E48-433/900T20S User Manual

433/900 MHz SMD wireless module

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Chengdu Ebyte Electronic Technology Co.,Ltd.

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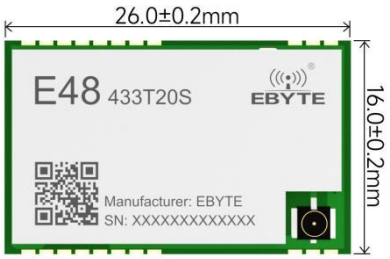
1.Overview

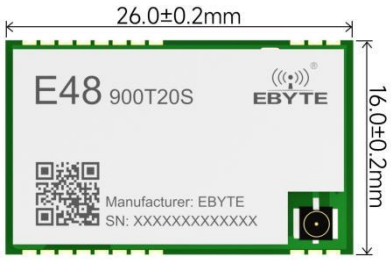
1.1 Introduction

E48-433T20S and E48-900T20S are a cost-effective wireless data transmission module launched by Chengdu Ebyte. It has 4 working modes. It has a variety of transmission methods and can be applied to a variety of application scenarios.

E48-433T20S and E48-900T20S support a maximum transmit power of 20dBm. The module works in the 433MHz/900MHz frequency band, TTL level output, and is compatible with 3.3V IO port voltage. It supports functions such as wake-up over the air, wireless configuration, relay networking, communication keys, etc. At the same time, the module has a data encryption function . Through strict encryption and decryption algorithms, it ensures data security and improves communication reliability and transmission efficiency.



E48-433T20S



E48-900T20S

1.2 Features and functions

- The measured communication distance can reach 3.5 km ;
- The maximum transmit power is 100mW, multi-level software adjustable;
- Support global license-free ISM 433/900 MHz frequency band;
- Support data transmission rate from 2.4 Kbps to 500Kbps;
- Support frequency hopping transceiver and automatic re-transmission function to ensure communication stability;
- Support LBT function, which monitors the channel environment noise before sending, which can greatly improve the communication success rate of the module in harsh environments;
- Support users to set their own communication keys, which cannot be read, greatly improving the confidentiality of user data;
- Support relay networking, multi-level relay is suitable for ultra-long distance communication;
- Support RSSI signal strength indication function, which is used to evaluate signal quality and improve communication networks;
- Support wireless parameter configuration, sends command data packets wirelessly, and remotely configures or reads wireless module parameters;
- Support wake-up over the air, an ultra-low power consumption function, suitable for battery-powered applications;
- Support fixed-point transmission, broadcast transmission, and channel monitoring ;
- Support deep sleep, the power consumption of the whole machine in this mode is about 3.5uA; supports GFSK modulation method;
- Support DC 2.7V~5.5V power supply;
- Industrial-grade standard design, support long-term use at -40 ~ 85 ℃ ;

- Support stamp holes and IPEX antenna interfaces, users can choose to use them according to their own needs.

1.3 Application scenarios

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

2. Specifications

2.1 Limit parameters

RF parameters	unit	model		Remark
		E48-433T20S	E48-900T20S	
Working frequency	MHz	410～450	855～925	Support ISM frequency band
Transmit power	dBm	20±1		Multi-level adjustable according to configuration parameters
Blocking power	dBm	0～10.0		Less likely to be burned if used at close range
Receive sensitivity	dBm	-120±2		Air rate 2.4kbps
Measured distance	km	3.5km		Sunny and open air, antenna gain 3.5 dBi, antenna is put in a height of 2.5 meters, air rate 2.4kbps
air data rate	kbps	2.4～500		Control based on configuration parameters

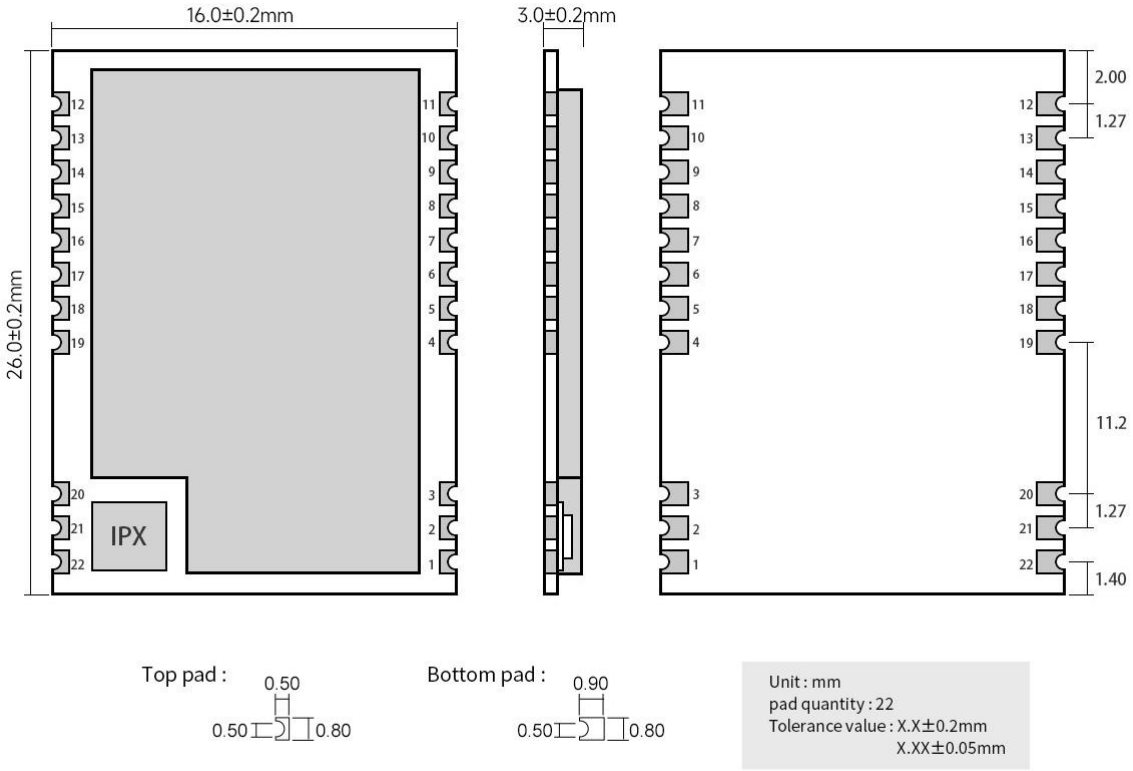
2.2 Working parameters

Electrical parameters	unit	model		Remark
		E48-433T20S	E48-900T20S	
Operating Voltage	V	2.7V~5.5V		＞ 3.3V guarantees output power
Communication level	V	3.3		There is risk of burning out by using 5V TTL
Emission current	mA	95	110	Instantaneous power consumption , @ 5V power supply
receive current	mA	12		@ 5V power supply
Sleep current	u A	3.5		Software shutdown
Operating temperature	℃	-40 ~ +85		Industrial grade

