EFR32BG22 Bluetooth Low Energy 5.0 Master-Slave Module and Protocol

Version V1.7

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Revision History

Date	Version No.	Description
2020.09.28	V1.0	The initial version is released.
2021.01.16	V1.1	Add device information Service. Add RF-BM-BG22Ax series module description. Add Bluetooth pairing function. Add AT command to configure the serial port packet size and delay time. Update the stable transmission rate. Add the serial port hardware flow control, and adjust RTS and CTS pins into PB1 and PB2 respectively (previously PC2 and PC3). Add the function of scanning broadcast response packets in observer mode. Add Long Range broadcast. Add the command to enter the authentication key for the master role. Add sleep command. Add the PHY setting commands for the master role when scanning and connecting. Modify most commands from taking effective after reboot to taking effect immediately. Modify the minimum TX power from -30 dBm to -28 dBm. Update the MCU reference code. Update the peripheral reference design. Update the measured power consumption.
2021.01.21	V1.2	Update the serial port pins. Update the stable transmission rate. Update the measured power consumption.
2021.03.10	V1.3	Adjust the setting method of the broadcast name, user-defined broadcast, and extended broadcast. Add a carriage return and line feed when APP sends AT command.

		Change the default connection PHY from 2M PHY to 1M PHY. Modify the function that the handle value sent by the current master always points to the newly established connection when a connection is established. Cancel the master-slave identity setting command in the master-slave mode, and the set transparent transmission handle determines whether the current data is transparently transmitted to the master or the slave in the master-slave mode. Add the collected battery voltage parameters and button detection parameters into the broadcast package. Add the enhanced broadcast function in Beacon mode. Add the observer filtering function. Add the function of scanning the expanded broadcast. Add the function of setting the broadcast response packet data by AT command. Add FCC and CE certificates.
2021.12.30	V1.4	Change the storage mode of the broadcast response packet to power-off save. Optimize the AT+SCAN to scan the broadcast name type of Shortened Local Name (08 type). Update the chapter description.
2022.05.12	V1.5	Add the filter conditions of the broadcast data in Observer mode. Add the serial port wake-up function in the Sleep command. Add the function of reading the specified UUID. Add the function of The automatic reconnection command increases the setting to trigger the reconnection parameter immediately Delete the duplicate function of "AT+DEV_DEL=?". Add IPEX version module dimension and footprint. Add the power consumption and the serial port power consumption data at 6 dBm. Update the module power-on stabilization time to 600 ms. Update the chapter description.
2022.06.08	V1.6	Update the chapter description. Update the pin attribute diagram.
2022.08.02	V1.6	Add the RF-BM-BG22Bx and RF-BM-BG22Cx descriptions.

		Update the chapter description.
2022.08.10	V1.7	Add the max. voltage specification of the RESET pin. Add the reference design of BG22Bx and BG22Cx modules.
2023.05.25	V1.7	Update the Shenzhen office address.

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.rfstariot.com, www.szrfstar.com.

Table of Contents

1 Overview

1.1 Introduction

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

In bridge mode, user MCU can communicate with the mobile device bi-directionally through the universal 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 operate the write to the module through the APP. And the data written will be sent to the user MCU through serial ports. Then the module will transmit the data packets from the user MCU to the mobile devices automatically. Under the development in this mode, the user needs to undertake the code design for the MCU and the APP for mobile devices.

In order to ensure the stability of the program, the module will start to work normally after it is powered on for ***600 ms***. 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.

1.2 Features

1. Easy to use, no need for any application experience of Bluetooth protocol stack.
2. Support all features of BLE 5.0: 2M PHY, Long Range broadcast, Extended broadcast. Modules based on EFR32BG22C112 don’t support Long Range broadcast.
3. Support BLE master mode, slave mode, master-slave mode, and Beacon mode.
4. Support concurrent slave and master roles, that is, the module can connect to other slave devices when it is connected by one master device (master-slave mode).
5. Support multi-connection during master mode and master-slave mode. Up to 8 slave devices can be connected concurrently under master mode. Under master-slave mode, 7 slave devices can be connected concurrently, and it also can be connected as a slave by another master device at the same time.
6. Default connection interval of 20 ms, which makes quick connections and enhances the compatible stability of Android and iOS phones.
7. Universal serial port design for user interface, full-duplex bi-directional communication, and support the minimum baud rate of 1200 bps and the maximum baud rate of 921600 bps.
8. Support software reset module by AT command.
9. Support acquire and modify the MAC address (take effect after resetting) by AT command.
10. Support modify the Bluetooth connection interval and control different transmit rates (dynamic power consumption

adjustment) by AT command.

11. Support the modification of the transmit power, the broadcast interval, the serial port baud rate, and the module name by AT commands, please check for details in AT Command.
12. Support modify the Service UUID by AT command.
13. Support modify serial port frame size and timeout time by AT command.
14. In the master or master-slave mode, support the user-defined selection of the UUID channel for receiving and sending.
15. AT commands can be sent through APP or serial port.
16. High-speed transparent transmission rate, stable transmission at 50 KB/s (512000 bps).
17. Support to modify the PHY communication speed: 1M, 2M, LE Coded (125 kbps & 500 kbps).
18. Support user-defined broadcast data, the longest user-defined length is 26 bytes.
19. Support extended broadcast packets, a maximum of 251 bytes of an extended broadcast packet can be user-defined.
20. Support setting Long Range broadcast packet (Long Range/LE Coded).
21. Support setting Bluetooth pairing and bonding functions.
22. Ultra-low working power consumption, the measured power consumption of the module is as follows (When the watchdog function is turned off, the power consumption will be lower by 2 ~ 3 μA overall):

Table 1. Power Consumption

Event	Average Current	Test Condition / Remark
Sleep	3.02 μA	No Broadcast
Broadcast interval: 200 ms	57.82 μA	0 dBm
	101.89 μA	6 dBm
Broadcast interval: 500 ms	24.13 μA	0 dBm
	41.20 μA	6 dBm
Broadcast interval: 1000 ms	15.12 μA	0 dBm
	24.78 μA	6 dBm
Connection interval: 20 ms	146.74 μA	0 dBm
	181.01 μA	6 dBm
Connection interval: 1000 ms	9.39 μA	0 dBm
	11.64 μA	6 dBm
Open serial port	1.2 mA	Turn off broadcasting

1.3 Working Mode Specification

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 working mode can be switched through the AT command "**AT+ROLE**". Please check the AT Command in detail. In the Beacon mode, the serial port is turned off, and the working mode only can be switched by sending commands through the mobile APP.

1.4 Default Configurations in Slave Mode

1. Device name: RFstar_XXXX (XXXX is the last two bytes of the MAC address).
2. Broadcast interval: 200 ms.
3. Connection interval: 20 ms.
4. 128-bit UUID
5. Broadcast mode: connectable
6. Device status: transparent transmission

1.5 Default Configuration in Beacon Mode

1. Company ID: 0x4C00 (Apple iBeacon).
2. Major UUID: 0x0708.
3. Minor UUID: 0x0506.
4. RSSI: -48 dBm.
5. UUID: 0x01122334455667788 99AABBCCDDEEFF0.

   In Beacon mode, the serial port is closed and unavailable, thus, the data cannot be transmitted transparently. if the serial port is needed, pls try hardware wakeup and AT commands.

1.6 Description of Default Broadcast Data


Raw data:

0x020106081B0079E642AC33BC11079ECA DC240EE5A9E093F3A3B50100406E06FF5 2460CDB070C095246737461725F4536373 9

Details:

LEN.	TYPE	VALUE
2	0x01	0x06
8	0x1B	0x0079E642AC33BC
17	0x07	0x9ECADC240EE5A9E093F3A3B501 00406E
6	0xFF	0x52460CDB07
12	0x09	0x5246737461725F45363739

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

As shown in the figure above, it is the default broadcast data of the device.

TYPE: 0x1B: the last 6 bytes of it are the MAC address of the BLE device (low byte first).

TYPE: 0x07: the 128-bit service UUID.

TYPE: 0xFF: the manufacturer-defined field.

0x5246: the vendor ID

0x0CDB: the power supply voltage of the module, that is, 3291 mV, the data will update every hour.

0x07: the input status of the three IOs (PC3, PC4, PC5) of the RF-BM-BG22Ax and RF-BM-BG22Bx module, update in real time. The pull-up is at a high level by default.

TYPE: 0x09: the device name (RFstar_E679).

1.7 Device Status Specifications

1. **DEVICE START**: The device starts to work.
2. **XX:XX:XX:XX:XX:XX CONNECTED Y***: BLE slave is successfully connected. (Y means the serial number of the connected slave module.)
3. **XX:XX:XX:XX:XX:XX DISCONNECTED**: BLE slave is disconnected.
4. **B:CONNECTED**: Beacon is successfully connected.
5. **B:DISCONNECTED**: Beacon is disconnected.
6. **BONDING COMPLETED**: Bonding and pairing succeeded.
7. **BONDING FAILED**: Bonding and pairing failed.
8. **ENTER THE PAIRING PASSWORD**: The other slave device requires the master device to enter the pairing PIN

code.

9. **BPS SET AFTER 2S...**: The serial port baud rate has been changed and will be re-initialized after 2 seconds.
10. **DEVICE ALREADY CONNECTED**: The connected devices.
11. **XX:XX:XX:XX:XX:XX CONNECTED Y**: BLE master is successfully connected (The string in red is the MAC address of the connected slave device).
12. **XX:XX:XX:XX:XX:XX DISCONNECTED**: BLE master is disconnected (The string in red is the MAC address of the disconnected slave device).
13. **XX:XX:XX:XX:XX:XX CONNECT 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 10 s after the command is run, a timeout will be prompted.

The above status can be turned on or off by the AT command “AT+STATUS”. For details, please refer to AT Command.

1.8 Multi-Connection

1. Up to 8 slave devices can be connected concurrently under master mode. Under master-slave mode, 7 slave devices can be connected concurrently, 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, the prompt will show 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 latest device established the connection by default. If the device with the corresponding handle is disconnected, the handle value will be automatically switched to the first device in the connection list. (The Handle value can be obtained from "XX:XX:XX:XX:XX:XX CONNECTED Y" in the return message when the connection is successfully established.)
5. The user disconnects the device which is set 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 packets, otherwise it cannot be identified which device the data came from.

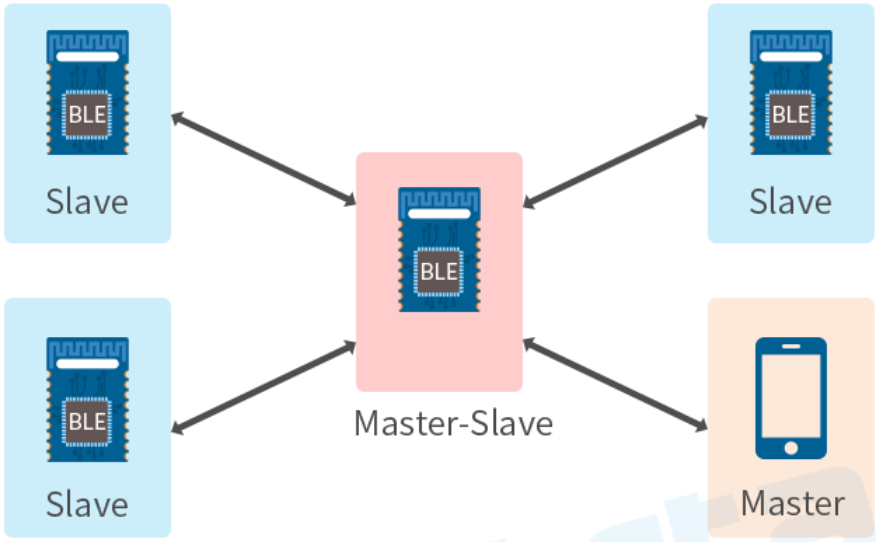


Figure 1. Multi-Connection Diagram

2 Package and Pin Assignment

2.1 RF-BM-Ax(I)

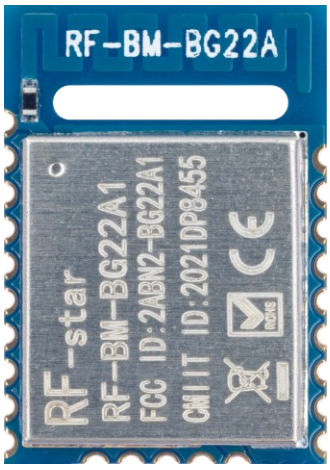
RF-BM-BG22Ax(I) includes RF-BM-BG22A1, RF-BM-BG22A1I, RF-BM-BG22A3, and RF-BM-BG22A3I.

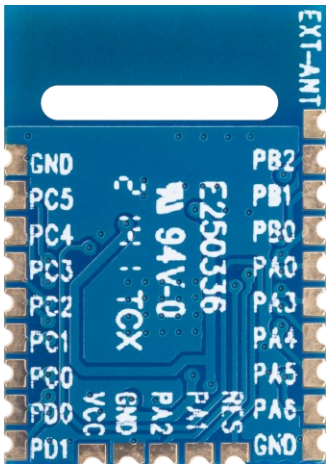
There is a series of RF-BM-BG22Ax Bluetooth 5.2 Low Energy modules. All of them are based on Silicon Labs EFR32BG22 SoC series. Because the EFR32BG22 series ICs are compatible in package, pins, and peripherals, those modules are pin-to-pin compatible with each other as well.

Table 2. Module Series of RF-BM-BG22Ax

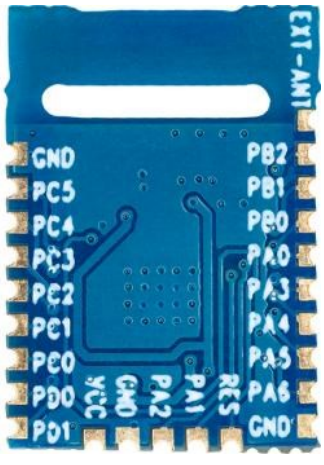
Model	Chip Model	Max. CPU Speed	TX Power	FLASH	RAM	Protocol
BG22A1	EFR32BG22C112F352GM32-C	38.4 MHz	0 dBm	352 KB	32 KB	BT5.2
BG22A1I	EFR32BG22C112F352GM32-C	38.4 MHz	0 dBm	352 KB	32 KB	BT5.2
BG22A3	EFR32BG22C224F512GM32-C	76.8 MHz	+6 dBm	512 KB	32 KB	BT5.2 Direction finding Proprietary
BG22A3I	EFR32BG22C224F512GM32-C	76.8 MHz	+6 dBm	512 KB	32 KB	BT5.2 Direction finding Proprietary

Note: RF-BM-BG22A1 and RF-BM-BG22A1I do not support AoA/AoD and LE Long Range (125 Kbps and 500 Kbps) PHYs.

