EoRa PI User Manual

ESP32-S3 SX1268 SX1262 LoRa Spread Spectrum

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Chapter 1 Product Overview

1.1 Product Profile

EoRa PI is based on Loxin ESP32-S3FH4R2 chip and EBYTE LoRa module and developed two development boards EoRa-S3-400TB, EoRa-S3-900TB, development boards integrated Type-C interface, E22-400/900MM22S LoRa module, 0.96-inch OLED display, SD card slot, Li-ion battery charging circuit and its power circuit. slot, Li-ion battery charging circuit and its power supply circuit.

The ESP32-S3 is a low-power MCU system-on-chip (SoC) that supports 2.4 GHz Wi-Fi and Bluetooth® LE wireless communication. The chip integrates a high-performance Xtensa® 32-bit LX7 dual-core processor, an ultra-low-power co-processor, Wi-Fi baseband, Bluetooth baseband, RF module, and peripherals up to 240 MHz, with 384 KB of ROM, 512 KB of SRAM, 16 KB of RTC SRAM, and 4 MB of FLASH and 2 MB of PSRAM in the ESP32-S3FH4R2 package. FLASH and 2 MB PSRAM are additionally integrated in the ESP32-S3FH4R2 package.

MCU datasheet link: ESP32-S3 Datasheet

LoRa module information link: E22-400MM22S User's Manual

LoRa chip datasheet link: Semtech SX126X Chip Brochure

1.2 Characteristic functions

- The Xtensa® 32-bit LX7 dual-core processor with up to 240 MHz and an additional 4 MB of FLASH and 2 MB of PSRAM are integrated in the package;
- It also supports Wi-Fi and low-power Bluetooth, with a maximum output power of +21dBm for WIFI and +20dBm for BLE, sharing a common antenna;
- Wi-Fi: Supports IEEE 802.11b/g/n protocols, 20 MHz and 40 MHz bandwidths, 1T1R mode, and data rates up to 150 Mbps;
- Wi-Fi: Supports Infrastructure BSS Station mode, SoftAP mode and Station + SoftAP mode;
- Wi-Fi: Supports 802.11 mc FTM for high-precision indoor positioning;
- Bluetooth LE: Supports rates of 125 Kbps, 500 Kbps, 1 Mbps, 2 Mbps;
- Bluetooth LE: Supports Bluetooth 5, Bluetooth mesh;
- E22-400MM22S: Adopts SX1268 chip, supports operating frequency 410 ~ 493 MHz, maximum output power +22 dBm;
- E22-900MM22S: Adopts SX1262 chip, supports operating frequency 850 ~ 930 MHz, maximum output power +22 dBm;
- Supports 0.96″ OLED display;
- Supports battery charging, designed for a rated charging current of 500mA;
- Tpye-C interface with USB 2.0 protocol.

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1.3 Application scenarios

- Smart home as well as industrial automation;
- Healthcare;
- Smart agriculture, service robotics;
- General Purpose Low Power IoT Sensor Hub, General Purpose Low Power IoT Data Logger;
- Audio devices, camera video streaming;
- USB devices, consumer electronics;
- Speech recognition, image recognition;
- Wi-Fi + Bluetooth network card;
- Touch and proximity sensing.

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Chapter 2 Specifications

2.1 Limit parameters

Main parameters	performances		note
	minimum value	maximum values	
Supply Voltage	0 V	5.5 V	Supply voltage above 5.5 V may cause module burnout
LoRa Blocking Power	-	10 dBm	Less likely to burn out in close proximity
operating temperature	-40 ° C	+85 ° C	industrial grade

2.2 Operating parameters

2.2.1 Parameters of the whole machine

Main parameters	performances			note
	minimum value	typical value	maximum values	
Whole machine working voltage (V)	3.2	3.3	5	≥3.3V guaranteed output power
UART communication level (V)		3.3		Risk of burn-in using 5V TTL
Operating temperature (° C)	-40	-	+85	Industrial-grade design

