



E22-400T22S User Manual

SX1268 434MHz SMD Wireless Module



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1. Overview

1.1 Introduction

E22-400T22S is a wireless serial port module (UART) based on SEMTECH's SX1268 RF chip. It has multiple transmission modes, working in the 434MHz, LoRa spread spectrum technology, TTL level output, compatible with 3.3V and 5V IO port voltage.

LoRa direct sequence spread spectrum technology will bring longer communication distance, and has the advantages of concentrated power density and strong anti-interference ability. The module has a software FEC forward error correction algorithm, which has high coding efficiency and strong error correction capability. In the case of sudden interference, it can actively correct the interfered data packets, greatly improving reliability and transmission distance. When without FEC, such packets can only be discarded.

The module has data encryption. Data transmitted over the air, with randomness, makes data interception meaningless through strict encryption and decryption algorithms. The module reserves multiple IO interfaces to provide custom development services. It supports packet length setting and also supports different real-time and data packets.

1.2 Features

- Communication distance tested is up to 7km;
- Support the global license-free ISM 434MHz band;
- Support air data rate of 0.3kbps ~ 62.5kbps;
- Support new generation LoRa technology based on SX1268;
- Compared with SX1276, the power consumption of hardware is reduced by 40%, and the power consumption of software is reduced by 35%;
- Compared with the SX1276, for the same power consumption, the transmission power is increased by 80%;
- Low power consumption for battery supplied applications;
- Support 3.3V~5.5V power supply, power supply over 5.0 V can guarantee the best performance;
- Industrial grade standard design, support -40 ~ 85 °C for working over a long time;
- IPEX and stamp hole optional, good for secondary development and integration.

1.3 Application

- Home security alarm and remote keyless entry;
- Smart home and industrial sensors;
- Wireless alarm security system;
- Building automation solutions;
- Wireless industrial-grade remote control;
- Health care products;
- Advanced Meter Reading Architecture(AMI);
- Automotive industry applications.

1.4 Function introduction

- **LoRa spread spectrum:** LoRa direct sequence spread spectrum technology will bring longer communication distance; low transmit power density, it is not easy to cause interference to other equipment.
- **High confidentiality,** extremely low probability of interception; strong anti-interference ability, strong suppression of co-channel interference and various noises; excellent anti-multipath fading performance.
- **LBT:** The module has a Listen before talk (LBT) function. When this function is enabled, the module actively monitors the channel environment noise before transmitting. If the noise exceeds the threshold, it will be sent delayed. This feature can greatly improve the communication success rate of the module in harsh environments. This function can be used for network transmission and anti-collision processing.
- **RSSI:** The signal strength indication function. The module supports packet signal strength serial output. Can be used to assess signal quality, improve communication networks, and ranging. The module supports ambient noise signal strength serial output. It can be used to implement LBT functions manually.
- **Wireless configuration:** Remotely configure or read wireless module parameters by sending command packets wirelessly.
- **Ultra-low power consumption:** the air wake-up function. It is especially suitable for battery-powered applications: when the module is in WOR state, the configuration module WOR monitors the overall power consumption of the adjustable module. The maximum configurable response delay of the module is 4000ms. The average current of the module in this mode is about 2uA.
- **Broadcast monitoring:** Set the module address to 0xFFFF, which can monitor the data transmission of the module on the same channel; the transmitted data can be received by the module of any address on the same channel, thus playing the role of broadcasting and monitoring.
- **Forward error correction:** The module has FEC forward error correction algorithm, which has high coding efficiency and strong error correction capability. In the case of sudden interference, it can actively correct the interfered data packets, greatly improving reliability and transmission distance. When without FEC, such packets can only be discarded.
- **Deep sleep function:** When the module is in sleep mode, mode 3, the wireless receiver is turned off and the micro-controller is in a sleep state; at this time, the power consumption of the whole device is about 2uA.

- **Watchdog:** The module has a built-in watchdog and performs precise time layout. Once an exception occurs, the module will restart within 1 second and continue to work according to the previous parameter settings.
- **Parameter saving:** After the user sets the parameters, the module parameters will be saved, the power will not be lost, and the module will work according to the set parameters after power-on.
- **Applicable environment:** 434MHz is free frequency band, users can use it directly without application; 434MHz features certain penetration and diffraction ability, suitable for environment with small data volume, long transmission distance and easy to be interfered.

