# E28-2G4M27SX User Manual

SX1281 2.4GHz 500mW SPI High-speed LoRa module



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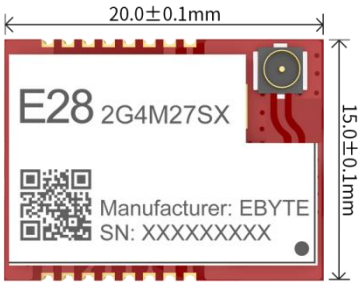
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# Chapter 1 Product Overview

## 1.1 Product Introduction

E28-2G4M27SX is a 2.4GHz RF transceiver module designed and produced by Ebyte Company, with a transmit power of 500mW, SPI interface, and extremely low current consumption in low-power mode; the module is a small-volume SMD type (pin spacing 1.27mm), using 52MHz industrial-grade high-precision low-temperature drift crystal oscillator to ensure its industrial characteristics and its stable performance.




Using Semtech's SX1281 radio frequency chip, this chip contains a variety of physical layers and a variety of modulation methods, such as LoRa, FLRC, GFSK, and is compatible with Bluetooth protocols; special modulation and processing methods make LoRa and FLRC modulation The transmission distance has significant Improvement, built-in power amplifier (PA) and low noise amplifier (LNA) on the basis of the original, so that the maximum transmit power reaches 500mW and the receiving sensitivity is further improved, and the overall communication stability is compared with no power amplifier and low Noise amplifier products have been greatly improved; excellent low-power performance, on-chip DC-DC and Time-of-flight make this chip powerful and can be used in smart homes, security systems, location tracking, wearable devices, Smart bracelets and health management, etc. SX1281 supports RSSI, users can realize in-depth secondary development according to their needs.

E28-2G4M27SX is a pure RF transceiver module, which needs to be driven by MCU or use a dedicated SPI debugging tool.

## 1.2 Features and Functions

- Under ideal conditions, the communication distance can reach 8km;
- Built-in PA+LNA, maximum transmit power 500mW;
- Compatible with BLE protocol;
- Support license-free ISM 2.4GHz frequency band;
- Support data transmission rate of 0.595k～2Mbps;
- Support multiple modulation modes (GFSK Mode, FLRC Mode, LoRa Mode);
- Support 2.5 ~ 3.6V power supply, more than 3.3V power supply can ensure the best performance;
- Adjustable air rate, up to 1.3Mbps under FLRC modulation;
- Excellent anti-blocking properties;

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## 1.3 Application

- Smart home and industrial sensors, etc;
- Security system, positioning system;
- Wireless remote control, drone;
- Wireless game remote;
- Healthcare products;
- Wireless voice, wireless headset;
- Automotive industry applications.

# Chapter 2 Technical Parameters

## 2.1 Limit parameters

| Main parameters | Performance | | Remark |
|---|---|---|---|
| | Min | Max | |
| Supply voltage (V) | 0 | 3.6 | Exceeding 3.6V will permanently burn the module |
| Blocking power (dBm) | - | 10 | The probability of burning at close range is small |
| Working temperature (℃) | -40 | +85 | Industrial grade |

## 2.2 Working parameters

| Main parameters | | Performance | | | Remark |
|---|---|---|---|---|---|
| | | Min | Typ | Max | |
| Working voltage (V) | | 2.5 | 3.3 | 3.6 | ≥3.3V can guarantee output power |
| Communication level (V) | | | 3.3 | | Risk of burnout with 5V TTL |
| Working temperature (℃) | | -40 | - | 85 | Industrial grade design |
| Working frequency band (MHz) | | 2400 | 2450 | 2500 | Support ISM band |
| Power consumption | Emission current (mA) | | 580 | | Instantaneous power consumption |
| | Receive current (mA) | | 14.5 | | |
| | Sleep current (μA) | | 2.0 | | software shutdown |
| Maximum transmit power (dBm) | | 26 | 26.5 | 27 | See section 4.2 for details |
| Receive Sensitivity (dBm) | | -130 | -131 | -132 | LoRa receiver sensitivity with CR=4/5 and high sensitivity mode enabled 1 SF12,BW=203kHz |
| Air Rate | LoRa (bps) | 0.595k | - | 253.9k | User programmable customization |

