E22-xxxT22D User Manual

AT Command 22dBm LoRa Wireless Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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1 Product Overview

1.1 Product introduction

E22-xxxT22D is a new generation of LoRa wireless data transmission modules. It is developed based on SEMTECH high-performance RF chips, with a transmission power of 22dBm and multiple transmission modes. The operating frequency bands are in the 230, 400, and 900mhz, respectively. LoRa spreading technology, TTL level output, and compatibility with 3.3V IO port voltage.

E22-xxxT22D adopts the new generation LoRa spreading technology, which is faster, lower power consumption, and smaller in size; Supports functions such as WOR, wireless configuration, carrier monitoring, automatic relay, communication keys, etc., supports packet length settings, and can provide customized development services. The three modules in the figure have the same power but different frequency bands.



Figure 1：E22-230T22D



Figure 2：E22-400T22D



Figure 3：E22-900T22D

1.2 Features

- Adopting the new generation LoRa spread spectrum modulation technology, it brings longer communication distance and stronger anti-interference ability;
- Support serial port firmware upgrade, making firmware updates more convenient;
- Support AT commands for more convenient use;
- Support automatic relay networking, multi-level relay is suitable for ultra long distance communication, and multiple networks operate simultaneously in the same area;
- Support users to set their own communication keys that cannot be read, greatly improving the confidentiality of user data;
- Support LBT function, monitor channel environment noise before sending, which can greatly improve the communication success rate of the module in harsh environments;
- Support RSSI signal strength indication function for evaluating signal quality, improving communication network, and ranging;
- Support wireless parameter configuration, send command data packets wirelessly, and remotely configure or read wireless module parameters;
- Support WOR, which is an ultra-low power consumption function suitable for battery powered application solutions;
- Support fixed-point transmission, broadcast transmission, and channel monitoring;
- Support deep sleep mode, in which the overall power consumption is about 3uA;

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- Under ideal conditions, the communication distance can reach 5km;
- Save the parameters after power failure, and after re powering on, the module will operate according to the set parameters;
- Efficient watchdog design, once an exception occurs, the module will automatically restart and continue to work according to the previous parameter settings;
- E22-400T22D and E22-900T22D support data transfer rates of 2.4K to 62.5Kbps;
- E22-230T22D supports data transmission rates of 2.4K to 15.6Kbps;
- Support power supply of 2.7-5.5V, ensuring optimal performance for power supply greater than 5V;
- Industrial grade standard design, supporting long-term use at -40~+85 ℃;

1.3 Application

- Home security alarm and remote keyless entry;
- Smart homes and industrial sensors, etc;
- Wireless alarm security system;
- Building automation solutions;
- Wireless industrial grade remote control;
- Healthcare products;
- Advanced Meter Reading Architecture (AMI);
- Application in the automotive industry.

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2 Specification and parameter

2.1 RF parameter

RF parameter	Unit	Model NO.			Remarks
		E22-230T22DV2.2	E22-400T22DV2.2	E2 2-900T 22DV2.2	
Max TX power	dBm	22.0± 1	22.0± 1	22.0± 1	-
Receiving sensitivity	dBm	- 138	- 147	- 147	Air data rate is 2.4 kbps
Tested distance	M	5K	5K	5K	In clear and open area, the antenna gain is 5dBi with height of 2.5 m, and the air rate is 2.4 kbps.
Operating frequency	MHz	220.125～236.125MHz	410.125～493.125MHz	850.125～930.125MHz	for ISM band
Air data rate	bps	2.4K～15.6K	2.4K～62.5K	2.4K～62.5K	User Programmed Control
Block power	dBm	10	10	10	Less likely to be burned if used at close range
TX length	byte	240	240	240	Sub-package 32/64/128/240 bytes can be set to be sent via command

2.2 Electrical parameters

Electrical parameters		unit	Model NO.			Remark
			E2 2-230T 22 DV2.2	E2 2-400T 22 DV2.2	E2 2-900T 22 DV2.2	
Operating Voltage		V	2. 7～5.5	2. 7～5.5	2. 7～5.5	≥ 5 V can guarantee the output power , exceeding 5.5 V will permanently burn the module .
Communication level		V	3.3V	3.3V	3.3V	Using 5V TTL risks burning out
Power consumption	TX current	mA	110	110	150	Instantaneous power consumption@22dBm
	RX current	mA	15	15	17	
	Sleep current	uA	3	3	3	Software shutdown
temperature	Operating temperature	℃	-40 ～ + 85			Industrial grade design
	Storage temperature	℃	-40 ～ + 85			Industrial grade design

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2.3 Hardware parameters

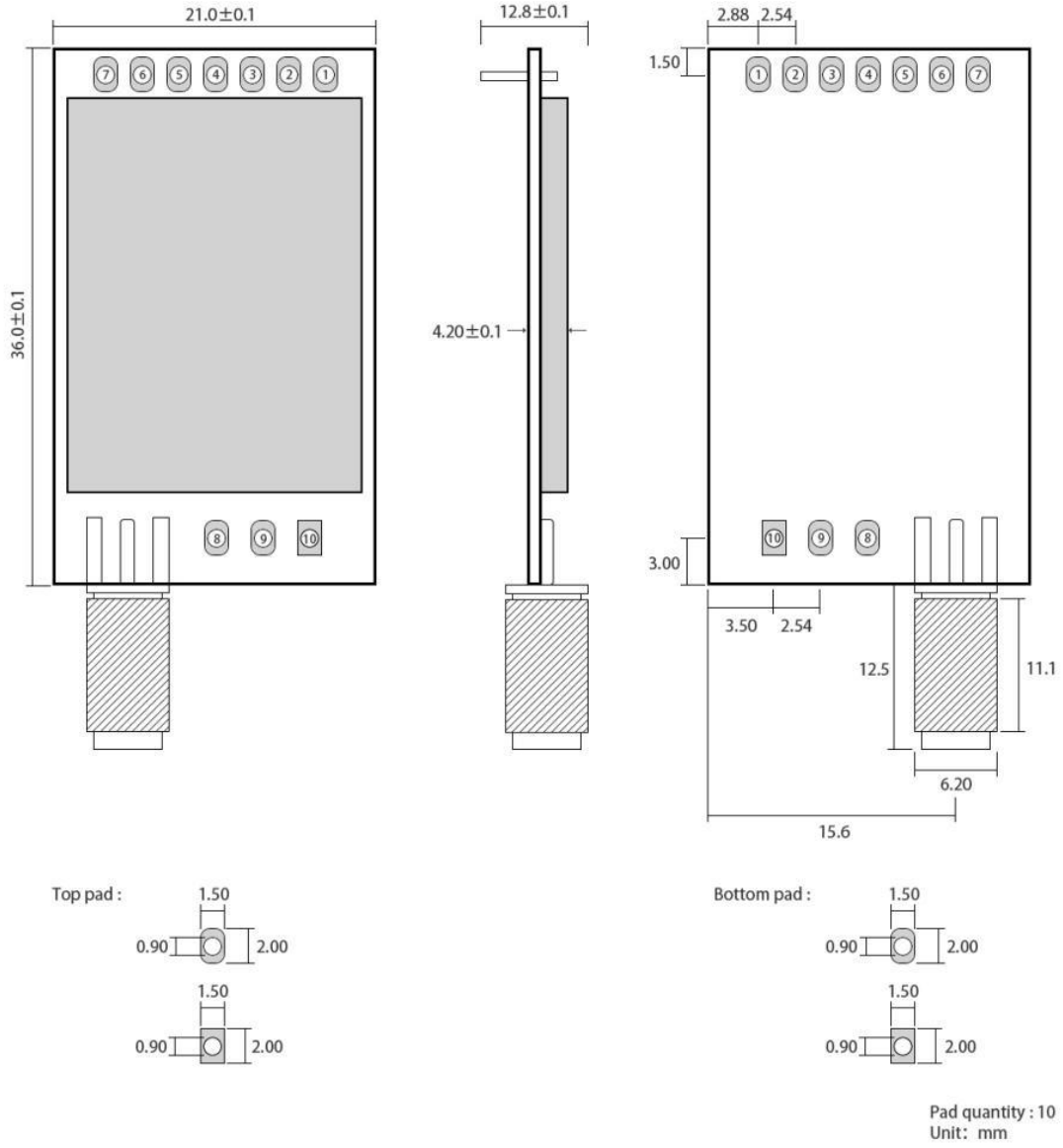
Hardware parameters	Model NO.			Remark
	E22-230T22D V2.2	E22-400T22D V2.2	E22-900T22D V2.2	
Crystal frequency	32MHz			Industrial grade high-precision crystal oscillator
Modulation	LoRa			New generation LoRa modulation technology
Interface mode	1.27mm stamp hole			
Communication Interface	UART serial port			TTL level
TX length	240 Byte			Subpackage 32/64/128/240 bytes can be set to be sent via command
Packaging method	SMD			-
cache capacity	1000 Byte			-
Antenna interface	IPEX/stamp hole			Equivalent impedance is about 50 Ω
size	36mm*21mm			±0.1mm
Product Weight	2.4g			±0.05g

