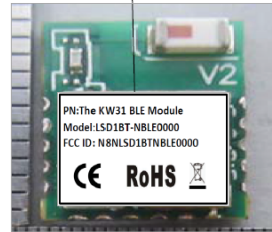


LIERDA Science & Technology GROUP Co., LTD.

Product Specification



PN: The KW31 BLE Module
Model: LSD1BT-NBLE0000
FCC ID: N8NLS1BTNBLE0000
CE **RoHS** 



Product Name: The KW31 BLE module

Product Model: LSD1BT-NBLE0000

Version: V1.5

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Document Revision Record

| Product Name | The KW31 BLE Module | Product Model | | LSD1BT-NBLE0000 | |
|--------------|--|---------------------|------------|------------------|---------------|
| Prepared by | Qiu Mangang | Date of Preparation | | May 14, 2017 | |
| No. | Revision log | Revised by | Checked by | Document Version | Revision Date |
| 1 | Initial version | Qiu Mangang | | V0.1 | May 14, 2017 |
| 2 | Hardware upgrade change leads to I0 port | Qiu Mangang | | V0.2 | Jun. 13, 2017 |
| 3 | Revise user model | Qiu Mangang | | V0.3 | Nov. 6, 2017 |
| 4 | Update dimension drawing; update some parameters; update documentation error; release officially | Qiu Mangang | | V1.4 | Apr. 27, 2018 |
| 5 | Revise module state output I0 port | Huang Lutong | | V1.5 | Jun. 13,2018 |

Chapter I: Functional Features

LSD1BT-NBLE0000 (The KW31 BLE Module) is a highly integrated low-power Bluetooth module based on NXP Kinetis KW31Z Soc chip development. Built-in ceramic antenna provides a complete RF solution without the need for any additional wireless investment to accelerate product development. Arm® Cortex™-M0+ 32-bit based processor supports Bluetooth 4.2 to provide efficient connection. Built-in DC-DC conversion supports 1.8-4.2V wide voltage input to improve power efficiency. 512K Flash 128K RAM supports a variety of applications for customers. The module can be widely used in short-range wireless communication fields in various occasions to realize full transparent transmission. Users can configure various UART data formats according to actual applications and have the characteristics of small size, low power dissipation, long transmission distance, strong anti-interference ability, etc., convenient for customers to choose;

The KW31 BLE Module can be widely used in the following occasions:

- Smart toys;
- Health testing;
- Smart family;
- Safety and security.

Chapter II: Specification Parameters

Table 2 LSD1BT-NBLE0000 module parameters

| Parameters | Performance | Remarks |
|---|--------------------------|--|
| Operating voltage | 1.8V to 4.2V | 2.1V required to startup |
| Operating temperature | -40 ~ 85 °C | |
| Operating frequency | 2402~ 2480MHz | |
| Power dissipation | Transmitting state | $\leq 11\text{mA}@3.3\text{V}$ Typical value: 10.6mA@0dBm CW |
| | Receiving state | $\leq 12\text{mA}@3.3\text{V}$ Typical value: 11.5mA@MCU RUN |
| | Sleep state | $\leq 20\mu\text{A}@3.3\text{V}$ VLPS at Buck mode(3.3 V), |
| Transmitting power | 2--3dBm | Typical value: 2.52dBm @3.3V CW |
| Receiving sensitivity | Better than -93 dBm | Typical value: -90dBm |
| Channel | 40 | Channel spacing 2M |
| Modulation system | GFSK @ 1Mbps | |
| Communication Protocol | BLE | |
| Reliable transmission distance | $>12\text{m}@0\text{dB}$ | Open visual environment, the actual distance is affected by factors e.g. surrounding environment, air humidity, etc. |
| Interface type | Stamp hole patch type | |
| Shield | Yes | |
| Dimensions (length × width × thickness) | 9mm×11.5mm×2.7mm | The module comes with ceramic antenna |
| Antenna type | Multilayer Chip Antenna | |
| Antenna gain | 0.5dBi | |

| | | |
|-----------------------|-----------|--|
| Antenna size (L*W) | 3.2*1.6mm | |
|-----------------------|-----------|--|

Remarks:

The actual distance is affected by various factors, e.g. ambient temperature, humidity, bottom plate, casing, mobile phone, etc. The data is only used for reference and not for guarantee.

