EoRa_HUB_xxxTB User Manual

ESP32-S3 LR1121 LoRa Dual-Band Development Board

Chengdu Ebyte Electronic Technology Co.,Ltd.

Contents

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1 Product Overview

1.1 Product Introduction

EoRa-HUB-400/900TB is a LR1121 development board designed and produced by Ebyte. It consists of E80 series modules (LR1121 modules) and ESP32-S3. It has abundant external pins and a 0.96-inch OLED display, and provides three communication methods: LoRa, Wi-Fi and Bluetooth. The device has been widely used in the field of IoT development and long-distance communication, especially in the application of SEMTECH One-ChannelHub (LoRaWAN single-channel gateway) technology, which has been recognized by the majority of users.

LoRa module information link: E80-400M2213S User Manual , E80-900M2213S User Manual

LoRa chip data link: SEMTECH LR1121 chip data

MCU data link: ESP32-S3 chip data

1.2 Features

- Support SEMTECH LoRaWAN One-Channel Hub (single-channel LoRaWAN gateway) protocol, factory-installed firmware;
- E80-400M2213S: uses LR1121 chip, supports LoRa dual-band 410 ~ 493MHz/2.4GHz, and has a maximum output power of +22dBm(SuB-GHz)/+13dBm(2.4GHz);
- E80-900M2213S: uses LR1121 chip, supports LoRa dual-band 850 ~ 930MHz/2.4GHz, and has a maximum output power of +22dBm(SuB-GHz)/+13dBm(2.4GHz);
- ESP32-S3FH4R2 is equipped with Xtensa® 32-bit LX7 dual-core processor with a main frequency of up to 240MHz, and integrates 4MB FLASH and 2MB PSRAM on the chip ;
- Supports both Wi-Fi and low-power Bluetooth, with a maximum output power of +21dBm for Wi-Fi and +20dBm for BLE, sharing one antenna;
- Wi-Fi: Supports IEEE 802.11b / g/n protocols, 20MHz and 40MHz bandwidths, 1T1R mode, and data rates up to 150Mbps;
- Wi-Fi: Supports infrastructure BSS Station mode, SoftAP mode and Station+SoftAP mode ;
- Wi-Fi: supports 802.11 mc FTM , which can provide high-precision indoor positioning services;
- Bluetooth LE : supports 125Kbps, 500 Kbps, 1Mbps, 2Mbps rates ;
- Bluetooth LE : supports Bluetooth 5, Bluetooth mesh;
- Support 0.96-inch OLED display;
- Support lithium battery power supply/charging, with a designed rated charging current of 500mA;
- Type-C interface, using USB 2.0 protocol.

1.3 Application Scenarios

- Smart home (real-time monitoring and reporting to the cloud by various sensors and civil meters) ;
- Industrial Internet of Things and asset tracking (factory equipment monitoring and real-time control and monitoring of industrial valves and meters reporting to the cloud);
- Smart agriculture and environmental monitoring (soil moisture, temperature sensors and other sensors monitor and report to the cloud in real time);
- Smart cities and public facilities (real-time monitoring of street lights, reporting of abnormal status of security alarm systems

to the cloud);

- Healthcare and wearable devices (remote monitoring, drug tracking and traceability information reporting to the cloud) ;
- Energy and public utilities (intelligent meter reading, energy pipeline monitoring and reporting to the cloud) ;
- Warehousing and logistics management (cargo positioning, inventory management, and logistics scheduling information reporting to the cloud).

2 Specifications

2.1 Limit parameters

Main parameters	performance		Remark
	Minimum	Maximum	
Supply voltage (V)	0	5.5	A supply voltage exceeding 5.5 V may cause the module to burn out.
Blocking power (dBm)	-	10	The probability of burning is lower when used at close range
Operating temperature (℃)	-40	+ 85	Industrial Grade

2.2 Working parameters

2.2.1 Machine parameters

Main parameters	performance			Remark
	Minimum	Typical Value	Maximum	
Machine operating voltage (V)	3. 2	3.3	5	≥3.3V can guarantee output power
UART communication level (V)		3.3		Using 5V TTL may burn out
Operating temperature (°C)	-40	-	+85	Industrial-grade design

