E32-xxxT30x Product Specification

AT Command 30dBm LoRa Wireless Module

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Catalogs

Disclaimer and Copyright Notice 4
Ⅰ Product Overview 5
1.1 Product Description 5
1.2 Features 5
1.3 Application Scenarios 6
Ⅱ Specification 6
2.1 RF parameters 6
2.2 Electrical parameters 7
2.3 Hardware Parameters 7
Ⅲ Mechanical Dimensions and Pin Definitions 8
3.1 E32-400/900T30S Mechanical Dimensions and Pin Definitions 8
3.2 E32-400/900T30D Mechanical Dimensions and Pin Definitions 10
Ⅳ Recommended Connecting Charts 11
Ⅴ Functions in detail 12
5.1 Transmit at a fixed point 12
5.2 Broadcast Emission 12
5.3 Broadcast Address 13
5.4 Listening address 13
5.5 Module reset 13
5.6 AUX Explained 13
5.6.1 Serial data output indication 13
5.6.2 radio transmission indication 14
5.6.3 Module is in the process of being configured 14
5.6.4 notes: 14
Ⅵ Working mode 15
6.1 Mode switching precautions 15
6.2 General mode (mode 0) 16
6.3 WOR mode (mode 1) 16
6.4 Power saving mode (mode 2) 17
6.5 Deep sleep mode (mode 3) 17
Ⅶ Register read/write control 18
7.1 Command Introduction 18
7.2 Reading of operating parameters 18
7.3 Version number reading 18
7.4 Reset command 19
7.5 E32-xxxT30x Register Description 19
7.6 Factory Default Parameters 21
Ⅷ AT command 21
8.1 AT Command Table 21
8.2 AT Parameter Analysis 23
8.3 Serial Port Upgrade Firmware Notes 24
Ⅸ Configuration instructions for the host computer 24
Ⅹ Hardware Design 25

XI Frequently Asked Questions 26
11.1 Unsatisfactory transmission distance 26
11.2 Modules are vulnerable 26
11.3 BER is too high 26
11.4 Antenna Selection 27
XII Welding instructions 27
12.1 Reflow temperature 27
12.2 Reflow Profile 28
XIII Related Models ..... 错误！未定义书签。
XIV Antenna Guide ..... 错误！未定义书签。
14.1 Antenna Recommendations ..... 错误！未定义书签。
XV Batch packing method 29
15.1 E32-433/900T30S Batch packing method 29
15.2 E32-433/900T30D Batch packing method 29
Revision history 30
About us 30

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Ⅰ Product Overview

1.1 Product Description

E32-xxxT30x series (UART) modules are based on SEMTECH's classic RF chip, with a transmit power of 30dBm, multiple transmission modes, working frequency bands in 400 and 900 bands, LoRa spread spectrum technology, TTL level output, and compatibility with 3.3V IO port voltage.

The E32-xxxT30x utilizes the new generation of LoRa spread spectrum technology, LoRa™ direct-sequence spread spectrum technology has the advantage of longer communication distance, strong anti-jamming ability, and strong confidentiality. The factory default air rate is 2.4kbps, the transmit power is 30dBm, with PA power amplifier and LNA low-noise amplifier, which improves the communication stability and extends the communication distance; the industrial-grade active temperature-compensated crystals are used to ensure its stability and consistency. At present, it has been in stable mass production, and has been applied to a large number of three-meter industry, IOT transformation, smart home and other fields.

The following four modules have the same power and different frequency bands.

Figure 1：E32-433T30S

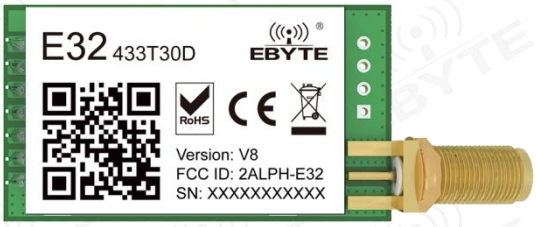


Figure 2：E32-433T30D

Figure 3：E32-900T30S

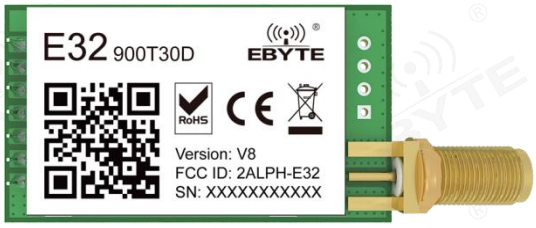


Figure 4：E32-900T30D

1.2 Features

- adopts the new generation LoRa spread spectrum modulation technology, which brings longer communication distance and stronger anti-interference ability;
- supports serial port to upgrade firmware, which makes updating firmware more convenient;
- supports AT command, which is more convenient to use;
- supports FEC forward error correction, improving communication stability;
- supports global license-free ISM 433MHz band;

- supports 868/915MHz EU common frequency band;
- supports users to set their own communication key, and it cannot be read, which greatly improves the confidentiality of user data;
- Supports Wake-on-Air, i.e. ultra-low power consumption function, suitable for battery-powered application solutions;
- supports fixed-point transmission, broadcast transmission and channel listening;
- Supports deep sleep, the power consumption of the whole machine is about 3uA under this mode;
- The communication distance can reach 8km under ideal conditions;
- Parameters are saved after power down, and the module will work according to the set parameters after power up again;
- supports 2.4K～19.2Kbps data transmission rate;
- supports 2.7~5.5V power supply, more than 5V power supply can ensure the best performance;
- industrial-grade standard design, support -40 ~ +85 ℃ long time use;
- module power up to 1W (30dBm), transmission farther and more stable.

1.3 Application Scenarios

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

Ⅱ Specification

2.1 RF parameters

RF parameters	unit (of measure)	performances			note
		minimum value	typical value	maximum values	
Maximum Transmit Power	dBm	29.5	30	30.5	-
receiver sensitivity	dBm	-133	-134	-135	Air rate of 2.4kbps
reference distance	M	-	8K	-	Clear and open, antenna gain 5dBi, antenna height 2.5 meters, air rate 2.4kbps.
operating	MHz	410	433	441	Suitable for E32-433T30S,

frequency					E32-433T30D.
	MHz	862	900	930	Suitable for E32-900T30S, E32-900T30D.
air speed	bps	2.4K	2.4K	19.2K	User Programmable Controls
blocking power	dBm	-	-10	-	Less probability of burnout in close proximity

2.2 Electrical parameters

Electrical parameters		unit (of measure)	Model			note
			minimum value	typical value	maximum values	
operating voltage		V	2.7	5.0	5.5	Output power is guaranteed at ⩾ 5V, above 5.5V the module is permanently fried.
communications level		V	-	3.3V	-	Risk of burn-in using 5V TTL
power consumption	response current (electricity)	mA	460	518	563	Instantaneous power consumption @30dBm
	Receiving Current	mA	-	14	-	
	Sleep Current	uA	2.9	3.0	3.2	software shutdown
temperature	operating temperature	℃	-40～+85			Industrial-grade design
	Storage temperature	℃	-40～+85			Industrial-grade design

