E220-xxxTxxx User Manual

AT Command 20/30dBm LoRa Wireless Module

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Contents

1 Introduction

1.1 Brief Introduction

E220-xxxTxxx is a new generation of LoRa wireless module, this series (UART) module is developed based on SEMTECH high-performance RF chip, which has a maximum transmit power of 30dBm, multiple transmission modes, working frequency bands are in the 400 band and 900 band respectively, LoRa spread spectrum technology, TTL level output, and compatible with 3.3V IO port voltage.

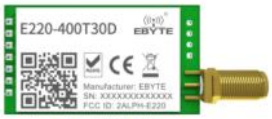
E220-xxxTxxx adopts the new generation of LoRa spread spectrum technology, faster speed, lower power consumption, smaller size; supports the functions of Wake-on-Air, Wireless Configuration, Carrier Listening, Communication Key, etc., supports the sub-packet length setting, and provides customized development services. The following eight modules have different power, different frequency bands and different packages, only for the appearance of the schematic diagram.

E220-400T22D

E220-400T22S

E220-900T22D

E220-900T22S



E220-400T30D

E220-400T30S

E220-900T30D

E220-900T30S

1.2 Features

- Adopts the new generation of LoRa spread spectrum modulation technology, which brings longer communication distance and stronger anti-interference ability;
- Supports serial port to upgrade firmware, which makes updating firmware more convenient;
- Supports AT command, which is more convenient to use;
- Supports users to set their own communication key and cannot be read, which greatly improves the confidentiality of user data;
- Supports RSSI signal strength indication function, which is used for evaluating signal quality, improving communication network, and ranging;
- Supports Wake-on-Air, i.e., ultra-low power consumption function, which is suitable for battery-powered application solutions;
- Supports fixed-point transmission, broadcast transmission, and channel listening;
- Communication distance up to 10km under ideal conditions;
- Parameters are saved when power down, and the module will work according to the set parameters after power up again;
- High-efficiency watchdog design, once an exception occurs, the module will be in the automatic restart, and can continue to continue to work in accordance with the previous parameter settings;

- Support 2.4K ~ 62.5Kbps data transfer rate;
- Supports 2.7~5.5V power supply, ≥ 5V power supply can ensure the best performance;
- Industrial-grade standard design, support -40 ~ +85 ℃ long time use;
- Module power can be up to 1W (30dBm), transmission farther and more stable.

1.3 Application

- Home security alarms and remote keyless entry;
- Smart home as well as industrial sensors and more;
- Wireless alarm security systems;
- Building automation solutions;
- Wireless industrial grade remote controls;
- Healthcare products;
- Advanced Meter Reading Architecture (AMI).

2 Specification

2.1 400MHz band module RF parameters

RF parameters	unit	Model Number				Remark
		E220-400T22S	E220-400T22D	E220-400T30S	E220-400T30D	
Maximum Transmit Power	dBm	22	22	30	30	-
reference distance	m	5000	5000	10000	10000	Clear and open, antenna gain 5dBi, antenna height 2.5 meters, air rate 2.4kbps.
Operating Frequency Bands	MHz	410.125～493.125				Supports ISM bands
Air Rate	bps	2.4K～62.5K				User Programmed Controls
Receiving Sensitivity	dBm	-124dBm,BW_L=125kHz,SF = 7,LORA™; -129dBm,BW_L=125kHz,SF = 9,LORA™; -121dBm,BW_L=250kHz,SF = 7,LORA™; -129dBm,BW_L=250kHz,SF = 10,LORA™; -117dBm,BW_L=500kHz,SF = 7,LORA™; -127dBm,BW_L=500kHz,SF = 11,LORA™;				Air rate of 2.4kbps at -129dBm typical

2.2 900MHz band module RF parameters

RF parameters	unit	Model Number				Remark
		E220-900T22S	E220-900T22D	E220-900T30S	E220-900T30D	
Maximum Transmit Power	dBm	22	22	30	30	-
reference distance	m	5000	5000	10000	10000	Clear and open, antenna gain 5dBi, antenna height 2.5 meters, air rate 2.4kbps.
Operating Frequency Bands	MHz	850.125～930.125MHz				Support European and American frequency band 868/915MHz
Air Rate	bps	2.4K～62.5K				User Programmable Controls
Receiving Sensitivity	dBm	-124dBm,BW_L=125kHz,SF = 7,LORA™; -129dBm,BW_L=125kHz,SF = 9,LORA™; -121dBm,BW_L=250kHz,SF = 7,LORA™; -129dBm,BW_L=250kHz,SF = 10,LORA™; -117dBm,BW_L=500kHz,SF = 7,LORA™; -127dBm,BW_L=500kHz,SF = 11,LORA™;				Air rate of 2.4kbps at -129dBm typical

2.3 Electrical parameters

Electrical parameters		unit	Model Number				Remark
			E220-400T22S E220-900T22S	E220-400T22D E220-900T22D	E220-400T30S E220-900T30S	E220-400T30D E220-900T30D	
Operating Voltage		V	2.7～5.5	2.7～5.5	2.7～5.5	2.7～5.5	Output power is guaranteed at ≥5V, above 5.5V the module is permanently fried.
Communication level		V	3.3	3.3	3.3	3.3	Risk of burn-in using 5V TTL.
power wastage	Transmit Current	mA	110	110	600	600	momentary power consumption
	Receive Current	mA	8	8	14	14	-

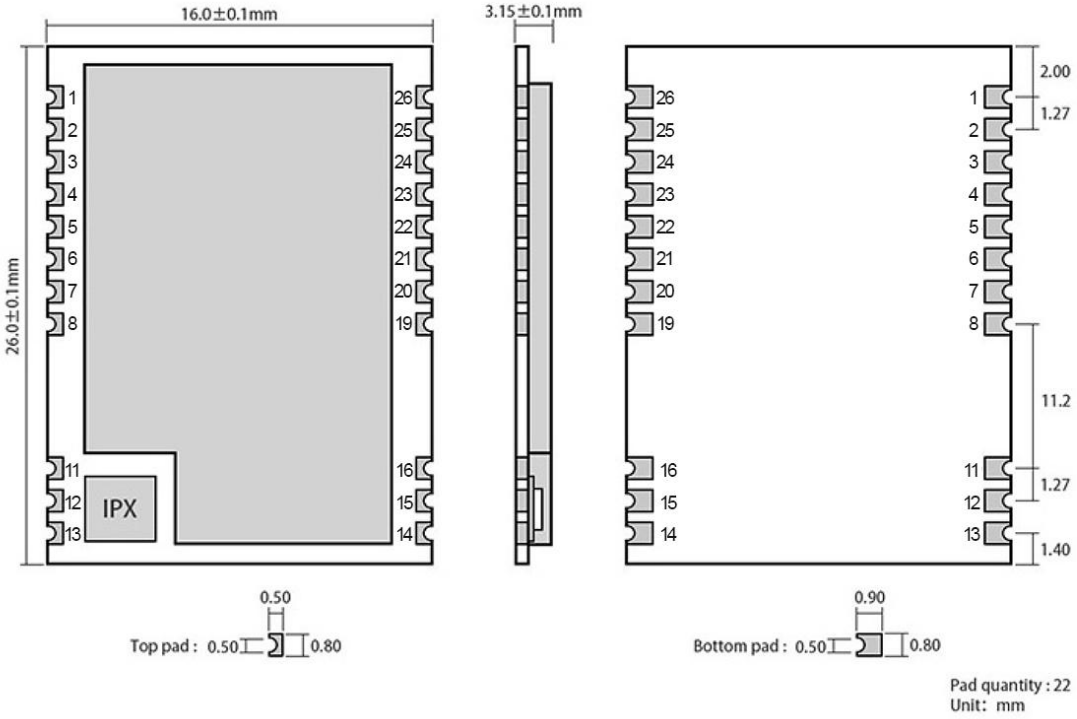
	Sleep Current	uA	3	3	2	2	software shutdown
temperature	Operating Temperature	℃	-40～+85				Industrial-grade design
	Storage Temperature	℃	-40～+85				Industrial-grade design

2.4 Hardware parameters

Hardware parameters	model number				Remark
	E220-400T22S E220-900T22S	E220-400T22D E220-900T22D	E220-400T30S E220-900T30S	E220-400T30D E220-900T30D	
Crystal Frequency	32MHz	32MHz	32MHz	32MHz	Industrial Grade High Precision Crystals
Modulation mode	LoRa	LoRa	LoRa	LoRa	Next-generation LoRa modulation technology
Interface Mode	1.27mm Stamp Hole	2.54mm Pin Header	1.27mm Stamp Hole	2.54mm Pin Header	
Communication Interface	UART Serial Port	UART Serial Port	UART Serial Port	UART Serial Port	TTL level
Transmit length	200 Byte	200 Byte	200 Byte	200 Byte	Packetized 32/64/128/200 byte transmission can be set by command.
Package	SMD	DIP	SMD	DIP	-
Cache Capacity	400Byte	400Byte	400Byte	400Byte	-
Antenna Interface	IPEX/Stamp Holes	SMA-K	IPEX/Stamp Holes	SMA-K	Equivalent impedance about 50Ω
Dimension	16*26mm	21*36mm	24*43mm	40.5*25 mm	±0.2mm
Net Weight	1.95g	6.5g	5.8g	11g	±0.2g