2.2.2 Wi-Fi parameters

Wi-Fi parameters				
Main parameters	performances			note
	minimum value	typical value	maximum values	
Operating frequency band (MHz)	2412	-	2484	
Maximum transmit power (dBm)	18	-	21	See Loxin ESP32-S3 official datasheet for details
Transmission rate (Mbps)	1	-	150	Maximum rate of 11 Mbps under 802.11b standard Maximum speed of 54 Mbps under 802.11g standard Maximum speed of 150 Mbps under 802.11n standard
Receiving sensitivity	-98.4	-	-71.4	See Loxin ESP32-S3 official datasheet for

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(dBm)				details
Emission current (mA)	286	-	340	See Loxin ESP32-S3 official datasheet for details
Operating current (mA)	88	-	91	See Loxin ESP32-S3 official datasheet for details

2.2.2 BLE parameters

BLE parameters				
Operating frequency band (MHz)	2402	-	2480	
Transmit power (dBm)	-24	0	20	
Transmission rate (Mbps)	0.125	-	2	
Emission current (mA)	-	-	380	
Operating current (mA)	-	-	95	
Receiving sensitivity (dBm)	-104.5	-	-93.5	Sensitivity varies at different rates, the lower the rate the higher the sensitivity

2.2.3 LoRa Parameters - EoRa-S3-400TB

400MHz LoRa Parameters				
Operating frequency band (MHz)	410	-	493	Supports ISM bands
Transmit power (dBm)	-9	-	22	
Emission current (mA)	-	120	-	Instantaneous emission power consumption
Receiving current (mA)	-	10	-	Flat receiving current
Transmit power (dBm)	-9	22	22	
Air rate (bps)	0.6K		300K	FSK mode, software configuration
	0.018K	-	62.5K	LoRa mode, software configuration
Receiving sensitivity (dBm)	-147	-146	-145	Airspeed is 0.3kbps (LoRa)

2.2.4 LoRa Parameters-EoRa-S3-900TB

900MHz LoRa Parameters				
Operating frequency band (MHz)	850	-	930	Supports 868MHz/915MHz bands in Europe and the US
Transmit power (dBm)	-9	-	22	
Emission current (mA)	-	120	-	Instantaneous emission power consumption

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Receiving current (mA)	-	10	-	Flat receiving current
Transmit power (dBm)	-9	22	22	
Air rate (bps)	0.6K		300K	FSK mode, software configuration
	0.018K	-	62.5K	LoRa mode, software configuration
Receiving sensitivity (dBm)	-147	-146	-145	Airspeed of 0.3kbps (LoRa)

2.2.4 Internal LoRa module parameters

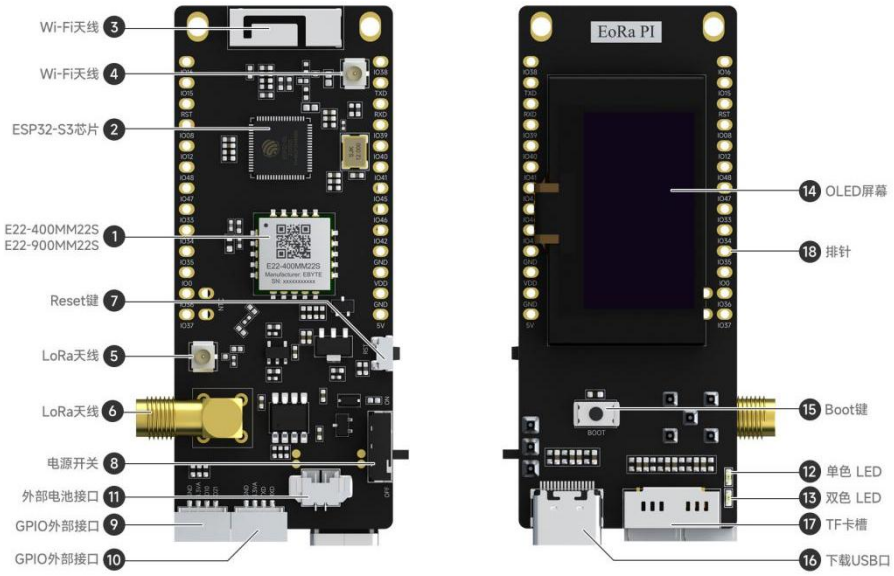
LoRa module main parameters	descriptive	note
reference distance	6000 m	Clear and open environment, antenna gain 5dBi, antenna height 2.5 meters, LoRa air rate 0.3kbps.(This parameter is measured in the open area of Chengdu city.)
FIFO	256 Btye	Maximum length of a single transmission
crystal frequency	32 MHz	passive crystal
modulation method	GFSK/LoRa	Recommended for LoRa
Package	chip-based	
interface method	SPI	
Overall Dimension	10*10*2.5 mm	
Antenna Interface	SMA/IPEX	Characteristic impedance approx. 50 ohms