2. Specification and parameter

2.1 Limit parameter

Main parameter	Performance		Remark
	Min.	Max.	
Power supply (V)	0	5.5	Voltage over 5.5V will cause permanent damage to module
Blocking power (dBm)	-	10	Chances of burn is slim when modules are used in short distance
Operating temperature (°C)	-40	85	/

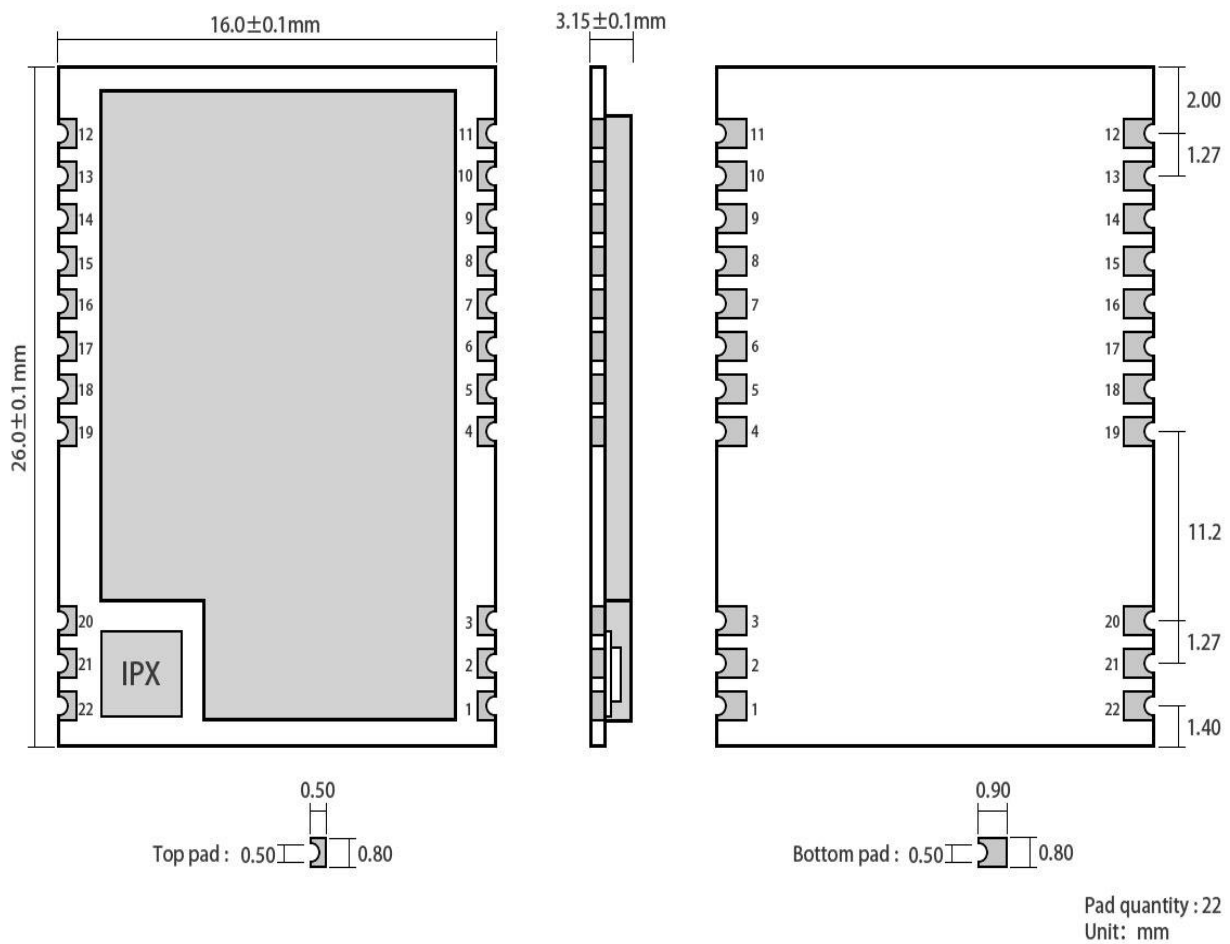
2.2 Operating parameter

Main parameter		Performance			Remark
		Min.	Typ.	Max.	
Operating voltage (V)		2.3	5.0	5.5	≥5.0 V ensures output power
Communication level (V)			3.3		For 5V TTL, it may be at risk of burning down
Operating temperature (°C)		-40	-	85	Industrial design
Operating frequency (MHz)			434		Support ISM band
Power consumption	TX current (mA)		133		Instant power consumption
	RX current (mA)		11		
	Sleep current (μA)		469		Software is shut down
Max Tx power (dBm)		-	10	-	
Receiving sensitivity (dBm)		-146	-147	-148	Air data rate is 2.4kbps
Air data rate (bps)		0.3k	2.4k	62.5k	Controlled via user's programming