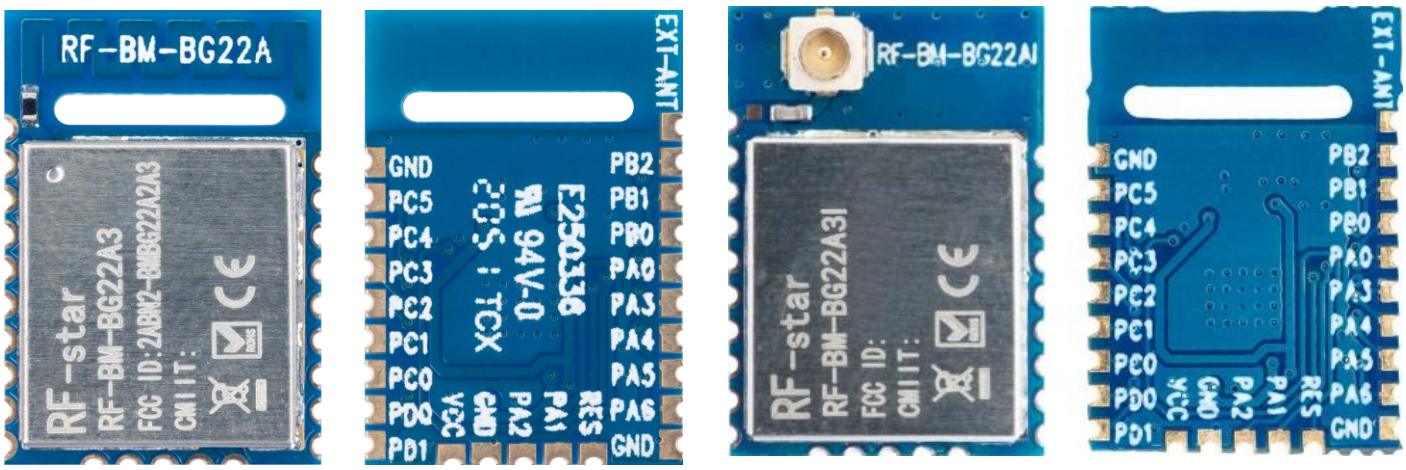




RF-BM-BG22A1

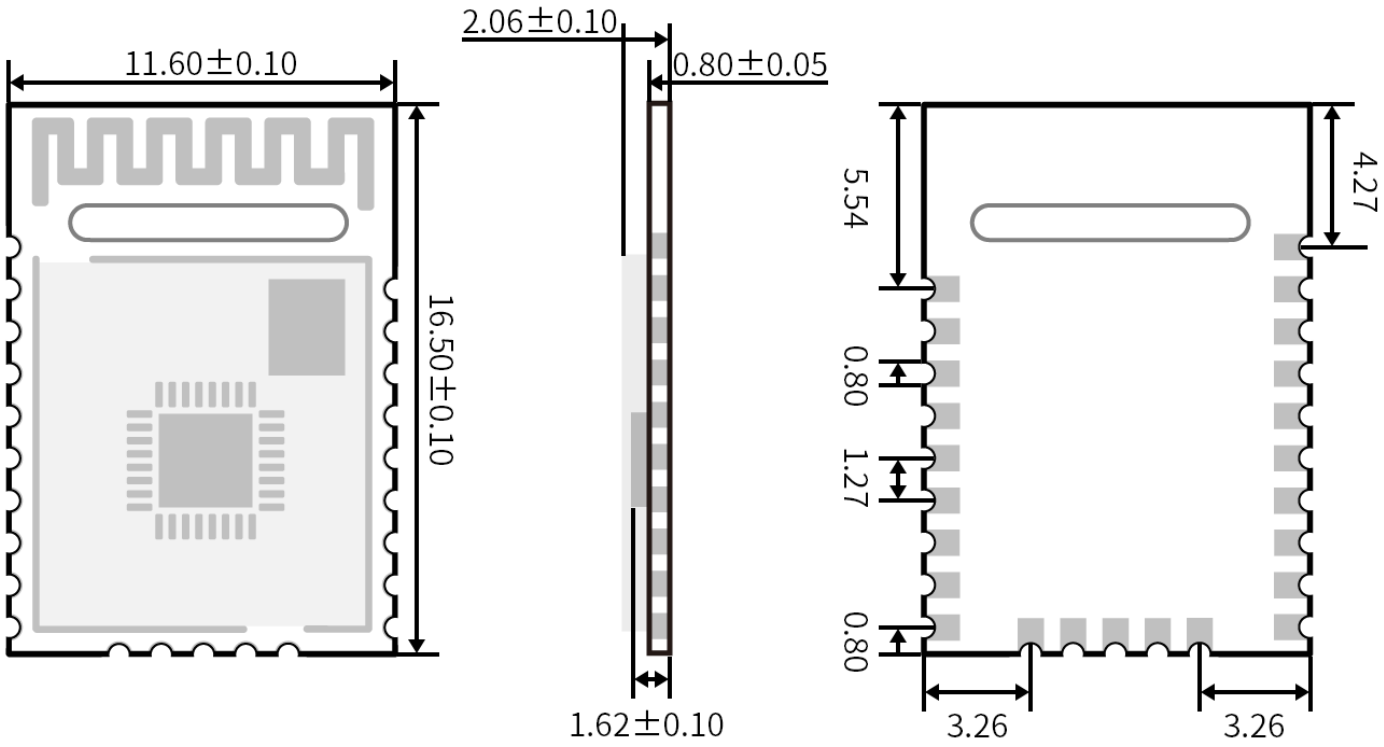


RF-BM-BG22A1I

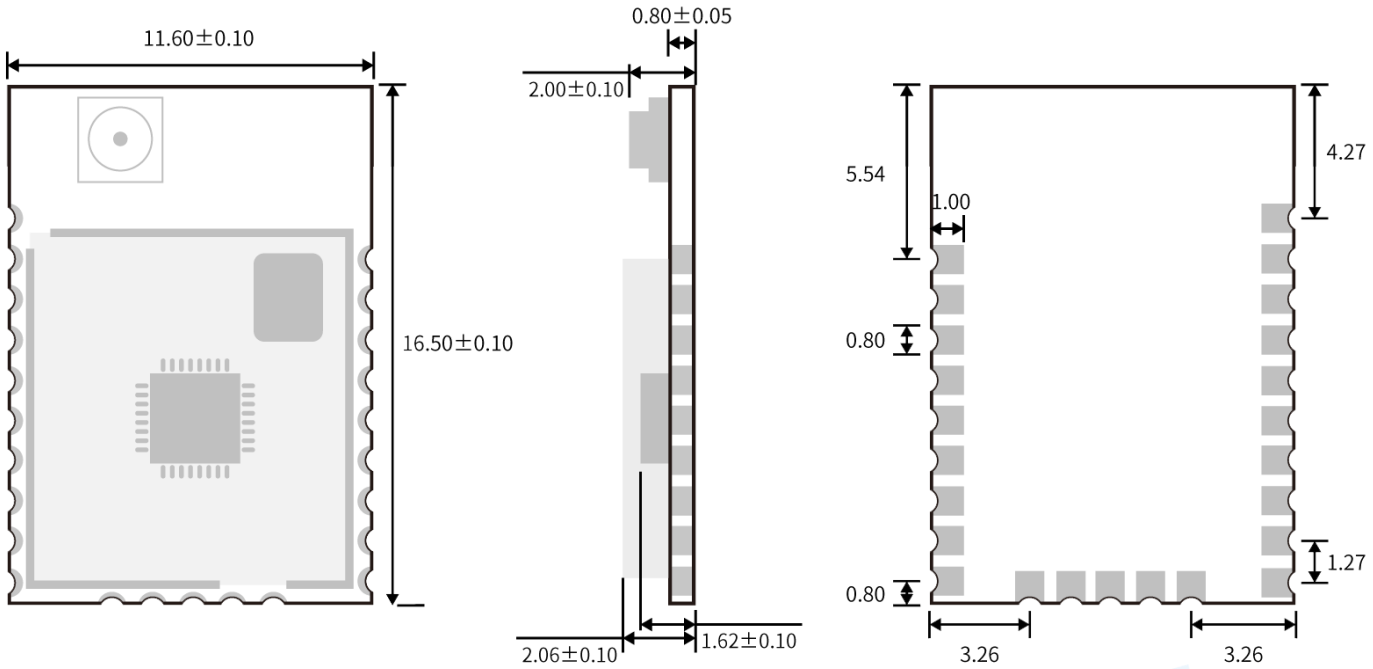


RF-BM-BG22A3 RF-BM-BG22A3I

Figure 2. Module Photos of RF-BM-BG22Ax(I)



RF-BM-BG22Ax



RF-BM-BG22AxI

Figure 3. PCB Footprint of RF-BM-BG22Ax(I)

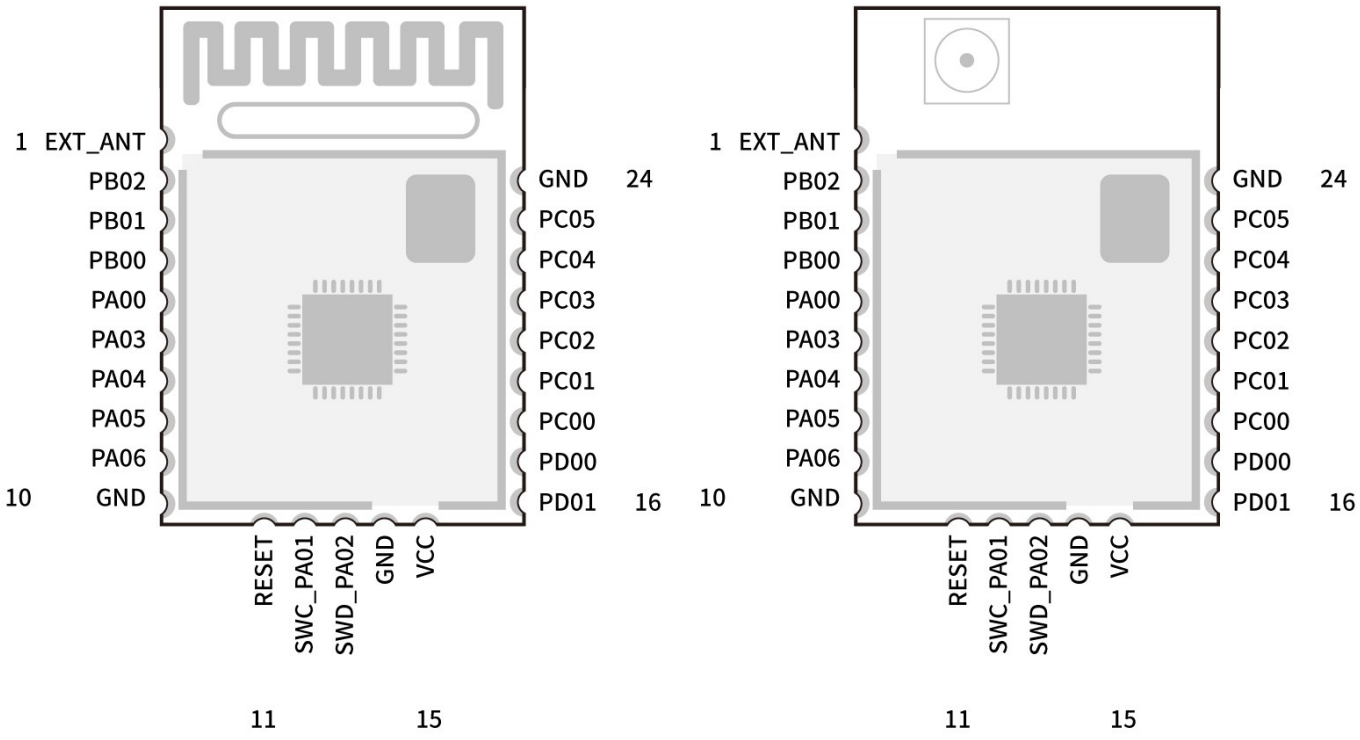


Figure 4. Pin Assignment of RF-BM-BG22Ax(I)

Table 3. Pin Functions of RF-BM-BG22Ax(I)

Pin	Name	Function	Description
1	EXT_ANT	-	External antenna output
2	PB02	I/O	GPIO
3	PB01	I/O	GPIO
4	PB00	RESTORE	All parameters will be reset to factory settings after this pin is set low for 5 s.
5	PA00	I/O	GPIO
6	PA03	CTS	The 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. Remark: It is best not to leave this pin floating, otherwise, the power consumption will be higher and the serial port may work unstably.
7	PA04	RTS	The 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.
8	PA05	TX	Serial port TX
9	PA06	RX	Serial port RX
10	GND	-	Ground
11	RESET	I	Reset pin, active low (internal pull-up). **Max. power supply: 1.8V.**
12	PA01	I/O	GPIO/SWCLK (connect J-Link)
13	PA02	I/O	GPIO/SWDIO (connect J-Link)
14	GND	-	Ground
15	VCC	-	Power supply: 2.2 V~ 3.8 V, recommended to 3.3 V
16	PD01	Status indicator	Slave role (including Beacon) connection status indicator: at a low level during connection (LED always on)
17	PD00	Status indicator	Master role connection status indicator: at a low level during connection (LED always on)
18	PC00	I/O	GPIO
19	PC01	I/O	GPIO

20	PC02	I/O	GPIO
21	PC03	I	Input status monitoring, the tatus will update in the broadcast packet in real time. See details in “Description of default broadcast data”.
22	PC04	I	Input status monitoring, the tatus will update in the broadcast packet in real time. See details in “Description of default broadcast data”.
23	PC05	I	Input status monitoring, the tatus will update in the broadcast packet in real time. See details in “Description of default broadcast data”.
24	GND	-	Ground

2.2 RF-BM-Bx

RF-BM-BG22Bx includes RF-BM-BG22B1.

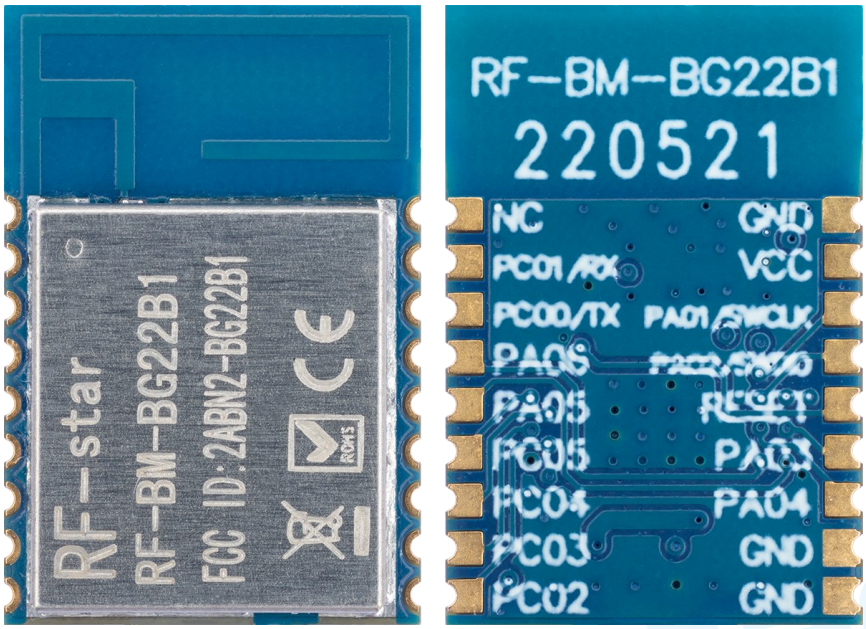


Figure 5. Module Photos of RF-BM-BG22B1

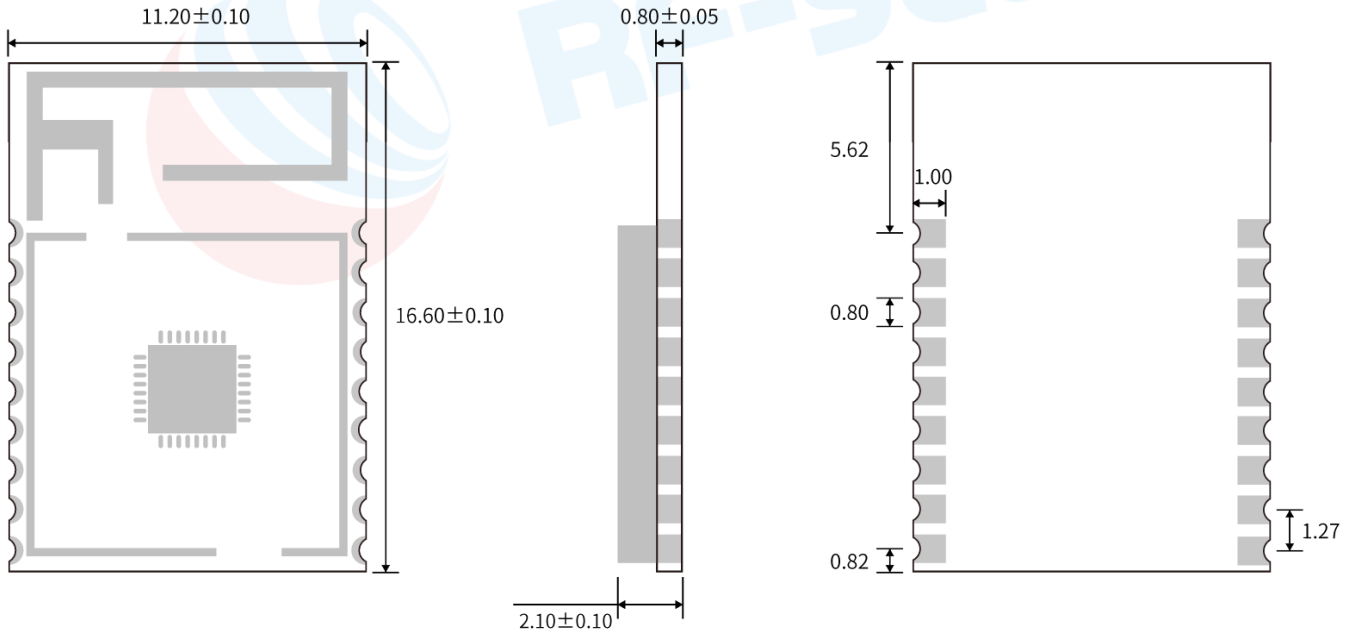


Figure 6. PCB Footprint of RF-BM-BG22B1

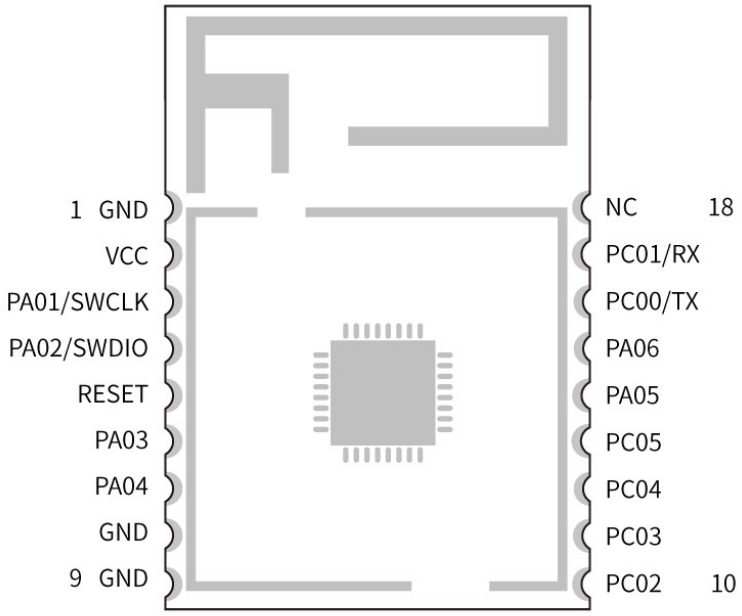


Figure 7. Pin Assignment of RF-BM-BG22B1

Table 4. Pin Functions of RF-BM-BG22B1

Pin	Name	Function	Description
1	GND	-	Ground
2	VCC	-	Power supply: 2.2 V~ 3.8 V, recommended to 3.3 V
3	PA01/SWCLK	I/O	GPIO/SWCLK (connect J-Link)
4	PA02/SWDIO	I/O	GPIO/SWDIO (connect J-Link)
5	RESET	I	Reset pin, active low (internal pull-up). **Max. power supply: 1.8V.**
6	PA03	RESTORE	All parameters will be reset to factory settings after this pin is set low for 5 s.
7	PA04	Status indicator	Slave role (including Beacon) connection status indicator: at a low level during connection (LED always on)
8	GND	-	Ground
9	GND	-	Ground
10	PC02	Status indicator	Master role connection status indicator: at a low level during connection (LED always on)
11	PC03	I	Input status monitoring, the tatus will update in the broadcast packet in real time. See details in “Description of default broadcast data”.
12	PC04	I	Input status monitoring, the tatus will update in the broadcast packet

			in real time. See details in “Description of default broadcast data”.
13	PC05	I	Input status monitoring, the tatus will update in the broadcast packet in real time. See details in “Description of default broadcast data”.
14	PA05	CTS	The 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. Remark: It is best not to leave this pin floating, otherwise, the power consumption will be higher and the serial port may work unstably.
15	PA06	RTS	The 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	PC00/TX	TX	Serial port TX
17	PC01/RX	RX	Serial port RX
18	NC	-	NC

2.3 RF-BM-Cx

RF-BM-BG22Cx includes RF-BM-BG22C3.

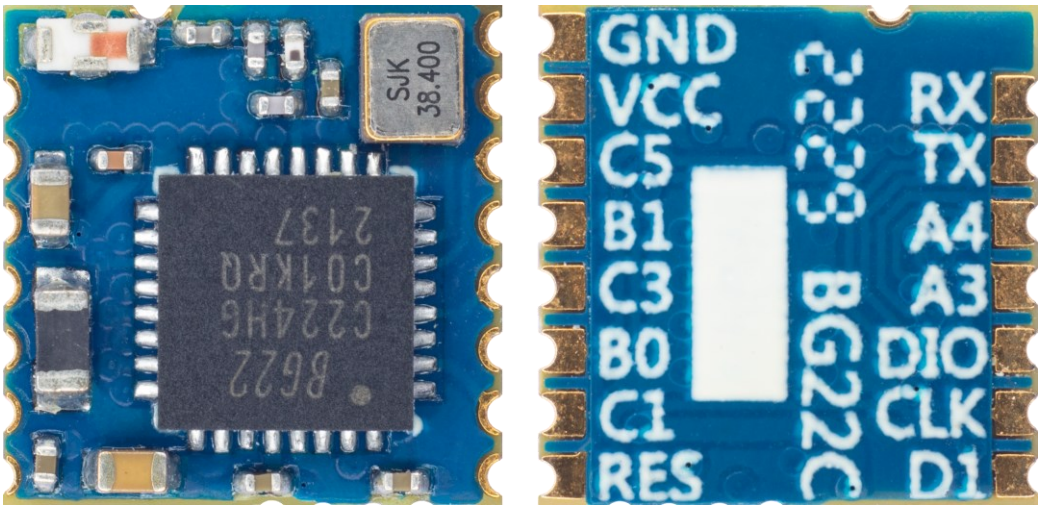


Figure 8. Module Photos of RF-BM-BG22C3

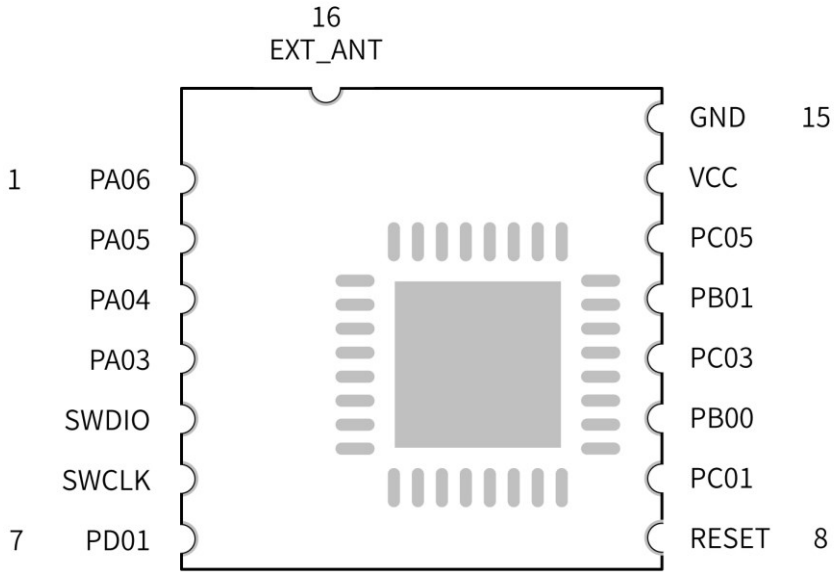


Figure 9. PCB Footprint of RF-BM-BG22C3

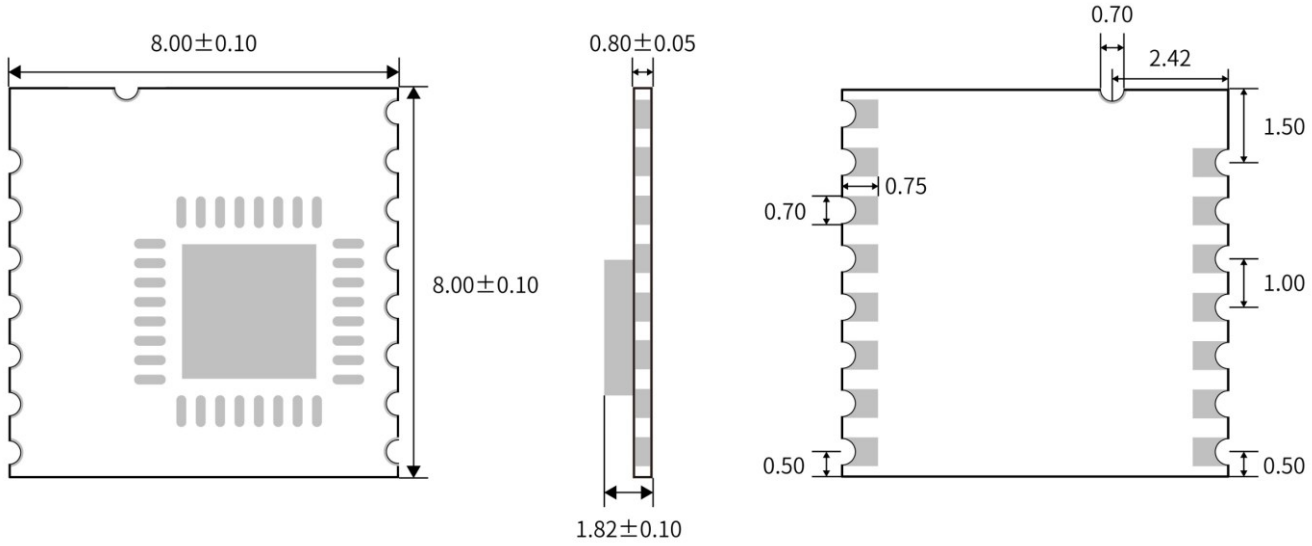


Figure 10. Pin Assignment of RF-BM-BG22C3

Table 5. Pin Functions of RF-BM-BG22C3

Pin	Name	Function	Description
1	PA06	RX	Serial port RX
2	PA05	TX	Serial port TX
3	PA04	RTS	The 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.
4	PA03	CTS	The 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. Remark: It is best not to leave this pin floating, otherwise, the power consumption will be higher and the serial port may work unstably.
5	PA02/SWDIO	I/O	GPIO/SWDIO (connect J-Link)
6	PA01/SWCLK	I/O	GPIO/SWCLK (connect J-Link)
7	PD01	I	Input status monitoring, the tatus will update in the broadcast packet in real time. See details in “Description of default broadcast data”.
8	RESET	I	Reset pin, active low (internal pull-up). **Max. power supply: 1.8V.**