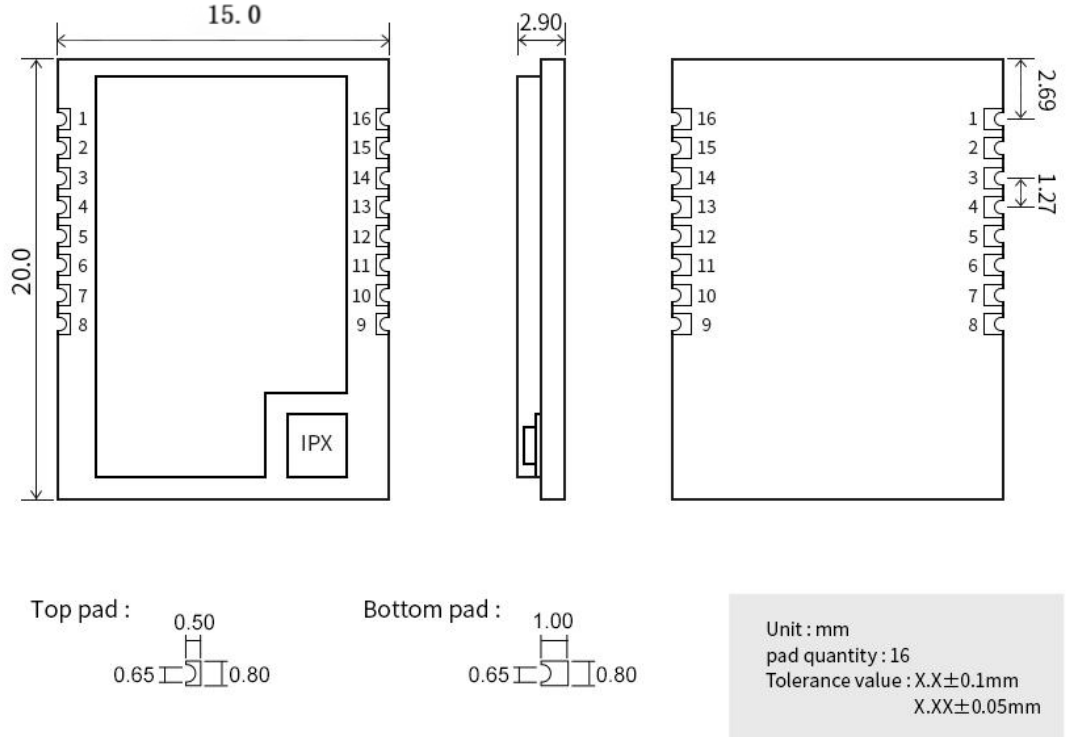
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| | | | | | |
|---|---|---|---|---|---|
| | FLRC（bps） | 260k | - | 1.3M | User programmable customization |
| | GFSK（bps） | 125k | - | 2M | User programmable customization |

| Main parameters | Description | Remark |
|---|---|---|
| Reference Distance | 8000m | Clear and open, antenna gain 5dBi, antenna height 2.5 meters, air rate 1kbps |
| FIFO | 256Byte | The maximum length of a single transmission |
| Crystal Frequency | 52MHz | ±10ppm/11pF |
| Modulation | LoRa(recommend) | GFSK, FLRC, LoRa |
| Packaging Method | SMD | |
| Interface | 1.27mm | |
| Communication Interface | SPI | 0～10Mbps |
| Dimensions | 15*20mm | |
| Antenna Interface | IPEX/PCB | Equivalent impedance is about 50Ω |

# Chapter 3 Mechanical Dimensions and Pin Definition




| Pin Number | Pin item | Pin Orientation | Application |
|---|---|---|---|
| 1 | VCC | | Power supply, range 2.5~3.6V (recommended to add external ceramic |

