EWM181-Z12S Series User Manual

2.4GHz 12dBm ZigBee3.0 wireless module



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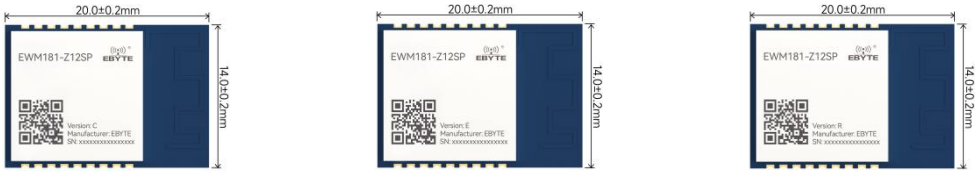
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1 Product Overview

1.1 Product Introduction

The EWM181-Z12SX/EWM181-Z12SP series is a small-volume 2.4GHz frequency band ZigBee3.0 to serial port wireless module designed and produced by Ebyte. It is a SMD type with a maximum transmission power of 12dBm and a pin spacing of 1.27mm. It comes with self-organizing network firmware and is simple and easy to use. It is mainly suitable for data transmission application scenarios.



EWM181-Z12SP(C) EWM181-Z12SP(E) EWM181-Z12SP(R)



EWM181-Z12SX(C) EWM181-Z12SX(E) EWM181-Z12SX(R)

1.2 Features

- Automatic networking: The coordinator automatically builds a network when powered on, and terminals and routers automatically search and join the network.
- Network self-healing: If an intermediate node in the network is lost, other networks will automatically join or remain in the original network (isolated nodes will automatically join the original network, and routing nodes will remain in the original network); if the coordinator is lost and there are non-isolated nodes in the original network, the coordinator can join the network again after it is started.
- Ultra-low power consumption: When the device is in terminal state, it can be set to low power consumption mode. The device sleep time can be changed according to the user's usage time. The standby power consumption in low power consumption mode is less than 2uA. During the parent node data storage time, the device can receive the messages it should receive within the user-set time.
- Automatic retransmission: In unicast (on-demand) mode, the device automatically retransmits when it fails to send a message to the next node. Each message can be retransmitted three times, once every 6 seconds.
- Automatic routing: The module supports network routing function; the router and coordinator carry the network data routing function, and users can perform multi-hop networking.
- Encryption protocol: The module adopts AES 128-bit encryption function, which can encrypt the network and prevent monitoring;

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- Serial port configuration: The module has built-in serial port commands, and users can configure (view) the parameters and functions of the module through issuing serial port commands.
- Multi-type data communication: supports network-wide broadcast, multicast and on-demand (unicast) functions; also supports several transmission methods in broadcast and unicast modes.
- Multiple working mode selection: supports transparent transmission mode, semi-transparent transmission mode, protocol mode, three working modes, users can switch freely.
- Channel change: supports 16 channel changes from 11 to 26 (2405 to 2480MHZ), and different channels correspond to different frequency bands.
- Network PAN_ID change: Any switch of network PAN_ID, users can customize PAN_ID to join the corresponding network or PAN_ID will be automatically selected to join the network.
- Serial port baud rate change: Users can set the baud rate, up to 230400, the default number of bits is 8, stop bit is 1, no check bit.
- Short address search: Users can find the corresponding short address based on the MAC address (unique, fixed) of the module that has joined the network.
- Instruction format switching: This module supports two instruction modes: AT instruction and HEX instruction, which can be easily configured and switched by the user.
- Module reset: Users can reset the module through serial port commands.
- Restore factory settings: Users can restore the module to factory settings through serial port commands.
- Network node management: The coordinator can record the nodes connected to the network, enumerate the information of the connected nodes, delete unnecessary nodes, and facilitate the automated management of networked devices.
- Coordinator devices: EWM181-Z12SP(C), EWM181-Z12SX(C).
- Router devices: EWM181-Z12SP(R), EWM181-Z12SX(R).
- Terminal equipment: EWM181-Z12SP(E), EWM181-Z12SX(E).

1.3 Introduction to ZigBee

ZigBee technology is a short-range, low-complexity, low-power, low-rate, low-cost two-way wireless communication technology. There are three types of logical devices in a ZigBee network: Coordinator, Router, and End-Device. A ZigBee network consists of a Coordinator, multiple Routers, and multiple End_Devices, supporting star, tree, mesh, or hybrid MESH network topologies.

The functions of each type of equipment are as follows:

Coordinator

The coordinator is responsible for starting the entire network and is also the first device in the network. The coordinator selects a channel and a network ID (also called a PAN ID, i.e. Personal Area Network ID), and then starts (establishes) the entire network. The coordinator can also be used to assist in establishing the bindings of the

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security layer and the application layer in the network.

Note that the role of the coordinator is mainly related to the startup and configuration of the network. Once these are completed, the coordinator works like a router (or disappears away). Due to the distributed nature of the ZigBee network itself, the operation of the entire network is no longer dependent on the presence of the coordinator. If a new device needs to join the network, the coordinator is still needed to record and allocate resources, otherwise the new device cannot join the network.

Router

The functions of a router are mainly to allow other devices to join the network, multi-hop routing and assist the communication of its own sub-terminal dormant devices.

Normally, a router is expected to be always active, so it must be powered by the mains, but when using a network mode such as Tree Group, the router is allowed to operate once in a certain period, so that it can be powered by batteries.

End-Device

The end device has no specific responsibility for maintaining the network structure, it can sleep and wake up, so it can be a battery-powered device.

1.4 Application Scenarios

- Smart home and industrial sensors, etc.
- Security systems;
- Wireless remote control;
- Healthcare products;
- Automotive industry applications.

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2 Specifications

2.1 Limit parameters

Main parameters	performance		Remark
	Minimum	Maximum	
Supply voltage (V)	0	3.6	Over 3.6V will permanently burn the module
Blocking power (dBm)	-	10	The probability of burning is lower when used at close range
Operating temperature (°C)	-40	+85	Industrial Grade

2.2 Working parameters

Main parameters		performance			Remark
		Minimum	Typical Value	Maximum	
Operating voltage (V)		2.0	3.3	3.6	≥3.3V can guarantee output power
Communication level (V)			3.3		Using 5V TTL may burn out
Operating temperature (°C)		-40	-	+85	Industrial-grade design
Operating frequency band (GHz)		2.400	-	2.480	Support ISM band
Power consumption	Emission current (mA)		28		Instantaneous power consumption
	Receive current (mA)		10		
	Sleep current (μA)		2		Long-term dormancy
Maximum transmit power (dBm)		-3	12	12	

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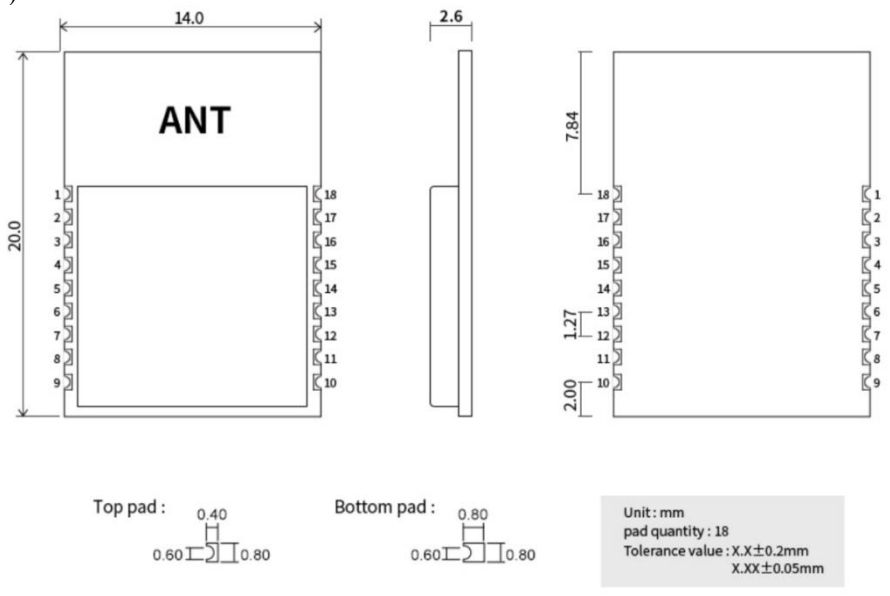
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Main parameters		describe	Rem ark
EWM181-Z12SP communication distance		300 m	Clear and open space, onboard PCB antenna, height 2 meters, air rate 250kbps
EWM181-Z12SX communication distance		600m	Clear and open space, antenna gain 3.0dBi, height 2 meters, air rate 250kbps
protocol		ZigBee	
Communication interface		UART	TTL level
Packaging		SMD	
Packet length	Transparent transmission	150 Bytes	
	Fixed-point broadcast/multicast	75 Bytes	
	Fixed-point unicast	128 Bytes	
Interface		Stamp Holes	1.27mm pitch
Dimensions		1 4 *2 0 mm	±0.2mm
EWM181-Z12SP Antenna Interface		PCB	Equivalent impedance is about 50Ω
EWM181-Z12SX Antenna Interface		IPEX	
EWM181-Z12SP Product Weight		1.0g	±0.1g
EWM181-Z12SX Product Weight		1.3g	

3 Mechanical Dimensions and Pin Definition

3.1 Dimensions and pin definitions

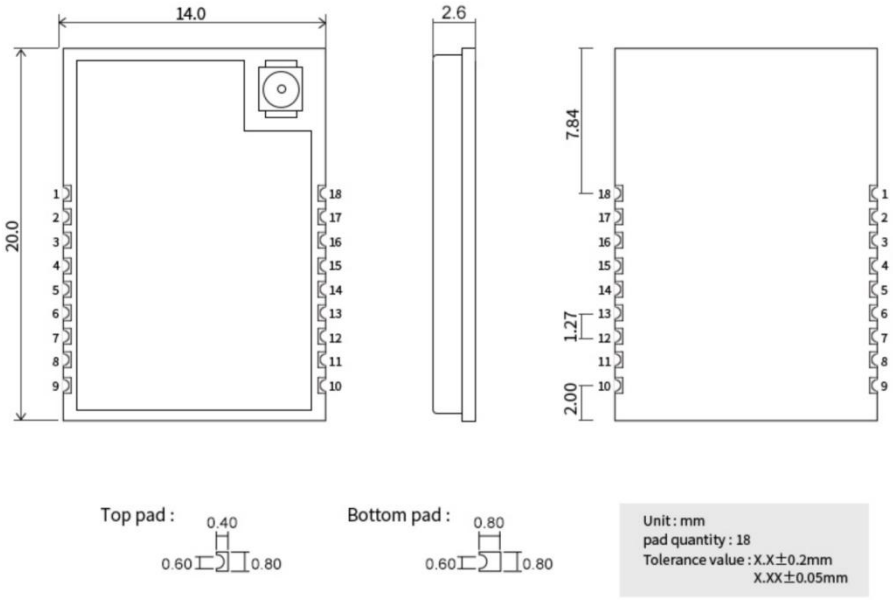
EWM181-Z12SP(x):



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EWM181-Z12SX(x):

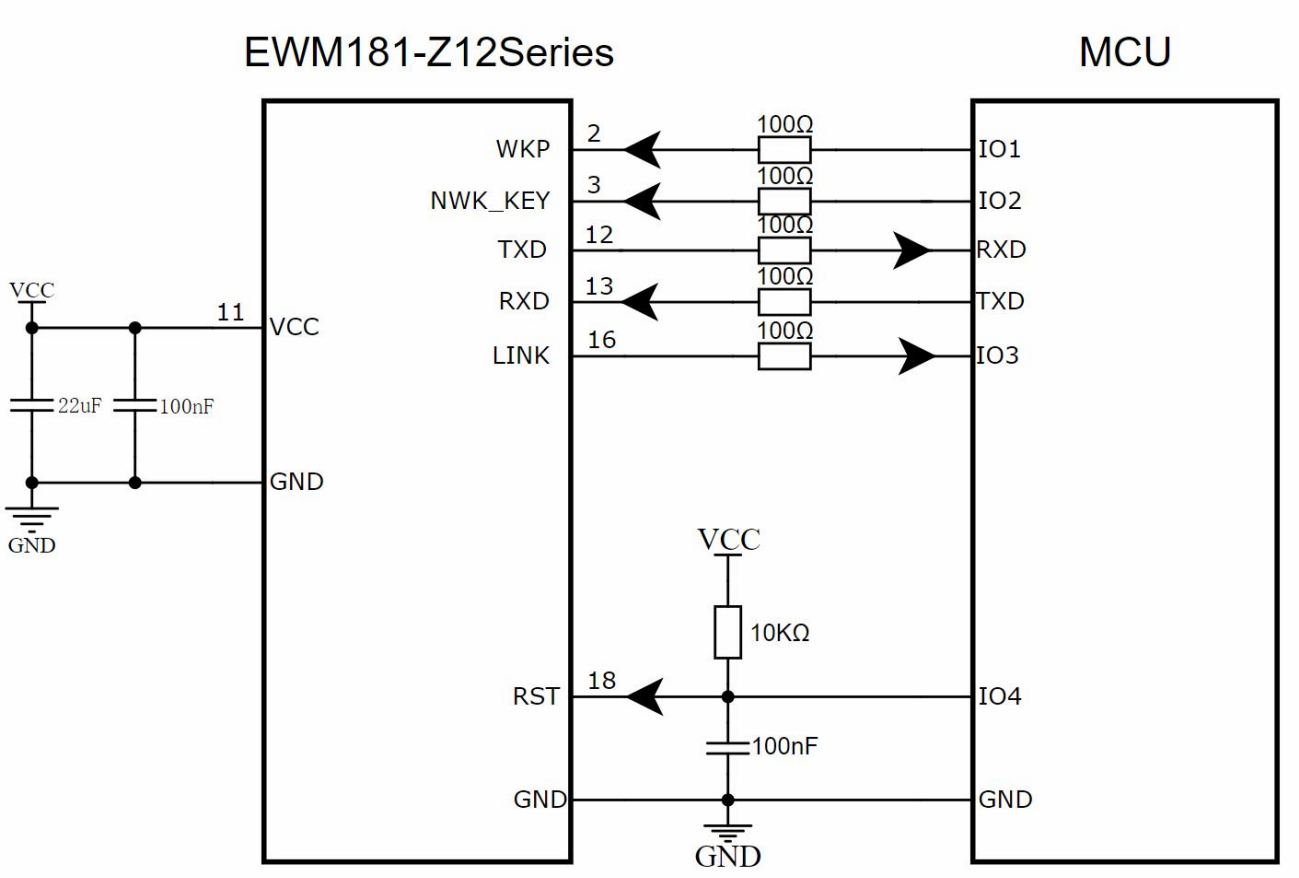


Pin number	Pin Name	Pin Direction	Pin Purpose
1	GND	Input/Output	Ground wire, connected to the power reference ground
2	WKP	enter	Module sleep wake-up pin, low level wake-up, default pull-up
3	NWK_KEY	enter	One-key networking pin, 10ms~1000ms low level network configuration, 5s low level network reset, default pull-up
4	P D4	Input/Output	Reserved, users do not need to pay attention
5	PA7	Input/Output	Reserved, users do not need to pay attention
6	P D2	Input/Output	Reserved, users do not need to pay attention
7	P D7	Input/Output	Reserved, users do not need to pay attention
8	B7	Input/Output	Reserved, users do not need to pay attention
9	B6	Input/Output	Reserved, users do not need to pay attention
10	GND	Input/Output	Ground wire, connected to the power reference ground
11	VCC	enter	Power supply, 2.0~3.6V DC power supply
12	TXD	Output	Serial data output
13	RxD	enter	Serial data input
14	PC1	Input/Output	Reserved, users do not need to pay attention
15	PC4	Input/Output	Reserved, users do not need to pay attention
16	LINK	Output	Network status indicator, high level network is valid, default low level
17	C0	Input/Output	Reserved, users do not need to pay attention
18	RST	enter	Reset pin

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3.2 Recommended wiring diagram



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4 Working Mode

<table>
<tr><th colspan="2">Working Mode</th><th>illustrate</th></tr>
<tr><td rowspan="2">Transmission Mode</td><td>Transparent mode</td><td>Data sending:
UART directly inputs the message to be transmitted, and the module directly sends the data. If the module is not networked, it cannot send data. To whom the data is sent is determined by the configuration parameters "destination address" and "destination port" in the module, which can be configured as unicast, multicast, and broadcast.
After turning on "Print network prompt information", the sent data will return "OK\r\n", "FAIL\r\n", "ERROR\r\n" to indicate the sending result.

Data reception:
After the networking module receives the data message, it directly prints out all the data messages via UART.

Mode switch:
Enter "+AT" to enter AT command mode
Enter "+++" to enter HEX command mode</td></tr>
<tr><td>Semi-transparent mode</td><td>Data sending:
UART input is in the format of "send to whom + data message", where "send to whom" consists of three bytes, the first two bytes are "destination address" (little endian format), and the third byte is "destination port". These two parameters are used in the same way as the "destination address" and "destination port" in the configuration parameters, but will not change the settings of these two configuration parameters.

Data reception:
After the networked module receives the data message, UART prints the format of "who sent the data + data message". The "who sent the data" consists of three bytes, including two bytes of "source address" (little endian format) and one byte of "source port".

Mode switch:
Enter "+AT" to enter AT command mode
Enter "+++" to enter HEX command mode</td></tr>
<tr><td colspan="2">AT command mode</td><td>Mode Description:
In this mode, AT commands are used to configure and query the module. Each AT command has its own corresponding HEX command. In AT command mode.
There are three functions of AT commands: execution, query and configuration.

Execution:
The command input format is "AT+command name" without any symbols or parameters at the end, such as "AT+JOIN". System LOG information such as "OK\r\n" and "FAIL\r\n" is returned.

Query type:
Enter the command "AT+command name?" followed by "?", for example, "AT+NWK?". The current value of the configuration parameter corresponding to the command is returned in the format of "command name=parameter value" followed by a carriage return and line feed symbol, for example, "NWK=1\r\n".