9	PC01	I	Input status monitoring, the tatus will update in the broadcast packet in real time. See details in “Description of default broadcast data”.
10	PB00	RESTORE	All parameters will be reset to factory settings after this pin is set low for 5 s.
11	PC03	-	
12	PB01	Status indicator	Master role connection status indicator: at a low level during connection (LED always on)
13	PC05	Status indicator	Slave role (including Beacon) connection status indicator: at a low level during connection (LED always on)
14	VCC	-	Power supply: 2.2 V~ 3.8 V, recommended to 3.3 V
15	GND	-	Ground
16	EXT_ANT	-	External antennal output

3 UART Transparent Transmission Protocol (Bridge Mode)

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

1. The default hardware protocol of the serial port: 115200 bps, 8, no parity, 1 stop bit.
2. **The serial port is enabled by default in other modes except for beacon mode**. If the serial port needs to be closed, please use the command "AT+SLEEP=0".
3. 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 at a high level, it indicates that the receive buffer of the serial port is full (maximum buffer is **3328** bytes), or the serial port is busy.
4. Data packets from a mobile device to the module must be sub-packed automatically (within 1 ~ 247 bytes per packet) before sending. The module will transmit the packets to the master RXD in turn after receiving the packets.
5. Most serial port tools on the PC end do not have CTS detection. When the Bluetooth communication rate is lower than the serial port rate, **for reliable transparent transmission, please use flow control**. It is recommended to use the software SecureCRT.

4 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, and any data will be processed as commands (No need to use +++ to enter the command mode). **The command must end with a carriage return and line feed (CRLF) (\r\n or 0x0D0A etc.).** **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	Shenzhen RF-star Technology Co., Ltd.

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-BG22A3, 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 v0.2.1_2021.01.12, it Indicates the firmware version is V0.2.1 generated on January 12th, 2021.

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 xxxxxxFFFExxxxxx, and xx is the physical address of the module chip MAC, six bytes.

Generic Access UUID: 0x1800

Device Name

Characteristics UUID	0x2A00
Executable operations	READ
Remarks	The default is RFstar_XXXX, "XXXX" is the last two bytes of the module's MAC address, and it will be updated synchronously after modification with the command "AT+NAME=".

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 user-defined.**

5 AT Command

5.1 AT Command Format

Table 3. 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 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 the 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.** It must end with a carriage return and line feed (CRLF). **No need to add CRLF for "+++"**.
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 setting value can not be exceeding the settable range of the parameters.

5.2 AT Command List

Table 3. AT Command List

AT Command	Function	Remark
+++	Enter AT command mode.	No need to add CRLF.
AT+EXIT	Exit AT command mode.	Take effect immediately.
AT+NAME	Query/set the device name.	Take effect immediately, can be saved after power off.
AT+MAC	Query/set the MAC address.	Take effect after reboot, can be saved after power off.
AT+ROLE	Query/set the device role.	Take effect after reboot, can be saved after power off.
AT+POWER	Query/set the device power.	Take effect immediately, can be saved after power off.
AT+ADS	Query/set the broadcast parameters under slave mode.	Take effect immediately, can be saved after power off.
AT+ADV_DATA	Query/set the user-defined broadcast data.	Take effect immediately, can be saved after power off.
AT+RSP_DATA	Query/set the user-defined broadcast response packet data.	Take effect immediately, can be saved after power off.
AT+LE_CODED	Query/set the Long Range broadcast	Take effect immediately, can be saved after power off.
AT+ADV_EXT	Query/set the user-defined extended broadcast.	Take effect immediately, can be saved after power off.
AT+BEACON	Query/set the Beacon parameters.	Take effect immediately, can be saved after power off.
AT+SCAN	Scan the device.	Only effective in master mode and master-slave mode.
AT+SCAN_PHY	Query/set the PHY of the master.	Take effect immediately, can be saved after power off.
AT+S_NAME	Scan the slave device name and print it out.	Only effective in master mode and master-slave mode.
AT+SEND	Send data via AT command.	Take effect immediately.
AT+CONNECT	Connect the device.	Only effective in master mode and master-slave mode.

AT+CNT_LIST	Query the connected device list of the current device.	Take effect immediately.
AT+DISCONNECT	Disconnect the connected device.	Take effect immediately.
AT+AUTO_CNT	Automatically reconnect the slave devices.	Only effective in master mode and master-slave mode. Take effect immediately, can be saved after power off.
AT+DEV_DEL	Delete the saved automatic reconnection devices.	Take effect immediately, can be saved after power off.
AT+CNT_INTERVAL	Query/set the connection interval.	Take effect immediately, can be saved after power off.
AT+TTM_HANDLE	Designate the transparent transmission handle during multi-connection.	Only effective in master mode and master-slave mode. Take effect immediately, cannot be saved after power off.
AT+SERVICE	Query/set the slave UUID.	Take effect after reboot, can be saved after power off.
AT+UUID_SCAN	Enable/disable the master UUID configuration function.	Take effect immediately, can be saved after power off.
AT+TRX_CHAN	Configure the master UUID.	Take effect immediately, can be saved after power off.
AT+OBSERVER	Enable/disable the observer function.	Only effective in master mode and master-slave mode.
AT+PHY	Query/set the PHY rate.	Take effect immediately; can be saved after power off
AT+UART	Query/set the baud rate.	Take effect immediately, can be saved after power off.
AT+PACK	Query/set the serial port frame size and timeout time.	Take effect immediately, cannot be saved after power off.
AT+ECHO	Query/set whether the serial port is echoed.	Take effect immediately, cannot be saved after power off.
AT+STATUS	Query/set whether to display the device status.	Take effect immediately, cannot be saved after power off.
AT+AUTH	Query/set the user authentication.	Take effect after the next connection, can be

		saved after power off.
AT+AUTH_KEY	Enter the user authentication passkey.	Only effective in master mode and master-slave mode.
AT+PAIR	Query/set the slave role pairing function.	Only effective in slave mode. Take effect after reboot, can be saved after power off.
AT+MASTER_PAIR	Query/set the master role pairing function.	Only effective in master mode and master-slave mode. Take effect after reboot, can be saved after power off.
AT+PASSKEY	The master role enters the pairing passkey.	Only effective in master mode and master-slave mode. Take effect immediately.
AT+PAIR_LIST	Query the pairing list.	
AT+PAIR_DEL	Delete the paired device.	Take effect immediately, can be saved after power off.
AT+SLEEP	Query/set the device sleep mode (effective for once)	Take effect immediately, cannot be saved after power off.
AT+WDOG	Enable/disable the watchdog.	Take effect after reboot, can be saved after power off.
AT+RESTART	Restart the device.	Take effect immediately.
AT+RESET	Device parameters restore factory settings and reboot.	Take effect immediately.
AT+VERSION	Query the device 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.	

5.3 Detailed AT Command

- **Enter AT Command Mode**

+++	
Function	Enter AT command mode.
Example	+++ **(No CRLF).**
Return Value	OK.
Remark	No need to add CRLF. If OK is returned, the commands sent need to add CRLF. Need to exit AT command mode, the transparent transmission data can be received as well. The prefix "+RESEIVED:" refers to transparent transmission data. The data can be transmitted by "AT+SEND".

- **Exit AT Command Mode**

AT+EXIT	
Function	Exit AT command mode and switch to transparent transmission mode.
Example	AT+EXIT
Return Value	OK
Remark	

- **Device Name**

AT+NAME?	
Function	Query the device name.
Example	AT+NAME?
Return Value	AT+NAME=0,RFstar_XXXX OK.
Remark	Parameter 1: Broadcast name input format of the current device. (0: ASCII, 1: HEX) Parameter 2: Broadcast name of the current device. The factory default is RFstar_XXXX. XXXX is the last two bytes of the MAC address.

AT+NAME=	
Function	Set the device name.
Example	AT+NAME=0,TEST-NAME
Example	AT+NAME=1,544553542D4E414D45

Return Value	OK.
Remark	0 means that the name input format is in ASCII format, 1 means that the name input format is in HEX format. The maximum setting length is 16 bytes. The command "AT+NAME=0" or "AT+NAME=1" can be used to restore the device to its default factory name. Take effect immediately, can be saved after power off.

- **MAC Address**

AT+MAC?	
Function	Query the 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 the device MAC address.
Example	AT+MAC=F1:F2:F3:F4:F5:F6
Return Value	OK
Remark	The new MAC will take effect after reboot, and be saved after power off. Set to **00:00:00:00:00:00** or **FF:FF:FF:FF:FF:FF** to restore factory settings of the MAC address.

- **Device Role**

AT+ROLE=?	
Function	Query the parameter range of this command.
Example	AT+ROLE=?
Return Value	AT+ROLE=[0,1,2,3] OK
Remark	0: Slave **(by default)** 1: Master 2: Master-slave 3: Beacon, connectable. (The serial port is disabled by default and unavailable in this mode. The serial port can be enabled by pulling low the CTS pin.)

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

AT+ROLE=	
Function	Set the device role.
Example	AT+ROLE=1
Return Value	OK
Remark	Set the current role of the device as the master role. **Take effect after reboot**, can be saved after power off. **Switching roles will cause the list of paired devices and auto-reconnect devices to be cleared.**

- **TX Power**

AT+POWER=?	
Function	Query the parameter range of this command.
Example	AT+POWER=?
Return Value	AT+POWER=[-28,-20,-10,-5,-3,0,1,2,4,6] OK
Remark	The maximum TX power of RF-BM-BG22A1(I) is 0 dBm, and the return value of this command is [-28,-20,-10,-5,-3,0]

AT+POWER?	
Function	Query the 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 the device's TX power.

Example	AT+POWER=-10
Return Value	OK
Remark	Set the device TX power to -10 dBm. Take effect immediately after setting, can be saved after power off.

- **Broadcast Parameter**

AT+ADS=?	
Function	Query the parameter range of this command.
Example	AT+ADS=?
Return Value	AT+ADS=<0,1>,<0,1>,<20~10240> OK
Remark	**Parameter 1**: Set broadcast status (0: Disable. 1: Enable). **Parameter 2**: Set broadcast mode (0: Non-connectable. 1: Connectable). **Parameter 3**: Set broadcast interval (in ms, Range 20 ms ~ 10240 ms, the default is 200 ms).

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

AT+ADS=	
Function	Set the broadcast parameters.
Example	AT+ADS=1,0,500
Return Value	OK
Remark	Enable unconnectable broadcasting with 500 ms broadcast interval. Take effect immediately after setting, can be saved after power off. Invalid under master mode. Remark: The minimum broadcast interval is 20 ms.

- **User-defined Broadcast Data**

AT+ADV_DATA?	
Function	Query the user-defined broadcast data.
Example	AT+ADV_DATA?
Return Value	AT+ADV_DATA=0,XXXXXXXXXXXXXXXXX…… OK
Remark	Parameter 1: Broadcast data input format of the current device. (0: ASCII, 1: HEX) Parameter 2: Broadcast data of the current device. If this parameter is not set, NULL will be returned.

AT+ADV_DATA=	
Function	Set the user-defined broadcast data.
Example	AT+ADV_DATA=0,112233445566778899AA#S=+
Example	AT+ADV_DATA=1,313132323333343435353636373738383939414123533D2B
Return Value	OK
Remark	1. **Parameter 1**: 0 means that the input broadcast data is in ASCII format, 1 means that the input broadcast data is in HEX format. 2. The data is placed in the user-defined zone, and the user can user-definedize the broadcast data up to **26** bytes. 3. Use "AT+ADV_DATA=0" or "AT+ADV_DATA=1" command to restore the broadcast data to the default data. 4. Take effect immediately after setting, can be saved after power off.

- **User-defined Broadcast Response Packet Data**

AT+RSP_DATA?	
Function	Query the user-defined broadcast response packet data.
Example	AT+RSP_DATA?
Return Value	AT+RSP_DATA=0,XXXXXXXXXXXXXXXXX…… OK
Remark	Parameter 1: The current device input format of broadcast response packet data. (0: ASCII, 1: HEX) Parameter 2: The current device broadcasts response packet data. If the user does not set this parameter, it returns NULL.

AT+RSP_DATA=	
Function	Set the user-defined broadcast response packet data.
Example	AT+RSP_DATA=1,0709524673746172 06FF5246010203
Return Value	OK
Remark	1. 0 means that the input broadcast response packet data is in ASCII format, 1 means that the input broadcast response packet data is in HEX format. 2. The user can user-definedize the broadcast response packet data up to **31** bytes. 3. The "AT+RSP_DATA=0" or "AT+RSP_DATA=1" command can be used to restore the broadcast response packet data to its default data. 4. Take effect immediately after setting, can be saved after power off. Note: Since the setting of the response packet data occupies the position of the broadcast name, the broadcast name command will become invalid after setting the response packet data. If the broadcast name is required, the user needs to add it to the user-defined data.

- **Long Range Broadcast**

AT+LE_CODED?	
Function	Query the user-defined Long Range broadcast status.
Example	AT+LE_CODED?
Return Value	AT+LE_CODED=1 OK
Remark	0: Disable Long Range broadcast (Default). 1: Enable Long Range broadcast.

AT+LE_CODED=	
Function	Set the Long Range broadcast (enable/disable).
Example	AT+LE_CODED=1
Return Value	OK
Remark	Enable Long Range broadcast. After enabled, the broadcast itself does not carry data, and the command "AT+ADV_EXT" needs to be used to set the user's data. At the same time, the master must be in the LE CODED PHY to be able to scan this broadcast and connect. Take effect immediately after setting, can be saved after power off. Remark: RF-BM-BG22A1 and RF-BM-BG22A1I do not support this command. Beacon mode does

	not support Long Range broadcast.

- **Extended Broadcast (Big Broadcast Packet)**

AT+ADV_EXT?	
Function	Query the user-defined **extended** broadcast packet.
Example	AT+ADV_EXT?
Return Value	AT+ADV_EXT=120\r\n XXXXXXXXXXXXXXXXXXXXXXXXX…… OK
Remark	**Parameter 1**: Current extended broadcast data length. **Parameter 2**: XXX is the returned user-defined extended broadcast data. There is a carriage return and line feed (CRLF) followed by parameter 1 and parameter 2 in the returned data. If the user does not set this parameter, it will return “AT+ ADV_EXT=NULL”.

AT+ADV_EXT=	
Function	Set the user-defined extended broadcast packet.
Example	AT+ADV_EXT=120,5000
Return Value	OK INPUT_ADV_EXT:120
Remark	**Parameter 1**: The extended broadcast data length (range:1 byte ~ 251 bytes). **Parameter 2**: Broadcast data input timeout time (range: 1 ms ~ 5000 ms, and the default parameter is 500 ms). The above example is a user-defined extended broadcast with a length of 120 bytes, and the input timeout is 5000 ms. If the broadcast data of the specified length is entered within the set valid time, it will return OK when the specified length is reached, as shown below. If the set timeout time is up but the specified input data length is not reached, it will return to RECEIVE_TIMEOUT. For example: Send →◇AT+ADV_EXT=120,5000 Receive ←◆OK INPUT_ADV_EXT:120 Send→◇ 123456789a123456789a123456789a123456789a123456789a123456789a123456789a123456789a123456789a123456789a123456789a123456789a

	Receive←◆OK The user can customize the extended broadcast data up to 251 bytes. When this function is enabled, the extended broadcast packet will be without the device name. At the same time, the module will automatically add the broadcast length (Len) and broadcast type (0xFF) to the data front end of the data set by the user. **When the length of the extended broadcast data is no less than 189 bytes, the device is connectable. If it exceeds 189 bytes, the device is unconnectable.** Take effect immediately after setting, can be saved after power off.

- **Beacon**

AT+BEACON=?	
Function	Query the parameter range of this command.
Example	AT+BEACON=?
Return Value	AT+BEACON=<0~FFFF>,<0~FFFF>,<0~FFFF>,<-90~4>,<0~FF...>,<0,1> OK
Remark	**Parameter 1**: Company ID, 0x4C00 is by default. **Parameter 2**: Major UUID, 0x0708 is by default. **Parameter 3**: Minor UUID, 0x0506 is by default. **Parameter 4**: Reference RSSI at 1 m, -48 is by default. **Parameter 5**: User-defined UUID data, 0x0112233445566778899AABBCCDDEEFF0 is by default. **Parameter 6**: Enhanced broadcast (0: Disable, 1: Enable). When enabled, it will broadcast three times for every broadcast event, to improve the crawl rate of the master. Remark: In this mode, the serial port is disabled and unavailable. The serial port can be enabled by pulling down the CTS pin.

AT+BEACON?	
Function	Query the Beacon parameters.
Example	AT+BEACON?
Return Value	AT+BEACON=4C00,0708,0506,-48,0112233445566778899AABBCCDDEEFF0 OK

AT+BEACON=	
Function	Set the Beacon parameters.
Example	AT+BEACON=4546,0102,0304,-50,0102030405060708090A0B0C0D0EF010

Return Value	OK
Remark	Set the Company ID to 4546. Set Major to 0102. Set Minor to 0304. Set the reference RSSI at 1 m to -50 dBm. Set user-defined UUID data as 0102030405060708090A0B0C0D0EF010.

- **Scan as a Master**

AT+SCAN=?	
Function	Query the parameter range of this command.
Example	AT+SCAN=?
Return Value	AT+SCAN=[0,1],<1-65535>,<0,1>,<1-255> OK
Remark	**Parameter 1**: The current scan status, 0 means to stop scanning, 1 means scanning. **Parameter 2**: Scan timeout time in s. **Parameter 3**: Whether to enable the display name function, 1: enable, 0: disable (1 is by default) Only effective in master mode and master-slave mode. **Parameter 4**: It means the time interval of scanning the reconnection device list after enabling the reconnection function. Modifying this parameter can increase the speed of automatic reconnection. In s, 3 seconds is by default.