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Chapter 3 Mechanical Dimensions and Pin Definitions

3.1 Introduction to Functional Components



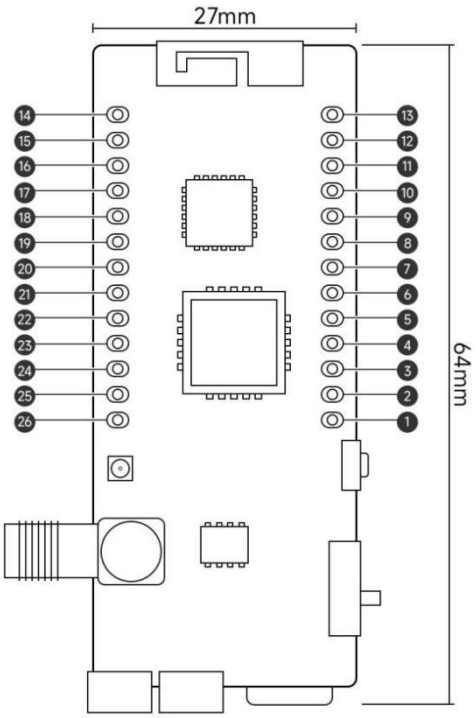
serial number	Main Hardware	present (sb for a job etc)
1	e22-400mm22s&e22-900mm22s	E22-400MM22S and E22-900MM22S are ultra-small size and suitable for 433MHz, 470MHz, 868MHz, 915MHz chip LoRa™ wireless modules independently researched and developed by Chengdu Yibert Electronics Co. Module.
2	ESP32-S3 chip	The ESP32-S3 is a low-power MCU system-on-chip (SoC) that supports 2.4 GHz Wi-Fi and Bluetooth® LE wireless communication.
3	3D Omni Antenna (WiFi Antenna)	Maximum gain 4.9dBi, 2.4G WiFi omni-directional antenna
4	IPEX Seat (WiFi Antenna)	IPEX Generation Seat
5	IPEX Seat (LoRa Antenna)	IPEX Generation Seat
6	SMA RF interface (LoRa Antenna)	Full length 14.5mm SMA head
7	Reset key	Reset button.
8	Power switch	For complete disconnection of battery power
9	GPIO external interface	GPIOs leading from the ESP32, SH1.0mm, 4-pin interface

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10	GPIO external interface	GPIOs leading from the ESP32, SH1.0mm, 4-pin interface
11	External Battery Connector	SH1.25mm, 2pin battery connector
12	RGB LED	Addressable RGB LED, driven by GPIO8.
13	Dual Color LED	Charging indicator, red for charging status, green for full status
14	OLED screen	0.96-inch OLED screen
15	Boot Key	Download button. Press the Reset key while holding down the Boot key to enter Firmware Download mode and download the firmware through the serial port.
16	USB Type-C connector	USB interface. It can be used as a power supply for the development board or as a communication interface between the PC and the ESP32-S3 chip.
17	TF Card Slot	Short body TF card slot
18	a row of needles	All available GPIO pins (except the SPI bus for flash) are pinned out to the development board's pinout. See Pinout for more information.