Profiles:</td></tr>
</table>

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	Enter the command in the format of "AT+command name=command parameter", for example "AT+NWK=1". The return command format is "command name=parameter value" to indicate whether the parameter setting is valid. If the returned parameter is not equal to the set parameter, it means that the setting is invalid. **Mode switch:** Enter "AT+EXIT" to exit the transmission mode or do not enter any AT command and wait for 1 minute to exit the transmission mode. When exiting the AT command mode, UART prints out the prompt message "EXIT_AT\r\n".
HEX Command Mode	**Mode Description:** HEX commands are divided into two categories according to their functions: local commands and remote commands. Each local command has its own corresponding AT command. **Command format:** The three formats of input command, return command and asynchronous reception start with FE, FB and FC respectively. The second byte of the command is the command frame length, the third byte of the command is the command category, the fourth byte of the command is the command code, the fifth byte is the command parameter, and the last byte of the command is the AA end symbol. The command length includes the third byte to the last byte AA. Each input command must trigger a corresponding return command. If there is no return command, it means the module may be abnormal. **Local commands:** The local commands of HEX commands have corresponding AT commands. When the parameters of HEX commands are empty, the execution or query effect of the same AT commands is triggered. **Remote Commands:** Remote commands need to wait for Zigbee wireless transmission, and the delay time of the return command is slightly longer than that of the local configuration command. The parameters of the remote command include the target address and the target port, which can be arranged and combined into unicast, multicast, and broadcast, just like the destination address and the target port in the transparent transmission mode. Remote commands can be used for data transmission, remote configuration, and remote query. Remote configuration and remote query will trigger asynchronous receive commands. If it is multicast or broadcast, multiple asynchronous receive commands may be triggered. **Asynchronous reception:** Asynchronous receiving commands include the following messages: receiving data sent by other modules in HEX command mode; receiving return messages of remote configuration and remote query and heartbeat packets of other modules; receiving system notification messages such as network disconnection, etc.

5 Communication Methods

Serial number	Communication	describe

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1	broadcast	After joining the network, users can broadcast to the entire network according to instructions (divided into three broadcast modes) 1. Broadcast mode 1 - the message is broadcast to all devices in the entire network; 2. Broadcast mode 2 - the message is broadcast only to devices that have turned on reception (except sleep mode); 3. Broadcast mode 3 - The message is broadcast to all full-function devices (routers and coordinators). The target short address is 0xFFFC (broadcast mode 3), 0xFFFD (broadcast mode 2), 0xFFFF (broadcast mode 1), and the target port is 0x01 or 0xFF
2	Multicast	When joining the network, users can multicast to all non-sleeping devices in the network. Non-sleeping devices that receive multicast need to join a group. A device can join multiple groups at the same time and can also exit a specified group freely. The target short address is the group ID, and the target port is 0x00
3	On Demand	When joining a network, users can communicate with devices in the network individually using short addresses according to instructions. The target short address is the other party's short address, and the target port is 0x01

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6 Function Introduction

6.1 Special Pins

6.1.1 Wake-up pin

The module's WKP is an external wake-up pin. When the module is configured as a sleep terminal, if you need to input commands or data into the UART, you need to pull the pin low. Then input the command or data. When the wake-up pin is pulled low, the UART outputs the "WAKEUP" keyword reminder, and when it is pulled high, it outputs the "SLEEP" keyword reminder.

In HEX command mode, the "WAKEUP" keyword and the "SLEEP" keyword cannot be output. Outputting the asynchronous command "FC 03 FF 01 AA" indicates that the module is awake, and outputting the asynchronous command "FC 03 FF 00 AA" indicates that the module is asleep.

6.1.2 Serial port wake-up

If the WKP pin of the module in sleep terminal mode is not pulled low, you can also input a 10us low level or send a single byte 00 5ms to 100ms before inputting commands or data to UART to wake up the module. This wake-up state can only last for less than 1 second. You need to enter "###" again to maintain the wake-up state for 60 seconds, or enter "+AT" to enter AT command mode to maintain the wake-up state for 60 seconds. When entering the wake-up maintenance state, the serial port outputs the "WAKEUP" keyword reminder. In the serial port wake-up maintenance mode, enter the "###" keyword, the "+AT" keyword or enter the correct AT command to keep the wake-up state for 60 seconds. In the serial port wake-up maintenance mode, enter the AT command "AT+SLEEP" or transparently transmit any data to enter sleep immediately. When entering the sleep mode, the module outputs the "SLEEP" keyword reminder.

In HEX command mode, the "###" keyword and "+AT keyword" cannot be recognized. You need to replace the wakeup keyword with the HEX command "FE 03 FF 01 AA" and receive the response of "FB 03 FF 01 AA". In HEX command mode, any valid HEX command including data transmission can make the serial port wake-up state last for 60 seconds. You need to enter the HEX command "FE 03 FF 00 AA" and receive the response of "FB 03 FF 00 AA" to sleep immediately. When the serial port wake-up mode reaches the time or the immediate sleep command is entered, the module sends the asynchronous command "FC 03 FF 00 AA" to enter the sleep state.

The priority of IO port wake-up is higher than that of serial port. When the timeout is about to arrive, the module that wakes up the serial port pulls the WKP pin low and remains awake. If the serial port wake-up module pulls the WKP pin high before the timeout arrives, it will immediately go into sleep and output the "SLEEP" keyword or the HEX command "FC 03 FF 00 AA".

6.1.3 One-click networking

The module's NWK_KEY pin is a one-key networking pin. A module that is not networked can enter the network configuration mode (coordinator creates a network, routers and terminal nodes search and join the network) by short

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pressing (10ms~1000ms low level). A coordinator that has established a network can short press this button to allow network access, and short press it again to turn off network access. A short press of this button on a router or terminal node that has joined the network has no effect.

If the module is connected to the network, long press this key (low level for more than 5 seconds), the module will exit the network. If the module is not connected to the network, long press this key, the module will clear the configuration parameters and restore to factory settings.

6.1.4 Network Status Pin

The module's LINK pin indicates the network status. The signal is as follows

- When there is no network, the LINK pin is at a low level;
- When there is a network, the LINK pin is high level;
- When the network is turned on (opened), the LINK pin outputs a 1Hz square wave; when the network is turned on (opened) time is up, the LINK pin returns to a high level;
- When joining the network, the LINK pin outputs a 3Hz square wave; when joining the network successfully, the joining action stops and the LINK pin remains at a high level; if joining the network is unsuccessful (timeout), the LINK pin remains at a low level;
- The dormant terminal has been connected to the network. If the WKP pin is pulled low, the LINK pin outputs a high level. If the WKP pin is not pulled low, the LINK pin outputs a high level pulse (1~2ms) each time the dormant terminal wakes up and receives data. If the dormant terminal receives data packets continuously, the pin outputs pulses continuously.
- When the dormant terminal first accesses the network, when the network is restored, and when the NWK_KEY pin is pulled low after accessing the network, the LINK pin outputs a high level for 5 seconds.

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7 Quick Start

The ZigBee self-organizing network module is easy to use. In order to allow users to quickly become familiar with the module, this section will guide users to achieve configuration and communication in various modes through simple configuration. The working mode is HEX instruction mode.

The user can pull the pin low to set the HEX command. To facilitate the host computer observation, this experiment uses the HEX command format. The AT command user is not tested in this experiment. (The AT command mode cannot be used for host computer configuration.)

In addition, users can use an external microcontroller (MCU) to directly connect to the module UART for serial command communication instead of using the baseboard to achieve secondary development.

7.1 Establishing a network

1. Prepare one EWM181-Z12S P (C) and one EWM181-Z12S P (E) module. EWM181-Z12S P (C) is the coordinator and EWM181-Z12S P (E) is the terminal node.
2. Connect to the coordinator module (EWM181-Z12S P (C)), open the host computer software "EWM181_Zigbee_Setting_V1.0", select the port number, set the serial port baud rate (default 115200), and open the serial port;



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3. Click to enter configuration, read parameters, and read the corresponding module parameters.



4. Click Configure Network and wait for the coordinator to start building the network. Users can view the module parameters. After the network is built, read the parameters: Configure network parameters :(WhenPAN ID is

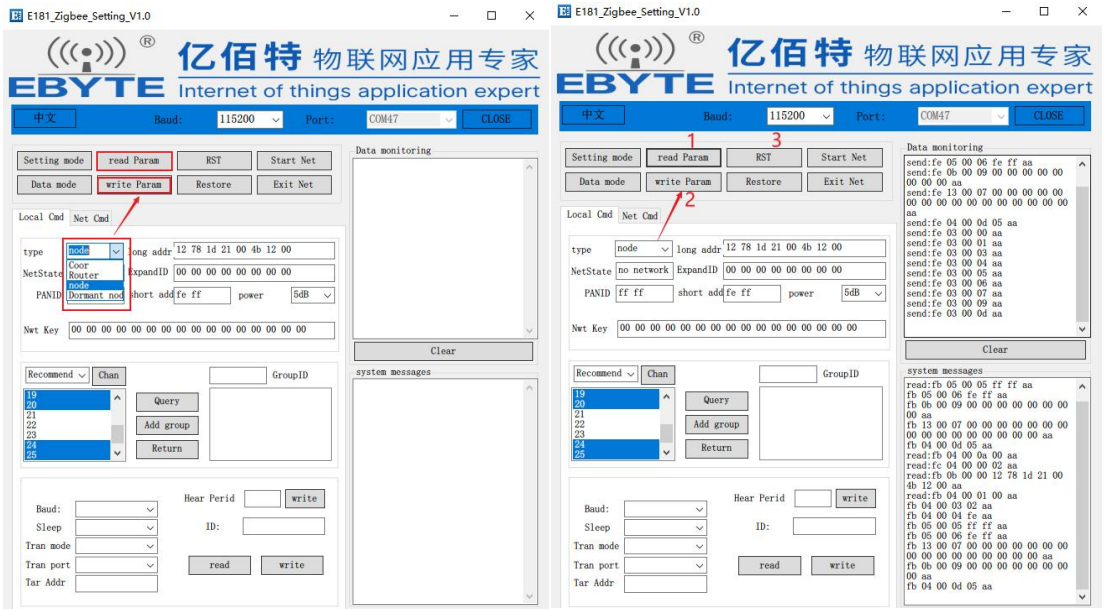


FFFF , it isautomaticPAN ID ）

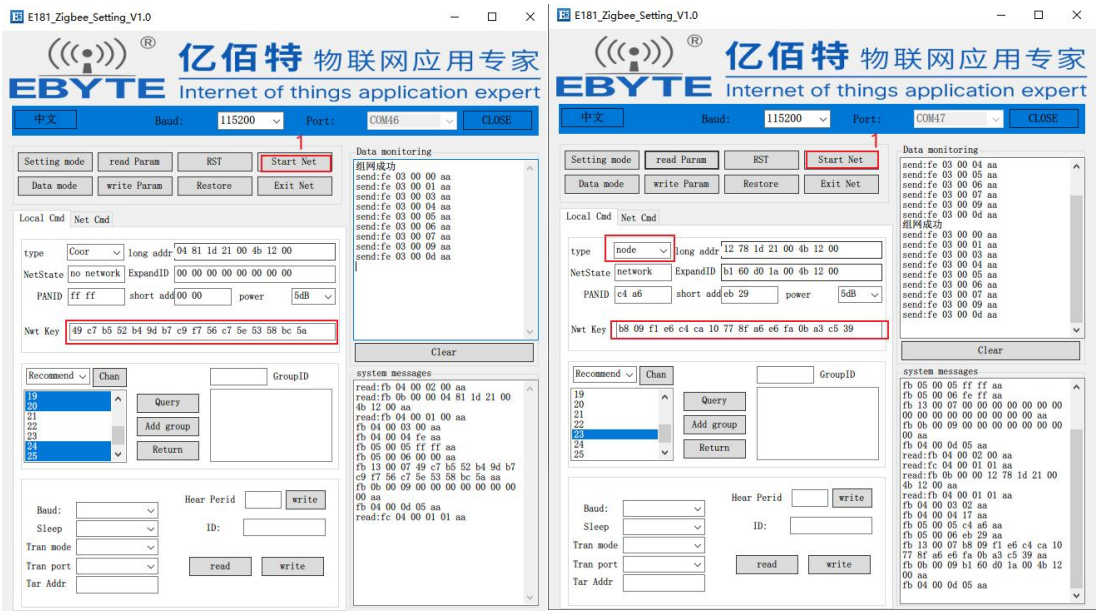
5. Select another terminal module EWM181-Z12S P (E) and follow the same steps to set it as a terminal or a dormant terminal (the module is a dormant terminal by factory default and needs to be set. Here it is set as a terminal).

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6. After configuring the terminal, click Configure Network, read the parameters PANID / Network Key successfully (consistent with the coordinator) and the network is successfully established.



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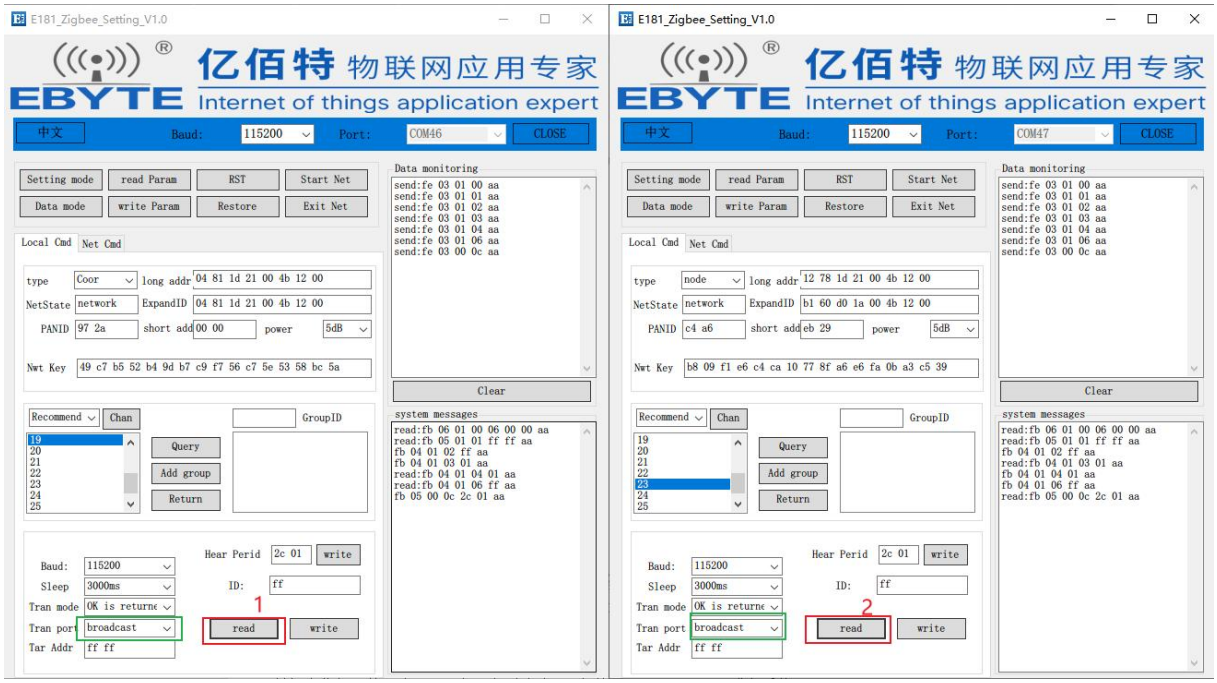
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7.2 Communication Test

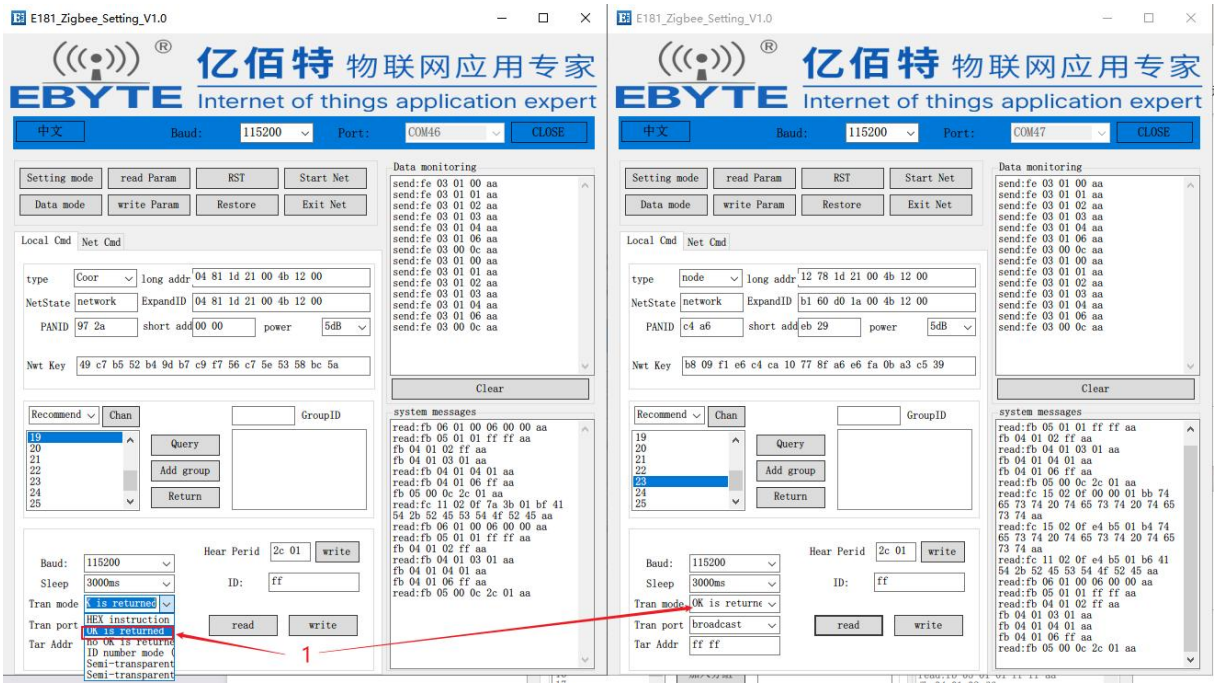
7.2.1 Coordinator transmits data to network terminals (on-demand communication)

Coordinator:

1. Click to read parameters



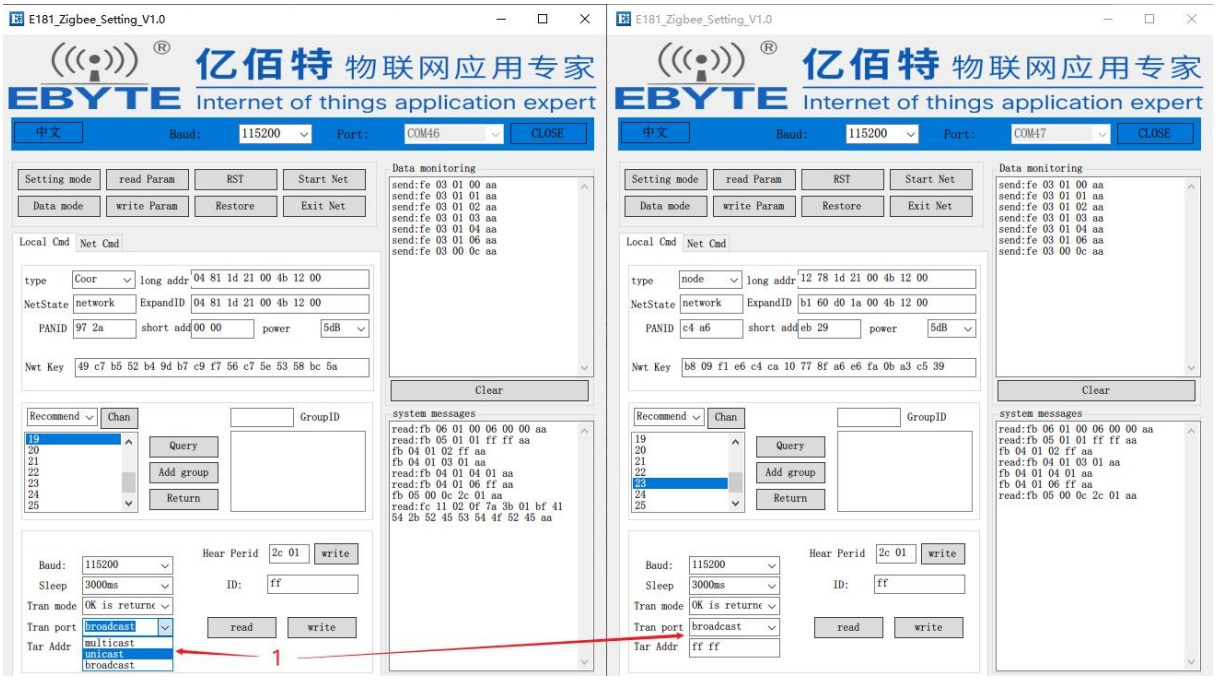
2. Select transparent transmission mode (mode 1)



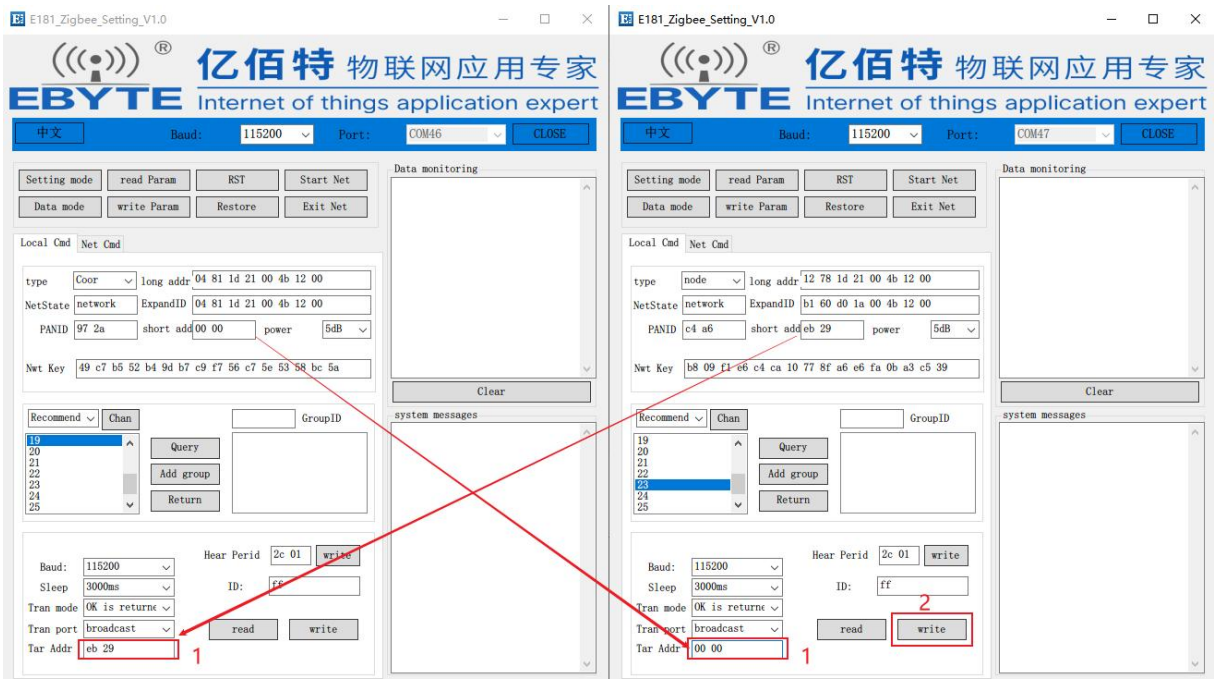
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3. Select transparent transmission protocol (unicast)



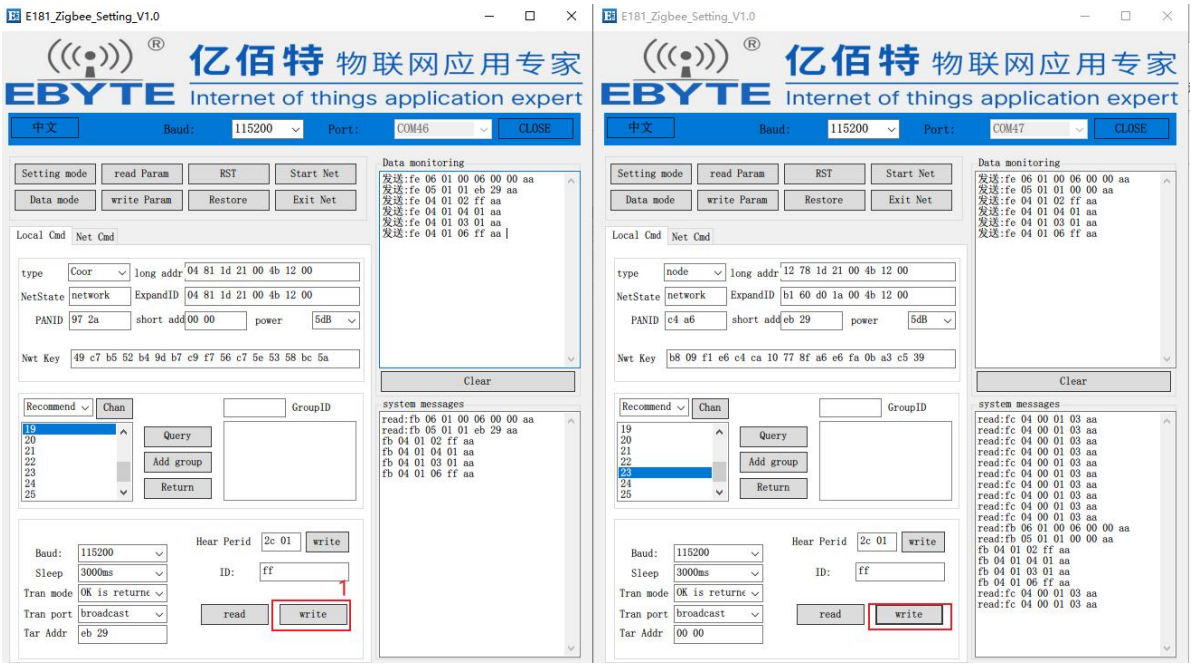
4. Fill in the target address (short address of the network terminal)



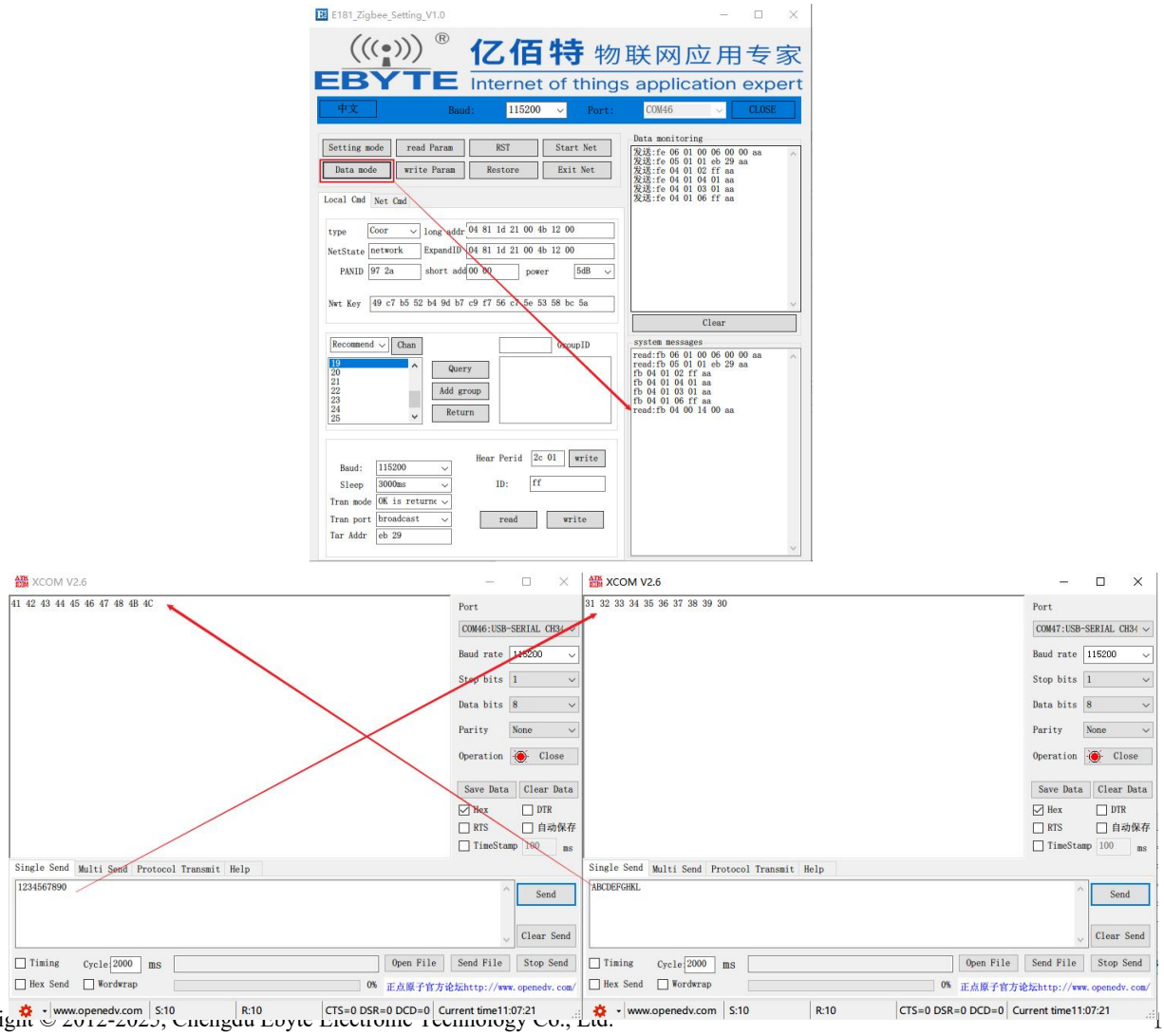
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5. Click Write Parameters



6. Finally, click to enter the transmission mode, shut down the host computer, and use the serial port tool to perform communication test



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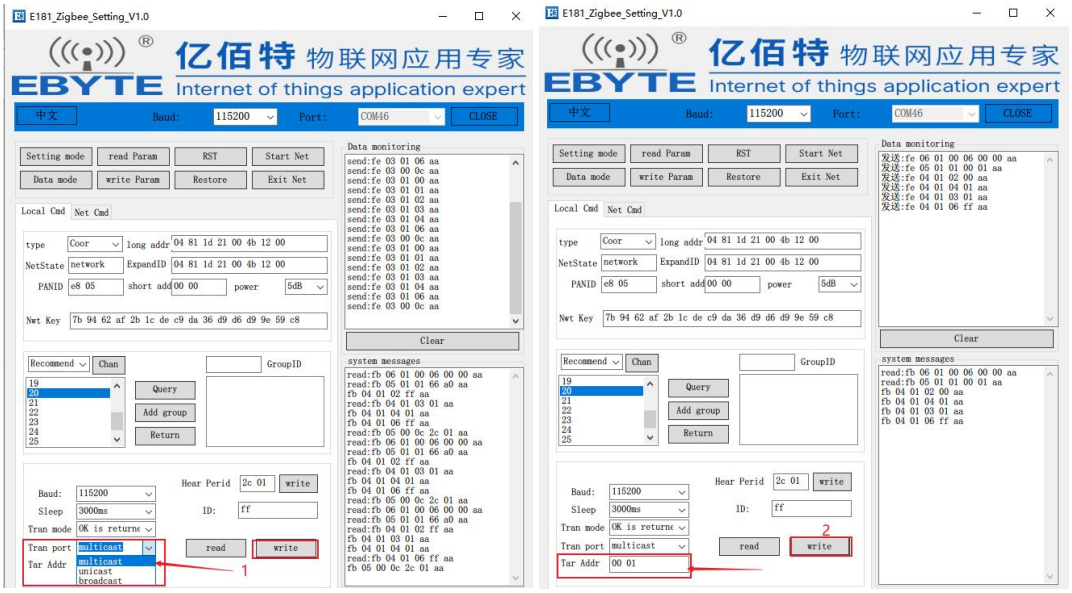
7.2.2 Coordinator transmits data to network terminals (multicast communication)

1. Group the nodes that need to be multicast on the basis of unicast. For example, add terminal A and terminal B to



group 00 01.

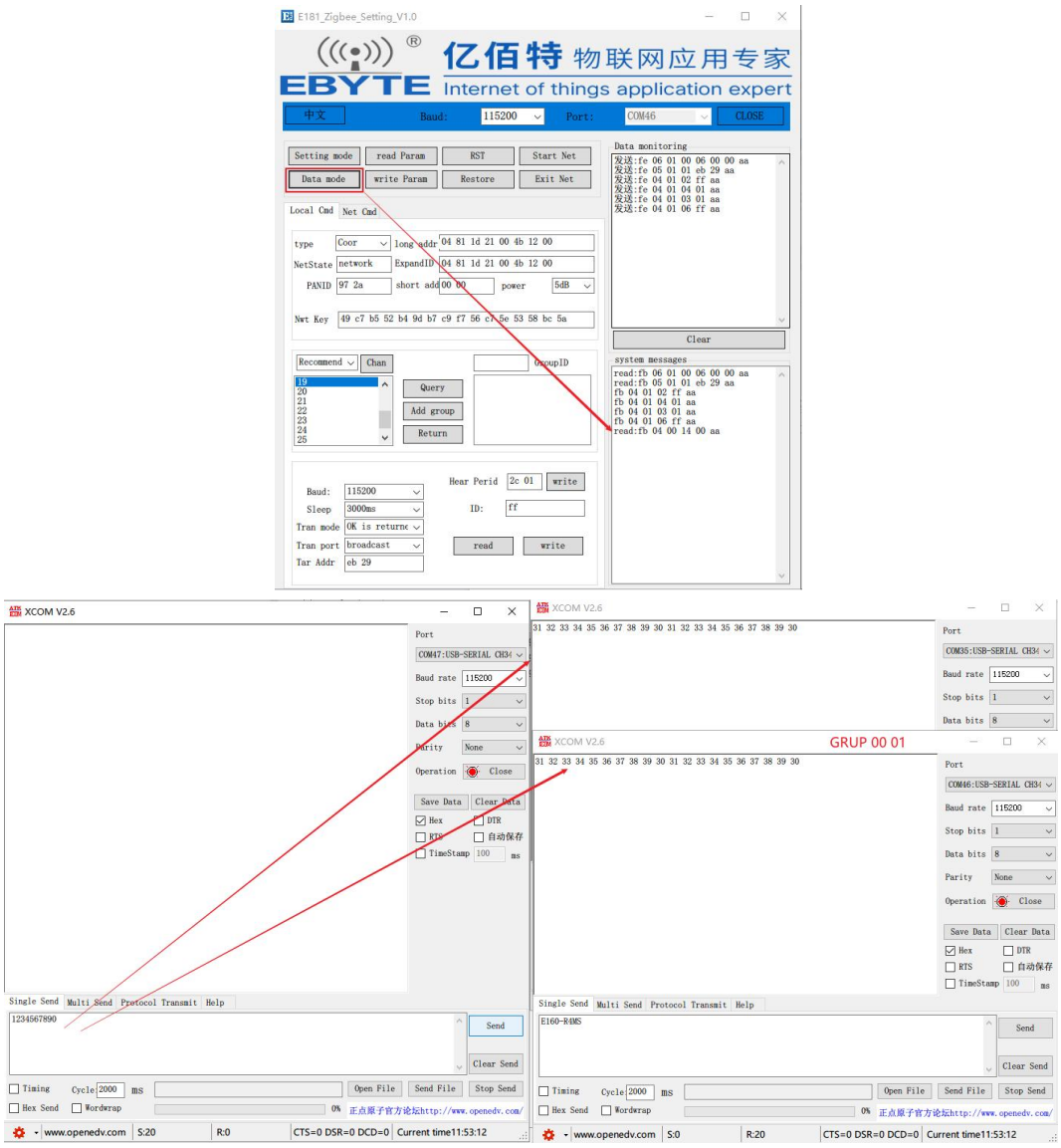
2. The coordinator selects multicast and fills in the group number



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3. Click the transmission mode, turn off the host computer, use the serial port tool to open the corresponding serial port, and perform communication test



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8 User Instruction Set

For the convenience of users, the EWM181 module uses two instruction formats, namely AT instruction format and HEX instruction format.

The module is in transmission mode by default. Enter +AT to enter AT command mode, and enter +++ to enter HEX command mode. When using AT commands, the line break character cannot be used at the end.

8.1 Command Format

The basic format of HEX command is:

HEX commands have three input and output modes:

Input command: 0xFE + frame length (1 byte) + command type (1 byte) + command code (1 byte) + command parameter ((frame length - 3) bytes) + 0xAA.