AT+SCAN?	
Function	Query the scan status and timeout time settings.
Example	AT+SCAN?
Return Value	AT+SCAN=0,10,1,3 OK
Remark	**Parameter 1**: 0 means the current device stops scanning. **Parameter 2**: The current scan timeout time is 10 s. **Parameter 3**: 1 means display device name. **Parameter 4**: The time interval of scanning the reconnection device list is 3 seconds. (This parameter is only effective when the automatic reconnection function is enabled.)

AT+SCAN=	
Function	Regularly scan the surrounding slave devices.

Example	AT+SCAN=1,10,1
Return Value	OK 0 53:60:52:A4:3E:66 -67 RF-STAR-SMMT 1 5D:61:9B:78:2E:5E -83 RFstar_2E5E ……
Remark	**Parameter 1**: 1 means to start scanning **Parameter 2**: 10 means the scan timeout is 10 s. Remark: Automatically stop scanning after the number of devices reaches 20 or the scan time reaches 10 seconds.

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 seconds), and print the MAC address, RSSI value, and device name of the slave devices, where "0, 1, 2, 3..." is the serial number of the scanned devices (Scan for devices with name by default).

- **PHY of Master Role**

AT+SCAN_PHY=?	
Function	Query the parameter range of this command.
Example	AT+SCAN_PHY=?
Return Value	AT+SCAN_PHY=[0,1] OK
Remark	0: 1 M PHY 1: CODED PHY Only effective in master mode and master-slave mode.

AT+SCAN_PHY?	
Function	Query the PHY layer of the device during scanning and connection.
Example	AT+SCAN_PHY?
Return Value	AT+SCAN_PHY=0 OK
Remark	The current PHY layer of the device during scanning and connection is 1 M PHY (by default).

AT+SCAN_PHY=	
Function	Set the PHY layer of the device during scanning and connection.
Example	AT+SCAN_PHY=1
Return Value	OK
Remark	Set the scan PHY of the current master role to LE CODED PHY. After setting LE CODED PHY, it can only scan the slave devices under the same LE CODED PHY, and can only connect to the device under LE CODED PHY. Take effect immediately after setting, can be saved after power off. Note: RF-BM-BG22A1 and RF-BM-BG22A1I do not support this command.

- **Scan and Print Out Slave Device Name**

AT+S_NAME=?	
Function	Query the parameter range of this command.
Example	AT+S_NAME=?
Return Value	AT+S_NAME=[0,1] OK
Remark	0: Stop scanning the slave device name. 1: Start scanning the slave device name. Only effective in master mode and master-slave mode.

AT+S_NAME?	
Function	Query the status of this function.
Example	AT+S_NAME?
Return Value	AT+S_NAME=1 OK
Remark	0 means the current scan status is stopped. 1 means the current scan status is scanning.

AT+S_NAME=	
Function	Set the status of scanning slave device name.
Example	AT+S_NAME=1
Return Value	OK MAC:5C:02:72:26:55:88,RSSI:-68,NAME:RFstar_XIANG7 MAC:AC:23:3F:5A:B7:DD,RSSI:-80,NAME:MBeacon ……
Remark	Enable the scan, and if need to stop scanning, please use the command "AT+S_NAME=0". Only effective in master mode and master-slave mode.

- **Connection as a Master**

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 device in the first place of the serial number list returned by "AT+SCAN" command.
Example 2	AT+CONNECT=,F1:F2:F3:F4:F5:F6
Return Value	OK F1:F2:F3:F4:F5:F6 CONNECTED 1
Remark	Connect to 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 time is settable. The timeout prompt: " F1:F2:F3:F4:F5:F6 CONNECT TIMEOUT". After the connection is successful, the last number of the connection prompt string is the handle of the newly established connection, and the current transparent transmission points to the same handle. **Remark:** 1. The number of connected devices has reached 8, and it will return FAIL when using the command to connect to a new device. And one of the connected devices needs to be disconnected before connecting the new device. 2. If the current mode is the master-slave mode, the master device can only connect up to 7 slave devices. 3. Please do not try to connect to an unconnectable broadcasting device.

	4. Only effective in master mode and master-slave mode.

- **Display the Connected Devices**

AT+CNT_LIST	
Function	Display the list of currently connected devices.
Example	AT+CNT_LIST
Return Value	AT+CNT_LIST= 1* (FF:1C:2B:D1:4C:BD) 2 (EB:71:5B:DE:08:87) OK
Remark	The string in red is the connect handle, and the " * " symbol behind the handle indicates that the connection is the master device (mobile phone or the module in master mode) connected to the slave role. And the string in the bracket is the device MAC address corresponding to the handle. This command is used with AT+TTM_HANDLE together. For example, AT+TTM_HANDLE=1 means that the master role transparently transmits the data value to the device whose handle value is 1 and MAC address is FF:1C:2B:D1:4C:BD.

- **Disconnection**

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

AT+DISCONNECT=	
Function	Disconnect the specified connection.
Example	AT+DISCONNECT=1,1
Return Value	OK F1:F2:F3:F4:F5:F6 DISCONNECTED
Remark	In the master role, disconnect the slave device with the handle value of 1.

AT+DISCONNECT	
Function	Disconnect all the currently connected devices.
Example	AT+DISCONNECT
Return Value	OK F1:F2:F3:F4:F5:F6 DISCONNECTED 5D:61:9B:78:2E:5E DISCONNECTED

- **Automatic Reconnection**

AT+AUTO_CNT=?	
Function	Query the parameter range of this command.
Example	AT+AUTO_CNT=?
Return Value	AT+AUTO_CNT=[0,1],<FF:FF:FF:FF:FF:FF>,<0,1> OK
Remark	**Parameter 1**: 0: Disable the automatic reconnection function. 1: Enable automatic reconnection function. **Parameter 2**: Optional parameter. Add the device MAC address to the automatic reconnection list. 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 the devices in the automatic reconnection list. When there are parameters 1 and 2, the automatic reconnection function takes effect on the parameter 2 specified MAC address device, and other devices maintain the original status. **Parameter 3**: Optional parameter. 1: Automatic reconnection function will be enabled immediately, although the device is not

	connected before. The default setting is 0. If the parameter is set as 1, after the command is sent, pls operate according to the following steps to automatically reconnect the slave devices. **Note: The device with the automatic reconnection function will not automatically connect to the slave devices in the following cases:** 1. Use "AT+DISCONNECT" 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 current automatic reconnection status of the device and the stored device list of the automatic reconnection devices.
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 (can be saved after power off). Device EB:71:5B:DE:08:87 disabled automatic reconnection function.

AT+AUTO_CNT=	
Function	Set the automatic reconnection function. Only effective in master mode and master-slave mode.
Example 1	AT+AUTO_CNT=1
Return Value	OK
Remark	Enable the automatic reconnection function of all devices in the automatic reconnection list.
Example 2	AT+AUTO_CNT=0,EB:71:5B:DE:08:87

Return Value	OK
Remark	Disable the automatic reconnection function of the device with MAC address EB:71:5B:DE:08:87. Take effect immediately after setting, can be saved after power off.
Example 3	AT+AUTO_CNT=1,EB:71:5B:DE:08:87,1
Return Value	OK
Remark	Add the device with MAC address EB:71:5B:DE:08:87 to the automatic reconnection device list. The device will automatically reconnect immediately.

- **Delete Automatic Reconnection Device**

AT+DEV_DEL=	
Function	Delete the stored devices. Take effect immediately after setting, can be saved after power off. Only effective in master mode and master-slave mode.
Example 1	AT+DEV_DEL=FF:1C:2B:D1:4C:BD
Return Value	OK
Remark	Delete the device with the MAC address of FF:1C:2B:D1:4C:BD. Query the stored devices by “AT+AUTO_CNT?”.
Example 2	AT+DEV_DEL=ALL
Return Value	OK
Remark	Delete all devices in the list. This command will not actively disconnect the device. For example: When the device is connected to the FF:1C:2B:D1:4C:BD device, only the stored device list is cleared after this command is executed, and the connection with the FF:1C:2B:D1:4C:BD device will not be actively disconnected.

- **Connection Interval**

AT+CNT_INTERVAL=?	
Function	Query the parameter range of this command.
Example	AT+CNT_INTERVAL=?
Return Value	AT+CNT_INTERVAL=[6~3200] OK
Remark	The parameter range is 6 ~ 3200. The connection interval = parameter * 1.25 ms, which corresponds to 7.5 ms ~ 4000 ms.

	20 ms is by default.

AT+CNT_INTERVAL?	
Function	Query the current connection interval of the device.
Example	AT+CNT_INTERVAL?
Return Value	AT+CNT_INTERVAL=16 OK
Remark	The current connection interval of the device is 20 ms (16 * 1.25 ms).

AT+CNT_INTERVAL=	
Function	Set the device connection interval.
Example	AT+CNT_INTERVAL=16
Return Value	OK
Remark	1. The connection interval is set as 20 ms. Take effect immediately after setting, can be saved after power off. 2. The connection interval can reach less than 20 ms (minimum 8 ms), when the Bluetooth module is working as a master. 3. Due to system problems with mobile phones, the minimum connection interval can only be 20 ms. 4. After the connection interval takes effect, the connection interval will be coordinated according to different mobile phones. Maximum coordination to 2 times the set interval. For example, if the connection interval is set to 10 ms by the command, the maximum coordinated connection interval is 20 ms.

- **Designate Transmission Device**

AT+TTM_HANDLE=?	
Function	Query the available handle value.
Example	AT+TTM_HANDLE=?
Return Value	AT+TTM_HANDLE=[1~8] OK
Remark	The handle value range is 1 ~ 8. And it is allocated by the system. Remark: There are at most 8 values. It is that the module is simultaneously connected to 8 slave devices, and each handle corresponds to a slave device.

AT+TTM_HANDLE?	
Function	Query the current data transparent transmission handle of the device.
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=1
Return Value	OK
Remark	Set the device with a handle value of 1 to transmit data. Use AT+CNT_LIST to get the current handle value of the device to be connected. Take effect immediately after setting, do not be saved after power off. Only effective in master mode and master-slave mode.

- **Set the UUID of Slave Role**

AT+SERVICE=?	
Function	Query the 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 reboot). **Parameter 2**: Device service UUID (the 3rd 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). Remark: 1. The basic UUID of 0000xxxx-0000-1000-8000-00805F9B34FB cannot be used. 2. This command is only effective in the slave role. (Slave mode, master-slave mode, and Beacon mode)

AT+SERVICE?

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

AT+SERVICE=	
Function	Set the related service parameters of the device.
Example	AT+SERVICE=0,FFF0,FFFF1,FFF2,FFF3
Return Value	OK
Remark	The device is in 16-bit UUID mode. UUID is FFF0, FFFF1, FFF2, FFF3 respectively. Set the basic 128-bit UUID, if it exceeds 16 bytes, only the first 16 bytes will be taken, if it is less than 16 bytes, the end will be filled with 0. Take effect after reboot, can be saved after power off.

- **Enable/Disable UUID Configuration Function of Master Role**

AT+ UUID_SCAN=?	
Function	Query the parameter range of this command.
Example	AT+ UUID_SCAN=?
Return Value	AT+ UUID_SCAN?=[0,1] OK
Remark	0: Enable the user-defined UUID transmission channel function. 1: Disable the user-defined UUID transmission channel function.

AT+ UUID_SCAN?	
Function	Query the enable status of the user-defined UUID transmission channel.
Example	AT+ UUID_SCAN?
Return Value	AT+ UUID_SCAN=0 OK
Remark	0: Disable the user-defined UUID transmission channel function. 1: Enabled the user-defined UUID transmission channel function. **Remark: After enabled, the master will print the characteristic UUID of each slave in turn when connecting. It is shown as follows:** -CHAR:0 UUID:002A,Read;

	-CHAR:1 UUID:052A,Indicate; -CHAR:2 UUID:E4FF,Notify; -CHAR:3 UUID:E9FF,Write Without Response,Write; -CHAR:4 UUID:F3FF,Read,Notify; -CHAR:5 UUID:91FF,Read,Write Without Response,Write; …… Up to 16 services and 32 UUID channels can be found. Then the "AT+TRX_CHAN" can be used to select the data sending and receiving channel according to the serial number. Take effect immediately after setting, can be saved after power off.

AT+ UUID_SCAN=	
Function	Disable/enable the user-defined UUID transmission channel function. Only effective in master mode and master-slave mode.
Example	AT+ UUID_SCAN=1
Return Value	OK
Remark	Enable user-defined UUID transmission channel function

- **Configure UUID of Master Role**

AT+TRX_CHAN=	
Function	Set the user-defined UUID channel for sending and receiving. Only effective in master mode and master-slave mode.
Example	AT+TRX_CHAN=1,8,7,0
Return Value	OK
Remark	**Parameter 1**: The connection handle value, can be obtained by "AT+CNT_LIST". **Parameter 2**: The serial number is scanned and printed by the serial port by "AT+UUID_SCAN". This parameter sets the channel to be selected when the master sends data (channels with Write attribute). **Parameter 3**: The serial number is scanned and printed by the serial port by "AT+UUID_SCAN". This parameter sets the channel to be selected when the master receives data (channels with Notify and Indicate attributes). **Parameter 4:** The specific attribute to be selected of Parameter 2 Write operation. For example, if the Write channel to be selected is Without Response attribute, the parameter should be 0; if the Write channel to be selected is Write attribute, the parameter should be 1.

	Take effect after setting, can be saved after power off (Supports the use under multi-connections, but the function of saving after power off is only valid for the first connected device).

- **Master Role Reads the Specified UUID Data**

AT+READ_UUID=	
Function	Read the specified channel data. Only effective in master mode and master-slave mode.
Example	AT+READ_UUID=1,8
Return Value	OK
Remark	**Parameter 1**: The connection handle value, can be obtained by "AT+CNT_LIST". **Parameter 2**: The serial number is scanned and printed by the serial port by "AT+UUID_SCAN". This parameter sets the channel to be selected when the master reads data (channels with Read attribute).

- **Send Data by AT Command**

AT+SEND=?	
Function	Query the parameter range of this command.
Example	AT+SEND=?
Return Value	AT+SEND=[1~8],[1~3328],<1~5000> OK
Remark	**Parameter 1**: Connection handle value (range: 1~8), can be obtained by "AT+CNT_LIST". **Parameter 2**: Length of data sent (range: 1 byte ~ 3328 bytes). **Parameter 3**: The input timeout time during sending data (range: 1 ms ~ 5000 ms. 500 ms is by default).

AT+SEND=	
Function	The master role sends data in AT command mode.
Example	AT+SEND=1,10,1000
Return Value	OK INPUT_BLE_DATA:10
Remark	The example above shows that the connection handle value is 1, the data length is 10 bytes, and the input timeout time is 1000 ms. If the sending data with the specified length is entered within the set valid time, it will return OK when the specified length is reached. If the set timeout time is up but the specified input length is

	not reached, it will return to RECEIVE_TIMEOUT (If there is “\r\n”, two bits will be occupied).
Receiving Specification	In AT command mode, if BLE data is received from the other end, the prefix "+RECEIVED:" will be printed. The first parameter after the prefix is the connection handle value, and the second parameter is the length of the received data, "123456789A\r\ n" is the received data. When receiving BLE data, it will return: +RECEIVED:1,10 OUTPUT_BLE_DATA 123456789A OK If it is the data received in transparent transmission mode, there will be no prefix of “+RECEIVED” and the data will be printed directly.

- **Observer**

AT+OBSERVER?	
Function	Query the current configuration of the observer function.
Example	AT+OBSERVER?
Return Value	AT+OBSERVER=1,1,F1:F2:F3:F4:F5,RF,-60,4C00
Remark	**Parameter 1**: Observer function status: (0: Disable, 1: Enable the normal observer function, 2: Enable scanning extended broadcast packets.) **Parameter 2**: Filter, parameter range 0 ~ 15. It can enable the observer filter function (0: Disable is by default.). Each bit determines the enable and disable of the corresponding filtering function (0: Disable, 1: Enable). The specific meaning is as follows: bit 0: MAC address bit 1: Broadcast name bit 2: RSSI value bit 3: Vendor ID bit 4: The specified data field of the broadcast packet or broadcast response packet bit 5 ~ 7: Reserved **Parameter 3**: The MAC address that needs to be filtered. The 6-byte complete MAC address needs to be filled in. **Parameter 4**: The broadcast name that needs to be filtered, at least one character needs to be filled in. The device in which the broadcast name starts with the selected character will be filtered out. **Parameter 5**: The RSSI that needs to be filtered. The value less than the RSSI value will be filtered. **Parameter 6**: The vendor ID that needs to be filtered. 2-byte complete ID needs to be filled in.

	Parameter 7: The data field that needs to be filtered. The bit 4 of parameter 4 should be set as 1. The length is 1 ~ 16 bytes. The specified data contained in the broadcast packet or broadcast response packet can be filtered. In the observer mode, the broadcasts from the surrounding slave devices will be monitored, but not every broadcast from the slave device can be monitored. For example, if a device broadcasts in a period of 1 s, it may take 2 to 3 times broadcasts to scan the broadcast device for once. This monitor loss event is varying to some degree from the number of surrounding devices and signal strength (RSSI). At the same time, the device will not receive broadcast packets, when the observer itself switches channels at the end of each scanning interval. If the device that satisfies the filtering conditions is in the broadcast response packet, the time to scan the broadcast response packet of the device will be longer, because the efficiency of the observer itself in obtaining the response packet is not high, and the response packets cannot be obtained every time.

AT+OBSERVER=	
Function	Disable/enable the observer function to scan and print out the slave devices. Only effective in master mode and master-slave mode.
Example 1	AT+OBSERVER=1,20,,,-60,,020106
Return Value	OK MAC:FA:8D:0D:27:50:C6, RSSI:-50 ADV/RSP:0201060C095246737461725F3838383838
Remark	The normal observer function is enabled, and the slave device information is always scanned and printed out after it is enabled. And the scan filter function is enabled too. That is, only devices whose RSSI value is greater than -60 dBm and broadcast name with "020106" can be scanned. If you only would like to filter the devices with “RF” character in the broadcast name, only need to change the “020106” to “5246”. Wherein “5246” is the hexadecimal format for ASCII character “RF”. Or, you can change the parameter 4 to do the filter. The command "AT+OBSERVER=0" can be sent to stop scanning. Wherein, "ADV" is the broadcast packet data, and "RSP" is the broadcast response packet.
Example 2	AT+OBSERVER=2
Return Value	OK Primary PHY:FA:8D:0D:27:50:C6,

	Secondary PHY:-75, SID:0, RSSI:-47, ADV:8FFF3132333435363738396131323334353637383961313233343536373839613132333435363738396131323334353637383961313233343536373839613132333435363738396131323334353637383961313233343536373839613132333435363738396131323334353637383961313233343536373839610D0A
Remark	Enable scanning extended broadcast packet function, "Primary PHY" is the primary physical layer, "Secondary PHY" is the second physical layer, and "SID" is the authentication ID. Extended broadcast has no filtering function, and parameters of 2 ~ 6 are considered invalid.

- **PHY Rate**

AT+PHY=?	
Function	Query the parameter range of this command.
Example	AT+PHY=?
Return Value	AT+PHY=[1~15] OK
Remark	1: 1M PHY 2: 2M PHY 4: 125k Coded PHY 8: 500k Coded PHY This parameter is a bitfield, multiple PHYs can be set. For example: Setting AT+PHY=3 means 1M PHY and 2M PHY are preferred. A setting of 15 means that all 4 PHY rates are preferred. The default PHY is 1M PHY. This command only takes effect in slave mode. If the slave device is connected, the parameters will be updated immediately, otherwise, it will take effect at the next connection, and the settings will be saved after power-off. Remark: RF-BM-BG22A1 and RF-BM-BG22A1I only support 1M PHY and 2M PHY.

AT+PHY?	
Function	Query the preferred PHY when connecting.
Example	AT+PHY?
Return Value	AT+PHY=1

	OK
Remark	The preferred PHY when connecting is 1M PHY.

AT+PHY=	
Function	Set the preferred PHY when connecting.
Example	AT+PHY=2
Return Value	OK
Remark	Set the preferred PHY currently connected to 2 M.

