# E80-xxxM2213S User Manual

## Sub-GHz/2.4GHz LoRa Dual-band Wireless Module



成都亿佰特电子科技有限公司
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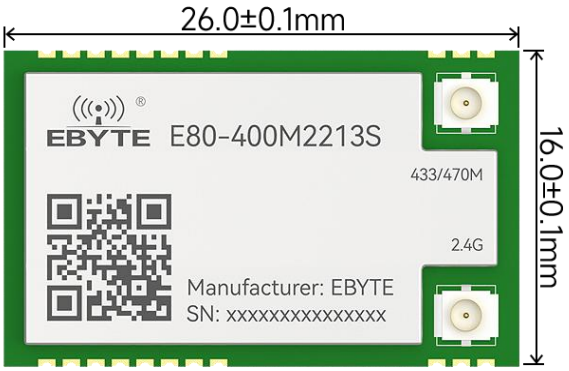
# Chapter 1 Product Overview

## 1.1 Product Introduction

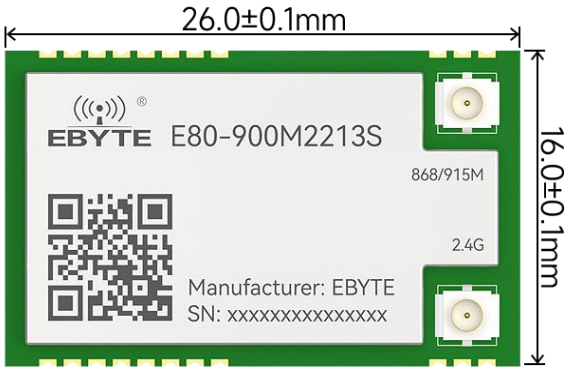
E80 -xxxM2213S is a dual-frequency SMD LoRa hardware SPI wireless module independently developed based on SEMTECH LoRa Connect™ LR1121 chip for multi-band global connectivity, with a transmit power of 22 dBm and 13 dBm respectively . The module integrates an industrial-grade 48MHz high-precision low-temperature drift crystal oscillator.

LR1121 is SEMTECH third generation ultra-low power LoRa transceiver. It provides multi-band LoRa and long-range frequency hopping spread spectrum (LR-FHSS) communications based on the Sub -GHz and 2.4 GHz ISM bands, as well as satellite S-band connectivity. LR1121 is designed to comply with LoRa Alliance® published the physical layer requirements of the LoRaWAN® specification while remaining configurable to meet different application needs and proprietary protocols .

* *Since this module is a pure hardware RF module, it needs to be programmed by the user before use.*




E80-400 M2213S




E80 - 900M2213S

## 1.2 Features

- Low power consumption and high sensitivity LoRa/(G)FSK half-duplex RF transceiver;
- Global ISM band support ranges from 150-960MHz ( Sub- GHz ) and 2.4 GHz, as well as 2.1 GHz S-band;
- Built-in low noise figure RX front end, enhanced LoRa / ( G ) FSK sensitivity;
- Maximum transmit power 2 2 dBm @ Sub - GHz/ 13 dBm @ 2.4GHz, software-adjustable in multiple levels;
- Under ideal conditions, the communication distance can reach 5.6 km @ 433MHz / 5.6km@ 868 MHz / 2.6km @2.4G Hz ;
- The chip has a built-in LR-FHSS modulator , which supports remote frequency hopping spread spectrum in the 2.4 GHz band ;
- Integrated PA regulator power selector simplifies dual power supply design, achieving a maximum RF output power of +15/+22dBm ( Sub- GHz only ) on a single board ;
- Built-in DC-DC power supply circuit, lower power consumption and more stable system;
- Capable of supporting multi-regional BOMs worldwide, with circuits that adapt matching networks to meet regulatory restrictions ;
- with SX126x devices under Sub-GHz communication and compliant with LoRa The LoRaWAN ® standard defined by the Alliance® ;
- with SX12 8x devices ( except FLRC modulation ) at 2.4GHz communication and compliant with LoRa The LoRa standard defined by Alliance® ;

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- Hardware supports AES-128 encryption/decryption algorithms ;
- The module includes 48M high-speed crystal oscillator/32.768k low-speed crystal oscillator ;
- Industrial-grade standard design, supports long-term use at -40～+85℃;
- Dual antennas are optional (IPEX/stamp hole), users can choose to use according to their needs ;

## 1.3 Application Scenario

- Smart Meter
- Building Automation
- Agricultural Sensors
- Smart City
- Retail Store Sensors
- Asset Tracking
- Street lighting
- Reversing radar
- Environmental Sensors
- Safety Sensors
- Remote control application
- Smart Home
- Radio-controlled toys and drones

# Chapter 2 Specifications

## 2.1 RF parameters

| RF parameters | Parameter Value | | Remark |
|---|---|---|---|
| | E80-400M2213S | E80-900M2213S | |
| 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 |
| Reference communication distance ( km ) | ≤5.6 | | @Sub-GHz, clear and open environment, antenna gain 3.5dBi , antenna height 2.5 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 |

