



E107-SC01 User Manual



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1. Overview

1.1 Introduction

E107-SC01 series is a 2.4GHz low-power data acquisition communication module designed and manufactured by Ebyte. Its extremely low node static power consumption supports large-scale star network networking. The number of network nodes is theoretically unlimited and can be applied. Data acquisition and sensor acquisition systems for indoor or small areas. This module is a small volume patch type (pin pitch 1.27mm), the module comes with a high-performance PCB on-board antenna and IPEX interface.



This module has ultra-low static power consumption, average current is less than 1uA, wireless uses frequency hopping data transmission, and has good anti-interference ability; high data transmission efficiency up to 1Mbps air rate; data transmission protocol handshake mechanism to prevent data packet loss. Support logical network division function, support a maximum of 65535 logical groupings, and realize multiple groups working simultaneously in the same area. Suitable for industrial data mining, smart home, smart wearable devices, indoor positioning, etc.

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1.2 Features

- Logical network grouping supports up to 65536.
- The static low power consumption of the data acquisition transmitter is less than 1uA.
- Support over-the-air data encryption.
- Support wireless frequency hopping transceiver function.
- Support LBT to effectively avoid radio frequency conflict.
- Support data retransmission to ensure no packet loss.
- Support data RSSI detection, can be used for simple indoor positioning
- The measured communication distance can reach 110 meters;
- Maximum transmit power + 5dBm, support software multi-level adjustable;
- Support license-free ISM 2.4GHz band;
- Support GFSK modulation mode;
- Industrial standard design, support long time use at $-40 \sim +85^{\circ}\text{C}$;
- Dual antenna optional (IPX / PCB), which is convenient for integration;
- Support 1Mbps air-rate transmission;

1.3 Application

- Smart home and industrial sensors;
- Security system, positioning system;
- Wireless remote control, drone;
- Wireless game remote control;
- Health care products;

- Wireless voice, wireless headset;
- Automotive industry applications.

2. Specification and parameter

2.1 Limit parameter

| Main parameter | Performance | | Remark |
|----------------------------|-------------|------|---|
| | Min. | Max. | |
| Power supply (V) | 0 | 3.8 | Voltage over 3.8V 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 | Industrial grade |