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| | | | |
|---|---|---|---|
| | | | filter capacitor) |
| 2 | GND | | Ground wire, connected to the power reference ground |
| 3 | MISO_TX | Output | SPI data output pin; can also be used as UART transmit pin (see SX1281 manual for details) |
| 4 | MOSI_RX | Input | SPI data input pin; can also be used as a UART receive pin (see SX1281 manual for details) |
| 5 | SCK_RTSN | Input | SPI clock input pin; can also be used as a UART request to transmit pin (see SX1281 manual for details) |
| 6 | NSS_CTS | Input | Module chip select pin, used to start an SPI communication; also used for UART clear transmit pin (See SX1281 manual for details) |
| 7 | GND | | Ground wire, connected to the power reference ground |
| 8 | RX_EN | Input | LNA control pin, active high |
| 9 | TX_EN | Input | PA control pin, active high |
| 10 | GND | | Ground wire, connected to the power reference ground |
| 11 | NRESET | Input | Chip reset trigger input pin, active low, built-in pull-up resistor 50K |
| 12 | BUSY | Output | Used for status indication (see SX1281 manual for details) |
| 13 | DIO1 | Input/Output | Configurable general-purpose IO ports (see SX1281 manual for details) |
| 14 | DIO2 | Input/Output | Configurable general-purpose IO ports (see SX1281 manual for details) |
| 15 | DIO3 | Input/Output | Configurable general-purpose IO ports (see SX1281 manual for details) |
| 16 | GND | | Ground wire, connected to the power reference ground |

# Chapter 4 Basic Operations

## 4.1 Hardware design

- It is recommended to use a DC regulated power supply to supply power to the module, the power supply ripple coefficient should be as small as possible, and the module should be grounded reliably;
- Please pay attention to the correct connection of the positive and negative poles of the power supply, such as reverse connection may cause permanent damage to the module;
- Please check the power supply to ensure that it is between the recommended power supply voltages. 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 and frequently;
- When designing the power supply circuit for the module, it is often recommended to reserve more than 30% of the margin, so that the whole machine can work stably for a long time;
- The module should be kept as far away as possible from the power supply, transformer, high-frequency wiring and other parts with large electromagnetic interference;
- High-frequency digital traces, high-frequency analog traces, and power traces must avoid the

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underside of the module. If it is absolutely necessary to pass under the module, assuming that the module is soldered on the Top Layer, lay copper on the Top Layer of the contact part of the module. Copper and well grounded), must be close to the digital part of the module and routed on the Bottom Layer;

- Assuming that the module is soldered or placed on the Top Layer, it is also wrong to arbitrarily route wires on the Bottom Layer or other layers, which will affect the stray and receiving sensitivity of the module to varying degrees;
- Assuming that there are devices with large electromagnetic interference around the module, it will also greatly affect the performance of the module. It is recommended to stay away from the module according to the intensity of the interference. If the situation allows, appropriate isolation and shielding can be done;
- Assuming that there are traces with large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power traces), the performance of the module will also be greatly affected. It is recommended to stay away from the module according to the intensity of the interference. Proper isolation and shielding;
- If the communication line uses 5V level, a 1k-5.1k resistor must be connected in series (not recommended, there is still a risk of damage);
- Try to stay away from some TTL protocols whose physical layer is also 2.4GHz, such as USB3.0;
- The antenna installation structure has a great influence on the performance of the module. Make sure that the antenna is exposed, preferably vertically upward. When the module is installed inside the casing, a high-quality antenna extension cable can be used to extend the antenna to the outside of the casing;
- The antenna must not be installed inside the metal shell, which will greatly reduce the transmission distance.