Main parameter	Description	Remark
Distance for reference	7000m	Test condition: clear and open area, antenna gain: 5dBi, antenna height: 2.5m, air data rate: 2.4kbps
TX length	240 Btye	Can be configured via command as 32/64/128/240

		bytes per packet to transmit
Buffer	1000 Btye	
Modulation	GFSK	
	LoRa	
Communication interface	UART	
Package	SMD	
Connector	1.27mm	
Size	16 * 26 mm	
Antenna	IPEX/stamp hole	50 ohm impedance

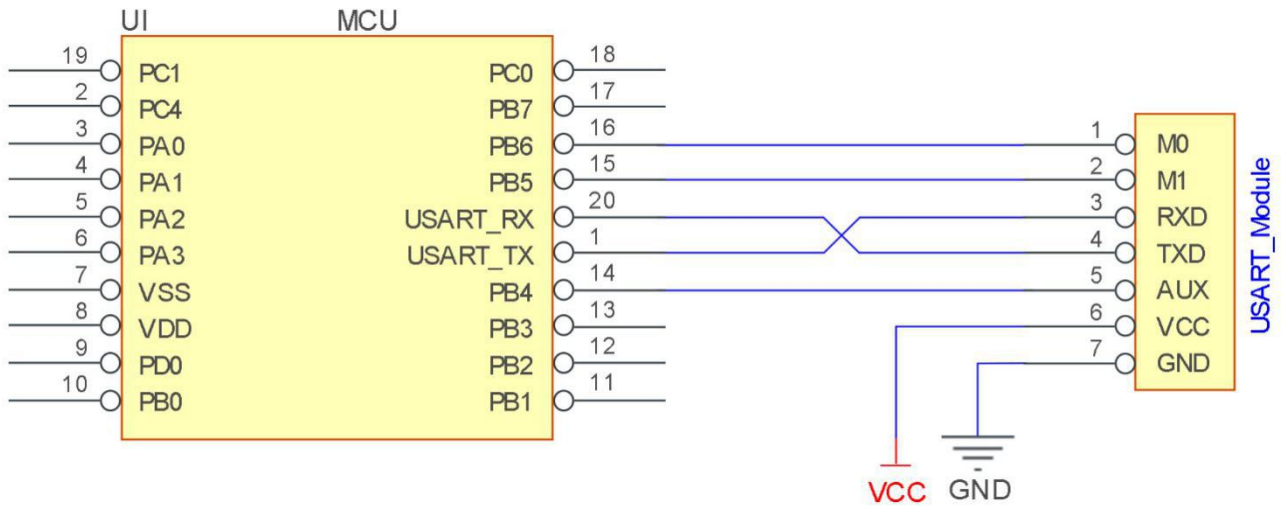
3 Size and pin definition



No.	Name	Direction	Function
1	GND		Ground
2	GND		Ground
3	GND		Ground

4	GND		Ground
5	M0	Input (weak pull-up)	Work with M1 to decide 4 working modes of module (not suspended, if not used, could be grounded).
6	M1	Input (weak pull-up)	Work with M0 to decide 4 working modes of module (not suspended, if not used, could be grounded).
7	RXD	Input	TTL UART inputs, connects to external (MCU, PC) TXD output pin. Can be configured as open-drain or pull-up input.
8	TXD	Output	TTL UART outputs, connects to external RXD (MCU, PC) input pin. Can be configured as open-drain or push-pull output
9	AUX	Output	To indicate module 's working status & wakes up the external MCU. During the procedure of self-check initialization, the pin outputs low level. Can be configured as push-pull output (suspending is allowed).
10	VCC		Power supply : 2.3~ 5.2V DC
11	GND		Ground
12	NC		
13	GND		Ground
14	NC		
15	NC		
16	NC		
17	NC		
18	NC		
19	GND		Ground
20	GND		Ground
21	ANT		Antenna
22	GND		Ground