3 Mechanical Dimensions and Pin Definitions

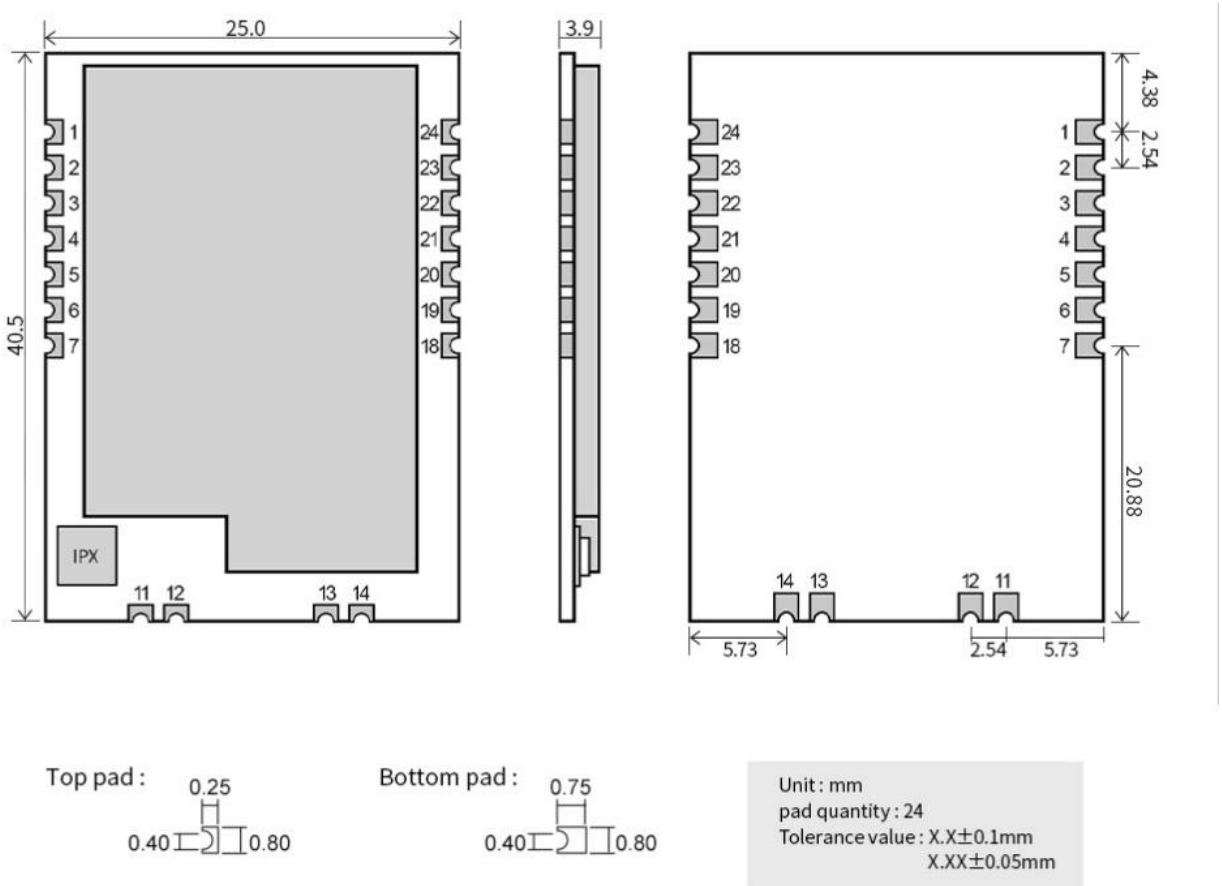
3.1 E220-400/900T22S Mechanical Dimensions and Pin Definitions



Pin No.	Name	Pin Direction	Pin Usage
1	NC	-	Empty Pin
2	GND	-	Module Ground
3	NC	-	Empty Pin
4	NC	-	Empty Pin
5	NC	-	Empty foot
6	NC	-	Empty foot
7	NC	-	Empty Foot
8	GND	-	Module Ground
11	GND	-	Module Ground
12	ANT	-	Antenna
13	GND	-	Modular Ground
14	GND	-	Modular Ground

15	GND	-	Modular Ground
16	GND	-	Modular Ground
19	GND	-	Module Ground
20	M0	Input (very weak pull-up)	In conjunction with M1, determines the 4 operating modes of the module (non-suspendable, can be grounded if not in use).
21	M1	Input (very weak pull-up)	In conjunction with M0, determines the 4 modes of operation of the module (not dangling, can be grounded if not in use)
22	RXD	Input	TTL serial input, connected to external TXD output pin;
23	TXD	Output	TTL serial output, connected to external RXD input pin;
24	AUX	Output	Used to indicate the working status of the module;
25	VCC	-	User wake-up external MCU, power-on self-test initialization period output low level; (can be suspended)
26	GND	-	Module power supply positive reference, voltage range: 2.3 ~ 5.5V DC

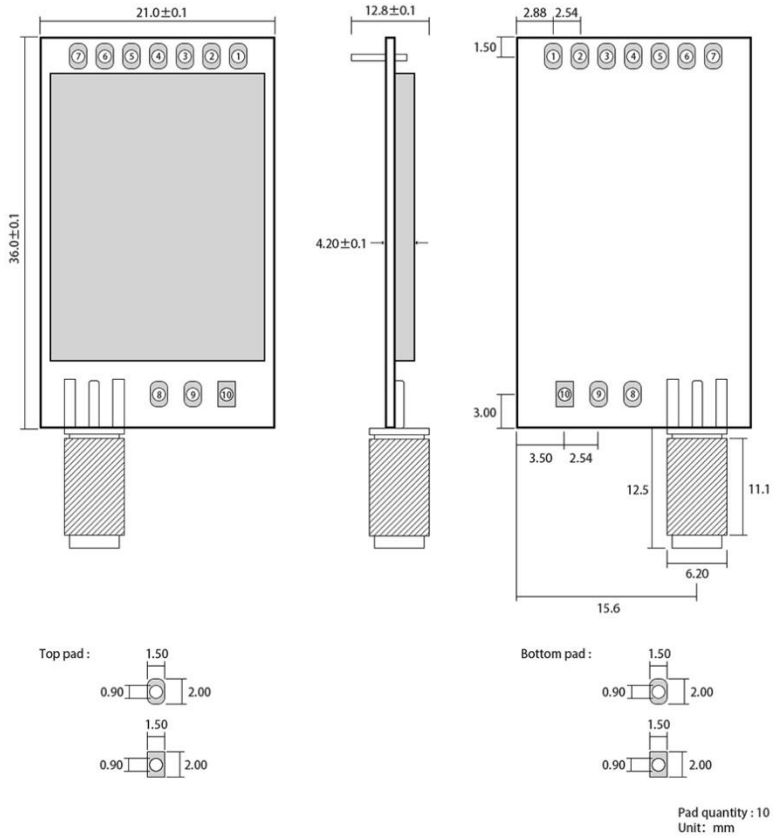
3.2 E220-400/900T30S Mechanical Dimensions and Pin Definitions



No.	Name	Pin Direction	Pin Usage

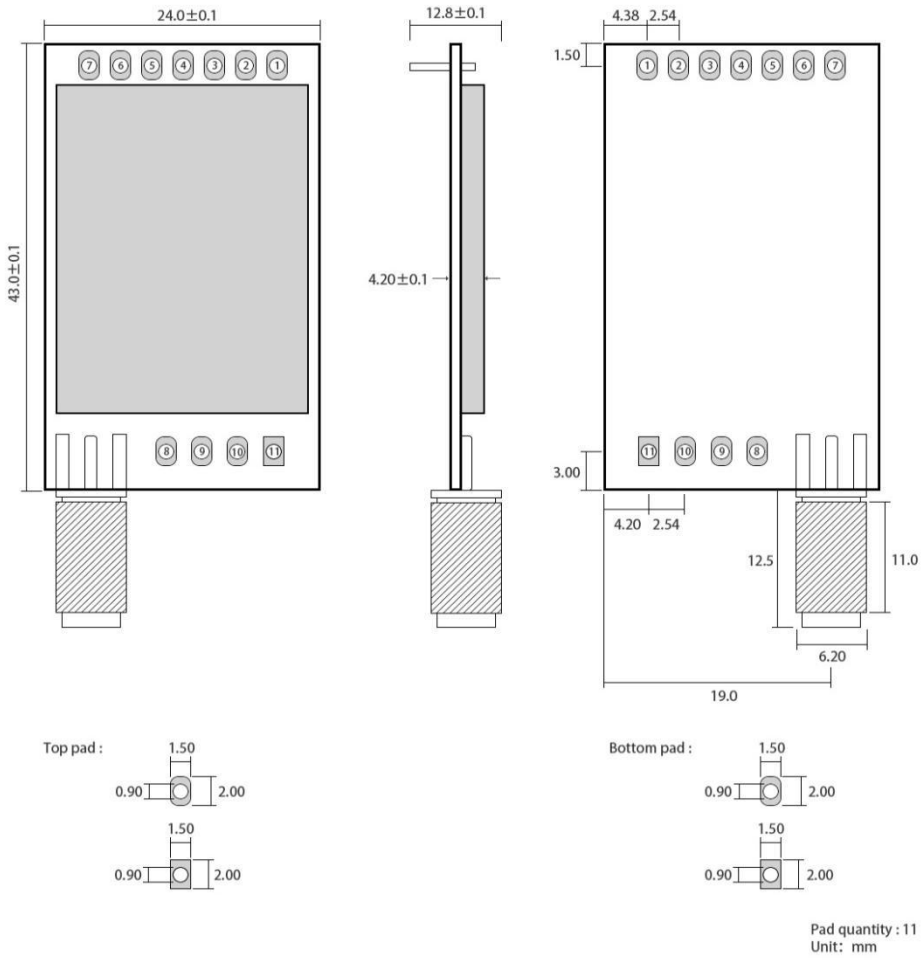
1	GND	Input	Module Ground
2	VCC	Input	Module power supply positive reference, voltage range: 3.3~5.5V DC
3	AUX	Outputs	Used to indicate the working status of the module; the user wakes up the external MCU and outputs a low level during power-on self-test initialization; (can be suspended)
4	TXD	Outputs	TTL serial output, connected to external RXD input pin;
5	RXD	Input	TTL serial input, connected to external TXD output pin;
6	M1	Input (very weak pull-up)	Works with M0 to determine the 4 modes of operation of the module (non-suspendable, can be grounded if not used)
7	M0	Input (very weak pull-up)	In conjunction with M1, determines the 4 modes of operation of the module (non-suspendable, can be grounded if not used)
11	ANT	Output	Antenna Interface (HF Signal Output, 50 Ohm Characteristic Impedance)
12	GND	-	Fixed Ground
13	GND	-	Fixed Ground
14	GND	-	Fixed Ground
18	NC	-	SWCLK Clock pin for program loading (left blank, no user connection required)
19	NC	-	SWDIO Data pin for program loading (left blank, no user connection needed)
20	NC	-	485_EN
21	NC	-	Internal 3.3V connection for download power; (Dangling, no user connection required)
22	RESET	Input	Module reset pin, low level trigger. It is recommended that customers use microcontroller connection to reset the processing and restore the work in case of accident.
23	GND	-	Fixed Ground
24	NC	-	Empty pin

3.3 E220-400/900T22D Mechanical Dimensions and Pin Definitions



No.	Name	Pin Direction	Pin Usage
1	M0	Input (very weak pull-up)	In conjunction with M1, determines the 4 operating modes of the module (non-hoverable, groundable if not in use)
2	M1	Input (very weak pull-up)	In conjunction with M0, determines the 4 modes of operation of the module (cannot be suspended, can be grounded if not in use)
3	RXD	Input	TTL serial input, connected to external TXD output pin;
4	TXD	Output	TTL serial output, connected to external RXD input pin;
5	AUX	Output	Used to indicate the working status of the module; the user wakes up the external MCU and outputs a low level during power-on self-test initialization; (can be suspended)
6	VCC	Input	Module power supply positive reference, voltage range: 3.0 to 5.5V (DC)
7	GND	Input	Module Ground
8	Fixed hole	-	Fixed Hole
9	Fixed hole	-	Fixed Hole
10	Fixed hole	-	Fixed Hole