## 4.2 Software editing

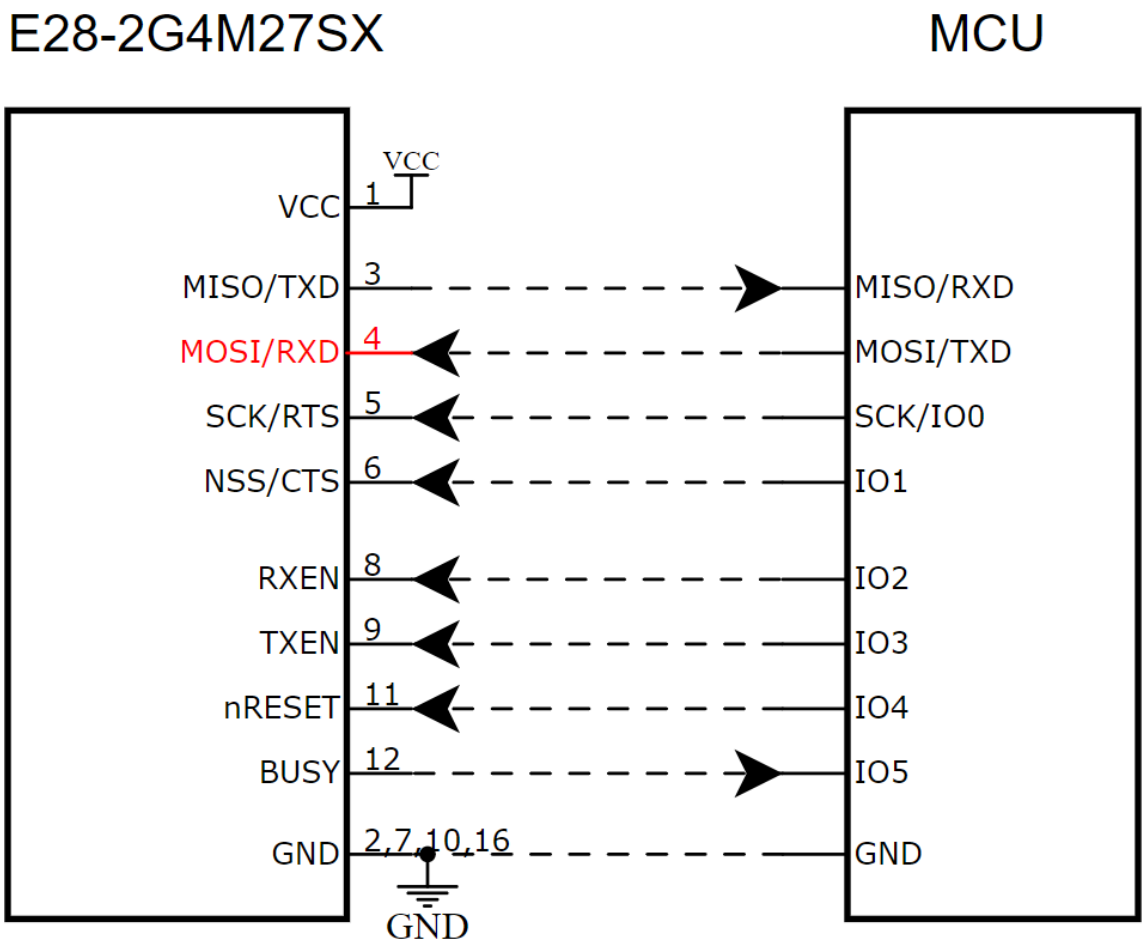
- This module is SX1281+PA+LNA, its driving mode is completely equivalent to SX1281, users can operate according to the SX1281 chip manual;
- GDO0 is a general-purpose I/O port, see SX1281 manual;
- GDO2 is generally configured as an IRQ-like function, or it can be disconnected. The SPI query method can be used to obtain the interrupt status, but it is recommended to use the external interrupt of the microcontroller for connection;
- After the SX1281 is restored to IDLE mode or configured in sleep mode, it is recommended to re-initialize the power configuration table.
- It is recommended to set the power output parameter of SX1281 to 0dBm. At this time, the module can output power of 27dBm. When the output power of SX1281 is increased, the current will increase, and the power will not increase significantly.