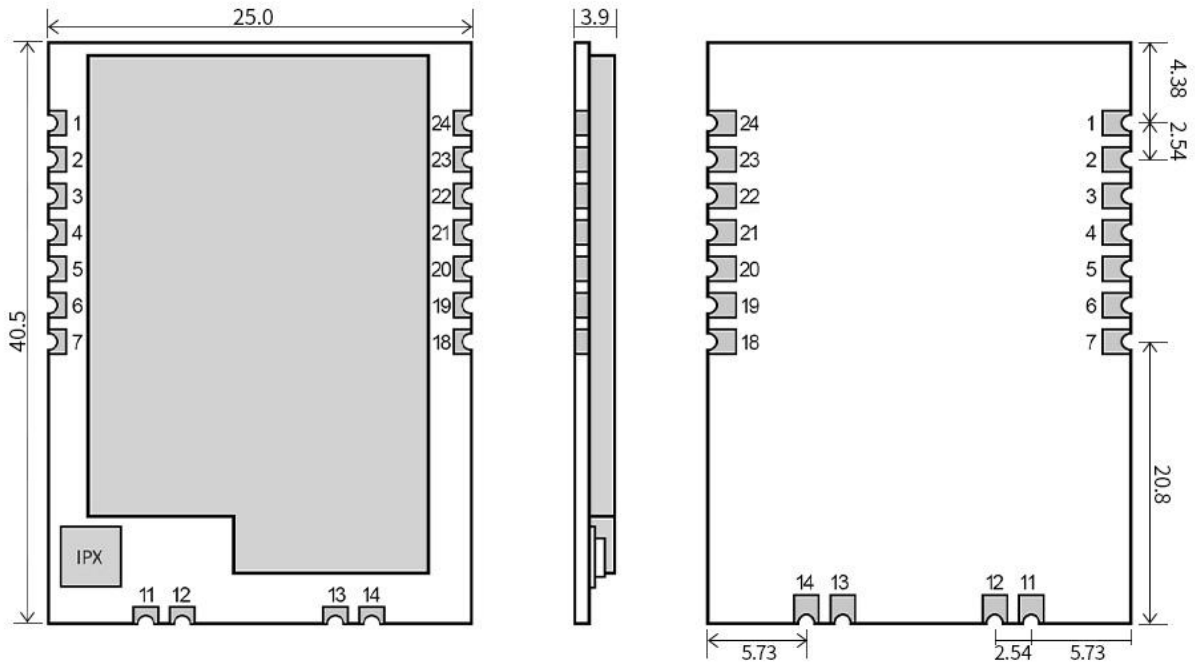
2.3 Hardware Parameters

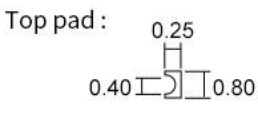
Hardware parameters	Model				Notice
	E32-433T30S	E32-433T30D	E32-900T30S	E32-900T30D	
modulation method	LoRa				New generation of LoRa modulation technology
interface method	1.27mm stamp hole	Pin Inserts	1.27mm stamp hole	Pin Inserts	
communicati	UART serial port				TTL level

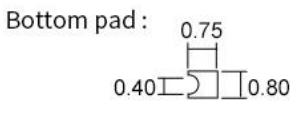
ons interface					
launch length	58 Btye				Maximum capacity of a single package, automatically divided into packages after exceeding it
Package	SMD				-
cache capacity	512Btye				-
Antenna Interface	IPEX/Stamp Hole	SMA-K	IPEX/Stamp Hole	SMA-K	Equivalent impedance approx. 50Ω
sizes	40.5 * 25 mm	43 * 24 mm	40.5 * 25 mm	43 * 24 mm	±0.1mm
Net Weight	5.8g	11g	5.8g	11g	±0.05g

Ⅲ Mechanical Dimensions and Pin Definitions

3.1 E32-400/900T30S Mechanical Dimensions and Pin Definitions



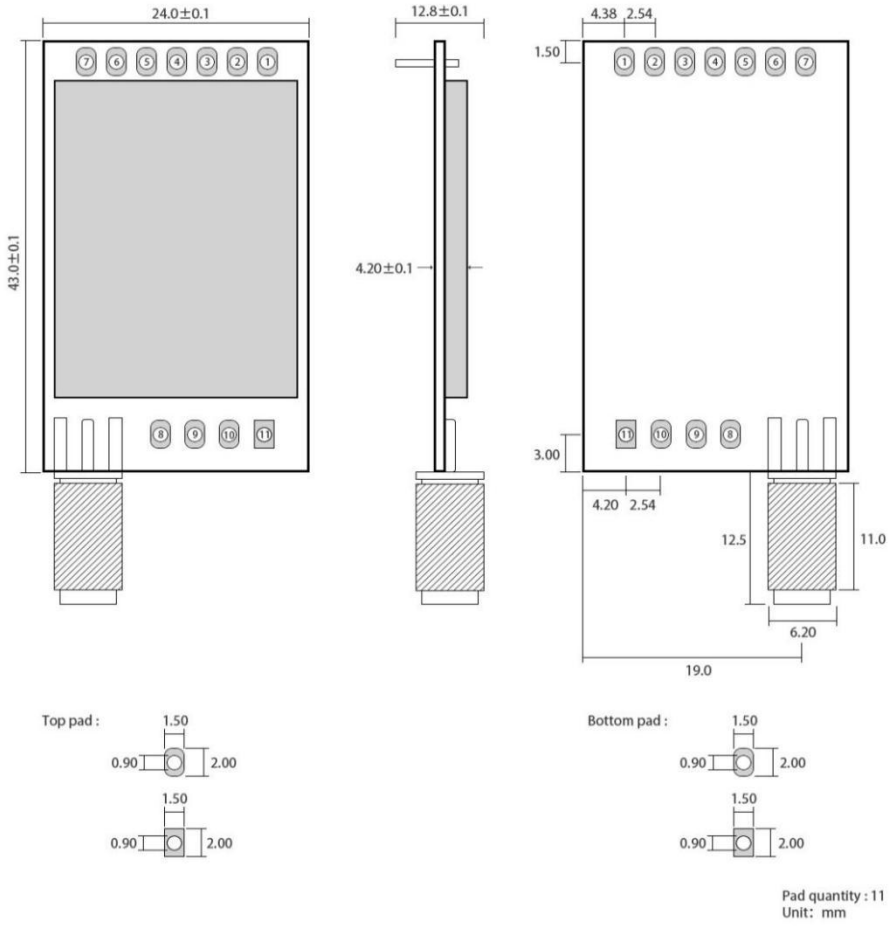




Unit: mm
pad quantity: 24
Tolerance value: X.X±0.1mm
X.XX±0.05mm

Pin Number	Pin Name	Pin Orientation	Pin Usage
1	GND	input	Module Ground
2	VCC	input	Module power supply positive reference, voltage range: 3.3 to 5.5V DC
3	AUX	output	Used to indicate the working status of the module; the user wakes up the external MCU and outputs a low level during power-on self-test initialization; (can be suspended)
4	TXD	output	TTL serial output connected to external RXD input pin;
5	RXD	input	TTL serial input connected to an external TXD output pin;
6	M1	Input (very weak pull-up)	In conjunction with M0, determines the 4 modes of operation of the module (cannot be left unattended, can be grounded if not in use)
7	M0	Input (very weak pull-up)	In conjunction with the M1, determines the 4 modes of operation of the module (non-hovering, can be grounded if not in use)
11	ANT	output	Antenna interface (HF signal output, 50 ohm characteristic impedance)
12	GND	-	grounding
13	GND	-	grounding
14	GND	-	grounding
18	NC	-	SWCLK(Suspended, user does not need to connect)
19	NC	-	SWDIO(Suspended, user does not need to connect)
20	NC	-	485_EN
21	NC	-	Internally connect 3.3V for download power;
22	RESET	Input	Module reset pin, low level trigger. It is recommended that customers use a single chip computer connection to reset processing and resume work in unexpected cases.
23	GND	-	grounding
24	NC	-	empty-pin