Chapter III: Hardware Layout and Interface Specification

The definition of LSD1BT-NBLE0000 module pin is as shown in figure 1:

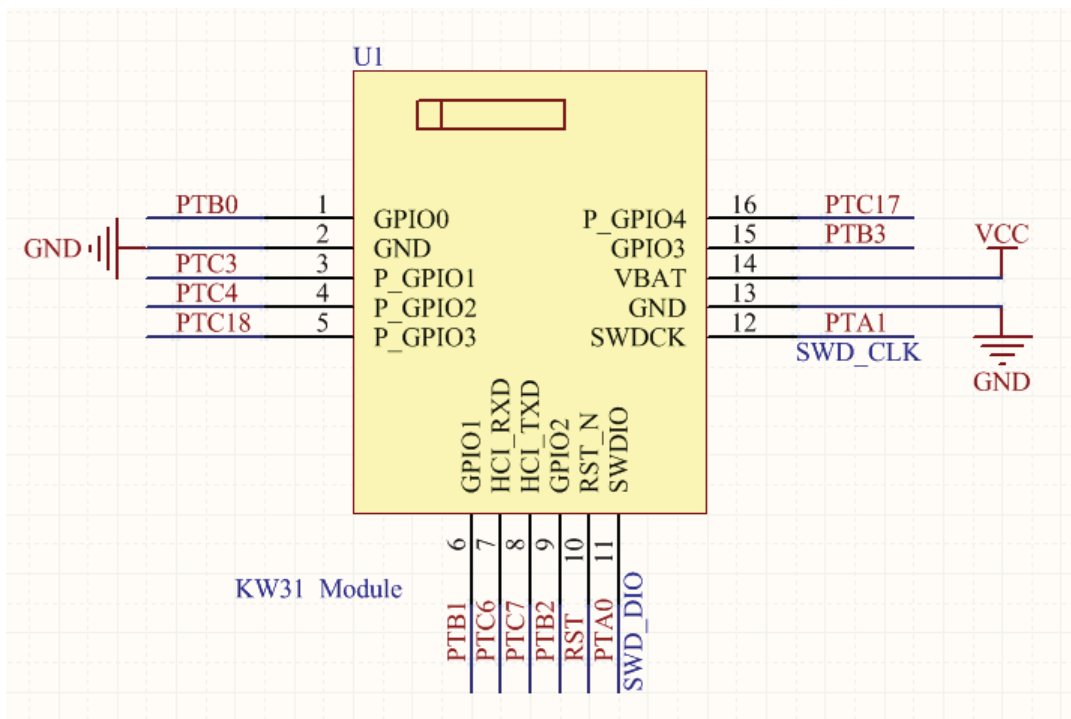
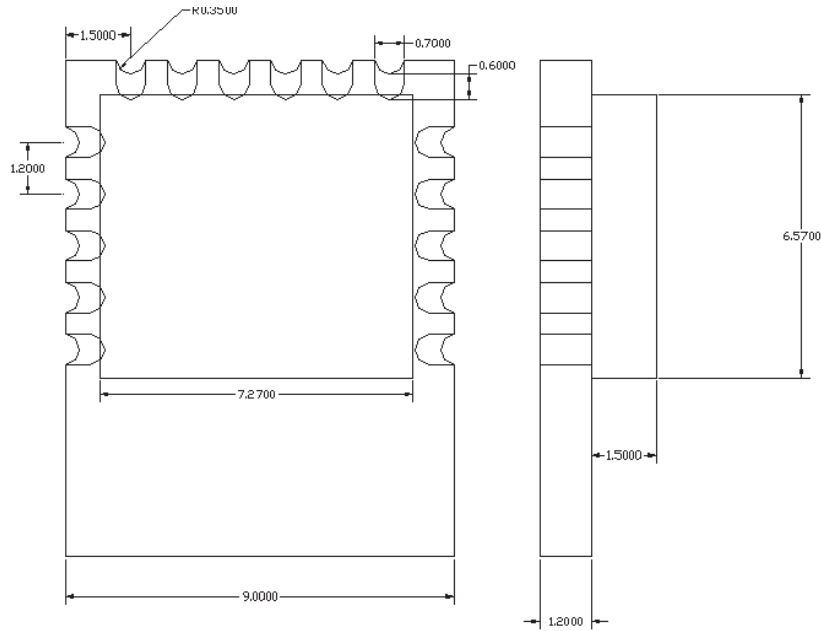