Return command: 0xFB + frame length (1 byte) + command type (1 byte) + command code (1 byte) + command parameters ((frame length - 3) bytes) + 0xAA. For each input command, only one return command is generated.

Receive command: 0xFC + frame length (1 byte) + command type (1 byte) + command code (1 byte) + command parameters ((frame length - 3) bytes) + 0xAA. The receive command includes network status information, receive data, etc.

The basic format of AT commands:

The basic format of AT commands is "AT+command name", where AT commands are divided into three input formats: execution format, query format, and configuration format.

Execution type: "AT+command name", followed by nothing, including characters or symbols, such as "AT+JOIN". Execution type commands return status values such as "OK\r\n" and "ERROR\r\n".

Query type: "AT+command name?", that is, the command name followed by the ASC character '?', for example, "AT+NWK?". Execution type returns the format of "command name=parameter value\r\n", for example, "NWK=1\r\n".

Configuration format: "AT+command name=configuration value", the command name is followed by '=', for example, "AT+CH=25". The execution format returns the "command name=parameter value\r\n" format, for example, "CH=25\r\n". If the returned parameter value is not equal to the configured value, it means that the parameter value is incorrect and the configuration is invalid.

8.2 AT Commands

AT commands are used to configure the module. The input format is "AT+command keyword". The symbol "=" or "?" after the keyword indicates configuration, query and other operations respectively. If there is no symbol after the

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keyword, it means execution operation.

8.1.1 Local MAC address:

AT command: local MAC		
	enter	return
Query	AT+ MAC ?	MAC=mac_asc \r\n
parameter	mac_asc: ASCII format of the MAC address, 8 two-digit characters, each two-digit character is separated by ":", for example, 00:12:4B:00:1A:D0:60:E3. The ASCII format MAC address is output in MSB big-endian format.	
illustrate	none	
Example	enter	return
Query	AT+ MAC ?	MAC= 00:12:4B:00:1A:D0:60:E3 \r\n

8.1.2 Network Status

AT command: network status		
	enter	return
Query	AT+ NWK ?	NWK = nwk _asc \r\n
parameter	nwk_asc: Network status, ASCII code format, range 0~2.	
	nwk_asc (ASCII format)	state
	0	No network
	1	Networked
	2	Network established but offline
illustrate	none	
Example		
	enter	return
Query	AT+ NWK ?	NWK = 1 \r\n

8.1.3 Networking

AT command: Networking		
	enter	return
implement	AT+ JOIN	status_asc\r\n
parameter	status_asc : Network status, in ASCII code format.	
	status_asc (ASCII format)	state
	OK	Operation is effective
	JOINED	Networked
	INVALID	Invalid operation
illustrate	1. The coordinator executes this command for the first time to create a network, and executes this command thereafter to open the network and accept new devices to join the network. 2. This command is valid for routers, terminal nodes, and dormant terminals that are not connected to the network. This command is invalid for routers that are connected to the network. 3. Returning OK only means that the network has started, not that the network has been successfully established. To determine whether the network is successfully established, please use "Query Network Status" or turn on the "System Print" mode.	
Example		
	enter	return
implement	AT+ JOIN	OK \r\n

8.1.4 Network Roles

AT Commands: Network Role		
	enter	return
Query	AT+DEV?	DEV=dev_asc\r\n
set up	AT+DEV=dev_asc	DEV=dev_asc\r\n

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parameter	dev_asc: Network role, ASCII code format. dev_asc (ASCII format), uppercase letters are valid: Network Role C: Coordinator R: router E: Endpoints S: Sleep terminal (default)
illustrate	1. The coordinator module and router module cannot switch roles, but the terminal node and dormant terminal can switch between each other. 2. After modifying the network role, you need to restart the module to take effect. 3. Modifying the role after networking will cause network disconnection and network clearing.

Example

	enter	return
Query	AT+DEV ?	DEV= S \r\n
set up	AT+DEV= R	DEV= R \r\n

8.1.5 Network Channels

AT command: network channel

	enter	return
Query	AT+CH?	CH=ch_asc\r\n
set up	AT+CH=ch_asc	CH=ch_asc\r\n
implement		

parameter — ch_asc: channel, in ASCII format, with a maximum value of 255.

ch_asc (ASCII format)	Channel
11~26	Fixed scanning of a single channel
254	Scan channels 11, 14, 15, 19, 20, 24, 25 simultaneously
255	Scan channels 11 to 26 simultaneously (default)
other	Invalid channel, do not change the current value

illustrate:
1. Set the channel to the scanning channel during networking, not the real channel.
2. The coordinator can establish a network using a fixed channel
3. Routers, terminal nodes, and dormant terminals scan a single channel and join the channel coordinator first. If there is no suitable coordinator for the channel, they may join other channel coordinators.

Example

	enter	return
Query	AT+ CH?	CH= 255 \r\n
set up	AT+ CH = 11	CH= 11 \r\n

8.1.6 PANID (Network ID)

AT command: PANID

	enter	return
Query	AT+PANID?	PANID=panid_asc\r\n
set up	AT+PANID=panid_asc	PANID=panid_asc\r\n
implement		

parameter — panid_asc: Network ID, in ASCII format, representing 4 hexadecimal digits.

panid_asc (ASCII format)	PANID
0xFFFF	Random PANID (default)
other	Fixed PANID

illustrate:
1. The coordinator generates a random PANID or a fixed PANID.
2. After setting a fixed PANID, routers, terminal nodes, and dormant terminals can only join the coordinator of the PANID.

Example

	enter	return
Query	AT+ PANID?	PANID= 0xFFFF \r\n
set up	AT+ PANID = 0x3E44	PANID= 0x3E44 \r\n

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8.1.7 Network Short Address

<table>
<tr><td colspan="3">AT command: network address</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+ADDR?</td><td>ADDR=addr_asc\r\n</td></tr>
<tr><td>parameter</td><td colspan="2">addr_asc: Network short address, ASCII code format, representing 4 hexadecimal digits .
<table>
<tr><td>addr_asc (ASCII format)</td><td>Short URL</td></tr>
<tr><td>0xFFFE</td><td>Invalid short address, no network (default).</td></tr>
<tr><td>0x0000</td><td>Coordinator short address.</td></tr>
<tr><td>0x0001~0xFFF7</td><td>Valid short address, non-coordinator (networking).</td></tr>
<tr><td>0xFFF8~0xFFFF</td><td>The address is reserved and will not appear.</td></tr>
</table></td></tr>
<tr><td>illustrate</td><td colspan="2">1. When no network is established, the network address is 0xFFFE.
2. After the coordinator establishes the network, its own network address is 0x0000. The network addresses of routers, terminal nodes, and dormant nodes are assigned by the coordinator after they enter the network, and the coordinator does not have the authority to set and modify them.
3.0xFFFC, 0xFFFD, 0xFFFF are broadcast addresses, 0xFFF8 to 0xFFFB are reserved addresses, and these addresses are not assigned to any device.
4. When the number of networks reaches a high level, there will be a certain probability that the network addresses of two nodes are the same, and the network address will jump.</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+ADDR?</td><td>ADDR= 0xECFF \r\n</td></tr>
</table>

8.1.8 Network Key

<table>
<tr><td colspan="3">AT command: Network key</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+KEY?</td><td>KEY=key_asc\r\n</td></tr>
<tr><td>parameter</td><td colspan="2">key_asc: Network key, in ASCII code format, representing 32 hexadecimal digits.</td></tr>
<tr><td>illustrate</td><td colspan="2">The coordinator randomly generates a key when establishing a network. Routers, terminal nodes, and dormant terminals obtain keys from the coordinator after joining the coordinator. The key of a module that is not networked is "00000000000000000000000000000000".</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+KEY?</td><td>KEY= EE23333E1DFE6E6C7EB0155B3D99B404 \r\n</td></tr>
</table>

8.1.9 Group (multicast) control

<table>
<tr><td colspan="3">AT command: group (multicast) control</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query added group</td><td>AT+GROUP?</td><td>GROUP=group_list_asc\r\n</td></tr>
<tr><td>Join Group</td><td>AT+GROUP=1,group_id_asc</td><td>GROUP=group_list_asc\r\n</td></tr>
<tr><td>Exit Group</td><td>AT+GROUP=0,group_id_asc</td><td>GROUP=group_list_asc\r\n</td></tr>
<tr><td>parameter</td><td colspan="2">group_id_asc: group number, ASCII code format , representing 4 hexadecimal numbers. For example, "0x0001", the valid range is "0x0001~0xFFFE"

group_list_asc: group list, ASCII code format, representing 4 hexadecimal numbers. For example, "[0x0001,x0002]", arrays are separated by commas. When the device is not added to any group, the "[]" is empty.</td></tr>
<tr><td>illustrate</td><td colspan="2">1. After a non-sleeping device joins a group, it can receive multicast messages sent by any device to the group.
2. Dormant terminal nodes cannot receive multicast messages.
3. Each device can only join 8 different groups at most.</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query added group</td><td>AT+GROUP?</td><td>GROUP= [0x0001] \r\n, when not joining any group, returns GROUP= [] \r\n</td></tr>
<tr><td>Join Group</td><td>AT+GROUP=1, 0x0002</td><td>GROUP = [0x0001,0x0002] \r\n</td></tr>
</table>

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Exit Group	AT+GROUP=0, 0x0001	GROUP= [0x0002] \r\n

8.1.10 Extended Network ID (EPANID)

AT command: Extended PANID		
	enter	return
Query	AT+EPANID?	EPANID=epanid_asc\r\n
set up	AT+EPANID=epanid_asc	EPANID=epanid_asc\r\n
parameter	epanid_asc: Extended network ID, in ASCII format, representing 16 hexadecimal digits, such as "EF0FC532004B1200".	
illustrate	1. The default value of the extended PANID is "0000000000000000". After the coordinator creates a network, it uses its own MAC (LSB little-endian format) as the extended PANID. The coordinator can freely set a different extended PANID after each factory reset to indicate that the network created this time is different from the last one. 2. Routers, terminal nodes, and dormant terminals can freely join any coordinator using the default extended PANID. After setting the extended PANID, they can only join the coordinator of the extended PANID.	
Example		
	enter	return
Query	AT+EPANID?	EPANID= EF0FC532004B1200 \r\n
set up	AT+EPANID= EF0FC532004B1200	EPANID= EF0FC532004B1200 \r\n

8.1.11 Reset

AT command: reset		
	enter	return
implement	AT+RESET	status_asc\r\n
parameter	status_asc (ASCII format) / state OK / Operation is effective	
illustrate	After returning "OK", the system will reset.	
Example		
	enter	return
implement	AT+RESET	OK\r\n

8.1.12 System Printing

AT command: system print		
	enter	return
Query	AT+MSG?	MSG=msg_asc\r\n
set up	AT+MSG=msg_asc	MSG=msg_asc\r\n
parameter	msg_asc: single character in ASCII format, 0 or 1 msg_asc (ASCII format) / System Printing 0 / Off (default) 1 / Open	
illustrate	This function can turn on or off the system printing information in transfer mode.	
Example		
	enter	return
Query	AT+MSG?	MSG= 0 \r\n
set up	AT+MSG= 1	MSG= 1 \r\n

8.1.13 Heartbeat Packet Cycle

AT command: heartbeat packet cycle		
	enter	return
Query	AT+HEART?	HEART=heart_asc\r\n
set up	AT+HEART=heart_asc	HEART=heart_asc\r\n
parameter	heart_asc: heartbeat packet period, ASCII code format, represents a decimal number, value range 1~65535, default value 300, unit second	

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illustrate	1. The content of the heartbeat packet is the module's ZCL attribute "custom ID number". The coordinator can output and print the heartbeat packet in HEX command mode. 2. When the heartbeat packet period is set to 65535, turn off the heartbeat packet.

Example

	enter	return
Query	AT+HEART?	HEART= 300 \r\n
set up	AT+HEART= 180	HEART= 180 \r\n

8.1.14 Transmit power

AT command: transmit power

	enter	return
Query	AT+POWER?	POWER=power_asc\r\n
set up	AT+POWER=power_asc	POWER=power_asc\r\n

parameter: power_asc: Transmit power value, ASCII code format, range 0~5, default value 5.

power_asc	Power value (dBm)
0	-3
1	0
2	3
3	6
4	9
5	12

illustrate: none

Example

	enter	return
Query	AT+POWER?	POWER= 5 \r\n
set up	AT+POWER= 0	POWER= 0 \r\n

8.1.15 Firmware version

AT command: Firmware version

	enter	return
Query	AT+FWCODE?	FWCODE=wcode_asc\r\n

parameter: fwcode_asc: Firmware version string, such as "7515-0-10".

illustrate: none

Example

	enter	return
Query	AT+FWCODE?	FWCODE= 7515-0-10 \r\n

8.1.16 Return short address based on MAC address

AT command: return short address based on MAC address

	enter	return
set up	AT+QRYADDR=mac_asc_input	MAC= mac_asc,ADDR=addr_asc\r\n

parameter:

mac_asc_input: MAC address, in ASCII format, representing 16 hexadecimal digits, with ":" separating every two hexadecimal digits, for example, "00:12:4B:00:32:C5:0F:EF". The MAC address input in ASCII format is in MSB big-endian format.

mac_asc: The returned MAC address is in ASCII code format, representing 16 hexadecimal digits. Every two hexadecimal digits are separated by ":", for example, "00:12:4B:00:32:C5:0F:EF". The MAC address entered in ASCII code format is in MSB big-endian format.

addr_asc: Returns a short address in ASCII format, representing 4 hexadecimal digits, such as "0x1234".

illustrate:
1. If the device corresponding to the MAC address is not found, the short address "0xFFFE" is returned.
2. If the corresponding device is found, the command will be returned immediately. If the corresponding device is not found, the command will be returned after about 6 seconds.

Example

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	enter	return
Query	AT+QRYADDR= 00:12:4B:00:32:C5:0F:EF	MAC= 00:12:4B:00:32:C5:0F:EF ,ADDR= 0x1234 \r\n

8.1.17 Exit the network

AT command: exit network		
	enter	return
implement	AT+LEAVE	status_asc\r\n
parameter	status_asc (ASCII format) / state OK / Operation is effective NO_NWK / Currently not connected to the network	
illustrate	none	
Example		
	enter	return
implement	AT+LEAVE	OK\r\n

8.1.18 Factory Reset

AT command: factory reset		
	enter	return
implement	AT+RESTORE	status_asc\r\n
parameter	status_asc (ASCII format) / state OK / Operation is effective	
illustrate	none	
Example		
	enter	return
implement	AT+RESTORE	OK\r\n

8.1.19 Coordinator closes the network configuration

AT command: Coordinator closes network configuration		
	enter	return
implement	AT+CLOSE	status_asc\r\n
parameter	status_asc (ASCII format) / state OK / Operation is effective	
illustrate	none	
Example		
	enter	return
implement	AT+CLOSE	OK\r\n

8.1.20 Exit command mode (exit HEX/AT mode to transmission mode)

AT command: Coordinator closes network configuration		
	enter	return
implement	AT+EXIT	status_asc\r\n
parameter	status_asc (ASCII format) / state OK / Operation is effective	
illustrate	none	
Example		
	enter	return
implement	AT+EXIT	OK\r\n

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8.1.21 Serial port mode configuration

<table>
<tr><td colspan="3">AT command: serial port mode configuration</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+ UART ?</td><td>UART=uart_asc_0,uart_asc_1,uart_asc2 \r\n</td></tr>
<tr><td>set up</td><td>AT+UART=uart_asc_0,uart_asc_1,uart_asc2</td><td>UART=uart_asc_0,uart_asc_1,uart_asc2 \r\n</td></tr>
<tr><td>parameter</td><td colspan="2">uart_asc_0: baud rate, ASC format, range 0~7
<table><tr><td>uart_asc_0 (ASC format)</td><td>Baud rate</td></tr><tr><td>0</td><td>2400</td></tr><tr><td>1</td><td>4800</td></tr><tr><td>2</td><td>9600</td></tr><tr><td>3</td><td>19200</td></tr><tr><td>4</td><td>38400</td></tr><tr><td>5</td><td>57600</td></tr><tr><td>6</td><td>115200 (default)</td></tr><tr><td>7</td><td>230400</td></tr></table>uart_asc_1: stop bit, ASC format, range 0~1
<table><tr><td>uart_asc_ 1 (ASC format)</td><td>Stop bits</td></tr><tr><td>0</td><td>1 bit (default value)</td></tr><tr><td>1</td><td>2bit</td></tr></table>uart_asc2 : check bit, ASC format, range 0~2
<table><tr><td>uart_asc_ 2 (ASC format)</td><td>Check digit</td></tr><tr><td>0</td><td>No validation (default)</td></tr><tr><td>1</td><td>Odd Parity</td></tr><tr><td>2</td><td>Even parity</td></tr></table></td></tr>
<tr><td>illustrate</td><td colspan="2">1. This setting triggers automatic restart
2. If the parameter setting exceeds the maximum value, the maximum value is directly applied. For example, if the baud rate is set to 8, the baud rate is forced to be set to 7, which corresponds to 230400.</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+ UART ?</td><td>UART= 6,0,0 \r\n</td></tr>
<tr><td>set up</td><td>AT+UART= 7,1,2</td><td>UART= 7,1,2 \r\n</td></tr>
</table>

8.1.22 Target Address

<table>
<tr><td colspan="3">AT command: target address</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+ DSTADDR ?</td><td>DSTADDR=dstaddr_asc \r\n</td></tr>
<tr><td>set up</td><td>AT+DSTADDR=dstaddr_asc</td><td>DSTADDR=dstaddr_asc \r\n</td></tr>
<tr><td>parameter</td><td colspan="2">dstaddr_asc: transparent transmission destination address ASCII code format, 4-character hexadecimal format starting with "0x", such as "0x1234"</td></tr>
<tr><td>illustrate</td><td colspan="2">The target address in transparent transmission mode, the default value is "0xFFFF", which means broadcast mode.</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+ DSTADDR ?</td><td>DSTADDR = 0xFFFF \r\n</td></tr>
<tr><td>set up</td><td>AT+DSTADDR= 0x1234</td><td>DSTADDR = 0x1234 \r\n</td></tr>
</table>