3.2 GPIO Pin Definition and Size Introduction



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Pin Number	Pin Name	Pin orientation	Pin Usage
1	VCC	power supply	Power pin, can be used as 5V power output after normal power supply
2	GND	power supply	Power GND
3	VDD	power supply	Power pin, can be used as 3.3V power output after normal power supply, prohibit external input power supply
4	GND	power supply	Power GND
5	GPIO42	Input/Output	
6	GPIO46	Input/Output	
7	GPIO45	Input/Output	
8	GPIO41	Input/Output	
9	GPIO40	Input/Output	
10	GPIO39	Input/Output	
11	U0RXD	importation	UART serial port RXD
12	U0TXD	exports	UART serial port TXD
13	GPIO38	Input/Output	
14	GPIO16	Input/Output	
15	GPIO15	Input/Output	
16	RST	Input/Output	Connect to the ESP32-S3 reset pin
17	GPIO08	Input/Output	Connect to the reset pin of the LoRa module
18	GPIO12	Input/Output	
19	GPIO48	Input/Output	
20	GPIO47	Input/Output	
21	GPIO33	Input/Output	DIO1 connected to the LoRa module
22	GPIO34	Input/Output	BUSY connected to the LoRa module
23	GPIO35	Input/Output	
24	GPIO0	Input/Output	Connect to the BOOT button on the backplane
25	GPIO36	Input/Output	
26	GPIO37	Input/Output	LEDs connected to the baseboard

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Chapter 4 Basic Product Use Introduction

4.1 Product Use Details

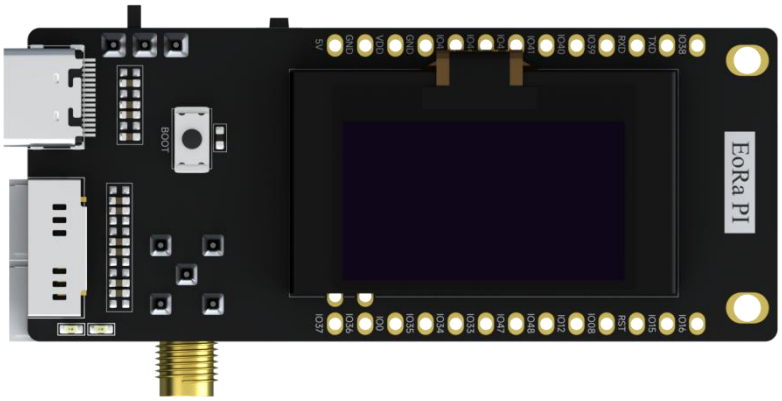


Figure 5.1.1 Product Physical Drawing

- The hardware integrates ESP32-S3 and peripheral circuits, E22-400MM22S LoRa module and peripheral circuits, power supply circuits, Li-ion battery charging circuits and power voltage detection circuits, OLED display and peripheral circuits, TF card slot and peripheral circuits, reset button circuits and BOOT button circuits.
- ESP32-S3 supports USB 2.0 interface protocol, connect the USB 2.0 interface to the computer USB can automatically start installing the driver, after the installation is complete, there will be a USB serial device (COM9), can be used for program download.
- GPIO43 and GPIO44 are used as UART interfaces for log output or inter-serial communication, if you need a computer to view the UART print log you need a TTL to USB tool.