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3 Mechanical dimensions and pin definitions

3.1 E22-230/400/900T22D mechanical dimensions and pin definitions



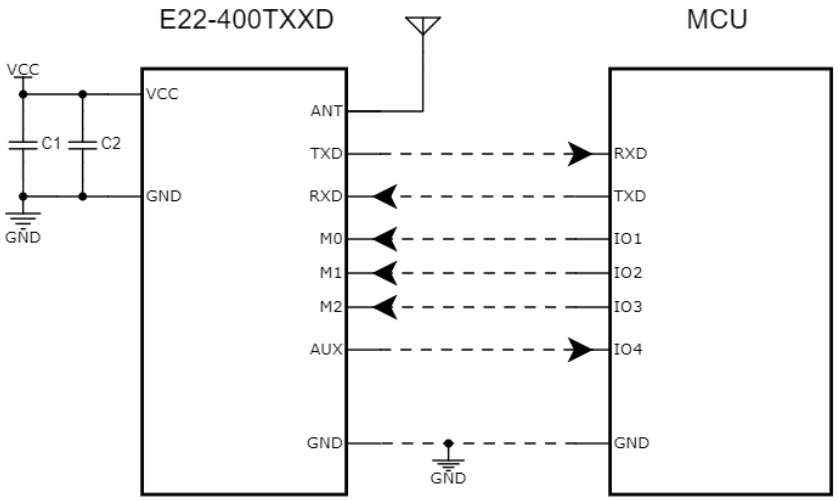
Pin number	Pin name	Pin direction	Pin usage
1	M0	Input (very weak pull-up)	Cooperate with M1 to determine the 4 working modes of the module (cannot be left floating, can be grounded if not used)
2	M1	Input (very weak pull-up)	Cooperate with M0 to determine the 4 working modes of the module (cannot be left floating, can be grounded if not used)
3	RXD	enter	TTL serial port input, connected to the external TXD output pin;
4	TxD	output	TTL serial port output, connected to the external RXD input pin;
5	AUX	output	Used to indicate module working status; The user wakes up the external MCU and outputs low level during power-on

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			self-test initialization; (can be left floating)
6	VCC	power supply	Module power supply positive reference, voltage range: 2.3 ~ 5.5V DC
7	GND	power supply	Module ground wire
8	Fixing hole		Fixing hole
9	Fixing hole		Fixing hole
10	Fixing hole		Fixing hole

4 Recommended connection diagram

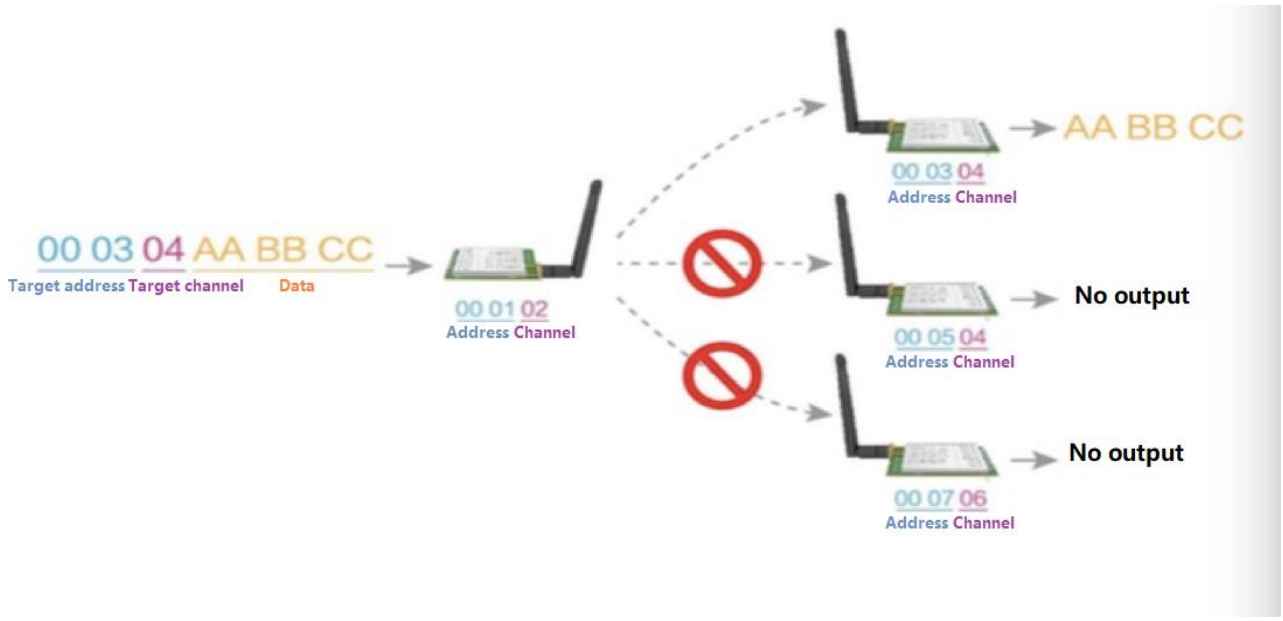


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5 Function description

5.1 Fixed- point transmission



5.2 Broadcast transmission



5.3 Broadcast address

- Example: Set the module A address to 0xFFFF and the channel to 0x04.

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- When module A is used as a transmitter (same mode, transparent transmission mode), all receiving modules under the 0x04 channel can receive data to achieve the purpose of broadcasting.

5.4 Listening address

- Example: Set the module A address to 0xFFFF and the channel to 0x04.
- When module A is used as a receiver, it can receive all data under the 0x04 channel to achieve the purpose of monitoring.

5.5 Module reset

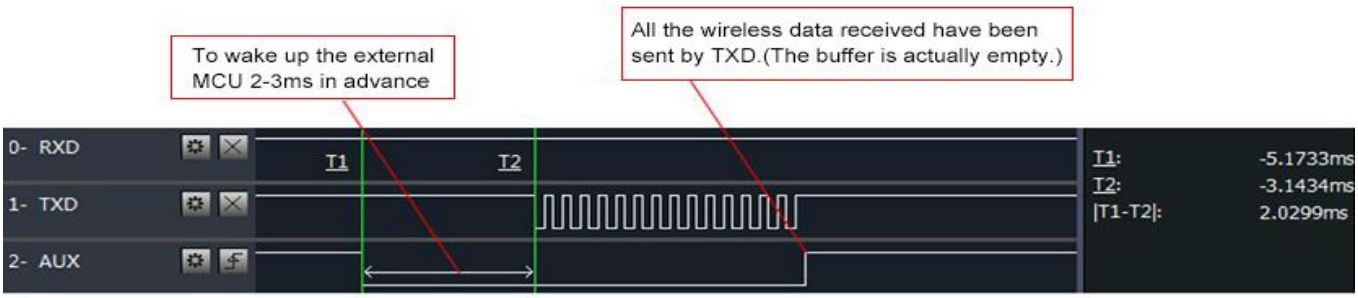
- After the module is powered on, AUX will immediately output a low level, perform hardware self-test, and set the working mode according to user parameters;
  During this process, AUX remains low level. After completion, AUX outputs high level and starts working normally according to the working mode combined by M1 and M0;
  Therefore, the user needs to wait for the rising edge of AUX as the starting point for the module to work normally.