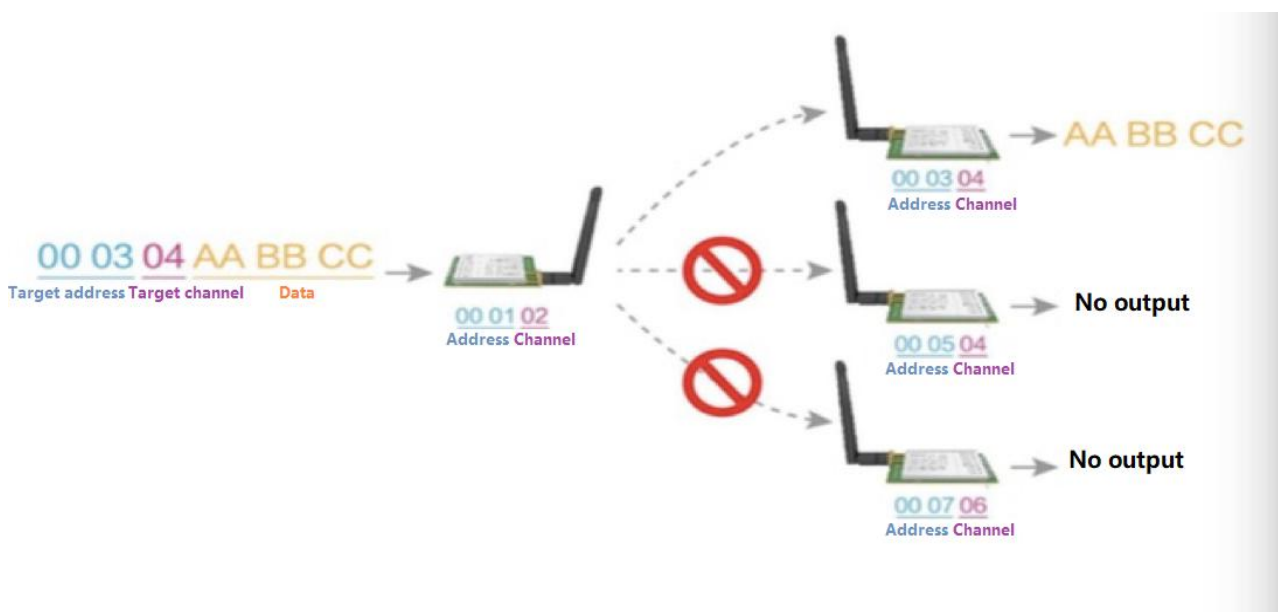
4. Connect to MCU



No.	Description (STM8L MCU)
1	The UART module is TTL level.
2	For some MCU works at 5VDC, it may need to add 4-10K pull-up resistor for the TXD & AUX pin.

5 Function description

5.1 Fixed transmission



5.2 Broadcasting transmission



5.3 Broadcasting address

- For example: Set the address of module A as 0xFFFF or 0x0000, and the channel as 0x04;
- When module is the transmitter (transparent transmission), all modules under channel 0x04 will receive the data, the purpose of broadcast is realized.

5.4 Monitor address

- For example: Set the address of module A as 0xFFFF or 0x0000, and the channel as 0x04;
- When module A is the receiver, it can receive the data sent from all modules under channel 0x04, the purpose of monitor is realized.

5.5 Reset

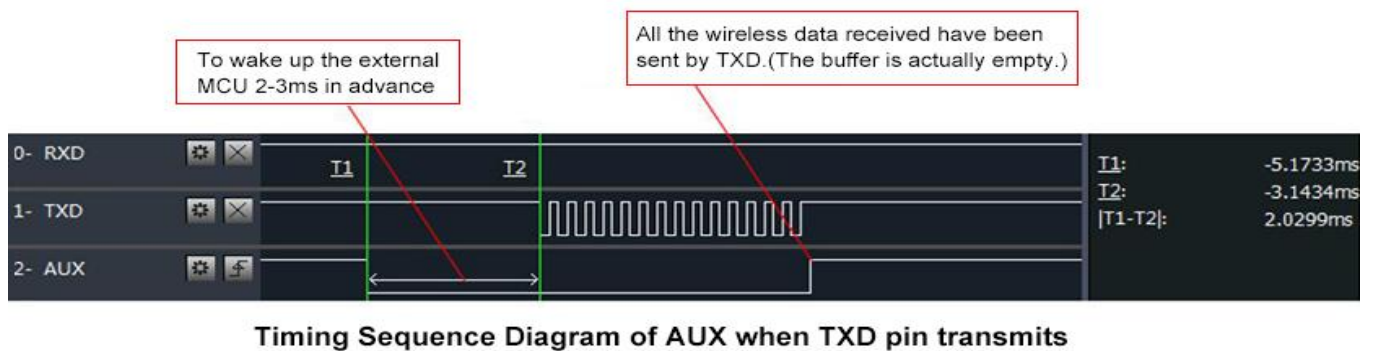
When the module is powered, AUX outputs low level immediately, conducts hardware self-check and sets the operating mode based on user's parameters. During the process, the AUX remains low level. After the process completed, the AUX outputs high level and starts to work as per the operating mode combined by M1 and M0. Therefore, users need to wait the AUX rising edge as the start of module's normal work.

5.6 AUX description

- AUX Pin can be used as indication for wireless send & receive buffer and self-check.
- It can indicate whether there are data that are not sent yet via wireless way, or whether all wireless data has been sent through UART, or whether the module is still in the process of self-check initialization.