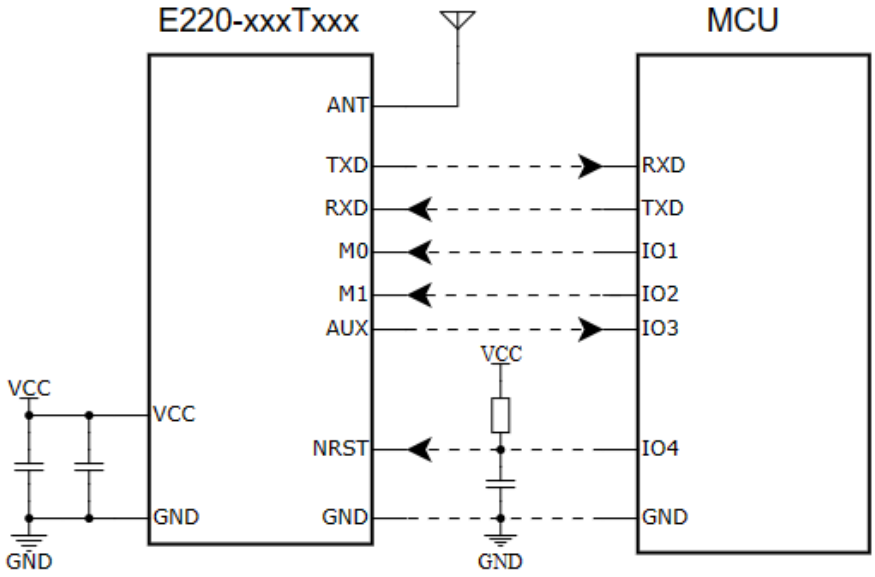
3.4 E220-400/900T30D Mechanical Dimensions and Pin Definitions



No.	Name	Pin Direction	Pin Usage
1	M0	Input (very weak pull-up)	In conjunction with M1, determines the 4 operating modes of the module (non-hoverable, groundable if not in use)
2	M1	Input (very weak pull-up)	In conjunction with M0, determines the 4 modes of operation of the module (cannot be suspended, can be grounded if not in use)
3	RXD	Input	TTL serial input, connected to external TXD output pin;
4	TXD	Output	TTL serial output, connected to external RXD input pin;
5	AUX	Output	Used to indicate the working status of the module; the user wakes up the external MCU and outputs a low level during power-on self-test initialization; (can be suspended)
6	VCC	Input	Module power supply positive reference, voltage range: 3.3~5.5V DC
7	GND	Input	Module Ground
8	Fixed hole	-	Fixing hole
9	Fixed	-	Fixed Hole

	hole		
10	Fixed hole	-	Fixed hole
11	Fixed hole	-	Fixed Hole

4 Recommended Connectivity Charts



No	Module and microcontroller brief connection description (the above figure takes STM8L microcontroller as an example)
1	The wireless serial module is TTL level, please connect with TTL level MCU.
2	For some 5V microcontrollers, it may be necessary to add 4 to 10K pull-up resistors to the TXD and AUX pins of the module.

5 Functions in detail

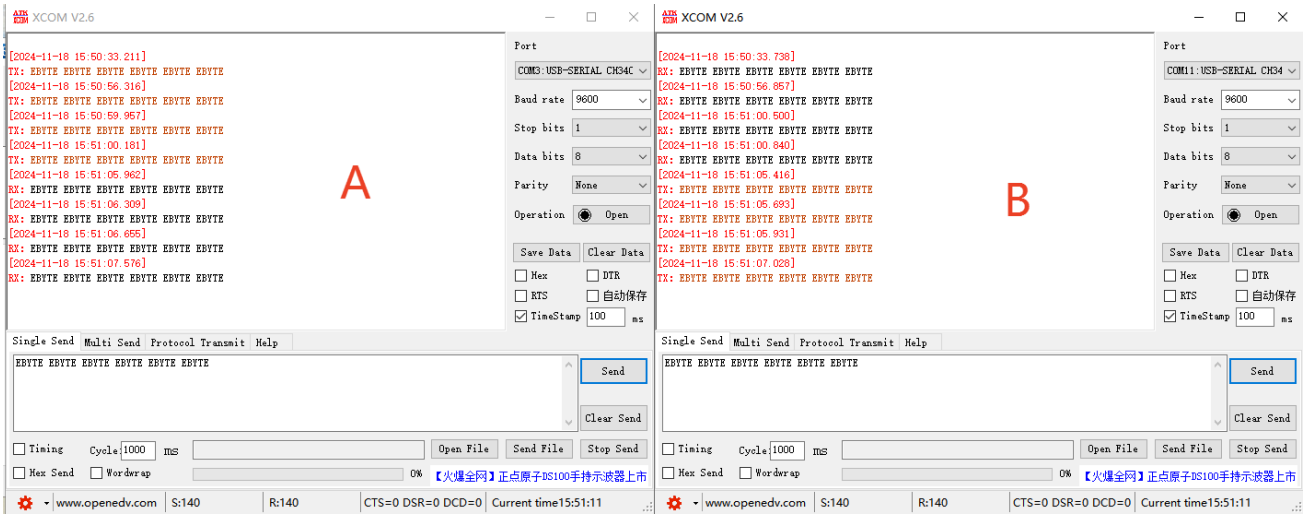
5.1 Working mode

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

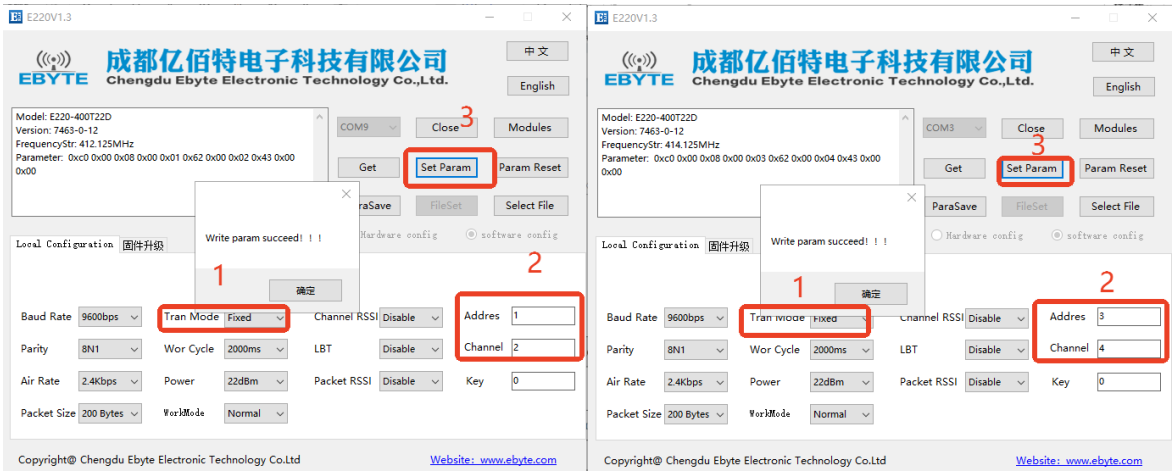
Mode（0-3）	M1	M0	Mode Introduction	Remark
0 Transmission Mode	0	0	Serial port open, wireless open, transparent transmission	—
1 WOR Transmit	0	1	WOR sends data, WOR receives data	Wake-on-Air support
Mode	1	0	WOR sends data off, WOR receives data	—
2 WOR Receive	1	1	Configurable parameters	—

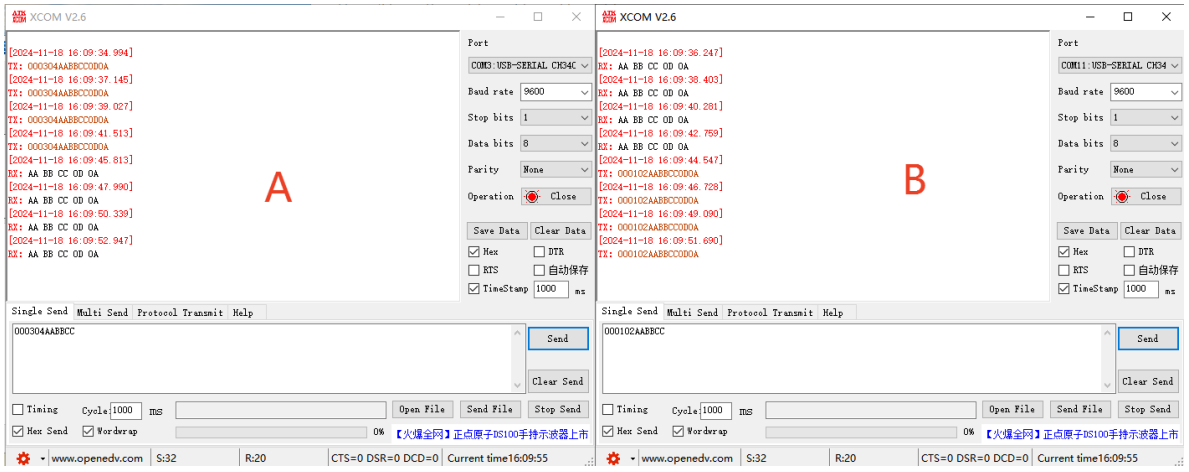
5.1.1 Transmission mode use (M1, M0 pins set to 0,0)

- Transparent Transmission Function: What you send is what you get, you can use the serial port assistant to communicate with each other (the factory default parameters are the same, and the transmission methods are transparent transmission), the examples are as follows:



- Fixed-point transmission function: Fixed data format for data sending and receiving, in the form of format: target address + target channel + data, effectively avoiding the occurrence of partial interference.