5.6 Detailed explanation of AUX

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

5.6.1 Serial port data output indication

- Used to wake up the external MCU from sleep;



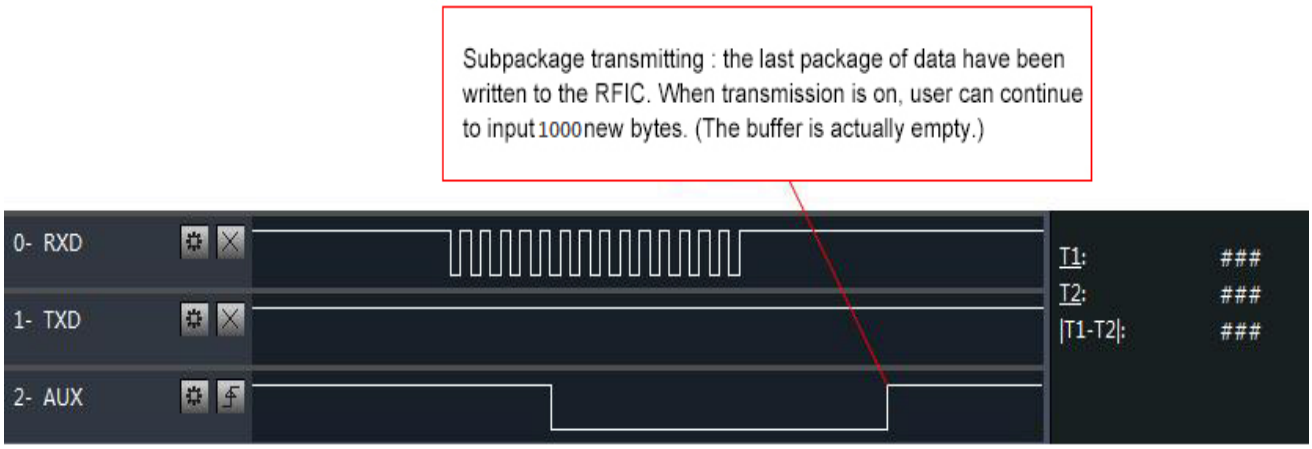
Timing Sequence Diagram of AUX when TXD pin transmits

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5.6.2 Wireless transmission instructions

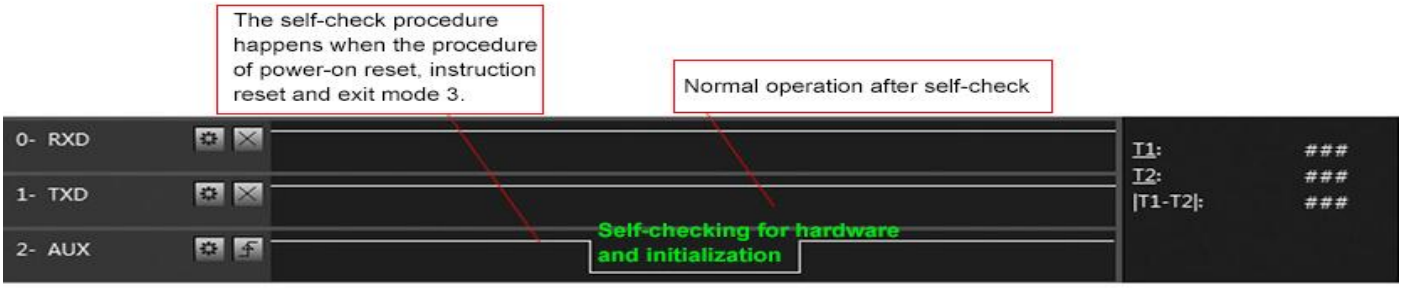
- The buffer is empty: the data in the internal 1000-byte buffer is written to the wireless chip (automatic sub-packetization) ;
  When AUX=1, the user continuously initiates data less than 1000 bytes without overflow ;
  When AUX=0, the buffer is not empty: all the data in the internal 1000-byte buffer has not yet been written to the wireless chip and the transmission has been started. At this time, the module may be waiting for user data to end and time out, or it may be transmitting wireless packets. .



Timing Sequence Diagram of AUX when RXD pin receives

5.6.3 The module is in the process of configuration

- Only when resetting and exiting sleep mode;



Timing Sequence Diagram of AUX when self-check

5.6.4 Precautions

Serial number	AUX considerations
1	The above functions 1 and 2 give priority to low-level output, that is, if any low-level output condition is met, AUX will output low-level; When all low level conditions are not met, 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 outputs high level within 1ms, the mode switching work will be completed.
3	After the user switches to a new working mode, the module will not actually enter this mode until at least 2ms after the rising edge of AUX; If AUX remains high, the mode switch will take effect immediately.

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4	When the user enters other modes from mode 3 (sleep mode) or during the reset process, the module will reset the user parameters, during which the AUX output is low level.
5	Due to the characteristics of the LoRa modulation method, the information transmission delay is much longer than that of FSK. For example, at an air speed of 2.4 kbps, the transmission delay of 100 bytes is about 1.5 seconds. It is recommended that customers not conduct big data at low air speeds . Mass transmission to avoid communication abnormalities caused by data loss due to data accumulation.

6 Operating mode

The module has four working modes, which are set by pins M1 and M0; details are shown in the following table:

Mode (0-3)	M1	M0	Mode introduction	Remark
0 transmission mode	0	0	Open serial port, open wireless, transparent transmission	Support special command over-the-air configuration
1 WOR mode	0	1	Can be defined as WOR sender and WOR receiver	Support air wake-up
2 configuration mode	1	0	Users can access the registers through the serial port to control the working status of the module.	
3 deep sleep	1	1	Module goes to sleep	

6.1 Precautions for mode switching

serial number	Remark
1	● Users can combine M1 and M0 with high and low levels to determine the module working mode. The 2 GPIOs of the MCU can be used to control mode switching; ● After changing M1 and M0: If the module is idle, it can start working in the new mode after 1ms; ● If the module has serial port data that has not yet been transmitted wirelessly, it can enter the new working mode only after the transmission is completed; ● If the module receives wireless data and sends data out through the serial port, it needs to be sent before it can enter the new working mode; ● Therefore, mode switching can only be effective when AUX outputs 1, otherwise the switching will be delayed.
2	● For example, if the user continuously inputs a large amount of data and switches modes at the same time, the mode switching operation is invalid at this time; the module will process all user data before performing new mode detection; ● Therefore, the general recommendation is: detect the output status of the AUX pin and wait 2ms after outputting a high level before switching.
3	● When the module is switched from other modes to sleep mode, if there is data that has not been processed yet; ● The module will enter sleep mode only after processing these data (including receiving and sending). This feature can be used for fast sleep, thereby saving power consumption; for example: the transmitter module works in mode 0, the user initiates the serial port data "12345", and then does not have to wait for the AUX pin to be idle (high level), and can directly switch to sleep mode. And put the user's main MCU to sleep immediately. The module will automatically send all user data through wireless and automatically enter sleep within 1ms; ● This saves the MCU's working time and reduces power consumption.

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4	● In the same way, any mode switching can take advantage of this feature. After the module processes the current mode event, it will automatically enter the new mode within 1ms; thus saving the user the work of querying AUX and achieving the purpose of fast switching; ● For example, switching from transmit mode to receive mode; the user MCU can also enter sleep in advance before mode switching and use the external interrupt function to obtain AUX changes to perform mode switching.
5	● This operation method is very flexible and efficient. It is completely designed according to the user's MCU operation convenience and can reduce the workload of the entire system as much as possible, improve system efficiency and reduce power consumption.

6.2 Normal mode (mode 0)

Type	When M0 = 0, M1 = 0, the module works in mode 0
Transmitting	The user can input data through the serial port, and the module will start wireless transmission.
Receiving	The wireless receiving function of the module is turned on. After receiving the wireless data, it will be output through the serial port TXD pin.

