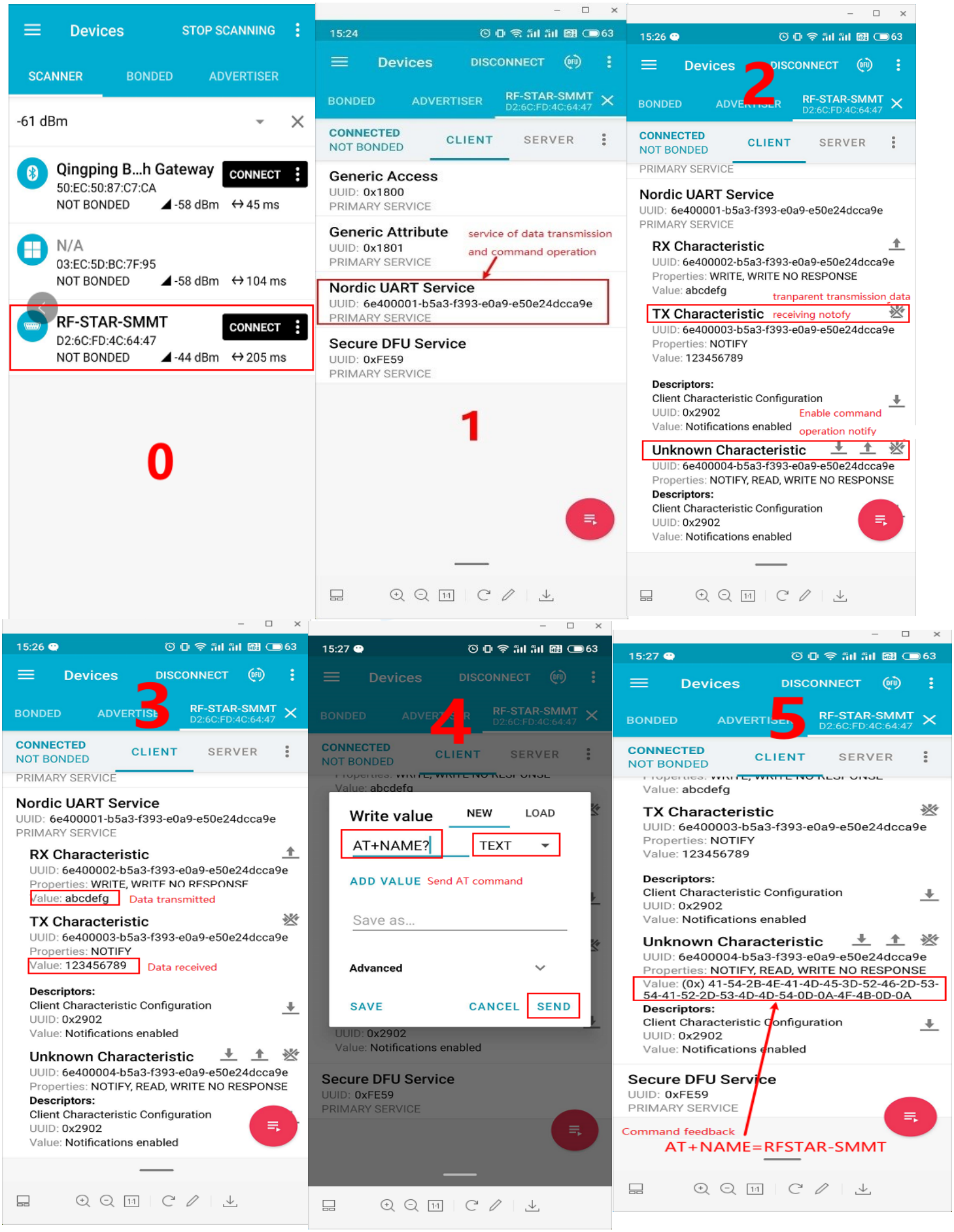
nRF Connect

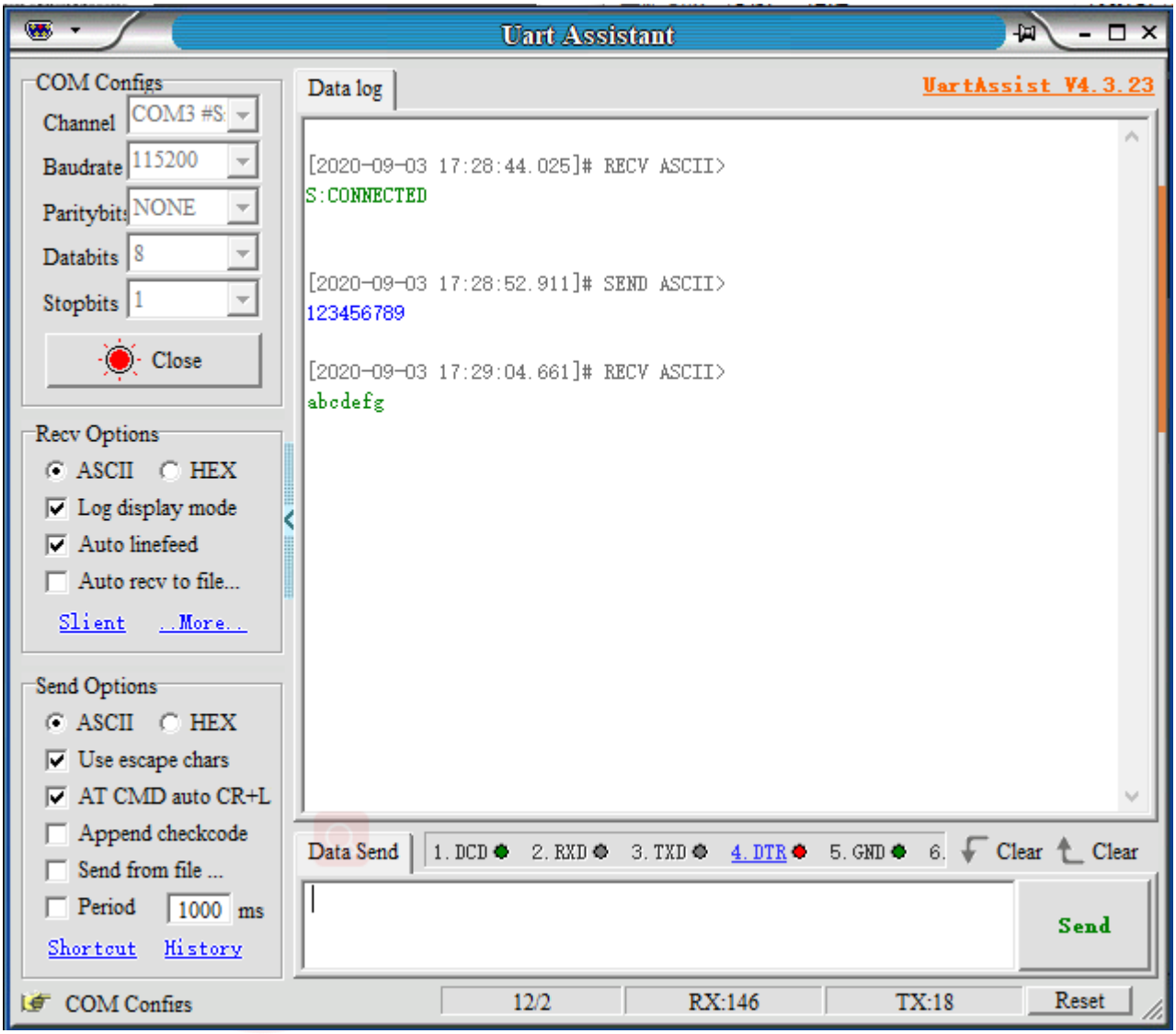
2. Connect the module to the COM port of the computer through the USB to serial port tool, and check the computer port number used (step: right-click the computer → management → device manager → port).

   Open the UartAssist tool, set the correct port number and baud rate, the initial baud rate of the module is 115200 (the default baud rate of the module is 115200, the data bit is 8, the parity bit is none, and the stop bit is 1).



Open the nRFConnect to search (mobile phone Bluetooth needs to be turned on), a list of nearby BLE devices that are broadcasting will appear. Click on one of the BLE devices to start the connection process (The default factory name of ND04C(I)/ND08C(I) is: RF-STAR-SMMT). After the connection is successful, the Service UUID of the module appears on the mobile phone APP side, and S:CONNECTED appears on the computer serial port debugging tool side. Find the data transmission and command operation Service in the APP, turn on the notify enable for receiving and AT command operation, and then the bi-directional data transparent transmission and AT command between the mobile phone and the PC (analog MCU) will be started. As shown in the following pictures:


0
Devices
STOP SCANNING
SCANNER
BONDED
ADVERTISER
-61 dBm
Qingping B...h Gateway
50:EC:50:87:C7:CA
NOT BONDED
-58 dBm
45 ms
CONNECT
N/A
03:EC:5D:BC:7F:95
NOT BONDED
-58 dBm
104 ms
RF-STAR-SMMT
D2:6C:FD:4C:64:47
NOT BONDED
-44 dBm
205 ms
CONNECT
1
15:24
Devices
DISCONNECT
BONDED
ADVERTISER
RF-STAR-SMMT
D2:6C:FD:4C:64:47
CONNECTED
NOT BONDED
CLIENT
SERVER
Generic Access
UUID: 0x1800
PRIMARY SERVICE
Generic Attribute
UUID: 0x1801
PRIMARY SERVICE
service of data transmission and command operation
Nordic UART Service
UUID: 6e400001-b5a3-f393-e0a9-e50e24dcca9e
PRIMARY SERVICE
Secure DFU Service
UUID: 0xFE59
PRIMARY SERVICE
2
15:26
Devices
DISCONNECT
BONDED
RF-STAR-SMMT
D2:6C:FD:4C:64:47
CONNECTED
NOT BONDED
CLIENT
SERVER
PRIMARY SERVICE
Nordic UART Service
UUID: 6e400001-b5a3-f393-e0a9-e50e24dcca9e
PRIMARY SERVICE
RX Characteristic
UUID: 6e400002-b5a3-f393-e0a9-e50e24dcca9e
Properties: WRITE, WRITE NO RESPONSE
Value: abcdefg
tranparent transmission data
TX Characteristic
receiving notofy
UUID: 6e400003-b5a3-f393-e0a9-e50e24dcca9e
Properties: NOTIFY
Value: 123456789
Descriptors:
Client Characteristic Configuration
UUID: 0x2902
Value: Notifications enabled
Enable command operation notify
Unknown Characteristic
UUID: 6e400004-b5a3-f393-e0a9-e50e24dcca9e
Properties: NOTIFY, READ, WRITE NO RESPONSE
Descriptors:
Client Characteristic Configuration
UUID: 0x2902
Value: Notifications enabled
3
15:26
Devices
DISCONNECT
BONDED
RF-STAR-SMMT
D2:6C:FD:4C:64:47
CONNECTED
NOT BONDED
CLIENT
SERVER
PRIMARY SERVICE
Nordic UART Service
UUID: 6e400001-b5a3-f393-e0a9-e50e24dcca9e
PRIMARY SERVICE
RX Characteristic
UUID: 6e400002-b5a3-f393-e0a9-e50e24dcca9e
Properties: WRITE, WRITE NO RESPONSE
Value: abcdefg
Data transmitted
TX Characteristic
UUID: 6e400003-b5a3-f393-e0a9-e50e24dcca9e
Properties: NOTIFY
Value: 123456789
Data received
Descriptors:
Client Characteristic Configuration
UUID: 0x2902
Value: Notifications enabled
Unknown Characteristic
UUID: 6e400004-b5a3-f393-e0a9-e50e24dcca9e
Properties: NOTIFY, READ, WRITE NO RESPONSE
Descriptors:
Client Characteristic Configuration
UUID: 0x2902
Value: Notifications enabled
4
15:27
Devices
DISCONNECT
CONNECTED
NOT BONDED
CLIENT
SERVER
Value: abcdefg
Write value
NEW
LOAD
AT+NAME?
TEXT
ADD VALUE
Send AT command
Save as...
Advanced
SAVE
CANCEL
SEND
UUID: 0x2902
Value: Notifications enabled
Secure DFU Service
UUID: 0xFE59
PRIMARY SERVICE
5
15:27
Devices
DISCONNECT
BONDED
RF-STAR-SMMT
D2:6C:FD:4C:64:47
CONNECTED
NOT BONDED
CLIENT
SERVER
Value: abcdefg
TX Characteristic
UUID: 6e400003-b5a3-f393-e0a9-e50e24dcca9e
Properties: NOTIFY
Value: 123456789
Descriptors:
Client Characteristic Configuration
UUID: 0x2902
Value: Notifications enabled
Unknown Characteristic
UUID: 6e400004-b5a3-f393-e0a9-e50e24dcca9e
Properties: NOTIFY, READ, WRITE NO RESPONSE
Value: (0x) 41-54-2B-4E-41-4D-45-3D-52-46-2D-53-54-41-52-2D-53-4D-4D-54-0D-0A-4F-4B-0D-0A
Descriptors:
Client Characteristic Configuration
UUID: 0x2902
Value: Notifications enabled
Secure DFU Service
UUID: 0xFE59
PRIMARY SERVICE
Command feedback
AT+NAME=RFSTAR-SMMT


Uart Assistant
COM Configs
Channel
COM3 #S
Baudrate
115200
Paritybits
NONE
Databits
8
Stopbits
1
Close
Recv Options
ASCII
HEX
Log display mode
Auto linefeed
Auto recv to file...
Slient
..More..
Send Options
ASCII
HEX
Use escape chars
AT CMD auto CR+L
Append checkcode
Send from file ...
Period
1000
ms
Shortcut
History
Data log
UartAssist V4.3.23
[2020-09-03 17:28:44.025]# RECV ASCII>
S:CONNECTED
[2020-09-03 17:28:52.911]# SEND ASCII>
123456789
[2020-09-03 17:29:04.661]# RECV ASCII>
abcdefg
Data Send
1. DCD
2. RXD
3. TXD
4. DTR
5. GND
6.
Clear
Clear
Send
COM Configs
12/2
RX:146
TX:18
Reset

7.2 Test by PC End

Preparation before Use

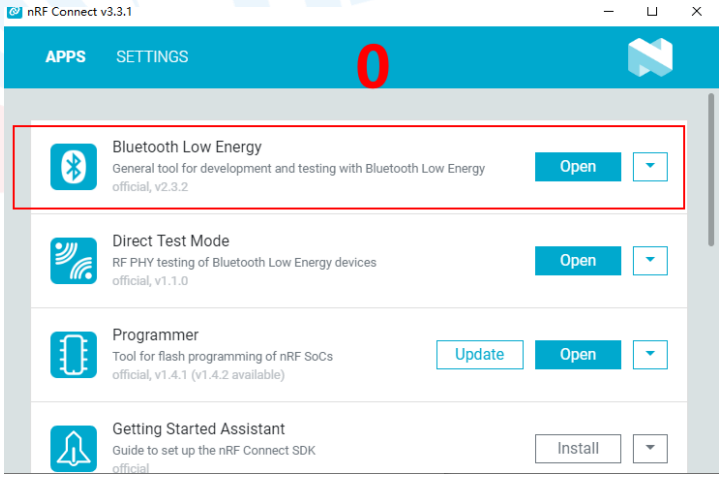
1. Hardware preparation
   - PC with standard Type-A USB interface
   - RF-DG-40A (nRF52840 dongle)
   - RF-BM-ND04C(I) / RF-BM-BD08C(I)
2. Software preparation
   - nRF Connect for Desktop

   Download address:

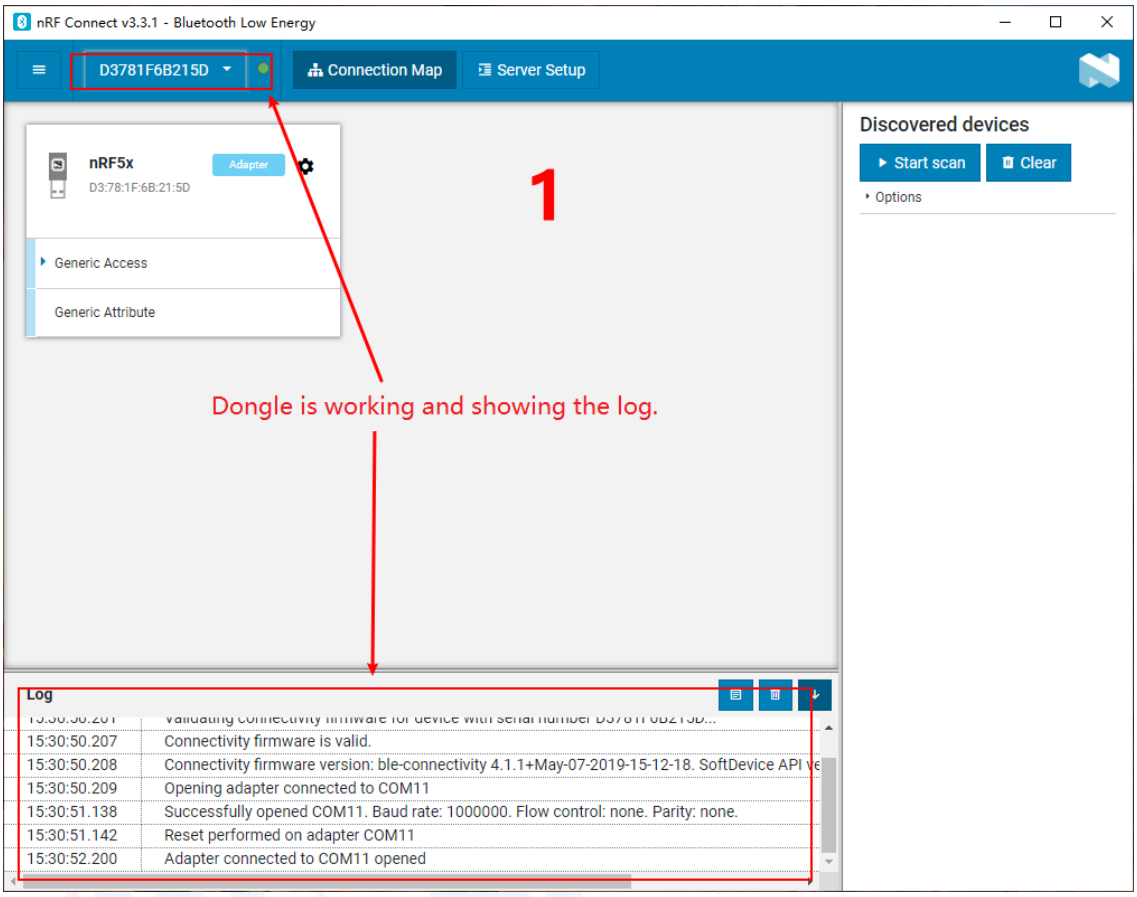
   https://www.nordicsemi.com/Software-and-tools/Development-Tools/nRF-Connect-for-desktop/Download#infotabs
   - Operation system: MacOS, Linux, or Windows 7 or later

