E22P-T Series User Manual

High Performance 433/ 470/ 868/915MHz LoRa Wireless Module



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1 Product Overview

1.1 Product Introduction

The E22P-T series products are a new generation of enhanced LoRa wireless data transmission modules. This series of UART modules is developed based on SEMTECH high-performance RF chips , with a maximum transmit power of 30 dBm. It has multiple transmission modes and operates in the 433MHz , 470MHz , 868MHz and 915MHz bands . It features LoRa spread spectrum technology, UART communication interface and TTL level output.

The E22P-T series products adopt the new generation of LoRa spread spectrum technology, which is faster, consumes less power, and is smaller in size; it supports functions such as air wake-up, wireless configuration, carrier listening, automatic relay, and communication keys, supports packet length setting, and can provide customized development services.

The three modules have different frequency bands but are packaged compatibly. For detailed parameters, please refer to the E22P-T series product selection comparison in section 2.1 .

1.2 Features and Functions

- It adopts a new generation of LoRa spread spectrum modulation technology, which has a longer communication distance and stronger anti-interference ability;
- multiple frequency bands : 433 / 470/ 868/915MHz (customizable) ;
- Supports serial port firmware upgrades and OTA (Over-The-Air) firmware upgrades , making maintenance more convenient;
- Built-in high-performance PA, SAW, LNA and other components, with strong protection and anti-interference capabilities;
- Equipped with a 32MHz high-precision active temperature-compensated crystal oscillator ;
- It supports both HEX and AT command systems , allowing users to choose flexibly .
- Supports relay networking; multi-level relays are suitable for ultra-long-distance communication; multiple networks can operate simultaneously in the same area.
- It supports users setting their own communication keys, which cannot be read, greatly improving the confidentiality of user data;
- It supports LBT function, which listens to the channel environment noise before transmission, which can greatly improve the communication success rate of the module in harsh environments;
- Supports RSSI signal strength indication function for evaluating signal quality;
- Supports wireless parameter configuration, allowing remote configuration or retrieval of wireless module parameters via wireless command data packets;
- It supports over-the-air wake-up, which is an ultra-low power consumption function suitable for battery-powered applications.
- Supports fixed-point transmission, broadcast transmission, and channel monitoring;
- Supports deep sleep mode;
- The air transmission rate is adjustable in multiple levels;
- The parameters are saved after power failure, and the module will work according to the set parameters after power is restored;
- Built-in watchdog timer automatically resets and resumes operation in case of an accident;

1.3 Application Scenarios

- Intelligent irrigation and environmental monitoring in agriculture;
- Photovoltaic power plant monitoring and distributed photovoltaic system management, etc.
- Home security alarm and remote keyless entry;
- Smart home and industrial sensors, etc.;

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- Wireless alarm security system;
- Building automation solutions;
- Wireless industrial-grade remote control;
- Healthcare products;
- Advanced Meter Reading Architecture (AMI) .

2 Specifications

2.1 Comparison of E22P-T Series Products

Product Model	E22P-433T30S	E22P-868T30S	E22P-915T30S
Product Appearance			
Modulation method	Next-generation LoRa modulation technology	Next-generation LoRa modulation technology	Next-generation LoRa modulation technology
Operating frequency band ①	429～440MHz	863.3～873.3MHz	902～928MHz
Cache capacity	1000 Byte	1000 Byte	1000 Byte
Transmitting length ②	240 Byte	240 Byte	240 Byte
Air speed ③	1.75～15.5Kbps	1.75～15.5Kbps	1.75～15.5Kbps
Blocking power	10dBm	10dBm	10dBm
Transmission power ④	30 dBm	30 dBm	30 dBm
Receiving sensitivity ⑤	-134dBm	-134dBm	-134dBm
Operating voltage ⑥	3.3～5.5V	2.7～5.5V	2.7～5.5V
Communication level	3.3V	3.3V	3.3V
Emission current ⑦	582～621mA	582～621mA	582～621mA
Received current⑧	17～18mA	23～26 mA	17～18mA
Dormant current	≈3uA	≈3uA	≈3uA
Reference distance ⑨	10km	10km	10km
Operating temperature	-40～+85℃	-40～+85℃	-40～+85℃
Storage temperature	-40～+95℃	-40～+95℃	-40～+95℃
Antenna type ⑩	IPEX-1/Stamp Hole	IPEX-1/Stamp Hole	IPEX-1/Stamp Hole
Interface method	1.27mm stamp hole	1.27mm stamp hole	1.27mm stamp hole
Communication interface	UART serial port (3.3V)	UART serial port (3.3V)	UART serial port (3.3V)
Packaging method	SMD	SMD	SMD
Size	40.5*25 *3.9 mm	40.5*25 *3.9 mm	40.5*25 *3.9 mm
Weight	≈4.9g	≈4.9g	≈4.9g

Note:

(1)Operating frequency band ①: The frequency band range can be customized by the user;

(2)Transmission length ②: Maximum capacity of a single packet. If the capacity is exceeded, the packet will be automatically split. It can be adjusted via the host computer or by command. For detailed commands, please refer to Chapter 6 of this document .

(3)Air speed ③: Air speed is adjustable in multiple levels. See Chapters 6 and 7 of this document for details ;

(4)Transmit power ④: 30dBm=1000mW, power is adjustable in multiple levels, see Chapters 6 and 7 of this article for details ;

(5)Receiver sensitivity ⑤: Data under SF9 @BW125 conditions;

(6)Operating voltage ⑥: 30dBm output module ≥5V can guarantee output power, exceeding 5.5V poses a risk of

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permanent module burnout;

(7)Transmit current ⑦: Instantaneous power consumption @30dBm, Tc=25℃, VCC=5.0V, 433MHz/868MHz/915MHz;

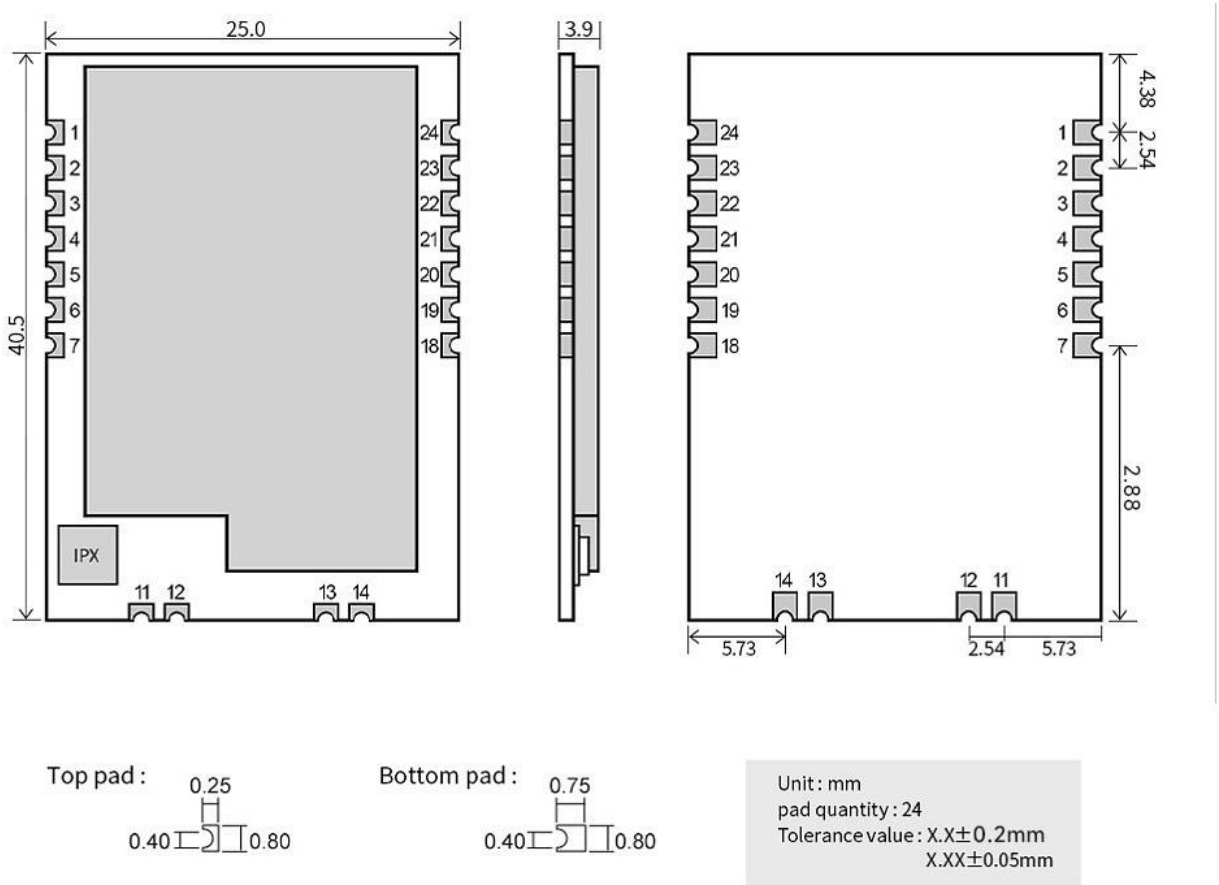
(8)Received current ⑧: Tc=25℃, VCC=5.0V, 433MHz/868MHz/915MHz;

(9)Reference distance ⑨: In clear weather and open environment, with the antenna mounted at a height of 2 meters and an airspeed of 1.75 kbps (for reference only, actual measurement is recommended);

(10)Antenna type ⑩: Equivalent impedance approximately 50Ω;

3 Mechanical Dimensions and Pin Definitions

3.1 E22P-433/868/915T30S Mechanical Dimensions and Pin Definitions



Pin number	Pin Name	Pin direction	Pin Applications
1	GND	Input	Module ground wire
2	VCC	Input	Module power supply (please refer to the electrical parameters section)

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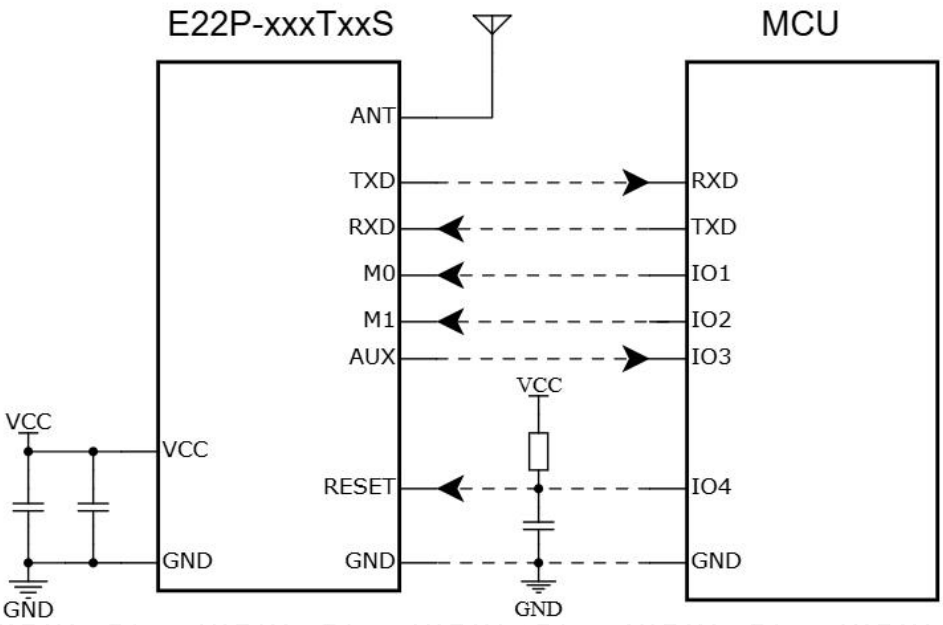
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Pin number	Pin Name	Pin direction	Pin Applications
3	AUX	Output	1. Indicator module working status (can be left floating); 2. During normal operation, a low level on this pin indicates a busy state, and a high level indicates an idle state; 3. It is not recommended to use this pin to drive external devices or pull down this pin. Otherwise, if the module detects that the AUX pin is continuously pulled low externally during power-up, it may be forced into upgrade mode and fail to work properly. For details, please see Chapter 5 .
4	TXD	Output	3.3V serial port output, connected to the external RXD input pin;
5	RXD	Input	3.3V serial port input, connected to the external TXD output pin;
6	M1	Input (very weak pull-up)	In conjunction with M0, it determines the module's four operating modes (cannot be left floating).
7	M0	Input (very weak pull-up)	In conjunction with M1, it determines the module's four operating modes (cannot be left floating).
11	ANT	Output	Antenna interface (high-frequency signal output, 50 ohm characteristic impedance)
12	GND	-	Fixed
13	GND	-	Fixed
14	GND	-	Fixed
18	NC		Unattended pins (programming pins; it is recommended to bring them out if possible for easier future maintenance or firmware customization).
19	NC		Unattended pins (programming pins; it is recommended to bring them out if possible for easier future maintenance or firmware customization).
20	NC		Unsupported foot (please keep it suspended in the air)
21	NC		Unsupported foot (please keep it suspended in the air)
22	RESET	Input	1.Module reset pin. Low level triggers reset, and the pull-low time needs to be greater than 100us; 2.It is strongly recommended that users connect to a microcontroller to reset and restore operation in case of an accident.
23	GND	-	Fixed
24	NC	-	Unsupported foot (please keep it suspended in the air)

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4 Recommended Connection Diagram



SN	Precautions
1	The module has a 3.3V serial port and I/O pins. If the user is using a 5V microcontroller, level conversion needs to be considered.
2	It is strongly recommended to connect the RESET pin to avoid unexpected malfunctions or other special situations.
3	If you are considering adding an external switch to the module's VCC, please consider the leakage current of the external microcontroller's serial port; otherwise, the module will not be able to be turned off.
4	It is not recommended to use the AUX pin to drive external components, such as LEDs or relays, as they will not function if continuously pulled low by an external source during power-on.
5	(Optional) For surface mount modules, consider bringing out the module's programming pins for easier future maintenance or firmware customization.
6	(Optional) Consider bringing out an additional interface for the module's serial port to facilitate future maintenance (can be upgraded online with PC tools).