6.3 WOR mode (mode 1)

Type	When M0 = 1, M1 = 0, the module works in mode 1
Transmitting	When defined as the transmitter, a wake-up code will be automatically added for a certain period of time before transmitting.
Receiving	Data can be received normally, and the receiving function is equivalent to mode 0

6.4 Configuration mode (mode 2)

Type	When M0 = 0, M1 = 1, the module works in mode 2
Transmitting	Wireless transmission is turned off and automatically turned on during wireless configuration.
Receiving	Wireless reception is turned off and automatically turned on during wireless configuration.
Configuration	Users can access registers to configure module working status

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6.5 Deep sleep mode (mode 3)

Type	When M0 = 1, M1 = 1, the module works in mode 3
Transmitting	Unable to transmit wireless data.
Receiving	Unable to receive wireless data.
Notice	When entering other modes from sleep mode, the module will reconfigure parameters. During the configuration process, A UX remains low; After completion, it outputs high level, so it is recommended that the user detects the rising edge of AUX .

7 Register read and write control

7.1 Instruction format

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

serial number	Command format	Detailed description
1	Set register	Instruction: C0+start address+length+parameters Response: C1+start address+length+parameters Example 1: Configure the channel as 0x09 Instruction starting address length parameter Send: C0 05 01 09 Return: C1 05 01 09 Example 2: Configure module address (0x1234), network address (0x00), serial port (9600 8N1), and air speed (1.2K) at the same time Send: C0 00 04 12 34 00 61 Return: C1 00 04 12 34 00 61
2	Read register	Instruction: C1+start address+length Response: C1+start address+length+parameters Example 1: Reading the channel Instruction starting address length parameter Send: C1 05 01 Return: C1 05 01 09 Example 2: Read module address, network address, serial port, and airspeed simultaneously Send: C1 00 04 Return: C1 00 04 12 34 00 61
3	Set temporary register	Instruction: C2 + starting address + length + parameters Response: C1 + starting address + length + parameters Example 1: Configure the channel as 0x09 Instruction starting address length parameter Send: C2 05 01 09 Return: C1 05 01 09 Example 2: Configure module address (0x1234), network address (0x00), serial port (9600 8N1), and air speed (2.4K) at the same time

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		Send: C2 00 04 12 34 00 61 Return: C1 00 04 12 34 00 61
4	wireless configuration	Instructions: CF CF + regular instructions Response: CF CF + regular response Example 1: The wireless configuration channel is 0x09 Wireless command header command starting address length parameter Send: CF CF C0 05 01 09 Return: CF CF C1 05 01 09 Example 2: Wireless simultaneous configuration of module address (0x1234), network address (0x00), serial port (9600 8N1), and air speed (2.4K) Send: CF CF C0 00 04 12 34 00 61 Return: CF CF C1 00 04 12 34 00 61
5	wrong format	Format error response FF FF FF

7.2 E22-400/900T22D register description

<table>
<tr><th>serial number</th><th>Read and write</th><th>Name</th><th colspan="5">Describe</th><th>Remark</th></tr>
<tr><td>00H</td><td>read/write</td><td>ADDH</td><td colspan="5">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 a broadcast and listening address, that is, the module will not perform address filtering at this time.</td></tr>
<tr><td>01H</td><td>read/write</td><td>ADDL</td><td colspan="5">ADDL (default 0)</td></tr>
<tr><td>02H</td><td>read/write</td><td>NETID</td><td colspan="5">NETID (default 0)</td><td>Network address, used to distinguish networks ;
When communicating with each other, they should be set to the same value.</td></tr>
<tr><td rowspan="15">0 3H</td><td rowspan="15">read/write</td><td rowspan="15">REG0</td><td>7</td><td>6</td><td>5</td><td>U ART serial port rate (bps)</td><td rowspan="9">Two modules communicating with each other can have different serial port baud rates and different verification methods ;

When transmitting large data packets continuously, users need to consider data blocking and possible loss caused by the same baud rate ;

It is generally recommended that both communication parties have the same baud rate.</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>Serial port baud rate is 1200</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>Serial baud rate is 2400</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>Serial baud rate is 4800</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>Serial port baud rate is 9600 (default)</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>The serial port baud rate is 19200</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>Serial baud rate is 38400</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>Serial baud rate is 57600</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>The serial port baud rate is 115200</td></tr>
<tr><td>4</td><td>3</td><td colspan="3">Serial port check digit</td><td rowspan="5">The serial port modes of the communicating parties can be different ;</td></tr>
<tr><td>0</td><td>0</td><td colspan="3">8N1 (default)</td></tr>
<tr><td>0</td><td>1</td><td colspan="3">8O1</td></tr>
<tr><td>1</td><td>0</td><td colspan="3">8E1</td></tr>
<tr><td>1</td><td>1</td><td colspan="3">8N1 (equal to 0 0)</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>Wireless air rate (bps)</td><td>The air speed of both communicating parties must</td></tr>
</table>

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			0	0	0	Air rate 2.4k	be the same ; air rate, the smaller the delay and the shorter the transmission distance.
			0	0	1	Air rate 2.4k	
			0	1	0	Air rate 2.4k (default)	
			0	1	1	Air rate 4.8k	
			1	0	0	Air speed 9.6k	
			1	0	1	Air rate 1 9.2k	
			1	1	0	Air speed 38.4k	
			1	1	1	Air speed 62.5k	
0 4H	read/write	REG1	7	6	Subcontracting settings		The data sent by the user is less than the packet length, and the serial port output at the receiving end appears as uninterrupted continuous output ; The data sent by the user is larger than the packet length, and the serial port of the receiving end will be packetized and output.
			0	0	240 bytes (default)		
			0	1	128 bytes		
			1	0	64 bytes		
			1	1	32 bytes		
			5	RSSI environmental noise enable			After enabling, the command C0 C1 C2 C3 command can be sent in transfer mode or WOR send mode to read the register ; Register 0x00: Current environmental noise RSSI ; Register 0X01: RSSI when data was last received (The current channel noise is: dBm = - (256 - RSSI)) ; Instruction format: C0 C1 C2 C3+start address+read length ; Return: C1 + address + read length + read valid value; for example: send C0 C1 C2 C3 00 01 Return C1 00 01 RSSI **(address can only start from 0 0)**
			0	Disabled (default)			
			1	enable			
			4	3	reserve		
			2	Software mode switching			If you do not want to use the M0 M1 pins to switch working modes, you can To enable this feature, use specific serial port commands to switch modes. 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 Return: C1 C2 C3 02 + working mode Note: After enabling this function, WOR mode and sleep mode only support Maintain 9600 baud rate.
			0	Disabled (default)			
			1	enable			
			1	0	Transmit power		There is a non-linear relationship between power and current. At the maximum power, the power supply efficiency is the highest ; Current does not decrease proportionally with lower power.
			0	0	22 dBm (default)		
			0	1	17 dBm		
			1	0	13 dBm		
			1	1	1 0 dBm		

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<table>
<tr><td>0 5H</td><td>read/write</td><td>REG2</td><td colspan="4">Channel Control (CH)
0-83 respectively represent a total of 8 4 channels (applicable to the 400 frequency band)
0-80 respectively represent a total of 81 channels (applicable to the 900 frequency band)</td><td>Actual frequency = 410.125 + CH * 1M
Actual frequency = 850.125 + CH *1M</td></tr>
<tr><td rowspan="20">0 6H</td><td rowspan="20">read/write</td><td rowspan="20">REG3</td><td>7</td><td colspan="3">Enable RSSI bytes</td><td rowspan="3">After enabling, the module receives wireless data and outputs it through the serial port TXD, which will be followed by an RSSI strength byte.</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>6</td><td colspan="3">transfer method</td><td rowspan="3">During fixed-point transmission, the module will identify the first three bytes of serial port data as: address high + address low + channel, and use them as wireless transmission targets.</td></tr>
<tr><td>0</td><td colspan="3">Transparent transmission (default)</td></tr>
<tr><td>1</td><td colspan="3">Fixed point transmission</td></tr>
<tr><td>5</td><td colspan="3">Relay function</td><td rowspan="3">After the relay function is enabled, if the target address is not the module itself, the module will start a forwarding ;
In order to prevent data from being transmitted back, it is recommended to use it in conjunction with fixed-point mode ; that is, the destination address and source address are different.</td></tr>
<tr><td>0</td><td colspan="3">Disable relay functionality (default)</td></tr>
<tr><td>1</td><td colspan="3">Enable relay function</td></tr>
<tr><td>4</td><td colspan="3">LBT enable</td><td rowspan="3">When enabled, wireless data will be monitored before transmission, which can avoid interference to a certain extent, but may cause data delays ;