Figure 4.1.2 Getting the port number

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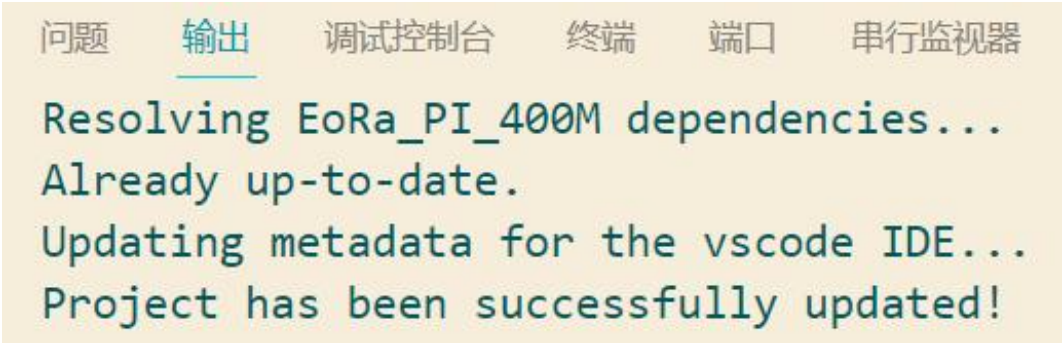
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4.2 Introduction to using the product development environment

- The development environment is Visual Studio Code + PlatformIO, you need to install Visual Studio Code software and add PlatformIO plug-in.
- Visual Studio Code official website download address: Visual Studio Code official website download .
- Under PlatformIO plugin, the related environment packages will be downloaded automatically, and the main dependent libraries are shown in the figure below. If the download speed is slow, you need to wait patiently, and some resources require scientific internet access. If the download does not start automatically, try to press the Compile button.

```
PACKAGES:
 - framework-arduinoespressif32 @ 3.20011.230801 (2.0.11)
 - tool-esptoolpy @ 1.40501.0 (4.5.1)
 - tool-mkfatfs @ 2.0.1
 - tool-mklittlefs @ 1.203.210628 (2.3)
 - tool-mkspiffs @ 2.230.0 (2.30)
 - toolchain-riscv32-esp @ 8.4.0+2021r2-patch5
 - toolchain-xtensa-esp32s3 @ 8.4.0+2021r2-patch5
```

- When the installation of the environment is complete will remind Project has been successfully updated!



- After the environment is successfully built, buttons related to the PlatfromIO tool appear in the lower left of Visual Studio Code, where the main ones are Compile and Download, and the appropriate COM port is checked.



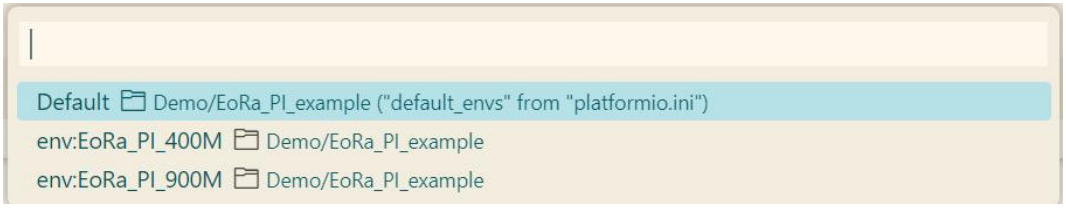
- Environment Configuration: The firmware supports devices in two frequency bands (400/900 MHz), just select the corresponding environment according to the device band.

  Default: EoRa_PI_400M is used in the default environment.

  EoRa_PI_400M: adopts SX1268 chip, default output frequency is 433 MHz, output power +22 dBm.

  EoRa_PI_900M: adopts SX1262 chip, default output frequency is 868 MHz, output power +22 dBm.

  Note: SX1268 and SX1262 chips are driven in exactly the same way, only the supported frequency bands are different.