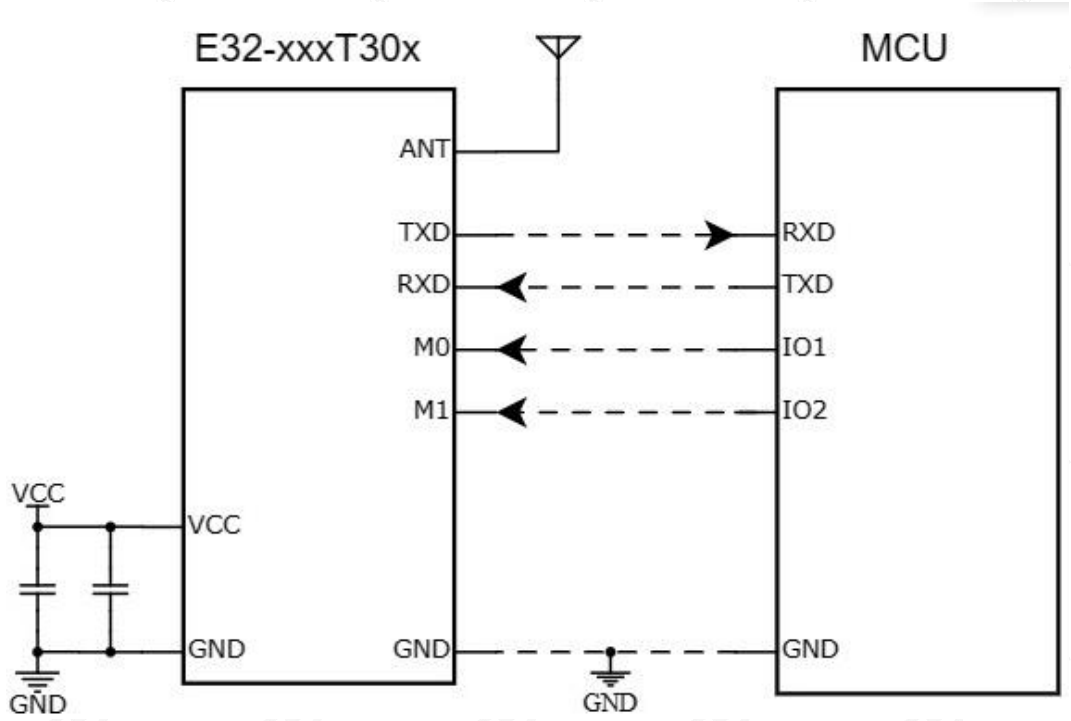
3.2 E32-400/900T30D Mechanical Dimensions and Pin Definitions



Pin Number	Pin Name	Pin Orientation	Pin Usage
1	M0	Input (very weak pull-up)	In conjunction with M1, determines the 4 operating modes of the module (cannot be suspended, can be grounded if not in use)
2	M1	Input (very weak pull-up)	In conjunction with M0, determines the 4 modes of operation of the module (cannot be suspended, can be grounded if not in use)
3	RXD	Input	TTL serial input connected to an external TXD output pin; Can be configured as an open drain or pull-up input, see Parameter Settings for details.
4	TXD	Output	TTL serial output connected to external RXD input pin; Configurable as open drain or push-pull outputs, see Parameter Settings for details.
5	AUX	Output	Used to indicate the working status of the module; the user wakes up the external MCU and outputs a low level during the power-on self-test initialization; it can be configured as an open drain output, or a push-pull output, see parameter setting for details. (can be suspended)
6	VCC	Input	Module power supply positive reference, voltage range: 3.3 to 5.5V DC
7	GND	Input	Module Ground
8	fixing	-	fixing hole

	hole		
9	fixing hole	-	fixing hole
10	fixing hole	-	fixing hole
11	fixing hole	-	fixing hole

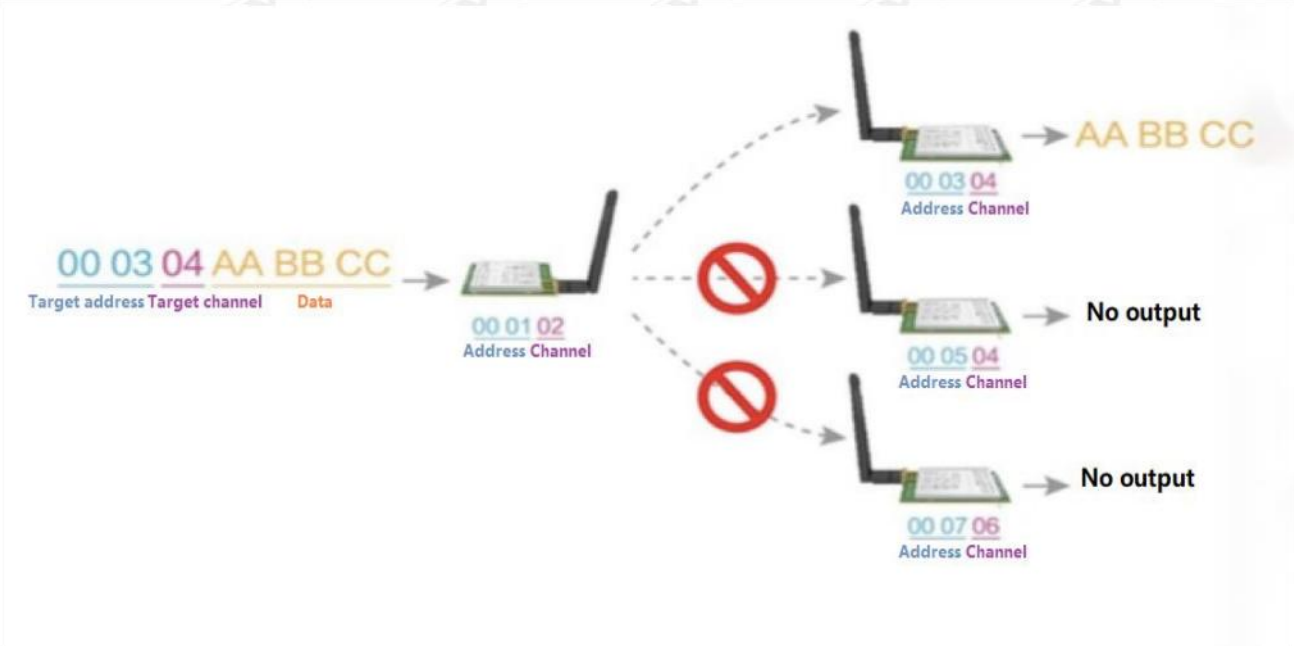
Ⅳ Recommended Connecting Charts



Serial Number	Brief connection description between the module and the microcontroller (the above figure takes the STM8L microcontroller as an example)
1	The wireless serial module is TTL level, please connect with TTL level MCU.
2	For some 5V microcontrollers, it may be necessary to add 4 to 10K pull-up resistors to the TXD and AUX pins of the module.

V Functions in detail

5.1 Transmit at a fixed point



5.2 Broadcast Emission

5.3 Broadcast Address

- Example: set the module A address to 0xFFFF and the channel to 0x04.
- When module A acts as a transmitter (same mode, transparent transmission method), all receiving modules under channel 0x04 can receive the data for broadcasting purposes.

5.4 Listening address

- Example: set module A address to 0xFFFF and channel to 0x04.
- When module A acts as a receiver, it can receive all the data under channel 0x04 for listening purpose.

5.5 Module reset

- After the module is powered on, AUX will immediately output a low level and perform hardware self-test, as well as set up the working mode according to the user parameters;

  During this process, AUX will keep low level, and when it is finished, AUX will output high level and start to work normally according to the working mode combined by M1 and M0;

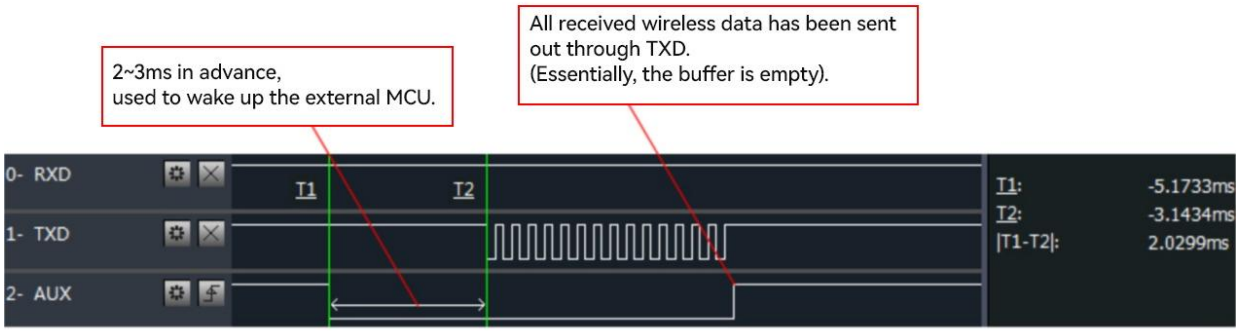
  Therefore, the user needs to wait for the rising edge of AUX as the starting point of normal operation of the module.