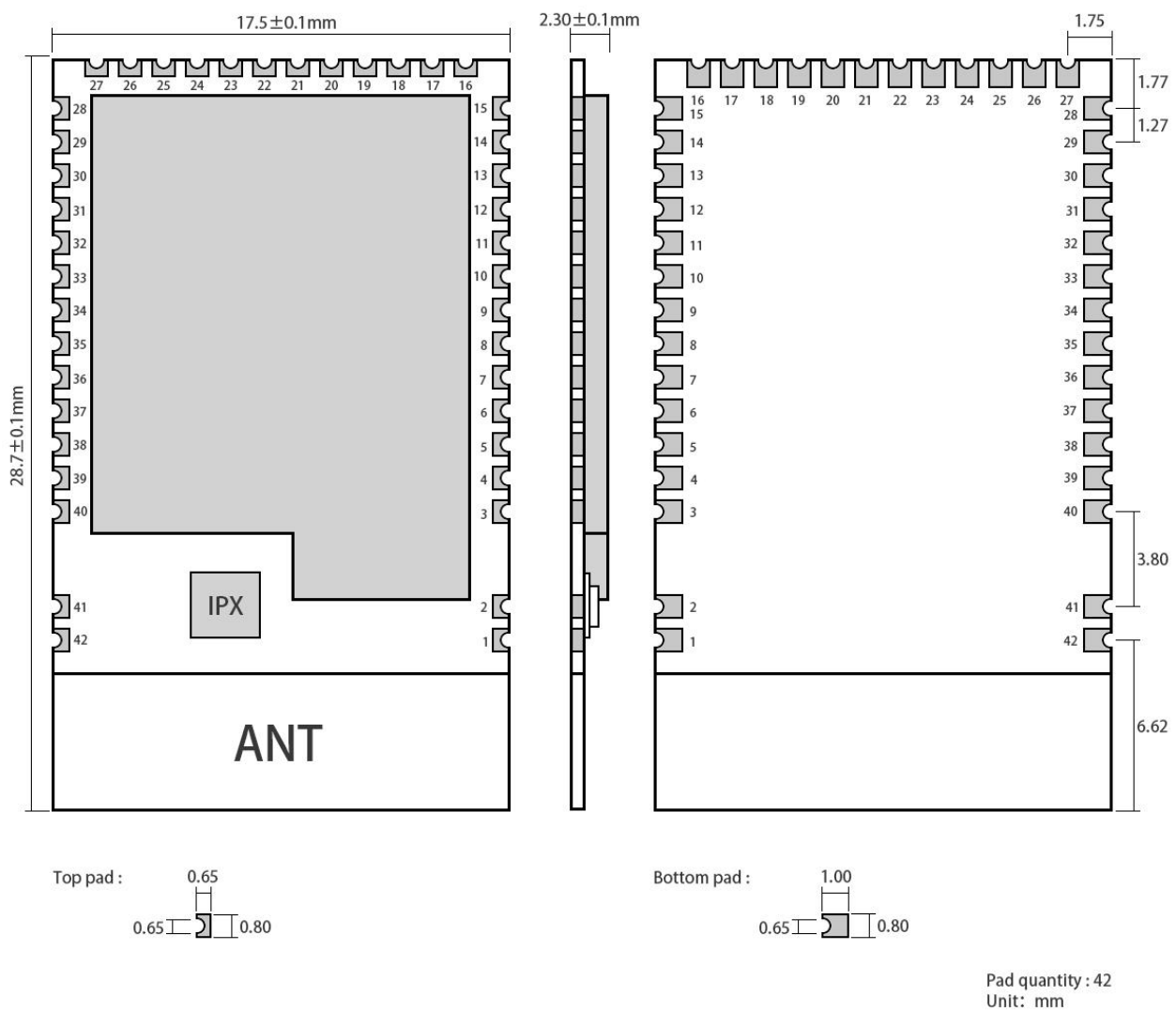
2.2 Operating parameter

| Main parameter | | Performance | | | Remark |
|-----------------------------|--------------------|-------------|------|--------|---|
| | | Min. | Typ. | Max. | |
| Operating voltage (V) | | 1.8 | 3.3 | 3.8 | ≥3.3V ensures output power |
| Communication level (V) | | | 3.0 | | For 5V TTL, it may be at risk of burning down |
| Operating temperature (°C) | | -40 | - | 85 | Industrial design |
| Operating frequency (MHz) | | 2402 | - | 2480 | Support ISM band |
| Power consumption | TX current (mA) | | 9.1 | | Instant power consumption |
| | RX current (mA) | | 6.1 | | |
| | Sleep current (μA) | | 1.2 | | Software is shut down |
| Max Tx power (dBm) | | 4.6 | 5.0 | 5.5 | |
| Receiving sensitivity (dBm) | | -98.5 | -99 | -100.5 | Air data rate is 250 kbps |
| Air data rate (bps) | | - | 1M | - | |

| Main parameter | Description | Remark |
|------------------------|-----------------|---|
| Distance for reference | 110m | Test condition : clear and open area, antenna gain: 5dBi, antenna height : 2.5m air data rate:1Mbps |
| Crystal frequency | 24MHz/32.768KHz | |
| protocol | BLE 4.2 | |
| Package | SMD | |
| Connector | 1.27mm | |

| | | |
|---------|--------------------------|------------------|
| FLASH | 128KB | |
| RAM | 28KB | |
| Core | Cortex-M3 + Cortex-M0 | |
| Size | 17.5*28.7mm | |
| Antenna | PCB/IPEX | 50 ohm impedance |