Figure 3-1 Definition of LSD1BT-NBLE0000 module pin



Unit: mm

Figure 3-2 Outline dimension drawing of LSD1BT-NBLE0000 module

Module wrapping is as shown in figure 3-2;

The description of pin function is as shown in figure 3-1.

Table 3-1 Description of LSD1BT-NBLE0000 module pin function

| No. | Name | Type | Pin | Explanation |
|-----|---------|-------------------------------|-----------------------------|---|
| 1 | GPIO0 | GPIO | PTB0 | General GPIO, supporting low power wakeup |
| 2 | GND | GND | Necessary ground connection | Power ground |
| 3 | P_GPIO0 | POW_CTRL (function I/O) | PTC3 | Low-power control pin. Falling edge enters low power dissipation; rising edge exits low-power dissipation |
| 4 | GPIO1 | BLE transmission state output | PTC4 | High level output during enabling transmission, low level output during disabling transmission |
| 5 | P_GPIO1 | BT_CTRL (function I/O) | PTC18 | Bluetooth broadcast control I/O. Broadcast at low level, closedown at high level; |

| | | | | |
|----|-------------------|--------------------------------|-----------------------------------|--|
| 6 | P_GPIO2 | BLE connection state output | PTB1 | Low level in connection state, high level in disconnection state |
| 7 | HCI_RXD | DI | PTC6 | UART_RX |
| 8 | HCI_TXD | DO | PTC7 | UART_TX |
| 9 | GPIO2 | GPIO | PTB2 | General I/O |
| 10 | RST_N | RESET | RST(Active Low) | Pin reset, low level reset, high level by default |
| 11 | SWDIO | SWD | PTA0 | SWD program download interface |
| 12 | SWDCK/ P_GPIO3 | SWD/module LED state | PTA1 | SWD program download interface; Flashing 2 times per second in connection state, flashing once every 3S in disconnection state. |
| 13 | GND | GND | Necessary ground connection | Power ground |
| 14 | Vbat | POWER | 1.8V—4.2V | Power 3.3V |
| 15 | GPIO3 | GPIO | PTB3 | General GPIO |
| 16 | P_GPIO4 | PIN_MODE (function I/O) | PTC17 | Command mode selection I/O Low level CMD, high level DTU |

Note: general GPIO is configured by default as floating input.

More pin function descriptions in KW31 latest data book;

