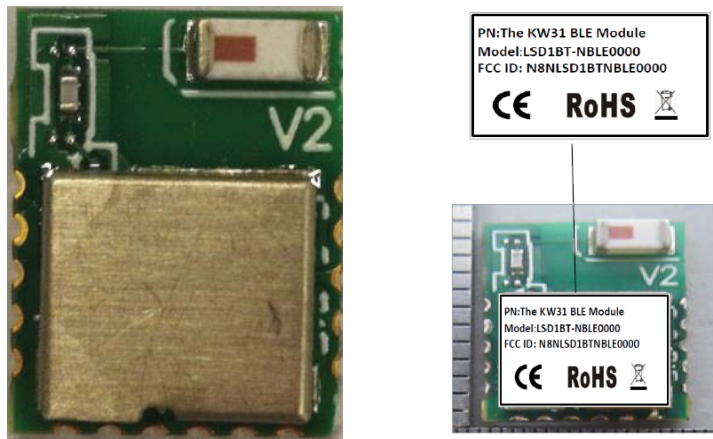


LIERDA Science & Technology GROUP Co., LTD.

Product Specification



Product Name: The KW31 BLE module

Product Model: LSD1BT-NBLE0000

Version: V1.5

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Document Revision Record

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Prepared by	Qiu Mangang	Date of Preparation		May 14, 2017	
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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	>12m@0dB		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	
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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:

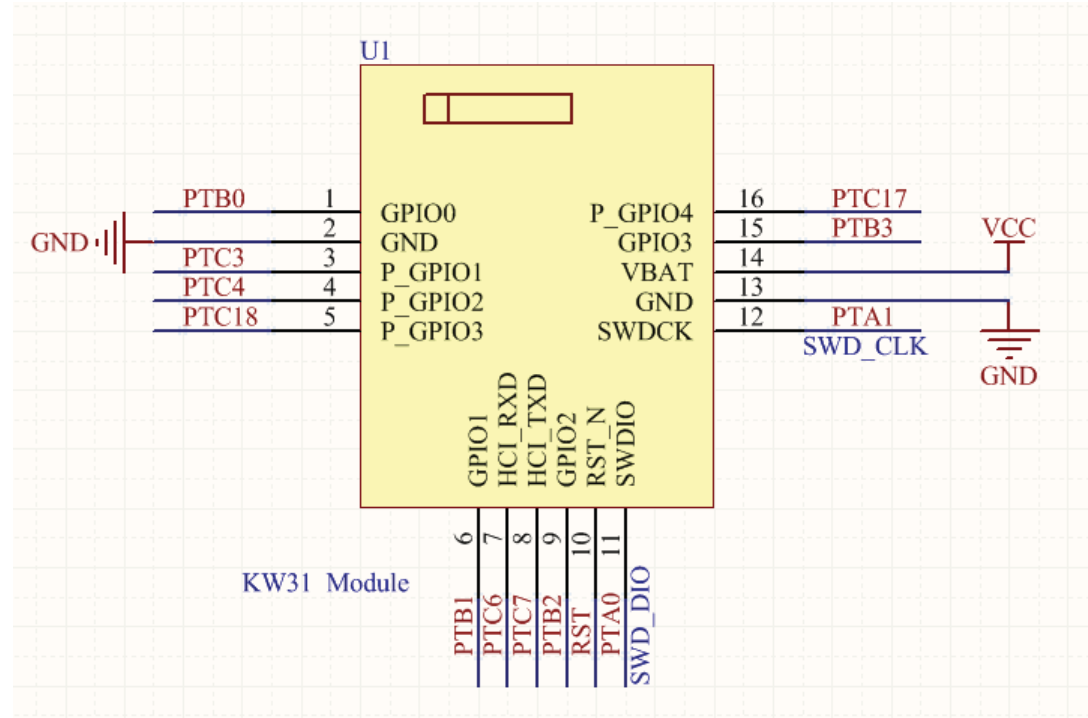
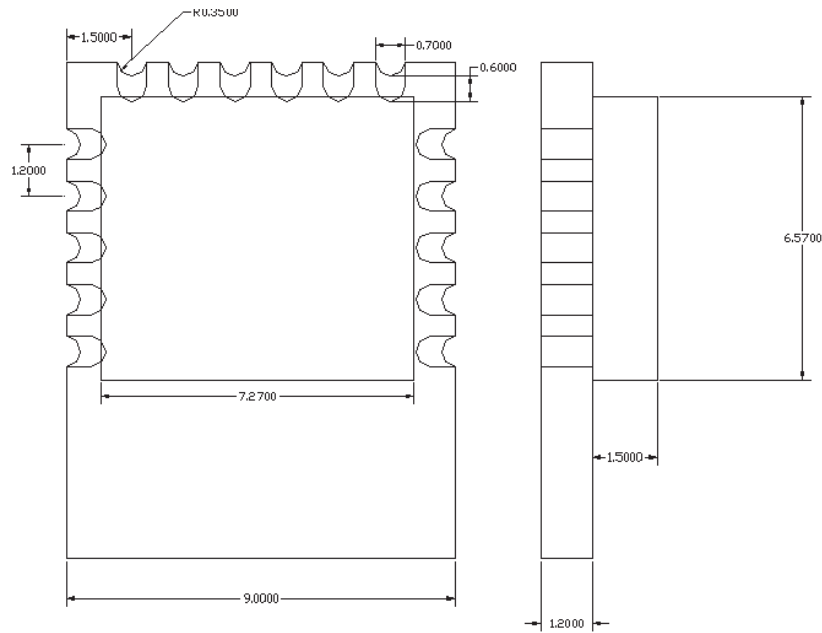