3. Size and pin definition



| Pin No. | Item | Direction | Description |
|---------|------|-----------|---|
| 1 | GND | | Ground, connecting to power source referential ground |
| 2 | GND | | Ground, connecting to power source referential ground |
| 3 | GND | | Ground, connecting to power source referential ground |

| | | | |
|----|----------|--------|---|
| 4 | DIO_0 | - | NC |
| 5 | DIO_1 | - | NC |
| 6 | RX | Input | Serial port reception |
| 7 | TX | Output | Serial output |
| 8 | DIO_4 | - | NC |
| 9 | DIO_5 | - | NC |
| 10 | DIO_6 | - | NC |
| 11 | DIO_7 | - | NC |
| 12 | DIO_8 | - | NC |
| 13 | DIO_9 | - | NC |
| 14 | DIO_10 | - | NC |
| 15 | DIO_11 | - | NC |
| 16 | DIO_12 | - | NC |
| 17 | WKP | - | N series: wake-up pin, internal pull-up. Low level wake up, high level sleep, can latch input signal. G series: NC |
| 18 | DIO_14 | - | NC |
| 19 | AUX | - | N series: Send instructions, push-pull output, low-level data transmission, high-level transmission is completed. G series: NC |
| 20 | JTAG_TMS | - | NC |
| 21 | JTAG_TCK | - | NC |
| 22 | DIO_16 | - | NC |
| 23 | DIO_17 | - | NC |
| 24 | DIO_18 | - | NC |
| 25 | DIO_19 | - | NC |
| 26 | DIO_20 | - | NC |
| 27 | GND | | Ground, connecting to power source referential ground |
| 28 | DIO_21 | - | NC |
| 29 | VCC | | power supply: 1.8~3.8V |
| 30 | DIO_22 | - | NC |
| 31 | DIO_23 | - | NC |
| 32 | nRESET | Input | Hardware reset, active low. |
| 33 | DIO_24 | - | NC |
| 34 | DIO_25 | - | NC |
| 35 | DIO_26 | - | NC |
| 36 | DIO_27 | - | NC |
| 37 | DIO_28 | - | NC |
| 38 | DIO_29 | - | NC |
| 39 | DIO_30 | - | NC |
| 40 | GND | | Ground, connecting to power source referential ground |

| | | | |
|----|-----|--|---|
| 41 | GND | | Ground, connecting to power source referential ground |
| 42 | GND | | Ground, connecting to power source referential ground |

4. Operation Mode

| No. | Operation mode | Function Description |
|---|-----------------------|--|
| 1 | Low power consumption | <p>N series: The module delays 200 milliseconds after power-on, and starts to detect the WKP pin status. If a high level is detected, the system immediately goes to sleep. During this period, the serial port cannot receive data and there is no RF transceiver operation. When the falling edge of WKP hardware is detected, it will exit low-power mode. Note that the WKP pin has an input level latch function. When a rising edge is detected, the internal pin is pulled up to enable the pin to maintain a high state, otherwise after the falling edge is input, the internal pin is pulled down to maintain the low status.</p> <p>G series: invalid</p> |
| 2 | Ordinary | <p>N series: The module is delayed by 200 milliseconds after power-up is completed, and the WKP pin status is detected. If a low level is detected, the system enters the normal working state, the serial port function is enabled, and data or configuration commands can be sent, and the wireless function is valid.</p> <p>G series: Always keep this state awake, the wireless receiving function is turned on, and the serial port prints out wireless data packets.</p> |
| <p>Special note: N series modules in normal mode, if data transmission is started, before a successful transmission (AUX output low level) can be switched to low power mode through the WKP pin, system power consumption is reduced compared to normal mode, but wireless Data transmission is not affected, and the system power consumption will return to normal after the data transmission is completed.</p> | | |

5. Features Introduction

5.1 Network model

The E107-SC01 series of products, working under the star network structure, are composed of two parts: the center E107-SC01-G and the node E107-SC01-N. There must be at least one center in a network responsible for centralized data collection. There can be multiple nodes. In principle, the number of nodes in a network is not limited. In the open environment, the maximum communication distance between the node and the center exceeds 100 meters.

The node sends data asynchronously. The host notifies the slave of the successful reception through a handshake signal. If the node does not receive the notification message from the center in time, it will automatically start data retransmission. At this time, the center will receive duplicate data packets.

5.2 Network ID

The network ID is used for logical network division. The center can only receive the network ID data. The network IDs of the nodes and the center can be configured by instructions. In particular, when the number of nodes in the network

is particularly large, in order to improve the data reception efficiency of the center, the number of network centers can be increased, that is, multiple central devices with the same network ID number are set, and each central device can be responsible for completing part of the node data receive.