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- The SDK package contains some routines, you need to use the platformio.ini file to compile different routines, by default the Factory is compiled (factory firmware).
- src_dir must not be enabled at the same time, otherwise the compiler will report an error.

```
[platformio]
default_envs = EoRa_PI_400M

src_dir = examples/Factory

; src_dir = examples/OLED/SSD1306SimpleDemo
; src_dir = examples/OLED/SSD1306UiDemo

; src_dir = examples/RadioLibExamples/SX1262/SX1262_Receive_Interrupt
; src_dir = examples/RadioLibExamples/SX1262/SX1262_Transmit_Interrupt

; src_dir = examples/SleepTest
```

- Start compiling the code, and the following interface will appear after the compilation is complete.

```
问题 1  输出  调试控制台  终端  端口  串行监视器

Compiling .pio\build\EoRa_PI_400M\src\SX1262_Transmit_Interrupt.ino.cpp.o
Linking .pio\build\EoRa_PI_400M\firmware.elf
Retrieving maximum program size .pio\build\EoRa_PI_400M\firmware.elf
Checking size .pio\build\EoRa_PI_400M\firmware.elf
Advanced Memory Usage is available via "PlatformIO Home > Project Inspect"
RAM:   [=         ]   6.7% (used 21840 bytes from 327680 bytes)
Flash: [===       ]  29.1% (used 381229 bytes from 1310720 bytes)
Building .pio\build\EoRa_PI_400M\firmware.bin
esptool.py v4.5.1
Creating esp32s3 image...
Merged 2 ELF sections
Successfully created esp32s3 image.
```

- Before downloading, you need to make sure that the COM port is correct, and start downloading the code, after the download is complete, the interface will appear as shown below.

```
问题 1  输出  调试控制台  终端  端口  串行监视器

Writing at 0x0003c655... (50 %)
Writing at 0x00041ed7... (57 %)
Writing at 0x0004755f... (64 %)
Writing at 0x0004c4db... (71 %)
Writing at 0x00051b5f... (78 %)
Writing at 0x00057da3... (85 %)
Writing at 0x000605c4... (92 %)
Writing at 0x0006820f... (100 %)
Wrote 381600 bytes (226683 compressed) at 0x00010000 in 3.5 seconds (effective 860.7 kbit/s)...
Hash of data verified.

Leaving...
Hard resetting via RTS pin...
================================================================================================

Environment    Status    Duration
-------------  --------  ------------
EoRa_PI_400M   SUCCESS   00:00:24.775
```

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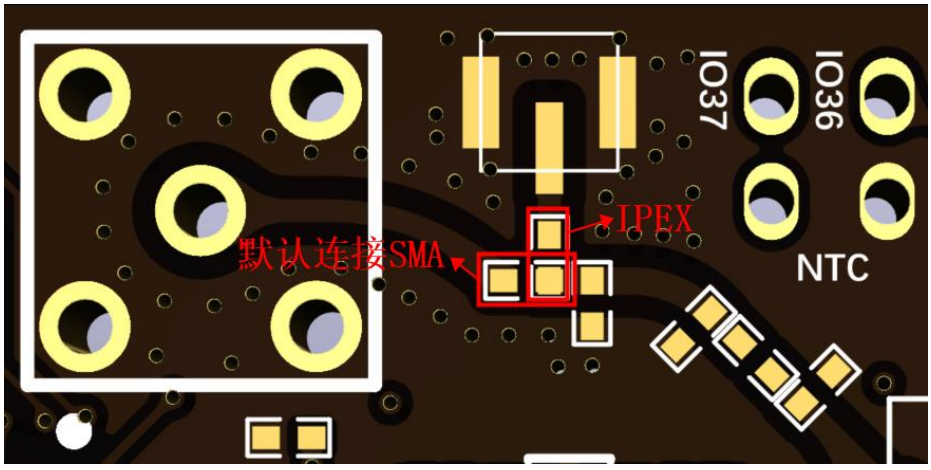
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4.3 Introduction to the routines