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# Chapter 5 Basic Applications

## 5.1 Basic circuit




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# Chapter 6 FAQ

## 6.1 Communication range is too short

- When there is a straight-line communication obstacle, the communication distance will be correspondingly attenuated;
- Temperature, humidity, and co-channel interference will increase the communication packet loss rate;
- The ground absorbs and reflects radio waves, and the test effect close to the ground is poor;
- Seawater has a strong ability to absorb radio waves, so the seaside test effect is poor;
- If there is a metal object near the antenna, or is placed in a metal shell, the signal attenuation will be very serious;
- The power register is set incorrectly, and the air rate is set too high (the higher the air rate, the closer the distance);
- The low voltage of the power supply at room temperature is lower than the recommended value, and the lower the voltage, the lower the output power;
- The antenna used is poorly matched with the module or the quality of the antenna itself is faulty.

## 6.2 Module is easy to damage

- Please check the power supply to ensure that it is between the recommended power supply voltages. 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 and frequently;
- Please ensure anti-static operation during installation and use, and high-frequency components are electrostatically sensitive;
- Please ensure that the humidity during installation and use should not be too high, and 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 co-frequency signal interference nearby, stay away from the interference source or modify the frequency and channel to avoid interference;
- The clock waveform on the SPI is not standard, check whether there is interference on the SPI line, and the SPI bus line should not be too long;
- If the power supply is not ideal, it may also cause garbled characters. Be sure to ensure the reliability of the power supply;
- Poor quality or too long extension lines and feeder lines will also cause a high bit error rate.

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# Chapter 7 Welding Operation Guidance