The maximum dwell time of LBT is 2 seconds. If it reaches two seconds, it will be forcibly issued.</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>3</td><td colspan="3">WOR mode transceiver control</td><td rowspan="3">Only valid for mode 1;
1. In the receiving mode of wor, the module can modify the delay time after waking up, and the default time is 0;
2. The receiving end needs to send the command C0 09 02 03 E8 in the configuration mode (C0 is the write command, 09 is the register starter address, 02 is the length, 03 E8 is the set delay, the maximum FFFF is 65535ms, set to 0 turns off the wake-up delay.)
3. Data can be sent within the delay</td></tr>
<tr><td>0</td><td colspan="3">W OR receiver (default)
Working in WOR listening mode, the listening cycle is shown below (WOR cycle), which can save a lot of power consumption.</td></tr>
<tr><td>1</td><td colspan="3">W OR transmitter
The module transceiver is turned on, and when transmitting data, a wake-up code for a certain period of time is added.</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>W OR cycle</td><td rowspan="10">Only valid for mode 1;

Period T= (1+WOR) *500ms , the maximum is 4000ms , the minimum is 500ms ;

WOR listening interval period, the lower the average power consumption, but the greater the data delay;

The sender and receiver must be consistent (very important)</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>500ms</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1000ms</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1500ms</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>2000ms</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>2500ms</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>3000ms</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>3500ms</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>4000ms</td></tr>
<tr><td>0 7H</td><td>Write</td><td>CRYPT_H</td><td colspan="4">Key high byte (default 0)</td><td rowspan="2">Write only, read returns 0 ;
Used for encryption to avoid interception of wireless data in the air by similar modules ;
The module will use these two bytes internally as calculation factors to transform and encrypt the air wireless signal.</td></tr>
<tr><td>0 8H</td><td>Write</td><td>CRYPT_L</td><td colspan="4">Key low byte (default 0)</td></tr>
<tr><td>8 0H ~ 8</td><td>read</td><td>PID</td><td colspan="4">Product information 7 bytes</td><td>Product information 7 bytes</td></tr>
</table>

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6H				

7.3 E22-230T22D register description

serial number	Read and write	name	describe				Remark
00H	read/write	ADDH	ADDH (default 0)				Module address high byte and low byte ; Note: When the module address is equal to FFFF, it can be used as a broadcast and listening address, that is, the module will not perform address filtering at this time.
01H	read/write	ADDL	ADDL (default 0)				
02H	read/write	NETID	NETID (default 0)				Network address, used to distinguish networks ; When communicating with each other, they should be set to the same value.
0 3H	read/write	REG0	7	6	5	U ART serial port rate (bps)	Two modules communicating with each other can have different serial port baud rates and different verification methods ; When transmitting large data packets continuously, users need to consider data blocking and possible loss caused by the same baud rate ; It is generally recommended that both communication parties have the same baud rate.
			0	0	0	Serial port baud rate is 1200	
			0	0	1	Serial baud rate is 2400	
			0	1	0	Serial baud rate is 4800	
			0	1	1	Serial port baud rate is 9600 (default)	
			1	0	0	The serial port baud rate is 19200	
			1	0	1	Serial baud rate is 38400	
			1	1	0	Serial baud rate is 57600	
			1	1	1	The serial port baud rate is 115200	
			4	3	Serial port check digit		The serial port modes of the communicating parties can be different ;
			0	0	8 N1 (default)		
			0	1	8O1		
			1	0	8 E1		
			1	1	8 N1 (equal to 0 0)		
			2	1	0	Wireless air rate (bps)	The air speed of both communicating parties must be the same ; air rate, the smaller the delay and the shorter the transmission distance.
			0	0	0	Air speed 2. 4k	
			0	0	1	Air speed 2. 4k	
			0	1	0	Air speed 2. 4k (default)	
			0	1	1	Air speed 4. 8k	
			1	0	0	Air speed 9. 6k	
			1	0	1	Air speed 19. 2k	
			1	1	0	Air speed 38. 4k	
			1	1	1	Air speed 62. 5k	

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0 4H	read/write	REG1	7	6	Subcontracting settings	The data sent by the user is less than the packet length, and the serial port output at the receiving end appears as uninterrupted continuous output ; The data sent by the user is larger than the packet length, and the serial port of the receiving end will be packetized and output.
			0	0	2 40 bytes (default)	
			0	1	1 28 bytes	
			1	0	6 4 bytes	
			1	1	3 2 bytes	
			5	RSSI environmental noise enable		After enabling, the command C0 C1 C2 C3 command can be sent in transfer mode or WOR send mode to read the register ; Register 0x00: Current environmental noise RSSI ; Register 0X01: RSSI when data was last received (The current channel noise is: dBm = -(256-HEX) HEX is hexadecimal) ; Instruction format: C0 C1 C2 C3+start address+read length ; Return: C1 + address + read length + read valid value; For example: send C0 C1 C2 C3 00 01 Return C1 00 01 RSSI **(address can only start from 0 0)**
			0	Disabled (default)		
			1	enable		
			4	Software mode switching		If you do not want to use the M0 M1 pins to switch working modes, you can To enable this feature, use specific serial port commands to switch modes. 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 Return: C1 C2 C3 02 + working mode Note: After enabling this function, WOR mode and sleep mode only support Maintain 9600 baud rate.
			0	Disabled (default)		
			1	enable		
			3	2	reserve	
			1	0	Transmit power	There is a non-linear relationship between power and current. At the maximum power, the power supply efficiency is the highest ; Current does not decrease proportionally with lower power.
			0	0	22 dBm (default)	
			0	1	17 dBm	
			1	0	13 dBm	
			1	1	1 0 dBm	
0 5H	read/write	REG2	Channel Control (CH) 0-64 respectively represent a total of 65 channels			Actual frequency = 220.125 + CH *0.25M
0 6H	read/write	REG3	7	Enable RSSI bytes		After enabling, the module receives wireless data and outputs it through the serial port TXD, which will be followed by an RSSI strength byte.
			0	Disabled (default)		
			1	enable		
			6	transfer method		During fixed-point transmission, the module will identify the first three bytes of serial port data as: address high + address low + channel, and use
			0	Transparent transmission (default)		

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			1	Fixed point transmission		them as wireless transmission targets.
			5	Relay function		After the relay function is enabled, if the target address is not the module itself, the module will start a forwarding ; In order to prevent data from being transmitted back, it is recommended to use it in conjunction with fixed-point mode ; that is, the destination address and source address are different.
			0	Disable relay functionality (default)		
			1	Enable relay function		
			4	LBT enable		When enabled, wireless data will be monitored before transmission, which can avoid interference to a certain extent, but may cause data delays ; The maximum dwell time of LBT is 2 seconds. If it reaches two seconds, it will be forcibly issued.
			0	Disabled (default)		
			1	enable		
			3	WOR mode transceiver control		Only valid for mode 1 ; 1. In the receiving mode of wor, the module can modify the delay time after waking up, and the default time is 0; 2. The receiving end needs to send the command C0 09 02 03 E8 in the configuration mode (C0 is the write command, 09 is the register starter address, 02 is the length, 03 E8 is the set delay, the maximum FFFF is 65535ms, set to 0 turns off the wake-up delay.) 3. Data can be sent within the delay
			0	W OR receiver (default) Working in WOR listening mode, the listening cycle is shown below (WOR cycle), which can save a lot of power consumption.		
			1	W OR transmitter The module transceiver is turned on, and when transmitting data, a wake-up code for a certain period of time is added.		
			2	1	0	W OR cycle
			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
07H	写	CRYPT_H	Key high byte (default 0)			Write only, read returns 0 ; Used for encryption to avoid interception of wireless data in the air by similar modules ; The module will use these two bytes internally as calculation factors to transform and encrypt the air wireless signal.
0 8H	Write	CRYPT_L	Key low byte (default 0)			
8 0H ~ 8 6H	read	PID	Product information 7 bytes			Product information 7 bytes

7.4 Factory default parameters

Model	**E22-230T22 D factory default parameter values: C0 00 09 00 00 00 6 0 00 28 03 00 00 E22-400T22D factory default parameter value: C0 00 09 00 00 00 60 00 17 03 00 00 E22-900T22D factory default parameter value: C0 00 09 00 00 00 60 00 12 03 00 00**						
Module model	frequency	address	channel	Air speed	baud rate	Serial port format	Transmit power

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E22-230T 22D	230.125MHz	0x0000	0x28	2.4kbps	9600	8N1	22dbm
E22-400T22D	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	22dbm
E22-900T22 D	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	22dbm

8 AT commands

- AT commands are used in configuration mode. AT commands are divided into three categories: command commands, setting commands and query commands;
- Users can query the AT command set supported by the module through "AT+HELP=?". The baud rate used by the AT command is 9600 8N1;
- When the input parameters exceed the range, they will be restricted. Please do not let the parameters exceed the range to avoid unknown situations.