5.3 center

After receiving the node data, the center E107-SC01-G will output the data through the serial port, including the effective length of the data, the node device address, the node wireless signal strength, and the effective data. The data packet format is as follows.

| | | | |
|---------------------------|--|------------------------|----------------------|
| Length HEX 1Byte | RSSI HEX 1Byte | MAC HEX 6Byte | Data HEX < 22Byte |
| Subsequent data length | Node wireless signal strength (number of signs) | Node device address | Payload data |

5.4 Node

Before sending data to the center through node E107-SC01-N, you need to first ensure that the node is in normal mode. In sleep mode, the WKP input remains low, and the system enters normal mode after about 100 milliseconds. The data transmission format is as follows.

| | |
|-----------------------------|------------------|
| Head (fixed) ASSIC 1Byte | Data < 22Byte |
| < | Payload |

After the node initiates the data transmission, it needs to wait for the handshake response from the center. If the transmission timed out, the node will automatically resend it. During data transmission, AUX will keep low level and output high level after successful transmission.

After the node initiates data transmission, before the successful transmission, that is, AUX remains low, and goes to sleep through the WKP high level, wireless data transmission will not be affected.

6. Parameter Configuration

E107-SC01 series products support serial command configuration query, the command format is as follows:

| Parameter query and configuration | | | | |
|-----------------------------------|-------------------------------|---------|-------------------------------|---------------------|
| Byte1 | Command header | C0H | Parameter configuration | |
| | | C1H | Parameter configuration reply | |
| | | | Parameter query | |
| | | | Parameter query reply | |
| Byte2 | High network ID | 00H~FFH | High byte (default 00H) | |
| Byte3 | Low network ID | 00H~FFH | Low byte (default 00H) | |
| Byte4 | Serial port verification[7:6] | 00H | No verification (default) | |
| | | 01H | Odd parity | |
| | | 02H | Even parity | |
| | | 03H | No check | |
| | Serial baud rate [5:3] | - | E107-SC01-N | E107-SC01-G |
| | | 00H | 1200bps | 9600bps |
| | | 01H | 2400bps | 19200bps |
| | | 02H | 4800bps | 38400bps |
| | | 03H | 9600bps | 57600bps |
| | | 04H | 19200bps | 115200bps (default) |
| | | 05H | 38400bps | 230400bps |
| | | 06H | 57600bps | 460800bps |
| | | 07H | 115200bps (default) | 921600bps |
| | Transmit power [2:1] | 00H | -3dBm | |
| | | 01H | 0dBm | |
| | | 02H | 3dBm | |
| | | 03H | 5dBm (default) | |
| | Keep [0] | - | | |

| Parameter query | | |
|--|---------|---------|
| Command header | 3 bytes | C1C1C1H |
| C0 [para] (para means parameter value) Similar: C0 01 01 3A | | |

| Version query | | |
|---------------------|------------------|---------|
| Command header | 3 bytes | C3C3C3H |
| Version query reply | | |
| E107-SC01-N | C301071000 (HEX) | |

| | |
|-------------|------------------|
| E107-SC01-G | C301071001 (HEX) |
|-------------|------------------|

| Module restart | | |
|----------------|---------|---------|
| Command header | 3 bytes | C4C4C4H |
| No reply | | |

| Data transmission Only supported by E107-SC01-N | | |
|--|------------|------------|
| Command header | < | Fixed head |
| Data | 1~22 bytes | valid data |
| No reply | | |

| Data reception Only E107-SC01-G support | | |
|--|------------------|--------------------------------------|
| Length | 08H~1DH | Length (including RSSI + MAC + data) |
| RSSI | 00H~FFH | RSSI strength |
| MAC | 6 bytes (HEX) | Sender MAC address |
| Data | 1~22 bytes (HEX) | valid data |