8.1.23 Destination Port

<table>
<tr><td colspan="3">AT command: target port</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>AT+ DSTEP ?</td><td>DSTEP=dstep_asc \r\n</td></tr>
<tr><td>set up</td><td>AT+DSTEP=dstep_asc</td><td>DSTEP=dstep_asc \r\n</td></tr>
<tr><td>parameter</td><td colspan="2">dstep_asc: transparent transmission target port ASCII code format, 2-character hexadecimal format starting with "0x", such as "0xFF"
<table><tr><td>dstep_asc (ASCII code format)</td><td>Destination Port</td></tr></table></td></tr>
</table>

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	Description	
	0x00	Multicast
	0x01	Unicast
	0x02~0xFE	reserve
	0xFF	Broadcast (default)
illustrate	1. During multicast, the destination port is set to 0x00 and the destination address is set to the corresponding group number. 2. It is recommended to set the destination port to 0x01 for unicast and 0xFF for broadcast.	
Example		
	enter	return
Query	AT+ DSTEP ?	DSTEP= 0xFF \r\n
set up	AT+DSTEP= 0x01	DSTEP= 0x01 \r\n

8.1.24 Transmission Mode

AT command: transfer mode		
	enter	return
Query	AT+ MODE ?	MODE=mode_asc \r\n
set up	AT+MODE=mode_asc	MODE=mode_asc \r\n
parameter	mode_asc: Transmission mode ASCII code format, decimal format.	
	mode_asc (ASCII code)	Transmission Mode
	0	Direct sending mode: no routing forwarding, how far it can be sent depends on the module power, and it cannot be sent to sleeping devices.
	1 (default)	Transparent transmission: Input data is sent directly to the target defined by the target address and target port.
	2	Transparent transmission with automatic retransmission: Same as mode 1, with automatic retransmission mechanism. After turning on "system printing", the delay can be seen from the returned information.
	3	Semi-transparent transmission: The first 3 bytes of the input data are the target address (HEX format LSB little-endian format) and the target port, and the subsequent data is the message content to be transmitted.
	4	Translucent transmission with automatic retransmission: Same as mode 3, with automatic retransmission mechanism. After turning on "system printing", the delay can be seen from the returned information.
illustrate	none	
Example		
	enter	return
Query	AT+ MODE ?	MODE= 1 \r\n
set up	AT+MODE= 0	MODE= 0 \r\n

8.1.25 Sleep Mode

AT command: Sleep mode		
	enter	return
Query	AT+ SLEEP ?	SLEEP=sleep_asc \r\n
set up	AT+SLEEP=sleep_asc	SLEEP=sleep_asc \r\n
parameter	sleep_asc: sleep mode ASCII code format, decimal format, range 0~6 or 60.	
	sleep_asc (ASCII code)	Sleep Mode
	0	Always dormant, no synchronization with the parent node occurs.
	1~6 (default 1)	Wake up every 1 to 6 seconds to receive parent node data.
	60	Wake up every 60 seconds and synchronize the parent node records.
illustrate	1. The dormant node needs to receive data. The setting range is 1 to 6. The larger the value, the worse the real-time performance of the received data and the higher the packet loss rate. 2. Set to 0 or 60, data cannot be received, but the low power consumption effect is better. 3. The sleep mode of the sleeping node can be modified dynamically, so that it wakes up frequently during the time period when it needs to receive data, and sleeps for a long time during the time period when it does not need to receive data.	
Example		

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	enter	return
Query	AT+ SLEEP ?	SLEEP = 1 \r\n
set up	AT+ SLEEP = 0	SLEEP = 0 \r\n

8.1.26 Custom Number

AT command: custom number		
	enter	return
Query	AT+ MBID ?	MBID=mbid_asc \r\n
set up	AT+ MBID =mbid_asc	MBID=mbid_asc \r\n
parameter	mbid_asc: ASCII code format of custom number, ranging from 0 to 255, default is 255.	
illustrate	The custom number will be included in the heartbeat packet and transmitted to the coordinator in the form of ZCL protocol.	
Example		
	enter	return
Query	AT+ MBID ?	MBID = 255 \r\n
set up	AT+ MBID = 1	MBID = 1 \r\n

8.1.27 Network access node table

AT command: Network node table		
	enter	return
Query single	AT+NODE=node_idx	NODE= node_idx, ADDR=addr_asc,MAC=mac_asc \r\n
Search all	AT+ NODE?	OK\r\n NODE= 0, ADDR=addr_asc_0,MAC=mac_asc_0 \r\n … NODE= n, ADDR=addr_asc_n,MAC=mac_asc_n \r\n
parameter	node_idx : The serial number of the node entering the network, valid from 0 to 127. addr_asc: short address of the node entering the network, 0x0000 to 0xFFF0 is valid mac_asc: MAC address of the access node short address of the nth node entering the network MAC address of the nth access node	
illustrate	Query a single access node and output the access node corresponding to the access node serial number. If there is no access node on the serial number or the access node is deleted, the corresponding short address and MAC address are invalid values. Query all networked nodes. The module continuously outputs all networked nodes and automatically skips the deleted node numbers.	
Example		
	enter	return
Query single	AT+ NODE= 0	NODE= 0 ,ADDR= 0xF21F ,MAC= A4.C1.38.FB.C0.6C.76.D4 \r\n
Search all	AT+NODE?	NODE= 0 ,ADDR= 0x0000 ,MAC= A4.C1.38.C6.FE.D2.18.CA \r\n NODE= 1 ,ADDR= 0xD047 ,MAC= A4.C1.38.05.91.57.5B.32 \r\n NODE= 2 ,ADDR= 0xB64B ,MAC= A4.C1.38.FF.42.B9.C1.A2 \r\n

8.1.28 Enumerating nodes

AT command: Enumerate nodes		
	enter	return
Enumerate Nodes	AT+ENUM=mac_addr	ENUM= mac_addr, ADDR=addr_asc \r\n
parameter	mac_asc: MAC address of the access node. addr_asc : short address of the node entering the network, 0x0000 to 0xFFF0 is valid.	
illustrate	When any node first joins the network, the coordinator automatically outputs its enumeration information and prints it out through the "enumeration notification" command (including AT command format and HEX command format). If the host computer does not save the information of the node's first access to the network, it is necessary to use this command to re-enumerate the device.	

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Example		
	enter	return
Query	AT+ENUM= A4:C1:38:FB:C0:6C:76:D4	ENUM= A4:C1:38:FB:C0:6C:76:D4,ADDR=0xF21F \r\n

8.1.29 Deleting a Node

AT command: delete node		
	enter	return
Deleting a Node	AT+DEL=mac_asc	OK\r\nor FAIL\r\n
parameter	mac_asc: MAC address of the deleted node.	
illustrate	If the deleted node exists in the table of connected nodes, it will return OK. The coordinator will send a kick command regardless of whether the node is in the table. If the coordinator receives node data that is not in this table, it can delete it with this command.	
Example		
	enter	return
Query	AT+DEL= A4:C1:38:FF:42:B9:C1:A2	OK\r\n

8.1.30 Host Mode

AT command: host mode		
	enter	return
Host Mode	AT+HOST	OK\r\n
parameter	none	
illustrate	This command forces the target address and target port of other devices to point to itself, so that other devices can transmit data to itself. The set object is determined by its own target address and target port. It is recommended that this command is only executed by the coordinator, and the coordinator is in broadcast mode. Alternatively, the router can also execute this command in multicast mode.	
Example		
	enter	return
Query	AT+HOST	OK\r\n

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8.2 HEX Commands——Local Configuration

Each HEX command starts with FE, the second byte is the command length, the third byte is the command type, the fourth byte is the command code, and the fifth byte and below are the input command parameters. Each HEX command ends with AA, and the command length includes the command end AA.

Each HEX command has a return command. The return command starts with FB. The second byte is the command length. The third byte is the command type, which is the same as the input command. The fourth byte is the command code, which is the same as the input command. The fifth byte and the following are the return command parameters. Each HEX command ends with AA, and the command length includes the command end AA.

8.2.1 Local MAC address:

HEX command: Local MAC		
	enter	return
Query	FE 03 00 00 AA	FB 0B 00 00 mac_hex AA
parameter	mac_hex: 8-byte HEX array of MAC address, for example, E3 60 D0 1A 00 4B 12 00. The HEX format MAC address is output in LSB little-endian format.	
illustrate	none	
Example		
	enter	return
Query	FE 03 00 00 AA	FB 0B 00 00 E3 60 D0 1A 00 4B 12 00 AA

8.2.2 Network Status

HEX command: Network status		
	enter	return
Query	FE 03 00 01 AA	FB 0 4 00 0 1 nwk _hex AA
parameter	nwk_hex: network status, HEX format, range 00~02	

nwk_hex (HEX format)	state
00	No network
01	Networked
02	Network established but offline

illustrate	none	
Example		
	enter	return
Query	FE 03 00 01 AA	FB 04 00 01 01 AA

8.2.3 Networking

HEX command: Networking		
	enter	return
implement	FE 03 00 02 AA	FB 0 4 00 0 2 status _hex AA
parameter	status_hex: network status, HEX format	

status_hex (ASCII format)	state
00	Operation is effective
FF	Invalid operation

illustrate	1. The coordinator executes this command for the first time to create a network, and executes this command thereafter to open the network and accept new devices to join the network. 2. This command is valid for routers, terminal nodes, and dormant terminals that are not connected to the network. This command is invalid for routers that are connected to the network. 3. The return of "Operation is valid" only means that the network has started, not that the network has been successfully established. To determine whether the network is successful, please use "Query Network Status" or

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	receive asynchronous commands.

Example

	enter	return
implement	FE 03 00 02 AA	FB 04 00 02 00 AA

8.2.4 Network roles

HEX command: Network role

	enter	return
Query	FE 03 00 03 AA	FB 04 00 03 dev_hex AA
set up	FE 04 00 03 dev_hex AA	FB 04 00 03 dev_hex AA
parameter	dev_hex: network role, HEX format, range 00~03	
illustrate	1. The coordinator module and router module cannot switch roles, but the terminal node and dormant terminal can switch between each other. 2. After modifying the network role, you need to restart the module to take effect. 3. Modifying the role after networking will cause network disconnection and network clearing.	

dev_hex (HEX format)	Network Role
00	Coordinator
01	router
02	Endpoints
03	Sleep terminal (default)

Example

	enter	return
Query	FE 03 00 03 AA	FB 04 00 03 03 AA
set up	FE 04 00 03 01 AA	FB 04 00 03 01 AA

8.2.5 Network Channels

HEX command: Network channel

	enter	return
Query	FE 03 00 04 AA	FB 04 00 04 ch_hex AA
set up	FE 04 00 04 ch_hex AA	FB 04 00 04 ch_hex AA
parameter	ch_hex: channel, maximum value FF.	
illustrate	1. Set the channel to the scanning channel during networking, not the real channel. 2. The coordinator can establish a network using a fixed channel 3. Routers, terminal nodes, and dormant terminals scan a single channel and join the channel coordinator first. If there is no suitable coordinator for the channel, they may join other channel coordinators.	

ch_hex (HEX format)	Channel
0B~1A	Fixed scanning of a single channel
FE	Scan channels 11, 14, 15, 19, 20, 24, 25 simultaneously
FF	Scan channels 11 to 26 simultaneously (default)
other	Invalid channel, do not change the current value

Example

	enter	return
Query	FE 04 00 04 AA	FB 04 00 04 FF AA
set up	FE 04 00 04 0B AA	FB 04 00 04 0B AA

8.2.6 PANID (Network ID)

HEX command: PANID

	enter	return
Query	FE 03 00 05 AA	FB 05 00 05 panid_hex AA
set up	FE 05 00 05 panid_hex AA	FB 05 00 05 panid_hex AA
parameter	panid_hex: PANID in HEX format, LSB little endian format. For example, "0x1234" is "34 12" in HEX instruction.	

panid_hex (HEX format)	PANID
FF FF	Random PANID (default)
other	Fixed PANID

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illustrate	1. The coordinator generates a random PANID or a fixed PANID. 2. After setting a fixed PANID, routers, terminal nodes, and dormant terminals can only join the coordinator of the PANID.

Example

	enter	return
Query	FE 03 00 05 AA	FB 05 00 05 FF FF AA
set up	FE 05 00 05 44 3E AA	FB 05 00 05 44 3E AA

8.2.7 Network Address

HEX command: network address

	enter	return
Query	FE 03 00 06 AA	FB 04 00 06 addr_hex AA
parameter	addr_hex: network address in HEX format, LSB little endian format. For example, "0x1234" is "34 12" in the HEX instruction. addr_hex (HEX format) / Short URL FE FF / Invalid short address, no network (default) 00 00 / Coordinator short address. 01 00 ~ F7 FF / Valid short address, non-coordinator (networking). F8 FF ~ FF FF / The address is reserved and will not appear.	
illustrate	1. When no network is established, the network address is "FE FF". 2. After the coordinator establishes the network, its own network address is "00 00". The network addresses of routers, terminal nodes, and dormant nodes are allocated by the coordinator after they enter the network, and the coordinator does not have the authority to set or modify them. 3. "FC FF", "FD FF", and "FF FF" are broadcast addresses, and "F8 FF" to "FF FF" are reserved addresses. These addresses are not assigned to any device. 4. When the number of networks reaches a high level, there will be a certain probability that the network addresses of two nodes are the same, and the network address will jump.	

Example

	enter	return
Query	FE 03 00 06 AA	FB 04 00 06 FF EC AA

8.2.8 Network Key

HEX command: Network key

	enter	return
Query	FE 03 00 07 AA	FB 13 00 07 key_hex AA
parameter	key_hex: 16-byte key, which can be treated as an array "uint8 key[16]".	
illustrate	The coordinator randomly generates a key when establishing a network. Routers, terminal nodes, and dormant terminals obtain keys from the coordinator after joining the coordinator. The keys of modules that are not networked are all arrays of 16 "00s".	

Example

	enter	return
Query	FE 03 00 07 AA	FB 13 00 07 EE 23 33 3E 1D FE 6E 6C 7E B0 15 5B 3D 99 B4 04 AA

8.2.9 Group (multicast) control

HEX command: group (multicast) control

	enter	return
Query added group	FE 03 00 08 AA	FB len 00 08 group_list_hex AA
Join Group	FE 06 00 08 01 group_id_hex AA	FB len 00 08 group_list_hex AA
Exit Group	FE 06 00 08 00 group_id_hex AA	FB len 00 08 group_list_hex AA
parameter	group_id_hex: group number, HEX format, LSB little endian format. For example, the group number "0x0001" is "01 00" in the HEX instruction. len: The length of the returned command is variable, and the actual value is determined by the content length of	

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	group_list_hex. group_list_hex: group number list, which can be treated as a uint16 array. For example , when the group number is an array of "[0x0001, 0x0002]", it is "01 00 02 00" in the HEX command. When the module is not added to any group, this field is empty and has no content.
illustrate	1. After a non-sleeping device joins a group, it can receive multicast messages sent by any device to the group. 2. Dormant terminal nodes cannot receive multicast messages.

Example

	enter	return
Query added group	FE 03 00 08 AA	FB 05 00 08 01 00 AA
Join Group	FE 06 00 08 01 02 00 AA	FB 07 00 08 01 00 02 00 AA
Exit Group	FE 06 00 08 00 01 00 AA	FB 03 00 08 AA

8.2.10 Extended PANID

HEX command: Extended PANID

	enter	return
Query	FE 03 00 09 AA	FB 0B 00 09 epanid_hex AA
set up	FE 0B 00 09 epanid_hex AA	FB 0B 00 09 epanid_hex AA
parameter	epanid_hex: HEX format of extended PANID, 8 bytes in total, for example "EF 0F C5 32 00 4B 12 00".	
illustrate	1. The default value of the extended PANID is "00 00 00 00 00 00 00 00". After the coordinator creates a network, it uses its own MAC (LSB little-endian format) as the extended PANID. The coordinator can freely set a different extended PANID after each factory reset to indicate that the network created this time is different from the last one. 2. Routers, terminal nodes, and dormant terminals can freely join any coordinator using the default extended PANID. After setting the extended PANID, they can only join the coordinator of the extended PANID.	

Example

	enter	return
Query	FE 03 00 09 AA	FB 0B 00 05 EF 0F C5 32 00 4B 12 00 AA
set up	FE 0B 00 09 EF 0F C5 32 00 4B 12 00 AA	FB 0B 00 05 EF 0F C5 32 00 4B 12 00 AA

8.2.11 Reset

HEX command: reset

	enter	return
implement	FE 03 00 0A AA	FB 04 00 0A status_hex AA
parameter	status_hex (HEX format) : 00 — state: Operation is effective	
illustrate	none	

Example

	enter	return
implement	FE 03 00 0A AA	FB 04 00 0A 00 AA

8.2.12 System Printing

HEX command: system print

	enter	return
Query	FE 03 00 0B AA	FB 04 00 0B msg_hex AA
set up	FE 04 00 0B msg_hex AA	FB 04 00 0B msg_hex AA
parameter	msg_hex: single-byte parameter, 00 or 01 msg_hex (HEX format) — System Printing 00 — Off (default) 01 — Open	
illustrate	This function can turn on or off the system printing information in transfer mode.	