- **Baud Rate**

AT+UART=?	
Function	Query the parameter range of this command.
Example	AT+UART=?
Return Value	AT+UART=[1200,2400,4800,9600,14400,19200,38400,56000,57600,115200,128000,230400,256000,460800,500000,512000,921600] OK
Remark	The default Baud rate is 115200 bps. After actual verification, under the conditions of the maximum MTU of the 2M physical layer and the minimum connection interval, the baud rate above 512000 bps can reach a stable transmission rate of up to 50 KB/s.

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

AT+UART=	
Function	Set the serial port baud rate.
Example	AT+UART=9600
Return Value	OK
Remark	Set the baud rate as 9600 bps. The changed setting will take effect after 2 s and print the string "BPS SET AFTER 2S..."

	Can be saved after power off.

- **Serial Port Frame Size and Timeout Time**

AT+PACK=?	
Function	Query the parameter range of this command.
Example	AT+PACK=?
Return Value	AT+PACK=<0~2048>,<1~1000> OK
Remark	**Parameter 1**: Serial port frame receiving size, in byte (Range: 0 byte ~ 1024 bytes), 0 byte is by default. When set to 0, the module will automatically adjust the frame size according to the current baud rate to meet high-speed transparent transmission. **Parameter 2**: Serial port frame receiving timeout time, in ms. Range: 1 ms ~ 1000 ms. **50 ms is by default.** The parameter is used to judge the end of the frame of the serial port input data stream. When the serial port data cut-off time exceeds the setting, the module will judge that the current serial port input data frame has been completed, and will forward the frame data after the timeout ends. When parameter 1 is set to a value non-zero, after the serial port input data length reaches the set value of parameter 1, the module will not make a frame end timeout judgment and will immediately forward the received frame data.

AT+PACK?	
Function	Query the receiving frame size and the timeout time.
Example	AT+PACK?
Return Value	AT+PACK=0,50 OK
Remark	The current timeout time is 50 ms. If the returned frame receiving size is 0, it means that the module will automatically adjust the frame receiving size according to the current baud rate.

AT+PACK=	
Function	Set the receiving frame size and the timeout time.
Example	AT+PACK=250,100
Return Value	OK
Remark	Set the receiving frame size to 250 bytes, and the receiving timeout time to 100 ms. Take effect immediately after setting, can be saved after power off.

- **Serial Port Echo**

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

AT+ECHO=	
Function	Set the serial port echo.
Example	AT+ECHO=1
Return Value	OK
Remark	Enable echo. Take effect immediately after setting, cannot be saved after power off.

- **Device Status Display**

AT+STATUS=?	
Function	Query the 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 status of the device.
Example	AT+STATUS?
Return Value	AT+STATUS=0 OK

AT+STATUS=	
Function	Set the display status of the device.
Example	AT+STATUS=0
Return Value	OK
Remark	Disable device status display. Take effect immediately after setting, cannot be saved after power off.

- **User Authentication**

AT+AUTH?	
Function	Query the parameter range of this command.
Example	AT+AUTH=?
Return Value	AT+AUTH=<0,1>,<******>,<1~65535> OK
Remark	Query parameter list and value range **Parameter 1**: Enable/disable user authentication function. **Parameter 2**: Key, up to 16 bytes of any visible character. **This parameter cannot be empty when authentication is enabled.** **Parameter 3**: Authentication valid time (in s), 15 s is by default. Remark: Take effect after reboot. 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 user authentication function.
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**: The valid time of user authentication is 15 s.

AT+AUTH=	
Function	Set the user authentication.
Example	AT+AUTH=1,12GH**__)),10
Return Value	OK
Remark	Enable user authentication function. Set key to 12GH**_)), and the valid time of user authentication is 10 s. Take effect immediately after setting, can be saved after power off.

- **Enter User Authentication Key**

AT+AUTH_KEY=	
Function	Enter the user authentication key on the master end.
Example	AT+AUTH_KEY=1,123456
Return Value	OK
Remark	**Parameter 1**: The connection handle value of the slave role. **Parameter 2**: When the authentication function is enabled on the slave device to be connected, the master needs to enter the key in the form of a command for authentication. **Only effective in master mode and master-slave mode.**

- **Pairing Function of Slave Role**

AT+PAIR=?	
Function	Query the parameter range of this command.
Example	AT+PAIR=?
Return Value	AT+PAIR=<0,1>,<******> OK
Remark	**Parameter 1**: 0: Disable the pairing function of the slave role. 1: Enable the pairing function of the slave role. **Parameter 2**: Pairing passkey, 123456 is by default. Only effective in slave mode.

AT+PAIR?

Function	Query the pairing setting of the slave role.
Example	AT+PAIR?
Return Value	AT+PAIR=0,123456 OK
Remark	Disable the pairing function of the slave role, and the pairing passkey is 123456.

AT+PAIR=	
Function	Set the pairing function of the slave role.
Example	AT+PAIR=1,135648
Return Value	OK
Remark	Enable the pairing function of the slave role and set the pairing passkey to 135648. The length of the passkey cannot exceed 6 characters. Take effect after reboot, can be saved after power off.

- **Pairing Function of Master Role**

AT+MASTER_PAIR=?	
Function	Query the parameter range of this command.
Example	AT+MASTER_PAIR=?
Return Value	AT+MASTER_PAIR=<0,1,2,3,4> OK
Remark	According to different pairing interaction processes, the master role has the following pairing functions for setting: 0: Display Only 1: Display with Yes/No-buttons 2: Keyboard Only (by default) 3: No Input and No Output 4: Display with Keyboard Remark: According to the above setting function, there will be 5 different pairing methods and processes, as shown below (Please refer to the table below for the correspondence between the pairing function and the pairing method) Pairing methods description: **A. Just works** In this case, it is impossible to confirm the identity of the connected device. This method does

not require interaction. The device will be paired and encrypted but not authenticated.

B. Numeric Comparison

In this mode, both devices will display a 6-digit key. The user must confirm that the two devices display the same key by pressing a button.

C. Passkey Entry (Initiator displays, Responder inputs)

The passkey is displayed on the Responder device and must be entered on the Initiator device.

D. Passkey Entry (Responder displays, Initiator inputs)

The passkey is displayed on the Initiator device and must be entered on the Responder device to confirm the authentication.

E. Passkey Entry (Responder and Initiator inputs)

In this case, both devices must enter the passkey.

The master device can generally be regarded as Responder, and the module adopts Keyboard Only in the master role by default (Corresponding pairing method C: Initiator displays, Responder inputs). In this mode, the master device will receive the pairing key request from the slave device (Initiator), at this time, the pairing passkey needs to be entered through the AT command “AT+PASSKEY=” to complete the pairing and bonding.

The configuration of this device should be set according to the configuration of the slave device to be paired, otherwise, the bonding may be failed.

Corresponding Reference of Pairing Function		Initiator				
		Display Only	Display with Yes/No-buttons	Keyboard Only	No Input and No Output	Display with Keyboard
Responder	Display Only	Just Works	Just Works	R displays I inputs	Just Works	R displays I inputs
	Display with Yes/No-buttons	Just Works	Numeric Comparison	R displays I inputs	Just Works	Numeric Comparison
	Keyboard Only	I displays R inputs	I displays R inputs	R displays I inputs	Just Works	I displays R inputs
	No Input and No Output	Just Works	Just Works	Just Works	Just Works	Just Works
	Display with	I displays	Numeric	R displays	Just Works	Numeric

	Keyboard	R inputs	Comparison	I inputs		Comparison

AT+MASTER_PAIR?	
Function	Query the pairing setting of the master role.
Example	AT+MASTER_PAIR?
Return Value	AT+MASTER_PAIR=2 OK
Remark	The current pairing method is Keyboard Only.

AT+MASTER_PAIR=	
Function	Set the pairing function of the master role.
Example	AT+MASTER_PAIR=0
Return Value	OK
Remark	Set the pairing setting of the master role to Display Only. Take effect after reboot, can be saved after power off.

- **Enter Pairing Passkey of Master Role**

AT+PASSKEY=	
Function	Enter the passkey when the master role is paired with the slave device.
Example	AT+PASSKEY=1,123456
Return Value	OK
Remark	**Parameter 1**: The connection handle value of the slave role. **Parameter 2**: When the pairing function is enabled on the slave device to be connected, enter the pairing passkey in the form of a command. Only effective in **master mode and master-slave mode**.

- **Pairing List**

AT+PAIR_LIST	
Function	Query the pairing list.
Example	AT+PAIR_LIST
Return Value	AT+PAIR_LIST= 0 (FF:1C:2B:D1:4C:BD) 1 (EB:71:5B:DE:08:87)

	…… OK
Remark	0, 1 is the pairing list serial number. There can be up to 6 paired devices under the master role or slave role respectively. When using this command in the master role (master and master-slave mode), the paired slave devices with the master will be obtained. When using this command in the slave role, the paired master devices with the slave will be obtained. If switch the working role, the current saved list of paired devices will be cleared.

- **Delete Paired Device**

AT+PAIR_DEL=	
Function	Delete the paired device.
Example 1	AT+PAIR_DEL=0
Return Value	OK
Remark	Delete the device with the serial number 0 in the pairing list. The device under connection will be disconnected after deletion. The pairing list serial number can be obtained through "AT+PAIR_LIST"
Example 2	AT+PAIR_DEL=ALL
Return Value	OK
Remark	Delete all devices in the pairing list. The devices under connection will be disconnected after deletion. When using this command in the master role (master and master-slave mode), the paired slave devices with the master will be deleted. When using this command in the slave role, the paired master devices with the slave will be deleted.

- **Sleep Mode**

AT+SLEEP=?	
Function	Query the parameter range of this command.
Example	AT+SLEEP=?
Return Value	AT+SLEEP=<0,1>,<0,1>,<0,1> OK
Remark	**Parameter 1**: Device serial port function switch (0: disable. 1: enable)

	Parameter 2: Device BLE function switch (0: disable. 1: enable) **Parameter 3**: Device serial port wake-up function switch (0: disable. 1: enable) Remark: After the serial port function is disabled, set the **CTS** pin at a high level first and then set it low to **wake up the serial port.** Also, it can be enabled by sending a command “AT+SLEEP=1 (BLE function needs to be enabled). If the serial port wake-up function is enabled, you can wake up the module by sending a **wake-up character** through the serial port during sleep. To wake up the module, the wake-up character must be **less than or equal to 3 bytes**, and at least 1 byte. Use parameter 2 to disable the BLE function. If the device is under connection, all connections with the device will be disconnected and the broadcast will be disabled. If the device is under broadcasting, the broadcast will be disabled. When the device is in the master role (in the master and master-slave mode), and the currently connected device is enabled the automatic reconnection function, the device will not automatically reconnect after disabling the BLE function. 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 the current sleep mode of the device.
Example	AT+SLEEP?
Return Value	AT+SLEEP=1,1,0 OK
Remark	**Parameter 1**: Enable the device serial port function. **Parameter 2**: Enable the device BLE function. **Parameter 3**: Disable the device serial port wake-up function (by default).

AT+SLEEP=	
Function	Set the device sleep mode.
Example	AT+SLEEP=
Return Value	AT+SLEEP=0, 0, 0 OK

Remark	Disable the device's BLE function, serial port, and serial port wakeup functions. If the device is connected, it will immediately disconnect the current connection. Take effect immediately after setting, cannot be saved after power off.

- **Enable/Disable Watchdog**

AT+WDOG?	
Function	Query the watchdog function status.
Example	AT+WDOG?
Return Value	AT+WDOG=0 OK
Remark	0: Disable Watchdog 1: Enable Watchdog. Enabled by default.

AT+WDOG=	
Function	Set the watchdog function.
Example	AT+WDOG=0
Return Value	OK
Remark	Disable the watchdog function, **the overall power consumption will be reduced by 2 μA ~ 3 μA**. Take effect after reboot, can be saved after power off.

- **Restart Device**

AT+RESTART	
Function	Restart the device.
Example	AT+RESTART
Return Value	OK
Remark	The device will be rebooted after setting. Take effect immediately.

- **Reset Device**

AT+RESET	
Function	Reset the device.
Example	AT+RESET
Return Value	OK
Remark	The device will be rebooted after setting. Take effect immediately.

- **Query Firmware Version**

AT+VERSION	
Function	Query the device firmware version.
Example	AT+VERSION
Return Value	AT+VERSION= RF_BM_BG22A3_V0.2.1_2021.01.21 OK
Remark	Query the firmware version information and the updated date.

6 Transparent Transmission Test

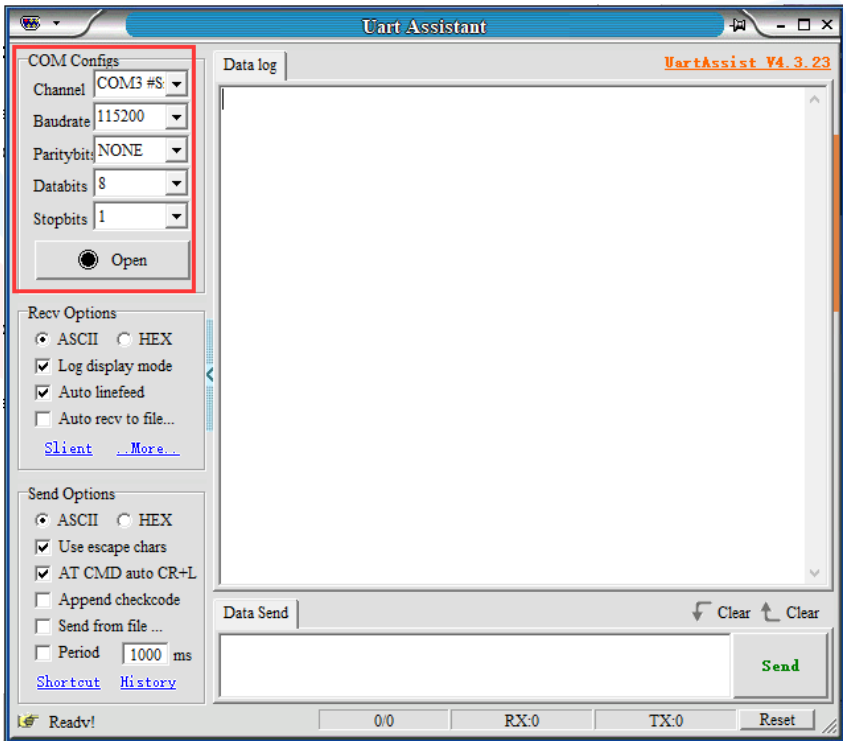
6.1 Test by APP (Android)

1. Turn on the mobile phone's Bluetooth function, 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.

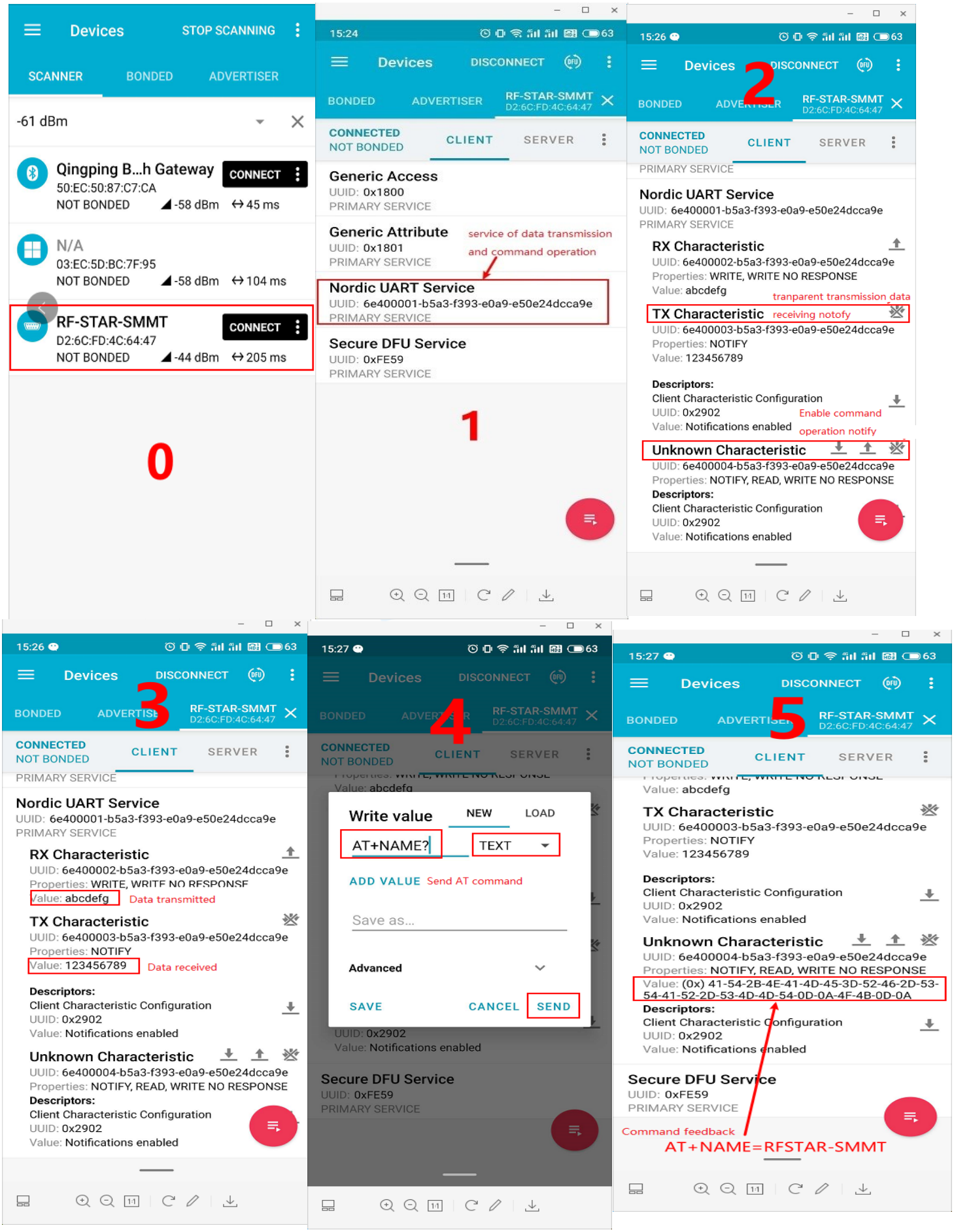
nRF Connect

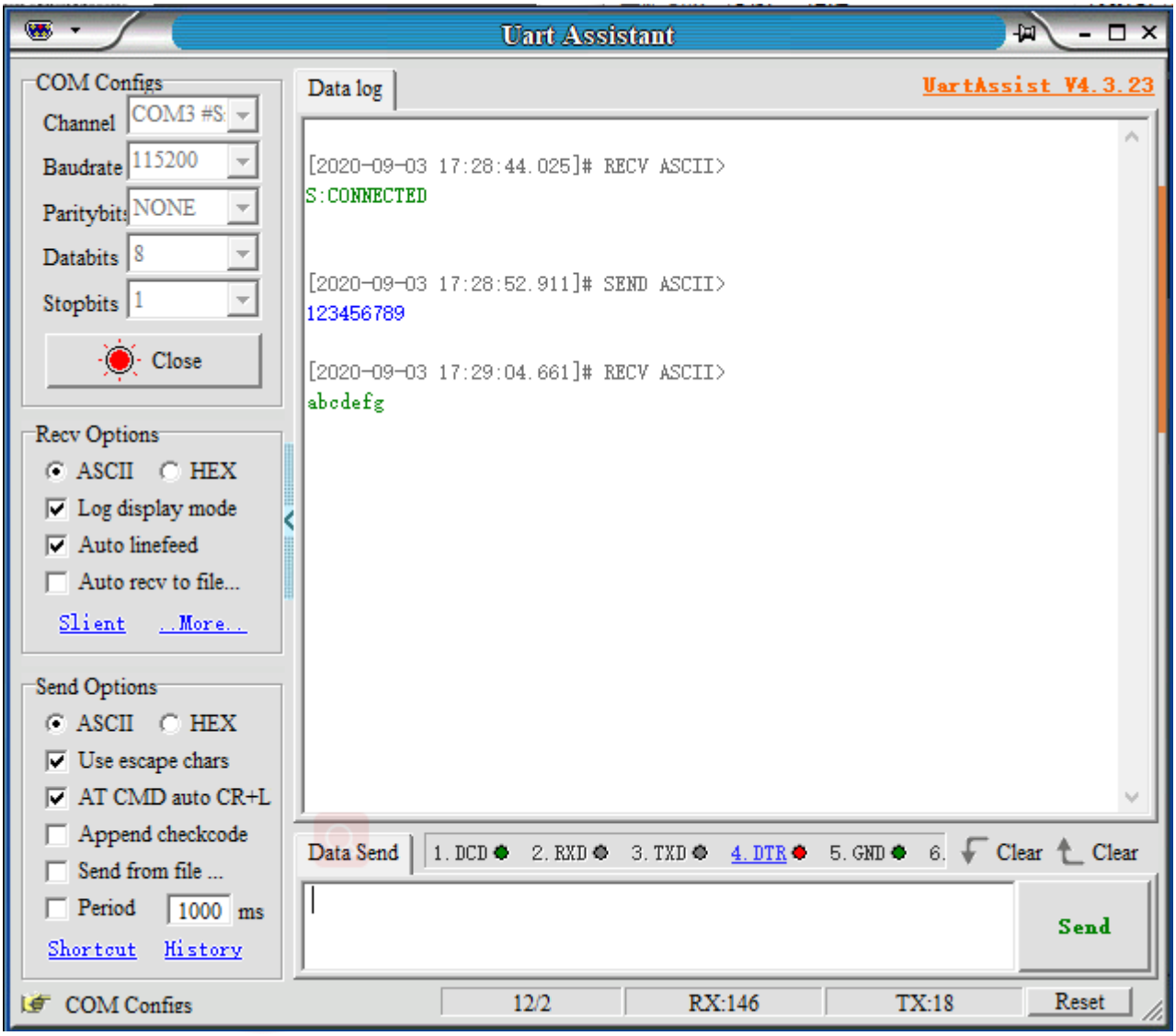
2. Connect the module to the COM port of the computer through the USB to serial port tool, and check the computer port number used (step: right-click the computer → management → device manager → port).