Connection Steps

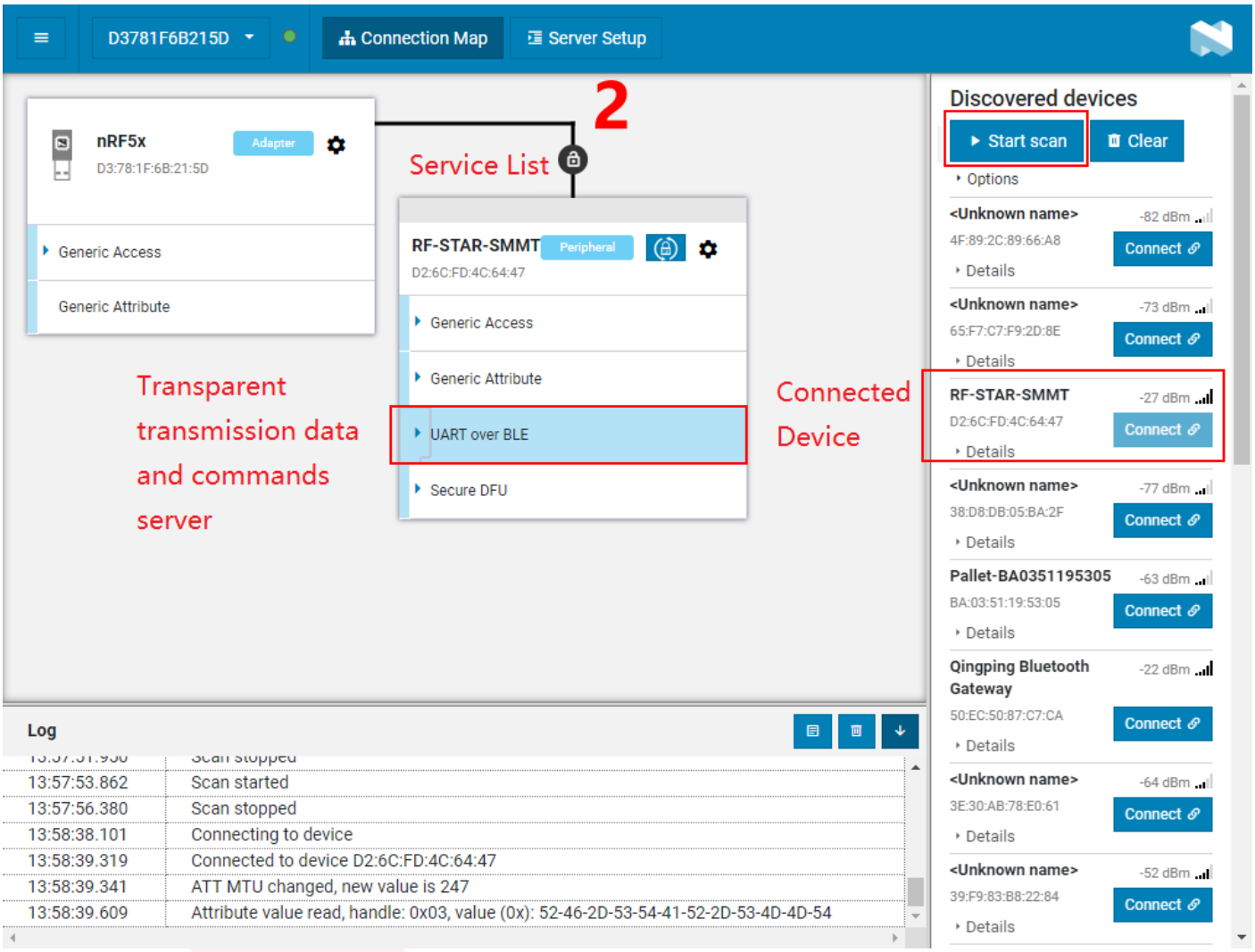
1. After the software is successfully installed, connect the RF-DG-40A to the PC via USB, open nRF Connect for Desktop, select Bluetooth Low Energy, if there is no Open option, you need to click Install first, as shown below.



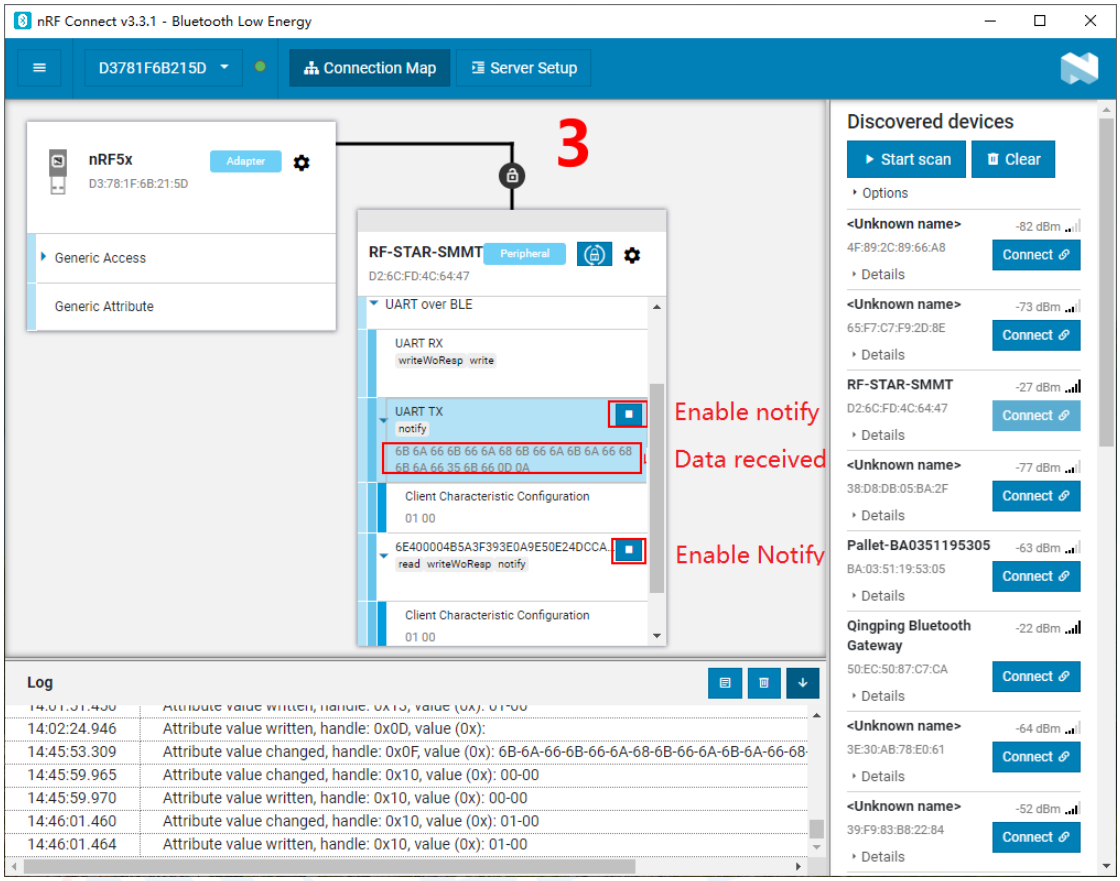
2. After installation, click the Open button and the operation interface will appear. At this time, you need to select the corresponding Dongle device for normal use. Click Select device to pop up the device name, and then click to select the corresponding device (this device name corresponds to the MAC address of the device)

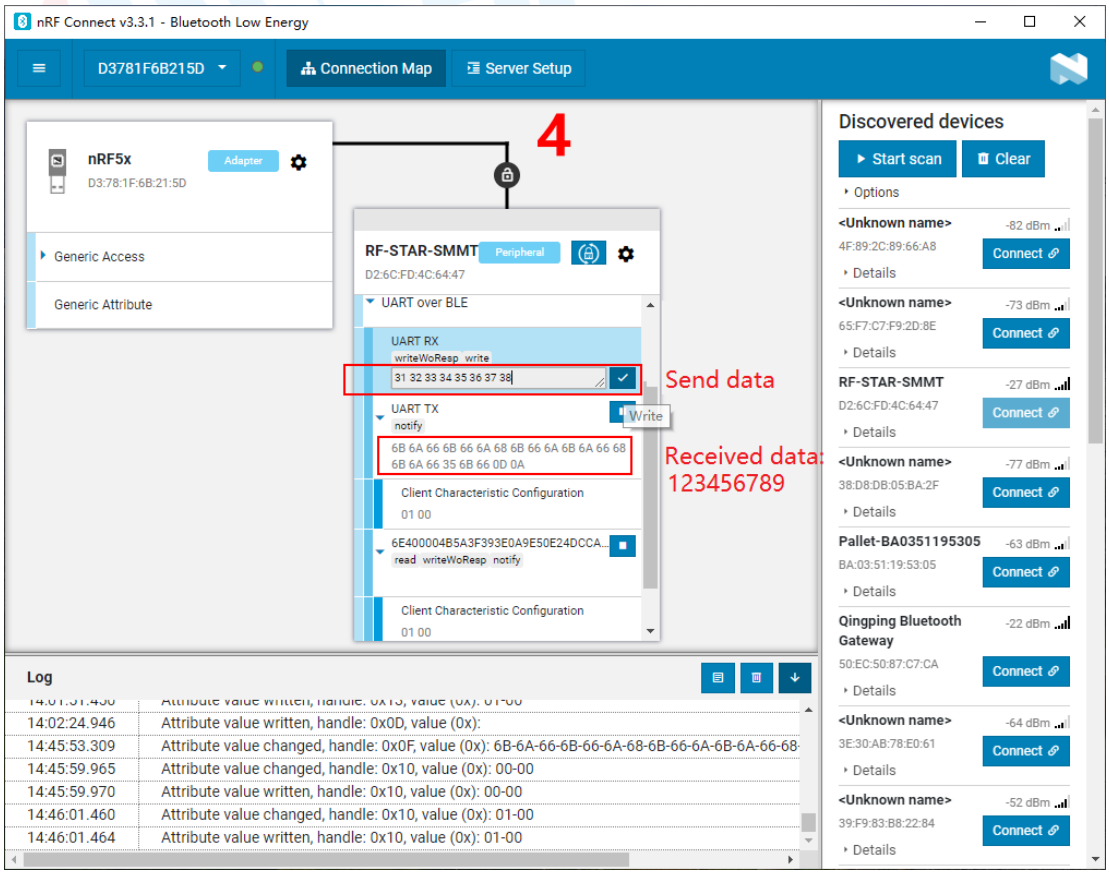


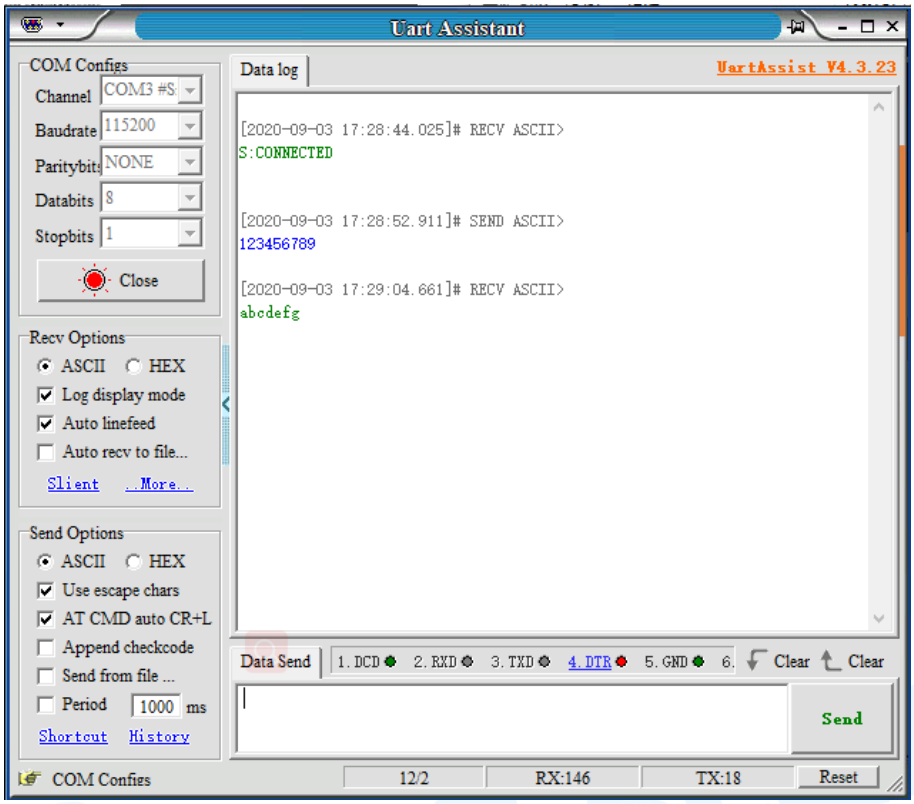
3. After the Dongle device is selected successfully, you can click Generic Access to view the related information of the device as the host. Then click the Start scan button to start scanning for broadcast devices, and then the scanned slave devices will be listed in the window on the right, after finding the corresponding slave device and clicking Connect (ND04C(I)/ND08C(I)) The default factory name is RF-STAR-SMMT, the following takes the RF-BM-ND04C module as the slave device as an example, referred to as ND04C), as shown in the figure below, Dongle has successfully connected the slave device ND04C:

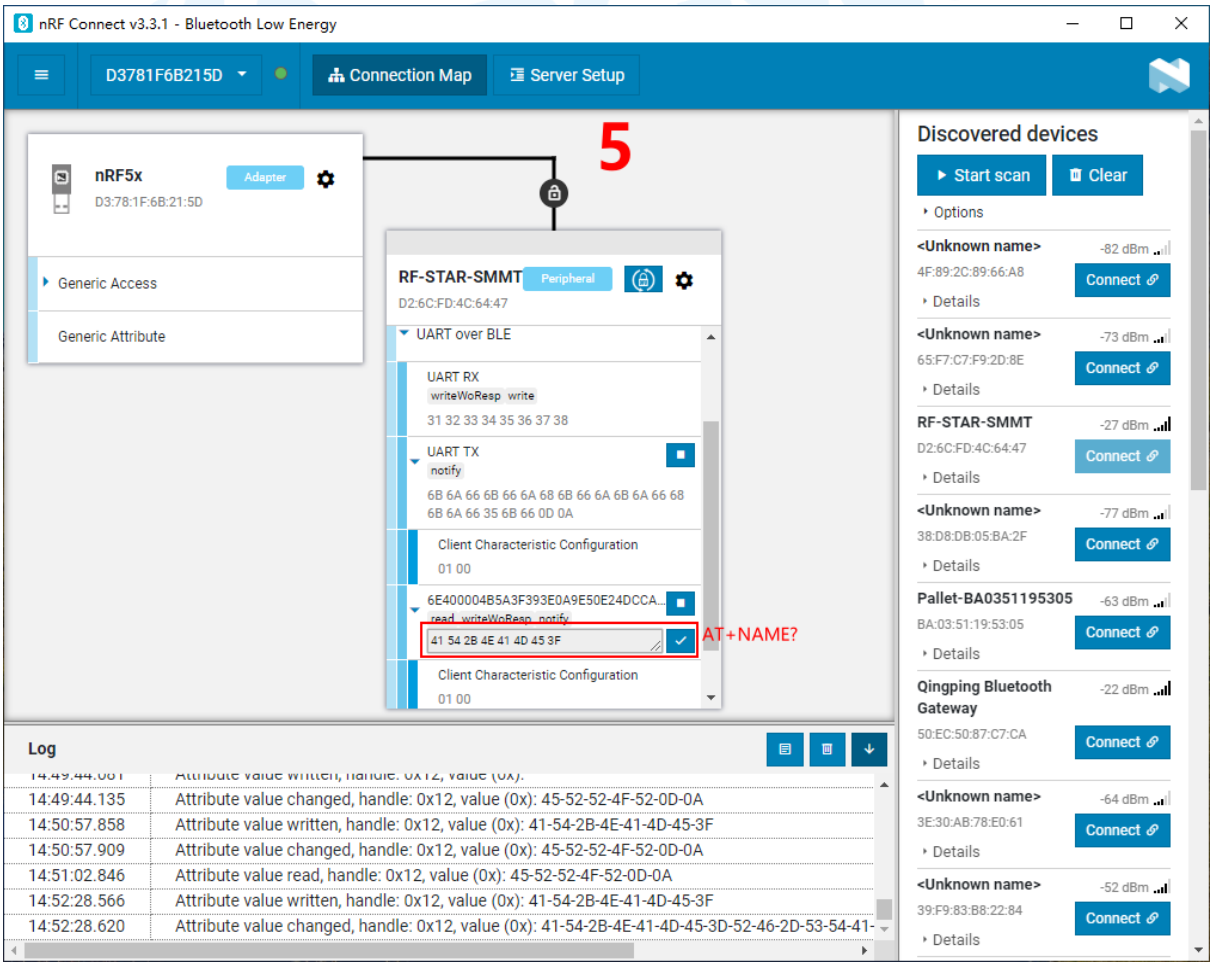


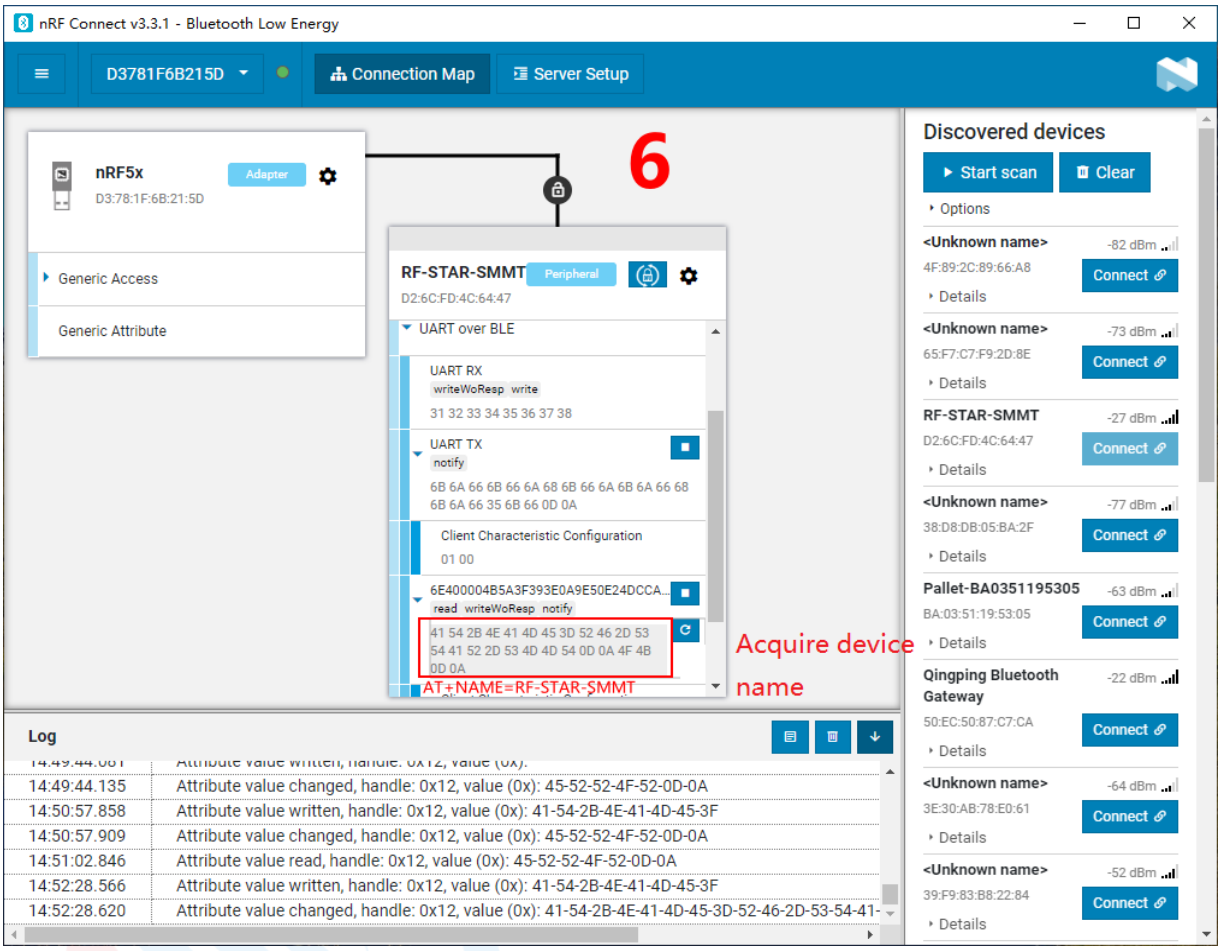
4. After the device is successfully connected, select to open the "UART over BLE" channel (as shown in the figure above), enable the Notify of the receiving channel, and then start the two-way data transparent transmission and AT between the module and the PC (with the help of Dongle as the master device) Ordered. As shown in the following pictures:


nRF Connect v3.3.1 - Bluetooth Low Energy
D3781F6B215D
Connection Map
Server Setup
nRF5x
Adapter
D3:78:1F:6B:21:5D
Generic Access
Generic Attribute
3
RF-STAR-SMMT
Peripheral
D2:6C:FD:4C:64:47
UART over BLE
UART RX
writeWoResp write
UART TX
notify
6B 6A 66 6B 66 6A 68 6B 66 6A 6B 6A 66 68 6B 6A 66 35 6B 66 0D 0A
Client Characteristic Configuration
01 00
6E400004B5A3F393E0A9E50E24DCCA...
read writeWoResp notify
Client Characteristic Configuration
01 00
Enable notify
Data received
Enable Notify
Discovered devices
Start scan
Clear
Options
<Unknown name> -82 dBm
4F:89:2C:89:66:A8
Connect
Details
<Unknown name> -73 dBm
65:F7:C7:F9:2D:8E
Connect
Details
RF-STAR-SMMT -27 dBm
D2:6C:FD:4C:64:47
Connect
Details
<Unknown name> -77 dBm
38:D8:DB:05:BA:2F
Connect
Details
Pallet-BA0351195305 -63 dBm
BA:03:51:19:53:05
Connect
Details
Qingping Bluetooth Gateway -22 dBm
50:EC:50:87:C7:CA
Connect
Details
<Unknown name> -64 dBm
3E:30:AB:78:E0:61
Connect
Details
<Unknown name> -52 dBm
39:F9:83:B8:22:84
Connect
Details
Log
14:02:24.946 Attribute value written, handle: 0x0D, value (0x):
14:45:53.309 Attribute value changed, handle: 0x0F, value (0x): 6B-6A-66-6B-66-6A-68-6B-66-6A-6B-6A-66-68
14:45:59.965 Attribute value changed, handle: 0x10, value (0x): 00-00
14:45:59.970 Attribute value written, handle: 0x10, value (0x): 00-00
14:46:01.460 Attribute value changed, handle: 0x10, value (0x): 01-00
14:46:01.464 Attribute value written, handle: 0x10, value (0x): 01-00