2.3 Hardware parameters

The main parameters	E48-433T20S	E48-900T20S	Remark
Dimensions	26*16mm		-
weight	2.0g		±0.1g
Launch length	58 Byte		Subpackage 58/116 bytes can be set to be sent through instructions
cache capacity	1000 Byte		-
Modulation	GFSK		-
Communication Interface	UART serial port		TTL level
Packaging method	SMD type, stamp hole, pin spacing 1.27mm		-
Antenna interface	IPEX / Stamp Hole		-

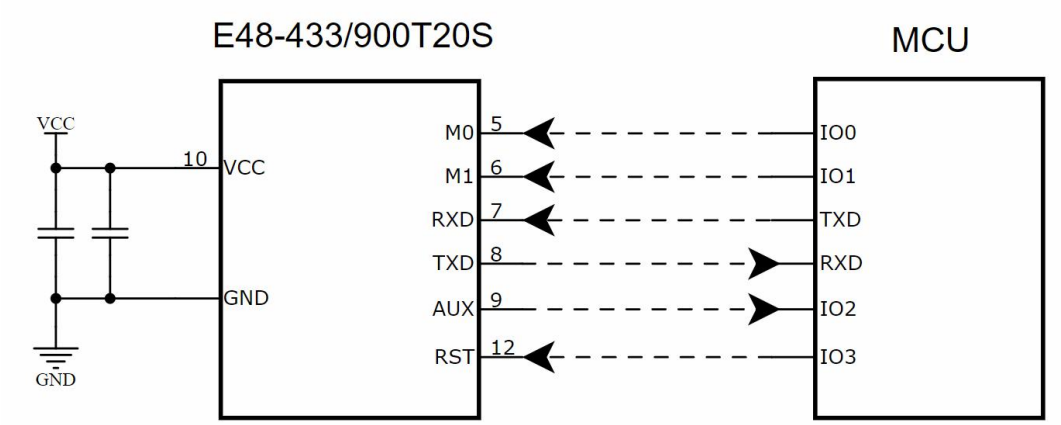
3. Dimensions and pin definitions



Note: The pin definitions of E48-433T20S and E48-900T20S are the same.

Pin #	Pin name	Pin direction	Pin usage
1	GND		Module ground wire
2	GND		Module ground wire
3	GND		Module ground wire
4	GND		Module ground wire
5	M0	Input (very weak pull-up)	Cooperate with M1 to determine the 4 working modes of the module. (Can be left floating, the module contains a pull-up resistor)
6	M1	Input (very weak pull-up)	Cooperate with M0 to determine the 4 working modes of the module. (Can be left floating, the module contains a pull-up resistor)
7	RXD	Input	TTL serial port input, connected to the external TXD output pin;
8	TXD	Output	TTL serial port output, connected to the external RXD input pin;
9	AUX	Output	Used to indicate the working status of the module; For user to wakes up the external MCU and it outputs low level during power-on self-check initialization;
10	VCC		Module power supply positive reference, voltage range: 2.7V~5.5V DC
11	GND		Module ground wire
12	RST	Input	Reset pin, active in low level
13	GND		Module ground wire
14	NC	-	-
15	NC	-	-
16	NC	-	-
17	NC	-	-
18	NC	-	-
19	GND		Module ground wire
20	GND		Module ground wire
21	ANT		Antenna
22	GND		Module ground wire

4. Recommended Connection Diagram



serial #	Brief connection instructions between the module and the micro controller (the above figure takes the STM8L micro controller as an example)
1	The wireless serial port module is TTL level, please connect it to a TTL level MCU.
2	Some 5V microcontrollers may need to add 4~10K pull-up resistors to the TXD and AUX pins of the module.
3	If the RST pin is not used, the RST pin can be left floating

5. Function Detailed Explanation

5.1 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.

5.2 Detailed explanation of AUX

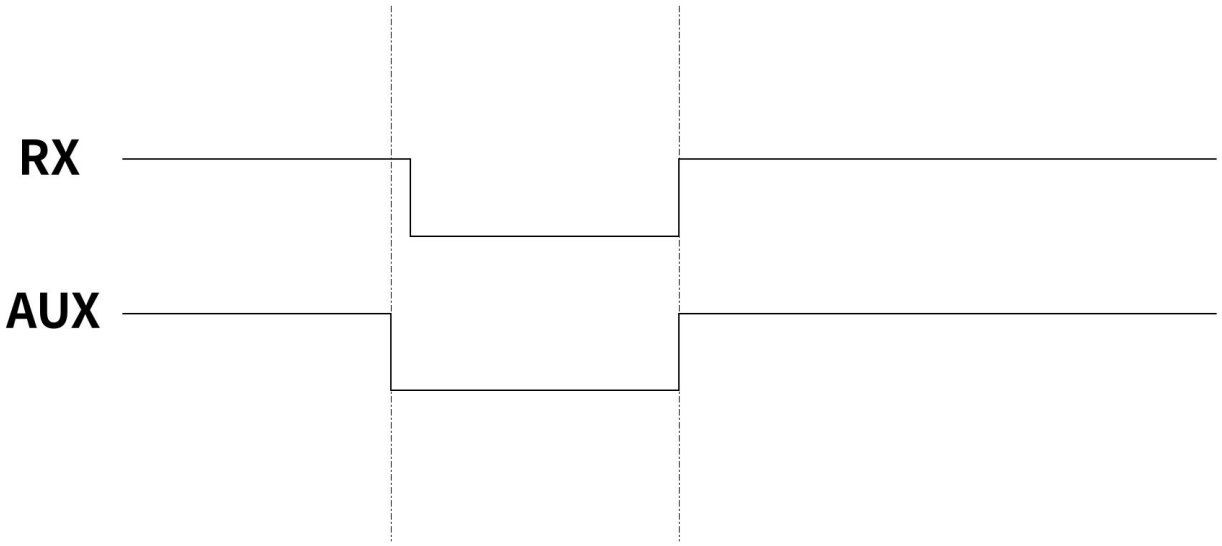
AUX is used for wireless transceiver buffer instructions and self-test instructions.

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.

Note: The picture below only illustrates the AUX function. The time and other specific data involved in the picture do not represent the actual parameters of the module. Please refer to the actual test for specific parameters.