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5 Functional Details

- In this chapter, the M1 and M0 pins are described as follows: 0 represents a low level and 1 represents a high level.
- If you are using software to switch modes, please refer to the AT+MODE command in Chapter 7 ;

5.1 Working Mode

The module has four operating modes, which are set by pins M1 and M0 , as detailed in the table below:

Mode (0-3)	M1	M0	Mode Introduction	Remark
0 Transmission Mode	0	0	Serial port enabled, wireless enabled, transparent transmission.	It can be configured remotely; see section 5.1.3.2 for details.
1 WOR mode	0	1	It can be defined as a WOR sender and a WOR receiver.	Supports over-the-air wake-up
2 Configuration Mode	1	0	Users can access the registers via the serial port to control the module's operating status.	-
3. Deep Sleep Mode	1	1	Module enters sleep mode	-

5.1.1 Transmission mode used, mode 0 (M1, M0 pins set to 0,0).

5.1.1.1 Quick Use of Transparent Transmission

What you send is what you get; you can communicate with each other using a serial port assistant (factory default parameters are all the same, and the transmission method is transparent transmission). An example is shown below:

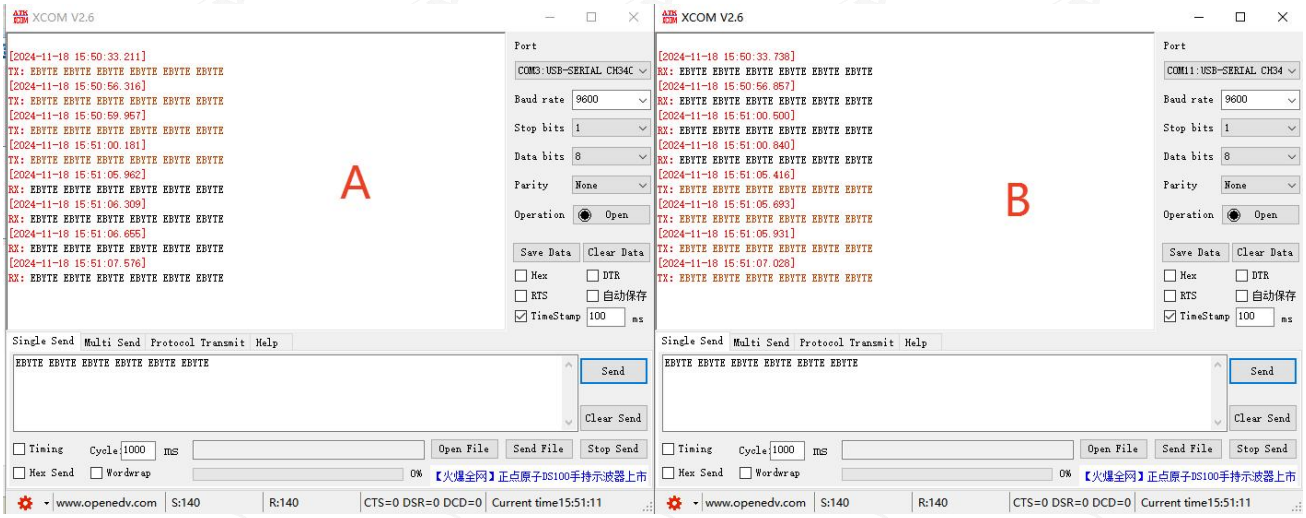


Figure 1. Schematic diagram of bidirectional transmission and reception

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5.1.1.2 Targeted transmission for quick use (specifying the destination address and channel)

Data is sent and received using a fixed data format: target address + target channel + data , which effectively avoids some interference.

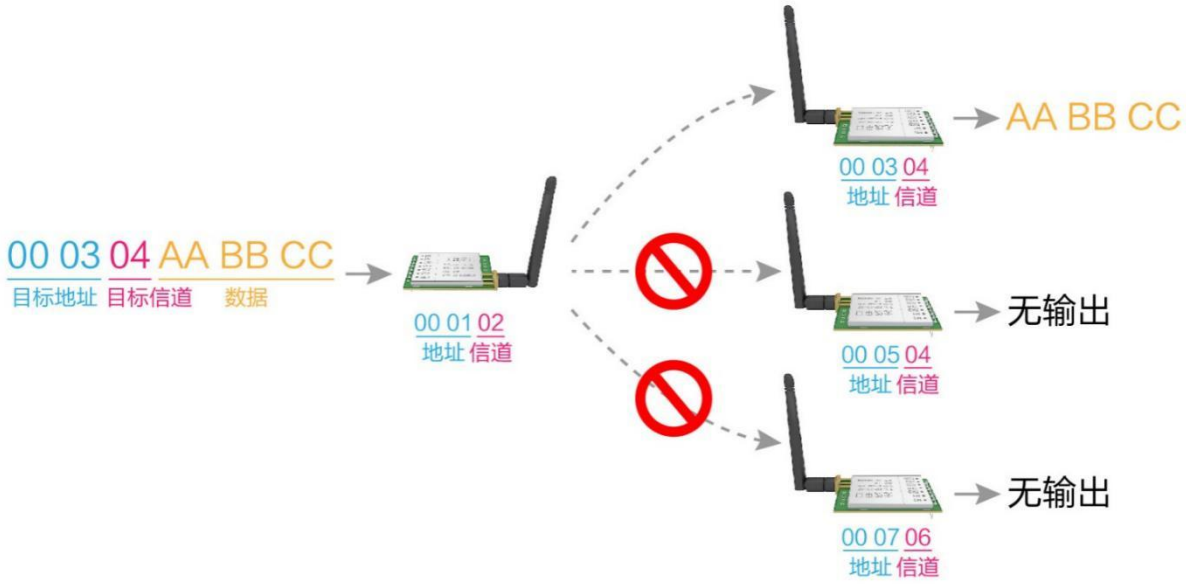


Figure 2 Schematic diagram of fixed-point transmission

Operating steps:

Step 1: Modify the module parameters via the host computer: Modify the module address and channel in configuration mode (M1, M0 pins set to 1, 0) , change the transparent transmission mode to fixed-point transmission, and finally write the parameters to complete the modification .

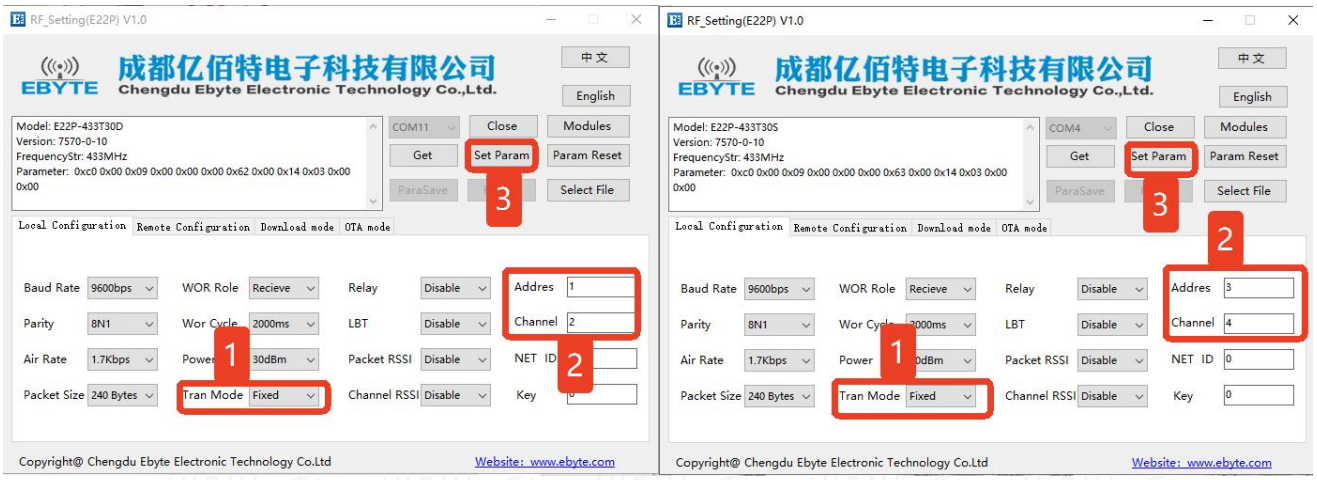


Figure 3 Host computer interface

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Step 2: Change the module's operating mode to normal mode: Edit the parameters of module A to 000304AABBCC and send it to module B. Similarly, module B sends data as 000102AABBCC. (In fixed-point mode, the data transmission format is: target address + target channel + data)

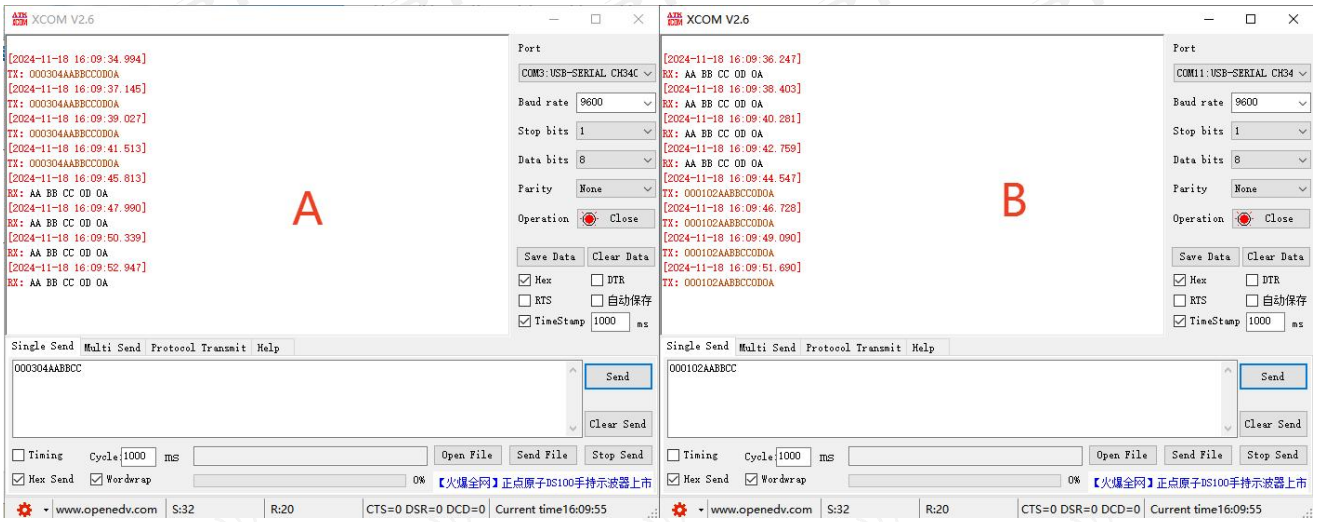


Figure 4 Data transmission diagram

5.1.1.3 Quick Use of Broadcast

- Set the address of module A to 0xFFFF and the channel to 0x04 . When module A is used as the transmitter (in the same mode, either transparent transmission or fixed-point transmission), all receiving modules under channel 0x04 can receive the data, achieving the purpose of broadcasting.
- Set the address of module A to 0xFFFF and the channel to 0x04. When module A acts as a receiver, it can receive all data under channel 0x04, achieving the purpose of monitoring.

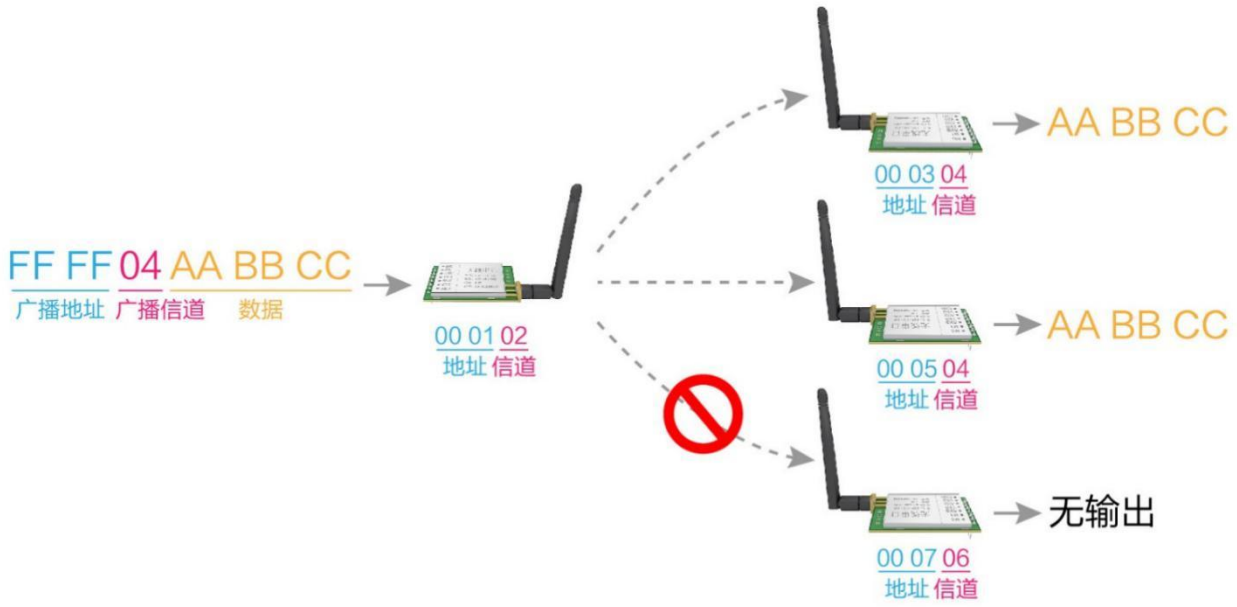


Figure 5. Schematic diagram of fixed-point broadcast transmission

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Operating steps:

Step 1: Modify the module parameters via the host computer: In configuration mode (M1 , M0 pins set to 1, 0) , modify the module address and channel, change the transparent transmission mode to fixed-point transmission, and finally write the parameters to complete the modification .