No	Steps in the use of spotting
1. Modify the parameters of the module through the upper computer: Modify the address and channel of the module under the configuration mode (M1,M0 pins are set to 1 and 1), change the transparent transmission mode to fixed-point transmission, and finally write the parameters to complete the	

modification.	
2. Module working mode is replaced by general mode: A module parameter is edited as 000304AABBCC and sent to B module, and similarly B module sends data as 000102AABBCC. (The format of transmission data in fixed point mode is: target address + target channel + data)	

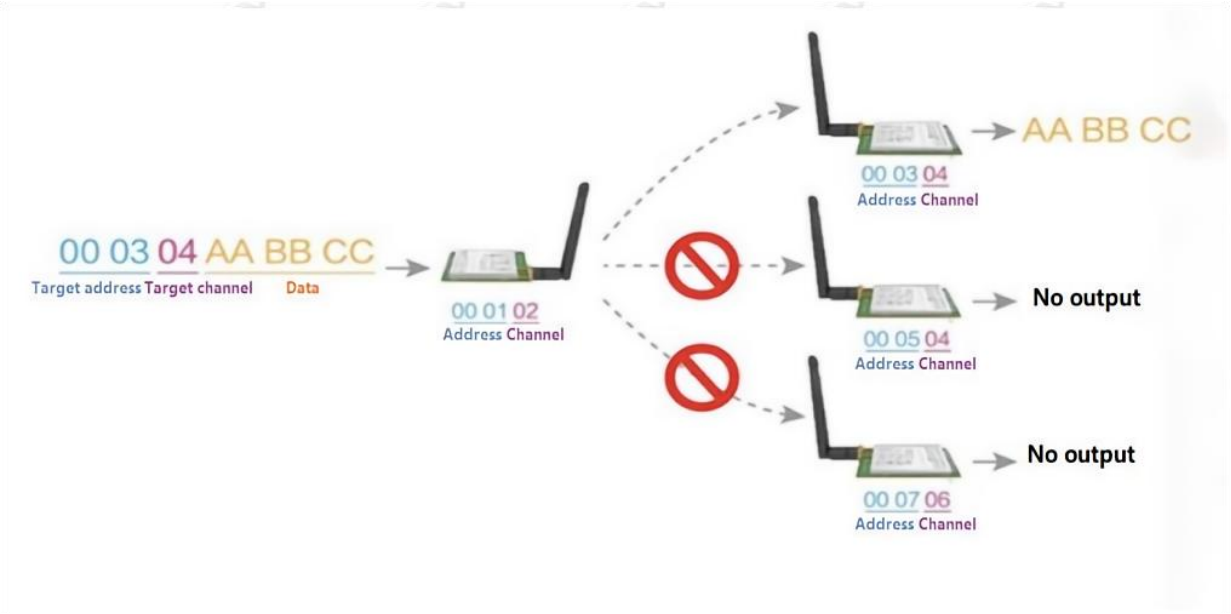


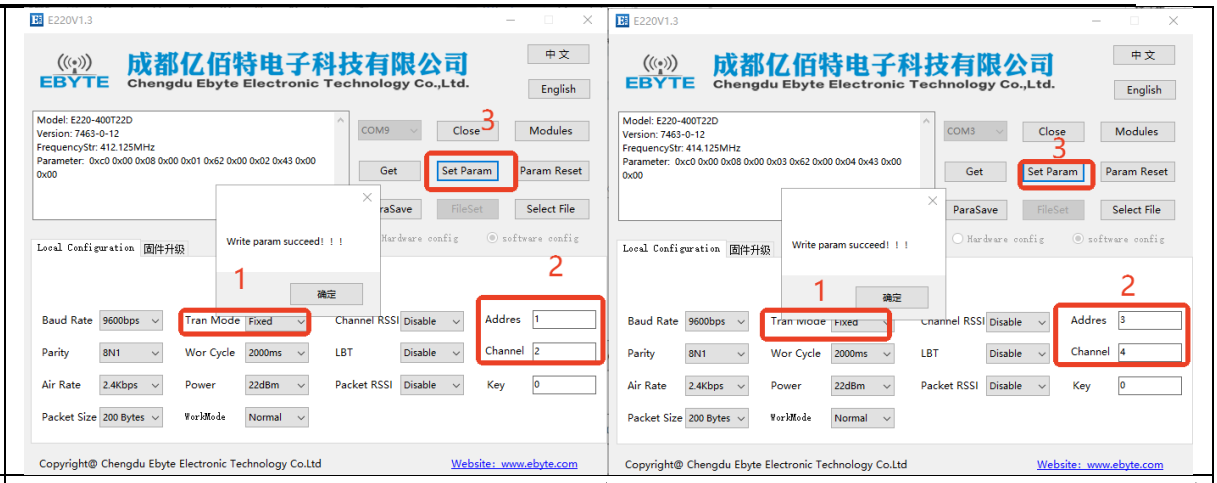
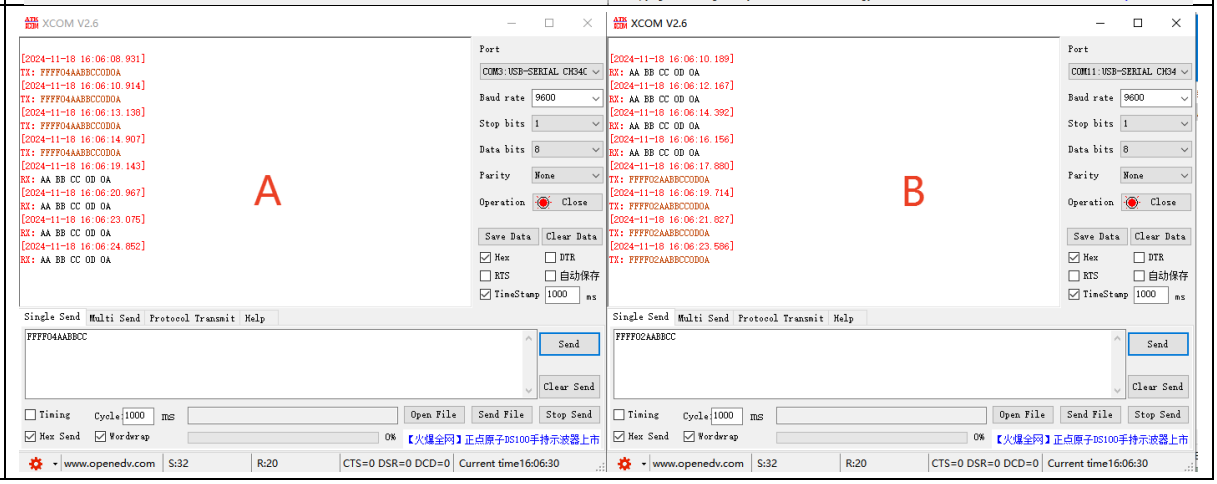
Fig. 1 Schematic diagram of fixed-point transmission

- broadcast function:

1)Set module A address to 0xFFFF and channel to 0x04. When module A is used as transmitter (same mode, transparent transmission or fixed-point transmission mode), all the receiving modules under 0x04 channel can receive the data to achieve the purpose of broadcasting.

2) sets the address of module A to 0xFFFF and the channel to 0x04. When module A acts as a receive, it can receive all the data under channel 0x04 for listening purpose.

No	Steps for the use of fixed-point radio transmissions

1. Modify the parameters of the module through the upper computer: Modify the address and channel of the module under the configuration mode (M1,M0 pins are set to 1 and 1), change the transparent transmission mode to fixed-point transmission, and finally write the parameters to complete the modification.	
2. Module working mode is replaced by general mode: A module parameter is edited as FFFF04AABBCC and sent to B module, similarly B module sends data as FFFF02AABBCC. (The format of transmission data under fixed-point broadcasting mode is: broadcasting address+target channel+data)）	

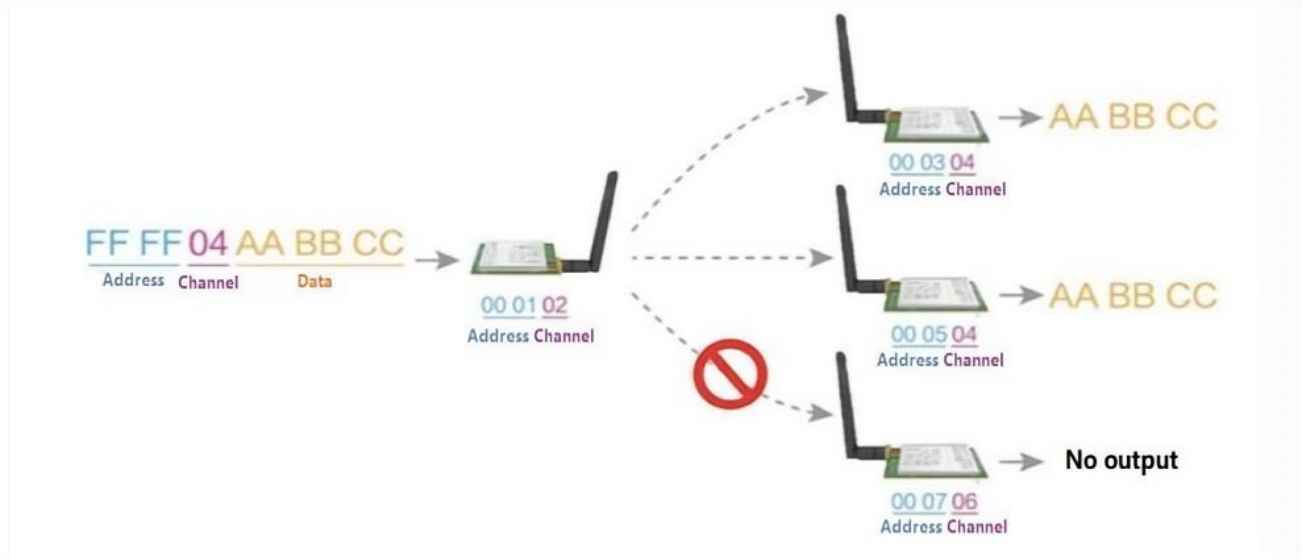


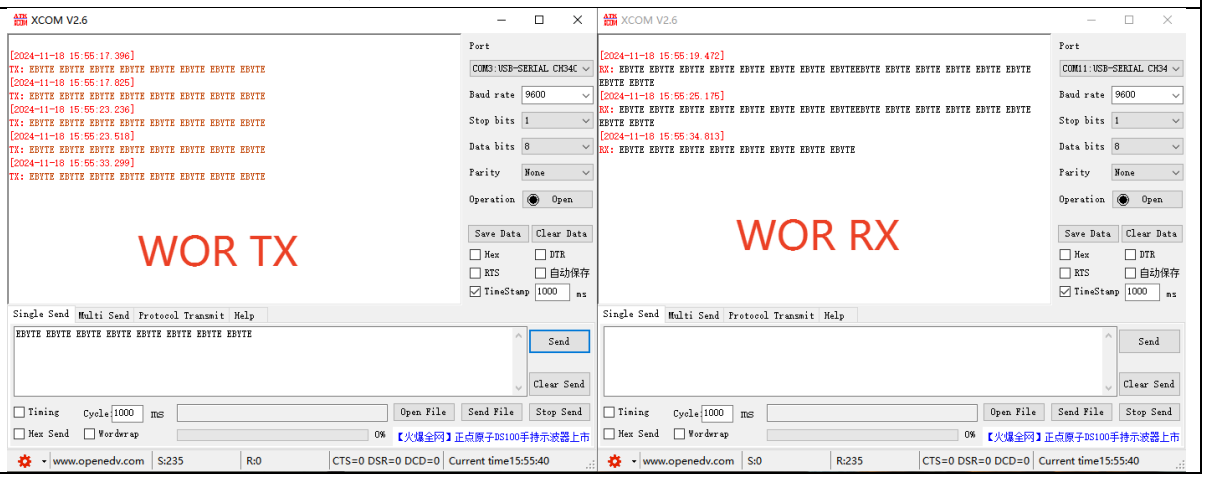
Fig. 2 Schematic diagram of fixed-point broadcast transmission

5.1.2 WOR Mode Usage

No	Steps for using WOR mode

1. Module M1, M0 pins through the module to modify the mode, A module pin set to 0,1 for WOR transmit mode, B module pin set to 1,0 for WOR receive mode.