7. Hardware Design

- It is recommended to use DC stabilized power supply to supply power to the module. The power supply ripple coefficient 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. If the reverse connection is connected, the module may be permanently damaged.
- Please check the power supply to ensure that between the recommended supply voltage, if exceeding the maximum, the module will be permanently damaged.
- Please check the stability of the power supply, the voltage can not be significantly frequent.
- When designing the power supply circuit for the module, it is often recommended to reserve more than 30% of the margin, and 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 traces, high-frequency analog traces, and power traces 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(All copper-covered and well grounded), and must be close to the digital part of the module and routed in the Bottom Layer.
- Assuming the module is soldered or placed in the Top Layer, it is also wrong to randomly route the Bottom Layer or other layers, which will affect the module's spurs and receiving sensitivity to varying degrees.
- Assuming that there are devices with large electromagnetic interference around the module, the performance of the

module will also be greatly affected. According to the intensity of the interference, it is suggested to stay away from the module appropriately. If circumstances permit, appropriate isolation and shielding can be done.

- Assume that there are traces with large electromagnetic interference around the module (high-frequency digital, high-frequency analog, power trace), which 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 and also have a 2.4GHz TTL protocol, for example: USB3.0.
- The antenna mounting structure 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 of the case.
- The antenna must not be installed inside the metal case, which will greatly reduce the transmission distance.

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).
- When the power supply at room temperature is lower than the recommended low voltage, the lower the voltage is, the lower the transmitting power is.
- Due to antenna quality or poor matching between antenna and module.

8.2 Module is easy to damage

- Please check the power supply and ensure it is within the recommended range. Voltage higher than the peak will lead to a permanent damage to the module.
- Please check the stability of power supply and ensure the voltage not to fluctuate too much.
- Please make sure anti-static measures are taken when installing and using, high frequency devices have electrostatic susceptibility.
- Please ensure the humidity is within limited range for some parts are sensitive to humidity.
- Please avoid using modules under too high or too low temperature.

8.3 High bit error rate

- There are co-channel signal interference nearby, keep away from interference sources or modify frequency, channel to avoid interference.
- Unsatisfactory power supply may also cause garbled characters, and ensure the reliability of the power supply.
- If the extension cable or feeder is of poor quality or too long, the bit error rate will be high.