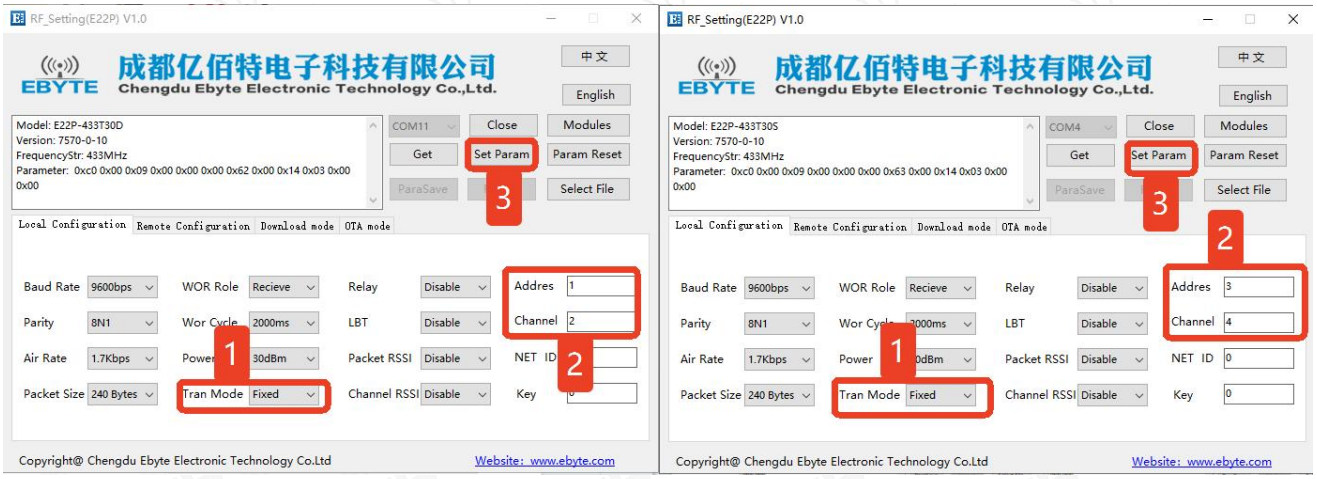


Figure 6 Computer interface diagram

Step 2: Change the module's working mode to normal mode: Edit the parameters of module A to FFFF04AABBCC and send them to module B. Similarly, module B sends data as FFFF02AABBCC. (In fixed-point broadcast mode, the data transmission format is: broadcast address + target channel + data).

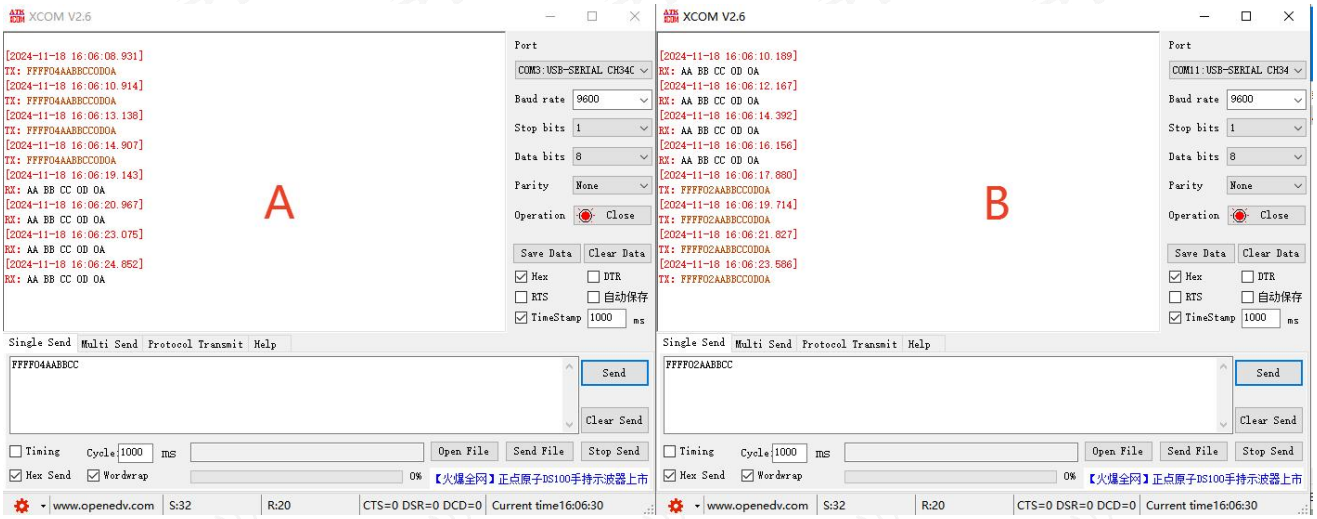


Figure 7 Data transmission diagram

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5.1.2 Use WOR mode , mode 1 (M1, M0 pins set to 0, 1).

5.1.2.1 Quick Use of Transparent Transmission

Operating steps:

Step 1: Modify the module parameters via the host computer: In configuration mode (M1, M0 pins set to 1, 0), modify the module's WOR role and write the parameters to complete the modification.

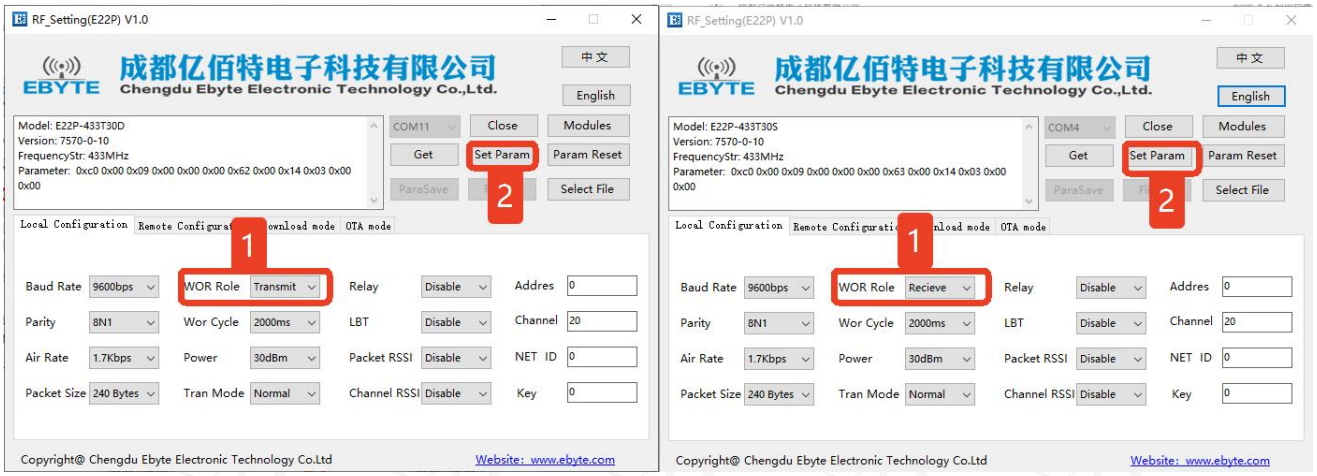


Figure 8 upper computer interface diagram

Step 2: Change the module's working mode to WOR mode (M1, M0 pins set to 0, 1): The WOR receiver module sends data to the WOR receiver module, but the WOR receiver module cannot send data to the sender.

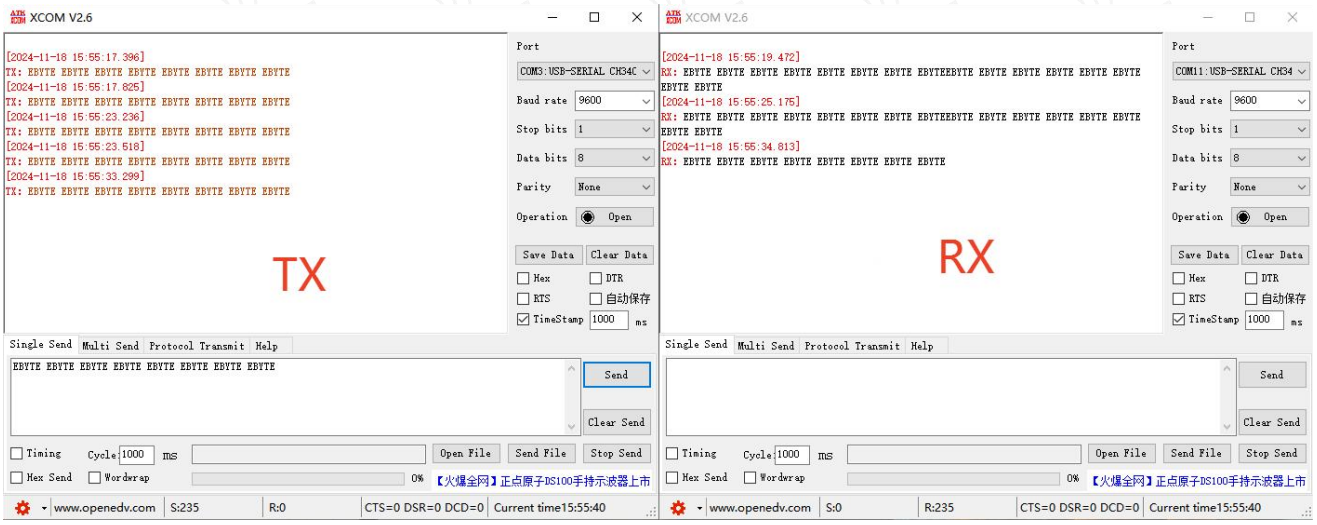


Figure 9 Data transmission diagram

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5.1.3 Configuration mode used, mode 2 (M1, M0 pins set to 1, 0).

5.1.3.1 Quick Use of Configuration Tools

The following diagram shows the host computer display interface for the module configuration. Users can switch to command mode via M0 and M1 to quickly configure and retrieve parameters on the host computer.



Figure 10 upper computer interface diagram

- In the host computer configuration, the module address, frequency channel, network ID, and key are all displayed in decimal mode; for the value range of each parameter, please refer to the specific parameters of different product models in the registers in section 6.3.
- When configuring the relay mode using the host computer, users need to pay special attention because the parameters are displayed in decimal mode. Therefore, the module address and network ID need to be converted to the correct base when entering them. For example, if the network ID entered by the transmitter A is 02 and the network ID entered by the receiver B is 10, then when setting the module address on the relay R, the hexadecimal value 0X020A should be converted to the decimal value 522 as the module address to be entered by the relay R. That is, the module address value that the relay R needs to enter at this time is 522.

5.1.3.2 Quick Use of Remote Configuration

Operating steps:

Step 1: Remotely read and modify module parameters via a host computer: Module A and Module B must have identical parameters for remote configuration. An example is shown in the right figure: Module A is in configuration mode, while Module B is in normal mode. Module A can be remotely configured and its parameters read using the host computer.

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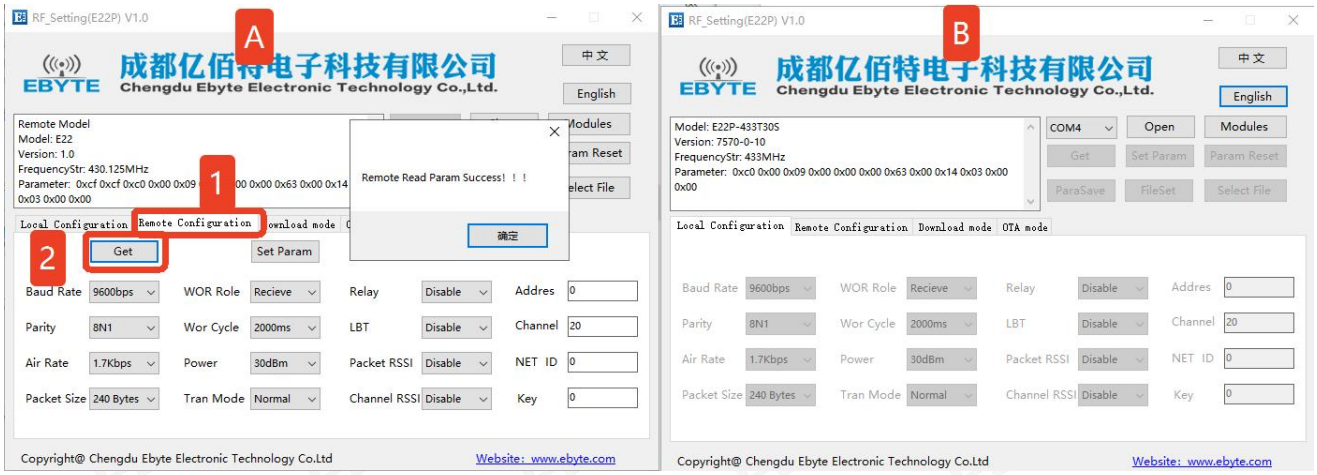


Figure 11 upper computer interface diagram

Step 2: Modify remote parameters and write the parameters.

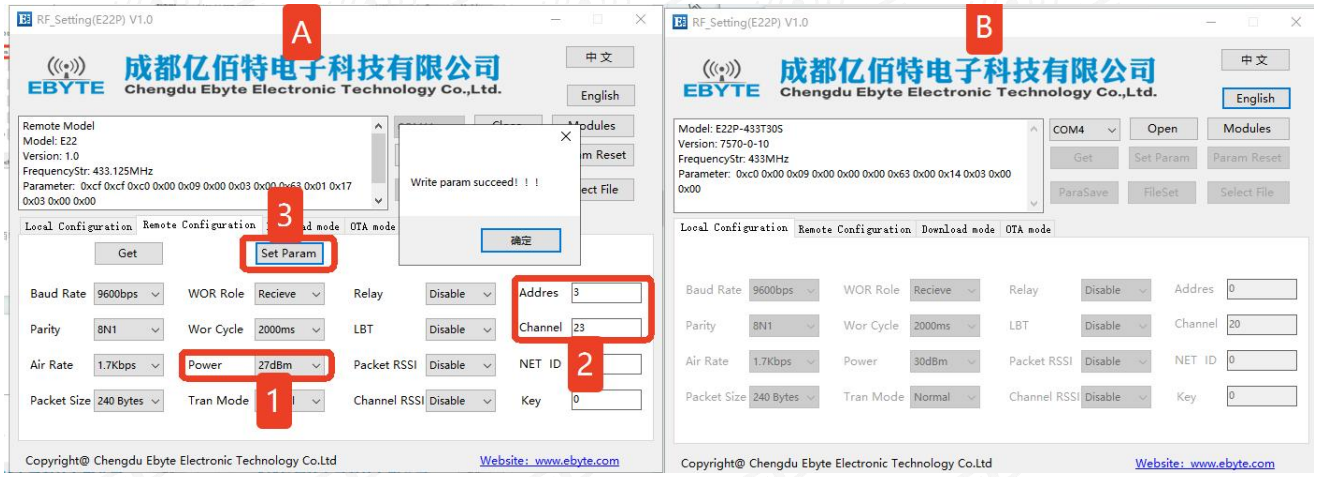


Figure 12 upper computer interface diagram

Step 3: Switch module B to configuration mode to view the modified parameters.