2.2.2 Wi-Fi parameters

Wi-Fi Parameters				
Main parameters	performance			Remark
	Minimum	Typical Value	Maximum	
Operating frequency band (MHz)	2412	-	2484	See the ESP32-S3 data sheet for details.
Maximum transmit power (dBm)	18	-	twenty one	The performance under the 802.11 standard is different. See the ESP32-S3 data sheet for details.
Transmission rate (Mbps)	1	-	150	The maximum speed under 802.11b standard can reach 11 Mbps The maximum speed can reach 54 Mbps under the 802.11g standard The maximum speed can reach 150 Mbps under the 802.11n standard

Receiving sensitivity (dBm)	-98.4	-	-71.4	The performance varies under the 802.11 standard and different transmission rates. See the ESP32-S3 data sheet for details.
Emission current (mA)	283	-	340	The performance varies under the 802.11 standard and different transmission rates. See the ESP32-S3 data sheet for details.
Receive current (mA)	88	-	91	The performance varies under the 802.11 standard and different transmission rates. See the ESP32-S3 data sheet for details.

2.2.2 BLE parameters

BLE Parameters				
Main parameters	**performance**			**Remark**
	Minimum	**Typical Value**	**Maximum**	
Operating frequency band (MHz)	2402	-	2480	See the ESP32-S3 data sheet for details.
Transmit power (dBm)	-twenty four	0	20	See the ESP32-S3 data sheet for details.
Transmission rate (Mbps)	0.125	-	2	See the ESP32-S3 data sheet for details.
Receiving sensitivity (dBm)	-104.5	-	-93.5	The sensitivity is different at different rates, the lower the rate, the higher the sensitivity
Emission current (mA)	-	-	380	-
Receive current (mA)	-	-	95	-