Figure 3-1 Definition of LSD1BT-NBLE0000 module pin



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

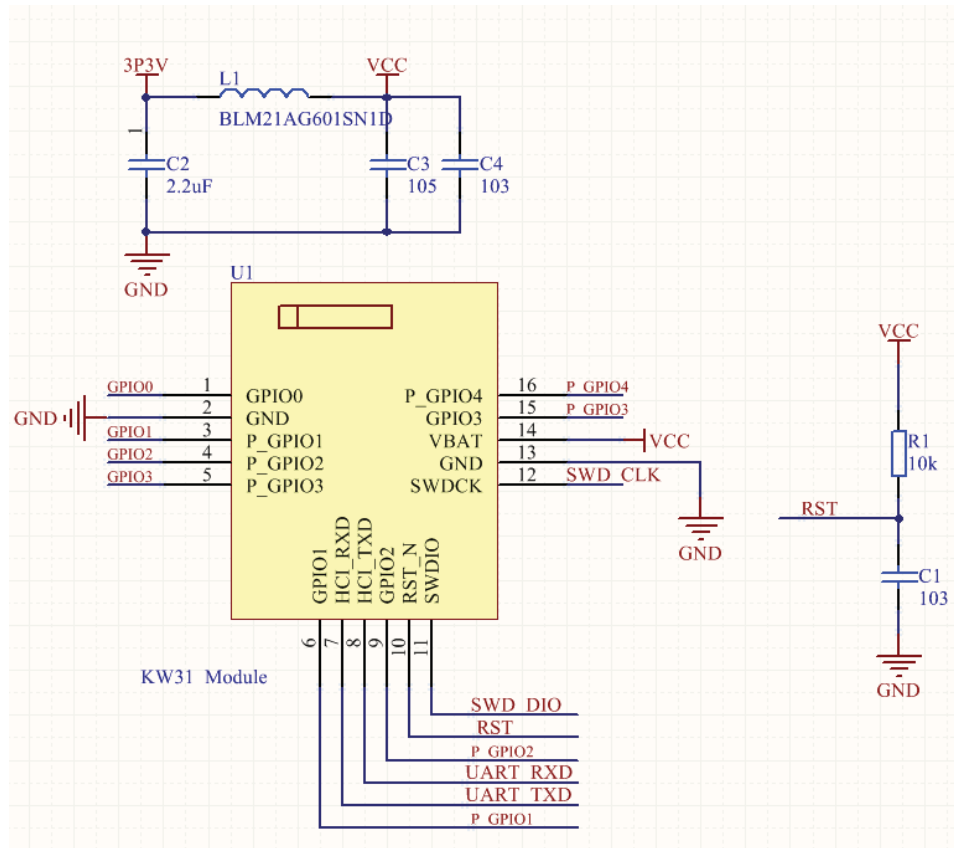


Figure 4-1 Module recommended minimum system

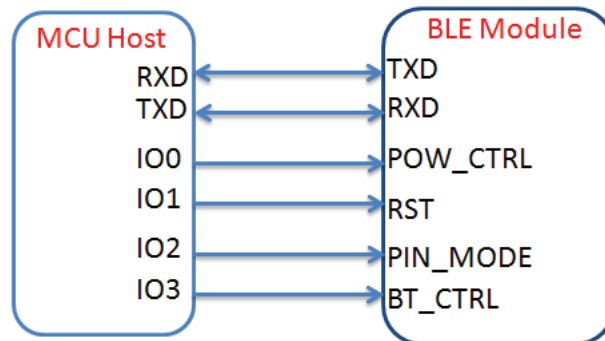


Figure 4-2 Connection between host and module pin

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 lower 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.

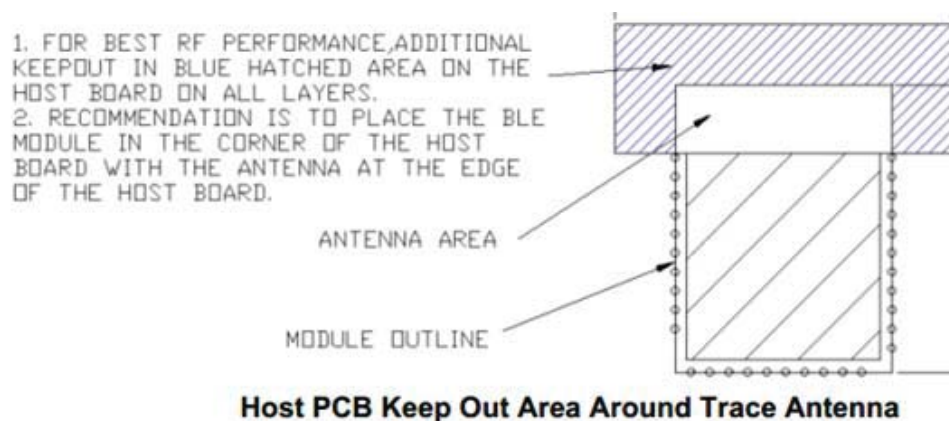


Figure 4-2 Module PCB layout

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.

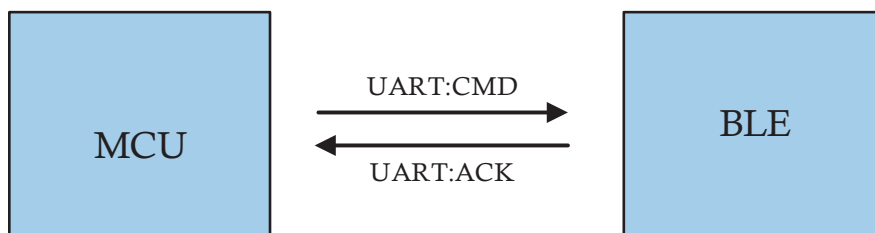


Figure 5-1 Main controller and BLE transparent transmission module command form

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.

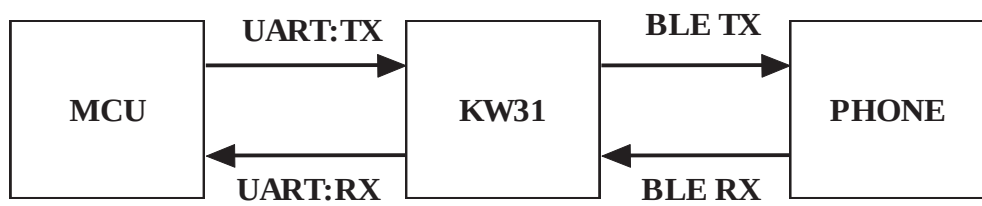


Figure 5-2 Specification of model transparent transmission

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(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

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

April, 2018

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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: N8NLSD1BTNBLE0000", or "Contains FCC ID: N8NLSD1BTNBLE0000 ", Any similar wording that expresses the same meaning may be used.