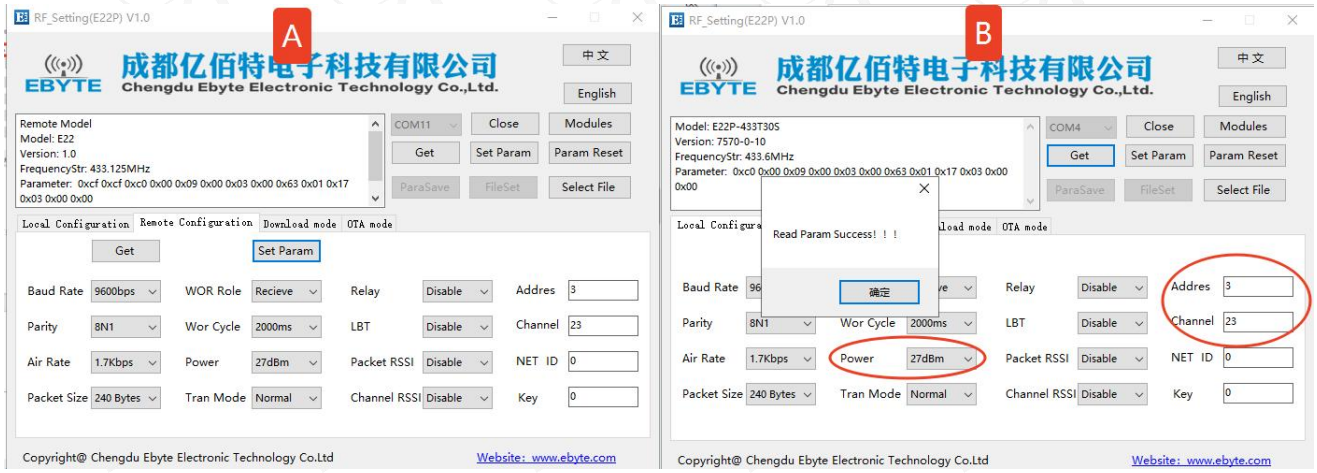


Figure 13 upper computer interface diagram

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5.1.4 Use sleep mode, mode 3 (M1, M0 pins set to 1, 1).

- To enter sleep mode, simply set the M1 and M0 pins to high level. In this mode, the module will be in sleep mode with minimal power consumption.

5.2 AUX Timing

5.2.1 Power-on start indication

Tc = 25°C, VCC = 5 V

Parameter	Describe	Typical value	Unit
T1	The entire startup process after the module's VCC is powered on takes a certain amount of time (entering the working mode, which is then operable by the user).	60	ms
T2	After the module's VCC is powered on, the AUX input will first pull low for a delay. It does not immediately indicate a busy state (low level) because the internal microcontroller also needs a certain startup time. Note: At the beginning of T2, the AUX pin is in an internal pull-up input state. If it is detected to be pulled low externally for more than 1 second (e.g., by an external pull-down resistor or shorted to GND), it will be forced into upgrade state and unable to send or receive wireless data and configuration commands normally. For more details, please refer to the firmware upgrade section.	13	ms

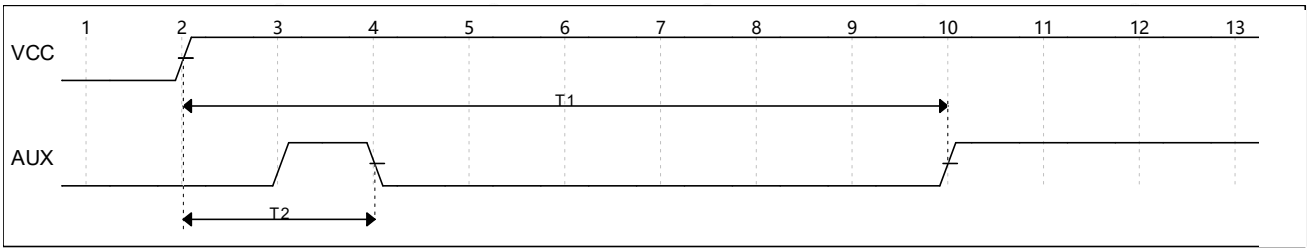


Figure 14 Power-on timing diagram

5.2.2 Serial Port Data Output Indicator

Conditions: Tc = 25°C, VCC = 5 V

Para meter	Describe	Typical value	Unit
T1	After the module has finished receiving air data packets, the AUX signal goes low to indicate the microcontroller's readiness time to the external user. It can also be used as a wake-up signal, suitable for some low-battery power applications.	3	ms
T2	The module outputs the time interval between two consecutive packets of air data. The first scenario: The sending end is transmitting data in a super-packet loop, and the air speed is much greater than the receiving end's serial port speed. In this case, the serial port output data of the receiving end module will exhibit a packet-merging effect (T2=0), and the length of a single serial port output data can exceed the user-set packet length. This is suitable for applications where Modbus reads multiple registers from the slave device and responds. The second scenario: The sending end is transmitting data in a multi-packet loop, but both	0 or Tx (Single packet in-flight time)	ms

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Para meter	Describe	Typical value	Unit
	the air speed and the serial port baud rate are slow (e.g., air speed 1.7K, serial port 9600 in default mode). In this case, the air transmission time is relatively long, so the receiving end will output data packets in segments at intervals.		

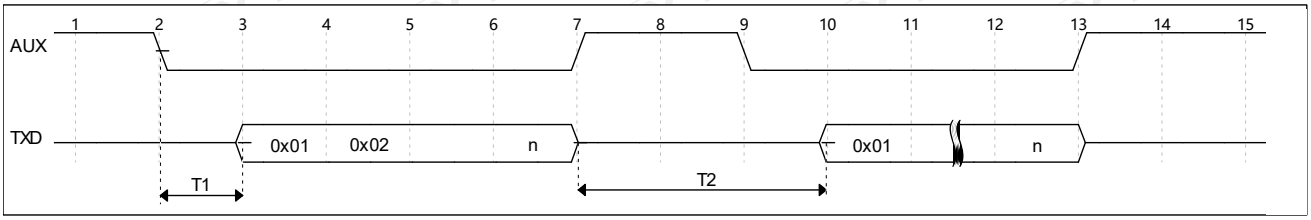
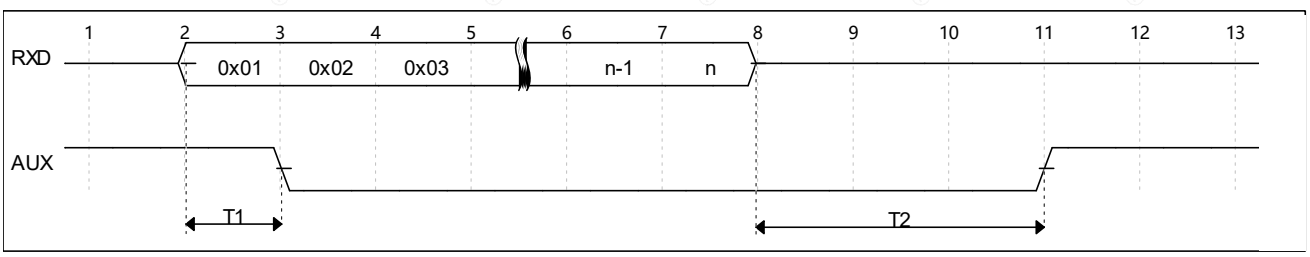


Figure 15 Serial port data output timing diagram

5.2.3 Wireless Transmission Indicator

Tc = 25°C, VCC = 5 V

Parameter	Describe	Typical value	Unit
n	The internal buffer capacity of the module's serial port (maximum data length that can be transmitted at one time). When the data to be transmitted in the buffer exceeds the user-defined packet length (default 240 bytes), it will be automatically split into packets for wireless transmission.	1000	Byte
T1	The AUX indicator displays the delay time when the module's serial port receives data. The module only starts indicating a busy state (pulled low) after the first byte of the serial data packet is recognized and received. Therefore, the delay time is related to the serial port baud rate (default 9600bps).	1	ms
T2	Module cache idle state AUX indicator delay (high) time In the first scenario: if the data length transmitted by the user to the module is less than the packet length (default 240 bytes), then T2 is the serial port reception time frame break delay, with a default frame break time of 3 bytes (related to the serial port baud rate , default 9600). As soon as the frame break countdown ends, the AUX pin is immediately pulled high to indicate that the buffer is idle, and the over-the-air transmission process is triggered at the same time (under default conditions, AUX will not indicate the wireless transmission busy process; for more settings, please refer to the AT+UAUX command). The second scenario: When the data length sent to the module exceeds the packet length , T2 represents the total over-the-air transmission time (related to the over-the-air rate). That is, during serial port reception, once the packet length is reached, the over-the-air transmission process is immediately triggered (LoRa over-the-air transmission is relatively time-consuming). Subsequent packet transmissions are repeated multiple times (related to the data length) until all data in the receive buffer has been sent, at which point the AUX pin is pulled high to indicate that the buffer is empty.	3 or Tx (Airborne transmission time)	ms



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Figure 16 Wireless Transmission Timing Diagram

5.2.4 Switch mode

When the module switches between all modes, the AUX input will indicate a busy state, as shown in the table below:

Original working mode	Switch mode	T1 switching time (ms)
Sleep mode	Transparent transmission mode	39～ 40
	WOR mode	39～40
	Configuration mode	39～40
Transparent transmission mode	Sleep mode	39～40
	WOR mode	39～40
	Sleep mode	39～40
Configuration mode	Sleep mode	39～40
	Transparent transmission mode	39～40
	WOR mode	39～40
WOR mode	Sleep mode	39～40
	Transparent transmission mode	39～40
	Configuration mode	39～40

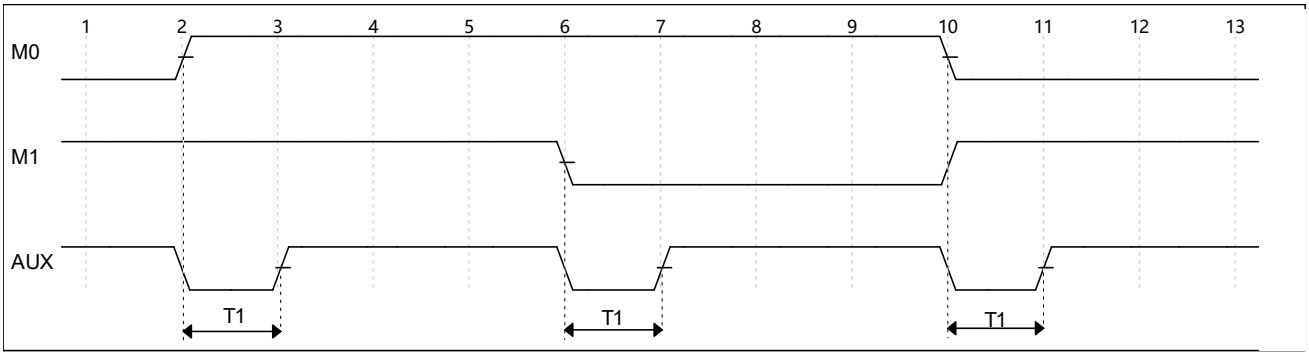


Figure 17 Mode switching timing diagram

5.2.4 Precautions

Serial Number	AUX Precautions
1	When the AUX output is low, it indicates that the module is busy, and no working mode detection will be performed at this time .
2	If AUX remains high, the mode switch will take effect immediately .
3	When a user moves from mode 2 (configuration mode) to another mode or during a reset, the module will reset the user parameters, during which the AUX output will be low.

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5.3 Relay networking rules

Relay networking extends network coverage and improves communication reliability by having relay nodes forward data between source and destination nodes.

Serial Number	Relay Mode Description
1	After configuring the relay mode, switching to normal mode enables the relay to function , allowing bidirectional data forwarding between the two NETIDs.
2	In relay mode, ADDH and ADDL are no longer used as module addresses, but are instead paired with NETID for forwarding. If the signal is received from one network, it is forwarded to the other network.
3	In relay mode, the relay module cannot send or receive data and cannot perform low-power operations.
4	The repeater's own network ID is invalid.
5	It is not recommended to use two or more relays with the same or swapped ADDH and ADDL , otherwise it may lead to circular forwarding between relays.

As shown in the example image below :

Level 1 relay

- Node 1 has a NETID of 08. Node 2 has a NETID of 33.
- The ADDH and ADDL of "Relay 1" are 08 and 33, respectively.
- Therefore, the signal sent by node 1 (08) can be forwarded to node 2 (33).
- Since Node 1 and Node 2 have the same address, the data sent by Node 1 can be received by Node 2.

Level 2 relay

- The ADDH and ADDL of "Relay 2" are 33 and 05 respectively.
- Therefore, relay 2 can forward the data from relay 1 to the network NETID: 05.
- Thus, nodes 3 and 4 can receive data from node 1. Node 4 outputs data normally, while node 3, whose address is different from node 1, does not output data.

Two-way relay

- As shown in the configuration diagram: Data sent by node 1 can be received by nodes 2 and 4, and data sent by nodes 2 and 4 can also be received by node 1.