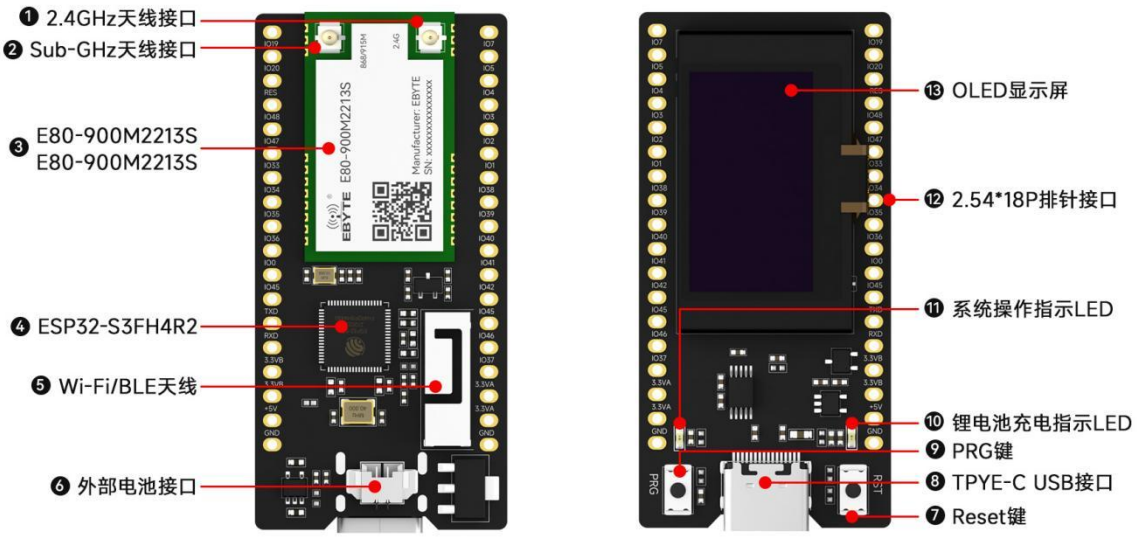
2.2.3 LoRa module parameters

RF parameters	**Parameter Value**		**Remark**
	E80-400M2213S	**E80-900M2213S**	
Operating voltage (V)	1.8 -3.7		≥3.3V can guarantee output power , more than 3.8V may cause burnout risk
Communication level (V)	3.3		Using 5V TTL may cause burnout , please use the conversion circuit reasonably
Operating frequency band (MHz)	410-493	850-930	@Sub-GHz, users can program the module to work at different frequencies
	2400-2500		@2.4GHz, users can program the module to work at different frequencies
Blocking power (dBm)	10		The probability of burning is lower when used at close range
Maximum transmit power (dBm)	21.5	22.0	@Sub-GHz, users can adjust the output power through programming
	13		@2.4GHz, users can adjust the output power through programming
Receive sensitivity (dBm)	-136		@Sub-GHz, BWL=125kHz, SF=9
	-129		@2.4GHz，BWL=406kHz, SF=7
Emission current (mA)	120		@433/470MHz, instantaneous power consumption
	125		@868/915MHz, instantaneous power consumption
	35		@2.4GHz, instantaneous power consumption
Receive current (mA)	9.5		@Sub-GHz
	9.0		@2.4GHz
Sleep current (μA)	10		Software shutdown , LoRa radio does not work
Reference communication	≤5.6		@Sub-GHz, clear and open environment, antenna gain 3.5dBi , antenna height 2.5

distance (km)		meters , air rate 2.4 kbps
	≤2.6	@2.4GHz, clear and open environment, antenna gain 5dBi , antenna height 2.5 meters, air rate 2.4k bps

3 Mechanical dimensions and pin definition

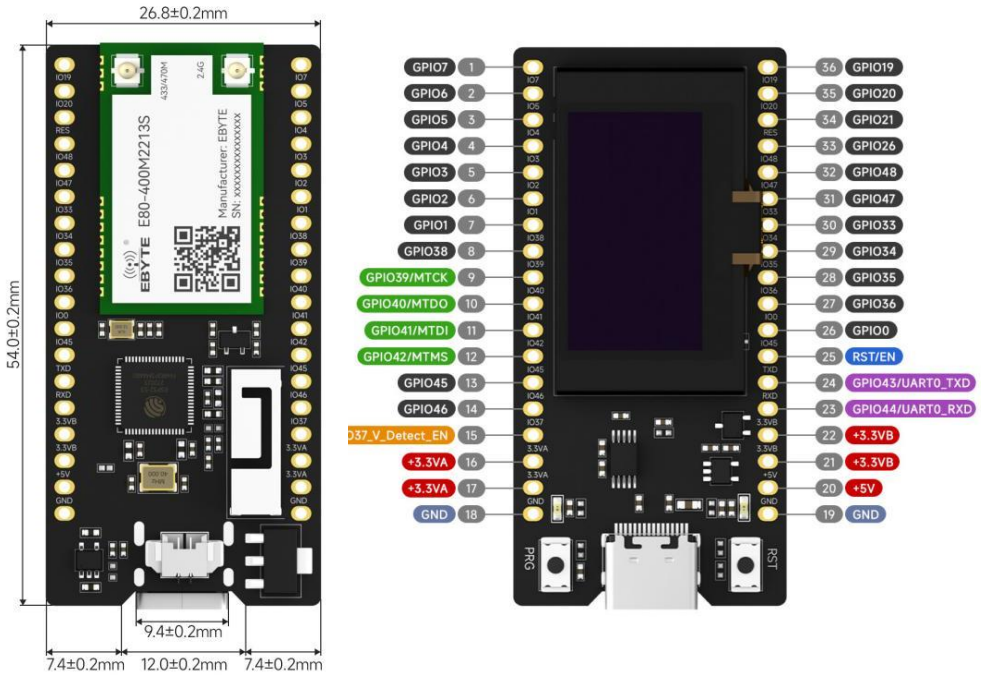
3.1 Introduction to functional components