2. After the working mode of the module is changed to WOR mode: the WOR receiver module sends data to the WOR receiver module, but the WOR receiver module cannot send data to the sender.



5.1.3 Sleep/configuration mode use (M1, M0 pins set to 1,1)

1) The following figure module configuration upper computer display interface, the user can switch to command mode through M0, M1, in the upper computer for rapid configuration and reading of parameters.

2) In the configuration of the upper computer, the module address, frequency channel, network ID, and key are in

decimal display mode; where each parameter takes the value range:

Network address: 0～65535

Frequency channel: 0～83

Key: 0～65535

5.2 Module reset

- After the module is reset, AUX will output a low level, and carry out hardware self-test, as well as set up the working mode according to user parameters;During this process, AUX keeps low level, and when it is finished, AUX outputs high level, and starts to work normally according to the working mode combined by M1 and M0;Therefore, the user needs to wait for the rising edge of AUX as the starting point of normal operation of the module.

5.3 AUX explained in detail

- AUX is used for wireless transceiver buffer indication and self-test indication.
- It indicates whether the module has data that has not yet been transmitted out through the wireless, or whether the wireless data that has already been received has not yet been sent out in full through the serial port, or whether the module is in the process of initializing the self-test.

5.3.1 Power-up indication

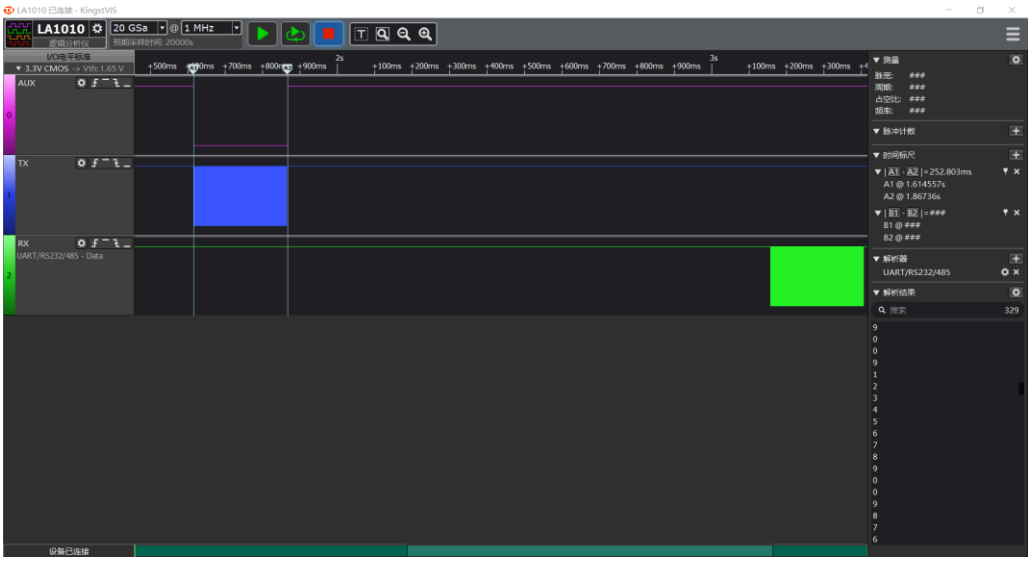
1)The whole startup process (entering the mode working state) takes about 16ms after power-on.
2) After power-on VCC is established, AUX does not immediately indicate a busy state (low level), because the internal microcontroller also needs a certain start-up time.

Figure 4 Power-on startup timing diagram

5.3.2 Serial Data Output Indication

1) When the receiving module receives a wireless packet, it will indicate a busy state (low level) through the AUX pin before giving data from the wired serial port;

2) Used to wake up the external MCU in hibernation;



AUX Timing Diagram for Outgoing Data from Module Serial Port

5.3.3 Wireless transmission indication

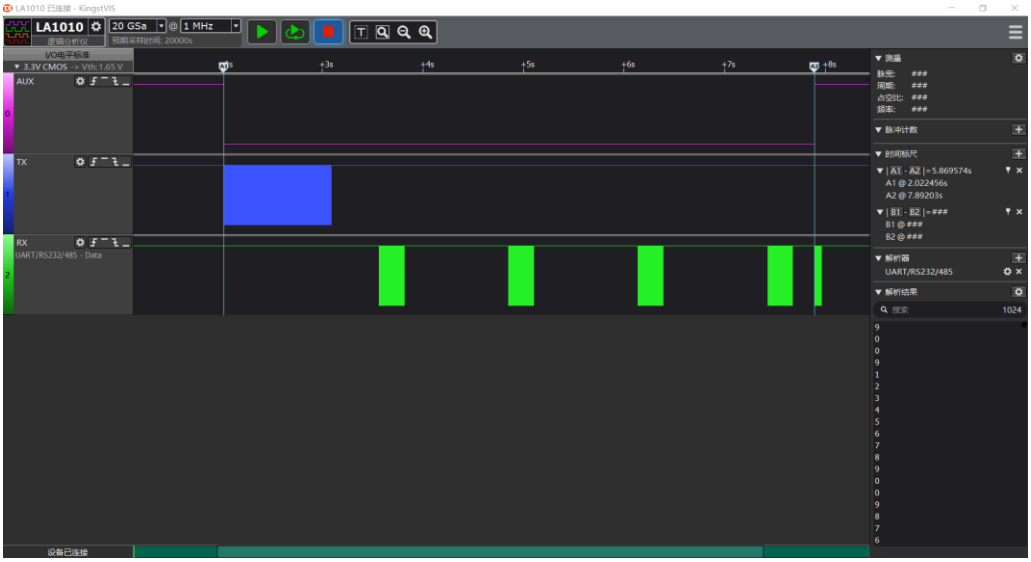
1) When the module is in idle state (non-sleeping), if the user inputs data to the module, it will start to indicate the busy state (low level) only when the first byte of the serial packet is recognized and received by the module. Depending on the serial port baud rate, there is a one-byte delay difference, and the user program needs to pay attention to the AUX detection logic.

2) Buffer Empty: The data in the internal 400 byte buffer are written to the wireless chip (automatic packetization);

When AUX=1 when the user continuously initiates less than 400 bytes of data, will not overflow;

When AUX = 0 when the buffer is not empty: internal 400 byte buffer data, not yet all written to the wireless chip and open the launch, at this time the module may be waiting for the end of the user's data timeout, or is being wireless sub-packet launch.

Attention: AUX=1 does not mean that all the serial data of the module have been launched through the wireless, or the last packet of data is being launched.

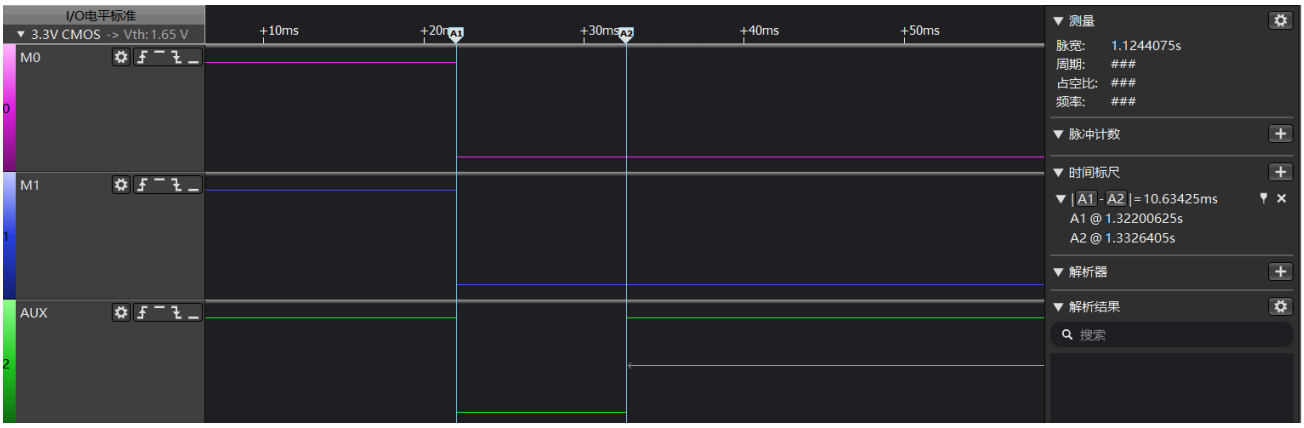


AUX timing diagram when the module receives data from the serial port

5.3.4 Switching Mode

The AUX indicates a busy state when the module is switched in all modes, as shown in the table below:

Original working mode	Switching Mode	E220-XXXTXXX switching time (ms)
Transmission Mode	Sleeping Mode	9～11
	WOR Transmit	9～11
	WOR Receive	9～11
WOR Transmit	Transmission Mode	9～11
	WOR Receive	9～11
	Sleeping Mode	9～11
WOR Receive	Transmission Mode	9～11
	WOR Transmit	9～11
	Sleeping Mode	9～11
Sleeping Mode	Transmission Mode	9～11
	WOR Transmit	9～11
	WOR Receive	9～11



5.3.5 Caution

No	AUX Caution
1	For the above function, the output low level is prioritized, i.e.: when any of the output low level conditions are satisfied, the AUX outputs a low level; When all low level conditions are not satisfied, AUX outputs high level.
2	When AUX outputs low level, it indicates that the module is busy, and no working mode detection will be performed at this time; When the module AUX output high level within 1ms, will complete the mode switching work.
3	After the user switches to a new operating mode, it takes at least 2ms after the rising edge of AUX for the module to actually enter that mode; If AUX stays high, then the mode switching will take effect immediately.
4	The module resets the user parameters when the user enters from mode 3 (sleep mode) or during a reset, during which the AUX output goes low.
5	Due to the characteristics of LoRa modulation, the information transmission delay is much longer than FSK, such as in 2.4kbps air speed, 100 bytes of transmission delay is about 1.5 seconds, it is recommended that customers do not carry out the transmission of large amounts of data at low air speeds, so as to avoid data loss due to the accumulation of data caused by the communication anomaly.