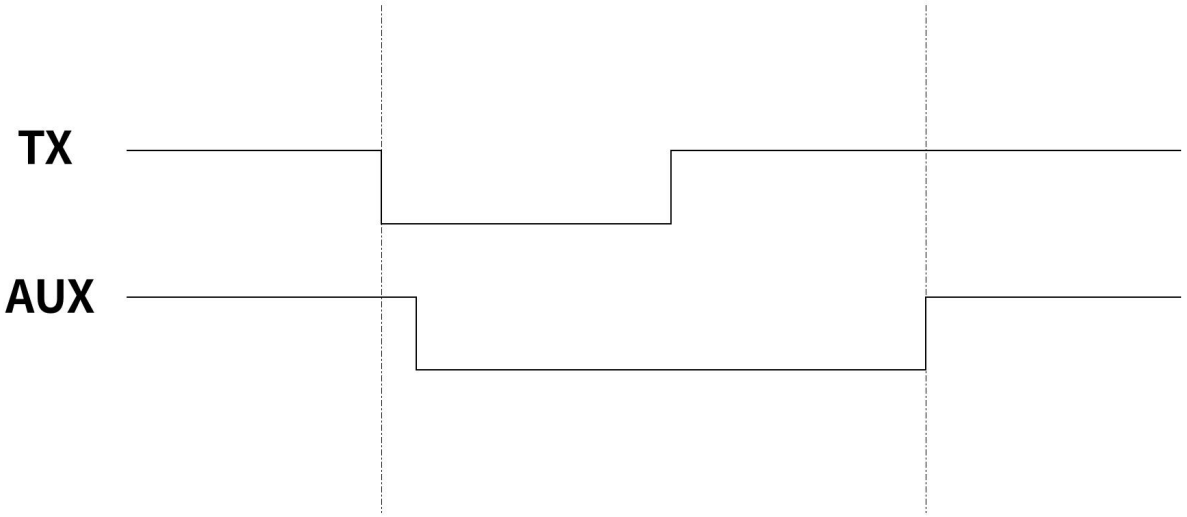
5.2.1 Wireless receiving instructions

After the module receives valid wireless data, it will immediately pull AUX low and start the serial port to output data. After the data output is completed, it will pull AUX high again.



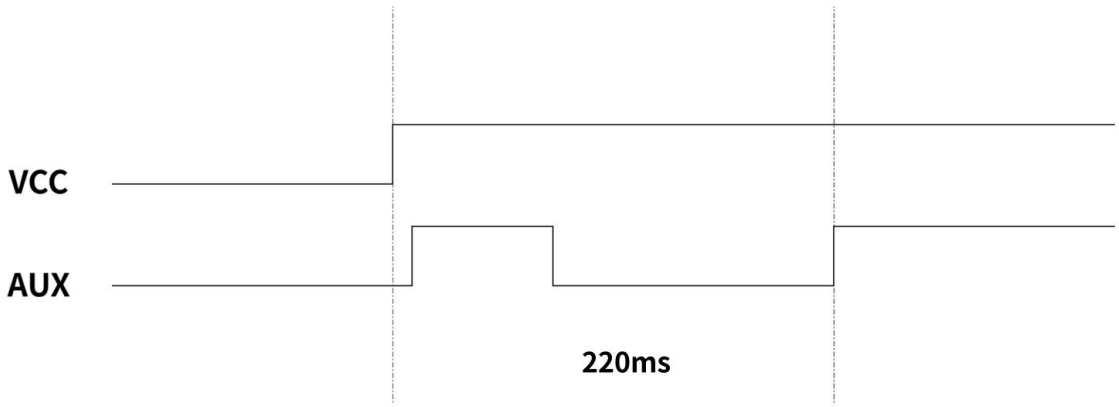
5.2.2 Wireless transmission instructions

After the module receives the serial port data, it will immediately pull AUX low and start sending data wirelessly. After all the data is sent, it will pull AUX high again.



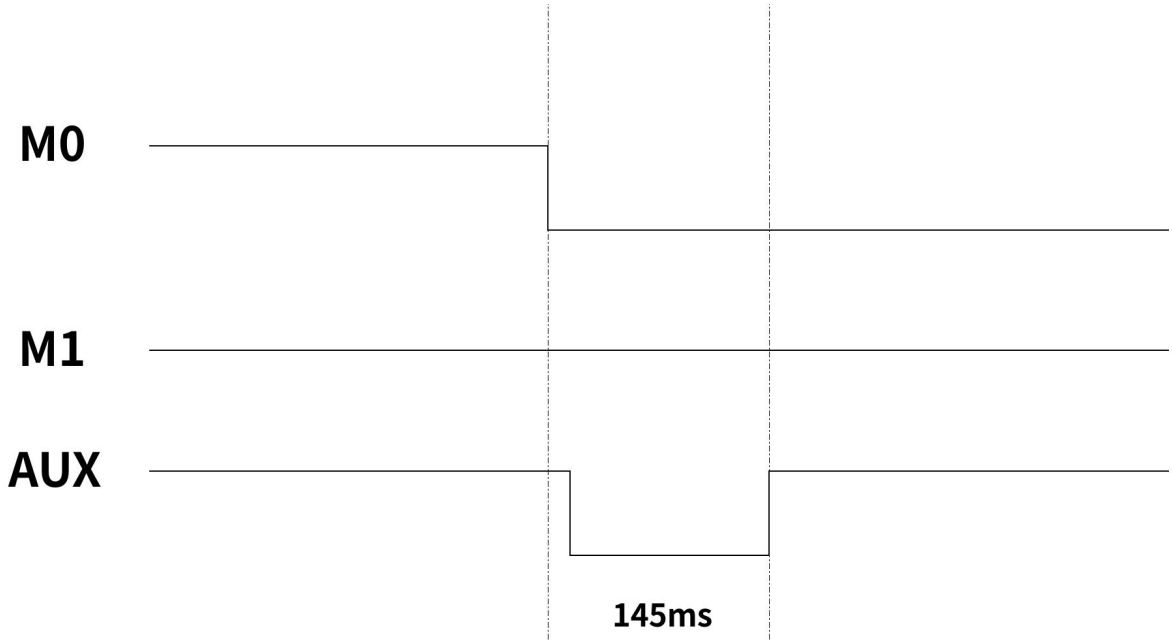
5.2.3 Reset

When resetting or restarting , the module will perform a self-test of about 220ms. It is recommended that users wait for more than 220ms after performing reset and restart actions before performing other operations.



5.2.4 mode switching

When switching modes , the module will perform a self-test of about 145ms. It is recommended that users wait for more than 145ms after performing reset and switching modes before performing other operations.



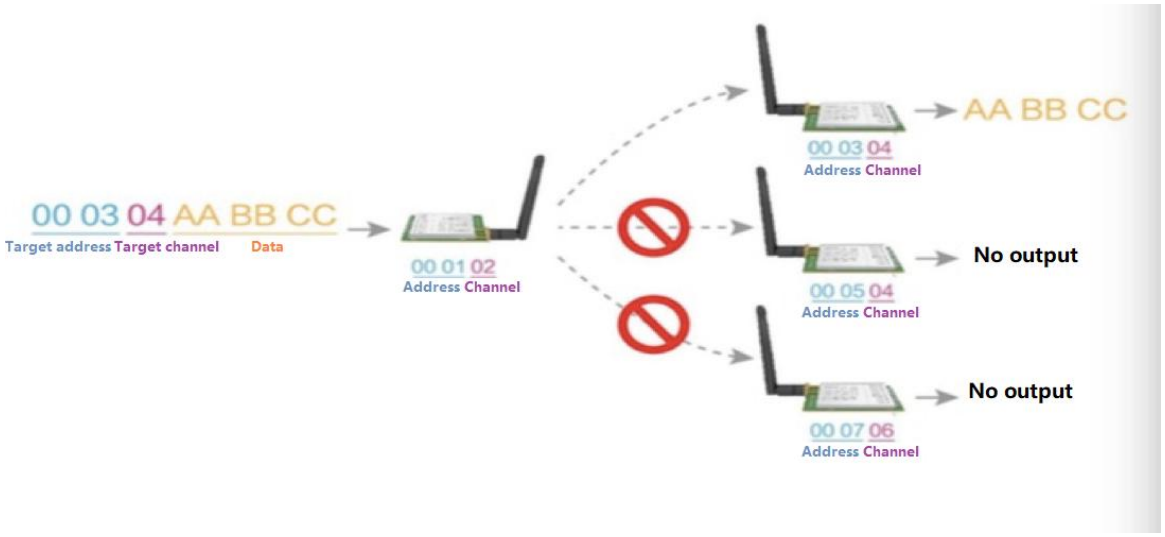
5.3.5 AUX precautions

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 will output high-level.