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Example		
	enter	return
Query	FE 03 00 0B AA	FB 04 00 0B 00 AA
set up	FE 04 00 0B 01 AA	FB 04 00 0B 01 AA

8.2.13 Heartbeat Packet Cycle

HEX command: heartbeat packet cycle		
	enter	return
Query	FE 03 00 0C AA	FB 05 00 0C heart_hex AA
set up	FE 05 00 0C heart_hex AA	FB 05 00 0C heart_hex AA
parameter	heart_hex: 2-byte HEX format value, LSB little endian format, range "01 00" to "FF FF", default "2C 01" (converted decimal = 300), unit is seconds.	
illustrate	1. The content of the heartbeat packet is the module's ZCL attribute "custom ID number". The coordinator can output and print the heartbeat packet in HEX command mode. 2. When the heartbeat packet period is set to "FF FF", the heartbeat packet is turned off.	
Example		
	enter	return
Query	FE 03 00 0C AA	FB 05 00 0C 2C 01 AA
set up	FE 05 00 0C B4 00 AA	FB 05 00 0C B4 00 AA

8.2.14 Transmit power

HEX command: Transmit power		
	enter	return
Query	FE 03 00 0D AA	FB 04 00 0D power_hex AA
set up	FE 04 00 0D power_hex AA	FB 04 00 0D power_hex AA
parameter	power_hex: single byte in HEX format, corresponding to the module transmit power, range 00~05, corresponding to -3~12dbm, default value 05.	
illustrate	This function can turn on or off the system printing information in transfer mode.	
Example		
	enter	return
Query	FE 03 00 0D AA	FB 04 00 0D 05 AA
set up	FE 04 00 0D 00 AA	FB 04 00 0D 00 AA

power_asc	Power value (dBm)
00	-3
01	0
02	3
03	6
04	9
05	12

8.2.15 Firmware version

HEX command: Firmware version		
	enter	return
Query	FE 03 00 0E AA	FB 04 00 0E fwcode_hex AA
parameter	fwcode_hex: A single byte in HEX format represents the firmware version, a total of 4 bytes.	
illustrate	none	
Example		
	enter	return
Query	FE 03 00 0E AA	FB 04 00 0E 5B 10 02 0A AA

8.2.16 Return short address based on MAC address

HEX command: Return short address based on MAC address		
	enter	return

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set up	FE 0B 00 10 mac_hex_input AA	FB 0D 00 10 mac_hex addr_hex AA
parameter	mac_hex_input: Enter the HEX format of the MAC address, LSB little endian format input, for example "EF 0F C5 32 00 4B 12 00" mac_hex: The HEX format of the returned MAC address, output in LSB little-endian format, for example "EF 0F C5 32 00 4B 12 00" addr_hex: The returned short address is in HEX format, LSB little endian format. For example, the address 0x1234 is represented as "34 12" in the HEX command.	
illustrate	1. If the device corresponding to the MAC address is not found, the short address "FE FF" is returned. 2. If the corresponding device is found, the command will be returned immediately. If the corresponding device is not found, the command will be returned after about 6 seconds.	
Example		
	enter	return
set up	FE 0B 00 10 EF 0F C5 32 00 4B 12 00 AA	FB 0D 00 0E EF 0F C5 32 00 4B 12 00 34 12 AA

8.2.17 Exit the network

HEX command: exit network		
	enter	return
implement	FE 03 00 11 AA	FB 04 00 11 status_hex AA
parameter	status_hex (HEX format) / 00 : state / Operation is effective	
illustrate	none	
Example		
	enter	return
implement	FE 03 00 11 AA	FB 04 00 11 00 AA

8.2.18 Factory Reset

HEX command: factory reset		
	enter	return
implement	FE 03 00 12 AA	FB 04 00 12 status_hex AA
parameter	status_hex (HEX format) / 00 : state / Operation is effective	
illustrate	none	
Example		
	enter	return
implement	FE 03 00 12 AA	FB 04 00 12 00 AA

8.2.19 Coordinator closes the network configuration

HEX command: Coordinator turns off network configuration		
	enter	return
implement	FE 03 00 13 AA	FB 04 00 13 status_hex AA
parameter	status_hex (HEX format) / 00 : state / Operation is effective	
illustrate	none	
Example		
	enter	return
implement	FE 03 00 13 AA	FB 04 00 13 00 AA

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8.2.20 Exit command mode (exit HEX/AT mode to transmission mode)

HEX command: Coordinator turns off network configuration		
	enter	return
implement	FE 03 00 14 AA	FB 04 00 14 status_hex AA
parameter	status_hex (HEX format) : 00 — state: Operation is effective	
illustrate	none	
Example		
	enter	return
implement	FE 03 00 14 AA	FB 04 00 14 00 AA

8.2.21 Serial port mode configuration

HEX command: Serial port mode configuration		
	enter	return
Query	FE 03 01 00 AA	FB 06 01 00 uart_hex_arry AA
set up	FE 06 01 00 uart_hex_arry AA	FB 06 01 00 uart_hex_arry AA
parameter	uart_hex_arry: 3-byte array, HEX format uart_hex_arry[0]: baud rate, range 00~07	

uart_hex_arry[0] (HEX format)	Baud rate
00	2400
01	4800
02	9600
03	19200
04	38400
05	57600
06	115200
07	230400

uart_hex_arry[1]: stop bit, range 00~01

uart_hex_arry[1] (HEX format)	Stop bits
00	1bit
01	2bit

uart_hex_arry[2] : check digit, range 00~2

uart_hex_arry[2] (HEX format)	Check digit
00	No verification
01	Odd Parity
02	Even parity

illustrate	1. This setting triggers automatic restart 2. If the parameter setting exceeds the maximum value, the maximum value is directly applied. For example, if the baud rate is set to "08", the baud rate is forced to be set to "07", which corresponds to 230400.
Example	

	enter	return
Query	FE 03 01 00 AA	FB 06 01 00 06 00 00 AA
set up	FE 06 01 00 07 01 02 AA	FB 06 01 00 07 01 02 AA

8.2.22 Target Address

HEX command: target address		
	enter	return
Query	FE 03 01 01 AA	FB 05 01 01 dstaddr_hex AA
set up	FE 05 01 01 dstaddr_hex AA	FB 05 01 01 dstaddr_hex AA

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parameter	dstaddr_hex: transparent transmission destination address HEX format, LSB little endian format, for example, 0x1234 address is "34 12" in the command
illustrate	The target address in transparent transmission mode. The default value is "FF FF", which means broadcast mode.

Example

	enter	return
Query	FE 03 01 01 AA	FB 05 01 01 FF FF AA
set up	FE 05 01 01 34 12 AA	FB 05 01 01 34 12 AA

8.2.23 Destination Port

HEX command: Target port

	enter	return
Query	FE 03 01 02 AA	FB 04 01 02 dstep_hex AA
set up	FE 05 01 02 dstep_hex AA	FB 04 01 02 dstep_hex AA

parameter: dstep_hex: Transparent transmission target port HEX format.

dstep_asc (ASCII code format)	Destination Port Description
00	Multicast
01	Unicast
02~FE	reserve
FF	Port broadcast (default)

illustrate:
1. When multicasting, the destination port is set to 00 and the destination address is set to the corresponding group number.
2. It is recommended to set the destination port to 01 for unicast and FF for broadcast.

Example

	enter	return
Query	FE 03 01 02 AA	FB 04 01 02 FF AA
set up	FE 04 01 02 01 AA	FB 04 01 02 01 AA

8.2.24 Transmission Mode

HEX command: transfer mode

	enter	return
Query	FE 03 01 03 AA	FB 04 01 03 mode_hex AA
set up	FE 05 01 03 mode_hex AA	FB 04 01 03 mode_hex AA

parameter: mode_hex: Transmission mode HEX format.

mode_hex (HEX format)	Transmission Mode
00	Direct sending mode: no routing forwarding, how far it can be sent depends on the module power, and it cannot be sent to sleeping devices.
01 (default)	Transparent transmission: input data is sent directly to the target defined by the target address and target port.
02	Transparent transmission with automatic retransmission: Same as mode 1, with automatic retransmission mechanism. After turning on "system printing", the delay can be seen from the returned information.
03	Semi-transparent transmission: The first 3 bytes of the input data are the target address (HEX format LSB little-endian format) and the target port, and the subsequent data is the message content to be transmitted.
04	Translucent transmission with automatic retransmission: Same as mode 3, with automatic retransmission mechanism. After turning on "system printing", the delay can be seen from the returned information.

illustrate: none

Example

	enter	return
Query	FE 03 01 03 AA	FB 04 01 03 01 AA
set up	FE 04 01 03 00 AA	FB 04 01 03 00 AA

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8.2.25 Sleep Mode

<table>
<tr><td colspan="3">HEX command: Sleep mode</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>FE 03 01 04 AA</td><td>FB 04 01 04 sleep_hex AA</td></tr>
<tr><td>set up</td><td>FE 05 01 04 sleep _hex AA</td><td>FB 04 01 04 sleep_hex AA</td></tr>
<tr><td>parameter</td><td colspan="2">sleep_hex: sleep mode HEX format, range 00~06 or 3C.
<table><tr><td>sleep_hex (HEX format)</td><td>Sleep Mode</td></tr><tr><td>00</td><td>Always dormant, no synchronization with the parent node occurs.</td></tr><tr><td>01~06 (default 01)</td><td>Wake up every 1 to 6 seconds to receive parent node data.</td></tr><tr><td>3C</td><td>Wake up every 60 seconds and synchronize the parent node records.</td></tr></table></td></tr>
<tr><td>illustrate</td><td colspan="2">none</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>FE 03 01 04 AA</td><td>FB 04 01 04 01 AA</td></tr>
<tr><td>set up</td><td>FE 04 01 04 00 AA</td><td>FB 04 01 04 00 AA</td></tr>
</table>

8.2.26 Custom Number

<table>
<tr><td colspan="3">HEX command: custom number</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>FE 03 01 06 AA</td><td>FB 04 01 06 mbid_hex AA</td></tr>
<tr><td>set up</td><td>FE 05 01 06 mbid_hex AA</td><td>FB 04 01 06 mbid_hex AA</td></tr>
<tr><td>parameter</td><td colspan="2">mbid_hex: HEX format of custom number, ranging from 00 to FF, default is FF.</td></tr>
<tr><td>illustrate</td><td colspan="2">The custom number will be included in the heartbeat packet and transmitted to the coordinator in the form of ZCL protocol.</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>FE 03 01 06 AA</td><td>FB 04 01 06 FF AA</td></tr>
<tr><td>set up</td><td>FE 04 01 06 01 AA</td><td>FB 04 01 06 01 AA</td></tr>
</table>

8.2.27 Network access node table

<table>
<tr><td colspan="3">HEX command: Network access node table</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>FE 05 00 17 node_idx AA</td><td>FB 0F 00 17 node_idx addr_hex mac_hex AA</td></tr>
<tr><td>parameter</td><td colspan="2">node_idx : the serial number of the node entering the network, 2-byte HEX format value, LSB little endian format, ranging from "00 00" to "7F 00".
addr_hex: short address of the node entering the network, 2-byte HEX format value, LSB little endian format, ranging from "00 00" to "F0 FF".
mac_hex: MAC address of the access node, 8-byte HEX value, LSB little-endian format.</td></tr>
<tr><td>illustrate</td><td colspan="2">Query the nodes connected to the network on the coordinator, and you can also find the parent node and child node on the router.</td></tr>
<tr><td colspan="3">Example</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>FE 05 00 17 00 00 AA</td><td>FB 0F 00 17 00 00 34 12 EF 0F C5 32 00 4B 12 00 AA</td></tr>
</table>

8.2.28 Enumerating nodes

<table>
<tr><td colspan="3">HEX command: Enumerate nodes</td></tr>
<tr><td></td><td>enter</td><td>return</td></tr>
<tr><td>Query</td><td>FE 0B 00 18 mac_hex AA</td><td>FB 0D 00 18 mac_hex addr_hex AA</td></tr>
<tr><td>parameter</td><td colspan="2">mac_hex: MAC address of the access node, 8-byte HEX value, LSB little-endian format.
addr_hex: short address of the node entering the network, 2-byte HEX format value, LSB little endian format, ranging from "00 00" to "F0 FF".</td></tr>
<tr><td>illustrate</td><td colspan="2">When any node first joins the network, the coordinator automatically outputs its enumeration information and prints it out through the "enumeration notification" command (including AT command format and HEX command</td></tr>
</table>

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	format). If the host computer does not save the information of the node's first access to the network, it is necessary to use this command to re-enumerate the device.
Example	

	enter	return
Query	FE 0B 00 18 D4 76 6C C0 FB 38 C1 A4 AA	FB 0D 00 18 D4 76 6C C0 FB 38 C1 A4 1F F2 AA

8.2.29 Deleting a Node

HEX command: delete node		
	enter	return
delete	FE 0B 00 19 mac_hex AA	FB 04 00 19 status AA
parameter	mac_hex: MAC address of the access node, 8-byte HEX value, LSB little-endian format. status: execution status, 00 = deletion successful, other values = not in the table	
illustrate	The deleted node returns a success status if it exists in the table of networked nodes. The coordinator will send a kick command regardless of whether the node is in the table. If the coordinator receives node data that is not in this table, it can delete it with this command.	
Example		
	enter	return
delete	FE 0B 00 19 A2 C1 B9 42 FF 38 C1 A4 AA	FB 04 00 19 00 AA

8.2.30 Host Mode

HEX command: host mode		
	enter	return
implement	FE 03 00 15 AA	FB 04 00 15 status AA
parameter	status: execution status, 00 - successful execution, other - execution failed.	
illustrate	This command forces the target address and target port of other devices to point to itself, so that other devices can transmit data to itself. The set object is determined by its own target address and target port. It is recommended that this command is only executed by the coordinator, and the coordinator is in broadcast mode. Alternatively, the router can also execute this command in multicast mode.	
Example		
	enter	return
implement	FE 03 00 15 AA	FB 04 00 15 00 AA

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8.3 Asynchronous commands and system printing information

Asynchronous commands are used to indicate external events of the module. In HEX command mode, commands starting with FC are printed. In data transmission or AT command mode, system printing needs to be turned on. External events will be converted into corresponding LOG information.

8.3.1 Module startup

<table>
<tr><td>Command Name</td><td>Module startup</td></tr>
<tr><td>HEX Commands</td><td>FC 04 00 00 boot_hex AA</td></tr>
<tr><td>HEX Parameters</td><td>boot_hex: boot code, 1 byte<table><tr><td>boot_hex</td><td>Startup Mode</td></tr><tr><td>00</td><td>Power on</td></tr><tr><td>01</td><td>Button reset</td></tr><tr><td>02</td><td>Watchdog soft reset</td></tr></table></td></tr>
<tr><td>HEX Command Examples</td><td>Press the module reset button
FC 04 00 00 01 AA</td></tr>
<tr><td>System Printing</td><td>BOOT= boot_log \r\n</td></tr>
<tr><td>System printing parameters</td><td>boot_log: corresponding to the startup mode<table><tr><td>boot_log</td><td>Startup Mode</td></tr><tr><td>PWR_ON</td><td>Power on</td></tr><tr><td>RESET</td><td>Button reset</td></tr><tr><td>WDT</td><td>Watchdog soft reset</td></tr></table></td></tr>
<tr><td>System Printing Example</td><td>Press the module reset button
"BOOT= RESET \r\n"</td></tr>
</table>

8.3.2 Network connection status

<table>
<tr><td>Command Name</td><td>Network connection status</td></tr>
<tr><td>HEX Commands</td><td>FC 04 00 01 nwk_status_hex AA</td></tr>
<tr><td>HEX Parameters</td><td>nwk_status_hex: network connection status, 1 byte<table><tr><td>nwk_status_hex</td><td>Network connection status</td></tr><tr><td>00</td><td>Screening failed</td></tr><tr><td>01</td><td>Network successfully joined/network opened</td></tr><tr><td>02</td><td>Restore network connection</td></tr><tr><td>03</td><td>Orphan nodes (offline)</td></tr><tr><td>04</td><td>Leave the network</td></tr></table></td></tr>
<tr><td>HEX Command Examples</td><td>The terminal node is offline:
FC 04 00 01 04 AA</td></tr>
<tr><td>System Printing</td><td>nwk_status_log \r\n</td></tr>
<tr><td>System printing parameters</td><td>nwk_status_log: corresponding startup mode<table><tr><td>boot_log</td><td>Network connection status</td></tr><tr><td>NWK_FAIL</td><td>Screening failed</td></tr><tr><td>NWK_JOINED</td><td>Network successfully joined/network opened</td></tr><tr><td>NWK_LINK</td><td>Restore network connection</td></tr><tr><td>NWK_ORPHAN</td><td>Orphan nodes (offline)</td></tr></table></td></tr>
</table>

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	NWK_LEAVE: Leave the network
System Printing Example	The terminal node is offline: "NWK_ORPHAN\r\n"
illustrate	1. When the coordinator opens the network, it will print the "Network Joined Successfully" status. 2. Orphan nodes only occur in terminal nodes and dormant terminals. As long as there are coordinators and routers, terminal nodes and dormant terminals can restore the connection. 3. For modules that have been connected to the network, as long as they do not actively exit the network, they will immediately trigger "restoring network connection" or become orphan nodes after powering on again.

8.3.3 Monitoring equipment access to the network

Command Name	Monitoring equipment access to the network
HEX Commands	FC 0E 00 02 join_mac_hex join_addr_hex join_mode_hex AA
HEX Parameters	join_mac_hex: 8 bytes, MAC address of the networked device, LSB little-endian format. join_addr_hex: 2 bytes, network address of the networked device, LSB little endian format. join_mode_hex: 1 byte, network joining mode. join_mode_hex: Network access mode 0: First time online 1: Device online notification
HEX Command Examples	A device with a MAC address of 00:12:4B:00:1A:D0:60:E3 is connected to the network and is assigned a network address of 0xECFF. FC 0E 00 03 E3 60 D0 1A 00 4B 12 00 FFEC 00 AA
System Printing	join_mode_asc MAC= mac_asc ,ADDR= addr_asc \r\n
System printing parameters	join_mode_asc: network access mode, string format join_mode_asc: Network access mode JOIN: First time online LINK: Device online notification mac_asc: ASCII code string of the MAC address. Each character is separated by a hyphen (:), for example, "00:12:4B:00:1A:D0:60:E3". addr_asc: network address of the networked device, in ASCII format, hexadecimal data starting with "0x", such as "0xECFF"
System Printing Example	A device with a MAC address of 00:12:4B:00:1A:D0:60:E3 is connected to the network and is assigned a network address of 0xECFF. " JOIN MAC= 00:12:4B:00:1A:D0:60:E3 ,ADDR= 0xECFF \r\n"
illustrate	1. When any device accesses the network for the first time, the coordinator will output "First access to the network", and the coordinator and router will output "Device online notification". 2. When a device that has been connected to the network is restarted, the coordinator and router will receive a "device online notification".

8.3.4 Monitoring equipment off-grid

Command Name	Monitoring equipment off-grid
HEX Commands	FC 0B 00 03 dev_mac_hex AA
HEX	dev_mac_hex: 8 bytes, MAC address of the off-network device, LSB little-endian format.