8.1AT command list

Command instructions	Describe	Example	Example description
AT+IAP (use with caution, please see 8.3 Precautions for Serial Port Firmware Upgrade in this article for details)	Enter IAP upgrade mode	AT+IAP	Enter IAP upgrade mode
AT+RESET	Device restart	AT+RESET	Device restart
AT+DEFAULT	Restore configuration parameters to default and the device restarts	AT+DEFAULT	Restore configuration parameters to default and the device restarts

Setup instructions	Describe	Example	Example description
AT+UART=baud,parity	Set baud rate and parity	AT+UART=3,0	Set the baud rate to 9600, 8N0
AT+RATE=rate	Set air speed	AT+RATE=7	Set the air rate to 16.4K
AT+PACKET=packet	Set packet length	AT+PACKET=0	Set the packet size to 240 bytes
AT+WOR=role,period	Set WOR roles and cycles	AT+WOR=0,3	Set to WOR reception, cycle is 2000ms
AT+POWER=power	Set transmit power	AT+POWER=0	Set the transmit power to 22dBm
AT+TRANS=mode	Set sending mode	AT+TRANS=1	Set to fixed point mode
AT+ROUTER=router	Set relay mode	AT+ROUTER=1	Set to relay mode
AT+LBT=lbt	Set Listen Before Talk function switch	AT+LBT=1	Setting is enabled, please refer to Section 7.2 LBT

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			Enable for details.
AT+ERSSI=erssi	Set the ambient noise RSSI switch	AT+ERSSI=1	The setting is enabled. For details, please refer to Section 7.2 RSSI Environmental Noise Function.
AT+DRSSI=data_rssi	Set the receive data RSSI switch	AT+DRSSI=1	Receive data RSSI function is turned on
AT+ADDR=addr	Set module address	AT+ADDR=1234	Set the module address to 1234
AT+CHANNEL=channel	Set module working channel	AT+CHANNEL=23	Set frequency to 433.125M
AT+NETID=netid	Set network ID	AT+NETID=2	Set network ID to 2
AT+KEY=key	Set module key	AT+KEY=1234	Set the module key to 1234
AT+DELAY=delay	Set WOR delay sleep time	AT+DELAY=1000	Set the WOR delay sleep time to 1000ms
AT+SWITCH=switch	Setting software mode switch	AT+SWITCH=1	Settings are turned on to allow software switching

Query command	Describe	Return example	Example description
AT+HELP=?	Query AT command table		Return to AT command list
AT+DEVTYPE=?	Query module model	DEVTYPE=E29-400T22S/D	Return module model
AT+FWCODE=?	Query firmware code	FWCODE=7432-0-10	Return firmware version
AT+UART=?	Query baud rate and checksum	AT+UART=3,0	Return baud rate 9600, 8N1
AT+RATE=?	Query air speed	AT+RATE=7	Return air rate is 16.4K
AT+PACKET=?	Query packet length	AT+PACKET=0	returned packet is 240 bytes
AT+WOR=?	Query WOR roles and cycles	AT+WOR=0,3	Return to WOR reception, the cycle is 2000ms
AT+POWER=?	Query transmit power	AT+POWER=0	The return transmit power is 22dBm
AT+TRANS=?	Query sending mode	AT+TRANS=1	Return to fixed point mode
AT+ROUTER=?	Query relay mode	AT+ROUTER=1	Return to relay mode
AT+LBT=?	Query the Listen Before Talk function switch	AT+LBT=1	Return LBT switch status
AT+ERSSI=?	Query the environmental	AT+ERSSI=1	Return to ambient noise

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	noise RSSI switch		switch status
AT+DRSSI=?	Query RSSI output	AT+DRSSI=1	Return channel RSSI function is enabled
AT+ADDR=?	Query module address	AT+ADDR=1234	The return module address is 1234
AT+CHANNEL=?	Query module working channel	AT+CHANNEL=23	return frequency is 433.125M
AT+NETID=?	Query network ID	AT+NETID=2	Return network ID is 2
AT+KEY=?	Query module key	Reading is not supported (security considerations)	Return ERR
AT+DELAY=?	Query WOR delayed sleep time	AT+DELAY=1000	Return to WOR delayed sleep time is 1000ms

8.2 AT parameter analysis

When the serial port receives the correct command, the serial port will return "command=OK", otherwise it will return "=ERR"

Command parameters	Parameter meaning
Baud (serial port 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 (over-the-air rate)	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: 240 1: 128 2:64 3:32
Role (WOR role)	0: Receive 1: Send
Period（WOR period）	0:500ms 1:1000ms 2:1500ms 3:2000ms 4:2500ms 5:3000ms 6:3500ms 7:4000ms
Power (transmission power) Note 1	0: 22dBm 1: 20dBm 2: 17dBm 3: 14dBm
Mode (transmission mode)	0: transparent 1: fixed point
Router (relay mode)	0: Close 1: open
LBT(listen before talk)	0: Close 1: open
Erssi (environment RSSI)	0: Close 1: open
Data_rssi (data RSSI)	0: Close 1: open
Addr (module address)	Module address 0~65535 (decimal)
Channel (module channel)	Module channel 0~83 (decimal)
Netid (Network ID)	Module network 0~255 (decimal)
Key	Module key 0~65535 (decimal)
Delay (WOR delayed sleep)	Delayed sleep 0~65535 (decimal)

Note 1: Modules with different powers have different settings. You can check the transmission power in Section 7.2 of the manual.

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8.3Things to note when upgrading firmware via serial port

If the customer needs to upgrade the firmware, they need to find the corresponding BIN file provided by the official, and then use the officially provided host computer to upgrade the firmware. Generally, users do not need to upgrade the firmware. Please do not use the "AT+IAP" command. .

The pins necessary for the upgrade must be lead out (M1, M0, AUX, TXD, RXD, VCC, GND), and then send the "AT+IAP" command in the configuration mode to enter the upgrade mode. If you need to exit the IAP upgrade mode, you need to keep Power on and wait 60 seconds, the program will automatically exit, otherwise it will enter the upgrade mode indefinitely even if it is restarted.

After entering the upgrade mode, the baud rate will automatically switch to 115200 until it automatically exits, during which there will be log output.

9 Relay networking mode use

No.	Relay mode description
1	After setting the relay mode through the configuration mode, switch to the general mode and the relay starts to work.
2	In relay mode, ADDH and ADDL are no longer used as module addresses, but correspond to NETID forwarding pairs respectively. If one of the networks is received, it will be forwarded to the other network ; The repeater's own network ID is invalid.
3	In relay mode, the relay module cannot send and receive data and cannot perform low-power operation.
4	When the user enters other modes from mode 3 (sleep mode) or during the reset process, the module will reset the user parameters, during which the AUX output is low level.

Description of trunk networking rules:

1、Forwarding rules, the relay can forward data in both directions between two NETIDs.

2、In relay mode, ADDH\ADDL is no longer used as module address, but as NETID forwarding pairing.

As shown in the picture:

1 relay

"Node 1" NETID is 08.