6 Register read/write control

6.1 Command format

The list of supported commands in the configuration mode (Mode 3: M1=1, M0=1) is as follows (only 9600, 8N1 format is supported during setup):

No	Command format	Detail
1	Setup Registers	Instruction: C0 + start address + length + parameters Response: C1 + start address + length + parameters Example 1: Configure the channel as 0x09

		Command Start address Length Parameters Send: C0 04 01 09 Return: C1 04 01 09 Example 2: Configure module address (0x1234), serial port (9600 8N1) and airspeed (2.4K) at the same time Send: C0 00 03 12 34 61 Return: C1 00 03 12 34 61
2	Read registers	Command: C1 + start address + length Response: C1 + start address + length + parameters Example 1: Read channel Command Start address Length Parameters Send: C1 04 01 09 Return: C1 04 01 09 Example 2: Read module address, serial port, airspeed at the same time Send: C1 00 03 Return: C1 00 03 12 34 61
3	Setting Temporary Registers	Command: C2 + start address + length + parameters Response: C1 + start address + length + parameters Example 1: Configure channel as 0x09 Command Start address Length Parameters Send: C2 04 01 09 Return: C1 04 01 09 Example 2: Configure module address (0x1234), serial port (9600 8N1) and airspeed (2.4K) at the same time Send: C2 00 03 12 34 61 Return: C1 00 03 12 34 61
4	formatting error	Format Error Response FF FF FF FF

6.2 E220-400/900Txxx Register Description

<table>
<tr><th>No</th><th>Read/ Write</th><th>Name</th><th colspan="4">Description</th><th>Remark</th></tr>
<tr><td>00H</td><td>Read/ Write</td><td>ADDH</td><td colspan="4">ADDH（default 0）</td><td rowspan="2">Module address high byte and low byte;
Note: When the module address is equal to FFFF, it can be used as the broadcast and listen address, i.e.: at this point the module will not perform address filtering</td></tr>
<tr><td>01H</td><td>Read/ Write</td><td>ADDL</td><td colspan="4">ADDL（default 0）</td></tr>
<tr><td rowspan="3">02H</td><td rowspan="3">Read/ Write</td><td rowspan="3">EG0</td><td>7</td><td>6</td><td>5</td><td>UART serial port rate（bps）</td><td rowspan="3">Two modules communicating with each other can have different serial port baud rates and different checksums;

When transmitting larger data packets continuously, the user needs to consider the</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>The serial port baud rate is 1200</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>The serial port baud rate is 2400</td></tr>
</table>

			0	1	0	The serial port baud rate is 4800	data blocking brought by the same baud rate, and may even be lost; It is generally recommended that the baud rates of the two communicating parties are the same.
			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 parity bits		The serial port modes can be different on both sides of the communication;
			0	0	8N1（default）		
			0	1	8O1		
			1	0	8E1		
			1	1	8N1（equal to 00）		
			2	1	0	wireless air speed（bps）	The air rate must be the same on both sides of the communication; The higher the airspeed, the lower the delay and the shorter the transmission distance。
			0	0	0	Airspeed 2.4k	
			0	0	1	Airspeed 2.4k	
			0	1	0	Airspeed 2.4k（default）	
			0	1	1	Airspeed 4.8k	
			1	0	0	Airspeed 9.6k	
			1	0	1	Airspeed 19.2k	
			1	1	0	Airspeed 38.4k	
			1	1	1	Airspeed 62.5k	
03H	Read/ Write	REG1	7	6	Subcontract Settings		If the data sent by the user is less than the packet length, the output of the serial port at the receiving end is presented as uninterrupted continuous output; If the data sent by the user is larger than the packet length, the serial port at the receiving end will output in packets.
			0	0	200 bytes（default）		
			0	1	128 bytes		
			1	0	64 bytes		
			1	1	32 bytes		
			5	RSSI Ambient Noise Enable			When enabled, command C0 C1 C2 C3 can be sent in transmit mode or WOR transmit mode Command Read Register; Register 0x00 : Current ambient noise RSSI; Register 0X01 : RSSI of last received data. (The current channel noise is: dBm = -(256 - RSSI)); Instruction format: C0 C1 C2 C3 + start address + read length; return: C1 + address + read length + read the effective value; for example: send C0 C1 C2 C3 00 01
			0	Disable (default)			
			1	enable			

						Return C1 00 01 RSSI (address can only start from 00) Translated with www.DeepL.com/Translator (free version)
			4	3	reserve	If you use our host computer to configure the parameters, the bit will be turned off voluntarily. If you do not want to use the M0 M1 pin to switch the working mode, you can You can enable this function and use specific serial commands to switch the mode. Format: C0 C1 C2 C3 02 + working mode Send C0 C1 C2 C3 02 00 to switch to pass-through mode. Send C0 C1 C2 C3 02 01 to toggle to WOR mode Send C0 C1 C2 C3 02 02 to switch to configuration mode Send C0 C1 C2 C3 02 03 Switch to sleep mode Return: C1 C2 C3 02 + WOR mode Note: When this function is enabled, WOR mode and sleep mode only support 9600 baud rate.
			2	Software Mode Switching		
			0	Disable (default)		
			1	enable		
			1	0	firing power	Power and current are non-linearly related, and the power supply is most efficient at maximum power; Current does not decrease in the same proportion as power decreases.
			0	0	22dBm/30dBm（default）	
			0	1	17dBm/27dBm	
			1	0	13dBm/24dBm	
			1	1	10dBm/21dBm	
04H	Read/ Write	REG2	Channel Control (CH) 0-83 represent a total of 84 channels (for 400 band) respectively 0-80 represent a total of 81 channels respectively (for 900 band)			Actual frequency = 410.125 + CH * 1M Actual frequency = 850.125 + CH * 1M
05H	Read/ Write	REG3	7	Enable RSSI bytes		When enabled, the module receives wireless data, which will follow an RSSI intensity byte when output through the serial port TXD.
			0	Disable (default)		
			1	Enable		
			6	Transmission Method		For fixed-point transmission, the module recognizes the first three bytes of the serial data as: address high + address low + channel, and uses them as the wireless transmit target.
			0	Transparent transmission (default)		
			1	Fixed transmission		
			5	Reserved		-
			0	-		
			1	-		

			4	Reserved		-
			0	-		
			1	-		
			3	WOR mode transceiver control		Valid only for mode 1; 1. wor's receive mode, the module can modify the delay time after wakeup, the default time is 0; 2. the receiver needs to send the command C0 09 02 03 E8 in the configuration mode (C0 is the write command, 09 is the address of the register initiator, 02 is the length, 03 E8 is the delay time set, the maximum FFFF is 65535ms, set to 0 to turn off the wake-up delay). 3. Data can be sent within the delay time.
			0	WOR receiver (default) Working in WOR listening mode with the listening period described below (WOR period) saves a lot of power consumption.		
			1	WOR Transmitter The module transmits and receives on and adds a wake-up code for a certain amount of time when transmitting data.		
			2	1	0	WOR cycle	Valid only for mode 1; Cycle time T= (1+WOR)*500ms, the maximum is 4000ms and the minimum is 500ms; The longer the period time between WOR listening intervals, the lower the average power consumption, but the higher the data delay; Both sender and receiver must agree (very important)
			0	0	0	500ms	
			0	0	1	1000ms	
			0	1	0	1500ms	
			0	1	1	2000ms	
			1	0	0	2500ms	
			1	0	1	3000ms	
			1	1	0	3500ms	
			1	1	1	4000ms	
06H	Write	CRYPT_H	Key high byte (default 0)				Write only, read returns 0; Used for encryption to avoid interception of over-the-air wireless data by similar modules; The module will internally use these two bytes as a calculation factor to transform and encrypt the over-the-air wireless signal.
07H	Write	CRYPT_L	Key low byte (default 0)				
80H～86H	Read	PID	1 byte of product information				1 byte of product information

6.3 Factory Default Parameters

Model Number	**E220-400Txxx series factory default parameter values: C0 00 09 00 00 62 00 17 03 00 00 E220-900Txxx Series Factory Default Parameter Value: C0 00 09 00 00 62 00 12 03 00 00**						
Model Number	frequency	address	channel	airspeed	baud rate	Serial Port Format	transmission power
E220-400T22S	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	22dbm
E220-400T22D	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	22dbm

E220-400T30S	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	30dbm
E220-400T30D	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	30dbm
E220-900T22S	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	22dbm
E220-900T22D	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	22dbm
E220-900T30S	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	30dbm
E220-900T30D	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	30dbm

7 AT Commands

- Using AT instructions for parameter configuration or querying needs to be done in the configuration mode;
- AT instructions are used in the configuration mode. AT instructions are divided into three categories in total: command instructions, setup instructions and query instructions;
- Users can pass “AT+HELP=?” Query to the AT instruction set supported by the module, the baud rate adopted by AT instruction is 9600 8N1;
- Will be limited when the input parameters exceed the range, please do not let the parameters exceed the range to avoid unknown situation.

7.1 AT command table

Command instruction	Description	Example	Example Description
AT+IAP(Use caution, see this article for details 7.3 Serial Port Upgrade Firmware Precautions)	Entering IAP upgrade mode	AT+IAP	Entering IAP upgrade mode
AT+RESET	Device reboot	AT+RESET	Device reboot
AT+DEFAULT	Configuration parameters are restored to default and the device reboots	AT+DEFAULT	Configuration parameters are restored to default and the device reboots

7.1.2 Setup command

Command instruction	Description	Example	Example Description
AT+UART=baud,parity	Setting the Baud Rate and	AT+UART=3,0	Set baud rate to 9600, 8N1

	Checksum		
AT+RATE=rate	Setting the air rate	AT+RATE=7	Set the air rate to 62.5K
AT+PACKET=packet	Set packet length	AT+PACKET=0	Set packetization to 200 bytes
AT+WTIME=wtime	Set WOR period	AT+WTIME=0	Set WOR period as 500ms
AT+POWER=power	Sets the transmit power	AT+POWER=0	Set the transmit power as 22/30dBm.
AT+TRANS=trans	Sets the transmit mode	AT+TRANS=1	Set to fixed point mode
AT+LBT=lbt	Setting the Listen Before Talk function switch	AT+LBT=1	Set on, refer to section 6.2 LBT enable for details.
AT+LBR=lrssi,ltime	Setting the RSSI judgment threshold and maximum waiting time for LBT function.	AT+LBR=-60,2000	Set the detection judgment threshold to -60dBm and the maximum delay time to 2 seconds.
AT+ERSSI=erssi	Setting the ambient noise RSSI switch	AT+ERSSI=1	Setting on, refer to section 6.2 RSSI ambient noise function for details
AT+DRSSI=data_rssi	Setting the receive data RSSI switch	AT+DRSSI=1	Receive data RSSI function on
AT+ADDR=addr	Setting the module address	AT+ADDR=1234	Set the module address to 1234
AT+CHANNEL=channel	Sets the module operating channel	AT+CHANNEL=23	Set frequency to 868/433M
AT+KEY=key	Set module key	AT+KEY=1234	Set the module key to 1234
AT+DELAY=delay	Setting the WOR delayed sleep time	AT+DELAY=1000	Set the WOR delayed sleep time to 1000ms.
AT+SWITCH=switch	Setting the software switching mode switch	AT+SWITCH=1	Setting on and allowing software switching
AT+SWITCH=switch	Setting the software switching mode switch	AT+SWITCH=1	Setting on in configuration mode allows software switching.
AT+MODE=mode	Switching the working mode	AT+MODE=0	Switch to pass-through mode
AT+UAUX=uaux	Setting the AUX indication mode	AT+UAUX=0	Switch to serial port cache status indication mode.