5.6 AUX Explained

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

5.6.1 Serial data output indication

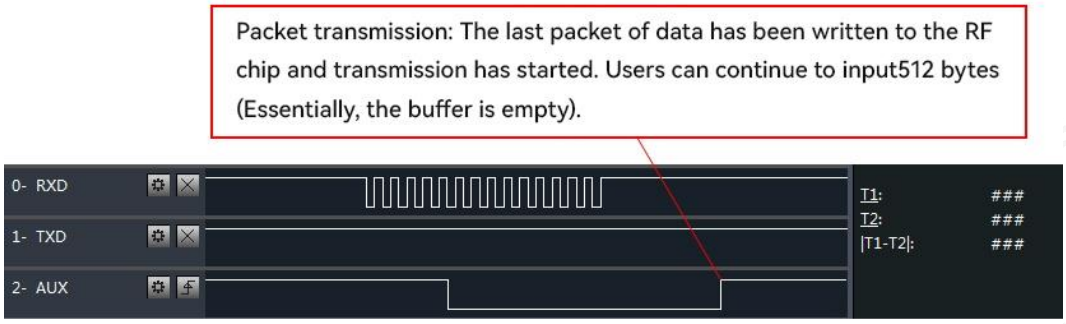
- for waking up a sleeping external MCU;



AUX pin timing diagram when module serial port sends out data.

5.6.2 radio transmission indication

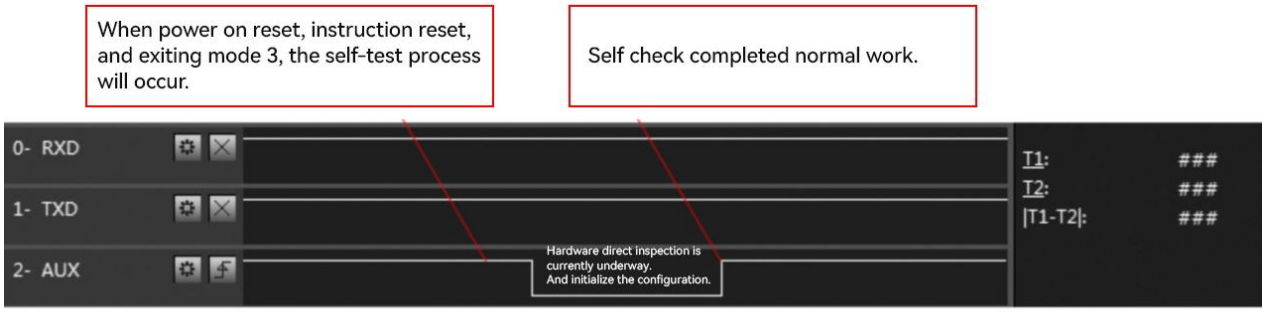
- Buffer Empty: the data in the internal 512 byte buffer are written to the wireless chip (automatic packetization).
- When AUX=1 when the user initiates less than 512 bytes of data continuously, it will not overflow. When AUX=0 when the buffer is not empty: the internal 512-byte buffer data, not yet all written to the wireless chip and open the launch, at this time the module may be waiting for the end of the user's data timeout, or are wireless packet launch.
- [Note]: AUX=1 does not mean that the module has finished transmitting all the serial data through the wireless, or the last packet of data may be transmitting.



AUX pin timing diagram when the module receives serial port data.

5.6.3 Module is in the process of being configured

- Only during reset and when exiting hibernation mode;;



During self check, AUX pin timing diagram.

5.6.4 notes:

Serial Number	AUX Notes
1	For Function 1 and Function 2 above, the output low level is prioritized, i.e.: when any of the output low level conditions are satisfied, the AUX outputs a low level; When all low level conditions are not satisfied, AUX outputs high level.
2	When AUX outputs low level, it indicates that the module is busy, and no working mode detection will be performed at this time; When the module AUX output high level within 1ms, will complete the mode switching work.
3	After the user switches to a new operating mode, it takes at least 2ms after the rising edge of AUX for the module to actually enter that mode; If AUX stays high, then the mode switching will take effect immediately.

4	The module resets the user parameters when the user enters from mode 3 (sleep mode) or during a reset, during which the AUX output goes low.
5	Due to the characteristics of LoRa modulation, the information transmission delay is much longer than FSK, for example, at 2.4kbps air speed, the transmission delay of 100 bytes is about 1.5 seconds, and it is recommended that customers do not transmit large data volumes at low air speeds, so as not to cause data loss due to the accumulation of data that can lead to communication anomalies.

VI Working mode

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

Mode (0-3)	M1	M0	Introduction to the model	Note
0 General mode	0	0	Serial open, wireless open, transparent transmission	The receiver must be mode 0, 1
1 Wake-up mode	0	1	Serial port open, wireless open; The only difference with mode 0: before the packet is transmitted, the wake-up code is automatically increased so as to wake up the receiver working in mode 2	Receiver can be mode 0 Receiver can be mode 1 Receiver can be mode 2
2 Power saving mode	1	0	Serial port reception is off, wireless is in Wake-on-Air mode, and when wireless data is received, the serial port is opened to send out the data.	Transmitter must be in mode 1 Cannot launch in this mode
3 Sleeping mode	1	1	Module goes to sleep and can receive parameter setting commands	See Working Parameters Detail

6.1 Mode switching precautions

Serial number	Note
1	● Users can combine M1 and M0 with high and low levels to determine the module working mode. The 2 GPIOs of MCU can be used to control the mode switching; ● When changing M1, M0: If the module is idle, it can start working according to the new mode after 1ms; ● If the module has serial data that has not yet finished transmitting through wireless, it can only enter the new working mode after the transmitting is finished; ● If the module receives the wireless data and sends out the data through the serial port, it needs to finish sending out before it can enter the new working mode; ● So the mode switching can only be effective when AUX outputs 1, otherwise the switching will be delayed.
2	● For example, if a user continuously enters a large amount of data and switches modes at the same time, the switching mode operation is invalid; the module will process all user data before performing a new mode detection; ● So the general recommendation is: detect the output state of the AUX pin and wait for 2ms after the output goes high before switching
3	● If there is data that has not yet been processed when the module is switched to sleep mode from other modes; ● The module will process these data (both transmit and receive) before entering sleep mode. This feature can be used for fast hibernation to save power consumption; for example: the transmitter module works in mode 0, the user initiates the serial data "12345", and then does not have to wait for the AUX pin to be idle (high), it can directly switch to hibernation mode and hibernate the user's main MCU immediately, and the module will automatically send the user's data through the wireless, and then

	automatically enter hibernation within 1ms; this feature can be used for fast hibernation to save power consumption. The module will automatically send out all the user data through the wireless, and then automatically enter the sleep mode within 1ms; ● thereby saving the MCU's operating time and reducing power consumption.
4	● Similarly, for any mode switching, this feature can be utilized, the module will automatically enter a new mode within 1ms after processing the current mode event; thus eliminating the need for the user to query the AUX, and can achieve the purpose of fast switching; ● For example, switching from transmit mode to receive mode; the user MCU can also go to sleep earlier before mode switching and use the external interrupt function to get the AUX change, so as to carry out mode switching.
5	● This operation method is very flexible and efficient, completely designed according to the user's MCU's operating convenience, and can minimize the workload of the whole system, improve system efficiency and reduce power consumption.