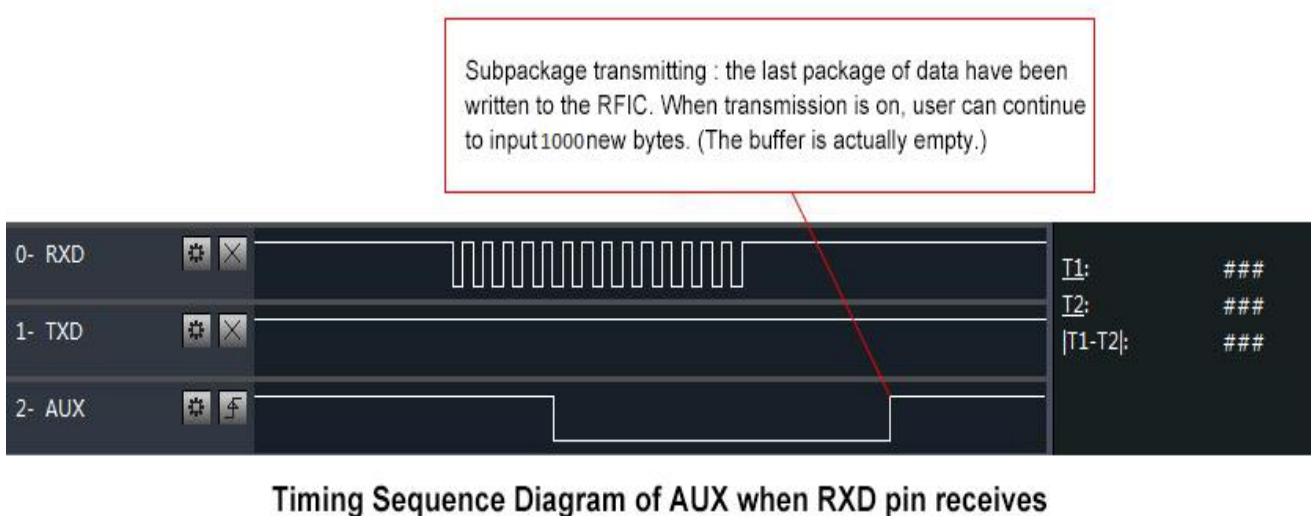
5.6.1 Indication of UART output

- To wake up external MCU



5.6.2 Indication of wireless transmitting

Buffer (empty): the internal 1000 bytes data in the buffer are written to the RFIC (Auto sub-packaging). When AUX=1, the user can input data less than 1000 bytes continuously without overflow. Buffer (not empty): when AUX=0, the internal 1000 bytes data in the buffer have not been written to the RFIC completely. If the user starts to transmit data at this circumstance, it may cause overtime when the module is waiting for the user data, or transmitting wireless sub package. When AUX = 1, it does not mean that all the UART data of the module have been transmitted already, perhaps the last packet of data is still in transmission.



5.6.3 Configuration procedure of module

- Only happened when power-on resetting or exiting sleep mode



Timing Sequence Diagram of AUX when self-check

5.6.4 Notes for AUX

No.	Description
1	For function 1 & function 2 mentioned above, the priority should be given to the one with low level output, which means if it meets each of any low level output condition, AUX outputs low level, if none of the low level condition is met, AUX outputs high level.
2	When AUX outputs low level, it means the module is busy & cannot conduct operating mode checking. Within 1ms since AUX outputs high level, the mode switch will be completed.
3	After switching to new operating mode, it will not work in the new mode immediately until AUX rising edge lasts for 2ms . If AUX stays on the high level, the operating mode switch can be effected immediately.
4	When the user switches to other operating modes from mode 3 (sleep mode) or it's still in reset process, the module will reset user parameters, during which AUX outputs low level.

6 Operating mode

There are four operating modes, which are set by M1 and M0, the details are as follows:

Mode(0-3)	M1	M0	Description	Remark
0 Normal mode	0	0	UART and wireless channel are open, transparent transmission is on	Supports configuration over air via special command
1 WOR mode	0	1	Can be defined as WOR transmitter and WOR receiver	Supports wake up over air
2 Configuration mode	1	0	Users can access the register through the serial port to control the working state of the module	
3 Deep sleep mode	1	1	Sleep mode	