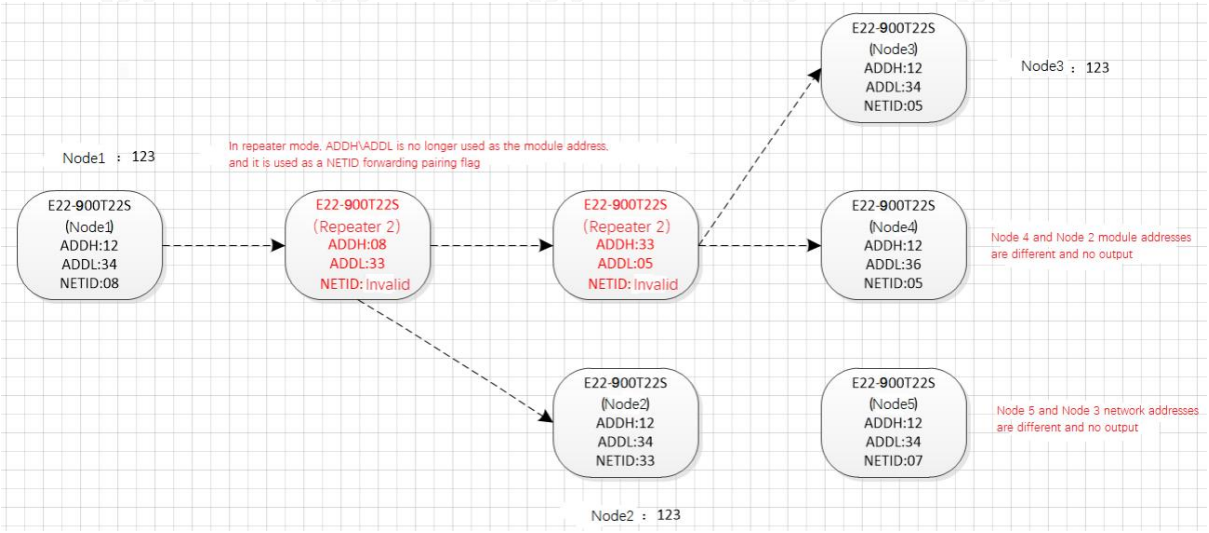


Figure 18 Relay network diagram

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5.4 Serial port firmware upgrade

- If customers need to upgrade the firmware, they need to contact the relevant person through the sales channel to obtain the corresponding upgrade package, and then use the host computer provided by EBITE to upgrade the firmware. Under normal circumstances, users do not need to upgrade the firmware, and please do not use the "AT+IAP" command at will .
- The necessary pins for the upgrade must be brought out (M1, M0, AUX, TXD, RXD, VCC, GND). Then, send the "AT+IAP" command in configuration mode to enter upgrade mode . If only the serial port pins TXD/RXD can be brought out, a hardware-triggered upgrade method can be considered. First, power off the module, then use tweezers to short-circuit the module's AUX pin and GND. Then power on the module and maintain the short circuit for at least 1 second. The module will be forced into upgrade mode.
- After entering upgrade mode, the baud rate will automatically switch to 115200 until it automatically exits, during which time logs will be output .

5.4.1 Upgrade the host computer quickly

Step 1: Enter configuration mode by changing M0 and M1 (Note: the baud rate is 9600 in configuration mode); open the configuration host computer and select the firmware upgrade tab.

Step 2: Click "Read Parameters" to view module information in the left window of the host computer.

Step 3: Open the file (select the firmware.bin file) > Click Start Download.

Step 4: Click "Start Download". The firmware upgrade will begin and a message will appear indicating successful download upon completion.

Step 5: After the firmware upgrade is complete, reopen the serial port to confirm the read parameters.



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Figure 18 upper computer interface diagram

5.5 Over-the-air (OTA) firmware updates

- You need to contact the relevant person through the sales channel to obtain the corresponding upgrade package. Note that since this is a differential upgrade, you need to specify the firmware version of the module to be upgraded.
- Currently, only single-point upgrades are supported; broadcast group upgrades are not yet supported.
- The upgrade process requires the user's microcontroller to actively send commands to the module. Therefore, customers need to consider writing the relevant triggering logic in advance during the application design phase.

5.5.1 Prepare auxiliary communication equipment

Step 1: If the target is model E22P-433T30S, it is recommended to use E22-400T22U as an auxiliary communication device. If the target is model E22P-868T30S or E22P-915T30S, it is recommended to use E22-900T22U as an auxiliary communication device.



Figure 19 E22-400T22U

Step 2: Use the E22P series host computer to read the auxiliary communication device and ensure it is in configuration mode (for the E22U series, you need to press and hold the side button and then release it to switch modes; when the indicator light turns red, it is in configuration mode).



Figure 20 upper computer interface

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5.5.2 The host computer begins listening.

Step 1: After confirming the auxiliary module, switch to the over-the-air design tab in the host computer interface.

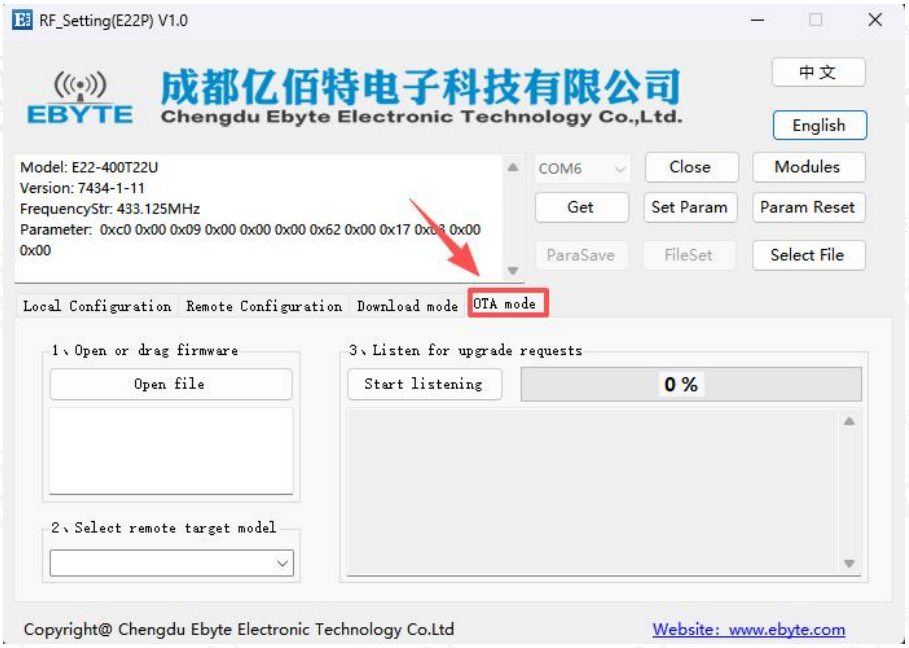


Figure 21 upper computer interface

Step 2: Following the on-screen instructions, open the firmware, select the target model, and finally click the button to start monitoring. Note the prompts; under normal circumstances, the timer will automatically start incrementing.

If you do not receive the correct prompts, you may consider shutting down the host computer and repeating the steps outlined above.

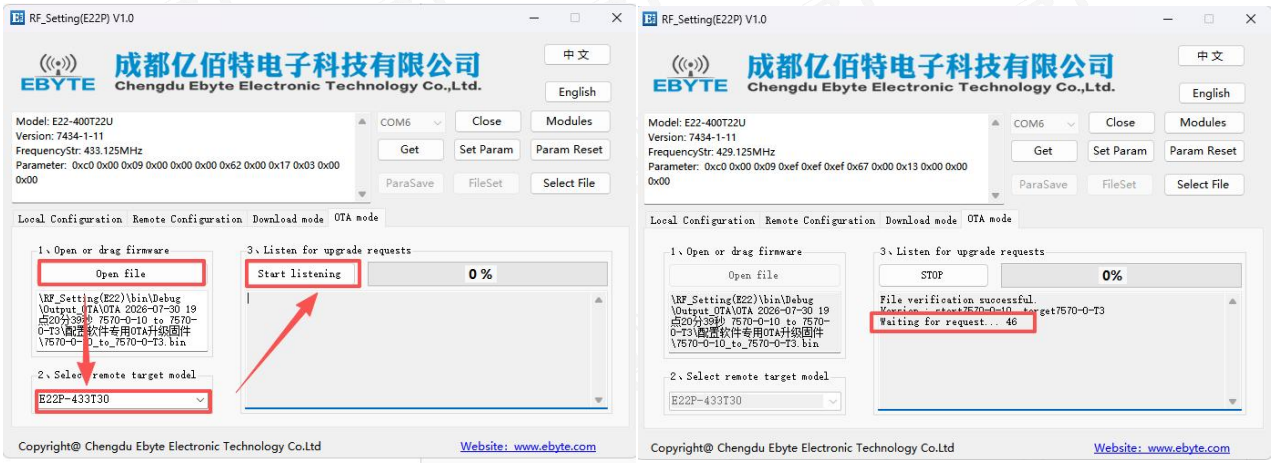


Figure 22 upper computer interface

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5.5.3 E22P Module-Triggered Upgrade

Step 1: The customer's microcontroller should ensure that the E22P module is in configuration mode, which can be triggered by sending the AT+OTA command. During OTA execution, it will not respond to other commands. It will not be affected by unexpected events such as power outages, and will automatically recover its working state after a failure.

Under normal circumstances, the E22P module automatically requests an upgrade firmware package from the remote host computer, and eventually completes the upgrade automatically, displaying the following success message:

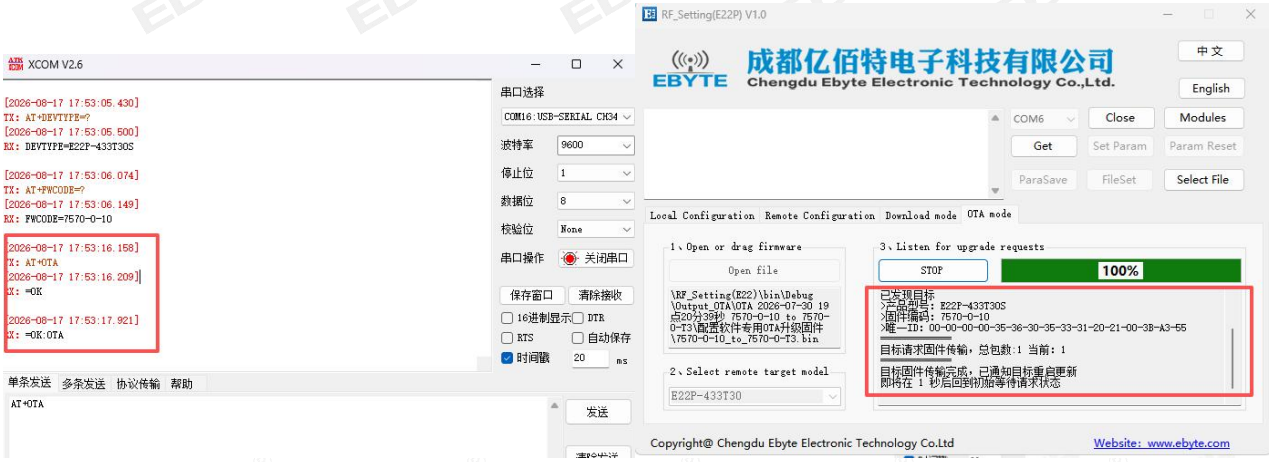


Figure 23 upper computer interface

Step 2: In abnormal situations, if the E22P module fails to request the correct firmware within 60 seconds, it will display an error message and automatically exit the OTA upgrade, resuming its working state.

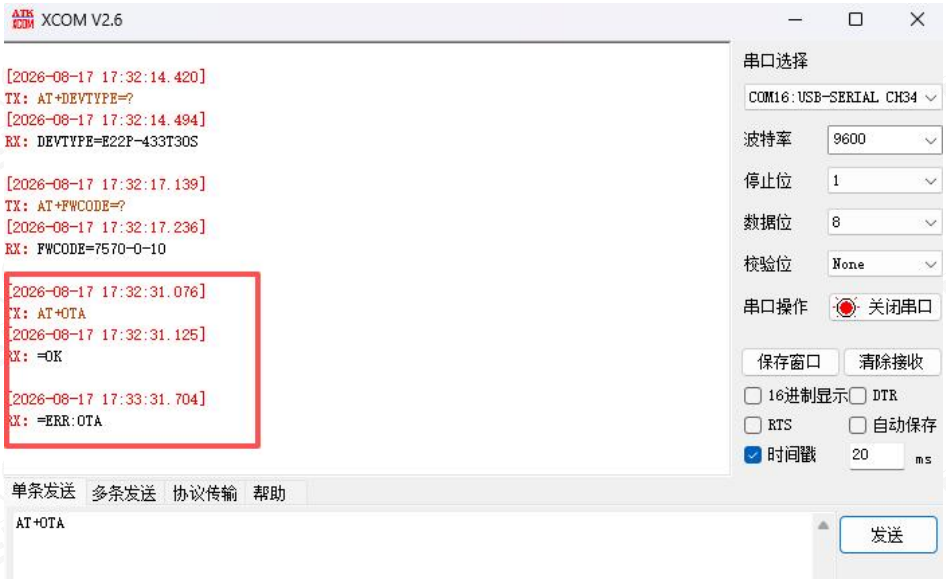


Figure 24 Parameter feedback interface

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6 Register Read/Write Control

6.1 HEX Command Format

configuration mode (Mode 2: M1=1, M0=0), the supported command list is as follows (**when setting, the serial port only supports 9600, 8N1 format**):

Serial Number	Instruction format	Detailed description
1	Set registers	Instruction: C0 + starting address + length + parameters Response: C1 + starting address + length + parameters Example 1: Configure channel as 0x09 Instruction start address Length parameter send: C0 05 01 09 return: C1 05 01 09 Example 2: Simultaneously configure module address (0x1234), network address (0x00), serial port (9600 8N1), and airspeed (1.75 K). Send: C0 00 04 12 34 00 63 Return: C1 00 04 12 34 00 63
2	Read registers	Instruction: C1 + starting address + length Response: C1 + starting address + length + parameters Example 1: Reading the channel Instruction start address length parameter send: C1 05 01 return: C1 05 01 09 Example 2: Simultaneously read module address, network address, serial port, and airspeed. Send: C1 00 04 Return: C1 00 04 12 34 00 63
3	Set temporary register	Instruction: C2 + starting address + length + parameters Response: C1 + starting address + length + parameters Example 1: Configure channel as 0x09 Instruction start address length parameter send: C2 05 01 09 return: C1 05 01 09 Example 2: Simultaneously configure module address (0x1234), network address (0x00), serial port (9600 8N1), and airspeed (1.75 K). Send: C2 00 04 12 34 00 63 Return: C1 00 04 12 34 00 63
4	Wireless configuration	Command: CF CF + regular command Response: CF CF + Regular Response Example 1: Wireless configuration channel is 0x09 Wireless command header Instruction start address length parameter send: CF CF C0 05 01 09 return: CF CF C1 05 01 09 Example 2: Simultaneously configure the wireless module address (0x1234), network address (0x00), serial port (9600 8N1), and airspeed (1.75 K). Send: CF CF C0 00 04 12 34 00 63 Return: CF CF C1 00 04 12 34 00 63
5	Formatting error	Format error response FF FF FF

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6.2 Register Function Overview

address	name	Bit							
		bit 7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
00h	ADDH	Communication address [15:8]							
01h	ADDL	Communication address [7:0]							
02h	NETID	Network address [7:0]							
03h	REG0	Serial port baud rate [2:0]			Serial port verification type [1:0]		Wireless transmission rate [2:0]		
04h	REG1	Serial port packet length [1:0]		Environmental RSSI	reserve	reserve	Soft cutting mode	Wireless transmission power [1:0]	
05h	REG2	Channel control [7:0]							
06h	REG3	Data RSSI	Transmission method	Relay enable	Listen first, then speak	Air wake-up	Airborne wake-up cycle [2:0]		
07h	CRYPT_H	Wireless data encryption key [15:8]							
08h	CRYPT_L	Wireless data encryption key [7:0]							
09h	WD_H	The receiver can be woken up over the air and respond (send) within a window of [15:8] after receiving data.							
0Ah	WD_L	The receiver can be woken up over the air and respond (send) within a window of [7:0] after receiving data.							