- Routines include: Factory, OLED, Radio Example, Sleep Test.
- Compiling different routines requires a different src_dir in platformio.ini, and you cannot have more than one src_dir enabled at the same time.
- Routine Factory is the factory default program, the main function pin test, LoRa RF transceiver, establish WIFI hotspot, drive OLED to display different contents, etc. The interface can be switched by Boot button, and long-pressing Boot button can enter the hibernation mode for 30 seconds (the hibernation current needs to be measured under the battery power supply).
- Routine OLEDs provide additional display styles.
- The Radio Example provides simple RF transceiver functionality.
- The routine Sleep Test provides a test of the development board's hibernation program. The hibernation mode will reawaken after 30 seconds.

4.4 Antenna Interface Switching

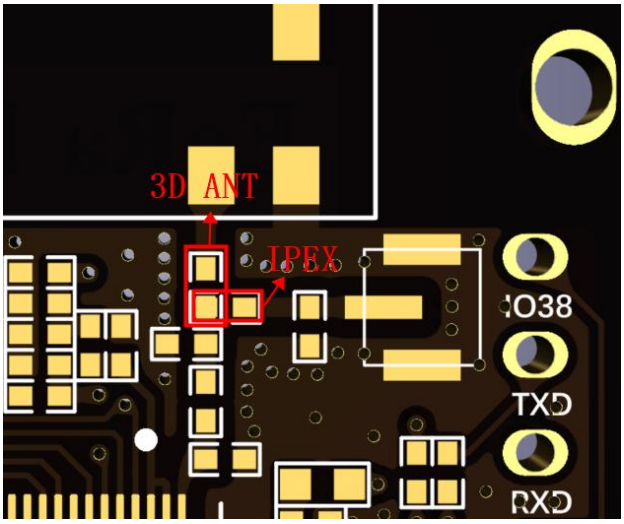
- LoRa module antenna adopts SMA interface by default, if you want to switch to IPEX interface you need to change the 0R resistor connecting to SMA interface (horizontal resistor as below) to the resistor position connecting to IPEX interface (vertical resistor as below).



- The WIFI/BLE module antenna adopts 3D metal antenna by default, if you want to switch to IPEX interface you need to user to change the 0R resistor connecting the 3D antenna (vertical resistor as below) to the resistor position connecting the IPEX interface (horizontal resistor as below).

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4.5 Battery charging

- The battery can be charged via the TYPE-C connector, the LED will always light up red to indicate when charging, and when full the LED will always light up green to indicate.
- When the TYPE-C port is turned on, the charging circuit will be passed through, so the current of the whole machine to enter the hibernation state is still maintained at a high level (500uA~1mA or so), and the hibernation current needs to be measured when the battery is turned on.
- Connecting the battery and not connecting the TPYE-C interface, the power consumption with the power off is around 5 uA. If the power is turned on and all peripherals are in sleep mode, the power consumption of the whole machine is around 25 uA.
- The battery is designed for a maximum charging current of 500mA, please ensure that the power supply capacity is sufficient.

Chapter 5 Hardware Design

- It is recommended that the module be powered by a DC regulated power supply with as low a ripple factor as possible, and that the module be reliably grounded;
- Please pay attention to the correct connection of the positive and negative terminals of the power supply, such as reverse connection may lead to permanent damage to the module;
- 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;
- When designing power supply circuits for modules, it is often recommended to keep more than 30% of the margin, with the whole machine is conducive to long-term stable operation;
- Modules should be kept as far away as possible from power supplies, transformers, high-frequency alignments, and other parts with high electromagnetic interference;
- High-frequency digital routing, high-frequency analog routing, power supply routing must be avoided below the module, if you really have to go through the module below, assuming that the module is soldered in the Top Layer, in the contact part of the module in the Top Layer laying copper (all laying copper and good

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grounding), must be close to the digital part of the module and routing in the Bottom Layer;