6.1 Mode switching

No.	Remark
1	- Users can combine M1 and M0 with high and low levels to determine the operating mode. Two GPIOs of the MCU can be used to control mode switching; - After changing M1 and M0: If the module is idle, after 1ms, it can start working according to the new mode; - If the serial port data of the module has not been transmitted through the wireless, the new working mode can be switched after the transmission is completed; - If the module receives the wireless data and transmits the data through the serial port, it needs to finish transmission before switching the new working mode; - Therefore, mode switching can only be valid when AUX output is 1, otherwise it will delay switching.
2	- For example, users continuously inputs a large amount of data and simultaneously performs mode switching. At this time, the switching mode operation is invalid; the module will process all the user data before performing the new mode detection; - Therefore, the general recommendation is to detect the output state of the AUX pin and switch after 2ms when the output is high.
3	- When the module is switched from other modes to sleep mode, if the data has not been processed yet; - The module will process these data (including receiving and sending) before entering sleep mode. This feature can be used for fast sleep, which saves power; for example, the transmitter module works in mode 0, the user transmits 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 immediately sleeps, the module will automatically transmit the user data through the wireless, and automatically enters sleep within 1ms; - This saves MCU's working time and reduces power consumption.
4	- Similarly, 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 eliminating the need for the user to query AUX and achieve the purpose of fast switching; - For example, switching from the transmit mode to the receive mode; the user MCU can also enter sleep before the mode switch, and use the external interrupt function to acquire the AUX change, thereby performing mode switching.
5	This operation mode is very flexible and efficient, and is designed according to the user's MCU's 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	M0 = 0, M1 = 0
Transmitting	Users can input data through the serial port and the module will start wireless transmission.
Receiving	The module wireless receiving function is turned on, and after receiving the wireless data, it will be output through the serial port TXD pin.

6.3 WOR mode (Mode 1)

Type	M0 = 1, M1 = 0
Transmitting	When defined as a transmitting party, a preamble is automatically added before transmitting.
Receiving	It can receive data normally, the receiving function is the same as mode 0.

6.4 Configuration mode (Mode 2)

Type	M0 = 0, M1 = 1
Transmitting	Wireless transmitting off
Receiving	Wireless receiving off
Configuration	Users can access the registers to configure the module's operation state.

6.5 Deep sleep mode (Mode 3)

Type	M0 = 1, M1 = 1
Transmitting	Unable to transmit wireless data
Receiving	Unable to receive wireless data
Note	When from the sleep mode to other modes, the module will reconfigure the parameters. During the configuration process, AUX will remain low; After configuration, it outputs high level, we suggest that user test rising edge T_BUSY.

7 Hardware design

- It is recommended to use a DC stabilized power supply. The power supply ripple factor is as small as possible, and the module needs to 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 it is within the recommended voltage otherwise when it exceeds the maximum value the module will be permanently damaged;
- Please check the stability of the power supply, the voltage can not be fluctuated frequently;
- When designing the power supply circuit for the module, it is often recommended to reserve more than 30%

of the margin, so the whole machine is beneficial for long-term stable operation.;

- The module should be as far away as possible from the power supply, transformers, high-frequency wiring and other parts with large electromagnetic interference.;
- High-frequency digital routing, high-frequency analog routing, and power routing must be avoided under the module. If it is necessary to pass through the module, assume that the module is soldered to the Top Layer, and the copper is spread on the Top Layer of the module contact part(well grounded), it must be close to the digital part of the module and routed in the Bottom Layer;
- Assuming the module is soldered or placed over the Top Layer, it is wrong to randomly route over the Bottom Layer or other layers, which will affect the module's spurs and receiving sensitivity to varying degrees;
- It is assumed that there are devices with large electromagnetic interference around the module that will greatly affect the performance. It is recommended to keep them away from the module according to the strength of the interference. If necessary, appropriate isolation and shielding can be done;
- Assume that there are traces with large electromagnetic interference (high-frequency digital, high-frequency analog, power traces) around the module that will greatly affect the performance of the module. It is recommended to stay away from the module according to the strength of the interference.If necessary, appropriate isolation and shielding can be done.
- If the communication line uses a 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 physical layers such as TTL protocol at 2.4GHz , for example: USB3.0;
- The mounting structure of antenna has a great influence on the performance of the module. It is necessary to ensure that the antenna is exposed, preferably vertically upward. When the module is mounted inside the case, use a good antenna extension cable to extend the antenna to the outside;
- The antenna must not be installed inside the metal case, which will cause the transmission distance to be greatly weakened.

8 FAQ

8.1 Communication range is too short

- The communication distance will be affected when obstacle exists.
- Data lose rate will be affected by temperature, humidity and co-channel interference.
- The ground will absorb and reflect wireless radio wave, so the performance will be poor when testing near ground.
- Sea water has great ability in absorbing wireless radio wave, so performance will be poor when testing near the sea.
- The signal will be affected when the antenna is near metal object or put in a metal case.
- Power register was set incorrectly, air data rate is set as too high (the higher the air data rate, the shorter the distance).
- The power supply low voltage under room temperature is lower than 2.5V, the lower the voltage, the lower the transmitting power.
- Due to antenna quality or poor matching between antenna and module.