6.3 Register Detailed Description

SN	Reading and writing	Name	Describe				Remark
00H	Reading /Writing	ADDH	ADDH (default 0)				1. The high and low bytes of the module address; 2. When the module address equals FFFF, it can be used as a broadcast and listening address; that is, the module will not perform address filtering in this case.
01H	Reading /Writing	ADDL	ADDL (default 0)				
02H	Reading /Writing	NETID	NETID (default 0)				1. Network addresses are used to distinguish networks; 2. When communicating with each other, the settings should be the same.
03H	Reading /Writing	REG0	7	6	5	UART serial port speed (bps)	1. Two modules that communicate with each other can have different serial port baud rates and different verification methods. 2. When sending large data packets in succession, users need to consider the data blocking caused by the same baud rate, which may even result in data loss. 3. It is generally recommended that both communicating parties use the same baud rate.
			0	0	0	The serial port baud rate is 1200.	
			0	0	1	The serial port baud rate is 2400.	
			0	1	0	The serial port baud rate is 4800.	
			0	1	1	The serial port baud rate is 9600 (default).	
			1	0	0	The serial port baud rate is 19200.	
			1	0	1	The serial port baud rate is 38400.	
			1	1	0	The serial port baud rate is 57600.	
			1	1	1	The serial port baud rate is 115200	
			4	3	Serial port check bit		The serial port modes of the two communicating parties can be different;
			0	0	8N1 (default)		
			0	1	8O1		
			1	0	8E1		
			1	1	8N1 (equivalent to 00)		
			2	1	0	Wireless air speed (bps)	

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<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td>E22P-433T30S
E22P-868T30S
E22P-915T30S</td><td></td></tr>
<tr><td></td><td></td><td></td><td>0</td><td>0</td><td>0</td><td>Air speed 1.75K</td><td rowspan="9">Note: The air speed of both communicating parties must be the same; the higher the air speed, the lower the delay and the shorter the transmission distance.</td></tr>
<tr><td></td><td></td><td></td><td>0</td><td>0</td><td>1</td><td>Air speed 1.75K</td></tr>
<tr><td></td><td></td><td></td><td>0</td><td>1</td><td>0</td><td>Air speed 1.75K</td></tr>
<tr><td></td><td></td><td></td><td>0</td><td>1</td><td>1</td><td>Air speed 1.75K (default)</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>0</td><td>0</td><td>Air speed 3.1K</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>0</td><td>1</td><td>Air speed 5.4K</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>0</td><td>Air speed 9.3K</td></tr>
<tr><td></td><td></td><td></td><td>1</td><td>1</td><td>1</td><td>Air speed 15.6k</td></tr>
<tr><td rowspan="6">04H</td><td rowspan="6">Reading /Writing</td><td rowspan="6">REG 1</td><td>7</td><td>6</td><td colspan="2">Sub-packing settings</td><td rowspan="5">Notice:
1. When the data sent by the user is less than the packet length, the serial port output of the receiving end will be a continuous output without interruption.
2. If the data sent by the user exceeds the packet length, the receiving end's serial port will output the data in packets.</td></tr>
<tr><td>0</td><td>0</td><td colspan="2">240 bytes (default)</td></tr>
<tr><td>0</td><td>1</td><td colspan="2">128 bytes</td></tr>
<tr><td>1</td><td>0</td><td colspan="2">64 bytes</td></tr>
<tr><td>1</td><td>1</td><td colspan="2">32 bytes</td></tr>
<tr><td>5</td><td colspan="3">RSSI Ambient Noise Enable</td><td rowspan="3">1. Once enabled, the C0 C1 C2 C3 instruction can be sent to read registers in either transmit mode or WOR send mode;
2. Register 0x00: Current ambient noise RSSI;
3. Register 0X01: RSSI of the last received data (current ambient noise is: dBm = -(256 - RSSI)); When the signal is too strong, RSSI may be 0, so no formula conversion is needed.
4. Instruction format: C0 C1 C2 C3 + starting address + read length;
●Returns: C1 + address + read length + valid value;
■ For example: Send C0 C1 C2 C3 00 01
■ Return : C1 00 01 RSSI (Address can only start from 00)</td></tr>
<tr><td>0</td><td colspan="3">Disabled (default)</td></tr>
<tr><td>1</td><td colspan="3">Enable</td></tr>
<tr><td rowspan="5"></td><td rowspan="5"></td><td rowspan="5"></td><td>4</td><td>3</td><td colspan="2">reserve</td><td></td></tr>
<tr><td>2</td><td colspan="3">Software mode switching</td><td rowspan="4">1. If you use our host computer configuration parameters, this bit will be automatically disabled. If you do not want to use the M0 and M1 pins to switch operating modes, you can enable this function and use specific serial port commands to switch modes.
2. Format: C0 C1 C2 C3 02 + Working Mode :
●Send C0 C1 C2 C3 02 00 to switch to transparent transmission mode ;
●Send C0 C1 C2 C3 02 01 to switch to WOR mode ;
●Send C0 C1 C2 C3 02 02 to switch to configuration mode ;
●Send C0 C1 C2 C3 02 03 to switch to sleep mode ;</td></tr>
<tr><td>0</td><td colspan="3">Disabled (default)</td></tr>
<tr><td>1</td><td colspan="3">Enable</td></tr>
</table>

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						●Return: C1 C2 C3 02 + Working Mode ; Note: Even after enabling this feature, the configuration mode still only supports a baud rate of 9600.
			1	0	Transmit power	1. The relationship between power and current is non-linear; the power supply efficiency is highest at maximum power. 2. The current does not decrease proportionally as the power decreases.
			0	0	30dBm (default)	
			0	1	27 dBm	
			1	0	24 dBm	
			1	1	21 dBm	
05H	Reading /Writing	REG 2	Channel control (CH) 0-55 represent a total of 55 channels (applicable to the 433 GHz band) . 0-50 represent a total of 50 channels (applicable to the 868 frequency band) . 0-130 represent a total of 130 channels (applicable to the 915 band) .			1. of the 433 MHz band = 429.0 + CH * 0.2MHz 2. of the 868 band = 863.3 + CH * 0.2MHz 3. of the 915 band = 902.0 + CH * 0.2M
06H	Reading /Writing	REG 3	7	Enable RSSI bytes (packet RSSI)		1. Once enabled, the module receives wireless data, outputs it via the serial port TXD, and then follows it with an RSSI strength byte. 2. The current data packet RSSI is: dBm = -(256 - RSSI) (When the signal is too strong, RSSI may be 0, in which case no formula conversion is needed.)
			0	Disabled (default)		
			1	Enable		
			6	Transmission method		During point-to-point transmission, the module identifies the first three bytes of the serial port data as: address high + address low + channel, and uses them as the wireless transmission target.
			0	Transparent transmission (default)		
			1	Fixed-point transmission		
			5	relay function		1. Once the relay function is enabled, if the target address is not the module itself, the module will initiate a forwarding operation. 2. To prevent data backhaul, it is recommended to use it in conjunction with fixed-point mode; that is, the destination address and the source address are different.
			0	Disable relay function (default)		
			1	Enable relay function		
			4	LBT Enable		1. Once enabled, it will listen for data before wireless data transmission, which can avoid interference to some extent, but may cause data delay. 2. The maximum dwell time for LBT is 2 seconds; it will be forcibly activated once the two-second duration is reached.
			0	Disabled (default)		
			1	Enable		
			3	WOR mode send/receive control		**Only applicable to Mode 1;** 1. In wor's receive mode, the module can modify the delay time after wake-up, with the default time being 0; 2. The receiving end needs to send the command C0 09 02 03 E8 in configuration mode (C0 is the write command, 09 is the register starter address, 02 is the length, and 03 E8 is the set delay, with a maximum of FFFF, which is 65535ms. Setting it to 0 disables the wake-up delay.) 3. Data can be sent within the delay period.
			0	WOR receiver (default) It operates in WOR listener mode, with a listener cycle described below (WOR cycle), which can save a significant amount of power consumption.		
			1	WOR Launcher The module is enabled for both transmitting and receiving, and a wake-up code is added for a certain period of time when transmitting data.		
			2	1	0	WOR cycle	**Only applicable to Mode 1;**

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			0	0	0	500ms	1. The period T = (1 + WOR) * 500ms, with a maximum of 4000ms and a minimum of 500ms; 2. The longer the WOR monitoring interval, the lower the average power consumption, but the greater the data latency. 3. Both the sender and receiver must agree (this is very important).
			0	0	1	1000ms	
			0	1	0	1500ms	
			0	1	1	2000ms (default)	
			1	0	0	2500ms	
			1	0	1	3000ms	
			1	1	0	3500ms	
			1	1	1	4000ms	
07H	Write	CRYPT_H	High byte of the key (default 0)				1. Write-only, read returns 0; 2. Used for encryption to prevent over-the-air wireless data from being intercepted by similar modules; 3. The module will use these two bytes as a calculation factor to transform and encrypt the airborne wireless signal.
08H	Write	CRYPT_L	Low byte of the key (default 0)				
80H ～ 86H	read	PID	Product information (7 bytes)				Product information (7 bytes) Note: Please refer to section 7.1 for a more convenient way to search for the command AT+DEVTYPE=?

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6.4 Register parameters factory default values

Model	433MHz module factory default parameter values: C0 00 09 00 00 00 63 00 14 03 00 00 868MHz module factory default parameter values: C0 00 09 00 00 00 63 00 18 03 00 00 915MHz module factory default parameter values: C0 00 09 00 00 00 63 00 41 03 00 00						
Module model	Frequency	Address	Channel	Air speed	Baud rate	Serial port format	Transmit power
E22P-433T30S	433.0 MHz	0x0000	0x14	1.7kbps	9600	8N1	30dbm
E22P-868T30S	868.1 MHz	0x0000	0x18	1.7kbps	9600	8N1	30dbm
E22P-915T30S	915.0 MHz	0x0000	0x41	1.7kbps	9600	8N1	30dBm

7 AT Commands

- Parameter configuration or querying using AT commands must be done in configuration mode (the serial port in configuration mode is forcibly fixed to 9600 8N1);
- Automatically recognizes the carriage return and newline character at the end of user AT commands, and still recognizes them even if no carriage return and newline character is added;
- An AT command recognition or execution error will result in an " =ERR " response.
- When the input parameters exceed the range, they will be restricted. Please do not allow the parameters to exceed the range to avoid unforeseen situations.

7.1 General instructions

7.1.1 AT+RESET soft reboot

Instruction format	AT+RESET
Execution Example	Send: AT+RESET Response: =OK
Feature Description	● The actual reset process will only begin after an OK response (=OK). Please wait approximately 30ms before proceeding to the next step.

7.1.2 AT+DEFAULT restores factory settings

Instruction format	AT+DEFAULT
Execution Example	Send: AT+DEFAULT Response: =OK
Feature Description	● After the response (=OK), in addition to parameter restoration, a restart process will be executed. Please wait approximately 30ms before proceeding to the next step.

7.1.3 Use AT+DEVTYPE to query product model

Instruction format	AT+DEVTYPE=?
Execution Example	Send: AT+DEVTYPE=? Response: DEVTYPE = E22 P -4 33 T 30S
Feature Description	● Product Series: E22P ● Operating frequency band: 433 (433/868/915) ● Maximum power: 30

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7.1.4 Use AT+FWCODE to query software version

Instruction format	AT+FWCODE=?
Execution Example	Send: AT+FWCODE=? Response: FWCODE=7 570 -0- 10
Feature Description	● Major version number: 7570 ● Branch number: 0 ● Minor version number: 10 (incrementing from 10)

7.1.5 Enable AT+SWITCH software switching of working mode

Instruction format	AT+SWITCH=<on_off>
Setup Example	Send: AT+SWITCH=0 Response: =OK
Query Example	Send: AT+SWITCH=? Response: AT+SWITCH=0
Parameter Description	**<on_off>** : Switch 0. Off (default) 1. Turn on
Feature Description	● The factory default setting is off; use the M0M1 pin to switch the operating mode (hard-switching). ● After activation, the M0M1 pin remains usable; hard switching/soft switching is determined by the last trigger. ● A restart is required for the changes to take effect after activation. ● Once enabled, you can use AT+MODE to specify the working mode (soft cut), and the working mode number will be saved immediately after each soft cut. ● After a power outage and restart, the last soft-swap save mode number will be used as the initial working mode. ● After being shut down, the system will use the M0 or M1 hardware modes as the initial operating modes upon power failure and restart.