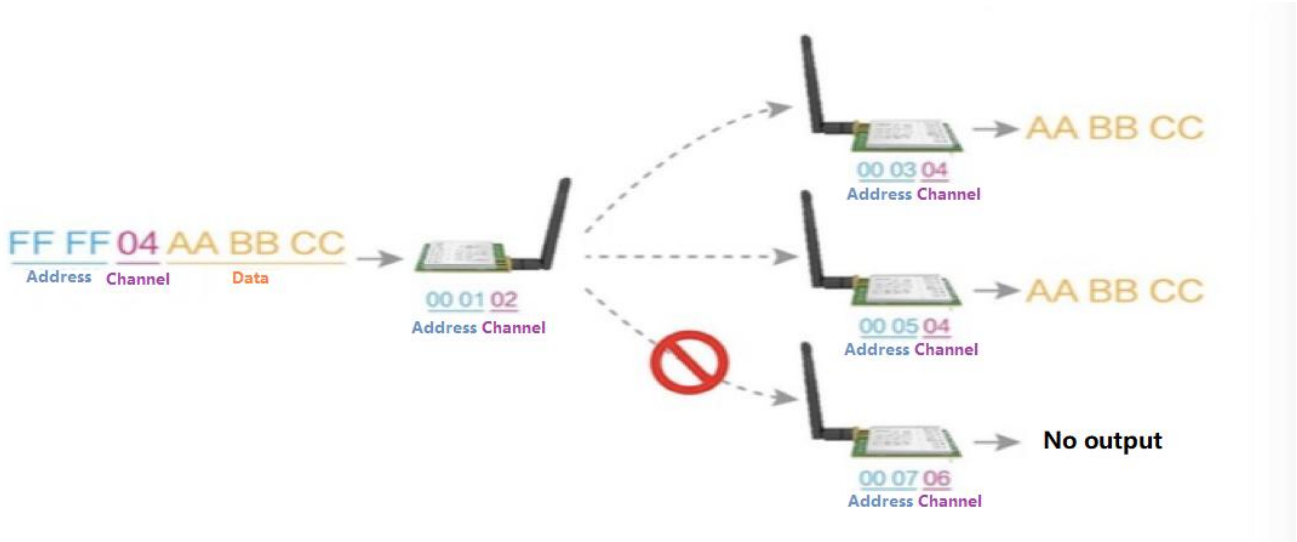
When the AUX outputs a low level, it means that the module is busy, and the working mode detection will not be performed at this time; when the module AUX outputs a high level, the mode switching work will be completed.

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.

5.3.6 Detailed explanation of fixed-point transmission



5.3.7 Broadcast transmission



5.3.8 Broadcast address

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

5.3.9 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.

6. Working Mode

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

Mode (0-3)	M1	M0	Mode introduction	Remark
0 normal mode	0	0	The serial port is turned on, the wireless is turned on, and the module sends and receives data according to the set transmission method.	The transmission methods of both senders and receivers must be consistent , and remote configuration with special instructions is supported.
1 WOR mode	0	1	Can be defined as WOR sender and WOR receiver	Support wake-up over the air
2 configuration mode	1	0	Can receive serial port commands, see the command list, the baud rate is fixed at 9600, 8N1	Parameter configuration
3 sleep mode	1	1	The module enters sleep and standby	Ultra-low power consumption

6.1 Mode switching

- Users can combine M0 and M1 with high and low levels to determine the module working mode. The two GPIOs of the MCU can be used to control mode switching;

After changing M0 and M1:

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 been transmitted wirelessly, after the transmission is completed, it will enter the new working mode;

If the module receives wireless data and sends data out through the serial port, it needs to finish transmission before switching to the new working mode;

so the mode switching can only be effective when AUX outputs 1, otherwise it will delay switching.

- For example: in mode 0, the user continuously inputs a large amount of data and switches modes at the same time. The mode switching operation at this time is invalid; the module will process all user data before performing a new mode detection; so the general recommendations are: Detect the output status of the AUX pin and wait 2ms after the AUX output is high before switching.
- When the module is switched from other modes to sleep mode, if there is data that has not yet been processed, the module will process the data (including receiving and sending) before entering sleep mode. 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 the user's main MCU will be put to sleep immediately. The module will automatically send all user data through wireless and automatically enter sleep within 1ms; thus saving the MCU's working time and reducing power consumption.
- In the same way, any mode switching can use 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 Normal mode to Sleep 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.
- 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. There are 3 transmission modes available in general transmission mode, as described below: Ordinary transmission: sending and receiving without ACK mechanism and frequency hopping mechanism Automatic retransmission: There is an ACK mechanism between the sender and the receiver. The sender will automatically retransmit within the number of retransmissions. The receiver will send a response to the sender after receiving the data. When the sender receives the response from the receiver, it will immediately end retransmission; Frequency hopping transmission: The sender and receiver will do frequency hopping transmission according to the configured channel parameters. Note: In mode 0, the transmission modes of both senders and receivers must be consistent.
Receiving	The module always turns on the wireless receiving function and can receive data packets from mode 0. After receiving the data packet, the module AUX outputs a low level and starts sending wireless data through the serial port TXD pin . Note: In mode 0, the transmission modes of both senders and receivers must be consistent.

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 certain wake-up code will be added before transmitting. When defined as a receiver , data cannot be transmitted.
Receiving	When defined as a transmitter, data from the sender can be received. When defined as a receiver, it can only receive data from the WOR sender.

6.4 Configuration mode (mode 2)

type	When M0 = 0, M1 = 1, the module works in mode 2
Transmitting	No wireless transmission is allowed .
Receiving	Wireless reception is not possible.
Configuration	It can be used to set module parameters. Fixed serial port 9600, 8N1 is used to set module working parameters through specific command formats.
Notice	When going from configuration mode to other mode, the module will reconfigure parameters, and AUX will remain low during configuration; After the completion of the output high level, so it is recommended that the user detect AUX rising edge.

6.5 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.
other	In an ultra-low power consumption state, all other functions of the module are turned off. It will exit sleep mode by switching M0 and M1.