nRF Connect v3.3.1 - Bluetooth Low Energy
D3781F6B215D
Connection Map
Server Setup
nRF5x
Adapter
D3:78:1F:6B:21:5D
Generic Access
Generic Attribute
4
RF-STAR-SMMT
Peripheral
D2:6C:FD:4C:64:47
UART over BLE
UART RX
writeWoResp write
31 32 33 34 35 36 37 38
UART TX
notify
Write
6B 6A 66 6B 66 6A 68 6B 66 6A 6B 6A 66 68 6B 6A 66 35 6B 66 0D 0A
Client Characteristic Configuration
01 00
6E400004B5A3F393E0A9E50E24DCCA...
read writeWoResp notify
Client Characteristic Configuration
01 00
Send data
Received data:
123456789
Discovered devices
Start scan
Clear
Options
<Unknown name> -82 dBm
4F:89:2C:89:66:A8
Connect
Details
<Unknown name> -73 dBm
65:F7:C7:F9:2D:8E
Connect
Details
RF-STAR-SMMT -27 dBm
D2:6C:FD:4C:64:47
Connect
Details
<Unknown name> -77 dBm
38:D8:DB:05:BA:2F
Connect
Details
Pallet-BA0351195305 -63 dBm
BA:03:51:19:53:05
Connect
Details
Qingping Bluetooth Gateway -22 dBm
50:EC:50:87:C7:CA
Connect
Details
<Unknown name> -64 dBm
3E:30:AB:78:E0:61
Connect
Details
<Unknown name> -52 dBm
39:F9:83:B8:22:84
Connect
Details
Log
14:02:24.946 Attribute value written, handle: 0x0D, value (0x):
14:45:53.309 Attribute value changed, handle: 0x0F, value (0x): 6B-6A-66-6B-66-6A-68-6B-66-6A-6B-6A-66-68
14:45:59.965 Attribute value changed, handle: 0x10, value (0x): 00-00
14:45:59.970 Attribute value written, handle: 0x10, value (0x): 00-00
14:46:01.460 Attribute value changed, handle: 0x10, value (0x): 01-00
14:46:01.464 Attribute value written, handle: 0x10, value (0x): 01-00


Uart Assistant
COM Configs
Channel COM3 #S
Baudrate 115200
Paritybits NONE
Databits 8
Stopbits 1
Close
Recv Options
ASCII HEX
Log display mode
Auto linefeed
Auto recv to file...
Slient ..More..
Send Options
ASCII HEX
Use escape chars
AT CMD auto CR+L
Append checkcode
Send from file ...
Period 1000 ms
Shortcut History
Data log
UartAssist V4.3.23
[2020-09-03 17:28:44.025]# RECV ASCII>
S:CONNECTED
[2020-09-03 17:28:52.911]# SEND ASCII>
123456789
[2020-09-03 17:29:04.661]# RECV ASCII>
abcdefg
Data Send
1. DCD 2. RXD 3. TXD 4. DTR 5. GND 6.
Clear Clear
Send
COM Configs
12/2
RX:146
TX:18
Reset


nRF Connect v3.3.1 - Bluetooth Low Energy
D3781F6B215D
Connection Map
Server Setup
nRF5x
Adapter
D3:78:1F:6B:21:5D
Generic Access
Generic Attribute
5
RF-STAR-SMMT
Peripheral
D2:6C:FD:4C:64:47
UART over BLE
UART RX
writeWoResp write
31 32 33 34 35 36 37 38
UART TX
notify
6B 6A 66 6B 66 6A 68 6B 66 6A 6B 6A 66 68
6B 6A 66 35 6B 66 0D 0A
Client Characteristic Configuration
01 00
41 54 2B 4E 41 4D 45 3F
AT+NAME?
Discovered devices
Start scan
Clear
Options
<Unknown name> -82 dBm
4F:89:2C:89:66:A8
Connect
Details
<Unknown name> -73 dBm
65:F7:C7:F9:2D:8E
RF-STAR-SMMT -27 dBm
D2:6C:FD:4C:64:47
<Unknown name> -77 dBm
38:D8:DB:05:BA:2F
Pallet-BA0351195305 -63 dBm
BA:03:51:19:53:05
Qingping Bluetooth Gateway -22 dBm
50:EC:50:87:C7:CA
<Unknown name> -64 dBm
3E:30:AB:78:E0:61
<Unknown name> -52 dBm
39:F9:83:B8:22:84
Log
14:49:44.135 Attribute value changed, handle: 0x12, value (0x): 45-52-52-4F-52-0D-0A
14:50:57.858 Attribute value written, handle: 0x12, value (0x): 41-54-2B-4E-41-4D-45-3F
14:50:57.909 Attribute value changed, handle: 0x12, value (0x): 45-52-52-4F-52-0D-0A
14:51:02.846 Attribute value read, handle: 0x12, value (0x): 45-52-52-4F-52-0D-0A
14:52:28.566 Attribute value written, handle: 0x12, value (0x): 41-54-2B-4E-41-4D-45-3F
14:52:28.620 Attribute value changed, handle: 0x12, value (0x): 41-54-2B-4E-41-4D-45-3D-52-46-2D-53-54-41-


nRF Connect v3.3.1 - Bluetooth Low Energy
D3781F6B215D
Connection Map
Server Setup
nRF5x
Adapter
D3:78:1F:6B:21:5D
Generic Access
Generic Attribute
6
RF-STAR-SMMT
Peripheral
D2:6C:FD:4C:64:47
UART over BLE
UART RX
writeWoResp write
31 32 33 34 35 36 37 38
UART TX
notify
6B 6A 66 6B 66 6A 6B 6B 66 6A 6B 6A 66 68
6B 6A 66 35 6B 66 0D 0A
Client Characteristic Configuration
01 00
6E400004B5A3F393E0A9E50E24DCCA...
read writeWoResp notify
41 54 2B 4E 41 4D 45 3D 52 46 2D 53
54 41 52 2D 53 4D 4D 54 0D 0A 4F 4B
0D 0A
AT+NAME=RF-STAR-SMMT
Acquire device name
Discovered devices
Start scan
Clear
Options
<Unknown name> -82 dBm
4F:89:2C:89:66:A8
Connect
Details
<Unknown name> -73 dBm
65:F7:C7:F9:2D:8E
Connect
Details
RF-STAR-SMMT -27 dBm
D2:6C:FD:4C:64:47
Connect
Details
<Unknown name> -77 dBm
38:D8:DB:05:BA:2F
Connect
Details
Pallet-BA0351195305 -63 dBm
BA:03:51:19:53:05
Connect
Details
Qingping Bluetooth Gateway -22 dBm
50:EC:50:87:C7:CA
Connect
Details
<Unknown name> -64 dBm
3E:30:AB:78:E0:61
Connect
Details
<Unknown name> -52 dBm
39:F9:83:B8:22:84
Connect
Details
Log
14:49:44.135 Attribute value changed, handle: 0x12, value (0x): 45-52-52-4F-52-0D-0A
14:50:57.858 Attribute value written, handle: 0x12, value (0x): 41-54-2B-4E-41-4D-45-3F
14:50:57.909 Attribute value changed, handle: 0x12, value (0x): 45-52-52-4F-52-0D-0A
14:51:02.846 Attribute value read, handle: 0x12, value (0x): 45-52-52-4F-52-0D-0A
14:52:28.566 Attribute value written, handle: 0x12, value (0x): 41-54-2B-4E-41-4D-45-3F
14:52:28.620 Attribute value changed, handle: 0x12, value (0x): 41-54-2B-4E-41-4D-45-3D-52-46-2D-53-54-41-

8 iOS APP Programming Reference

The module is always broadcast as a slave, waiting for the mobile phone to scan and connect as a master. The scanning and connection are usually completed by APP. Due to the particularity of the BLE protocol, there is no need to scan and connect Bluetooth LE devices in the system settings of the Smartphone. Smart devices are responsible for BLE connection, communication, disconnection, etc. And usually, it is implemented by the APP.

Regarding BLE programming in iOS, the key point is the read, write and enable notify switch to **Characteristic (or called a channel)**. To read and write in the channel can realize the direct control on the direct-drive mode functions of the module and no extra MCU is needed. Typical functions that are involved are as follows:

```
/*!
* @method writeValue:forCharacteristic:withResponse:
* @param data The value to write.
* @param characteristic The characteristic on which to perform the write operation.
* @param type The type of write to be executed.
* @discussion Write the value of a characteristic.
* The passed data is copied and can be disposed of after the call finishes.
* The relevant delegate callback will then be invoked with the status of the request.
* @see peripheral:didWriteValueForCharacteristic:error:
*/
- (void)writeValue:(NSData *)data forCharacteristic:(CBCharacteristic *)characteristic type:(CBCharacteristicWriteType)type;
```

Note: to write to a characteristic.

```
NSData *d = [[NSData alloc] initWithBytes:&data length:mdata.length];
[p writeValue:d
forCharacteristic:c
type:CBCharacteristicWriteWithoutResponse];
```

```
/*!
* @method readValueForCharacteristic:
* @param characteristic The characteristic for which the value needs to be read.
* @discussion Fetch the value of a characteristic.
* The relevant delegate callback will then be invoked with the status of the request.
* @see peripheral:didUpdateValueForCharacteristic:error:
```

```
*/
- (void)readValueForCharacteristic:(CBCharacteristic *)characteristic;
```

Note: to read a characteristic

[p readValueForCharacteristic:c];

```
/*!
* @method setNotifyValue:forCharacteristic:
* @param notifyValue The value to set the client configuration descriptor.
* @param characteristic The characteristic containing the client configuration.
* @discussion Ask to start/stop receiving notifications for a characteristic.
* The relevant delegate callback will then be invoked with the status of the request.
* @see peripheral:didUpdateNotificationStateForCharacteristic:error:
*/
- (void)setNotifyValue:(BOOL)notifyValue forCharacteristic:(CBCharacteristic *)characteristic;
```

Note: to open a characteristic notify enable switch.