NO.	Main hardware	introduce
1	IPEX socket	IPEX-1 generation socket, LoRa 2.4GHz antenna interface .
2	IPEX socket	IPEX-1 generation socket, LoRa Sub-GHz antenna interface .
3	E80-400M2213S / E80-900M2213S	E80 series is a dual-frequency SMD LoRa hardware SPI wireless module independently developed by Ebyte based on SEMTECH's LoRa Connect™ LR1121 chip for multi-band global connectivity. *For details, please visit the official website of Ebyte.*
4	ESP32-S3 FH4R2 chip	ESP32-S3 is a low-power MCU system-on-chip (SoC) that supports 2.4GHz Wi-Fi and Bluetooth® LE wireless communications , with 384KB ROM, 512KB SRAM, 4MB FLASH, and 2MB PSRAM.. *Please refer to the ESP32-S3 datasheet for details.*
5	Wi - Fi / BLE Antenna	Maximum gain 4.9dBi, 2.4 GHz 3D omnidirectional antenna.
6	External battery interface	SH1.25mm , 2 PIN battery interface (lithium battery is recommended) .
7	Reset button	Reset button.
8	TYPE-C USB interface	Used to power the development board and download and burn the ESP32 - S3 chip firmware.
9	PRG key	System operation buttons .
10	Lithium battery charging indicator LED	Yellow LED, always on when charging, turns off when fully charged .

11	System operation indicator LED	The blue LED is always on when the system is successfully running after reset and restart.
12	2.54*18P pin header	2.54mm * 18PIN pin header soldering hole .
13	OLED screen	0.96-inch OLED display screen .

3.2 GPIO pin definition and size introduction



No.	Pin Name	Pin Direction	Pin Purpose
1	GPIO7	Input/Output	General I/O, see ESP32-S3 datasheet for details
2	GPIO6	Input/Output	General I/O, see ESP32-S3 datasheet for details
3	GPIO5	Input/Output	General I/O, see ESP32-S3 datasheet for details
4	GPIO4	Input/Output	General I/O, see ESP32-S3 datasheet for details
5	GPIO3	Input/Output	General I/O, see ESP32-S3 datasheet for details
6	GPIO2	Input/Output	General I/O, see ESP32-S3 datasheet for details
7	GPIO1	Input/Output	General I/O, see ESP32-S3 datasheet for details
8	GPIO38	Input/Output	General I/O, connect to lithium battery voltage circuit to monitor battery voltage, see ESP32-S3 data sheet and circuit schematic for details
9	GPIO39	Input/Output	General purpose I/O or JTAG interface (MTCK) for debugging, see the ESP32-S3 datasheet for details
10	GPIO40	Input/Output	General purpose I/O or JTAG interface for debugging (MTDO), see the ESP32-S3 datasheet for details
11	GPIO41	Input/Output	General purpose I/O or JTAG interface (MTDI) for debugging, see the ESP32-S3 datasheet for details
12	GPIO42	Input/Output	General purpose I/O or JTAG interface for debugging (MTMS), see the ESP32-S3 datasheet for details
13	GPIO45	Input/Output	General I/O, see ESP32-S3 datasheet for details
14	GPIO46	Input/Output	General I/O, see ESP32-S3 datasheet for details
1 5	GPIO37	Input/Output	General purpose I/O, connected to the switch enable pin of the lithium battery voltage monitoring circuit. For details, see the ESP32-S3 data sheet and circuit schematics
16	+3.3VA	power supply	ESP32-S3 chip power supply pin, see the circuit schematic for details