7. Command Format

7.1 Command format

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

No.	Command format	Detailed description
1	Set register	Command: C0+starting address+length+parameters Response: C1+starting address+length+parameters E.g 1: Configure Channel to be 0x09 command starting address length parameter Send: C0 05 01 09 Return: C1 05 01 09 E.g 2: Configure module address (0x1234), network address (0x00), serial port (9600 8N1) and air data rate (2.4K). Send: C0 00 04 12 34 00 62 Return: C1 00 04 12 34 00 62
2	Read register	Command: C1+starting address+ length Response: C1+starting address+length+parameters E.g 1: Read channel command starting address length parameter Send: C1 05 01 Returen: C1 05 01 09 E.g 2: Read module address, network address, serial port and air data rate. Send: C1 00 04 Return: C1 00 04 12 34 00 62
3	Set temporary register	Command: C2+starting address+length+parameters Response: C1+starting address+length+parameters E.g 1: Configure Channel to be 0x09 command starting address length parameter Send: C2 05 01 09 Return: C1 05 01 09 E.g 2: Configure module address (0x1234), network address (0x00), serial port (9600 8N1) and air data rate (2.4K). Send: C2 00 04 12 34 00 62 Return: C1 00 04 12 34 00 62
5	wireless configuration	Command: CF CF + normal command Respond: CF CF + normal respond

		E.g 1: Configure Channel to be 0x09 by wireless configuration Command head command starting address length parameter Send: CF CF C0 05 01 09 Returen: CF CF C1 05 01 09 E.g 2: Configure module address (0x1234), network address (0x00), serial port (9600 8N1) and air data rate (2.4K) by wireless configuration. Send: CF CF C0 00 04 12 34 00 62 Return: CF CF C1 00 04 12 34 00 62
6	wrong format	Format error response FF FF FF

7. 2 Parameter setting instructions

No.	Read and write	Name	Description				Remark
00H	read/write	ADDH	ADDH (default 0)				High byte and low byte in the module address; Note: When the module address is FFFF, it can be used as the 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 the network. When two or more modules need to communicate with each other, their network address should be the same.
03H	read/write	REG0	7	6	5	UART 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	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	Serial port baud rate is 115200	
			4	3	Serial port parity bit		The communication parties can have different serial parity bit.
			0	0	8N1 (default)		
			0	1	8O1		
			1	0	8E1		
			1	1	8N1 (equivalent to 00)		
			2	1	0	Wireless air rate (bps)	The communication parties must have the same air data rate. The higher the air data rate is, the smaller the delay in response, and the shorter the transmission distance is.
			0	0	0	Air data rate 2.4K (default)	
			0	0	1	Air data rate 4.8K	
			0	1	0	Air data rate 9.6k	

			0	1	1	Air data rate 20k	
			1	0	0	Air data rate 50k	
			1	0	1	Air data rate 100k	
			1	1	0	Air data rate 200k	
			1	1	1	Air data rate 500k	
04H	read/write	REG1	7	Sub packet setting			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	58 bytes (default)			
			1	116 bytes			
			6	RSSI environmental noise enable			Enable command (Sub packet settingg and transmit power are as default parameters, in configuration mode): C0 04 01 40 ; After enabling, the command C0 C1 C2 C3 command can be sent in normal mode or WOR send mode to read the register; Register 0x00: Current environmental noise RSSI; Register 0X01: RSSI at Last Data Received (The channel noise return value is the complement of an 8-bit signed number. For example, the obtained value is 0x80, and the actual value is -128); Command 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 00)**
			0	Disabled (default)			
			1	Enable			
			5	FEC function			Both communication parties must turn on or turn off the FEC function at the same time
			0	Disabled (default)			
			1	Enable			
			4	3	Transmission method in normal mode		It only takes effect in normal mode, and the transmission mode of both communication parties must be the same.
			0	0	Normal transmission (default)		
			0	1	Automatic re-transmission		
			1	0	Frequency hopping transmission		
			1	1	Normal transmission, equivalent to (00)		
			2	Software switching mode			You can use specific commands to switch the module working mode, but after enabling it, the baud rate is fixed at 9600bps in all working modes of the module.
			0	Disabled			
			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 in proportion to the decrease in power.
			0	0	20dBm (default)		
			0	1	17dBm		
			1	0	14dBm		
			1	1	11dBm		
05H	read/write	REG2	Channel control (CH) , actual frequency = starting frequency + CH*1MHz				433 frequency band support range: 0x00～0x28
							900 frequency band support range: 0x00～0x46
06H	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. Obtain the value as the complement of an 8-bit signed number. For example, if the value is 0x80, the actual value is -128.
			0	Disabled (default)			
			1	Enable			

<table>
<tr><td rowspan="20"></td><td rowspan="20"></td><td rowspan="20"></td><td>6</td><td colspan="4">Transmission method</td><td rowspan="4">During fixed-point transmission, the module will identify the three bytes of serial port data as: address high + address low + channel, and use it as a wireless transmission target.</td></tr>
<tr><td>0</td><td colspan="4">Transparent transmission (default)</td></tr>
<tr><td>1</td><td colspan="4">Fixed point transmission</td></tr>
<tr><td>5</td><td colspan="4">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="4">Disable relay functionality (default)</td></tr>
<tr><td>1</td><td colspan="4">Enable relay function</td></tr>
<tr><td>4</td><td colspan="4">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. The wireless data will be transmitted forcibly after 2 seconds.</td></tr>
<tr><td>0</td><td colspan="4">Disabled (default)</td></tr>
<tr><td>1</td><td colspan="4">enable</td></tr>
<tr><td>3</td><td colspan="4">WOR mode transceiver control</td><td rowspan="3">Only valid for mode 1</td></tr>
<tr><td>0</td><td colspan="4">WOR 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="4">WOR 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 colspan="2">WOR cycle grading</td><td rowspan="9">Only valid for mode 1;

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

The sending and receiving parties must be consistent (very important) ;

The cycle time is different at different air data rate, see the description below for details.</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td colspan="2">Level 0</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td colspan="2">Level 1</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td colspan="2">Level 2</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td colspan="2">Level 3</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td colspan="2">Level 4</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td colspan="2">Level 5</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td colspan="2">Level 6</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td colspan="2">Level 7</td></tr>
<tr><td rowspan="4">07H</td><td rowspan="4">read/write</td><td rowspan="4">REG4</td><td>7</td><td>6</td><td>5</td><td>4</td><td>reserve</td><td></td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>3</td><td>2</td><td>1</td><td>0</td><td>Number of automatic re-transmission</td><td rowspan="2">Automatic re-transmission only takes effect in normal mode</td></tr>
<tr><td colspan="6">Default 3</td></tr>
<tr><td>08H</td><td>write</td><td>CRYPT_H</td><td colspan="6">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>09H</td><td>write</td><td>CRYPT_L</td><td colspan="6">Key low byte (default 0)</td></tr>
<tr><td>80H～86H</td><td>read</td><td>PID</td><td colspan="6">Product information 7 bytes</td><td>Product information 7 bytes</td></tr>
</table>

7.3 Factory default parameters

model	Factory default parameters						
Module model	frequency	address	channel	Air data rate	baud rate	parity format	transmit power
E48-433T20S	433.00MHz	0x0000	0x17	2.4kbps	9600	8N1	20dBm
E48-900T20S	868.00MHz	0x0000	0x0D	2.4kbps	9600	8N1	20dBm

7.4 The specific time (ms) relationship between WOR cycle classification and air data rate (Kbps)

Air / cycle	2.4Kbps	4.8Kbps	9.6Kbps	20Kbps	50Kbps	100Kbps	200Kbps	500Kbps
Level 0	500ms	500ms	500ms	500ms	500ms	500ms	300ms	125ms
Level 1	1000ms	1000ms	1000ms	1000ms	1000ms	1000ms	600ms	250ms
Level 2	1500ms	1500ms	1500ms	1500ms	1500ms	1500ms	900ms	375ms
Level 3	2000ms	2000ms	2000ms	2000ms	2000ms	2000ms	1200ms	500ms
Level 4	2500ms	2500ms	2500ms	2500ms	2500ms	2500ms	1500ms	625ms
Level 5	3000ms	3000ms	3000ms	3000ms	3000ms	3000ms	1800ms	750ms
Level 6	3500ms	3500ms	3500ms	3500ms	3500ms	3500ms	2100ms	875ms
Level 7	4000ms	4000ms	4000ms	4000ms	4000ms	4000ms	2400ms	1000ms

8. AT command

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 commands 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.