7.1.6 AT+MODE Software Switching for Operating Mode

Instruction format	AT+MODE=<mode>
Setup Example	Send: AT+MODE=0 Response: AT+MODE=0
Query Example	Send: AT+MODE=? Response: AT+MODE=0
Parameter Description	**<mode>** : Working mode number 0 Transmission Mode 1. Wake-up over the Air (WOR) Mode 2 Configuration Mode 3. Sleep Mode
Feature Description	● It can only be used after enabling via AT+SWITCH. ● Can be used in any working mode ● The actual mode switch will only begin after the user responds (=OK). Please wait approximately 15ms before proceeding to the next step. ● Please read the AT+SWITCH feature description. ● For detailed information on switching time, please see Chapter 5.

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7.1.7 AT+UAUX Wireless AUX Indicator Enable

Instruction format	AT+UAUX=<on_off>
Setup Example	Send: AT+UAUX=0 Response: =OK
Query Example	Send: AT+UAUX=? Response: AT+UAUX=0
Parameter Description	**<on_off>** : Switch 0. Off (default) 1. Turn on
Feature Description	● AUX is disabled by default, and it does not indicate the wireless transmission process (to help some users transmit data packets faster). Enable it to ensure compatibility with previous versions of AUX timing. ● For detailed AUX timing output specifications, please refer to Chapter 5.

7.1.8 AT+ADDR Communication Address (Match Filtering)

Instruction format	AT+ADDR=<address>
Setup Example	Send: AT+ADDR=0 Response: =OK
Query Example	Send: AT+ADDR=? Response: AT+ADDR=0
Parameter Description	**<address>** : Communication address 0 - 65535
Feature Description	● Default address 0 ● The address is not a radio frequency characteristic; it is merely an identifier carried within the data packet to help the receiving software logic determine whether to perform match filtering. ● The broadcast address is 65535. As a receiver, it can receive data from any address on the same channel (without filtering). As a sender, the data packets it sends carry the broadcast address, so the recipient will not filter them (broadcast data).

7.1.9 AT+NETID Communication Network Code (Matching Filtering)

Instruction format	AT+NETID=<net>
Setup Example	Send: AT+NETID=0 Response: =OK
Query Example	Send: AT+NETID=? Response: AT+NETID=0
Parameter Description	**<net>** : Communication network code 0-255
Feature Description	● Default network 0 ● Network codes are not radio frequency characteristics; they are merely identifiers carried within data packets to help the receiving software logic determine whether to perform relay forwarding or filtering. ● Network code filtering has a lower priority than broadcast address filtering. Even if the network codes are different, broadcast data can still be received.

7.1.10 AT+CHANNEL Communication Channel (Carrier Frequency)

Instruction format	AT+CHANNEL=<ch>		
Setup Example	Send: AT+CHANNEL=0 Response: =OK		
Query Example	Send: AT+CHANNEL=? Response: AT+CHANNEL=0		
Parameter Description	**<ch>** : Communication channel 0-55 **E22 P - 433 T30 S**	**<ch>** : Communication channel 0-50 **E22 P - 868 T30S**	**<ch>** : Communication channel 0-130 **E22-915 T30S**
Feature Description	● The channel range varies depending on the frequency band; please pay attention to the differences. ● The actual frequency of the 433MHz band = 429.0 + CH * 0.2M		

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	● The actual frequency of the 868MHz band = 863.3 + CH * 0.2M ● The actual frequency of the 915MHz band = 902.0 + CH * 0.2M

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7.1.11 AT+KEY Communication Password (Data Encryption)

Instruction format	AT+KEY=<key>
Setup Example	Send: AT+KEY=0 Response: =OK
Parameter Description	**<key>** : Encryption/decryption password 0 - 65535
Feature Description	● Default 0 ● Unable to query (password cannot be read) ● Modules with inconsistent passwords cannot communicate (they cannot decode the correct data packets, fail verification, and are discarded).

7.1.12 AT+UART Serial Port Baud Rate and Checksum

Instruction format	AT+UART=<baud>,<parity>
Setup Example	Send: AT+UART=3,0 Response: =OK
Query Example	Send: AT+UART=? Response: AT+UART=3,0
Parameter Description	**<baud>** : Serial port baud rate 0 1200bps 1 2400bps 2 4800bps 3 9600bps (default) 4 19200bps 5 38400bps 6 57600bps 7 115200bps **<parity>** : Serial port verification type 0 No validation None (default) 1 Odd parity 2 Even parity
Feature Description	● In configuration mode (M0M1 Mode 2), force fix 9600 8N1. ● The change will take effect after switching working modes.

7.1.13 AT+PACKET Serial Port Packing Length

Instruction format	AT+PACKET=<len>
Setup Example	Send: AT+PACKET=0 Response: =OK
Query Example	Send: AT+PACKET=? Response: AT+PACKET=0
Parameter Description	**<len>** : Serial port data packet length 0 240 bytes (default) 1 128 bytes 2 64 bytes 3 32 bytes
Feature Description	● If the user-input data is less than the set length during serial port reception, it will be handled as a timeout frame break, then packaged and transmitted wirelessly. ● During serial port reception, when the user-input data reaches the set length, it will be immediately packaged and wirelessly transmitted. ● Data exceeding the set length will continue to accumulate in the serial port buffer. After wireless transmission is complete, it will be split into packets according to the set length and transmitted in a cyclical manner.

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7.1.14 AT+URXT Serial Port Frame Drop Conditions

Instruction format	AT+URXT=<byte>
Setup Example	Send: AT+URXT=3 Response: =OK
Query Example	Send: AT+URXT=? Response: AT+URXT=3
Parameter Description	**<byte>** : byte time 1 - 255
Feature Description	● By default, serial port timeout frame interruption is handled based on 3-byte intervals. ● The time (per byte) varies at different baud rates. At a baud rate of 9600, it's approximately 1 millisecond per byte; at a baud rate of 115200, it's approximately 100 microseconds per byte. ● When some customers input data from their external microcontrollers via serial ports to the module, the data is discontinuous (e.g., due to RTOS task interruption), exceeding the module's set byte time window. Therefore, the data is processed as fragmented frames, which manifests as segmented data packets at the receiving end.

7.1.15 AT+RATE Wireless Transmit/Receive Rate

Instruction format	AT+RATE=<rate>
Setup Example	Send: AT+RATE=2 Response: =OK
Query Example	Send: AT+ RATE =? Response: AT + RATE = 2
Parameter Description	**<rate>** : air speed **E22- 230 T30D , E22- 230 T30 S, E22- 230 T30D , E22- 230 T30 S** 0 1.75Kbps 1 1.75Kbps 2 1.75Kbps 3 1.75Kbps (default) 4 3.1Kbps 5 5.4Kbps 6 9.3Kbps 7 15.6Kbps
Feature Description	● The airspeed range varies depending on the frequency band; please pay attention to the differences. ● The higher the air speed, the lower the communication latency (shorter transmission time), but the worse the receiving sensitivity (shorter communication distance).

7.1.16 AT+TRANS Wireless Transmission Method (Pass-through/Fixed Point)

Instruction format	AT+TRANS=<mode>
Setup Example	Send: AT+TRANS=0 Response: =OK
Query Example	Send: AT+TRANS=? Response: AT+TRANS=0
Parameter Description	**<mode>** : Transmission mode 0 Transparent transmission (default) 1. Fixed-point transmission
Feature Description	● Point-to-point transmission processes the first three bytes of user input data specially. The first and second bytes are identified as the target communication address, and the third byte is identified as the target communication channel (automatic channel switching). ● After the fixed-point transmission completes the data transmission, it automatically switches back to the original channel.

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7.1.17 AT+LBT Listen Before Activation Enable (Avoidance)

Instruction format	AT+LBT=<on_off>
Setup Example	Send: AT+LBT=0 Response: =OK
Query Example	Send: AT+LBT=? Response: AT+LBT=0
Parameter Description	**<on_off>** : Switch 0. Off (default) 1. Turn on
Feature Description	● When the LBT (Listen Before Talk) function is enabled, it will check whether the ambient signal strength is lower than a set threshold before each wireless data transmission. If the condition is met within the timeout period, wireless transmission will actually start. If the condition is still not met after the maximum timeout period, wireless transmission will be forcibly started. ● For specific LBT settings, please refer to the AT+LBR command.

7.1.18 AT+LBR Listen Before Send Judgment Condition

Instruction format	AT+LBR=<rssi>,<timeout>
Setup Example	Send: AT+LBR=-55,2000 Response: =OK
Query Example	Send: AT+LBR=? Response: AT+LBR=-55,2000
Parameter Description	**<rssi>** : Signal strength threshold (dBm) 0 - (-128) **<timeout>** : Maximum timeout (milliseconds) 0 - 65535
Feature Description	

7.1.19 AT+ROUTER Relay Forwarding

Instruction format	AT+ROUTER=<on_off>
Setup Example	Send: AT+ROUTER=0 Response: =OK
Query Example	Send: AT+ROUTER=? Response: AT+ROUTER=0
Parameter Description	**<on_off>** : Switch 0. Off (default) 1. Turn on
Feature Description	● After activation, please refer to Chapter 5 for instructions on relay networking modes. ● Relaying essentially involves forwarding received wireless data again, thus doubling the air transmission time (delay). ● Relays operate on a half-duplex basis; please allow sufficient time for the relay to complete its forwarding process. If a user sends data to the relay during the forwarding process, data packet loss will occur.

7.1.20 AT+WOR Air Wake-up Character (Send/Receive)

Instruction format	AT+WOR=<role>
Setup Example	Send: AT+WOR=0 Response: =OK
Query Example	Send: AT+WOR=? Response: AT+WOR=0
Parameter Description	**<role>** **:** character 0. Receiver (default)

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	1. Sender
Feature Description	● The receiver operates in a low-power mode, while the sender operates at normal power. ● The receiver will enter sleep mode according to a pre-defined over-the-air wake-up cycle to reduce power consumption, and will be unable to receive wireless signals during this period. After the sleep period countdown ends, the RF unit will briefly wake up and enter receiving mode. If a wake-up signal is detected during the window, it will enter normal continuous receiving mode and wait for subsequent wireless data. If no wake-up signal is detected, it will enter the next sleep-wake cycle. ● The sender inserts a wake-up code before the user data according to the set over-the-air wake-up cycle, that is, it wakes up the receiver first and then transmits the data, thus resulting in a longer transmission time (delay).

7.1.21 AT+WTIME Over-the-Air Wake-up Cycle

Instruction format	**AT+WTIME=<timeout>**
Setup Example	Send: AT+WTIME=3 Response: =OK
Query Example	Send: AT+WTIME=? Response: AT+WTIME=3
Parameter Description	**<timeout>** : Sleep time 0 500ms 1 1000ms 2 1500ms 3 2000ms (default) 4 2500ms 5 3000ms 6 3500ms 7 4000ms
Feature Description	● The longer the receiver's sleep time during over-the-air wake-up, the lower the average power consumption, but the greater the communication latency.

7.1.22 AT+DELAY Wake-up Signal: Receiver's response time

Instruction format	**AT+DELAY=<timeout>**
Setup Example	Send: AT+DELAY=0 Response: =OK
Query Example	Send: AT+DELAY=? Response: AT+DELAY=0
Parameter Description	**<timeout>** : Response window time (milliseconds) 0 - 65535
Feature Description	● The default value is 0, meaning that after the receiver receives wireless data and outputs it via serial port, it immediately enters sleep mode. ● After setting the time (e.g., 1000 milliseconds), the over-the-air wake-up receiver will maintain a normal wake-up state for the set time after receiving wireless data and outputting it via serial port. Users can send response data to the module and transmit it within this window.

7.1.23 AT+ERSSI Ambient Signal Strength

Instruction format	**AT+ERSSI=<on_off>**
Setup Example	Send: AT+ERSSI=0 Response: =OK
Query Example	Send: AT+ERSSI=? Response: AT+ERSSI=0
Parameter	**<on_off>** : Switch

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Description	0. Off (default) 1. Turn on
Feature Description	● RSSI Ambient Noise Enable " section in the register description description chapter and use hexadecimal instructions to read the data.

7.1.24 AT+DRSSI Received Data Packet Signal Strength

Instruction format	**AT+DRSSI=<on_off>**
Setup Example	Send: AT+DRSSI=0 Response: =OK
Query Example	Send: AT+ERSSI=? Response: AT+ERSSI=0
Parameter Description	**<on_off>** : Switch 0. Off (default) 1. Turn on
Feature Description	● When enabled, signal strength data (1 byte, hexadecimal, signed number) will be appended to the end of the received data packet. ● Conversion Example: Assuming the obtained additional signal strength data is 0xC4 (-60dBm), the hexadecimal value 0xC4 is 196 in decimal. The conversion formula is: RSSI = -(256 - 196) = -60 ● If the distance between the sender and receiver is too short or the sender's power is too high, the received signal strength may be 0 (upper limit), please directly convert it to 0dBm.

7.1.25 AT+POWER Power Classification

Instruction format	AT+POWER = **<Power>**
Setup Example	Send: AT+POWER=0 Response: AT+POWER=0
Query Example	Send: AT+POWER=? Response: AT+POWER=0
Parameter Description	**<Power>** : Power **E22P - 433T30S , E22P - 868T30S , E22P - 915T30S ,** 0 30dBm (default) 1 27dBm 2 24dBm 3 21dBm
Feature Description	-

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7.2 Signaling testing (certification)

7.2.1 Test Instruction Declaration

The AT command testing section is intended for use only as an aid in product certification (e.g., CE, FCC certification) and should not be used for other purposes.

E-Best assumes no liability for any damages arising from failure to comply with relevant operating or design specifications. E-Best endeavors to ensure the completeness, accuracy, and timeliness of features under development, but does not exclude the possibility of errors or omissions in such features. Unless otherwise agreed, no implied or statutory warranties are made regarding the use of features under development. To the maximum extent permitted by applicable law, E-Best shall not be liable for any damages suffered as a result of using features under development, whether or not such damages were foreseeable.

7.2.2 Test Command List

- Detailed instructions and documentation can be obtained through Ebitech's sales channels.