7.1.3 Query command

Query command	Description	Back to Example	Example Description
AT+HELP=?	Query AT Command Table		Return to AT Command Table
AT+DEVTYPE=?	Query Module Model Number	DEVTYPE=E220-xxxTxxx	Return to Module Model Number
AT+FWCODE=?	Query Firmware Code	FWCODE=7432-0-10	Return to Firmware Version
AT+UART=?	Query baud rate and checksum	AT+UART=3,0	Returns the baud rate as 9600, 8N1
AT+RATE=?	Query Air Rate	AT+RATE=7	Returns the air rate as 62.5K
AT+PACKET=?	Query Packet Length	AT+PACKET=0	Returns the packet as 200

			bytes
AT+WOR=?	Query WOR Role	AT+WOR=0	Return to WOR receive
AT+POWER=?	Query Transmit Power	AT+POWER=0	Returns transmit power as 22/30 dBm
AT+TRANS=?	Query Transmit Mode	AT+TRANS=1	Return to fixed point mode
AT+LBT=?	Query Listen Before Talk function switch	AT+LBT=1	Return to LBT switch status
AT+LBR=?	Query LBT judgment parameter	AT+LBR=-55,2000	Returns judgment parameters
AT+ERSSI=?	Query ambient noise RSSI switch	AT+ERSSI=1	Returns ambient noise switch status
AT+DRSSI=?	Query RSSI output	AT+DRSSI=1	Return channel RSSI function on
AT+ADDR=?	Query module address	AT+ADDR=1234	Return module address is 1234
AT+CHANNEL=?	Query Module Operating Channel	AT+CHANNEL=23	Returns frequency 868/433M
AT+KEY=?	Query module key	Reading is not supported (security considerations)	Returns ERR
AT+DELAY=?	Query WOR delayed sleep time	AT+DELAY=1000	Return to WOR delayed sleep time of 1000ms.
AT+SWITCH=?	Query software switching mode switch	AT+SWITCH=0	Software switching mode off
AT+MODE=?	Query current working mode (all modes can be queried)	AT+MODE=0	Returns the current pass-through mode

7.2 AT Parameter Analysis

When the serial port receives the correct command, the serial port will return “Command = OK”, otherwise it will return “=ERR”.

Command parameter	Parameter significance
Baud（serial baud rate）	0:1200 1:2400 2:4800 3:9600 4:19200 5:38400 6:57600 7:115200
Parity（serial port parity bit）	0:8N1 1:8O1 2:8E1 3:8N1
Rate （airspeed）	0:2.4K 1:2.4K 2:2.4K 3:4.8K 4:9.6K 5:19.2K 6:38.4K 7:62.5K
Packet（Packet length）	0:200 1:128 2:64 3:32
Period/WTIME（WOR cycle）	0:500ms 1:1000ms 2:1500ms 3:2000ms 4:2500ms 5:3000ms 6:3500ms 7:4000ms
Power（firing power）	0:22/30dBm 1:17/27dBm 2:13/24dBm 3:10/21dBm

TRANS（transfer mode）	0:transparent 1:fixed point
LBT(listen before talk)	0:off 1:on
Lrssi	LBT function detection RSSI threshold -128~0
Ltime	Maximum wait time for LBT function detection 1~65535ms
Erssi (Environmental RSSI)	0:Off 1:On
Data_rssi (data RSSI)	0:off 1:on
Addr (module address)	Module address 0~65535 (decimal)
400MHz band Channel (module channel)	Module channel 0~83 (decimal)
900MHz band Channel (module channel)	Module channel 0~80 (decimal)
Key	Module key 0~65535 (decimal)
Delay (WOR sleep delay)	Delayed hibernation 0~65535 (decimal)
SWITCH (Software Switching Mode Switch)	0: off; 1: on
Mode	0: Transmission mode 1: WOR mode 2: WOR mode 3: Configuration mode/sleep mode
Uaux (AUX indication mode)	0: Serial buffer empty indication mode 1: Wireless transmit completion indication mode

7.3 Serial Port Upgrade Firmware Notes

- If customers need to upgrade the firmware, they need to find the corresponding BIN file provided by the official, and then use the upper computer provided by the official to upgrade the firmware, generally users do not need to upgrade the firmware, please do not use the “AT+IAP” command instructions.
- The pins necessary for upgrading must be pinned out (M1, M0, AUX, TXD, RXD, VCC, GND), and then send the “AT+IAP” command to enter the upgrade mode in the configuration mode, if you need to exit the IAP upgrade mode, you need to keep powering up and wait for 60 seconds. If you need to exit the IAP upgrade mode, you need to keep power on and wait for 60 seconds, the program will exit automatically, otherwise it will enter the upgrade mode indefinitely even if you reboot.
- After enters the upgrade mode, the baud rate will be automatically switched to 115200 until it exits automatically, during which a log will be output.

7.3.1 Steps for upgrading the host computer

- Upper computer command upgrade

1. Make the module enter the configuration mode by changing the host computer or serial port assistant XCOM (Note: the baud rate is 9600 in the configuration mode);
2. Open the official website to configure the host computer, choose to select the serial port → open the serial port → read the parameters → select the firmware upgrade → click to open the file, and select the required upgrade firmware → click to download it

8 Hardware design

- It is recommended to use a DC regulated power supply to power this module, the power supply ripple factor 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 terminals of the power supply, such as reverse connection may cause permanent damage to the module;
- Please check the power supply to ensure that it is between the recommended supply voltages, if it exceeds the maximum value it may cause permanent damage to the module;
- Please check the power supply stability, the voltage should not fluctuate significantly and frequently;
- In the design of power supply circuit for the module, it is often recommended to retain more than 30% of the margin, there is the whole machine is conducive to long-term stable work;
- Module should be as far away as possible from the power supply, transformers, high-frequency alignments and other electromagnetic interference in the larger part;
- High-frequency digital alignment, high-frequency analog alignment, power supply alignment must be avoided below the module, if you really need to go through the module below, assuming that the module is welded in the Top Layer, the Top Layer in the contact part of the module to lay the ground copper (all paved with copper and a good ground),

it must be close to the digital part of the module and alignment in the Bottom Layer;

- Assuming that the module is soldered or placed in the Top Layer, it is also wrong to randomly route the module in the Bottom Layer or any other layer, which will affect the spuriousness of the module as well as the reception sensitivity to varying degrees;
- Assuming that there is a large electromagnetic interference around the module device will also greatly affect the performance of the module, according to the intensity of the interference is recommended to stay away from the module, if the situation permits you can do appropriate isolation and shielding;
- Assume that there is a large electromagnetic interference around the module alignment (high-frequency digital, high-frequency analog, power supply alignment) will also greatly affect the performance of the module, according to the intensity of the interference is recommended to be appropriate away from the module, if the situation permits you can do appropriate isolation and shielding;
- Communication line if you use 5V level, must be connected in series with 1k-5.1k resistor (not recommended, there is still a risk of damage);
- Try to stay away from some TTL protocols where the physical layer is also 2.4GHz, e.g. USB3.0;
- The antenna mounting structure has a big impact on the module performance, make sure the antenna is exposed and preferably vertically upward;
- When the module is installed inside the chassis, use a good quality antenna extension cable to extend the antenna to the outside of the chassis;
- The antenna must not be installed inside the metal shell, which will lead to a great weakening of the transmission distance.

9 Common problems

9.1 Unsatisfactory transmission distance

- When there are linear communication barriers, the communication distance will decay accordingly;
- Temperature, humidity, and co-channel interference, which will lead to higher communication packet loss rate;
- The ground absorbs and reflects radio waves, and the test results are poorer near the ground;
- Seawater has a strong ability to absorb radio waves, so the effect of the seaside test is poor;
- Metal objects near the antenna, or placed in a metal shell, the signal attenuation will be very serious;
- Wrong power register setting, air rate setting is too high (the higher the air rate, the closer the distance);
- Low voltage of power supply at room temperature is lower than the recommended value, the lower the voltage the lower the hair power;
- The use of antenna and module matching degree is poor or the antenna itself quality problems.

9.2 Modules are fragile

- Please check the power supply to ensure that it is between the recommended supply voltages, if it exceeds the maximum value it will cause permanent damage to the module;
- Please check the power supply stability, the voltage can not be substantial frequent fluctuations;

- Please ensure that the installation and use process anti-static operation, high-frequency device electrostatic sensitivity;
- Please ensure that the installation and use of the process of humidity should not be too high, part of the components for humidity-sensitive devices;
- If there is no special demand is not recommended to be used at too high or too low a temperature.

9.3 BER is too high

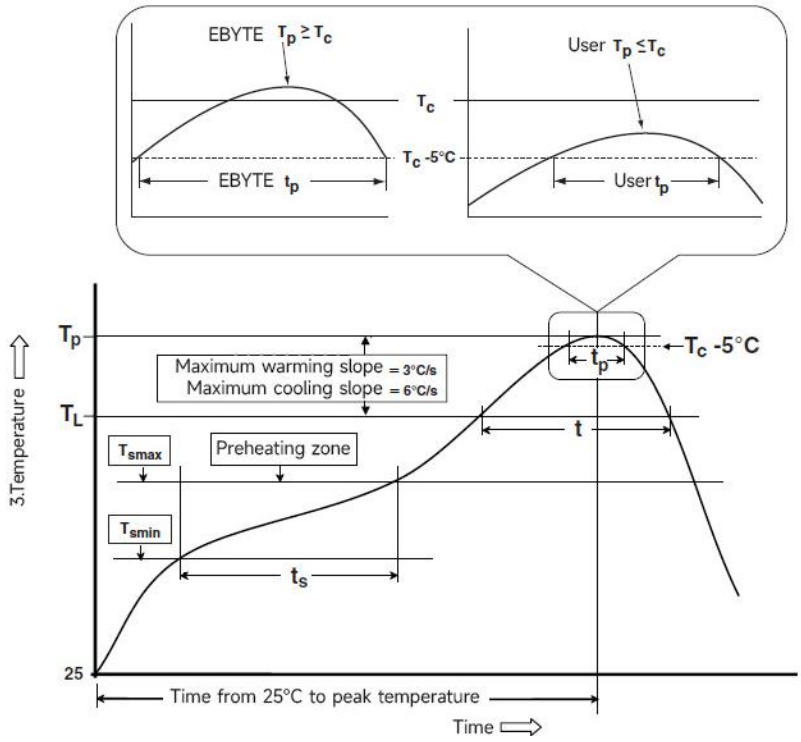
- Near the same frequency signal interference, away from the source of interference or modify the frequency and channel to avoid interference;
- Poor power supply may also cause garbled code, be sure to ensure the reliability of the power supply;
- Extension cords, feeder cords of poor quality or too long, can also cause high BER.