6.2 General mode (mode 0)

Type	When M0 = 0 and M1 = 0, the module operates in mode 0
Transmit	Module receives user data from the serial port, the module transmits wireless data packet length of 58 bytes, when the amount of data input by the user reaches 58 bytes, the module will start the wireless transmission, at this time, the user can continue to input the data that need to be emitted; when the user needs to transmit the bytes less than 58 bytes, the module waits for the 3 bytes of time, if there is no user data continue to input, it is considered to be the termination of the data, at this time, the module will be all the data packets through the wireless sent; when the module receives the first user data, will AUX output low level, when the module puts all the data into the RF chip and start transmitting, AUX output high level; at this time, it indicates that the last packet of wireless data has been started to transmit, the user can continue to input up to 512 bytes of data; the data packets sent out through mode 0 can only be received by the module in mode 0, mode 1 of the The packet sent through mode 0 can only be received by the receiver module in mode 0 and mode 1.
Receive	The module always turns on the wireless receive function and can receive packets sent from mode 0 and mode 1; After receiving the packet, the module AUX outputs a low level, and after a delay of 5ms, it starts to send out the wireless data through the TXD pin of the serial port, and after all the wireless data are output through the serial port, the module outputs the AUX to a high level.

6.3 WOR mode (mode 1)

Type	When M0 = 1 and M1 = 0, the module operates in mode 1

Transmit	The conditions for the module to start packet transmitting and the AUX function are equivalent to mode 0; the only difference is: the module will automatically add a wake-up code before each packet, and the length of the wake-up code depends on the wake-up time set in the user's parameter; the purpose of the wake-up code is to be used to wake up the receiver module which is working in mode 2; so the data transmitted in mode 1 can be received by modes 0, 1 and 2.
Receive	Equivalent to mode 0.

6.4 Power saving mode (mode 2)

Type	When M0 = 0 and M1 = 1, the module operates in mode 2
Transmit	The module is in hibernation state, the serial port is closed and cannot receive the serial data from the external MCU, so this mode does not have the wireless transmitting function.
Receive	In Mode 2, the transmitter is required to work in Mode 1; listen to the wake-up code at regular intervals, once a valid wake-up code is received, the module will continue to be in the receiving state and wait for the whole valid packet to be received; then AUX outputs a low level, and after a delay of 5ms, it opens the serial port and sends out the received wireless data through TXD, and after that, it outputs a high level from AUX; the module continues to enter the "sleep - listen" operating state (polling); by setting different wake-up times, the module has different receiving response delays (maximum 2s) and average power consumption (minimum 30u The wireless module continues to enter the "sleep-listening" working state (polling); by setting different wake-up times, the module has different reception response delays (up to 2s) and average power consumption (minimum 30uA); the user needs to achieve a balance between the communication delay time and the average power consumption.

6.5 Deep sleep mode (mode 3)

Type	When M0 = 1 and M1 = 1, the module operates in mode 3
Transmit	Unable to transmit wireless data.
Receive	Wireless data cannot be received.
Configure	The hibernation mode can be used for module parameter setting, using the serial port 9600, 8N1, to set the module operating parameters through a specific command format.
Note	When entering from hibernation mode to other modes, the module will reconfigure the parameters, and during the configuration process, AUX stays low; when finished, it outputs a high level, so it is recommended that the user detects the rising edge of AUX.

Ⅶ Register read/write control

7.1 Command Introduction

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

Serial number	Command format	Explanation
1	C0+ Operating Parameters	Sends C0 + 5 bytes of operating parameters in hexadecimal format for a total of 6 bytes, which must be sent continuously (power-down save)
2	C1+C1+C1	Three C1s are sent in hexadecimal format and the module returns the saved parameters, which must be sent consecutively.
3	C2+ Operating Parameters	Sends C2 + 5 bytes of operating parameters in hexadecimal format, for a total of 6 bytes, which must be sent continuously (power-down is not saved)
4	C3+C3+C3	Three C3s are sent in hexadecimal format and the module returns the version information, which must be sent consecutively.
5	C4+C4+C4	Sending three C4s in hexadecimal format will generate a reset in the module, which must be sent consecutively.

7.2 Reading of operating parameters

Command format	Explanation
C1+C1+C1	In Sleep mode (M0=1, M1=1), issue the command (in HEX format): C1 C1 C1, to the module's serial port. The module will return the current configuration parameters, e.g., C0 00 00 1A 06 44.

7.3 Version number reading

Command format	Explanation
C3+C3+C3	In sleep mode (M0=1, M1=1), issue the command (in HEX format): C3 C3 C3, to the module serial port. The module will return the current configuration parameters, for example:C3 32 XX YY; C3 is the command header, 32 represents the product model number, XX represents the version number, YY represents the interface format + the maximum power value of the module (hexadecimal). 0x10 for TTL interface, 0x40 for RS232, 0x80 for RS485

7.4 Reset command

Command format	Explanation
C4+C4+C4	In sleep mode (M0=1, M1=1), send a command (in HEX format) to the module serial port: C4 C4 C4, the The module will generate a reset; During the reset process, the module performs self-test and AUX outputs a low level; after the reset is completed, AUX outputs a high level and the module starts to work normally; At this time, mode switching or initiating the next command can be performed.

7.5 E32-xxxT30x Register Description

	Name	Descriptions				Note
0	HEAD	Fixed 0xC0 or 0xC2, indicating that this frame data is a control command				Must be 0xC0 or C2 C0: The set parameters are saved by power-down. C2: The set parameters will not be saved by power-down.
1	ADDH	High byte of module address (default 00H)				00H-FFH
2	ADDL	Module address low byte (default 00H)				00H-FFH
3	SPED	7	6	serial port parity bit		Serial port modes can be different on both sides of the communication
		0	0	8N1 (default)		
		0	1	8O1		
		1	0	8E1		
		1	1	8N1 (Equivalent to 00)		
		5	4	3	TTL serial port rate (bps)	The baud rate can be different between the two sides of the communication The serial port baud rate has nothing to do with the wireless transmission parameters and does not affect the wireless transceiver characteristics.
		0	0	0	Serial port baud rate of 1200	
		0	0	1	Serial port baud rate of 2400	
		0	1	0	Serial port baud rate of 4800	
		0	1	1	Serial port baud rate of 9600 (default)	
		1	0	0	Serial port baud rate of 19200	
		1	0	1	Serial port baud rate of 38400	
		1	1	0	Serial port baud rate of 57600	
		1	1	1	Serial port baud rate of 115200	
		2	1	0	Universal Radio Air Rate (bps)	The lower the air rate, the longer the distance, the stronger the anti-interference performance, and the longer the sending time. The airborne wireless transmission rate must be the same for both sides of the communication.
		0	0	0	Air rate 2.4k	
		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 rate 9.6k	
		1	0	1	Air rate 19.2k	
		1	1	0	Air rate 19.2k	
		1	1	1	Air rate 19.2k	
4	CHAN	General Model				
		7	6	5	Retain unused	Write 0