<http://cache.nxp.com/assets/documents/data/en/data-sheets/MKW41Z512.pdf>

Chapter IV: Application Specification

4.1 Module application circuit

Refer to the following circuit for module minimum system

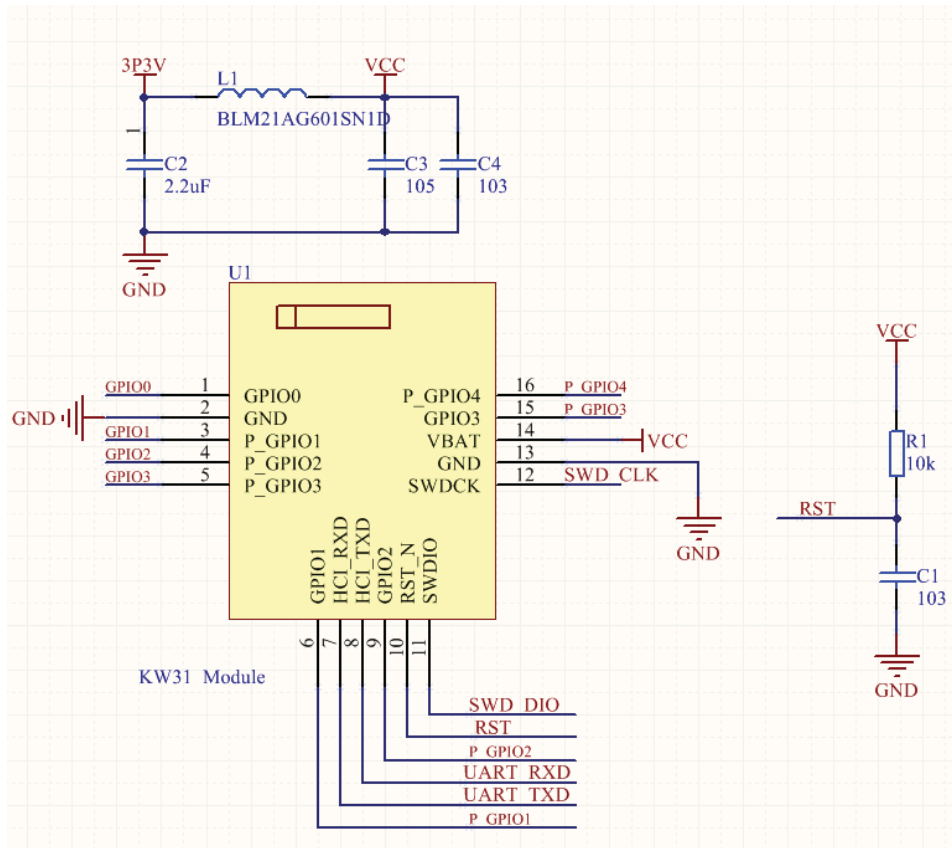


Figure 4-1 Module recommended minimum system

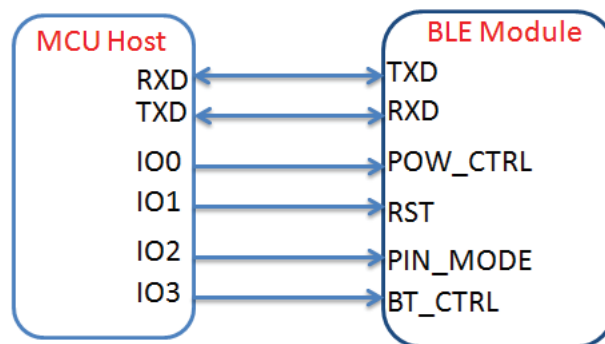


Figure 4-2 Connection between host and module pin

The pins that need to be connected to the host when the module works normally are as shown in figure 4-2. At least four IO ports are required to control the module. PWR_CTRL refers to low power control pin; the falling edge enters power dissipation, while the rising edge exits lower power dissipation. PIN_MODE refers to command and transparent transmission mode switch; pin low level is the command mode, while the high level is the transparent transmission mode. BT_CTRL refers to the broadcast control pin; it enters broadcast state at low level and the broadcast stops at high level.

4.2 Precautions on module usage

In order to ensure that RE performance of module is the most effective in applications, users shall

follow the following principles in use:

1. It is recommended to use DC stabilized power supply for the module. Power supply ripple coefficient shall be as small as possible. The module shall be grounded reliably. Please pay attention to the connection between positive and negative poles of the power supply. Reverse connection may cause permanent damage to the module;

2. It is recommended to place the module at the open space of bottom plate edge and the antenna shall face outwards;

3. PCB board (double-sided board and multi-layer board) below the antenna in the module needs to be cleaned and cannot be coated with copper, i.e. there shall be no grounding or signal trace for all layout layers below the antenna;

4. It is best not to have metal devices near the antenna, otherwise the communication distance of modules will be shortened to varying degrees in different environments.