8.1 AT command list

Command commands:

Command commands	Description	Example	Example description
AT+IAP	Enter IAP upgrade mode	AT+IAP	Enter IAP upgrade mode
AT+REST	Device restart	AT+REST	Device restart
AT+DEFAULT	Configured parameters are restored to default values and the device is restarted.	AT+DEFAULT	Configured parameters are restored to default values and the device is restarted.

Setting commands:

Setting commands	Description	Example	Example description
AT+UART=baud,parity	Set serial port and baud rate	AT+UART=3,0	Set the baud rate to 9600, 8N1
AT+RATE=rate	Set air data rate	AT+RATE=7	Set air data rate to 500K
AT+PACKET=packet	Set packet length	AT+PACKET=0	Set the packet length to 58
AT+WOR=role	Set up WOR role	AT+WOR=0	Set WOR role as receiver
AT+WTIME=period	Set WOR cycle level	AT+WTIME=0	Set the WOR cycle level to 0
AT+POWER=power	Set transmit power	AT+POWER=0	Set the transmit power to 20dBm
AT+TRANS=trans	Set the transmission method of normal mode	AT+TRANS=0	Set the transmission method of normal mode to normal transmission
AT+ROUTER=router	Set relay mode	AT+ROUTER=1	Set to relay mode
AT+LBT=lbt	Set the Listen Before Talk function switch	AT+LBT=1	Set the Listen Before Talk function enabled
AT+ERSSI=erssi	Set the environmental noise RSSI switch	AT+ERSSI=1	Set the environmental noise RSSI function enabled
AT+DRSSI=drssi	Set the receive data RSSI switch	AT+DRSSI=1	Set the receive data RSSI function enabled
AT+ADDR=addr	Set module address	AT+ADDR=1234	Set the module address to 1234
AT+CHANNEL=chan	Set module working channel	AT+CHANNEL=10	Set the module working channel to 10
AT+FEC=fec	Set FEC function switch	AT+FEC=1	Set the FEC function enabled
AT+PTOP=ptop	Set fixed-point transmission switch	AT+PTOP=1	Set the fixed-point transmission function enabled
AT+RESEND=resend	Set the number of automatic re-transmission	AT+RESEND=10	Set the number of automatic retransmission to 10
AT+NETID=netid	Set network ID	AT+NETID=1234	Set the network ID to 1234
AT+KEY=key	Set module key	AT+KEY=2345	Set the module key to 2345
AT+SWITCH=switch	Setting software mode switch	AT+SWITCH=1	Setting software switching mode function enabled

Query command:

Query command	describe	Return example	Example description
AT+HELP=?	Query AT command table		Return AT command list
AT+DEVTYPE=?	Query module model	DEVTYPE=E48-400T20S	Return module model
AT+FWCODE=?	Query module firmware code	FWCODE=7396-0-14	Return firmware version
AT+UART=?	Query serial port baud rate and verification	AT+UART=3,0	Return baud rate 9600, 8N1
AT+RATE=?	Query air data rate	AT+RATE=7	Return air data rate 500K
AT+PACKET=?	Query sub packet length	AT+PACKET=0	Return packet length 58byte
AT+WOR=?	Query WOR role	AT+WOR=0	Return WOR role as receiver
AT+WTIME=?	Query WOR cycle level	AT+WTIME=0	Returns WOR cycle level 0
AT+POWER=?	Query transmit power	AT+POWER=0	Return transmit power 20dBm
AT+TRANS=?	Query the transmission mode in normal mode	AT+TRANS=0	Return the transmission mode in normal mode as normal transmission.
AT+ROUTER=?	Query relay mode	AT+ROUTER=1	Return relay mode
AT+LBT=?	Query the Listen Before Talk function switch	AT+LBT=1	Return Listen Before Talk function enabled
AT+ERSSI=?	Query the environmental noise RSSI switch	AT+ERSSI=1	Return the environmental noise RSSI function enabled
AT+DRSSI=?	Query the receive data RSSI switch	AT+DRSSI=1	Return the receive data RSSI function enabled
AT+ADDR=?	Query module address	AT+ADDR=1234	Return module address 1234
AT+CHANNEL=?	Query module working channel	AT+CHANNEL=10	Return module working channel 10
AT+FEC=?	Check whether the FEC function is enabled	AT+FEC=1	Return FEC function enabled
AT+PTOP=?	Query the fixed-point transmission function switch	AT+PTOP=1	Return the fixed-point transmission function enabled
AT+RESEND=?	Query the number of automatic re-transmission	AT+RESEND=10	Returns the number of automatic re-transmission 10
AT+NETID=?	Query module network ID	AT+NETID=1234	Return module network ID 1234
AT+KEY=?	Query module key	AT+KEY=2345	Return module key 2345
AT+SWITCH=?	Query software switching mode function switch	AT+SWITCH=1	Return software switching mode function enabled

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 (air data rate)	0:2.4kbps 1:4.8kbps 2:9.6kbps 3:20kbps 4:50kbps 5:100kbps 6:200kbps 7:500kbps
packet (packet length)	0:58bytes 1:116bytes
role (WOR role)	0:receiver 1:transmitter
period (WOR period level)	0:Level 0 1:Level 1 2:Level 2 3:Level 3 4:Level 4 5:Level 5 6:Level 6 7:Level 7
power (transmit power)	0:11dBm 1:14dBm 2:17dBm 3:20dBm
trans (transmission mode in normal mode)	0: Normal transmission 1: Automatic re-transmission 2: Frequency hopping transmission 3: Normal transmission
router (relay mode switch)	0: off 1: on
lbt (Listen Before Talk function switch)	0: off 1: on
erssi (environmental noise rssi switch)	0: off 1: on
drssi (receive data rssi switch)	0: off 1: on
addr (module address)	The setting value does not exceed 65535
chan (module working channel)	The setting value varies according to different frequency bands.
fec (FEC function switch)	0: off 1: on
ptop (fixed point sending switch)	0: off 1: on
re-transmission (number of automatic re-transmission in normal mode)	Set to 0~15
netid (network ID)	Set value no more than 255
key (module key)	The setting value does not exceed 65535
switch (software switching mode function switch)	0: off 1: on

8.3 Precautions for IAP upgrade

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, and please do not use the "AT+IAP" command .