<table>
<tr><td></td><td></td><td colspan="4">communication channel</td><td rowspan="2">00H-1FH, corresponding to 410～441MHz
00H-45H, corresponding to 862-930MHz</td></tr>
<tr><td></td><td></td><td colspan="4">4 to 0, corresponding to (410MHz + CHAN * 1MHz), default 17H (433MHz) (for 400 band)
4 to 0, corresponds to (862MHz + CHAN * 1MHz), default 06H (868MHz) (applicable to 900 band)</td></tr>
<tr><td rowspan="15">5</td><td rowspan="15">OPTION</td><td>7</td><td colspan="3">Fixed-point transmit enable bit (MODBUS-like)</td><td rowspan="3">When it is 1, the first 3 bytes of each user data frame are used as high and low address and channel. When transmitting, the module changes its own address and channel, and when finished, restores the original settings.</td></tr>
<tr><td>0</td><td colspan="3">transparent transfer mode</td></tr>
<tr><td>1</td><td colspan="3">fixed-point transmission mode</td></tr>
<tr><td>6</td><td colspan="3">IO drive mode (default 1)</td><td rowspan="3">This bit is used to enable the module's internal pull-up resistor. The open drain method level adaptation is more robust and may require an external pull-up resistor in some cases.</td></tr>
<tr><td>1</td><td colspan="3">TXD, AUX push-pull outputs, RXD pull-up inputs</td></tr>
<tr><td>0</td><td colspan="3">TXD, AUX open output, RXD open input</td></tr>
<tr><td>5</td><td>4</td><td>3</td><td>Wireless Wake-Up Time</td><td rowspan="9">Both transceiver modules work in mode 0. This delay time is invalid and can be any value;
The transmitter works in mode 1 and will continuously transmit the wake-up code for the corresponding time;
The receiver works in mode 2, this time is the listening interval time (wireless wake-up) of the receiver, and can only receive data from the transmitter working in mode 1.</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>250ms（default）</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>500ms</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>750ms</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1000ms</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1250ms</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1500ms</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1750ms</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>2000ms</td></tr>
<tr><td>2</td><td colspan="3">FEC switches</td><td rowspan="3">When FEC is turned off, the actual data transmission rate is increased, but the anti-interference ability is weakened, and the distance is slightly closer, so please choose according to the actual application;
Both sides of communication must be on or off.</td></tr>
<tr><td>0</td><td colspan="3">Close FEC error correction</td></tr>
<tr><td>1</td><td colspan="3">Turn on FEC error correction (default)</td></tr>
<tr><td>1</td><td>0</td><td colspan="2">Transmit power (approximate)</td><td rowspan="5">The external power supply must provide more than 250mA of current output capability and ensure that the power supply ripple is less than 100mV;

It is not recommended to use lower power transmission, its power utilization efficiency is not high.</td></tr>
<tr><td>0</td><td>0</td><td colspan="2">30dBm（default）</td></tr>
<tr><td>0</td><td>1</td><td colspan="2">27dBm</td></tr>
<tr><td>1</td><td>0</td><td colspan="2">24dBm</td></tr>
<tr><td>1</td><td>1</td><td colspan="2">21dBm</td></tr>
</table>

Example (Meaning of the byte "SPED" in serial number 3):

Binary bits of this byte	7	6	5	4	3	2	1	0
Specific values (user-configurable)	0	0	0	1	1	0	1	0
representativeness	Serial port parity bit 8N1		Serial port baud rate of 9600			Air rate of 2.4k		
Corresponding hexadecimal	1					A		

7.6 Factory Default Parameters

Model	433MHz Factory default parameter value: C0 00 00 1A 17 03 868MHz Factory default parameter value: C0 00 00 1A 06 03						
Module Model	Frequency	Address	Channel	Air speed	Baud rate	Serial Port Format	Transmit Power
E32-433T30S	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	30dbm
E32-900T30S	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	30dbm
E32-433T30D	433.125MHz	0x0000	0x17	2.4kbps	9600	8N1	30dbm
E32-900T30D	868.125MHz	0x0000	0x12	2.4kbps	9600	8N1	30dbm

Ⅷ AT command

- Using AT instructions for parameter configuration or query needs to be done in configuration mode;
- AT commands are used in the configuration mode. AT commands are divided into three categories in total: command commands, setup commands and query commands;
- Users can use "AT+HELP=?" to query the AT instructions supported by the module. Users can query the AT instruction set supported by the module through "AT+HELP=?", and the baud rate adopted by AT instruction is 9600 8N1;
- When the input parameter exceeds the range, it will be limited, so please do not let the parameter exceed the range to avoid unknown situation.

8.1 AT Command Table

Command instruction	Descriptions	Example	Example Description
AT+IAP(Use caution, see this article 8.3 Notes on Upgrading Firmware on Serial Ports for more information)	Entering IAP upgrade mode	AT+IAP	Entering IAP upgrade mode
AT+RESET	Device Restart	AT+RESET	Device Restart
AT+DEFAULT	Configuration parameters are restored to default and the device	AT+DEFAULT	Configuration parameters are restored to default and the device restarts

	restarts		

Setup instruction	Description	Example	Example Description
AT+UART=baud,parity	Set baud rate and parity	AT+UART=3,0	Set the baud rate to 9600, 8N1
AT+RATE=rate	Setting the air rate	AT+RATE=7	Set the air rate to 19.2K
AT+WOR=role	Setting WOR roles and cycles	AT+WOR=0	Set to receive WOR
AT+POWER=power	Setting the transmission power	AT+POWER=0	Set the transmit power to 30dBm
AT+TRANS=mode	Setting the sending mode	AT+TRANS=1	Set to fixed point mode
AT+ADDR=addr	Setting the module address	AT+ADDR=1234	Set the module address to 1234
AT+CHANNEL=channel	Setting the module operating channel	AT+CHANNEL=23	Set frequency to 433.125M
AT+DELAY=delay	Setting the WOR delayed hibernation time	AT+DELAY=1000	Set WOR delayed sleep time to 1000ms
AT+SWITCH=switch	Setting the software toggle mode switch	AT+SWITCH=1	Setting on in configuration mode allows software switching.
AT+MODE=mode	Switching operating modes	AT+MODE=0	Switch to pass-through mode

Query Instructions	Descriptions	Return to Example	Example Description
AT+HELP=?	Query AT command table		Return to the AT command table
AT+DEVTYPE=?	Query Module Model	DEVTYPE=E32-400T30S/D	Return to Module Models
AT+FWCODE=?	Query Firmware Code	FWCODE=7432-0-10	Return to Firmware Version
AT+UART=?	Query baud rate and calibration	AT+UART=3,0	Returns baud rate of 9600, 8N1
AT+RATE=?	Query Air Rate	AT+RATE=7	Return air rate of 19.2K
AT+WOR=?	Query WOR Role	AT+WOR=0	Returns as WOR receive
AT+POWER=?	Query Transmit Power	AT+POWER=0	Return to transmit power of 30dBm
AT+TRANS=?	Query Send Mode	AT+TRANS=1	Return to fixed-point mode
AT+ADDR=?	Query Module Address	AT+ADDR=1234	Returns the module

			address to 1234
AT+CHANNEL=?	Query module operating channel	AT+CHANNEL=23	Return frequency is 433.125M
AT+DELAY=?	Query WOR delayed hibernation time	AT+DELAY=1000	Returns WOR delayed sleep time of 1000ms
AT+SWITCH=?	Query software switching mode switch	AT+SWITCH=0	Software switching mode off
AT+MODE=?	Query the current working mode (all modes can be queried)	AT+MODE=0	Returns the current transmission mode

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 parameter	meaning of a parameter
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 bits)	0:8N1 1:8O1 2:8E1 3:8N1
Rate (airspeed)	0:2.4K 1:2.4K 2:2.4K 3:4.8K 4:9.6K 5:19.2K 6:19.2K 7:19.2K
Packet (Packet length)	0:240 1:128 2:64 3:32
Role (WOR Role)	0:receive 1:send
Period (WOR cycle)	0:500ms 1:1000ms 2:1500ms 3:2000ms 4:2500ms 5:3000ms 6:3500ms 7:4000ms
Power (transmission power)	0:30dBm 1:27dBm 2:24dBm 3:21dBm
Mode (transfer mode)	0: transparency 1: fixed point
LBT(listen before talk)	0:close 1:open
Addr (module address)	Module address 0 to 65535 (decimal)
Channel (module channel)	Module channel 0 to 45 (decimal)
Netid (Network ID)	Module network 0~255 (decimal)
Key (keys)	Module key 0~65535 (decimal)
Delay (WOR time-delayed hibernation)	Delayed hibernation 0~65535 (decimal)
Mode(operating mode)	0: Transmission mode 1: Wake-up mode 2: Power saving mode 3: Sleep mode