10 Welding instructions

10.1 Reflow temperature

Reflow Profile Characteristics		Leaded process assembly	Lead-free process assembly
Preheating/Holding	lowest temperature（Tsmin）	100℃	150℃
	highest temperature（Tsmax）	150℃	200℃
	Time（Tsmin~Tsmin）	60-120s	60-120s
Temperature rise slope (TL~Tp)		3° C/sec, max.	3° C/sec, max.
Liquid phase temperature (TL)		183℃	217℃
Holding time above TL		60~90 seconds	60~90 seconds
Encapsulation peak temperature Tp		The user must not exceed the temperature indicated on the product's “ Moisture Sensitivity” label.	The user must not exceed the temperature indicated on the product's “ Moisture Sensitivity” label.
Time (Tp) within 5° C of the specified classification temperature (Tc), see the following graph		20 seconds	30 seconds
Cooling slope (Tp~TL)		6° C/sec, max.	6° C/sec, max.
Time from room temperature to peak temperature		6 minutes, max.	8 minutes, max.
※The peak temperature (Tp) tolerance of the temperature profile is defined as the user's upper limit.			

10.2 Reflow temperature



11 Related Models

Product Model	carrier frequency Hz	firing power dBm	Test Distance km	Package form	Product Size mm	communications interface
E22-230T22S	230M	22	5	SMD	16*26	TTL
E22-230T30S	230M	30	10	SMD	20*40.5	TTL
E22-400T22S	433/470M	22	5	SMD	16*26	TTL
E22-400T30E	433/470M	30	10	SMD	20*40.5	TTL
E22-900T22S	868/915M	22	5	SMD	16*26	TTL
E22-900T30S	868/915M	30	10	SMD	20*40.5	TTL
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

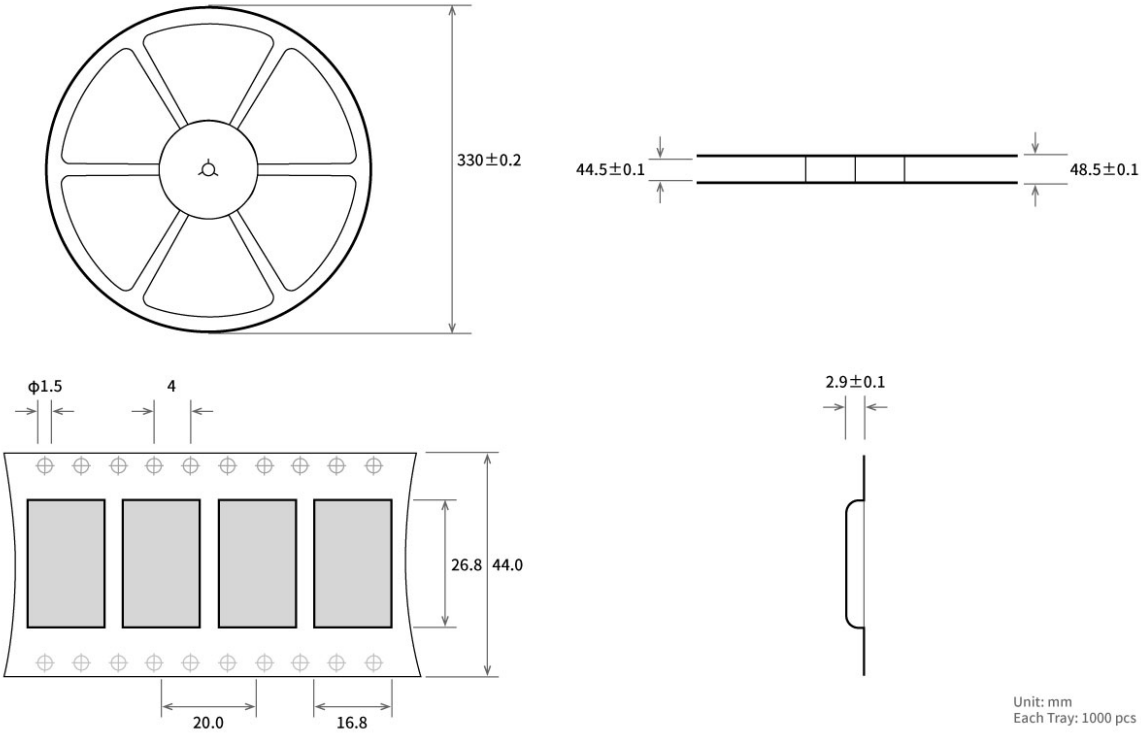
12.1 Antenna Recommendation

Antenna is an important role in the communication process, often poor-quality antenna will have a great impact on the communication system, so we recommend some of the antennas as a supporting our wireless module and the performance is more excellent and reasonably priced antenna.

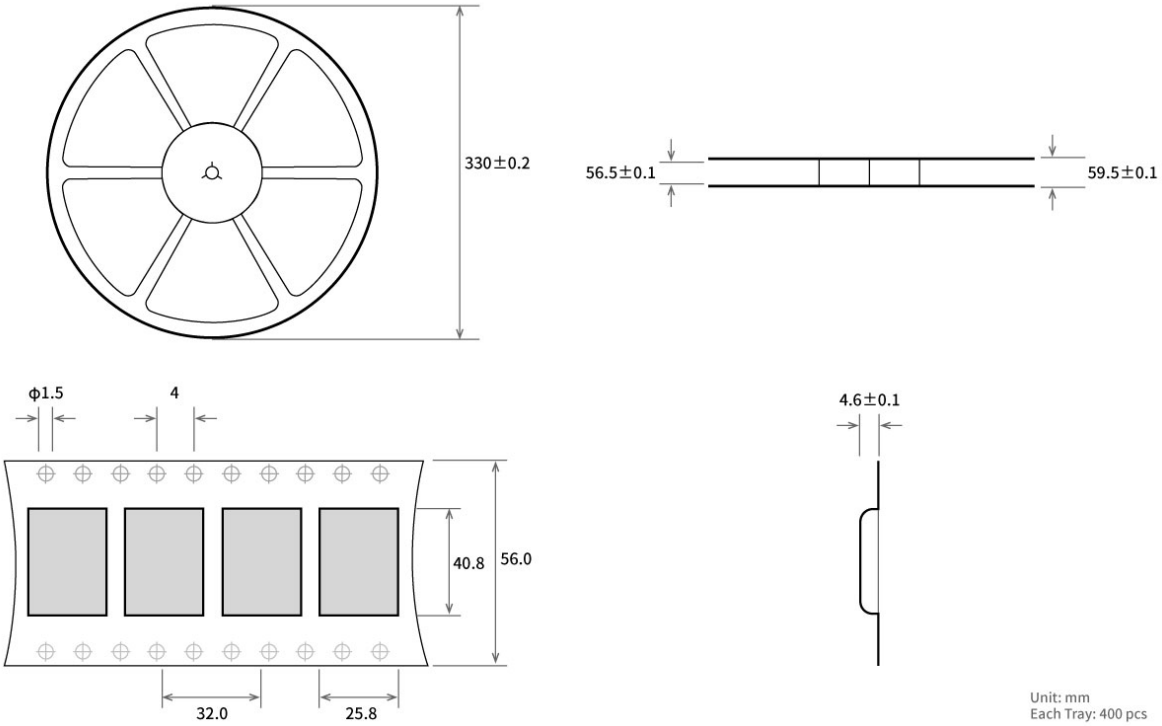
Product Model	type	frequency band Hz	Interface	Gain dBi	Height mm	Feeder cm	Function
TX433-JZ-5	Glue Stick Antennas	433M	SMA-J	2.0	52	-	Ultra Short Straight, Omni-Directional Antenna
TX433-JZG-6	Glue Stick Antenna	433M	SMA-J	2.5	62	-	Omni-Directional Antenna
TX433-JW-5	Rubber Stick Antenna	433M	SMA-J	2.0	50	-	Bent Rubber Stick, Omni-Directional Antenna
TX433-JWG-7	Rubber Stick Antenna	433M	SMA-J	2.5	75	-	Bendable Rubber Stick, Omni-Directional Antenna
TX433-JK-11	Rubber Stick Antenna	433M	SMA-J	2.5	110	-	Bendable Rubber Stick, Omni-Directional Antenna
TX433-XPL-100	Suction Cup Antenna	433M	SMA-J	3.5	185	100	Small 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 Stick Antenna	470/490 M	SMA-J	2.0	50	-	Ultra Short Straight, Omni Antenna
TX490-XPL-100	Suction Cup Antenna	470/490 M	SMA-J	3.5	120	100	Small Suction Cup Antenna, Cost Effective

13 Batch packing method

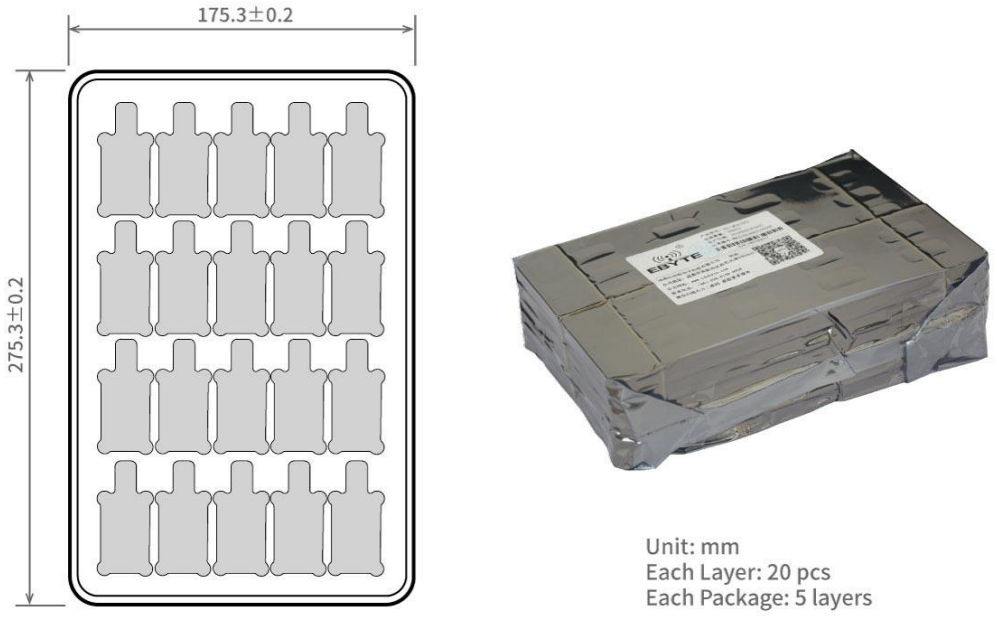
13.1 E220-400/900T22S Bulk packing method



13.2 E220-400/900T30S Bulk packing method



13.2 E220-400/900TxxD Bulk Packaging Methods



Revision history

Version	Date	Description	Issued by
1.0	2024.12.25	Initial version	Hao
1.1	2025-2-21	Error instruction amended	Hao
1.2	2025-6-10	Content revised	Hao
1.3	2025-6-26	Content revised	Hao
1.4	2025-8-6	Content revised	Hao

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