The necessary pins for the upgrade must be drawn out (M1, M0, AUX, TXD, RXD, VCC, GND), and then send the command command "AT+IAP" to enter the upgrade mode. If you need to exit the IAP upgrade mode, you need to keep power on and wait for 60 seconds. The program will automatically exit. Otherwise, even if you restart the device, it will enter unlimited upgrade mode.

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. Use of relay networking mode

No.	Relay mode description
1	After setting the relay mode through the configuration mode, switch it to the normal mode and the relay starts to work. WOR mode does not support the use of relays.
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 relay networking rules:

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

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

As shown in the picture:

①Level 1 relay

"Node 1" NETID is 08.

"Node 2" NETID is 33.

The ADDH\ADDL of relay 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.

②Level 2 relay

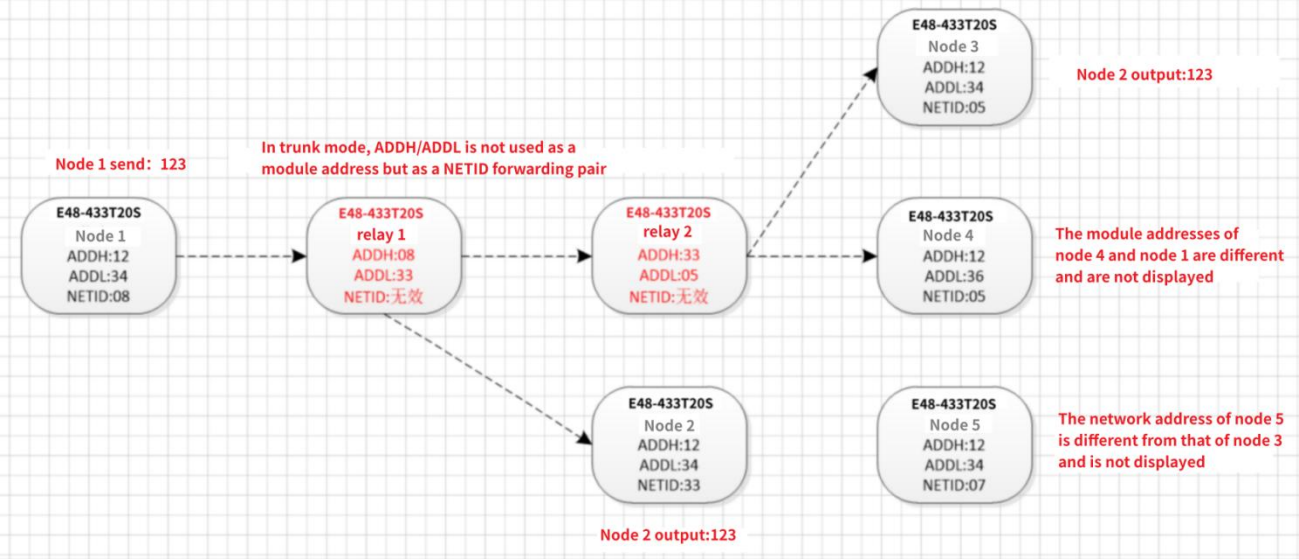
The ADDH\ADDL of relay 2 are 33 and 05 respectively.

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, 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.



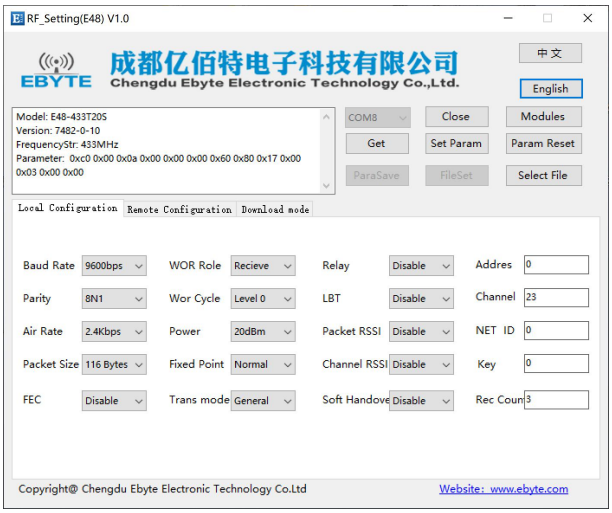
10. Hardware Design

- 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 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 wiring, high-frequency analog wiring, and power wiring must avoid the bottom of the module. If it is absolutely necessary to pass under the module, assuming that the module is welded on the Top Layer, lay copper on the Top Layer of the module contact part (all copper and well grounded), it 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, 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.

11. Host computer Configuration Instructions

- The picture below shows the display interface of E48 - XXXT20S configuration on host computer. Users can switch to command mode through M0 and M1 for quickly configuration and read parameters on the host computer.



- 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: 0～83

  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, in the configure software, if the network ID of Transmitter A is input 02, and the network ID of Receiver B is input 10, then the module address of Relay R should be set as 522. (The address of Relay R is 0X020A in hex, and it need to be converted to decimal.)

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

11. Frequently Asked Questions

11.1 Transmission distance is short

- 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.

11.2 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.
- If there are no special needs, it is not recommended to use it at a too high or too low temperature.

11.3 Bit error rate is too high

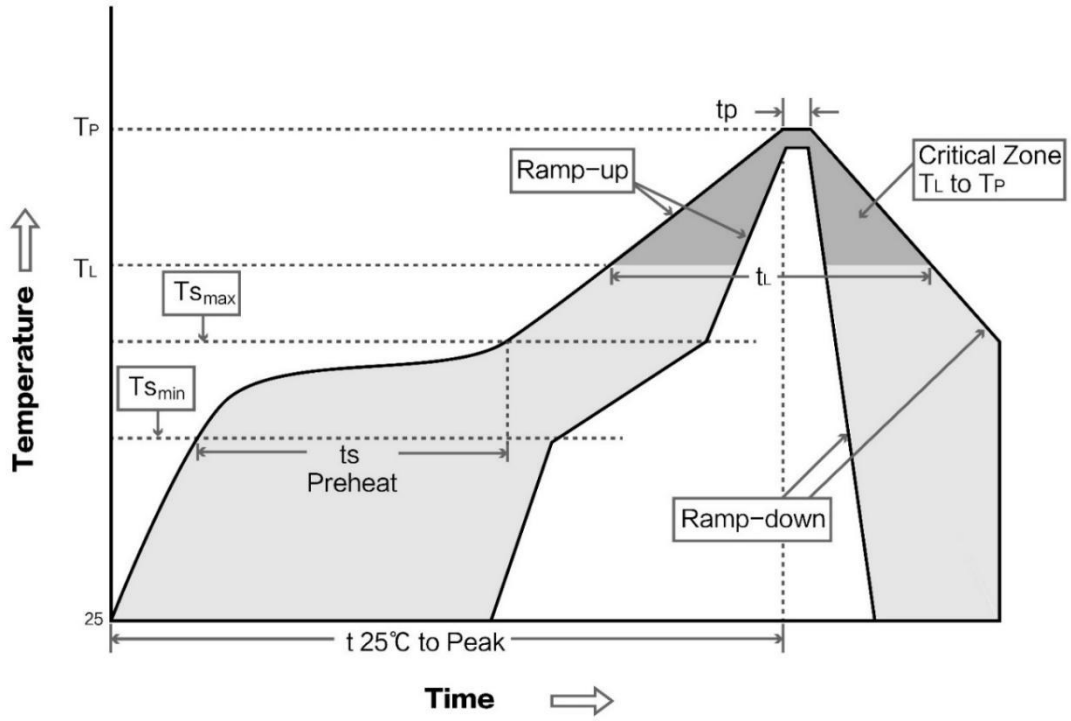
- If there is co-channel signal interference nearby, stay away from the interference source or modify the frequency or channel to avoid interference;
- Unsatisfactory power supply may also cause garbled code, so be sure to ensure the reliability of the power supply;
- Poor quality or too long extension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