8.3 Serial Port Upgrade Firmware Notes

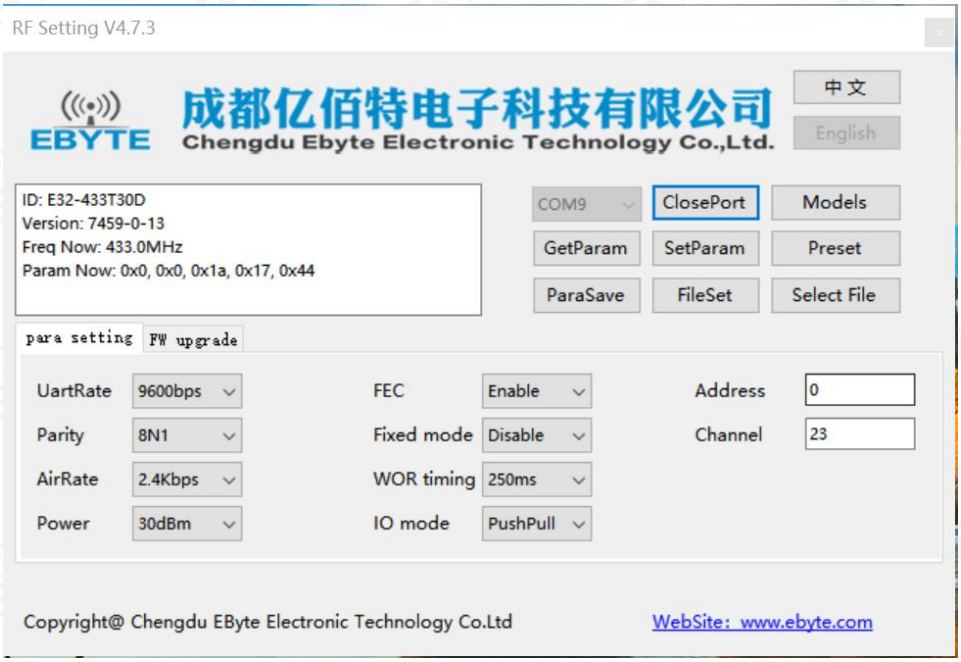
If customers need to upgrade the firmware, they need to find the corresponding BIN file provided by the official, and then use the upper computer provided by the official to upgrade the firmware, generally users do not need to upgrade the firmware, Do not use the "AT+IAP" command.。

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

The baud rate will automatically switch to 115200 after entering the upgrade mode until it automatically exits, during which time a log will be output.

Ⅸ Configuration instructions for the host computer

- The following figure shows the configuration upper display interface of E32-900T30S as an example. Users can switch to the command mode through M0 and M1 to quickly configure and read the parameters in the upper display.



- In the Configuration Upper, the module address, frequency channel, network ID, and key are displayed in decimal display mode; where each parameter takes a range of values:

  Network address: 0～65535

  Frequency channel: 0～45

  Network ID：0～255

  Key: 0～65535

X Hardware Design

- It is recommended to use a DC regulated power supply to power this module, the power supply ripple factor should be as small as possible, and the module should be reliably grounded
- Please pay attention to the correct connection of the positive and negative terminals of the power supply, if the reverse connection may cause permanent damage to the module;
- Please check the power supply to ensure that it is between the recommended supply voltages, if it exceeds the maximum value, it may cause permanent damage to the module;
- Check the stability of the power supply to ensure that the voltage does not fluctuate significantly and frequently;
- When designing the power supply circuit for the module, it is often recommended to keep more than 30% of the residual capacity, and the whole machine is conducive to long-term stable operation;
- Modules should be kept as far as possible from power supplies, transformers, high-frequency alignments and other parts of the electromagnetic interference;
- high-frequency digital alignment, high-frequency analog alignment, power supply alignment must be avoided below the module, if you really need to go through the module below, assuming that the module is welded in the Top Layer, in the module contact part of the Top Layer laying ground copper (all laying copper and a good ground), it must be close to the digital part of the module and the alignment in the Bottom Layer;
- Assuming that the module is soldered or placed in the Top Layer, it is also a mistake to run wires in the Bottom Layer or any other layer, which will affect the spuriousness of the module as well as the reception sensitivity to varying degrees;
- It is assumed that the module is surrounded by a large electromagnetic interference devices will also greatly affect the performance of the module, according to the intensity of the interference is recommended to stay away from the module, if the situation permits you can do appropriate isolation and shielding;
- assuming that there is a large electromagnetic interference around the module alignment (high-frequency digital, high-frequency analog, power supply alignment) will also greatly affect the performance of the module, according to the intensity of the interference is recommended to stay away from the module, if the situation permits you can do appropriate isolation and shielding;
- If 5V level is used for the communication line, 1k-5.1k resistors must be connected in series (not recommended, there is still a risk of damage);
- Try to stay away from TTL protocols where part of the physical layer is also 2.4GHz, e.g. USB3.0;
- When the module is installed inside the chassis, a good quality antenna extension cable can be used to extend the antenna to the outside of the chassis;
- When the module is installed inside the chassis, a good quality antenna extension cable can be used to extend the antenna to the outside of the chassis;
- The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.

XI Frequently Asked Questions

11.1 Unsatisfactory transmission distance

- When there is a straight line communication barrier, the communication distance will be attenuated accordingly;
- temperature, humidity, and co-channel interference, which can lead to higher communication packet loss;
- The ground absorbs and reflects radio waves, and the test effect is poorer near the ground;
- Seawater has a strong ability to absorb radio waves, so the effect of the seaside test is poor;
- metal objects near the antenna, or placed in a metal shell, the signal attenuation will be very serious;
- wrong power register setting, air rate setting is too high (the higher the air rate, the closer the distance);
- The low voltage of the power supply at room temperature is lower than the recommended value, the lower the voltage, the lower the power generated;
- The antenna used is poorly matched to the module or the antenna itself is of poor quality.

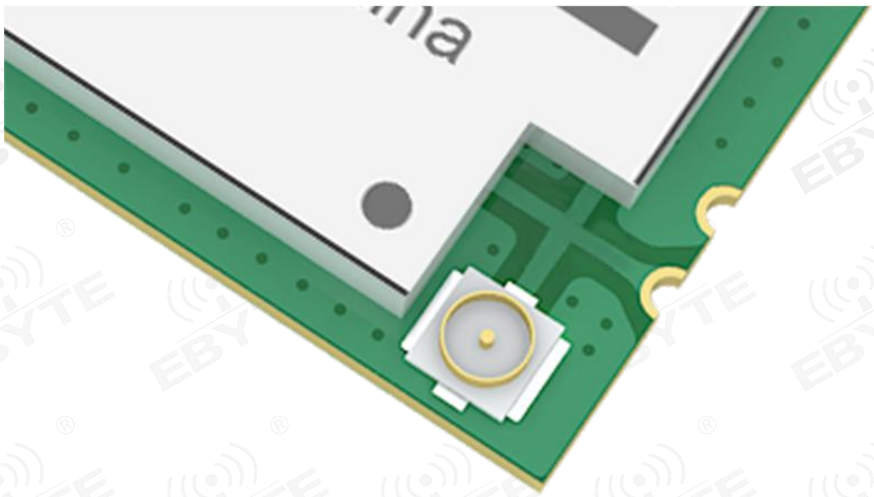
11.2 Modules are vulnerable

- Please check the power supply to ensure that it is between the recommended supply voltages, exceeding the maximum value can cause permanent damage to the module;
- Please check the stability of the power supply, the voltage should not fluctuate significantly and frequently;
- Please ensure that the installation and use of the process of anti-static operation, high-frequency device electrostatic sensitivity;
- Please ensure that the installation and use of the process of humidity should not be too high, part of the components for humidity-sensitive devices;
- If there is no special demand, it is not recommended to use it under too high or too low temperature.