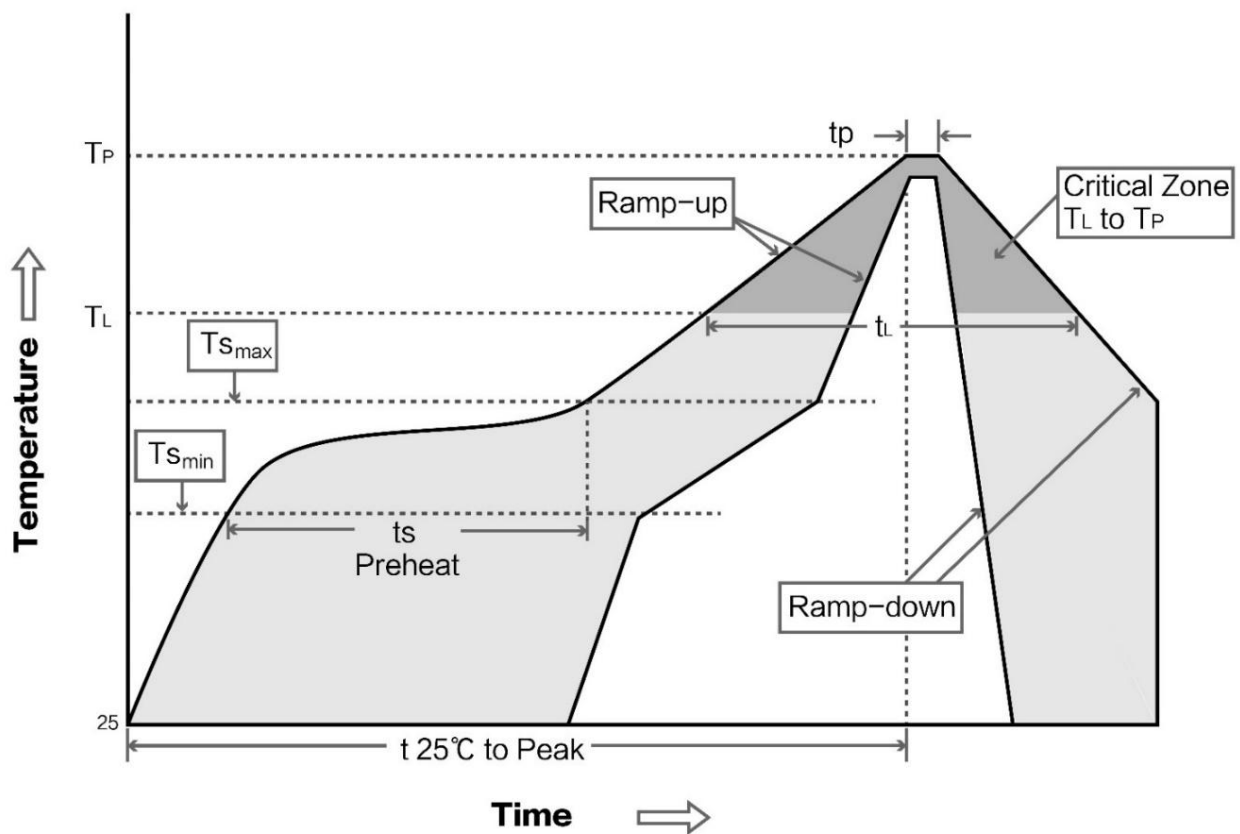
9. Welding operation guidance

9.1 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 (T _{min}) | Mini.preheating temperature | 100C° | 150C° |
| Preheat temperature max (T _{max}) | Max. preheating temperature | 150C° | 200C° |
| Preheat Time (T _{min} to T _{max})(ts) | Preheating temperature | 60-120 sec | 60-120 sec |
| Average ramp-up rate(T _{max} to T _p) | Average Rising Rate | 3C°/second max | 3C°/second max |
| Liquidous Temperature (TL) | Liquid phase temperature | 183C° | 217C° |
| Time (t _L) Maintained Above (TL) | Time above liquidus | 60-90 sec | 30-90 sec |
| Peak temperature (T _p) | Peak Temperature | 220-235C° | 230-250C° |
| Aveage ramp-down rate (T _p to | Average Decline | 6C°/second max | 6C°/second max |

| | | | |
|-------------------------------|------------------------------------|---------------|---------------|
| Tsmax) | Rate | | |
| Time 25C° to peak temperature | Time from 25C° to peak temperature | 6 minutes max | 8 minutes max |

9.2 Reflow soldering curve



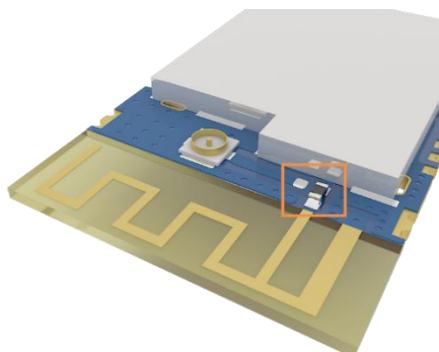
10. Antenna Type

10.1 Antenna recommendation

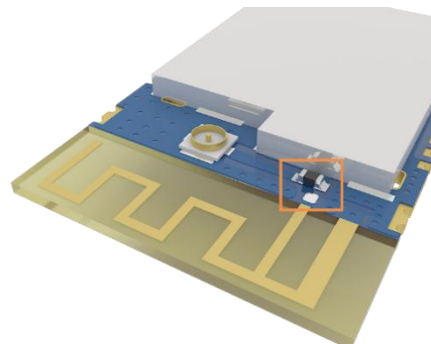
| Product | Type | Frequency | Gain | Size | Feeder | Interface | Features |
|--------------------------------|----------------|-----------|------|-------|--------|-----------|---|
| | | Hz | dBi | mm | cm | | |
| TX2400-NP-5010 | Soft antenna | 2.4G | 2.0 | 10x50 | - | IPEX | Flexible FPC Soft Antenna |
| TX2400-JZ-3 | Rubber antenna | 2.4G | 2.0 | 30 | - | SMA-J | Ultra-short straight, omnidirectional antenna |
| TX2400-JZ-5 | Rubber antenna | 2.4G | 2.0 | 50 | - | SMA-J | Ultra-short straight, |