   Open the UartAssist tool, and 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 nRF Connect to search (mobile phone's Bluetooth needs to be turned on), and 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 is: RFstar_XXXX**). After the connection is successful, the Service UUID of the module appears on the mobile phone APP side, 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
BONDED
RF-STAR-SMMT
D2:6C:FD:4C:64:47
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



6.2 Test by PC End

Preparation before Use

1. Hardware preparation
   - PC with standard Type-A USB interface
   - RF-DG-40A (nRF52840 dongle)
   - RF-BM-BG22Xx module
2. Software preparation
   - nRF Connect for Desktop

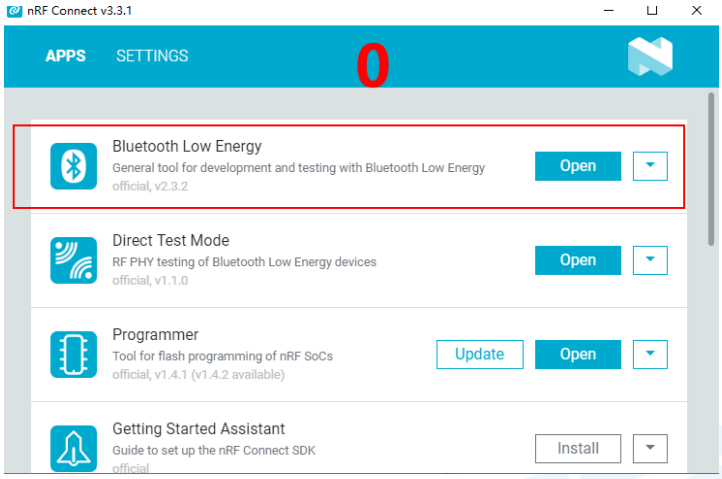
   Download address:

   https://www.nordicsemi.com/Software-and-tools/Development-Tools/nRF-Connect-for-desktop/Download#infotabs

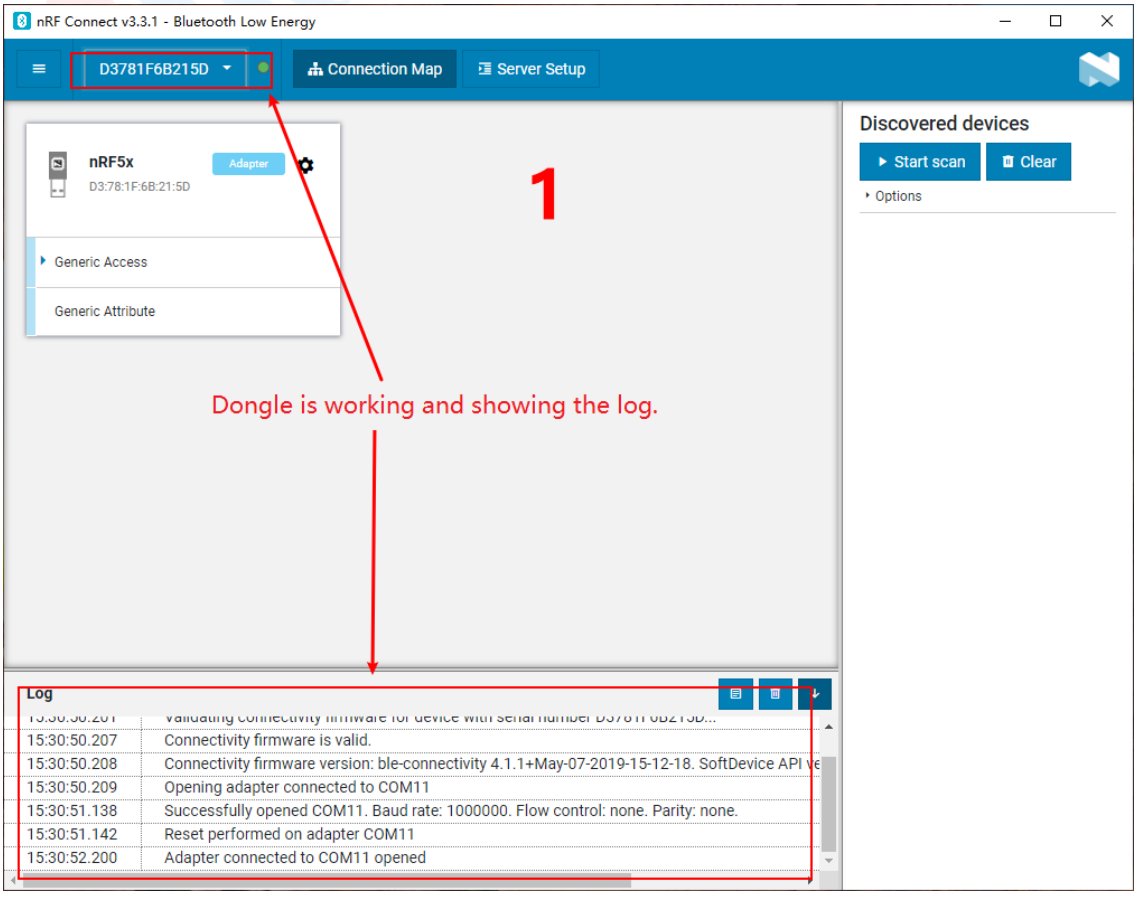
- Operation system: MacOS, Linux, or Windows 7 or later

Connection Steps

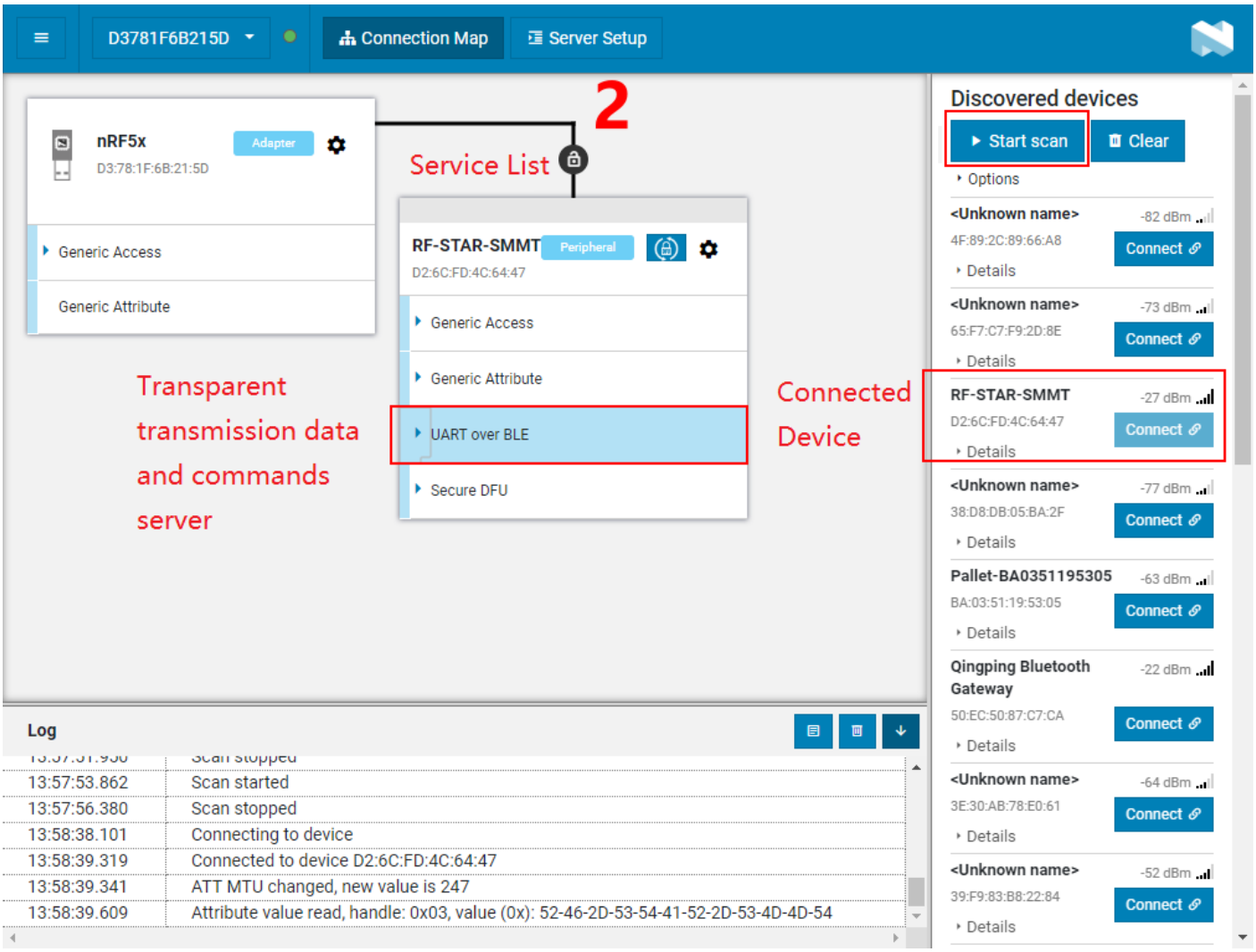
1. After the software is successfully installed, connect the RF-DG-40A to the PC via USB, open nRF Connect for Desktop, select Bluetooth Low Energy, if there is no Open option, you need to click Install first, as shown below.



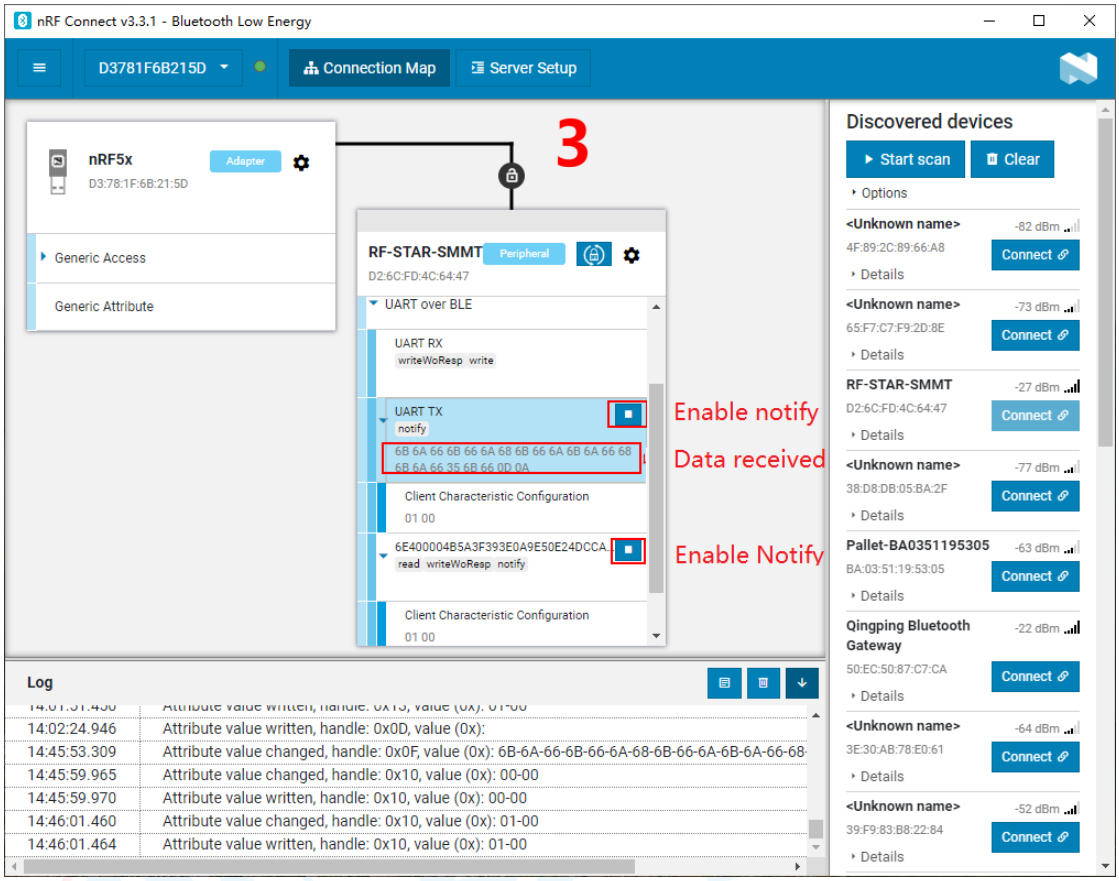
2. After installation, click the Open button and the operation interface will appear. At this time, you need to select the corresponding Dongle device for normal use. Click Select device to pop up the device name, and then click to select the corresponding device (this device name corresponds to the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

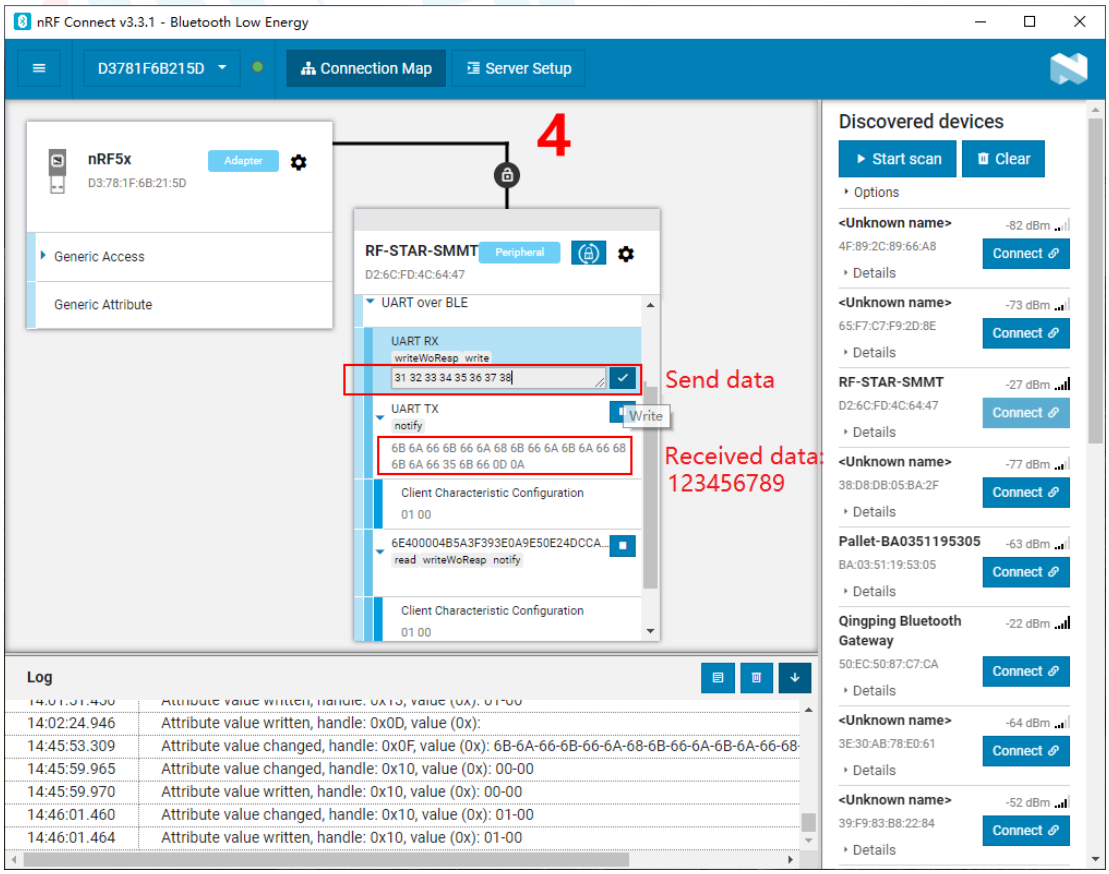


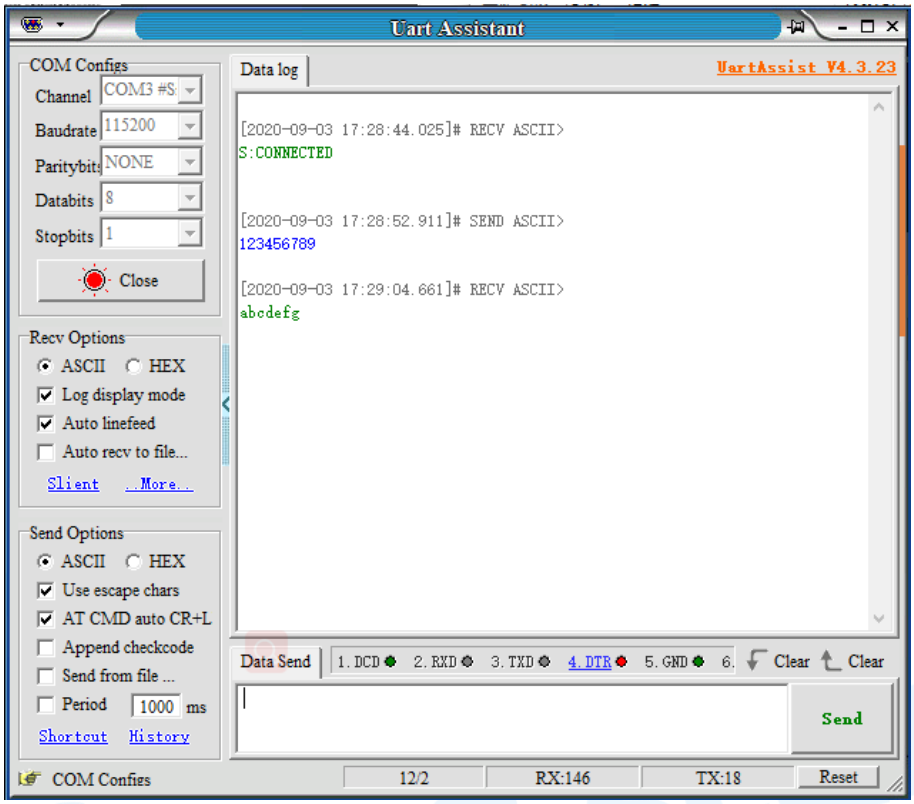
3. After the Dongle device is selected successfully, you can click Generic Access to view the related information of the device as the host. Then click the Start scan button to start scanning for broadcast devices, and then the scanned slave devices will be listed in the window on the right, after finding the corresponding slave device and clicking Connect (The default factory name is: RFstar_XXXX, the following example uses the RF-BM-BG22A1 module as the slave device, referred to as BG22A1), as shown in the figure below, Dongle has successfully connected the slave device BG22A1:

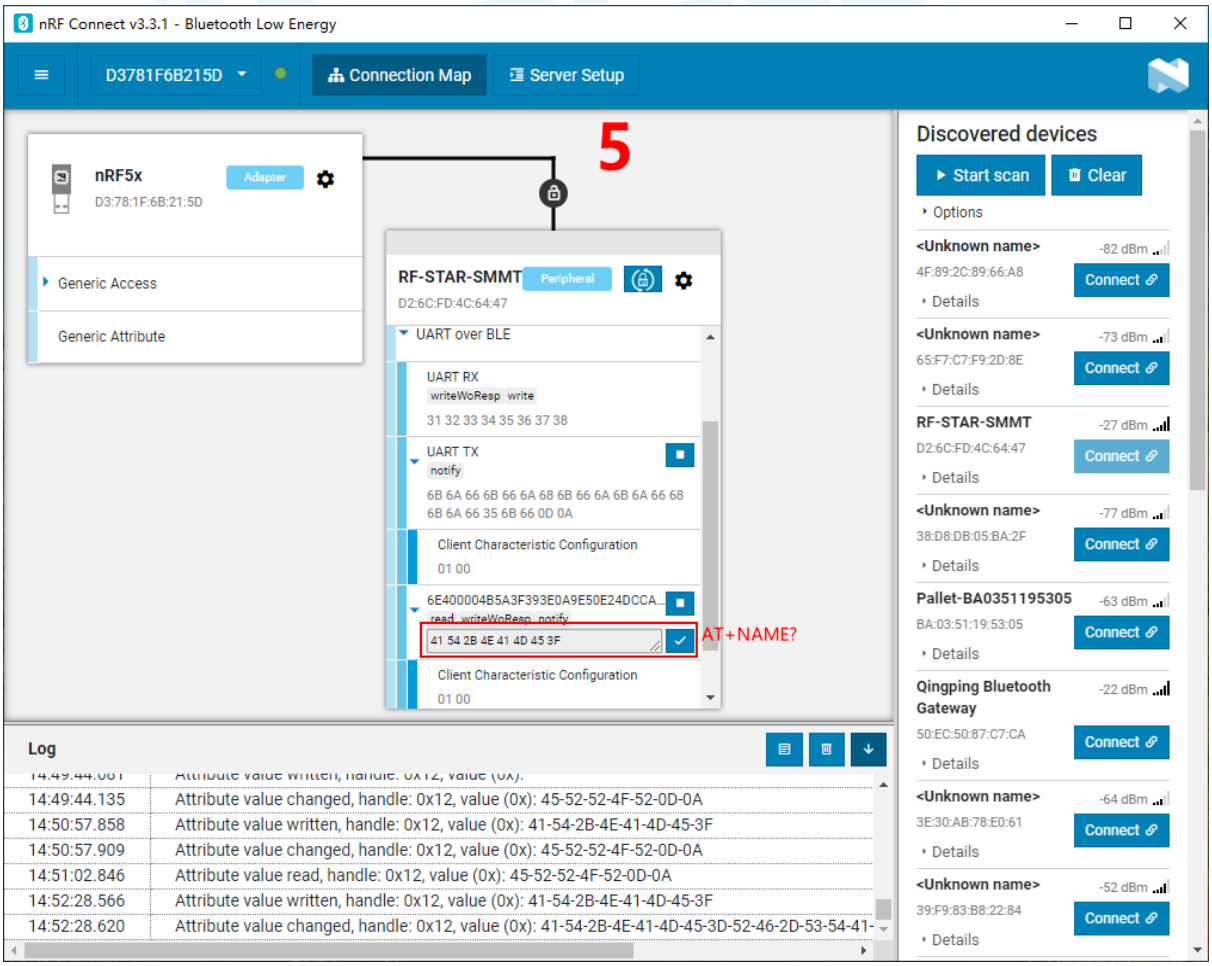


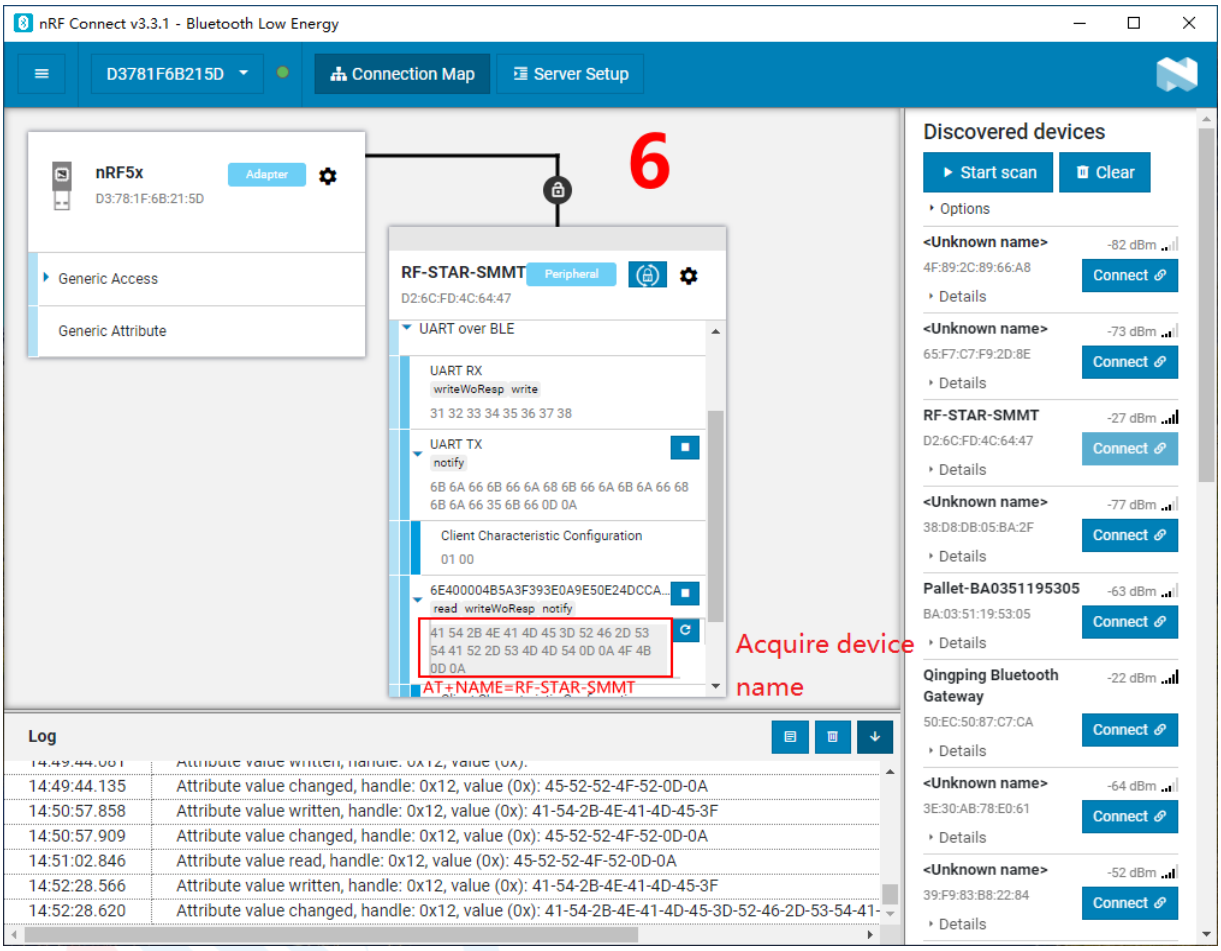
4. After the device is successfully connected, select to open the "UART over BLE" channel (as shown in the figure above), enable the Notify of the receiving channel, and then start the two-way data transparent transmission and AT between the module and the PC (with the help of Dongle as the master device) 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
6E400004B5A3F393E0A9E50E24DCCA...
read writeWoResp notify
41 54 2B 4E 41 4D 45 3F
AT+NAME?
Client Characteristic Configuration
01 00
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-


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-

7 iOS APP Programming Reference

The module is always broadcast as a slave, waiting for the master device of the mobile phone to scan and connect. 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 of the module direct-drive mode functions 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.