- Assuming that the module is soldered or placed in the Top Layer, it is also wrong to randomly route it 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;
- Assuming that there is a large electromagnetic interference devices around the module 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;
- The communication line must be connected in series with a 1k-5.1k resistor if using a 5V level (not recommended, still risk of damage);
- Try to stay away from some TTL protocols where the physical layer is also 2.4GHz, e.g. USB 3.0;
- The antenna mounting structure has a significant impact on module performance. It is important to ensure that the antenna is exposed and preferably vertically oriented;
- When the module is mounted inside the chassis, the antenna can be extended to the outside of the chassis using a good quality antenna extension cable;
- The antenna must not be mounted inside a metal casing, as this will result in a significant reduction in transmission distance.

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Chapter 6 Frequently asked questions

6.1 Unsatisfactory transmission distance

- When there is a straight-line communication barrier, the communication distance is attenuated accordingly;
- Temperature, humidity, and co-channel interference can lead to increased communication packet loss;
- The ground absorbs and reflects radio waves and is less effective when tested close to the ground;
- Seawater has a very strong ability to absorb radio waves, so the results of the seaside test are poor;
- Signal attenuation can be very severe with metal objects near the antenna, or when placed in a metal case;
- The power register is set incorrectly, the air rate is set too high (the higher the air rate, the closer the distance);
- The low voltage of the power supply at room temperature is lower than recommended, the lower the voltage the lower the transmit power;
- Using an antenna that is poorly matched to the module or the quality of the antenna itself.

6.2 Vulnerability of modules

- 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 devices electrostatic sensitivity;
- Please make sure that the humidity during installation and use is not too high, as some of the components are humidity sensitive;
- It is not recommended to use it at too high or too low a temperature if there is no special need.

6.3 BER too high

- There is co-channel signal interference in the vicinity, stay away from the interference source or modify the frequency or channel to avoid the interference;
- An unsatisfactory power supply may also cause garbled code, be sure to ensure the reliability of the power supply;
- Poor quality or too long extension cords and feeder cables can also cause high BER.

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Chapter 7 Antenna Guide

Antenna is an important role in the communication process, often poor-quality antenna will have a great impact on the communication system, so we recommend some of the antennas as a supporting our wireless module and the performance is more excellent and reasonably priced antenna.

Product Model	typology	(radio) band	gain (electronics)	sizes	feeders	connector	specificities
		Hz	dBi	mm	cm		
TX433-NP-4310	Flexible Antenna	433M	2.0	10x43	-	soldered	Flexible FPC Soft Antenna
TX433-JZ-5	glue stick antenna	433M	2.0	52	-	SMA-J	Ultra Short Straight, Omni-Directional Antenna
TX433-JZG-6	glue stick antenna	433M	2.5	62	-	SMA-J	Ultra Short Straight, Omni-Directional Antenna
TX433-JW-5	glue stick antenna	433M	2.0	50	-	SMA-J	Fixed Bend, Omni-Directional Antenna
TX433-JWG-7	glue stick antenna	433M	2.5	70	-	SMA-J	Fixed Bend, Omni-Directional Antenna
TX433-JK-11	glue stick antenna	433M	2.5	110	-	SMA-J	Bendable Rubber Stick, Omnidirectional Antenna
TX433-JK-20	glue stick antenna	433M	3.0	200	-	SMA-J	Bendable Rubber Stick, Omnidirectional Antenna
TX433-XPL-100	suction cup antenna	433M	3.5	185	100	SMA-J	Small suction cup antenna, cost-effective
TX433-XP-200	suction cup antenna	433M	4.0	190	200	SMA-J	Small suction cup antenna, low loss
TX433-XPH-300	suction cup antenna	433M	6.0	965	300	SMA-J	Small Suction Cup Antenna, High Gain

Revision history

releases	revision date	revised description	maintainer
1.0	2023-12-5	initial version	Weng
1.1	2025-1-9	Added a 4-pin interface size description	Hao

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