8.2 Module is easy to damage

- Please check the power supply source, ensure it is 2.0V~3.6V, voltage higher than 3.6V will damage the module.
- Please check the stability of power source, the voltage cannot fluctuate too much.
- Please make sure antistatic measure are taken when installing and using, high frequency devices have electrostatic susceptibility.
- Please ensure the humidity is within limited range, some parts are sensitive to humidity.
- Please avoid using modules under too high or too low temperature.

8.3 BER(Bit Error Rate) is high

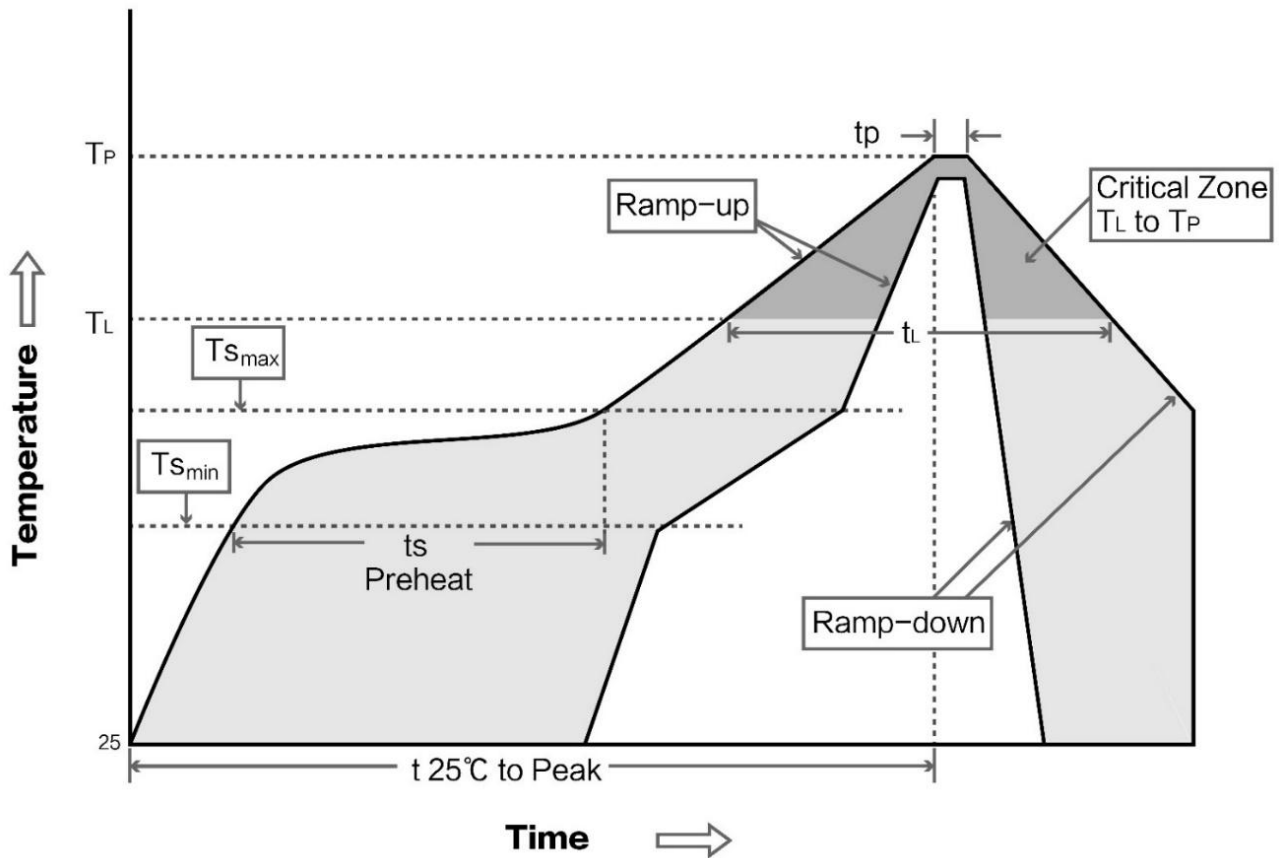
- There are co-channel signal interference nearby, please be away from interference sources or modify frequency and channel to avoid interference;
- Poor power supply may cause messy code. Make sure that the power supply is reliable.
- The extension line and feeder quality are poor or too long, so the bit error rate is high;