8 MCU Reference Code (Transparent Transmission)

The serial port between the module and the MCU uses hardware flow control 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 the 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 at a 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());
    }
}
```

9 Hardware Specifications

9.1 Module Parameters

Working voltage: 2.2 V ~ 3.8 V, recommended to 3.3 V

Working frequency band: 2402 MHz ~ 2480 MHz

Maximum TX power: 6 dBm (RF-BM-BG22x3/RF-BM-BG22A3I)

Maximum TX power: 0 dBm (RF-BM-BG22x1/ RF-BM-BG22A1I)

Receiving sensitivity: -106.7 dBm (RF-BM-BG22x3/RF-BM-BG22A3I)

Receiving sensitivity: -98 dBm (RF-BM-BG22x1/RF-BM-BG22A1I)

Frequency error: ±24 kHz

Working temperature: -40 ℃ ~ +85 ℃

Storage temperature: -40 ℃ ~ +125 ℃

9.2 Antenna

9.2.1 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 are key factors 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.

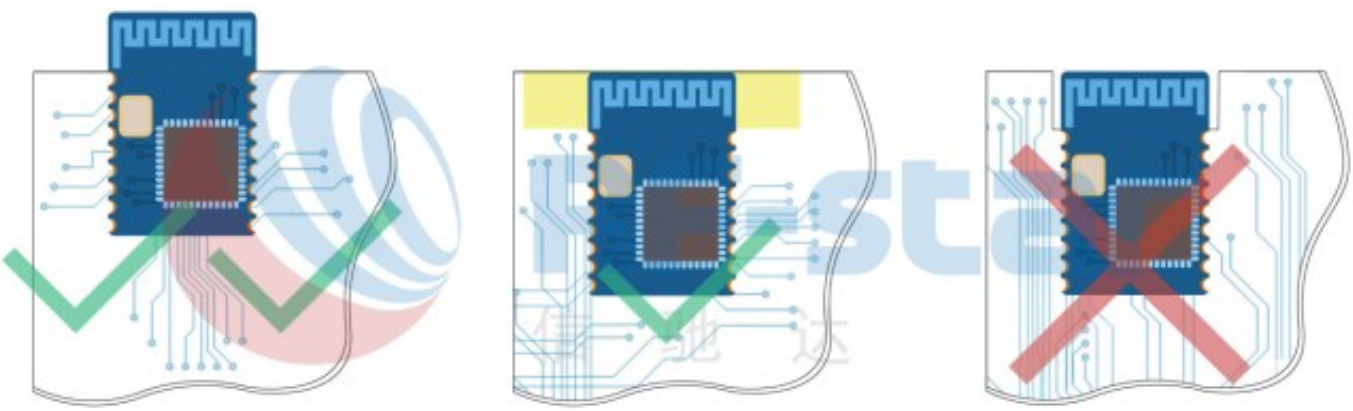


Figure 11. Recommendation of Antenna Layout

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

9.2.2 Antenna Output Mode Modification

1. RF-BM-BG22A3 has two antenna output modes. The one is an onboard PCB antenna and the other is a stamp half-hole output (ANT pin, see pin function table for details).

The default delivery is the ***onboard PCB antenna***, and R1 (0 Ω) is well welded. If you want to use the external antenna by the ANT pin, pls disconnect the R1. The location of R1 is shown in the figure below.

Figure 12. Antenna Output Mode Change of RF-BM-BG22A1

2. RF-BM-BG22A3I has two antenna output modes. The one is an IPEX connector and the other is a stamp half-hole output (ANT pin, see pin function table for details).

The default delivery is the ***IPEX connector***, and the capacitor connected to the IPEX is welded. If you want to use the external antenna by the ANT pin, the capacitor position should be removed to the left solder joint to have the access to the ANT pin. The location of the capacitor is shown in the figure below.

Figure 13. Antenna Output Mode Change of RF-BM-BG22A1I

9.2.3 External Antenna Design Recommendation of the Half-Hole ANT Pin

1. A Π-type matching circuit is reserved for the antenna, and 50 Ω impedance control is performed on the RF traces. The traces are as short as possible, and 135° or arc traces are used as much as possible. No vias are used to change layers. More GND vias are placed around the RF traces.

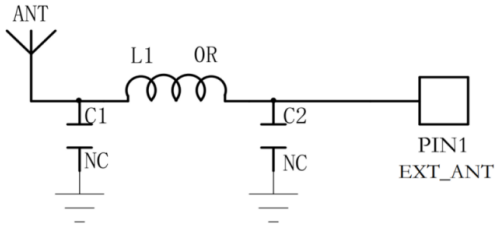


Figure 14. Reference Design of the External Antenna

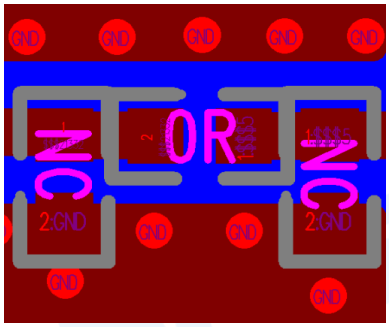


Figure 15. Reference Design of the External Antenna Traces

2. The RF trace width and copper-clad spacing can be calculated by SI9000 software, and the impedance is controlled to 50 Ω according to the actual board thickness, number of layers, plate, dielectric thickness, dielectric constant, copper thickness, line width, line spacing, and solder mask thickness.

   Example: FR4 is a double-layer board with a thickness of 1.0 mm. Through calculation, the width of the trace is 0.8254 mm, and the spacing between traces and copper is 0.22 mm.

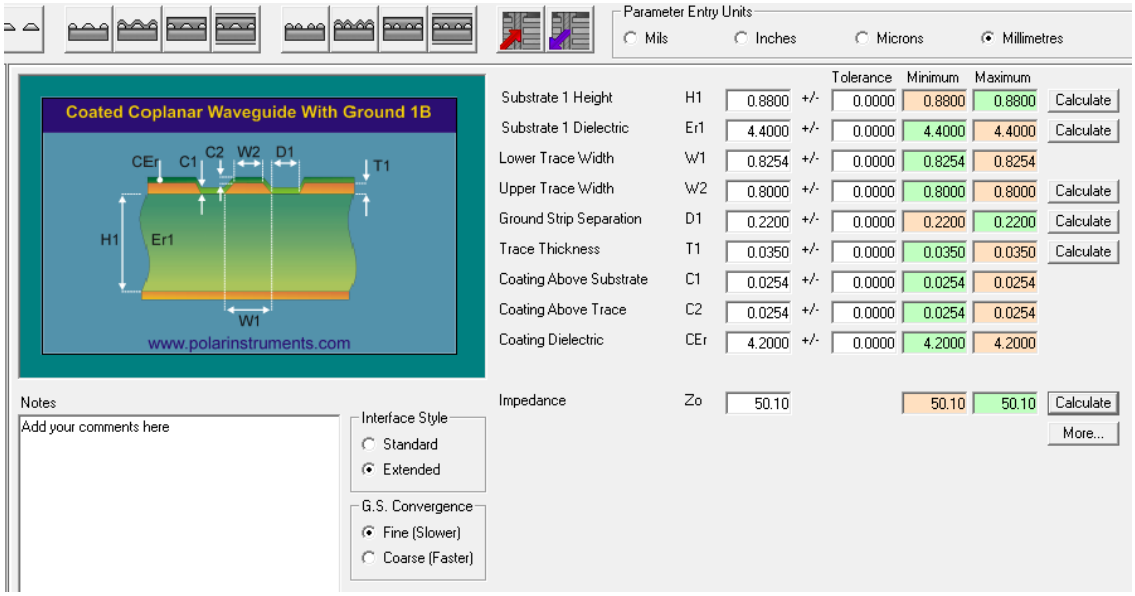


Figure 16. SI9000 Impedance Calculation Diagram

9.3 Reference Design

9.3.1 RF-BM-BG22Ax(I)

The reference design is as follows:

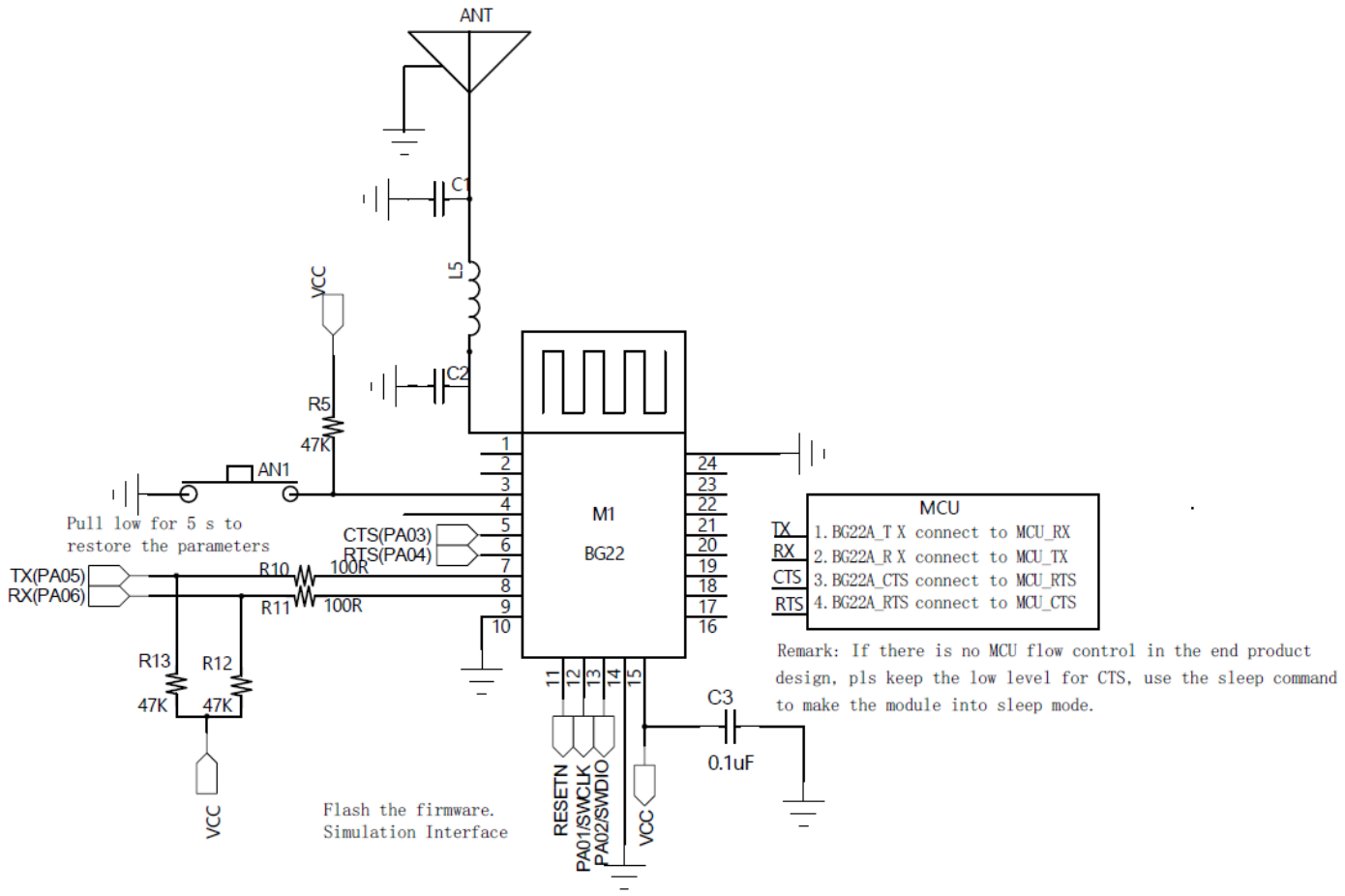


Figure 17. Reference Design of RF-BM-BG22Ax(I)

9.3.2 RF-BM-BG22Bx

The reference design is as follows:

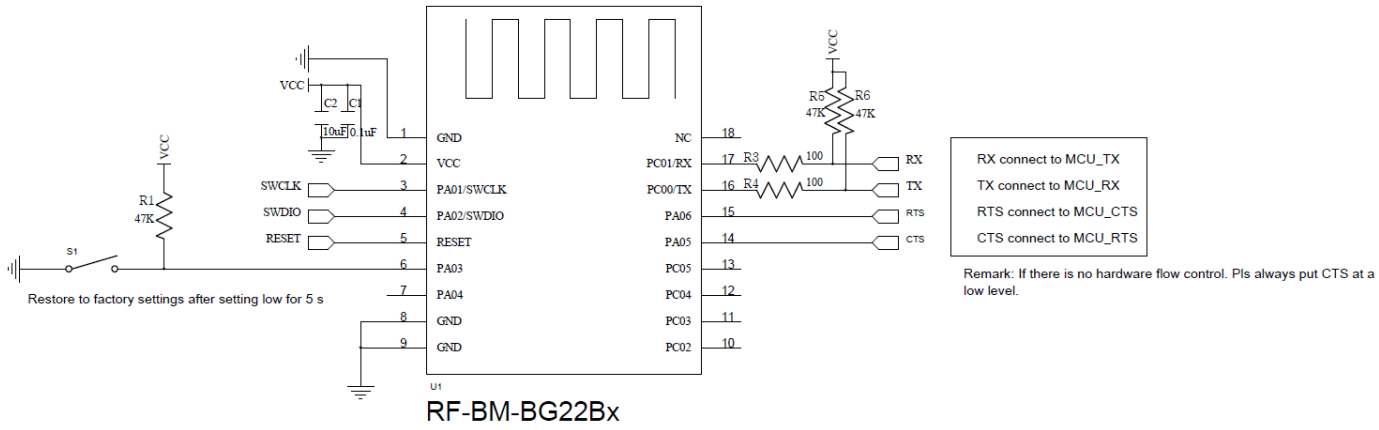


Figure 18. Reference Design of RF-BM-BG22Bx

9.3.3 RF-BM-BG22Cx

The reference design is as follows:

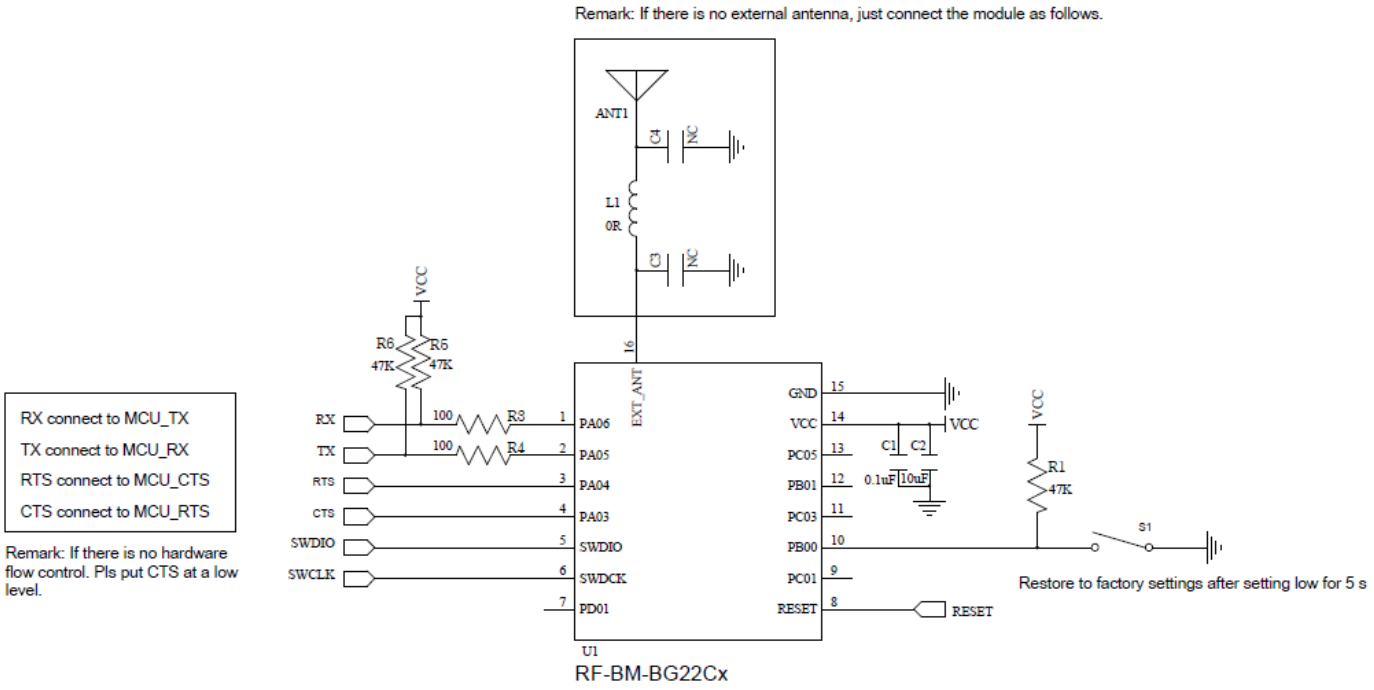


Figure 19. Reference Design of RF-BM-BG22Cx

9.4 Basic Operation of Hardware Design

1. It is recommended to offer the module 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 fluctuating 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 degree.
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 devices whose TTL protocol is the same 2.4 GHz physical layer, for example, USB 3.0.

9.5 Trouble Shooting

9.5.1 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 the communication packet loss rate. The performance 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 metal near the antenna or if the module is placed inside the metal shell.
4. The incorrect power register set or the high data rate in 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.

9.5.2 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 fluctuating 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.

9.5.3 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.

9.6 Electrostatics Discharge Warnings

The module will be damaged by 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.

9.7 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

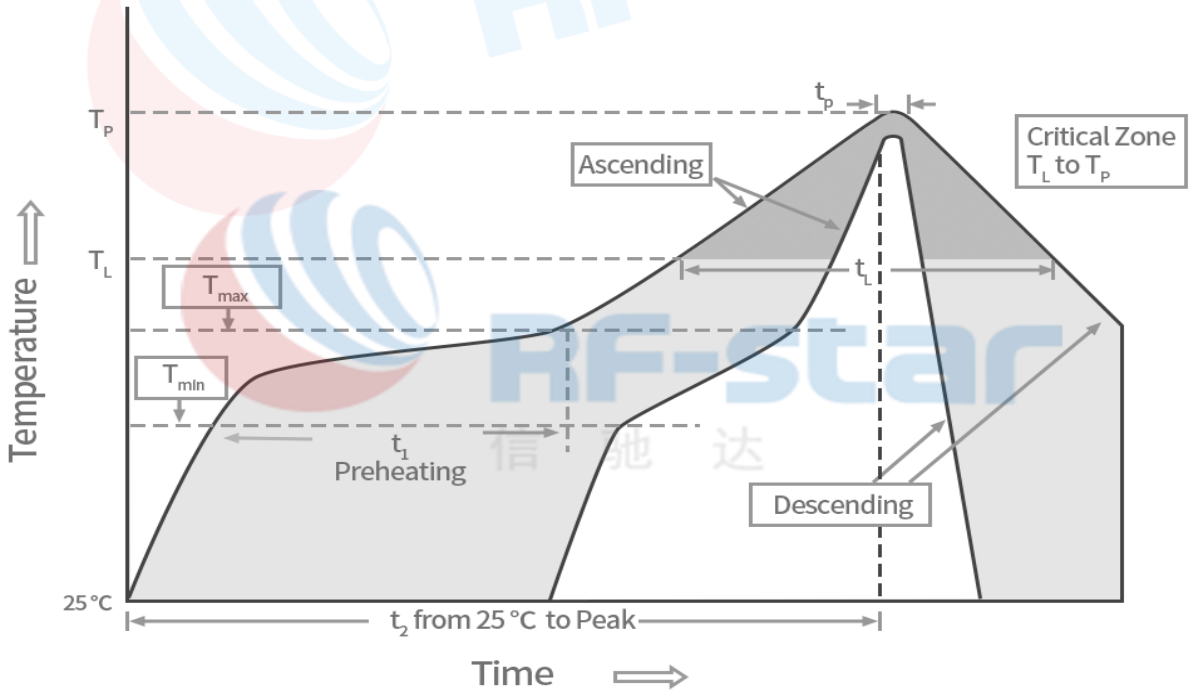


Figure 20. Recommended Reflow for Lead-Free Solder

10 Contact Us

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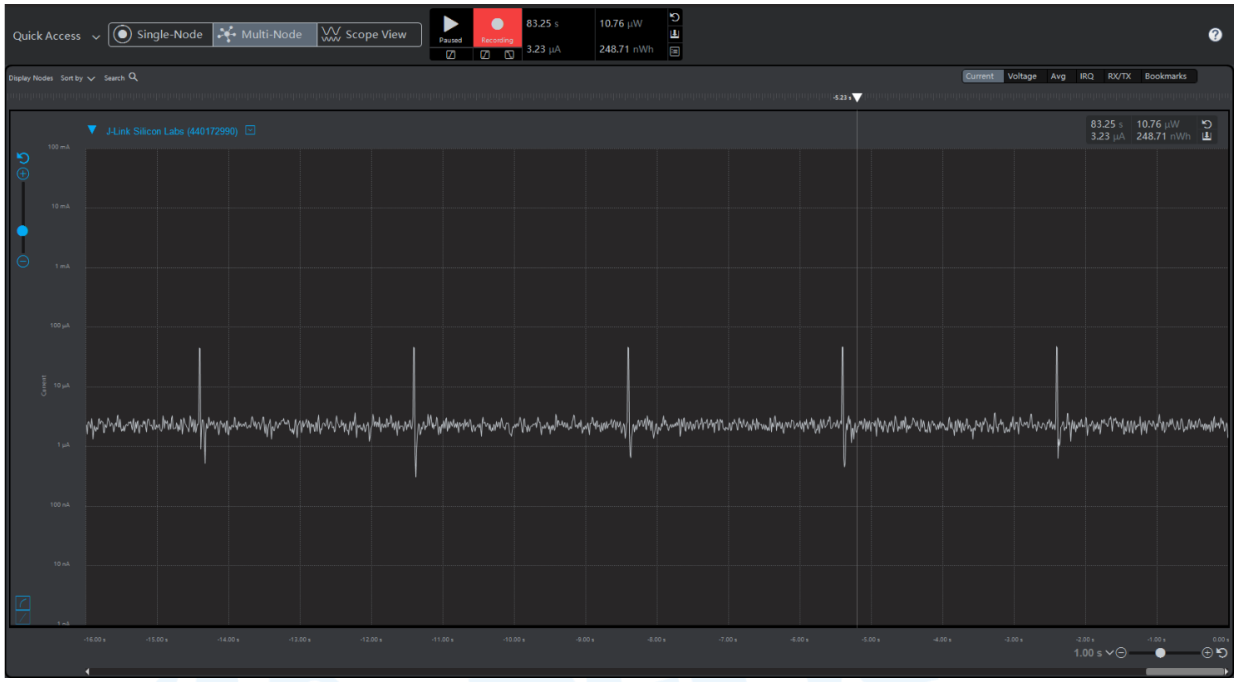
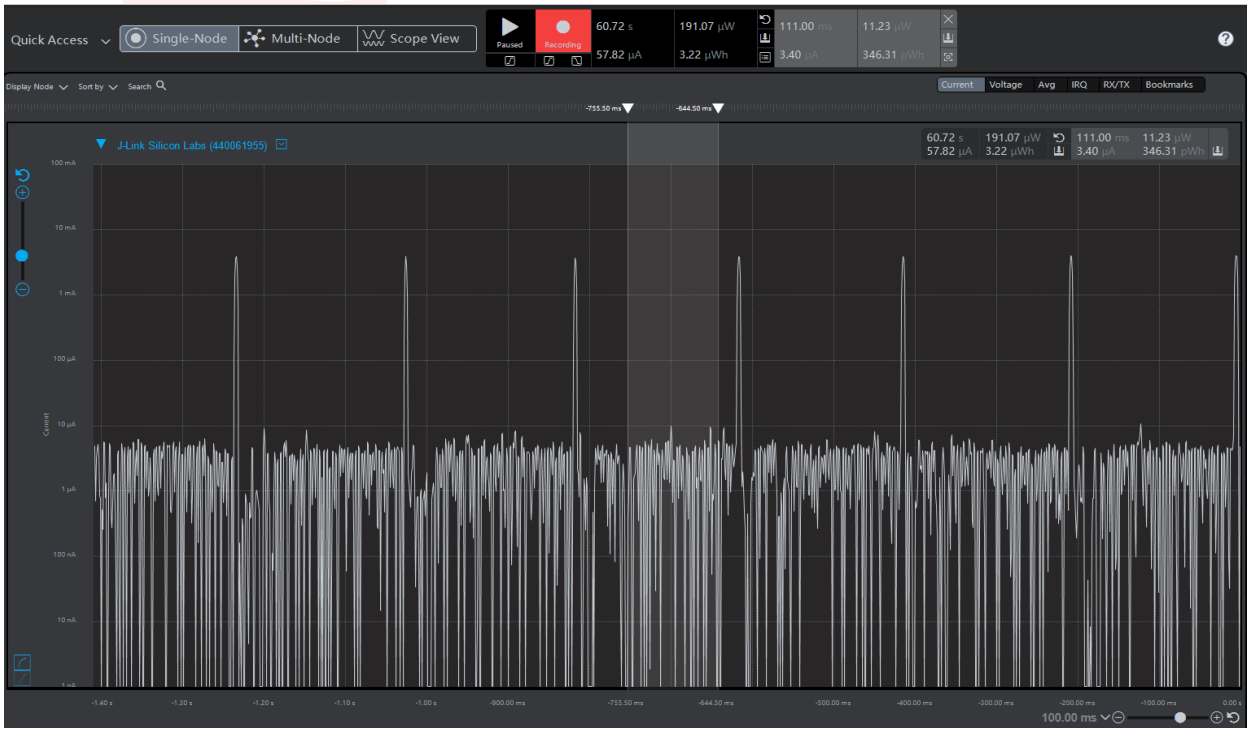
Appendix A: Power Consumption Test Screenshot

1 Sleep Mode: 3.23 μA

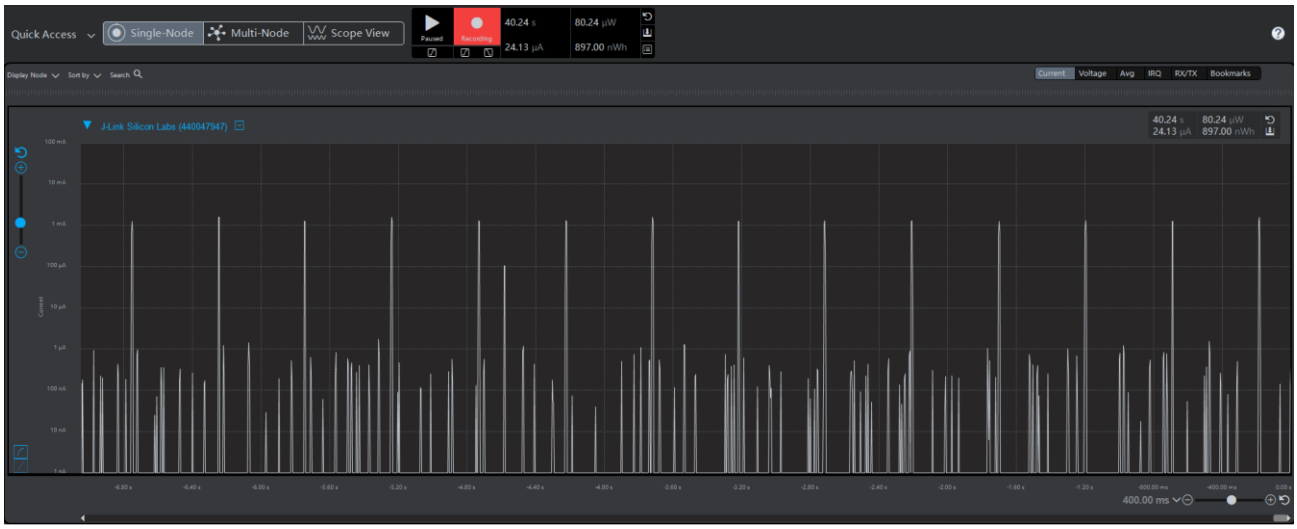


2 Broadcast Mode

2.1 0 dBm, 200 ms broadcast cycle: 57.82 μA



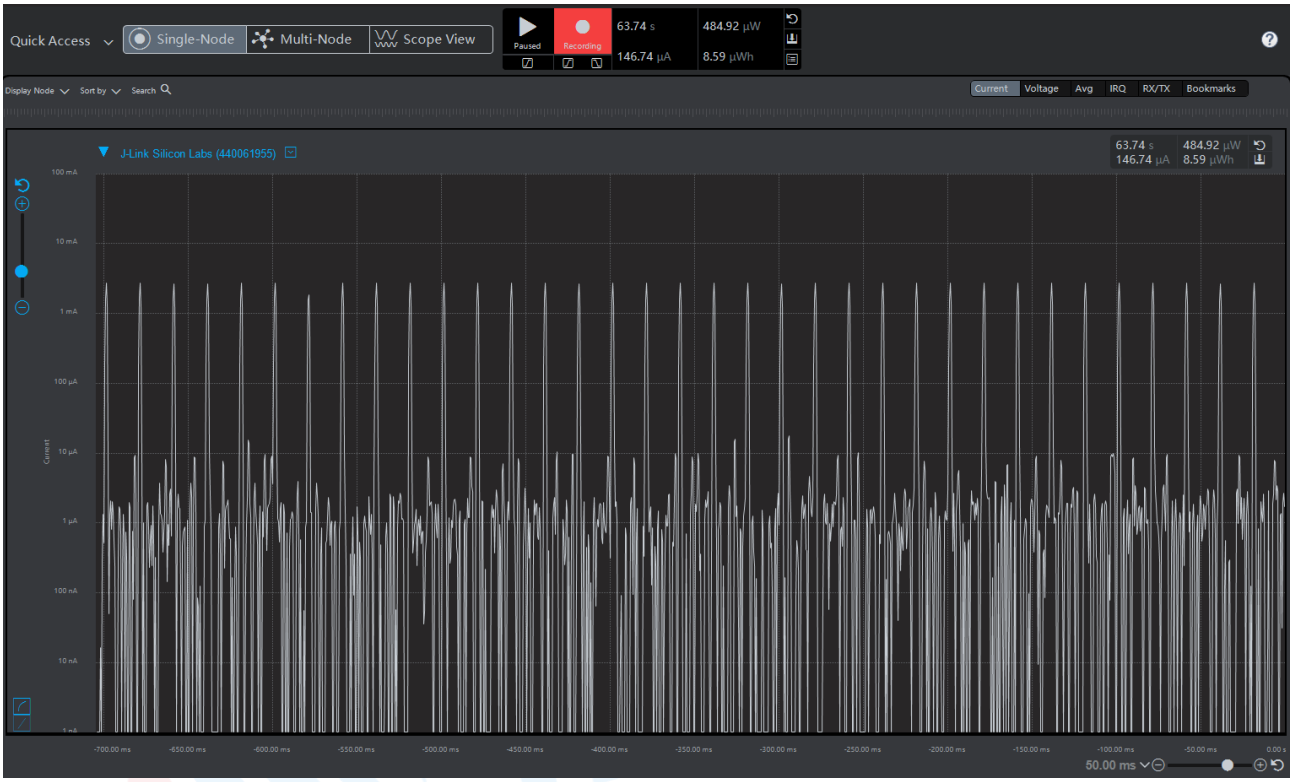
2.2 0 dBm, 500 ms broadcast cycle: 24.13 μA



2.3 0 dBm, 1000 ms broadcast cycle: 15.12 μA

3 Connection Mode

3.1 0 dBm, 30 ms connection interval: 146.74 μA



3.2 0 dBm, 100 ms connection interval: 34.68 μA