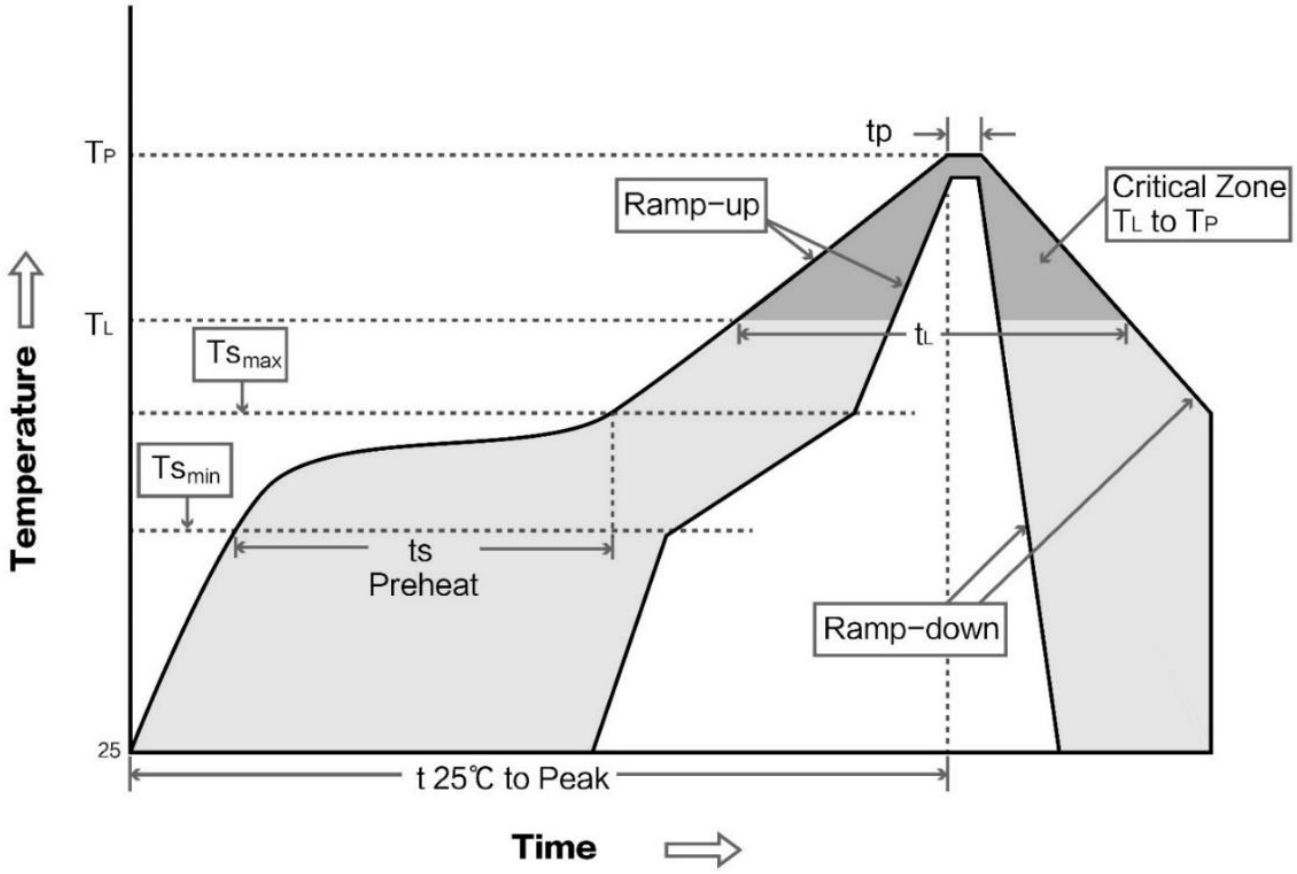
## 7.1 Reflow temperature

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

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## 7.2 Reflow soldering curve




# Chapter 8 Related Models

| Model | IC | Frequency | Power | Distance | Size | Package | Interface |
|---|---|---|---|---|---|---|---|
| | | Hz | dBm | km | mm | | |
| E28-2G4T12S | SX1280 | 2.4G | 12.5 | 3 | 17.5*28.7 | SMD | TTL |
| E28-2G4M27S | SX1281 | 2.4G | 27 | 8 | 15*26.5 | SMD | SPI |
| E28-2G4M20S | SX1281 | 2.4G | 20 | 6 | 15*26.5 | SMD | SPI |
| E28-2G4M12S | SX1281 | 2.4G | 12.5 | 3 | 25*14 | SMD | SPI |

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# Chapter 9 Antenna Guidelines

## 9.1 Antenna recommendation

Antennas play an important role in the communication process, and often inferior antennas will have a great impact on the communication system. Therefore, our company recommends some antennas as antennas with excellent performance and reasonable price for our wireless modules.

| Model | Type | Frequency | Gain | Size | Feeder | Interface | Features |
|---|---|---|---|---|---|---|---|
| | | Hz | dBi | mm | cm | | |
| TX2400-NP-5010 | FPC | 2.4G | 2.0 | 10x50 | - | IPEX | Flexible FPC Soft Antenna |
| TX2400-JZ-3 | Rubber | 2.4G | 2.0 | 30 | - | SMA-J | Ultra-short straight, omnidirectional antenna |
| TX2400-JZ-5 | Rubber | 2.4G | 2.0 | 50 | - | SMA-J | Ultra-short straight, omnidirectional antenna |
| TX2400-JW-5 | Rubber | 2.4G | 2.0 | 50 | - | SMA-J | Fixed bent, omnidirectional antenna |
| TX2400-JK-11 | Rubber | 2.4G | 2.5 | 110 | - | SMA-J | Bendable glue stick, omnidirectional antenna |
| TX2400-JK-20 | Rubber | 2.4G | 3.0 | 200 | - | SMA-J | Bendable glue stick, omnidirectional antenna |
| TX2400-XPL-150 | Sucker | 2.4G | 3.5 | 150 | 150 | SMA-J | Small suction cup antenna, cost-effective |

# Revise History

| Version | Revision Date | Revision Notes | Operator |
|---|---|---|---|
| 1.0 | 2022-10-13 | Bug fixes | Yan |
| 1.1 | 2024-2-23 | Bug fixes | Hao |
| 1.2 | 2024-4-18 | Modified ranging description | Hao |
| 1.3 | 2025-7-7 | Content revised | Hao |

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