9 Production guidance

9.1 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 (T _{smin})	Min preheating temp.	100°C	150°C
Preheat temperature max (T _{smax})	Mx preheating temp.	150°C	200°C
Preheat Time (T _{smin} to T _{smax})(ts)	Preheating time	60-120 sec	60-120 sec
Average ramp-up rate(T _{smax} to T _p)	Average ramp-up rate	3°C/second max	3°C/second max
Liquidous Temperature (TL)	Liquid phase temp.	183°C	217°C
Time (tL) Maintained Above (TL)	Time below liquid phase line	60-90 sec	30-90 sec
Peak temperature (T _p)	Peak temp.	220-235°C	230-250°C
Average ramp-down rate (T _p to T _{smax})	Average ramp-down rate	6°C/second max	6°C/second max
Time 25°C to peak temperature	Time to peak temperature for 25°C	max 6 minutes	max 8 minutes

9.2 Reflow soldering curve

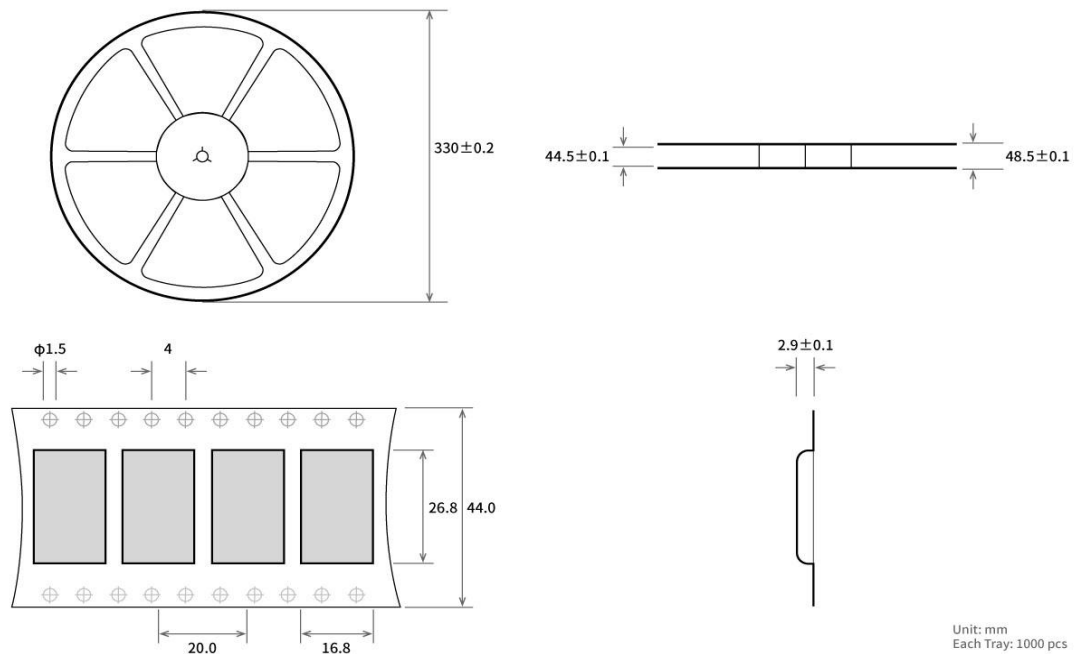


10 Antenna recommendation

The antenna is an important role in the communication process. A good antenna can largely improve the communication system. Therefore, we recommend some antennas for wireless modules with excellent performance and reasonable price.

Model No.	Type	Frequency Hz	Interface	Gain dBi	Height	Cable	Function feature
TX433-JK-20	Rubber antenna	434M	SMA-J	3	210mm	-	Flexible & omnidirectional

11 Package for batch order



Revision history

Version	Date	Description	Issued by
1.00	2018-01-08	Initial version	huaa
1.10	2018-04-16	Content updated	huaa
1.20	2018-05-24	Content updated	Huaa
1.21	2018-07-20	Model name revised	Huaa
1.30	2018-10-23	Model No. split	Huaa

About us

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Address: Innovation Center D347, 4# XI-XIN Road, Chengdu, Sichuan, China

FCC Statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Radiation Exposure Statement

This modular complies with FCC RF radiation exposure limits set forth for an uncontrolled environment.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

This modular must be installed and operated with a minimum distance of 20 cm between the radiator and user body.

If the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains Transmitter Module FCC ID: 2ALPH-E22400T22S Or Contains FCC ID: 2ALPH-E22400T22S "

When the module is installed inside another device, the user manual of the host must contain below warning statements;

1. This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) This device may not cause harmful interference.

(2) This device must accept any interference received, including interference that may cause undesired operation.

2. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

The devices must be installed and used in strict accordance with the manufacturer's instructions as described in the user documentation that comes with the product.

IP EX antenna port dont connect to all circuit and permanent disable function in device with FCC ID: 2ALPH-E22400T22S