12. Welding Operation Guidance

12 .1 Reflow soldering temperature

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

12.2 Reflow soldering curve



13. Related Models

Product number	Carrier frequency (Hz)	Transmit power (dBm)	Test distance (km)	Air data rate (bps)	Package form	Product size (mm)	Antenna form
E48-xxxT20S	433M	20	1	1.2k~200k	SMD	26*16	IPEX/stamp hole

14. Antenna Guide

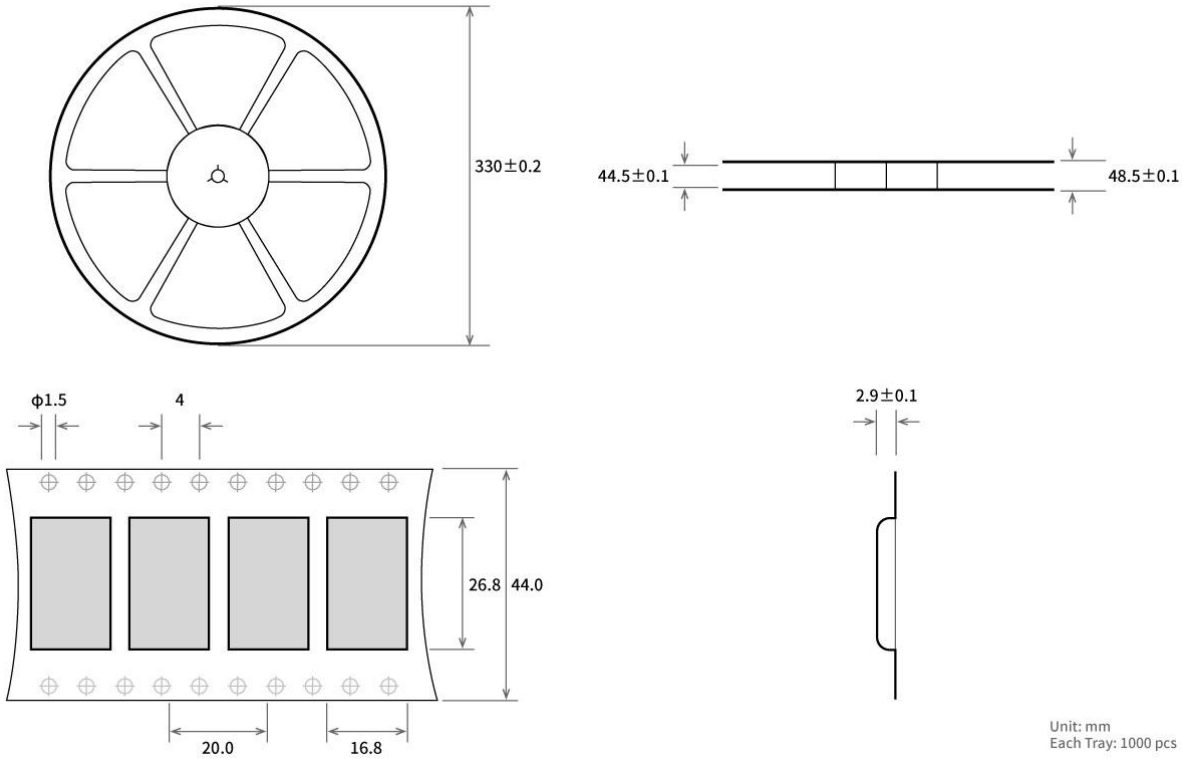
14.1 Antenna recommendations

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	Height mm	feeder	Features
TX433-PCB-4310	flexible antenna	433M	SMA-J	2	43.8*9.5	-	Built-in flexible PCB antenna
TX433-JW-5	rubber antenna	433M	SMA-J	2	50	-	Bendable rubber, omnidirectional antenna
TX433-JWG-7	rubber antenna	433M	SMA-J	2.5	75	-	Bendable rubber, omnidirectional antenna
TX433-JK-20	rubber antenna	433M	SMA-J	3	210	-	Bendable rubber, omnidirectional antenna
TX433-JK-11	rubber antenna	433M	SMA-J	2.5	110	-	Bendable rubber, omnidirectional antenna
TX433-XP-200	sucker antenna	433M	SMA-J	4	190	2m	sucker antenna, high gain
TX433-XP-100	sucker antenna	433M	SMA-J	3.5	185	1m	sucker antenna, high gain
TX433-XPH-300	sucker antenna	433M	SMA-J	6	965	3m	Car sucker antenna, ultra-high gain
TX433-JZG-6	rubber antenna	433M	SMA-J	2.5	52	-	Ultra-short straight, omnidirectional antenna
TX433-JZ-5	rubber antenna	433M	SMA-J	2	52	-	Ultra-short straight, omnidirectional antenna
TX490-XP-100	sucker antenna	490M	SMA-J	50	120	1m	sucker antenna, high gain

TX490-JZ-5	rubber antenna	490M	SMA-J	50	50	-	Ultra-short straight, omnidirectional antenna
TX 868 -JZ-5	rubber antenna	868 M	SMA-J	2.0	52	-	Ultra-short straight, omnidirectional antenna
TX 868 -JK-20	rubber antenna	868 M	SMA-J	3.0	210	-	Bendable rubber, omnidirectional antenna
TX 868 - XPL -100	sucker antenna	868 M	SMA-J	3.5	290	1m	Small sucker antenna, high cost performance
TX 915 -JZ-5	rubber antenna	915 M	SMA-J	2.0	5 2	-	Ultra-short straight, omnidirectional antenna
T X915-JK-11	rubber antenna	915M	SMA-J	2.5	1 10	-	Bendable rubber, omnidirectional antenna
T X915-JK-20	rubber antenna	915 M	SMA-J	3.0	210	-	Bendable rubber, omnidirectional antenna
TX 915 -XP L -100	sucker antenna	915 M	SMA-J	3.5	290	1m	Small sucker antenna, high cost performance

15. Batch Packaging Methods



Revise history

Version	Revision date	Revision Notes	Maintenance man
V1.0	2024-04-24	first edition	Bin
V1.1	2024-10-10	Content revision	Bin

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