"Node 2" NETID is 33.

The ADDH\ADDL of trunk 1 are 08 and 33 respectively.

So the signal sent by node 1 (08) can be forwarded to node 2 (33)

At the same time, node 1 and node 2 have the same address, so the data sent by node 1 can be received by node 2.

2 relay

The ADDH\ADDL of relay 2 are 33 and 05 respectively.

So relay 2 can forward relay 1's data to network NETID: 05.

Therefore, node 3 and node 4 can receive the node 1 data. Node 4 outputs data normally. Node 3 has different addresses from node 1,

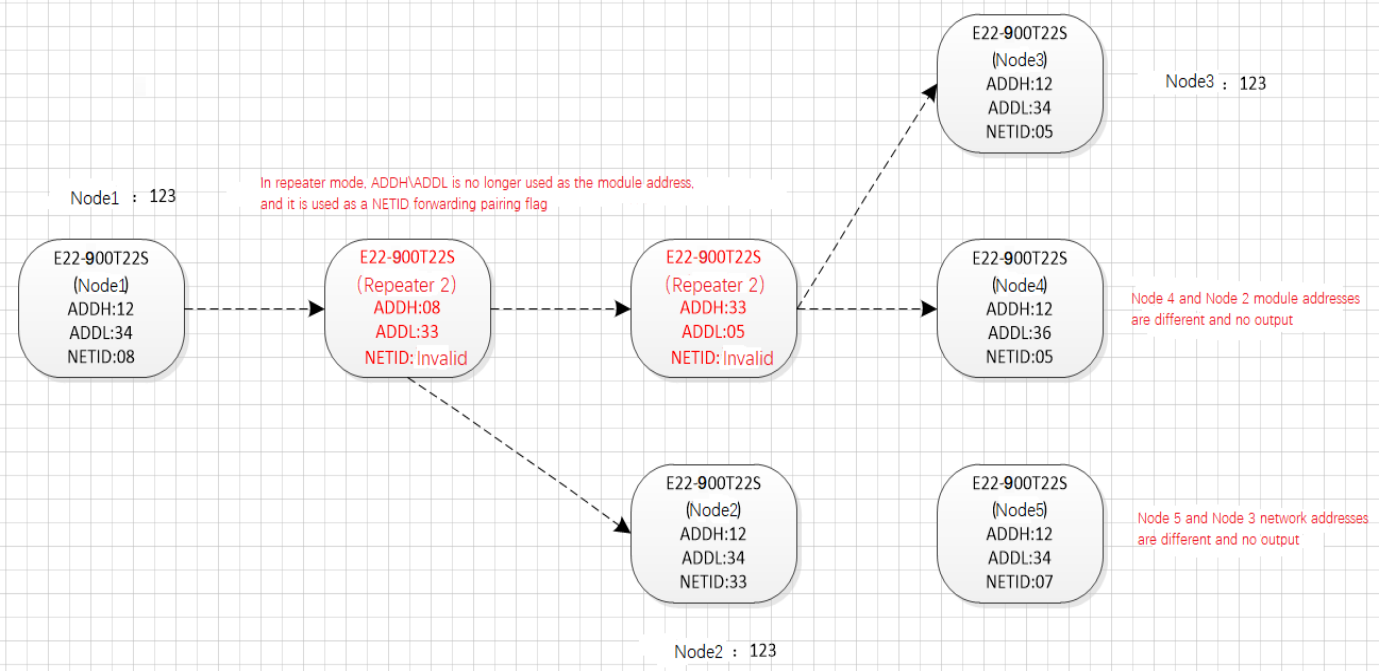
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so no data is output.

③Two -way relay

As shown in the figure, the data sent by node 1 can be received by nodes 2 and 4, and the data sent by nodes 2 and 4 can also be received by node 1.



10 Host computer configuration instructions

- The picture below shows the configuration host computer display interface of E2 2 - 9 00T22 D as an example . The user can switch to command mode through M0 and M1 to quickly configure and read parameters on the host computer.

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- In configuring the host computer, the module address, frequency channel, network ID, and key are all in decimal display mode; the value range of each parameter is:

  Network address: 0～65535

  Frequency channel: 0～8 1

  Network ID: 0～255

  Key: 0～65535

- Users need to pay special attention when using the host computer to configure the relay mode. Since the parameters in the host computer are in decimal display mode, the module address and network ID need to be filled in through decimal conversion;

  For example, the network ID input by the transmitter A is 02 and the network ID input by the receiver B is 10. When the relay R sets the module address, the hexadecimal value 0X020A is converted into the decimal value 522 and filled in by the relay R. module address;

  That is, the module address value that relay terminal R needs to fill in at this time is 522.

11 Hardware design

- It is recommended to use a DC regulated power supply to power the module. The power supply ripple coefficient should be as small as possible, and the module must be reliably grounded;
- Please pay attention to the correct connection of the positive and negative poles of the power supply. Reverse connection may cause permanent damage to the module;
- Please check the power supply to ensure that it is within the recommended power supply voltage. If it exceeds the maximum value, it will cause permanent damage to the module;
- Please check the stability of the power supply. The voltage cannot fluctuate greatly and frequently;
- When designing the power supply circuit for the module, it is often recommended to reserve more than 30% margin, so that the

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whole machine can work stably for a long time;

- The module should be kept as far away as possible from power supplies, transformers, high-frequency wiring and other parts with high electromagnetic interference;
- High-frequency digital traces, high-frequency analog traces, and power traces must avoid the bottom of the module. If it is really necessary to pass under the module, assume that the module is welded on the Top Layer, and ground copper is laid on the Top Layer of the module contact part (all copper is laid and Good grounding), must be close to the digital part of the module and routed on the Bottom Layer ;
- Assuming that the module is welded or placed on the Top Layer, it is also wrong to route traces randomly on the Bottom Layer or other layers, which will affect the module's spurious and receiving sensitivity to varying degrees ;
- Assuming that there are devices with large electromagnetic interference around the module, which will also greatly affect the performance of the module, it is recommended to stay away from the module according to the intensity of the interference. If the situation allows, appropriate isolation and shielding can be done;
- Assuming that there are traces with large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power traces), it will also greatly affect the performance of the module. It is recommended to stay away from the module according to the intensity of the interference. If the situation allows, you can make appropriate adjustments. isolation and shielding;
- If the communication line uses 5V level, a 1k-5.1k resistor must be connected in series (not recommended, there is still a risk of damage) ;
- Try to stay away from some TTL protocols whose physical layer is also 2.4GHz, such as USB3.0;
- The antenna installation structure has a great impact on module performance. Make sure the antenna is exposed and preferably vertically upward;
- When the module is installed inside the case, you can use a high-quality antenna extension cable to extend the antenna to the outside of the case;
- The antenna must not be installed inside a metal shell, as this will greatly reduce the transmission distance.

12 FAQ

12.1Transmission distance is not ideal

- When there are straight-line communication obstacles, the communication distance will be correspondingly attenuated ;
- Temperature, humidity, and co-channel interference will cause the communication packet loss rate to increase ;
- The ground absorbs and reflects radio waves, and the test effect is poor when close to the ground ;
- Seawater has a strong ability to absorb radio waves, so the seaside test results are poor ;
- If there are metal objects near the antenna, or if it is placed in a metal case, the signal attenuation will be very serious ;
- The power register setting is wrong and the air rate is set too high (the higher the air rate, the closer the distance) ;
- The low voltage of the power supply at room temperature is lower than the recommended value. The lower the voltage, the smaller the power generated ;
- There is a poor match between the antenna and the module or there is a problem with the quality of the antenna itself.

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12.2 Modules are easily damaged

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

12.3The bit error rate is too high

- If there is co-channel signal interference nearby, stay away from the interference source or modify the frequency or channel to avoid interference;
- Unsatisfactory power supply may also cause garbled code, so be sure to ensure the reliability of the power supply;
- Poor quality or too long extension cords and feeders can also cause a high bit error rate.