17	+3.3VA	power supply	ESP32-S3 chip power supply pin, see the circuit schematic for details
18	GND	power supply	Power GND
19	GND	power supply	Power GND
20	+5V	power supply	+5V power supply pin, when powered by Type-C USB port, can be used as +5V output pin, see circuit schematic for details
21	+3.3VB	power supply	E80 series modules and OLCD display power supply pins, see the circuit schematic for details
22	+3.3VB	power supply	E80 series modules and OLCD display power supply pins, see the circuit schematic for details
23	GPIO44	Input/Output	General I/O, used as UART0_RXD, connected to USB to TTL chip CH340, see ESP32-S3 data sheet and circuit schematic for details
24	GPIO43	Input/Output	General I/O, used as UART0_TXD, connected to USB to TTL chip CH340, see ESP32-S3 data sheet and circuit schematic for details
25	RST/EN	-	ESP32-S3 reset pin, connected to the RST key of the development board, see the ESP32-S3 data sheet and circuit schematic for details
26	GPIO0	Input/Output	General purpose I/O, connected to the PRG button pin, see the ESP32-S3 data sheet and circuit schematic for details
27	GPIO36	Input/Output	General I/O, see ESP32-S3 datasheet for details
28	GPIO35	Input/Output	General I/O, connect to the system operation indicator LED (blue), see the ESP32-S3 data sheet and circuit schematic for details
29	GPIO34	Input/Output	General I/O, connected to the lithium battery charging switch pin, see the ESP32-S3 data sheet and circuit schematic for details
30	GPIO33	Input/Output	General I/O, see ESP32-S3 datasheet for details
31	GPIO47	Input/Output	General I/O, see ESP32-S3 datasheet for details
32	GPIO48	Input/Output	General I/O, see ESP32-S3 datasheet for details
33	GPIO26	Input/Output	General I/O, see ESP32-S3 datasheet for details
34	GPIO21	Input/Output	General I/O, connected to the reset pin RES of the OLED display. For details, see the ESP32-S3 data sheet and circuit schematics
35	GPIO20	Input/Output	General I/O, see ESP32-S3 datasheet for details
36	GPIO19	Input/Output	General I/O, see ESP32-S3 datasheet for details

4 One-Channel Hub (Single-Channel Gateway) Application

4.1 Application Introduction

As LoRaWAN® technology becomes more and more popular in LPWAN (Low Power Wide Area Network) , it has been deployed in more than 100 countries around the world, solving the core pain points of low power consumption, wide coverage, and high security in the IoT field, and becoming a key infrastructure to support digital transformation such as Industry 4.0 , smart cities, and smart agriculture . Its openness and continuous innovation (such as satellite communication integration) will continue to promote the expansion of the boundaries of IoT applications . In order to further popularize LoRaWAN® communication technology, SEMTECH has launched a single-channel gateway device application technology that can be deployed on-site at low cost and in a miniaturized manner - One -Channel Hub. This technology solves the problem that LoRaWAN® gateway nodes occupy too much cost in some low-order node application scenarios.

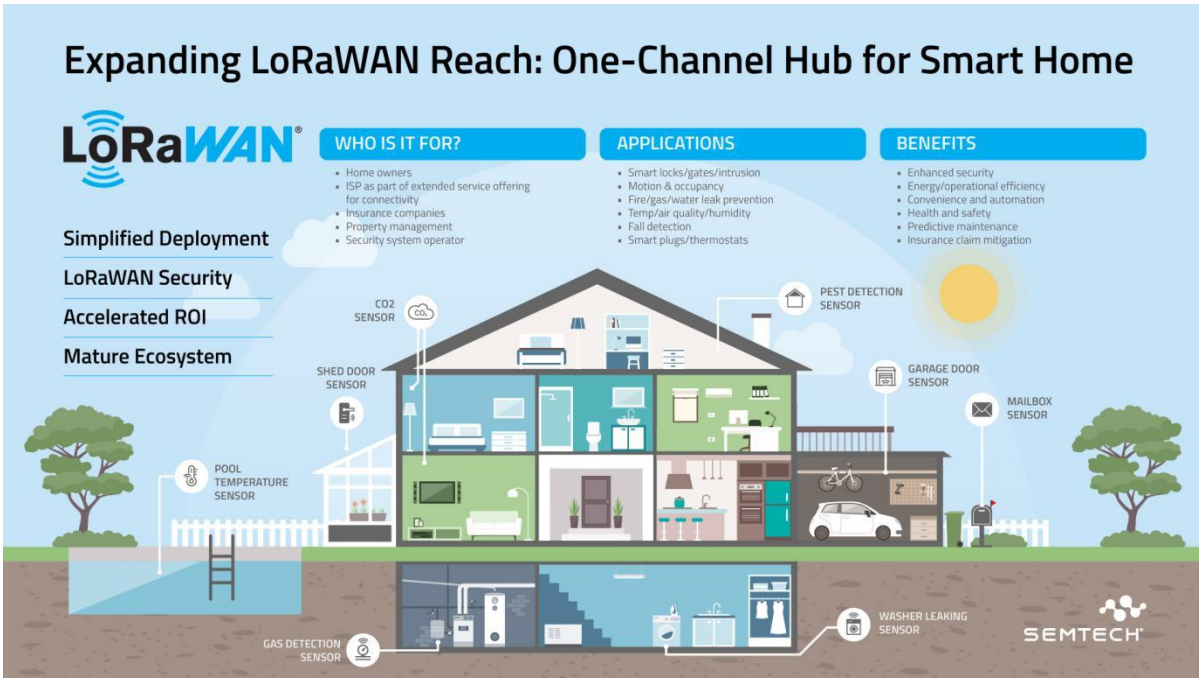
Compare the design performance of the traditional LoRaWAN ® gateway and One Channel Hub :