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## 2.2 Electrical parameters

| Electrical parameters | Minimum | Typical Value | Maximum | Remark |
|---|---|---|---|---|
| Operating voltage (V) | 1.8 | 3.3 | 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 |
| 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 , all radio frequencies are not working |
| Operating temperature (℃) | -40 | - | +85 | Industrial-grade design |
| Operating humidity ( %rh ) | 10 | - | 90 | - |
| Storage temperature (℃) | - 50 | - | +150 | - |

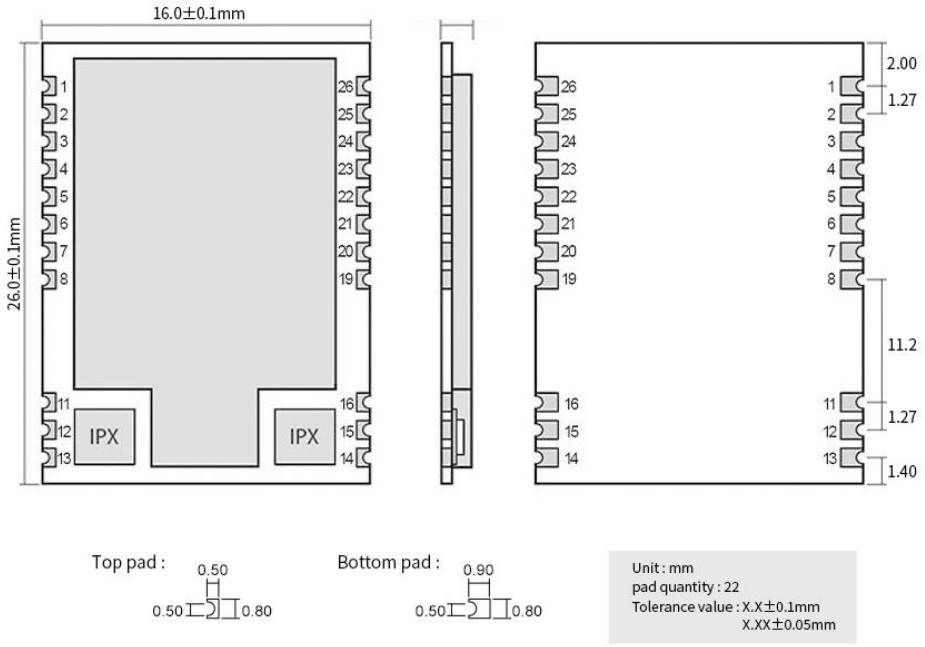
## 2.3 Hardware Parameters

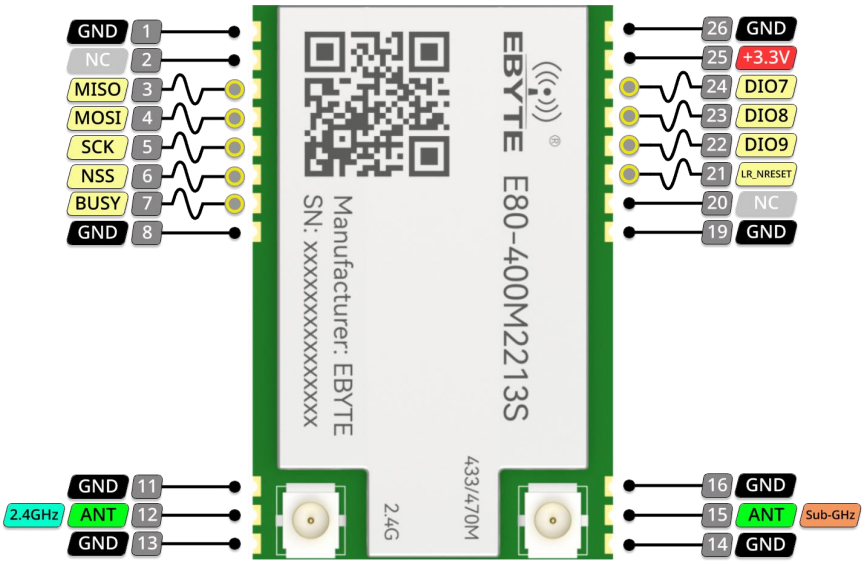
| Hardware Parameters | Parameter Value | Preparation Note |
|---|---|---|
| IC full name | LR1121IMLTRT | SEMTECH official website lead-free product number |
| High frequency crystal oscillator ( MHz ) | 32 | The module has built-in active temperature compensated crystal oscillator |
| Low frequency crystal oscillator ( KHz ) | 32.768 | The module is built in and connects to the "32k_P/DIO11" and "32k_N/DIO10" pins of the LR1121 RF chip |
| Module size (mm) | 26.0*16.0*3.0 | Length*Width*Height |
| Antenna type | IPEX-1/Stamp Hole | IPEX 1st generation socket, Sub-GHz/2.4GHz dual antenna interface design |
| Communication Interface | SPI | Communication level 1.8-3.7V, 3.3V is recommended to ensure data reliability |
| Packaging | Patch/Stamp Hole | Pin spacing 1.27mm, please see Chapter 3 for detailed dimension information |
| Weight ( g) | 1.85 | - |