13 Welding operation guidance

13.1Reflow soldering temperature

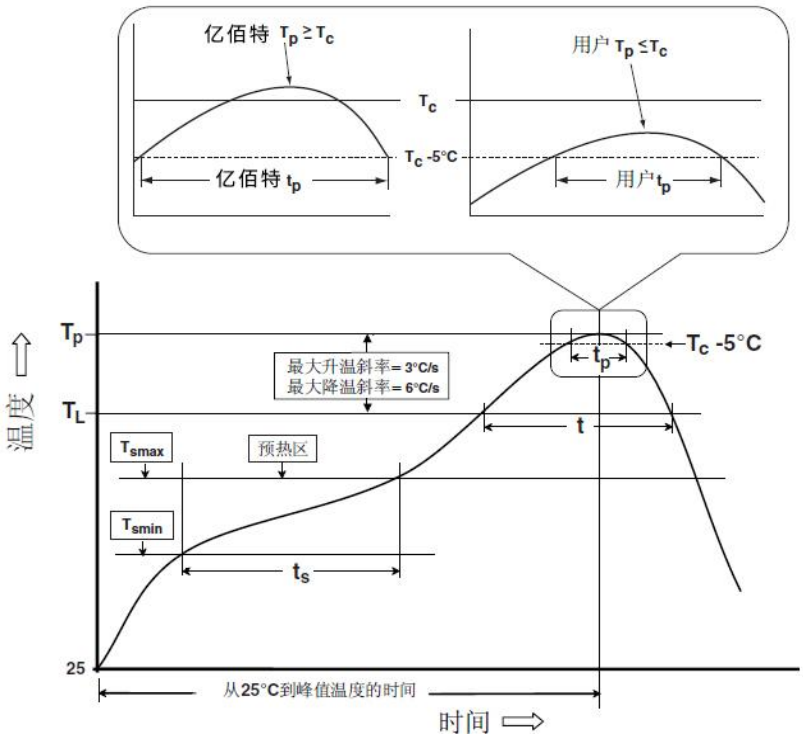
Reflow soldering curve characteristics		Lead process assembly	Lead-free process assembly
Preheat /keep warm	Minimum temperature (Tsmin)	100℃	150℃
	Maximum temperature (T smax)	150℃	200℃
	Time (T smin ~T smin)	60-120 seconds	60-120 seconds
Temperature rise slope (T L ~T p)		3℃/second, maximum	3℃/second, maximum
Liquidus temperature (TL)		183℃	217℃
Holding time above T L		60~ 90 seconds	60~ 90 seconds
Package peak temperature T p		Users should not exceed the temperature indicated on the product's "Moisture Sensitivity" label.	Users should not exceed the temperature indicated on the product's "Moisture Sensitivity" label.
p) within 5°C of the specified classification temperature (Tc) , see the figure below		20 seconds	30 seconds

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Cooling slope (T p ~T L)	6℃/second, maximum	6℃/second, maximum
Time from room temperature to peak temperature	6 minutes, maximum	8 minutes, maximum
※The peak temperature (Tp) tolerance definition of the temperature curve is the upper limit of the user		

13.2 Reflow soldering curve



14 Relat

Product number	carrier frequency Hz	Transmit power dBm	Test distance km	Package form	Product Size mm	Communication Interface
E22-230T22S	230M	twenty two	5	patch	16*26	TTL
E22-230T30S	230M	30	10	patch	20*40.5	TTL
E22-400T22S	433/470M	twenty two	5	patch	16*26	TTL
E22-400T30S	433/470M	30	10	patch	20*40.5	TTL
E22-900T22S	868 / 915M	twenty two	5	patch	16*26	TTL
E22-900T30S	868 / 915M	30	10	patch	20*40.5	TTL
E22-400M22S	433/470M	twenty two	7	patch	14*20	SPI
E22-400M30S	433/470M	30	12	patch	24*38.5	SPI
E22-900M22S	868 / 915M	twenty two	7	patch	14*20	SPI
E22-900M30S	868 / 915M	30	12	patch	24*38.5	SPI

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15 Antenna Guide

15.1 Antenna recommendations

Antennas play an important role in the communication process. Often poor-quality antennas will have a great impact on the communication system. Therefore, our company recommends some antennas as antennas that support our wireless modules and have excellent performance and reasonable prices.

Product number	type	frequency band Hz	interface	Gain dBi	high m m	feeder c m	Features
TX433-NP-4310	flexible antenna	433M	welding	2.0	43.8*9.5	-	Built-in flexible, FPC soft antenna
TX433-JZ-5	glue stick antenna	433M	SMA-J	2.0	52	-	Ultra-short straight, omnidirectional antenna
TX433-JZG-6	glue stick antenna	433M	SMA-J	2.5	6 2	-	Ultra-short straight, omnidirectional antenna
TX433-JW-5	glue stick antenna	433M	SMA-J	2.0	50	-	Bend glue stick, omnidirectional antenna
TX433-JWG-7	glue stick antenna	433M	SMA-J	2.5	75	-	Bend glue stick, omnidirectional antenna
TX433-JK-11	glue stick antenna	433M	SMA-J	2.5	110	-	Bendable glue stick, omnidirectional antenna

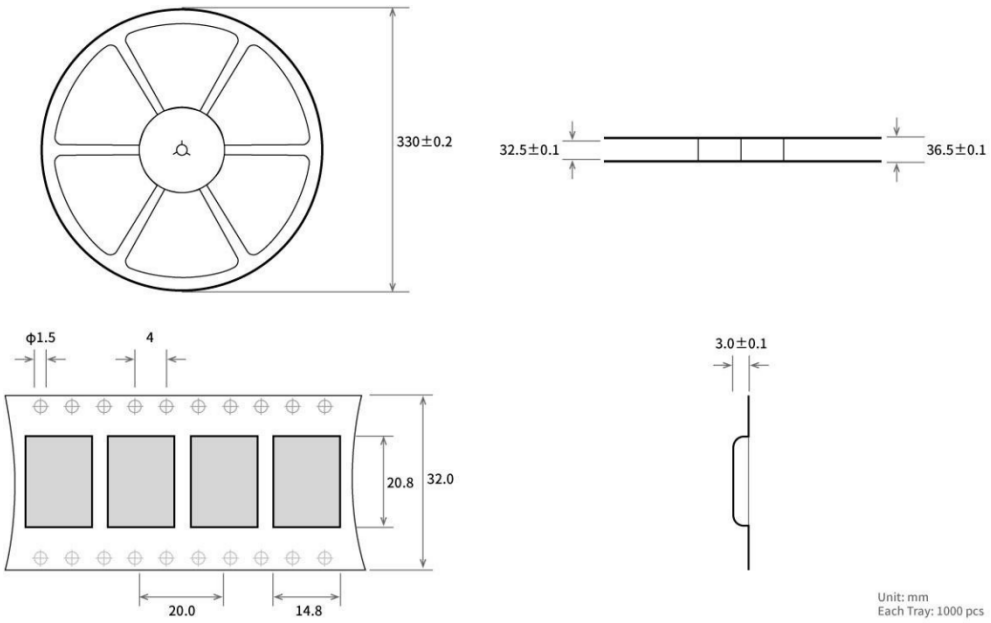
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TX433-JK-20	glue stick antenna	433M	SMA-J	3.0	210	-	Bendable glue stick, omnidirectional antenna
TX433-XPL -100	suction cup antenna	433M	SMA-J	3.5	18 5	100	Small suction cup antenna, cost-effective
TX433-XP-200	suction cup antenna	433M	SMA-J	4.0	19 0	200	Neutral suction cup antenna, low loss
TX433-XPH-300	suction cup antenna	433M	SMA-J	6.0	96 5	300	Large suction cup antenna, high gain
TX490-JZ-5	glue stick antenna	4 7 0 /490 M	SMA-J	2.0	50	-	Ultra-short straight, omnidirectional antenna
TX490-XPL -100	suction cup antenna	4 7 0 /490 M	SMA-J	3.5	12 0	100	Small suction cup antenna, cost-effective

16 Batch packaging methods

16.1 E22-230/400/900T22S batch packaging method



Revise history

Version	Revision date	Revision Notes	Maintenance man
1.0	2024-4-11	initial version	LAU
1.1	2024-6-6	Parameter modification	LAU
1.2	2025-3-14	Parameter modification	LAU

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