11.3 BER is too high

- There is interference from the same frequency signal nearby, stay away from the interference source or modify the frequency and channel to avoid interference;
- Poor power supply may also cause garbled code, make sure the reliability of the power supply;
- Poor quality or too long extension cables and feeder cables may also cause high BER.

11.4 Antenna Selection



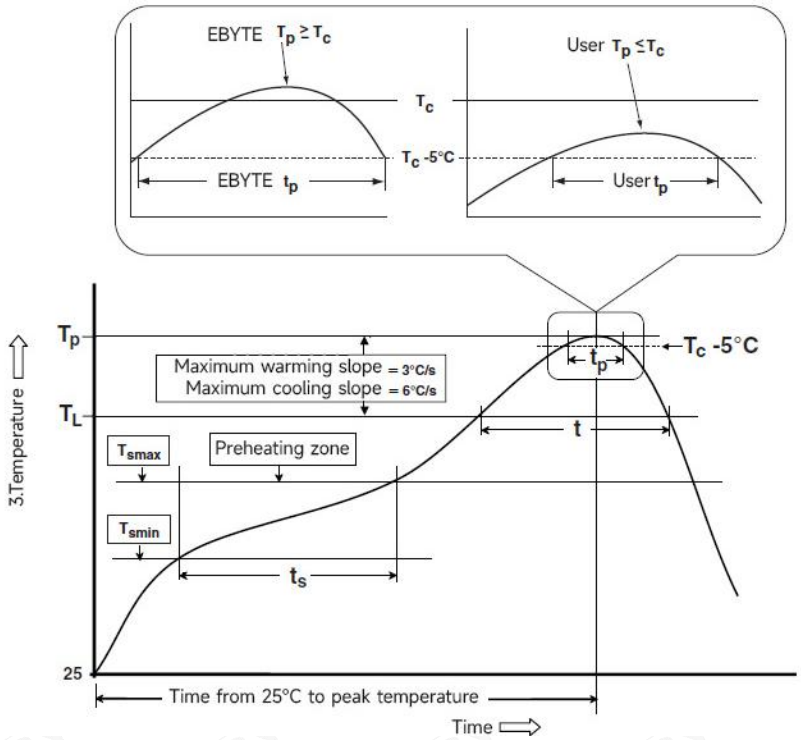
Both IPEX and stamp hole interfaces can be enabled at the same time, and the IPEX and stamp hole interfaces can be selected at will.

XII Welding instructions

12.1 Reflow temperature

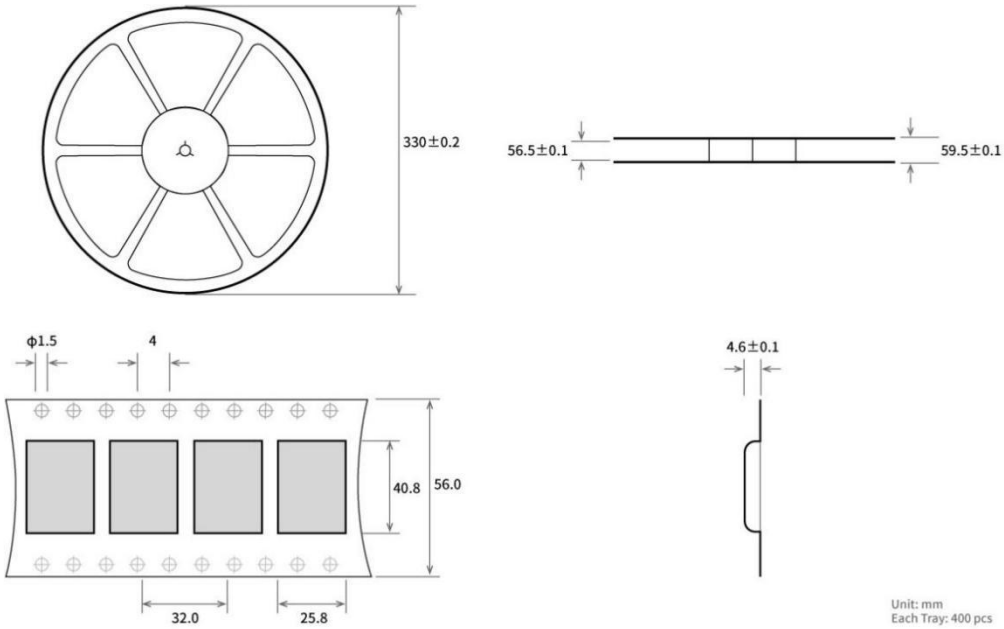
Reflow Profile Characteristics		Leaded process assembly	Lead-free process assembly
Preheating/Holding	minimum temperature（Tsmin）	100℃	150℃
	highest temperature（Tsmax）	150℃	200℃
	Time（Tsmin~Tsmin）	60-120 Seconds	60-120 Seconds
slope of temperature increase（T_L~T_P）		3°C/sec, max.	3°C/sec, max.
Liquid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

12.2 Reflow Profile

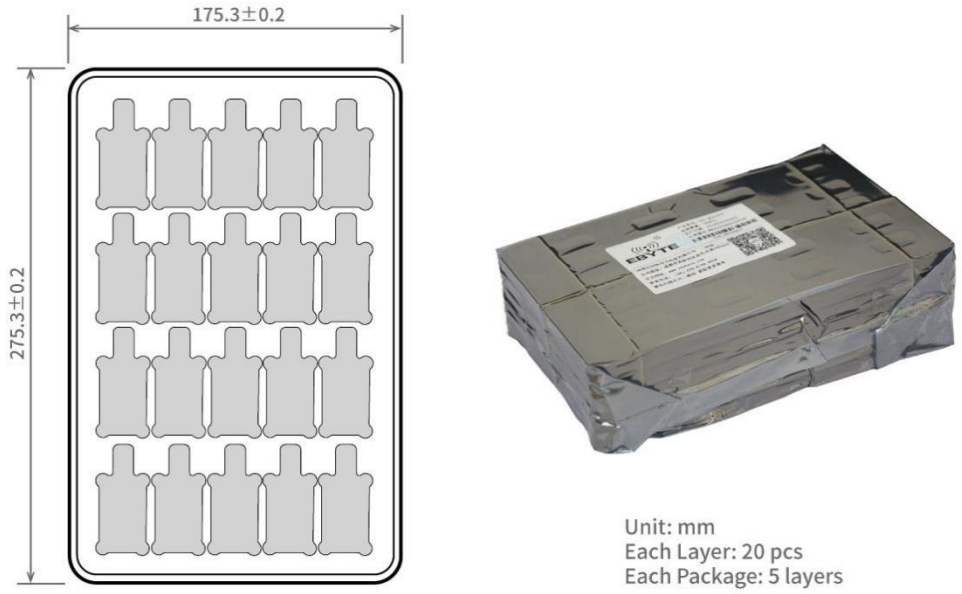


XIII Batch packing method

13.1 E32-433/900T30S Batch packing method



13.2 E32-433/900T30D Batch packing method



Revision history

Version	revision date	revised description	Maintainer
1.0	2023-10-25	initial version	Hao
1.1	2024-6-27	Content correction	Hao
1.2	2024-8-30	Correct pin description	Hao
1.3	2024-12-17	Modified sensitivity description	Hao
1.4	2024-12-26	Delete the authentication description	Lei

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