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Parameters	
HEX Command Examples	The device with MAC address 00:12:4B:00:1A:D0:60:E3 has left the network. FC 0B 00 03 E3 60 D0 1A 00 4B 12 00 AA
System Printing	LEAVE=mac_asc\r\n
System printing parameters	mac_asc: ASCII code string of the MAC address. Each character is separated by a hyphen (:), for example, "00:12:4B:00:1A:D0:60:E3".
System Printing Example	The device with MAC address 00:12:4B:00:1A:D0:60:E3 has left the network. "LEAVE= 00:12:4B:00:1A:D0:60:E3 "
illustrate	none

8.3.5 Device Enumeration Notification

Command Name	Monitoring equipment access to the network
HEX Commands	FC 13 00 04 finish_flag endpoint_hex mac_hex addr_hex profile_hex device_hex AA
HEX Parameters	finish_flag: end mark, 1 byte, indicating the last enumeration information of this node. sn_hex: device enumeration serial number, 9 bytes, LSB format. A node can be identified as multiple virtual devices, such as data transparent interface, PWM interface, and the device enumeration serial number can be used to identify the uniqueness of the virtual device. addr_hex: short address, 2 bytes, LSB format, the network short address of the node. endpoint_hex: port number, 1 byte, port number on the node. There may be multiple enumeration information for the same node. profile_hex: protocol profile, 2 bytes, used to mark the communication protocol type, data transmission equipment is "04 01". device_hex: device type, 2 bytes, used to identify the function of the node, the wireless module is "00 F0".
HEX Command Examples	A device with a MAC address of A4:C1:38:FB:C0:6C:76:D4 is connected to the network and is assigned a network address of 0xF21F. FC 13 00 04 01 01 D4 76 6C C0 FB 38 C1 A4 1F F2 04 01 00 F0 AA
System Printing	DEVICE ENUM:\r\n SN= sn_asc \r\n ADDR= addr_asc \r\n EP= endpoint_asc \r\n Profile= profile_asc \r\n Device ID= device_asc \r\n (EUNM FINISH: mac_asc \r\n)
System printing parameters	sn_asc: Device enumeration serial number, 9-digit hexadecimal number. A node can be identified as multiple virtual devices, such as data transparent transmission interface, PWM interface, and the device enumeration serial number can be used to identify the uniqueness of the virtual device. addr_asc: The network short address of the node. endpoint_asc: port number. There may be multiple enumeration information for the same node. profile_asc: protocol profile, used to mark the communication protocol type, data transmission equipment is "0x0104". device_asc: device type, used to identify the function of the node, the wireless module is "0xF000". mac_asc: Node MAC address, used to indicate that all enumeration information of the node has been printed.
System Printing Example	DEVICE ENUM:\r\n SN= A4 C1 38 FB C0 6C 76 D4 01 \r\n ADDR = 0xF21F \r\n EP= 0x01 \r\n Profile = 0x0104 \r\n Device ID = 0xF000 \r\n EUNM FINISH: A4:C1:38:FB:C0:6C:76:D4 \r\n
illustrate	1. The coordinator will automatically identify the enumeration information when the node first enters the network. The coordinator can output the enumeration information by turning on the debugging function in HEX instruction mode or transmission command mode. 2. If you missed the automatic enumeration information when the node first joined the network, you can use the "enumerate nodes" command of AT or HEX command to get the node enumeration information again.

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8.4 Remote Control Commands

Remote control commands are used for wireless control between devices, including wireless communication. Remote control commands only have HEX command format, not AT command format. Therefore, remote control commands have good backward compatibility .

8.4.1 HEX command to send data

<table>
<tr><td colspan="3">HEX command to send data</td></tr>
<tr><td>Function</td><td colspan="2">In HEX command mode, data is sent to the specified target device, and the data message and transmission mode are compatible.</td></tr>
<tr><td rowspan="2">Format</td><td>enter</td><td>return</td></tr>
<tr><td>FE len 02 0F dst_addr dst_ep ack_mode send_data AA</td><td>FB 04 02 0F rf_status AA</td></tr>
<tr><td>parameter</td><td colspan="2">
Enter the command parameters:
len: frame length occupies one byte, and the frame length is determined by the entire command parameter

dst_addr: destination address, 2 bytes, LSB little endian format. In multicast mode, the destination address is the LSB little endian format of the group number.
<table>
<tr><td>dst_addr (HEX format)</td><td>Destination address sending method</td></tr>
<tr><td>00 00 ~ F7 FF</td><td>Unicast mode</td></tr>
<tr><td>F8 FF ~ FB FF</td><td>reserve</td></tr>
<tr><td>FC FF</td><td>Broadcast to coordinator, router</td></tr>
<tr><td>FD FF</td><td>Broadcast to coordinators, routers, and end nodes (non-sleeping)</td></tr>
<tr><td>FF FF</td><td>Broadcast to all devices, including dormant terminals</td></tr>
</table>
dst_ep: destination port, 1 byte
<table>
<tr><td>dst_ep (HEX format)</td><td>Destination port sending mode</td></tr>
<tr><td>00</td><td>Multicast</td></tr>
<tr><td>01</td><td>Unicast</td></tr>
<tr><td>02 ~ FE</td><td>reserve</td></tr>
<tr><td>FF</td><td>Port Broadcast</td></tr>
</table>
ack_mode: Response mode, 1 byte
<table>
<tr><td>ack_mode (HEX format)</td><td>Answer Mode</td></tr>
<tr><td>00</td><td>Receive asynchronous reply command. Receiving asynchronous reply command indicates that the data has been sent to the correct target.</td></tr>
<tr><td>01</td><td>Asynchronous response commands are not received, but the underlying layer generates automatic retransmissions, and the return command may have a large delay.</td></tr>
<tr><td>02</td><td>Asynchronous response commands are not received, and the underlying layer does not generate automatic retransmission.</td></tr>
</table>
send_data: The data message sent, the number of bytes of the data message = len-5, that is, excluding dst_addr, dst_ep, ack_mode and frame tail.

Returns the command's parameters:
rf_status: Send result
<table>
<tr><td>rf_status (HEX format)</td><td>Send results</td></tr>
<tr><td>00</td><td>Send successfully</td></tr>
<tr><td>01</td><td>Send invalid</td></tr>
<tr><td>10~13</td><td>Module memory overflow (input data speed exceeds wireless transmission speed)</td></tr>
<tr><td>B7</td><td>Data retransmission failed (Response mode 1, return command delay increased, about 18 seconds)</td></tr>
<tr><td>C2</td><td>The module is not connected to the Internet or is offline.</td></tr>
<tr><td>CD</td><td>The destination does not exist</td></tr>
<tr><td>E1</td><td>Data packets are interfered by other wireless signals</td></tr>
<tr><td>E9</td><td>Data packet loss</td></tr>
<tr><td>F0</td><td>The data sent to the dormant terminal has timed out.</td></tr>
<tr><td>Other values</td><td>Unknown error</td></tr>
</table>
</td></tr>
<tr><td>Notes</td><td colspan="2">1. Use this command to send to the target device. If the target device is running in transmission mode, directly</td></tr>
</table>

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	output the data in "send_data". If the target device is running in HEX command mode, the received content is output in HEX command format. 2. Due to the existence of multiple routing forwarding in the Zigbee network, sending data in response mode 0 can receive asynchronous response commands, and judge whether the target has received the data through the response command, and whether the target device receiving the data is the correct device. Sending data in response mode 1 can directly judge whether the data has reached the target based on the "rf_status" in the return command, but the return command delay is large, and it is impossible to judge whether the target is correct.
Command Examples	Send the data packet "31 32 33 34 35 36 37 38 39 30" to the device with the network address "0xE4E5" using unicast (destination port = 1), do not enable retransmission, and the return command indicates "send successful". Send command: FE 11 02 0F E5 E4 01 00 31 32 33 34 35 36 37 38 39 30 AA Return command: FB 04 02 0F 00 AA

8.4.2 HEX command to receive data

HEX command to receive data	
Function	In HEX command mode, data transmitted by other modules is received and the received content is output in HEX command format.
Format	Asynchronous reception
	FC len 02 0F src_addr src_ep rx_rssi rx_data AA
parameter	**Parameters for asynchronous commands:** len: frame length occupies one byte, and the frame length is determined by the entire command parameter src_addr: source address, 2 bytes, LSB little endian format. dst_ep: source port, 1 byte. rx_rssi: data signal strength, 1 byte, converted to singed char format and then converted, for example, FF is converted to -1dmb. rx_data: received data message
Notes	none
Command Examples	The data packet "31 32 33 34 35 36 37 38 39 30" is received from the device 0xE4E5. The other party uses port 1 (data transmission port) to send the data packet. The signal strength RSSI of the data packet is 0xED, which is converted to -19dbm. Receive command: FC 11 02 0F E5 E4 01 ED 31 32 33 34 35 36 37 38 39 30 AA

8.4.3 HEX command receiving response command

HEX command receiving response command	
Function	Receiving the response command from the other device indicates that the other device has received the data.
Format	Asynchronous reception
	FC 08 02 0B src_addr src_ep rx_rssi status AA
parameter	**Parameters for asynchronous commands:** src_addr: source address, 2 bytes, LSB little endian format. dst_ep: source port, 1 byte. rx_rssi: data signal strength, 1 byte, converted to singed char format and then converted, for example, FF is converted to -1dmb. status: response status, 1 byte, used to determine whether the other device supports the data transmission function.

status（HEX）	Status description
00	The other device supports data transmission
other	The other device does not support data transmission

Notes	If a response command with a status other than 00 is received, it is possible that other illegal devices have entered the network. The probability of this occurring is extremely low.
Command Examples	After sending a data packet to the 0xE4E5 device, a response command is received from the other party. The signal strength of the other party's port 1 is 0xED = 19dmb, and the status is 00, which means that the other party supports data transmission. Receive: FC 08 02 0B E5 E4 01 ED 00 AA

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8.4.4 Remote query configuration parameters

<table>
<tr><td colspan="3">Remote query configuration parameters</td></tr>
<tr><td>Function</td><td colspan="2">Remotely query the configuration parameters of the other device, support broadcast query or multicast query, one command queries multiple devices, and the query results are received in asynchronous commands.</td></tr>
<tr><td rowspan="2">Format</td><td>enter</td><td>return</td></tr>
<tr><td>FE 07 02 00 dst_addr dst_ep attr_id AA</td><td>FB 04 02 00 rf_status AA</td></tr>
<tr><td>parameter</td><td colspan="2">Enter the command parameters:
dst_addr: destination address, 2 bytes, LSB little endian format. In multicast mode, the destination address is the LSB little endian format of the group number.
<table>
<tr><td>dst_addr (HEX format)</td><td>Destination address sending method</td></tr>
<tr><td>00 00 ~ F7 FF</td><td>Unicast mode</td></tr>
<tr><td>F8 FF ~ FB FF</td><td>reserve</td></tr>
<tr><td>FC FF</td><td>Broadcast to coordinator, router</td></tr>
<tr><td>FD FF</td><td>Broadcast to coordinators, routers, and end nodes (non-sleeping)</td></tr>
<tr><td>FF FF</td><td>Broadcast to all devices, including dormant terminals</td></tr>
</table>
dst_ep: destination port, 1 byte
<table>
<tr><td>dst_ep (HEX format)</td><td>Destination port sending mode</td></tr>
<tr><td>00</td><td>Multicast</td></tr>
<tr><td>01</td><td>Unicast</td></tr>
<tr><td>02 ~ FE</td><td>reserve</td></tr>
<tr><td>FF</td><td>Port Broadcast</td></tr>
</table>
attr_id: The configuration parameter code to be queried, 2 bytes, LSB little endian format, this configuration item is the same as the configuration item in the AT command.
<table>
<tr><td>addr_id (HEX format)</td><td>Corresponding parameters</td></tr>
<tr><td>00 00</td><td>Serial port mode configuration (baud rate, stop bit, parity bit)</td></tr>
<tr><td>01 00</td><td>Transparent target address</td></tr>
<tr><td>02 00</td><td>Transparent transmission target port</td></tr>
<tr><td>03 00</td><td>Transmission Mode</td></tr>
<tr><td>04 00</td><td>Sleep Mode</td></tr>
<tr><td>06 00</td><td>Custom number</td></tr>
</table>
Returns the command's parameters:
rf_status: Send result
<table>
<tr><td>rf_status (HEX format)</td><td>Send results</td></tr>
<tr><td>00</td><td>Send successfully</td></tr>
<tr><td>01</td><td>Send invalid</td></tr>
<tr><td>10~13</td><td>Module memory overflow (input data speed exceeds wireless transmission speed)</td></tr>
<tr><td>B7</td><td>Data retransmission failed (Response mode 1, return command delay increased, about 18 seconds)</td></tr>
<tr><td>C2</td><td>The module is not connected to the Internet or is offline.</td></tr>
<tr><td>CD</td><td>The destination does not exist</td></tr>
<tr><td>E1</td><td>Data packets are interfered by other wireless signals</td></tr>
<tr><td>E9</td><td>Data packet loss</td></tr>
<tr><td>F0</td><td>The data sent to the dormant terminal has timed out.</td></tr>
<tr><td>Other values</td><td>Unknown error</td></tr>
</table></td></tr>
<tr><td>Notes</td><td colspan="2">Parameters of command class = 01 in HEX command support remote query</td></tr>
<tr><td>Command Examples</td><td colspan="2">Broadcast query network all modules target short address
Send command: FE 08 02 00 FF FF FF 01 00 AA
Return command: FB 04 02 00 00 AA</td></tr>
</table>

8.4.5 Receive remote query configuration parameters

<table>
<tr><td colspan="2">Receive remote query configuration parameters</td></tr>
<tr><td>Function</td><td>After sending the remote query command, the query result is received. For broadcast or multicast query, multiple query results may be received at the same time.</td></tr>
<tr><td rowspan="2">Format</td><td>Asynchronous reception</td></tr>
<tr><td>FC len 02 00 src_addr src_ep rx_rssi attr_id data_type attr_data AA</td></tr>
</table>

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<table>
<tr><td>parameter</td><td>
Parameters for asynchronous commands:
len: frame length occupies one byte, and the frame length is determined by the entire command parameter

src_addr: source address, 2 bytes, LSB little endian format.

dst_ep: source port, 1 byte.

rx_rssi: data signal strength, 1 byte, converted to singed char format and then converted, for example, FF is converted to -1dmb.

attr_id: The configuration parameter code to be queried, 2 bytes, LSB little endian format, this configuration item is the same as the configuration item in the AT command.
<table>
<tr><td>addr_id (HEX format)</td><td>Corresponding parameters</td></tr>
<tr><td>00 00</td><td>Serial port mode configuration (baud rate, stop bit, parity bit)</td></tr>
<tr><td>01 00</td><td>Transparent target address</td></tr>
<tr><td>02 00</td><td>Transparent transmission target port</td></tr>
<tr><td>03 00</td><td>Transmission Mode</td></tr>
<tr><td>04 00</td><td>Sleep Mode</td></tr>
<tr><td>06 00</td><td>Custom number</td></tr>
</table>
data_type: data type, 1 byte, corresponding to the data size of the configuration parameter.
<table>
<tr><td>data_type</td><td>Data Types</td><td>Data size (bytes)</td></tr>
<tr><td>20</td><td>uint8</td><td>1</td></tr>
<tr><td>twenty one</td><td>uint16</td><td>2</td></tr>
<tr><td>twenty two</td><td>uint24</td><td>3</td></tr>
<tr><td>twenty three</td><td>uint32</td><td>4</td></tr>
</table>
attr_data: configuration parameter value, the data size is determined by data_type
</td></tr>
<tr><td>Notes</td><td>none</td></tr>
<tr><td>Command Examples</td><td>Receive the query result returned by the 0xE4E5 device. The data type of the query parameter 0x0001 (transmitted target address) is 0x21 (uint16 type) and the value is 0xFFFF.
Receive command: FC 0C 02 00 E5 E4 01 EE 01 00 twenty one FF FF AA</td></tr>
</table>

8.4.6 Receiving Heartbeat Packets

<table>
<tr><td colspan="2">Receive heartbeat packets</td></tr>
<tr><td>Function</td><td>The coordinator receives the node heartbeat packet</td></tr>
<tr><td>Format</td><td>Asynchronous reception
FC len 02 0A src_addr src_ep rx_rssi attr_id data_type attr_data AA</td></tr>
<tr><td>parameter</td><td>
Parameters for asynchronous commands:
len: frame length occupies one byte, and the frame length is determined by the entire command parameter

src_addr: source address, 2 bytes, LSB little endian format.

dst_ep: source port, 1 byte.

rx_rssi: data signal strength, 1 byte, converted to singed char format and then converted, for example, FF is converted to -1dmb.

attr_id: The configuration parameter code to be queried, 2 bytes, LSB little endian format, this configuration item is the same as the configuration item in the AT command.
<table>
<tr><td>addr_id (HEX format)</td><td>Corresponding parameters</td></tr>
<tr><td>00 00</td><td>Serial port mode configuration (baud rate, stop bit, parity bit)</td></tr>
<tr><td>01 00</td><td>Transparent target address</td></tr>
<tr><td>02 00</td><td>Transparent transmission target port</td></tr>
<tr><td>03 00</td><td>Transmission Mode</td></tr>
<tr><td>04 00</td><td>Sleep Mode</td></tr>
<tr><td>06 00</td><td>Custom number</td></tr>
</table>
data_type: data type, 1 byte, corresponding to the data size of the configuration parameter.
<table>
<tr><td>data_type</td><td>Data Types</td><td>Data size (bytes)</td></tr>
<tr><td>20</td><td>uint8</td><td>1</td></tr>
</table>
</td></tr>
</table>

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	twenty one | uint16 | 2 twenty two | uint24 | 3 twenty three | uint32 | 4 attr_data: configuration parameter value, the data size is determined by data_type
Notes	none
Command Examples	The heartbeat packet of the 0xECFF device is received. The heartbeat packet carries parameter 0x0006 (custom number) with a data type of 0x20 (uint8) and a value of 0xFF. Receive command: FC 0B 02 00 FF EC 01 E0 06 00 20 FF AA

8.4.7 Remotely modify configuration parameters

Remote query configuration parameters		
Function	Remotely query the configuration parameters of the other device, support broadcast query or multicast query, one command queries multiple devices, and the query results are received in asynchronous commands.	
Format	enter	return
	FE len 02 01 dst_addr dst_ep attr_id data_type attr_data AA	FB 04 02 01 rf_status AA

parameter

Enter the command parameters:

len: Command length is determined by attr_data

dst_addr: destination address, 2 bytes, LSB little endian format. In multicast mode, the destination address is the LSB little endian format of the group number.