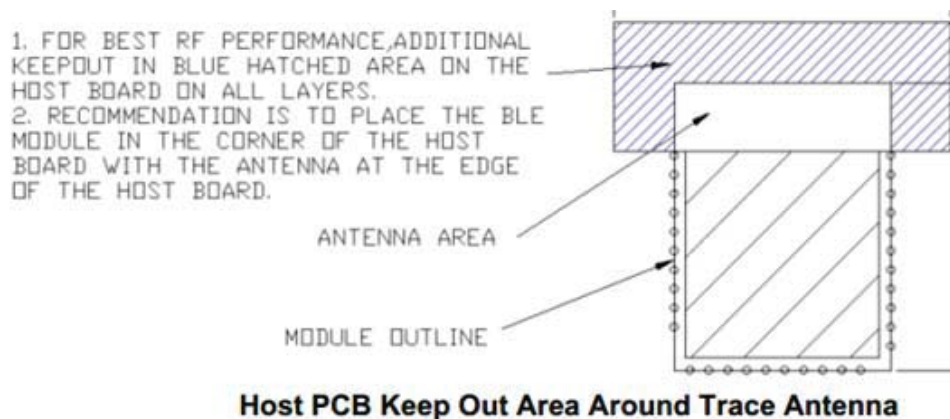


Figure 4-2 Module PCB layout

Chapter V: Functional Specification

5.1 Networking function

The transparent transmission module is temporarily only used as a slave device to connect to piconet with master device. The existence of these interfaces not only greatly expand the connection mode of the module but also can enable users to dock with the modules and realize the network transmission of data;

5.2 Serial port framing mechanism

URAT has a framing mechanism. The continuous transmission is one frame, but the number of bytes per frame must be less than 1500 bytes. The framing is related to the low power mode. In low power mode,

transparent transmission module will ignore all the data received. The module must be woken up before data can be set and received.

5.3 Transparent operating mode

Serial port transparent transmission working mode is supported to realize data transfer from wired serial port to Bluetooth wireless transmission or achieve transparent transmission to serial port through Bluetooth wireless transmission. Transparent transmission working mode enables products of customers to achieve the fastest and simplest wireless communication.

UART->APP: When uart sends data, the length of a packet to be sent needs to be determined by the transmission interval and the connection interval of modules. The data of one frame cannot exceed 1500 bytes.

APP->UART: APP needs to be cached. Ble can only send 1500 bytes in one frame (the frame will be dropped if there are more than 1500 bytes).

5.4 Command mode

Command configuration mode is supported to configure and read the device information of module as well as the parameters configured by users. See 5-11 serial port command overview for details.

5.5 Echo mode

The module enters echo mode when the module is in unconnected state and PIN_MODE is high. At this time, the data can be received at HCI_RXD terminal through HCI_TXD printing module to facilitate debugging by users.

5.6 Serial port upgrade mode

The module supports the serial port online upgrading function. When the module is reset, 16-byte format command “ymodem” is sent to the module at an 8-bit length of 115200 baud rate and one-stop bit no parity through the serial port. The module will return to “C” character after receiving the command, which indicates successful entry into the serial port upgrade mode and waiting to receive the upgrade program. It will be started according to the new program if the upgrade is successful, otherwise it will be started from the original program.

5.7 Low power mode

The module enters low power mode when the module POW_CTRL pin is pulled low. At this time, the module will no longer broadcast or receive the data sent by Bluetooth and the host serial port. It will exit the low power mode when POW_CTRL pin is pulled high.

5.8 Module mode switching

Table 5-1 Switching of module modes

| Mode | Entry Mode | Exit Mode |
|-------------------------------|--|--|
| Transparent transmission mode | POW_CTRL works properly for high modules. It enters transparent transmission mode after successful Bluetooth pairing | Module disconnection |
| Command mode | It enters command mode if PIN_MODE is low | Pulling command pin high |
| Echo mode | Pull PIN_MODE high and the module is not connected | Module connection or pulling down command pin |
| Serial port upgrading mode | See the IAP documentation for details | Automatically exiting after the upgrade is completed |
| Low power mode | Pull the PWR_CTRL pin low to enter low power mode | Pulling the PWR_CTRL pin high to exit low power mode |

In command mode, the users control BLE transparent transmission module through the serial port command, as shown in figure 5-1. The primary controller sends a command to BLE transparent transmission module. BLE transparent transmission module will send an acknowledge frame to the controller MCU after receiving the command and executing it to characterize the result of command execution.