Reference Design ID	Corecell SX1302 GW Traditional LoRaWAN® Gateway	One Channel Hub
Modem + RF Front End	SX1302+2*SX1250	LR1121
RX Channel Number	8	1
T X Number of channels	1	1
Country	America , Europe , China	America , Europe , China
Full-duplex/half-duplex	Full-duplex/half-duplex	Half Duplex
LBT	√	×
frequency	470-928MHz	470-928MHz
Transmit power	Maximum 27dBm (US & Europe) Maximum 22dBm (China)	Maximum 22dBm
Receiving sensitivity	Minimum -141dBm	Minimum -136dBm
processor	BCM2837B0, Quad-Core, 1.4GHz	Xtensa® 32-bit LX7, Dual-Core, 240MHz
Power consumption	350mA	125mA
Upload data method	Ethernet/WiFi	WiFi

Secondly, let's compare the deployment network capacity, number of channels, and difficulty:

Gateway Type	Traditional LoRaWAN® Gateway	One Channel Hub
Network capacity	>1000 nodes	50 nodes
Chip level	Gateway chip [SX1302]	Node-level chips [LR1121]
Operating system platform	Linux Platform	Embedded Platforms
Supported LoRaWAN® versions	1.0.x	1.0.x
Number of simultaneous detection channels	8CH x 6SF	1CH or 2SF
Supported node types	LoRaWAN Class A , B, C	LoRaWAN Class A ， C

From the above information comparison, it is not difficult to see that One Channel Hub is more suitable for small-scale deployment, such as the following scenarios:



Introduction to product application

- You can download the One Channel Hub project source code from SEMTECH on the GitHub open source website: https://github.com/Lora-net/one_channel_hub
- If you need to customize the One Channel Hub system, please go to the Espressif official website to download the ESP32-S3 IDE development tool: https://docs.espressif.com/projects/esp-idf/zh_CN/v5.4/esp32s3/get-started/index.html
- EoRa-HUB-xxxTB comes with One Channel Hub firmware and can be operated immediately after power-on.
  - ✧ If the computer system cannot recognize the device, please download the USB to Serial driver: https://www.ebyte.com/pdf-down/2938.html
  - ✧ In order to configure the WIFI access point, the mobile phone needs to download the configuration APP and select different software according to different systems:
    android: https://play.google.com/store/apps/details?id=com.espressif.provble
    iOS: https://apps.apple.com/in/app/esp-ble-provisioning/id1473590141
  - ✧ Power on the EoRa-HUB-xxxTB and press the RST button. Within the next five seconds, when the LED lights up, press the PRG button and continue pressing it until the OLED screen displays "LoRaHub - WiFi Provisioning" to confirm that the development board has entered the Provisioning mode.
  - ✧ Then follow these steps in the mobile app (WiFi configuration app needs to be installed in advance):
    1. Click the " Provision New Device " button ;
    2. Click " I don't have a QR code " button ;
    3. Select the device with the prefix " LRHB_ " , for example, a device name like "LRHB_617C30";
    4. Enter the P roof of possession PIN, the default is " abcd1234 ";
    5. Click “Next”;
    6. the name of the Wi-Fi network you want to join , enter the password, and click "Checking Provisioning Status" to wait for the connection;
    7. After the connection is successful, the EoRa-HUB-xxxTBOLED display will scroll "LoRaHub -Receiving", IP

address and One Channel Hub device ID (actually FFFE added after the third byte of the MAC address).