| | | | | | | | |
|--------------------------------|----------------|------|-----|-----|-----|-------|---|
| | | | | | | | omnidirectional antenna |
| TX2400-JW-5 | Rubber antenna | 2.4G | 2.0 | 50 | - | SMA-J | Fixed bending, omnidirectional antenna |
| TX2400-JK-11 | Rubber antenna | 2.4G | 2.5 | 110 | - | SMA-J | Bendable glue stick, omnidirectional antenna |
| TX2400-JK-20 | Rubber antenna | 2.4G | 3.0 | 200 | - | SMA-J | Bendable glue stick, omnidirectional antenna |
| TX2400-XPL-150 | Sucker antenna | 2.4G | 3.5 | 150 | 150 | SMA-J | Small suction cup antenna, high cost performance |

10.2 Antenna selection

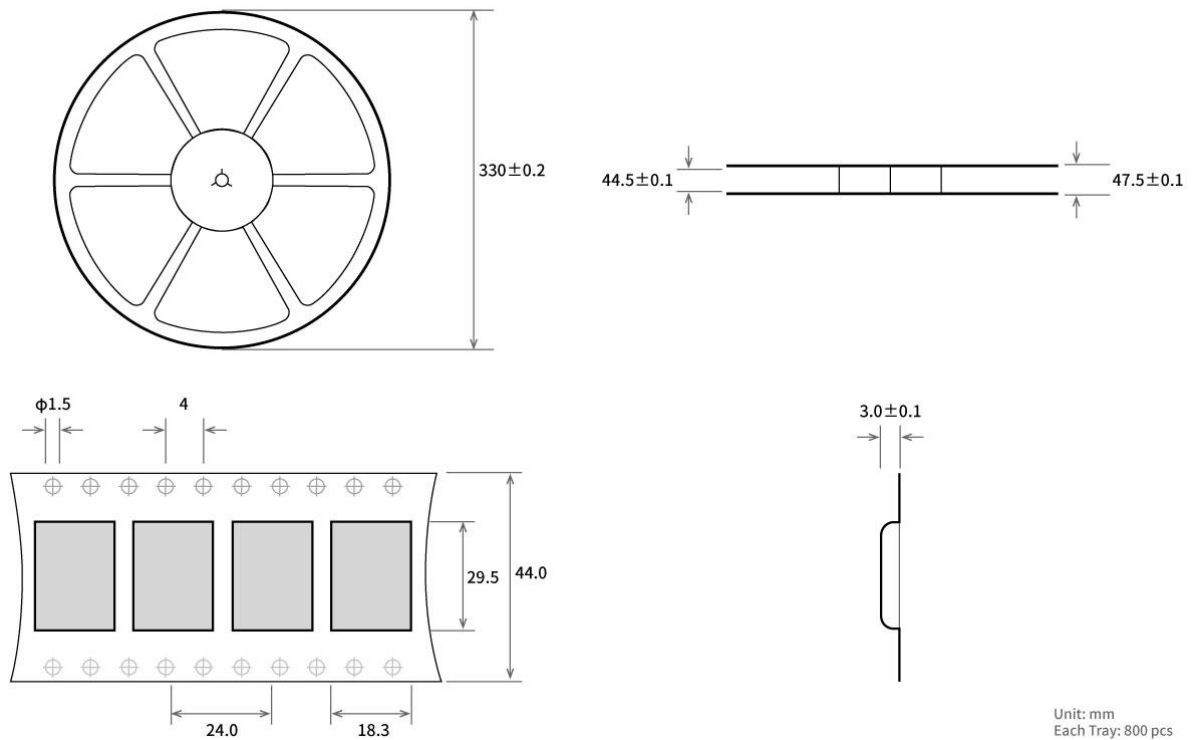


Enable PCB onboard antenna (default)



Enable IPEX interface

11. Batch packaging



Revision history

| Version | Date | Description | Issued by |
|---------|------------|------------------|-----------|
| 1.0 | 2020-01-03 | Original version | huaa |
| 1.1 | 2020-01-03 | Content added | Ren |

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