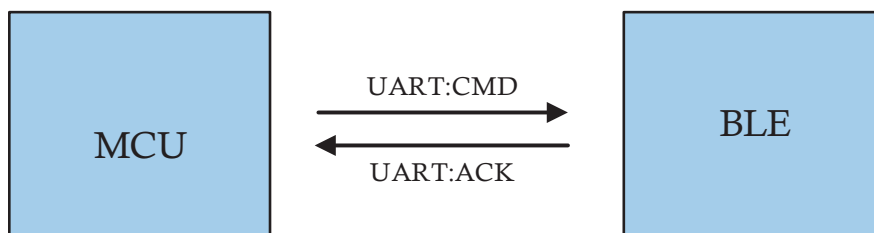


Figure 5-1 Main controller and BLE transparent transmission module command form

In transparent transmission mode, MCU sends data to the module, and then the module transmits to the mobile phone through BLE protocol. The mobile phone sends data to the module through BLE protocol, and then the module sends to MCU through the serial port, as shown in figure 5-2.

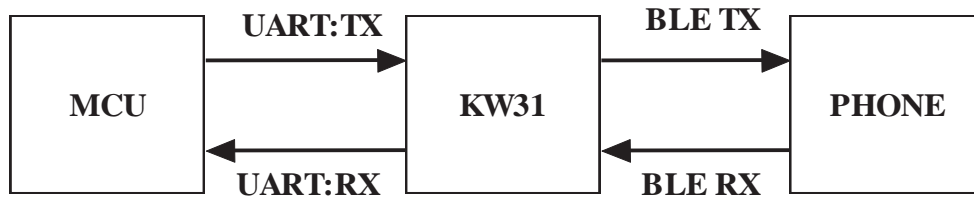


Figure 5-2 Specification of model transparent transmission

5.9 Service specification

| Service Name | UUID | Notes |
|----------------------------|--|--|
| service_gatt | 0x1801 | GATT service |
| service_gap | 0x1800 | GAP service |
| service_device_info | 0x180A | Equipment information service |
| service_battery | 0x180F | Battery service |
| service_dtu | 0xE0, 0x1C, 0x4B, 0x5E, 0x1E, 0xEB, 0xA1, 0x5C, 0xEE, 0xF4, 0x5E, 0xBA, 0xE7, 0xFE, 0xFF, 0x01 | Universal transparent transmission service |

5.10 Serial frame structure

The commands of transparent transmission module have a certain format, including five areas of “header”, “command ID”, “command information length” and “command information”.

The details are as follows:

Input command format (hex)

| Header | header | Command ID | Message length | Message Content |
|-----------|--------|------------|----------------|-----------------|
| 01 | FC | XX | XX | XX ... XX |

Output response format (hex)

| Header | Header | Command ID | Message Length | Message Content |
|-----------|--------|------------|----------------|-----------------|
| 04 | FC | XX | XX | XX ... XX |

Header: in order to ensure that the input command can be correctly parsed, all input command frames must start with prefix“01 FC”. All output response frames start with “04 FC”, which helps the user to distinguish command from data.

Command ID: command ID is an identifier between different commands. Different commands have unique command ID, which are described in detail below.

Message length: message length refers to the number of bytes of message content, excluding prefix, command ID and message length itself.

Information content: the information content of input command is some input parameters of the command execution, while the information content of output response is the result of command execution, which is described in details below.

5.11 Serial command overview

Table 5-2 is detailed specification of output response frame.

Table 5-2 Output response frame format specification

| No. | Command ID | Specification |
|-----|------------|---|
| 1 | 01 | Correct command, without additional data, return 04 FC 01 00 |
| 2 | XX | Correct command, with additional data, return 04 FC xx (corresponding to command ID) xx (message length) xx...(message content) |
| 3 | 02 | Command error, return 04 FC 02 00 |

The Bluetooth 4.2 protocol specifies that the pairing password is of 6 digits.

Table 5-3 refers to the detailed description of input command frame.

Table 5-3 Input command frame explanation

| Power-down Saving | Command ID | Command Description | Default | Command Format | Return Value |
|-------------------|------------|---------------------|----------------|--|--|
| Yes | 01 | Set baud rate | 115200 | 01 FC 01 04 XX XX XX XX (uint32, low endian) The baud rate unit is bps. The range is 230400~1200. It is transmitted in low byte rate, for example, for baud rate 115200, the hexadecimal is 0x0001C200, which shall be written as 00 C2 01 00 | 04 FC 01 00 Correct setup 04 FC 02 00 Setup error |
| / | 02 | Query baud rate | / | 01 FC 02 00 | 04 FC 02 04 XX XX XX XX (uint32, low endian, the same as ID:01) 04 FC 02 00 false command |
| Yes | 03 | Set connection | 0x0028 10ms | 01 FC 03 02 XX XX (uint16, low endian) | 04 FC 01 00 Correct setup 04 FC 02 00 Setup error |