AT commands	Function Summary
AT+FPOWER	Fine-tuning of transmit power
AT+XCAP	Crystal oscillator calibration
AT+ULORAM	LoRa modulation parameters modification (SF spreading factor, BW transmit bandwidth, CR coding rate)
AT+OPTIMIZE	Low-rate optimization options
AT+UFREQ	Carrier frequency adjustment (starting frequency, channel spacing)
AT+SWAVE	Fixed-frequency continuous single-carrier transmission
AT+MWAVE	Fixed-frequency continuous modulation wave transmission
AT+TFHSS	Frequency hopping modulated wave transmission
AT+DUTYTX	Fixed-frequency continuous single-carrier/modulated wave duty cycle transmission

8 Hardware Design

- It is recommended to use a DC regulated power supply to power this module, with the power supply ripple coefficient as small as possible, and the module must be reliably grounded;
- Please ensure the correct connection of the power supply positive and negative terminals. Reversing the connection may cause permanent damage to the module.
- Please check the power supply and ensure it is within the recommended voltage range. Exceeding the maximum value will cause permanent damage to the module.
- Please check the power supply stability; the voltage should not fluctuate significantly or frequently.
- When designing power supply circuits for modules, it is often recommended to retain a margin of more than 30% to ensure long-term stable operation of the entire unit.
- The module should be kept as far away as possible from power supplies, transformers, high-frequency traces, and other parts with high electromagnetic interference.
- High-frequency digital traces, high-frequency analog traces, and power traces must avoid the area under the module. If it is absolutely necessary to run under the module, assuming the module is soldered on the Top Layer, lay ground copper on the Top Layer of the module contact area (all copper and well grounded), and run the traces close to the digital part of the module on the Bottom Layer.
- Assuming the module is soldered or placed in the Top Layer, it is also wrong to arbitrarily route traces in the Bottom Layer or other layers, as this will affect the module's stray emissions and reception sensitivity to varying degrees.

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- If there are devices around the module that cause significant electromagnetic interference, it will greatly affect the module's performance. Depending on the intensity of the interference, it is recommended to keep them away from the module. If possible, appropriate isolation and shielding can be implemented.
- If there are traces around the module that cause significant electromagnetic interference (high-frequency digital, high-frequency analog, power supply traces), it will greatly affect the module's performance. Depending on the intensity of the interference, it is recommended to keep them away from the module. If possible, appropriate isolation and shielding can be implemented.
- The antenna mounting structure has a significant impact on module performance; it is essential to ensure that the antenna is exposed and preferably vertically upward.
- When the module is installed inside the housing, a high-quality antenna extension cable can be used to extend the antenna to the outside of the housing.
- Antennas should never be installed inside a metal casing, as this will greatly reduce the transmission distance.

9 Frequently Asked Questions

9.1 Transmission distance is not ideal

- When there are obstacles in line-of-sight communication, the communication distance will be reduced accordingly;
- Temperature, humidity, and co-channel interference can all lead to increased packet loss rates in communications.
- The ground absorbs and reflects radio waves, and the test results are poor when the ground is close to the ground.
- Seawater has a strong ability to absorb radio waves, so testing results are poor at the seaside.
- If there are metal objects near the antenna, or if it is placed inside a metal casing, the signal attenuation will be very severe.
- Power register settings are incorrect; air speed is set too high (the higher the air speed, the shorter the distance).
- At room temperature, the power supply voltage is lower than the recommended value; the lower the voltage, the lower the power output.
- The antenna may be poorly matched with the module or have quality issues.

9.2 Module is easily damaged

- Please check the power supply and ensure it is within the recommended voltage range. Exceeding the maximum value will cause permanent damage to the module.
- Please check the power supply stability; the voltage should not fluctuate significantly or frequently.
- Please ensure anti-static operation during installation and use, as high-frequency devices are sensitive to electrostatic discharge.
- Please ensure that the humidity is not too high during installation and use, as some components are humidity-sensitive.
- Unless there are special requirements, it is not recommended to use it at excessively high or low temperatures.

9.3 The bit error rate is too high.

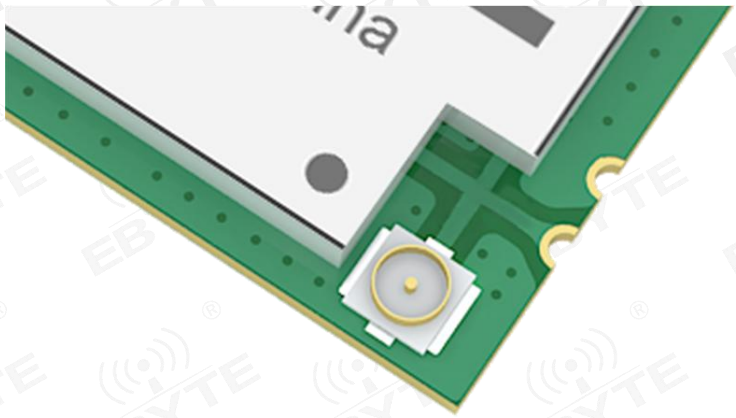
- If there is interference from a co-channel signal nearby, move away from the source of interference or change the frequency or channel to avoid the interference.

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- An inadequate power supply can also cause garbled characters, so it is essential to ensure the reliability of the power supply.
- Poor quality or excessive length of extension lines or feeders can also lead to a high bit error rate.

9.4 Antenna Selection



Both the IPEX interface and the stamp hole interface are enabled simultaneously; either the IPEX interface or the stamp hole interface can be selected arbitrarily.

10 Welding Operation Instructions

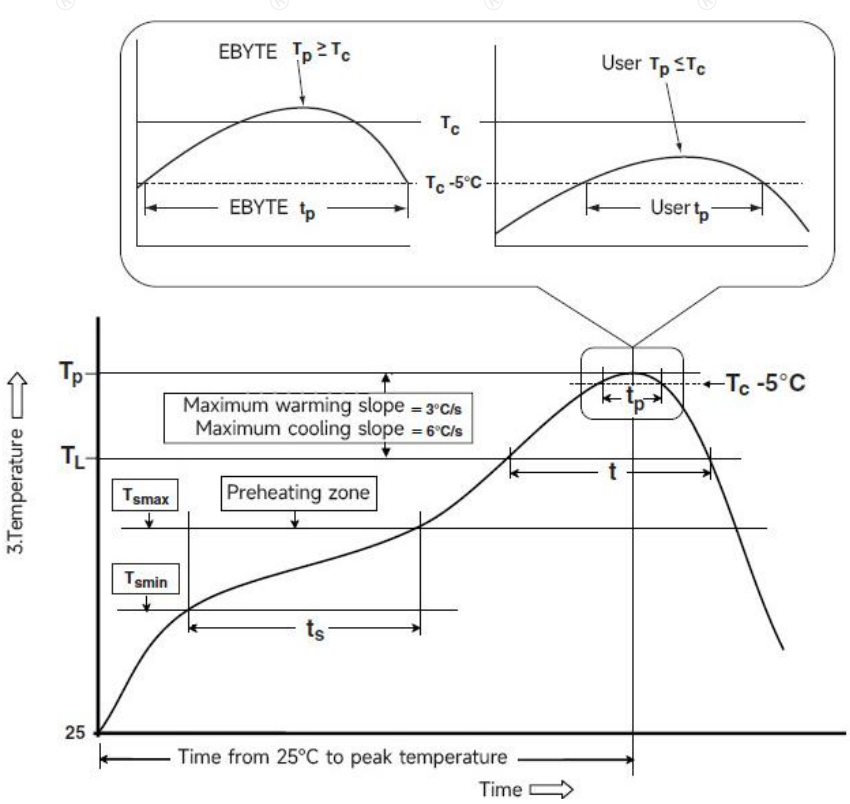
10.1 Reflow soldering temperature

Reflow soldering profile characteristics		Lead-based assembly	Lead-free assembly
Preheating/Insulation	Minimum temperature (Tsmin)	100℃	150℃
	Maximum temperature (T _{smax})	150℃	200℃
	Time (T smin ~ T smin)	60-120 seconds	60-120 seconds
Temperature rise slope (TL ~ Tp)		3℃/second, maximum value	3℃/second, maximum value
Liquid phase temperature (TL)		183℃	217℃
T L above the holding time		60~ 90 seconds	60~ 90 seconds
Package peak temperature Tp		Users must not exceed the temperature specified on the product's "humidity sensitivity" label.	Users must not exceed the temperature specified on the product's "humidity sensitivity" label.
Tp) within 5°C of the specified grading temperature (Tc) is shown in the figure below.		20 seconds	30 seconds
Cooling slope (Tp ~ TL)		6℃/second, maximum value	6℃/second, maximum value
Time from room temperature to peak temperature		6 minutes, the longest	8 minutes, the longest
* The peak temperature (Tp) tolerance of the temperature profile is defined as the user's upper limit.			

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10.2 Reflow Soldering Profile



11 Related Models

Product Model	Carrier frequency Hz	Transmit power dBm	Test distance (km)	Packaging	Product dimensions (mm)	Communication interface
E22-400M22S	433/470M	22	7	SMD	14*20	SPI
E22-400M30S	433/470M	30	12	SMD	24*38.5	SPI
E22-900M22S	868/915M	22	7	SMD	14*20	SPI
E22-900M30S	868/915M	30	12	SMD	24*38.5	SPI

12 Antenna Guide

12.1 Antenna Recommendation

Antennas play a crucial role in communication, and inferior antennas can often have a significant impact on communication systems. Therefore, our company recommends certain antennas that are high-performing and reasonably priced and compatible with our wireless modules.

Product Model	Type	Frequency band (Hz)	Interface	Gain (dBi)	Height (mm)	Feeder (cm)	Features

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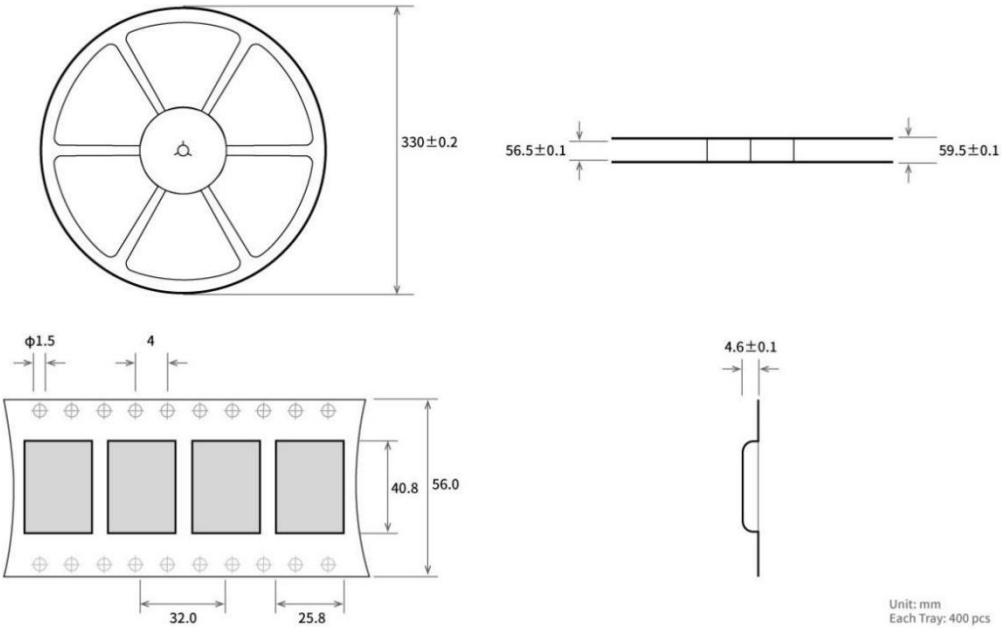
Product Model	Type	Frequency band (Hz)	Interface	Gain (dBi)	Height (mm)	Feeder (cm)	Features
TX433-JZG-6	Rubber antenna	433M	SMA-J	2.5	62	-	Ultra-short straight omnidirectional antenna
TX433-JW-5	Rubber antenna	433M	SMA-J	2.0	50	-	Bending a rubber rod, omnidirectional antenna
TX433-JWG-7	Rubber antenna	433M	SMA-J	2.5	75	-	Bending a rubber rod, omnidirectional antenna
TX433-JK-11	Rubber antenna	433M	SMA-J	2.5	110	-	Bendable rubber rod, omnidirectional antenna
TX433-XPL-100	Suction Cup Antenna	433M	SMA-J	3.5	185	100	Miniature suction cup antenna, cost-effective
TX433-XP-200	Suction Cup Antenna	433M	SMA-J	4.0	190	200	Neutral suction cup antenna, low loss
TX433-XPH-300	Suction Cup Antenna	433M	SMA-J	6.0	965	300	Large suction cup antenna, high gain
TX490-JZ-5	Rubber antenna	470/490M	SMA-J	2.0	50	-	Ultra-short straight omnidirectional antenna
TX490-XPL-100	Suction Cup Antenna	470/490M	SMA-J	3.5	120	100	Miniature suction cup antenna, cost-effective
TX868-JKS-IPX20	Rubber antenna	868M	IPEX-1	3.0	197	200	Bendable rubber rod, omnidirectional antenna
TX868-JZLW-15	Rubber antenna	868M	IPEX-1	3.0	165	150	Bendable rubber rod, omnidirectional antenna
TX868-XPL-100	Suction Cup Antenna	868M	SMA-J	3.5	290	100	Miniature suction cup antenna, cost-effective
TX868-JKD-20	Rubber antenna	868M	SMA-J	3.0	170	-	Bendable rubber rod, omnidirectional antenna
TX915-JKS-IPX20	Rubber antenna	915M	IPEX-1	3.0	197	200	Bendable rubber rod, omnidirectional antenna
TX915-JZLW-15	Rubber antenna	915M	IPEX-1	3.0	1 5 5	150	Bendable rubber rod, omnidirectional antenna
TX915-JKD-20	Rubber antenna	915M	SMA-J	3.5	200	-	Bendable rubber rod, omnidirectional antenna
TX915-XPL-100	Suction Cup Antenna	915M	SMA-J	3.5	260	100	Miniature suction cup antenna, cost-effective

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13 Bulk Packaging Methods

13.1 E22P-433/868/915T30S Bulk Packaging Method



Revision History

Version	Revision Date	Revision Notes	Maintainer
1.0	2026-08-27	Initial version	Hao

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