dst_addr (HEX format)	Destination address sending method
00 00 ~ F7 FF	Unicast mode
F8 FF ~ FB FF	reserve
FC FF	Broadcast to coordinator, router
FD FF	Broadcast to coordinators, routers, and end nodes (non-sleeping)
FF FF	Broadcast to all devices, including dormant terminals

dst_ep: destination port, 1 byte

dst_ep (HEX format)	Destination port sending mode
00	Multicast
01	Unicast
02 ~ FE	reserve
FF	Port Broadcast

attr_id: the configuration parameter code to be modified, 2 bytes, LSB little endian format, this configuration item is the same as the configuration item in the AT command.

data_type: data type, 1 byte, corresponding to the data size of the configuration parameter.

data_type	Data Types	Data size (bytes)
20	uint8	1
twenty one	uint16	2
twenty two	uint24	3
twenty three	uint32	4

attr_data: Configuration parameter value, see table

Remotely modify the configuration parameter command attr_id, data_type and the corresponding attr_data value range

Parameter name	attr_id	data_type	attr_data value range
Serial port mode configuration (baud rate, stop bit, parity bit)	00 00	uint24	attr_data[0] = [0:7] attr_data[1] = [0:1] attr_data[2] = [0:2]
Transparent target address	01 00	uint16	0x0000~0xFFFF (little endian format)
Transparent transmission target port	02 00	uint8	0x00~0xFF
Transmission Mode	03 00	uint8	0x00~0x04
Sleep Mode	04 00	uint8	0x00~0x06 or 0x3C
Custom number	06 00	uint8	0x00~0xFF

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<table>
<tr><td></td><td>Returns the command's parameters:
rf_status: Send result
<table>
<tr><td>rf_status (HEX format)</td><td>Send results</td></tr>
<tr><td>00</td><td>Send successfully</td></tr>
<tr><td>01</td><td>Send invalid</td></tr>
<tr><td>10~13</td><td>Module memory overflow (input data speed exceeds wireless transmission speed)</td></tr>
<tr><td>B7</td><td>Data retransmission failed (Response mode 1, return command delay increased, about 18 seconds)</td></tr>
<tr><td>C2</td><td>The module is not connected to the Internet or is offline.</td></tr>
<tr><td>CD</td><td>The destination does not exist</td></tr>
<tr><td>E1</td><td>Data packets are interfered by other wireless signals</td></tr>
<tr><td>E9</td><td>Data packet loss</td></tr>
<tr><td>F0</td><td>The data sent to the dormant terminal has timed out.</td></tr>
<tr><td>Other values</td><td>Unknown error</td></tr>
</table></td></tr>
<tr><td>Notes</td><td>The parameters of command class = 01 in the HEX command support remote query.</td></tr>
<tr><td>Command Examples</td><td>Broadcast sets the target short address of all modules in the network to 0x0000
Send command: FE 08 02 01 FF FF FF 01 00 twenty one 00 00 AA
Return command: FB 04 02 01 00 AA</td></tr>
</table>

8.4.8 Remote Configuration Parameter Response

<table>
<tr><td colspan="2">HEX command receiving response command</td></tr>
<tr><td>Function</td><td>Receive response commands for modifying configuration parameters. When broadcasting modifications, modification commands returned by multiple devices will be received.</td></tr>
<tr><td>Format</td><td>Asynchronous reception</td></tr>
<tr><td></td><td>FC len 02 01 src_addr src_ep rx_rssi status attr_id AA</td></tr>
<tr><td>parameter</td><td>Parameters for asynchronous commands:
len: frame length = 08 or 0A.

src_addr: source address, 2 bytes, LSB little endian format.

dst_ep: source port, 1 byte.

rx_rssi: data signal strength, 1 byte, converted to singed char format and then converted, for example, FF is converted to -1dmb.

status: response status, 1 byte, used to determine whether the other device supports the data transmission function.
<table>
<tr><td>status（HEX）</td><td>Status description</td></tr>
<tr><td>00</td><td>Modification successful</td></tr>
<tr><td>86</td><td>Parameter number does not exist</td></tr>
<tr><td>87</td><td>Parameter data range is incorrect</td></tr>
<tr><td>88</td><td>This parameter is read-only.</td></tr>
<tr><td>8D</td><td>data_type error</td></tr>
<tr><td>other</td><td>Modification failed for unknown reason</td></tr>
</table>
attr_id: configuration parameter number. If the modification fails, the response command will contain the parameter number.</td></tr>
<tr><td>Notes</td><td>If a response command with a status other than 00 is received, it is possible that other illegal devices have entered the network. The probability of this occurring is extremely low.</td></tr>
<tr><td>Command Examples</td><td>The device with address 0xE4E5 returns the parameter modification success.
Receive: FC 08 02 01 E5 E4 01 ED 00 AA</td></tr>
</table>

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9 User Notice

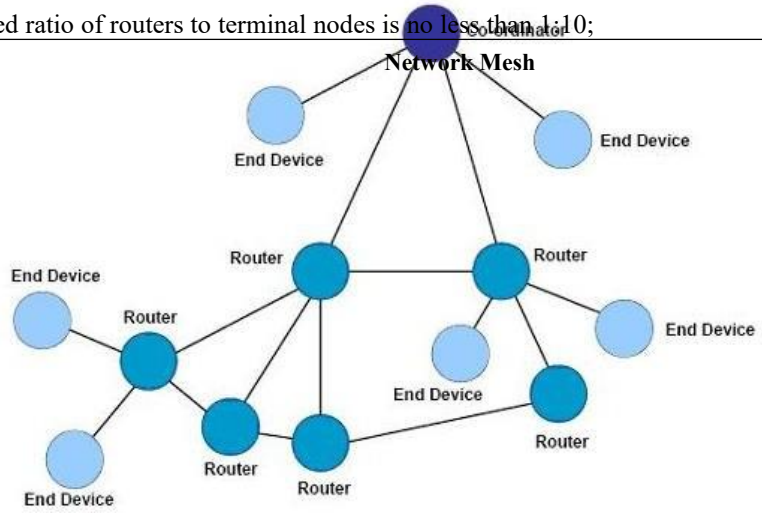
9.1 ZigBee network roles and considerations

Serial number	describe
1	This module adopts ZigBee network, which consists of a coordinator and any other devices (routers and terminals)
2	It has self-organization, self-routing, and network multi-hop functions. (The default supported network depth is 30, the total number of sub-nodes is 20, and the number of sub-routing nodes is 6)
3	The parent node devices (coordinator and router) can save data for dormant terminals for 7 seconds.
4	Only the terminal device has the sleep function. The sleep time can be set by the user. The maximum is 60 seconds. The default is 1, which means waking up once every 1 second . Since the parent node only saves 7 seconds, it will never wake up when it is set to 0 seconds. If it is set to more than 6 seconds, it will always wake up every 60 seconds. Setting it to 0 or 60 can be regarded as giving up data reception, pursuing the ultimate low power consumption.
5	ShortAddress communication is used for network communication. Note: The short address is randomly assigned when the device joins the network. The device MacAddress long address is unique and fixed. If you don't know the short address, you can use the corresponding instructions to find the ShortAddress in the network based on the MacAddress , and then conduct point-to-point communication.
6	The coordinator is unique in the network and its short address is fixed to 0000.
7	If the on-demand address is FFFF, FFFD, or FFFC, it corresponds to three broadcast modes respectively.
8	When the network parameter PANID is FFFF, it is automatically assigned. If the device PANID is different, networking cannot be achieved.
9	The network key is randomly generated by the coordinator each time it is restored to factory settings. Routers and terminals cannot set keys. The key of the coordinator to which they join is used.
10	All devices in the network have the broadcast function turned on. Multiple devices broadcasting at the same time or a single device broadcasting at a high frequency may cause serious network congestion. Please try to avoid this situation.
11	The module does not need to join the group when multicasting. It can directly multicast to any group according to the communication method. A module can join multiple multicasts at the same time, and the local group number will not change due to different multicast numbers.
12	After the sleep mode, it can be woken up through the serial port or through the wake-up pin. Note: In sleep mode, the first frame of data after the serial port wakes up is invalid. It is recommended that the first frame of data be a single byte 00, and the subsequent data be sent within 5ms~100ms.
13	When communicating in a ZigBee network, the transmission cycle of a single packet of data cannot be too fast (generally recommended to be more than 1 second), as this may cause data loss. (Pay special attention to the fact that if there are too many nodes in the network, a too fast broadcast cycle may cause network instability.)

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9.2 Network structure

The network structure of this module is a mesh network structure (MESH)
The network with MESH topology has powerful functions, and the network can communicate through "multi-hop"; This topology can also form an extremely complex network; the network also has self-organization and self-healing functions; The recommended ratio of routers to terminal nodes is no less than 1:10;


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10 Hardware Design

- It is recommended to use a DC regulated power supply to power the module. The power supply ripple coefficient should be as small as possible and the module should be reliably grounded.
- Please pay attention to the correct connection of the positive and negative poles of the power supply. Reverse connection may cause permanent damage to the module.
- Please check the power supply to ensure that it is within the recommended power supply voltage. If it exceeds the maximum value, the module will be permanently damaged.
- Please check the stability of the power supply. The voltage should not fluctuate greatly or frequently.
- When designing the power supply circuit for the module, it is often recommended to retain more than 30% margin, so that the whole machine can work stably for a long time;
- The module should be kept as far away as possible from power supplies, transformers, high-frequency wiring and other parts with large electromagnetic interference;
- High-frequency digital routing, high-frequency analog routing, and power routing must avoid the bottom of the module. If it is necessary to pass under the module, assuming that the module is soldered on the Top Layer, ground copper should be laid on the Top Layer of the module contact part (all copper should be laid and well grounded), and the routing must be close to the digital part of the module and on the Bottom Layer;
- Assuming the module is soldered or placed on the Top Layer, it is also wrong to randomly route the wires on the Bottom Layer or other layers, which will affect the module's spurious signal and receiving sensitivity to varying degrees;
- If there are devices with large electromagnetic interference around the module, it will also greatly affect the performance of the module. It is recommended to keep them away from the module according to the intensity of the interference. If possible, appropriate isolation and shielding can be performed.
- If there are traces with large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power traces), it will also greatly affect the performance of the module. It is recommended to keep them away from the module according to the intensity of the interference. If possible, appropriate isolation and shielding can be performed.
- If the communication line uses 5V level, a 1k-5.1k resistor must be connected in series (not recommended, there is still a risk of damage);
- Try to stay away from some TTL protocols whose physical layer is also 2.4GHz, such as USB3.0;
- The antenna installation structure has a great impact on the performance of the module. Make sure the antenna is exposed and preferably vertically upward. When the module is installed inside the housing, use a high-quality antenna extension cable to extend the antenna to the outside of the housing.
- The antenna must not be installed inside a metal shell, as this will greatly reduce the transmission distance.

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11 Frequently Asked Questions

11.1 The transmission distance is not ideal

- When there is a straight-line communication obstacle, the communication distance will be attenuated accordingly;
- Temperature, humidity, and co-channel interference can increase the communication packet loss rate;
- The ground absorbs and reflects radio waves, so the test results are poor when close to the ground;
- Seawater has a strong ability to absorb radio waves, so the test effect at the seaside is poor;
- If there are metal objects near the antenna, or the antenna is placed in a metal shell, the signal attenuation will be very serious;
- The power register is set incorrectly, or the air rate is set too high (the higher the air rate, the closer the distance);
- The power supply voltage at room temperature is lower than the recommended value. The lower the voltage, the lower the power output.
- The antenna used does not match the module well or the antenna itself has quality issues.

11.2 Module is easily damaged

- Please check the power supply to ensure that it is within the recommended power supply voltage. If it exceeds the maximum value, the module will be permanently damaged.
- Please check the stability of the power supply. The voltage should not fluctuate greatly or frequently.
- Please ensure anti-static operation during installation and use, as high-frequency components are sensitive to static electricity;
- Please ensure that the humidity is not too high during installation and use, as some components are humidity sensitive devices;
- If there is no special requirement, it is not recommended to use it at too high or too low temperature.

11.3 The bit error rate is too high

- There is interference from the same frequency signal nearby. Stay away from the interference source or change the frequency or channel to avoid interference.
- An unsatisfactory power supply may also cause garbled characters, so the reliability of the power supply must be ensured;
- Extension cables or feeder cables that are of poor quality or are too long can also cause a high bit error rate.
- The default transmission mode is broadcast mode. Broadcast forwarding will cause broadcast storms, so it is changed to unicast transmission.

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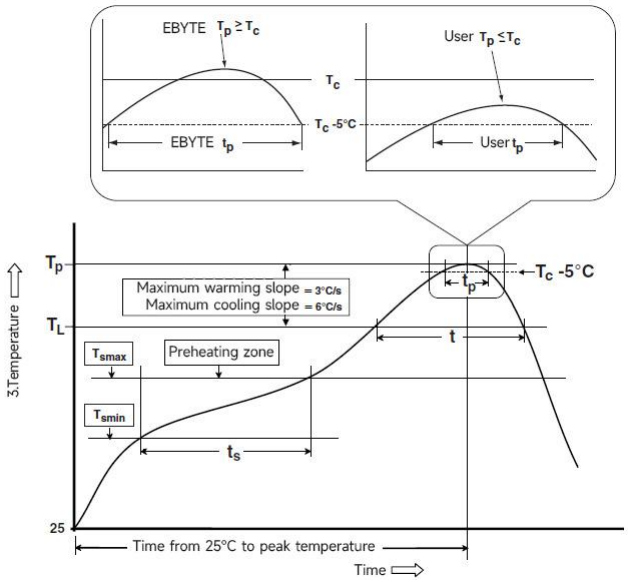
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12 Welding Operation Instructions

12. 1 Reflow temperature

Profile Feature	Curve characteristics	Sn-Pb Assembly	Pb-Free Assembly
Solder Paste	Solder Paste	Sn63/Pb37	Sn96.5/Ag3/Cu0.5
Preheat Temperature min (Tsmin)	Minimum preheating temperature	100℃	150℃
Preheat temperature max (Tsmax)	Maximum preheating temperature	150℃	200℃
Preheat Time (Tsmin to Tsmax)(ts)	Warm-up time	60-120 sec	60-120 sec
Average ramp-up rate(Tsmax to Tp)	Average ascent rate	3℃/second max	3℃/second max
Liquid Temperature (TL)	Liquidus temperature	183℃	217℃
Time(tL)Maintained Above(TL)	Time above liquidus	60-90 sec	30-90 sec
Peak temperature (Tp)	Peak temperature	220-235℃	230-250℃
Aveage ramp-down rate（Tp to Tsmax）	Average descent rate	6℃/second max	6℃/second max
Time 25℃ to peak temperature	Time from 25℃ to peak temperature	6 minutes max	8 minutes max

12. 2 Reflow Oven Profile



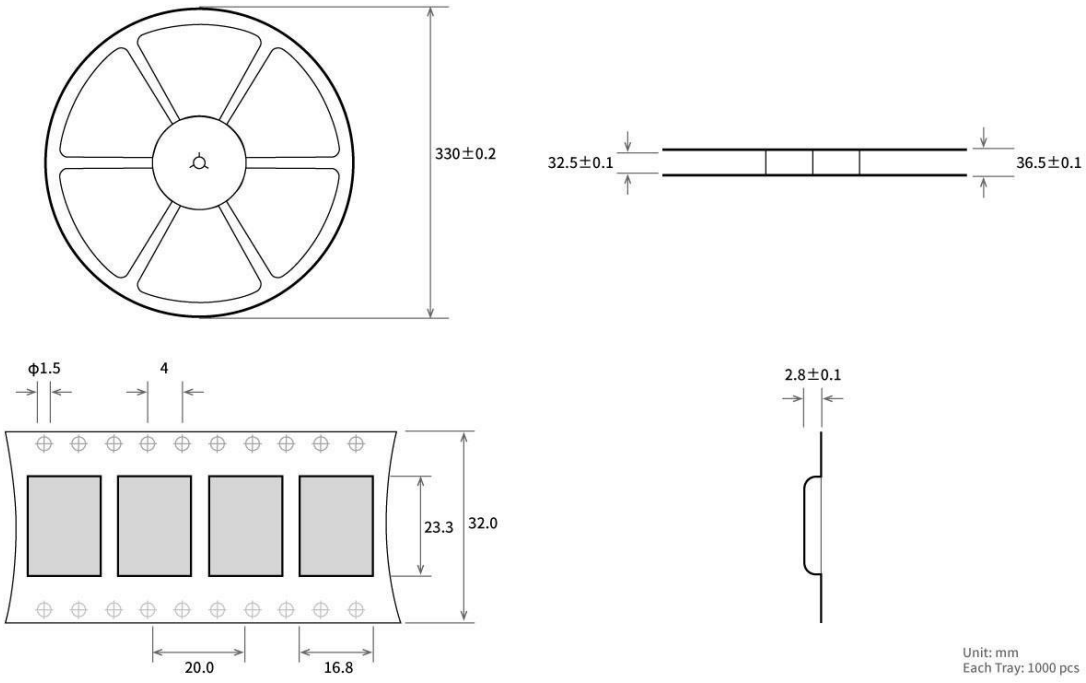
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13 Antenna Guide

Product Model	type	Frequency band	Gain	size	Feeder	interface	Features
		Hz	dBi	mm	cm		
TX2400-NP-5010	Flexible Antenna	2.4G	2.0	10x50	-	IPEX	Flexible FPC Soft Antenna
TX2400-JZ-3	Glue stick antenna	2.4G	2.0	30	-	SMA-J	Ultra-short straight, omnidirectional antenna
TX2400-JZ-5	Glue stick antenna	2.4G	2.0	50	-	SMA-J	Ultra-short straight, omnidirectional antenna
TX2400-JW-5	Glue stick antenna	2.4G	2.0	50	-	SMA-J	Fixed bending, omnidirectional antenna
TX2400-JK-11	Glue stick antenna	2.4G	2.5	110	-	SMA-J	Bendable glue stick, omnidirectional antenna
TX2400-JK-20	Glue stick antenna	2.4G	3.0	200	-	SMA-J	Bendable glue stick, omnidirectional antenna
TX2400-XPL-150	Suction cup antenna	2.4G	3.5	150	150	SMA-J	Small suction cup antenna, cost-effective

14 Product Packaging



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Revision History

Version	Revision Date	Revision Notes	Maintainer
1.0	2025-02-27	First edition	Bin

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