| | | | | | |
|-----|----|--------------------------------|----------------------------------|---|---|
| | | interval | | The unit of Bluetooth connection is 1.25ms. The scope is 0x0008~0x0640, i.e. 10ms~2s | |
| / | 04 | Query connection interval | / | 01 FC 04 00 | 04 FC 04 02 XX XX (uint16, low endian, the same as ID:01) 04 FC 02 00 False |
| Yes | 05 | Pairing password | 12345678 | 01 FC 05 06 XX XX XX XX XX (unit16, low endian) XX range 0~9, eight-digit password, default 12345678 E.g. 01 FC 05 06 01 02 03 04 05 06 The maximum number of pairing password digits defined by BLE4.2 specification is | 04 FC 01 00 Correct setup 04 FC 02 00 False command |
| / | 06 | Query pairing password | / | supported. 01 FC 06 00 | 04 FC 06 06 XX XX XX XX XX XX XX(uint16, low endian, the same as ID:01) 04 FC 02 00 False command |
| / | 07 | Query MAC address | Local master MAX | 01 FC 07 00 | 04 FC 07 06 XX...(6 bytes MAC address, low endian) 04 FC 02 00 False command |
| Yes | 08 | Set equipment name | | 01 FC 08 XX YY... XX: name length YY...: 1-15 byte device name The name length must be the same as the number of name bytes | 04 FC 01 00 Correct setup 04 FC 02 00 Setup error |
| / | 09 | Query equipment name | / | 01 FC 09 00 | 04 FC 09 XX (name length) YY...(1-20 byte name) 04 FC 02 00 False command |
| Yes | 0C | Set broadcast interval | 0x0258 (100ms) | 01 FC 0C 02 XX XX(uint16, low endian) the unit of Bluetooth broadcast is 625μs; the range is 32(20ms)~8000(5s) | 04 FC 01 00 Correct setup 04 FC 02 00 Setup error |
| / | 0D | Query broadcast interval | | 01 FC 0D 00 | 04 FC 0D 02 XX XX (uint16, low byte, the same as ID:0C) 04 FC 02 00 False command |
| Yes | 10 | Set I/O input and output state | All I/O initial output low level | 01 FC 10 01 XX1 XX2 XX3 (XX1 indicates selection of I/O, XX2 input output state, XX3 output level) The 0~3 bytes of XX1 respectively indicate module GPIO~GPIO3 input/output state The 0~3 bytes of XX2 correspond to The 0~3 bytes of XX3 correspond | 04 FC 01 00 Correct setup 04 FC 02 00 Setup error |

| | | | | | |
|-----|----|---|---|--|---|
| | | | | GPIO0~GPIO3 output level. | |
| / | 11 | Query I/O input and output state | | | |
| Yes | 12 | Read I/O state | | 01 FC 14 02 XX (XX respectively indicate that corresponding I/O state is read) | |
| / | 80 | Restore factory settings and restart to take effect | / | 01 FC 80 00 | 04 FC 01 00 Correct setup 04 FC 02 00 Setup error |
| / | 81 | Reset module | / | 01 FC 81 00 | 04 FC 01 00 Correct setup 04 FC 02 00 Setup error |
| / | F0 | Firmware version No. query | / | 01 FC F0 00 | 04 FC F0 02 XX (hardware version) YY (firmware version) 04 FC 02 00 Setup error |

Notes to Users:

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Prepared by: Microcontroller Business Division of LIERDA Science & Technology GROUP Co., LTD.

April, 2018

FCC Statement

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference, and
- (2) This device must accept any interference received, including interference that may cause undesired operation.

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

FCC Label Instructions:

The outside of final products that contains this module device must display a label referring to the enclosed module. This exterior label can use wording such as: "Contains Transmitter Module FCC ID: N8NLS1BTNBLE0000", or "Contains FCC ID: N8NLS1BTNBLE0000 ", Any similar wording that expresses the same meaning may be used.