[self setNotifyValue:YES forCharacteristic:c];//open notify enable switch.

[self setNotifyValue:NO forCharacteristic:c]; //close notify enable switch.

```
/*
* @method didUpdateValueForCharacteristic
* @param peripheral Pheripheral that got updated
* @param characteristic Characteristic that got updated
* @error error Error message if something went wrong
* @discussion didUpdateValueForCharacteristic is called when CoreBluetooth has updated a
* characteristic for a peripheral. All reads and notifications come here to be processed.
*
*/
-(void)peripheral:(CBPeripheral*)peripheral didUpdateValueForCharacteristic:(CBCharacteristic *)characteristic error:(NSError *)error
```

Note: after each reading operation, this callback function will be performed. The application layer saves the data that is read in this function.

About the details of scanning, connecting, and other communication operations, please refer to the test APP source code (BLE Transmit Module v1.29) for transparent transmission in iOS, in which it realizes, for FFE9 and FFE4, the operations of data transmit from BLE to serial port and from the serial port to BLE characteristics (notify and write). Other

controls on direct-drive functions are similar, all by reading or writing to a certain characteristic. The only difference is the characteristic UUID and the Bytes of reading and writing operations.

9. MCU Reference Code (Transparent Transmission)

The serial port between the module and the MCU uses hardware flow control two IO ports (CTS and RTS) to send and receive notifications and control.

These two IOs are always at a high level and will be triggered when pull low.

When the module can receive data, the module will pull the RTS signal low (CTS for the MCU) to notify the MCU that it can send data.

When MCU can receive data, MCU should pull RTS signal low (CTS for the module) to inform the module that it can send data.

The demo code is as follows (for reference only):

```
void main(void)
{
    //Wait for the BLE module to start successfully
    while(!memcmp(rx_ble_mode_data(),"DEVICE_START\r\n",strlen("DEVICE_START\r\n")));

    //Enable RTS, that is, MCU can receive date from BLE module
    set_rts_enable();

    While(1){
        //Aquire whether the CTS status is in low level
        If(get_cts_state()==0){

            // Send test data to BLE module
            mcu_send_to_ble_string("Test data.\r\n");
        }

        // Processing the data obtained by MCU
        mcu_data_process(mcu_uart_read_data());
    }
}
```

10 Application, Implementation and Layout

10.1 Module Parameters

Working voltage: 1.7 V ~ 3.6 V, recommended to 3.3 V

Working frequency band: 2402 MHz ~ 2480 MHz

Maximum TX power: 4 dBm (-20 dBm ~ +4 dBm, programmable)

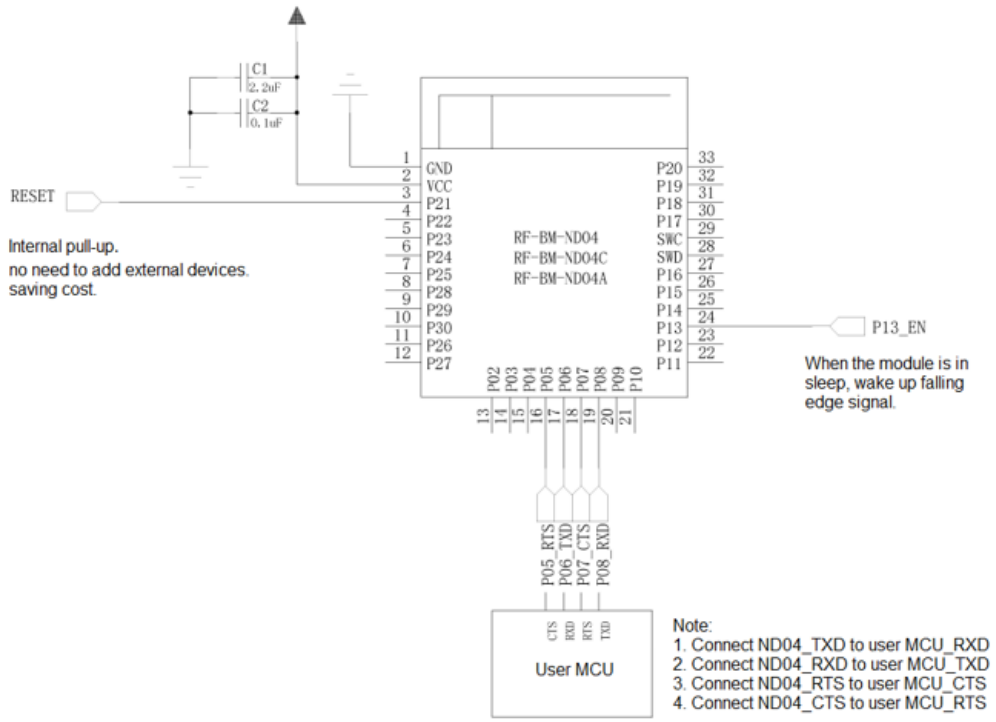
Receiving sensitivity: -96 dBm

Frequency error: ±20 kHz

Working temperature: -40℃ ~ +85℃

Storage temperature: -40℃ ~ +125℃

10.2 Reference Design



If the MCU has no hardware flow control, the following design can be referred to:

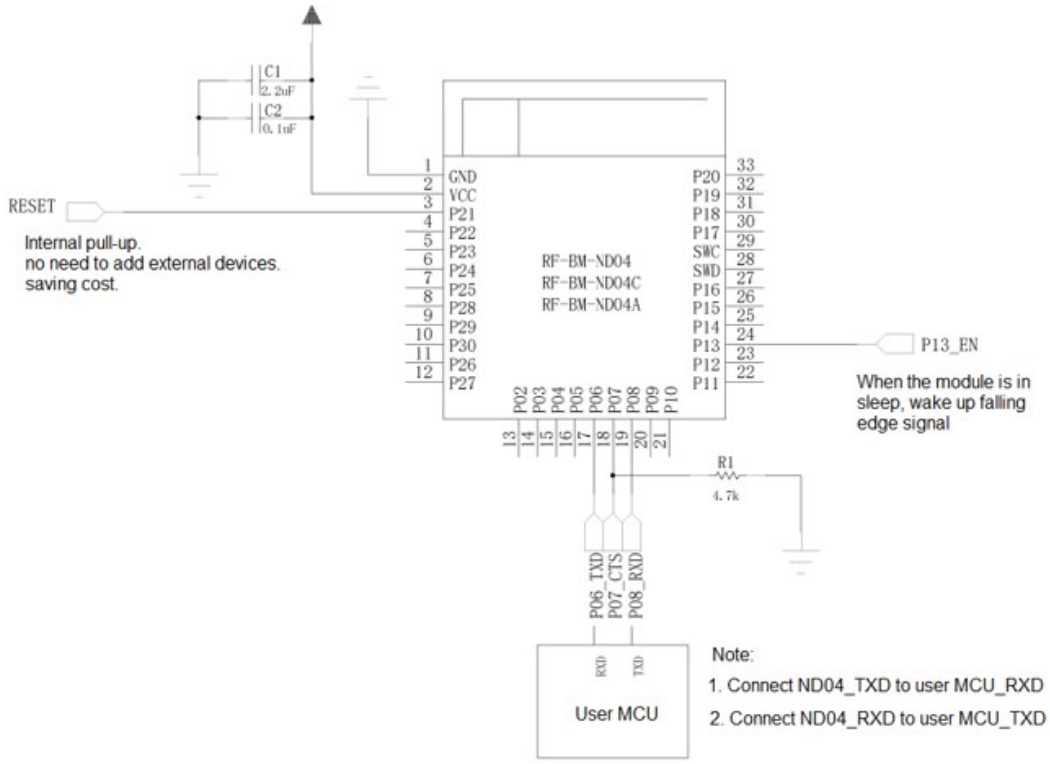


Figure 8. Reference Design

10.3 Antenna

10.3.1 Antenna Design Recommendation

1. The antenna installation structure has a great influence on the module performance. It is necessary to ensure the antenna is exposed and preferably vertically upward. When the module is installed inside of the case, a high-quality antenna extension wire can be used to extend the antenna to the outside of the case.
2. The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.
3. The recommendation of antenna layout.

   The inverted-F antenna position on PCB is free-space electromagnetic radiation. The location and layout of the antenna is a key factor to increase the data rate and transmission range.

   Therefore, the layout of the module antenna location and routing is recommended as follows:

   （1） Place the antenna on the edge (corner) of the PCB.

   （2） Make sure that there is no signal line or copper foil in each layer below the antenna.

   （3） It is best to hollow out the antenna position in the following figure to ensure that the S11 of the module is minimally affected.

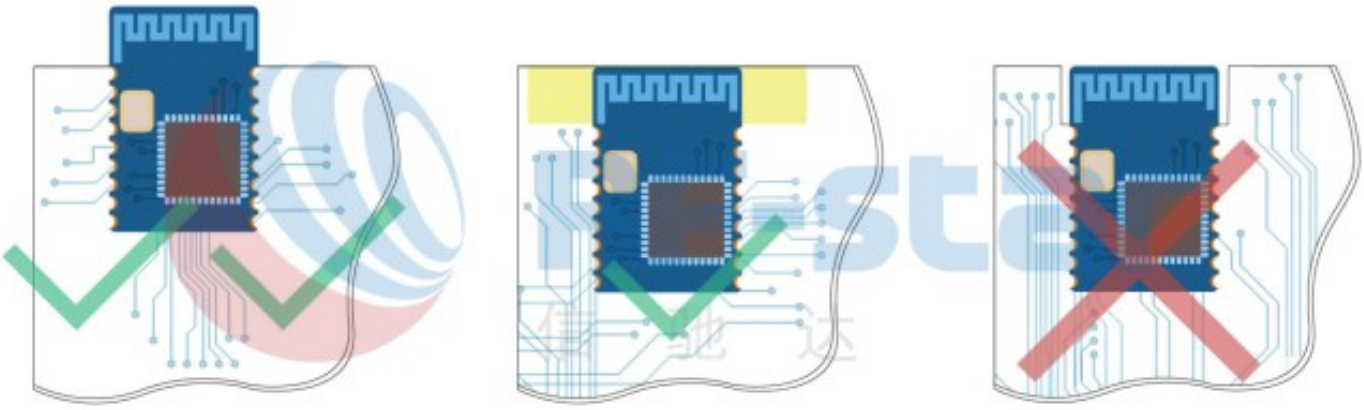


Figure 9. Recommendation of Antenna Layout

Note: The hollow-out position is based on the antenna used.