4.3 Example Introduction

- For related routines, please refer to the One Channel Hub project description on SEMTECH's GitHub open source website: https://github.com/Lora-net/one_channel_hub

4.5 Battery Charging

- The lithium battery can be charged via the Type-C USB port. The yellow LED will light up while charging and turn off when fully charged.
- The charging circuit is designed with a maximum charging current of 500mA. Please ensure that the power supply capacity is sufficient.

5 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 should 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, the module will be permanently damaged.
- Please check the stability of the power supply. The voltage should not fluctuate greatly or frequently.
- When designing the power supply circuit for the module, it is often recommended to retain 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 large electromagnetic interference;
- High-frequency digital routing, high-frequency analog routing, and power routing must avoid the bottom of the module. If it is necessary to pass under the module, assuming that the module is soldered on the Top Layer, ground copper is laid on the Top Layer of the module contact part (all copper is laid and well grounded), and it must be close to the digital part of the module and routed on the Bottom Layer;
- Assuming the module is soldered or placed on the Top Layer, it is also wrong to randomly route the wires on the Bottom Layer or other layers, which will affect the module's spurious signal and receiving sensitivity to varying degrees;
- If there are devices with large electromagnetic interference around the module, it will also greatly affect the performance of the module. It is recommended to keep them away from the module according to the intensity of the interference. If possible, appropriate isolation and shielding can be performed.
- If 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 keep them away from the module according to the intensity of the interference. If possible, appropriate isolation and shielding can be performed.
- 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 the module performance. Make sure the antenna is exposed and preferably vertically upward;
- When the module is installed inside the case, you can use a high-quality antenna extension cable to extend the antenna to the outside of the case;
- The antenna must not be installed inside a metal shell, as this will greatly reduce the transmission distance.

6 Frequently Asked Questions

6.1 The transmission distance is not ideal

- When there is a straight-line communication obstacle, the communication distance will be attenuated accordingly;
- Temperature, humidity, and co-channel interference can increase the communication packet loss rate;
- The ground absorbs and reflects radio waves, so the test results are poor when close to the ground;
- Seawater has a strong ability to absorb radio waves, so the test effect at the seaside is poor;
- If there are metal objects near the antenna, or the antenna is placed in a metal shell, the signal attenuation will be very serious;
- The power register is set incorrectly, or the air rate is set too high (the higher the air rate, the closer the distance);
- The power supply voltage is lower than the recommended value at room temperature. The lower the voltage, the lower the transmission power.
- The antenna used does not match the module well or the antenna itself has quality issues.

6.2 Modules are vulnerable to damage

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

6.3 Bit error rate is too high

- There is interference from the same frequency signal nearby. Stay away from the interference source or change the frequency or channel to avoid interference.
- An unsatisfactory power supply may also cause garbled characters, so the reliability of the power supply must be ensured;
- Extension cables or feeder cables that are of poor quality or are too long can also cause a high bit error rate.

10 Antenna Selection

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 matching antennas for our wireless modules with excellent performance and reasonable prices.

Product Model	type	Frequency band	Gain	size	Feeder	Interface	Features
		Hz	dBi	mm	mm		
TX433-JKS-IPX20	Glue stick antenna	433M	3.0	197	200	IPEX-1	Fixed bending, omnidirectional antenna
TX470-JKS-IPX20	Glue stick antenna	433M	3.0	197	200	IPEX-1	Fixed bending, omnidirectional antenna
TX868-JKS-IPX20	Glue stick antenna	433M	3.0	197	200	IPEX-1	Fixed bending, omnidirectional antenna
TX915-JKS-IPX20	Glue stick antenna	433M	3.0	197	200	IPEX-1	Fixed bending, omnidirectional antenna
TX2400-JKS-IPX20	Glue stick antenna	433M	5.0	197	200	IPEX-1	Fixed bending, omnidirectional antenna

Revision History

Version	Revision Date	Revision Notes	Maintainer
1.0	2025-3-17	Initial release	Ning

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