10.3.2 IPEX Connector

RF-BM-ND04I module is integrated the IPEX version 1 antenna seat, the specification of the antenna seat is as follow:

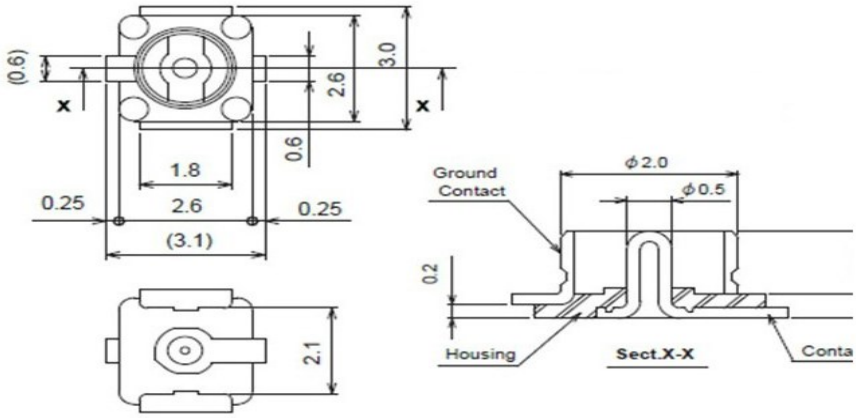


Figure 10. Specification of Antenna Seat

The specification of the IPEX wire end is as follow:

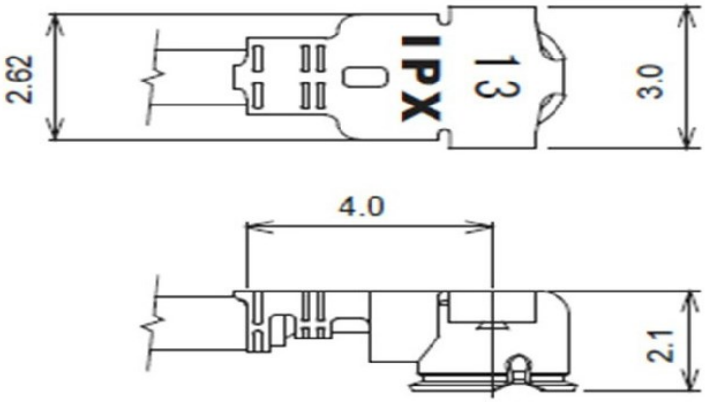


Figure 11. Specification of IPEX Wire

10.3.3 Antenna Output Mode Modification

RF-BM-ND04I has two antenna output modes: IPEX connector output and stamp half-hole antenna output (ANT pin, see pin function table for details).

The default delivery is IPEX connector mode. Under IPEX connector mode, C1 is off and C2 is welded. If you would like to change to half-hole antenna output mode, please disconnect C2 and weld C2. The locations of C1 and C2 (8 pF) are shown in the figure below.

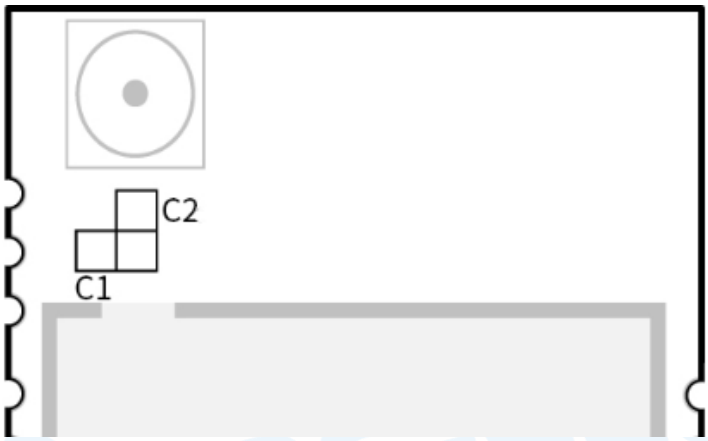


Figure 12. Antenna Output Mode Change of RF-BM-ND04I

RF-BM-ND08(I) has two antenna output modes, which are onboard PCB antenna and stamp half-hole output (ANT pin, see pin function table for details).

The default delivery is the onboard PCB antenna, L1 position (1NH) is welded. If you want to change to a half-hole antenna output, disconnect the L1 position capacitor. The location of L1 is shown in the figure below.

Figure 13. Antenna Output Mode Change of RF-ND08(I)

10.4 Basic Operation of Hardware Design

1. It is recommended to offer the module with a DC stabilized power supply, a tiny power supply ripple coefficient, and reliable ground. Please pay attention to the correct connection between the positive and negative poles of the power supply. Otherwise, the reverse connection may cause permanent damage to the module;
2. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged

if the voltage exceeds the maximum value. Please ensure a stable power supply and no frequently fluctuated voltage.

3. When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the margin, which is beneficial to the long-term stable operation of the whole machine. The module should be far away from the power electromagnetic, transformer, high-frequency wiring, and other parts with large electromagnetic interference.
4. The bottom of the module should avoid high-frequency digital routing, high-frequency analog routing, and power routing. If it has to route the wire on the bottom of the module, for example, it is assumed that the module is soldered to the Top Layer, the copper must be spread on the connection part of the top layer and the module, and be close to the digital part of the module and routed in the Bottom Layer (all copper is well-grounded).
5. Assuming that the module is soldered or placed in the Top Layer, it is also wrong to randomly route the Bottom Layer or other layers, which will affect the spurs and receiving sensitivity of the module to some degrees;
6. Assuming that there are devices with large electromagnetic interference around the module, which will greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
7. Assuming that there are routings of large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power routings), which will also greatly affect the module performance. It is recommended to stay away from the module according to the strength of the interference. If circumstances permit, appropriate isolation and shielding can be done.
8. It is recommended to stay away from the devices whose TTL protocol is the same 2.4 GHz physical layer, for example, USB 3.0.

10.5 Trouble Shooting

10.5.1 Unsatisfactory Transmission Distance

1. When there is a linear communication obstacle, the communication distance will be correspondingly weakened. Temperature, humidity, and co-channel interference will lead to an increase in communication packet loss rate. The performances of ground absorption and reflection of radio waves will be poor when the module is tested close to the ground.
2. Seawater has a strong ability to absorb radio waves, so the test results by the seaside are poor.
3. The signal attenuation will be very obvious if there is a metal near the antenna or the module is placed inside the metal shell.
4. The incorrect power register set or the high data rate in an open-air may shorten the communication distance. The higher the data rate, the closer the distance.
5. The low voltage of the power supply is lower than the recommended value at ambient temperature, and the lower the voltage, the smaller the power is.
6. The unmatchable antennas and modules or the poor quality of the antenna will affect the communication distance.

10.5.2 Vulnerable Module

1. Please ensure the supply voltage is between the recommended values. The module will be permanently damaged if the voltage exceeds the maximum value. Please ensure a stable power supply and no frequently fluctuated voltage.
2. Please ensure the anti-static installation and the electrostatic sensitivity of high-frequency devices.
3. Due to some humidity-sensitive components, please ensure suitable humidity during installation and application. If there is no special demand, it is not recommended to use at too high or too low temperature.

10.5.3 High Bit Error Rate

1. There are co-channel signal interferences nearby. It is recommended to be away from the interference sources or modify the frequency and channel to avoid interferences.
2. The unsatisfactory power supply may also cause garbled. It is necessary to ensure the power supply's reliability.
3. If the extension wire or feeder wire is of poor quality or too long, the bit error rate will be high.

10.6 Electrostatics Discharge Warnings

The module will be damaged for the discharge of static. RF-star suggests that all modules should follow the 3 precautions below:

1. According to the anti-static measures, bare hands are not allowed to touch modules.
2. Modules must be placed in anti-static areas.
3. Take the anti-static circuitry (when inputting HV or VHF) into consideration in product design.
   Static may result in the degradation in performance of the module, even causing the failure.

10.7 Soldering and Reflow Condition

1. Heating method: Conventional Convection or IR/convection.
2. Solder paste composition: Sn96.5 / Ag3.0 / Cu0.5
3. Allowable reflow soldering times: 2 times based on the following reflow soldering profile.
4. Temperature profile: Reflow soldering shall be done according to the following temperature profile.
5. Peak temperature: 245 ℃.

Table 6. Temperature Table of Soldering and Reflow

Profile Feature	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Sn63 / Pb37	Sn96.5 / Ag3.0 / Cu0.5
Min. Preheating Temperature (T_{min})	100 ℃	150 ℃
Max. Preheating Temperature (T_{max})	150 ℃	200 ℃
Preheating Time (T_{min} to T_{max}) (t_1)	60 s ~ 120 s	60 s ~ 120 s

Average Ascend Rate (T_{max} to T_p)	Max. 3 ℃/s	Max. 3 ℃/s
Liquid Temperature (T_L)	183 ℃	217 ℃
Time above Liquidus (t_L)	60 s ~ 90 s	30 s ~ 90 s
Peak Temperature (T_p)	220 ℃ ~ 235 ℃	230 ℃ ~ 250 ℃
Average Descend Rate (T_p to T_{max})	Max. 6 ℃/s	Max. 6 ℃/s
Time from 25 ℃ to Peak Temperature (t_2)	Max. 6 minutes	Max. 8 minutes
Time of Soldering Zone (t_P)	20±10 s	20±10 s

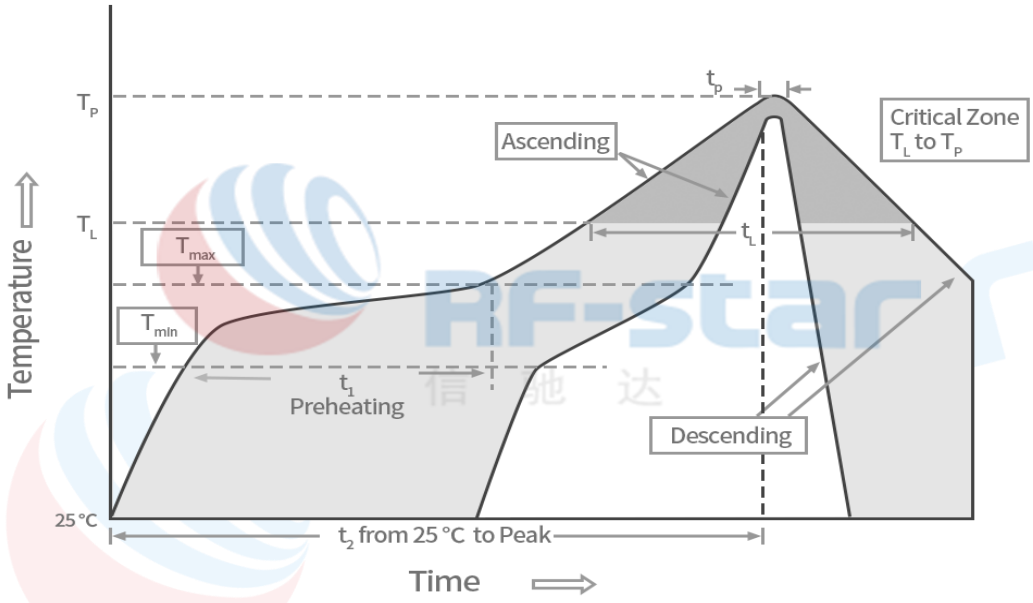


Figure 14. Recommended Reflow for Lead-Free Solder

10.8 Optional Packaging

Figure 15. Optional Packaging Mode

Note: Default tray packaging.

11 Revision History

Date	Version No.	Description
2020.01.10	V1.0	The initial version is released.
2020.06.05	V1.1	Add module RF-BM-ND08C(I). Update reset pin. Update the chapter of the transparent transmission function test by APP. Update the chapter of test by USB and BTool. Add the effective time and save the specification of AT commands. Update communication rate. Add power consumption table.
2020.06.24	V1.1	Update the description.
2020.08.14	V1.2	Modify the minimum broadcast interval of 20 ms. Add connection interval. Add hardware restore setting IO. Update the state indicator LED function.
2020.09.11	V1.3	Add observer mode. Update the description. Add reference design. Add power consumption.
2021.01.08	V1.4	Add device information. Update stable transmission rate. Update serial port hardware flow control description. Update the default connection interval to 20 ms. Add the wake-up character prompt after the serial port wakes up, see command "AT+SLEEP?" description for details. Update host (MCU) reference code.

		Update peripheral reference design. Update the measured power consumption.

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.

12 Contact Us

SHENZHEN RF-STAR TECHNOLOGY CO., LTD.

Shenzhen HQ:

Add.: C601, Skyworth Building, High-tech Park, Nanshan District, Shenzhen, Guangdong, China, 518057

Tel.: 86-755-3695 3756

Chengdu Branch:

Add.: B3-03, Building No.1, Incubation Park, High-Tech District, Chengdu, Sichuan, China, 610000

Tel.: 86-28-6577 5970

Email: sunny@szrfstar.com, sales@szrfstar.com

Web.: www.szrfstar.com

Appendix A: Certifications

1 SRRC

无线电发射设备
Radio Transmission Equipment
型号核准证
Type Approval Certificate

深圳市信能达科技有限公司：

根据《中华人民共和国无线电管理
In accordance with the provisions on the Radio
条例》，经审查，下列无线电发射设备
Regulations of the People's Republic of China , the following
符合中华人民共和国无线电管理规定和
radio transmission equipment , after examination , conforms
技术标准，其核准代码为：CMIIT ID:2019DP6546
to the provisions with its CMIIT ID:

有效期：五年
Validity

（发证机关）
Sealed by issuing authority
2019年 7月 30日
Year Month Date

编号：2019-6546
Number

设备名称：蓝牙模块
Equipment Name

设备型号：RF-BM-ND04
Equipment Type

主要功能：数据传输
Main Functions

调制方式：GFSK
Modulation Mode

主要技术参数及其指标值：
Main Technical Parameters

频率范围：2400-2483.5MHz
Frequency Range

频率容限：≤20ppm
Frequency Tolerance

发射功率：≤20dBm(EIRP)
Transmitting Power

占用带宽：≤2MHz
Occupied Bandwidth

杂散发射限值：≤-30dBm
Spurious Emission Limits

（核发单位章）
Sealed by issuing authority
2019年 7月 30日
Year Month Date

2 FCC

TCB

GRANT OF EQUIPMENT AUTHORIZATION
Certification
Issued Under the Authority of the
Federal Communications Commission
By:

TCB

MET Laboratories, Inc.
914 W. Patapsco Avenue
Baltimore, MD 21230-3432

Date of Grant: 04/03/2018
Application Dated: 04/03/2018

ShenZhen RF-STAR Technology CO.,LTD
2F,BLDG.8,Zone A,BaoAn Internet Industry Base,
BaoYuan Road,XiXiang, BaoAn DIST,
ShenZhen,
China

Attention: Aroo woo

NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFIER:	2ABN2-FBMND04
Name of Grantee:	ShenZhen RF-STAR Technology CO.,LTD
Equipment Class:	Digital Transmission System
Notes:	Nordic BLE module
Modular Type:	Single Modular

Grant Notes	FCC Rule Parts	Frequency Range (MHZ)	Output Watts	Frequency Tolerance	Emission Designator
	15C	2402.0 - 2480.0	0.0004966		

Single modular approval. Output Power listed is peak conducted.

3 CE

BLUE ASIA

Declaration of Conformity

The submitted sample of the following equipment has been tested for CE marking accordingto the following European Directive: the RED Directive 2014/53/EU.

Applicant name &address :	Shenzhen Rfstar Technology Co.,Ltd Room 601,Block C,Skyworth Building, NanShan,Shen Zhen 518057
Manufacturer name & Address :	Shenzhen Rfstar Technology Co.,Ltd Room 601,Block C,Skyworth Building, NanShan,Shen Zhen 518057
Product :	Bluetooth MODULE
Model/Type reference :	RF-BM-ND04
Trade mark :	RF-STAR
Order No. :	BLA-EMC-202012-A36

Essential Requirements		Applied Specification/Standards	Documentary Evidence
Art 3.1 (a)	Health	EN 62479:2010	Test Report BLA-EMC-202012-A3603
Art 3.1 (a)	Safety	EN IEC 62368-1:2020	Test Report BLA-S-202012-A07
Art 3.1 (b)	EMC	ETSI EN 301 489-1 V2.2.3 (2019-11) ETSI EN 301 489-17 V3.2.4 (2020-09)	Test Report BLA-EMC-202012-A3601
Art 3.2	Radio	ETSI EN 300 328 V2.2.2 (2019-07)	Test Report BLA-EMC-202012-A3602

This verification has been granted to the applicant based on the results of the tests, performed by laboratory of BlueAsia of Technical Services(Shenzhen) Co., Ltd.on the sample of the above-mentioned product in accordance with the provisions of the relevant specific standards and the product is in conformity with the essential requirements of Article 3.1(a) (b) 3.2 of Directive 2014/53/EU. The CE mark as shown below can be used, under the responsibility of the manufacturer, after completion of an EC Declaration of Conformity and compliance with all relevant EC Directives.

CE

Emen_li
Lab manager
Date: 2021/1/16

BlueAsia of Technology Services(Shenzhen) Co.,Ltd
Building C, No. 107, Shihuan Road, Shiyan Sub-District, Baoan District, Shenzhen, Guangdong Province, China
Tel: +86-755-23059481
Email: marketing@cblueasia.com
www.cblueasia.com

Appendix B: Power Consumption Test Screenshot

1 Sleep Mode: 2.76 μA

2 Broadcast Mode

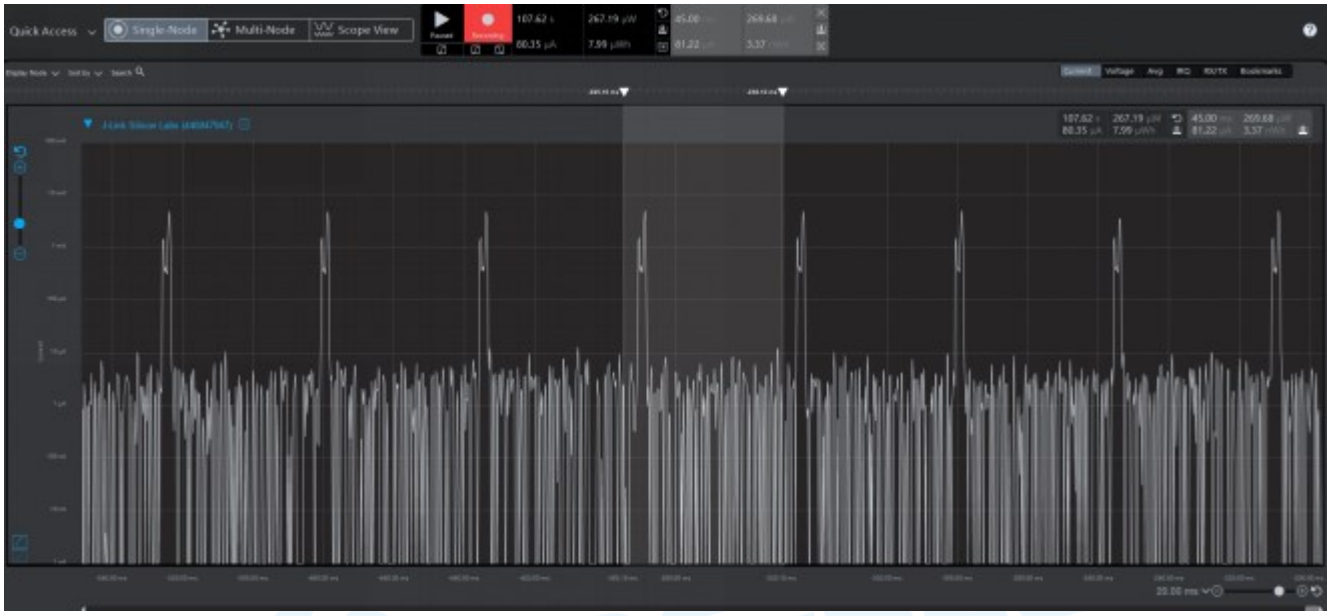
2.1 200 ms Broadcast Cycle: 76.98 μA

2.2 500 ms Broadcast Cycle: 32.79 μA

2.3 1000 ms Broadcast Cycle: 17.53 μA

3 Connection Mode

3.1 45 ms Connection Interval: 80.35 μA



3.2 100 ms Connection Interval: 27.25 μA