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# Chapter 3 Mechanical Dimensions and Pin Definition




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| Pin number | Pin Name | Pin Direction | Function |
|---|---|---|---|
| 1 | GND | power supply | - |
| 2 | NC | -- | - |
| 3 | MISO | Output | SPI interface pin, connected to "DIO4" of LR1121, please refer to the chip manual or Ebyte custom SDK information for details |
| 4 | MOSI | Input | SPI interface pin, connected to "DIO3" of LR1121, please refer to the chip manual or Ebyte custom SDK information for details |
| 5 | SCK | Input | SPI interface pin, connected to "DIO2" of LR1121, please refer to the chip manual or Ebyte custom SDK information for details |
| 6 | NSS | Input | SPI interface pin, connected to "DIO1" of LR1121, please refer to the chip manual or Ebyte custom SDK information for details |
| 7 | BUSY | Output | Module "busy" indication, connected to LR1121's "BUSY", for details, please refer to the chip manual or Ebyte custom SDK information |
| 8 | GND | power supply | - |
| 9 | none | none | Reserve space for future expansion |
| 10 | none | none | Reserve space for future expansion |
| 11 | GND | power supply | - |
| 12 | ANT | Input/Output | 2.4GHz antenna interface |
| 13 | GND | power supply | - |
| 14 | GND | power supply | - |
| 15 | ANT | Input/Output | Sub-GHz Antenna Interface |
| 16 | GND | power supply | - |
| 17 | none | none | Reserve space for future expansion |
| 18 | none | none | Reserve space for future expansion |
| 19 | GND | power supply | - |
| 20 | NC | -- | - |
| 21 | LR_NRESET | Input | Module reset pin, low level is effective, connected to "NRESET" of LR1121, please refer to the chip manual for details |
| 22 | DIO9 | Output | It is used for LR1121 RF interrupt output, which is usually a low level. When an interrupt is generated, it will output a pulse signal (it is recommended that the rising edge of the external main control unit GPIO pin be triggered to respond to this signal). For details of the interrupt source, please refer to the chip manual. |
| 23 | DIO8 | Input/Output | Available to connect to LR1121 , leave it unconnected if not in use. For details, please refer to the chip manual |
| 24 | DIO7 | Input/Output | Available to connect to LR1121 . If not in use, please leave it vacant. For details, please refer to the chip manual. |
| 25 | VCC | power input | - |
| 26 | GND | power supply | - |

Note:
1. The "32k_P/DIO11" and "32k_N/DIO10" pins of the LR1121 RF chip inside the module have been connected to a 32.768k crystal oscillator;
2. The "XTA", "XTB" and "VTCXO" pins of the LR1121 RF chip inside the module have been connected to a 32M active crystal oscillator;
3. The "DIO5/RFSW0" and "DIO6/RFSW1" pins of the LR1121 RF chip inside the module have been connected to the RF switch to control the "Sub-1GHz" and "2.4GHz" RF transceivers. Since the control state of the RF switch is different from the default control state of the SEMTECH official SDK, please pay attention to the difference. For details, please refer to the SEMTECH official original SDK or Ebyte custom SDK.

| DIO5/RFSW0 | DIO6/RFSW1 | RF Status |
|---|---|---|
| 0 | 0 | RX |
| 0 | 1 | TX (Sub-1GHz low power mode) |
| 1 | 0 | TX (Sub-1GHz high power mode) |
| 1 | 1 | TX (2.4GHz) |

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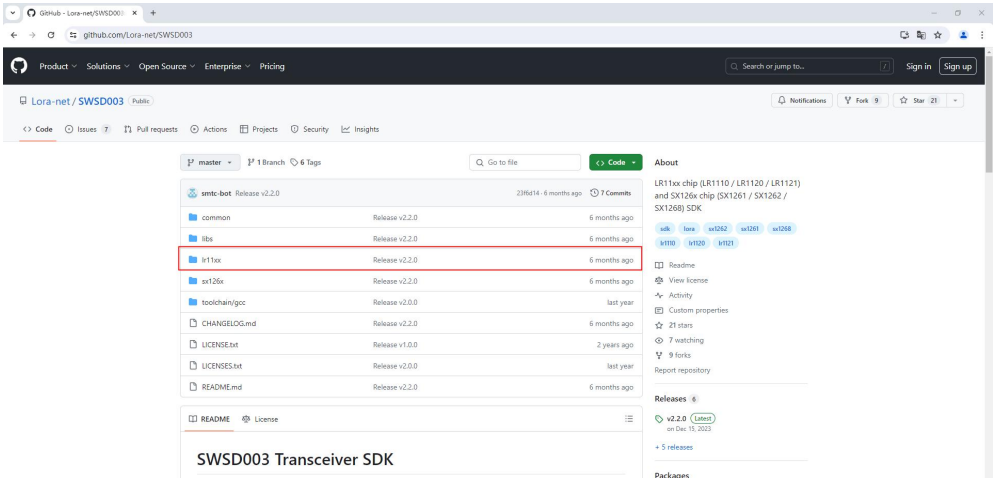

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# Chapter 4 Software development and use

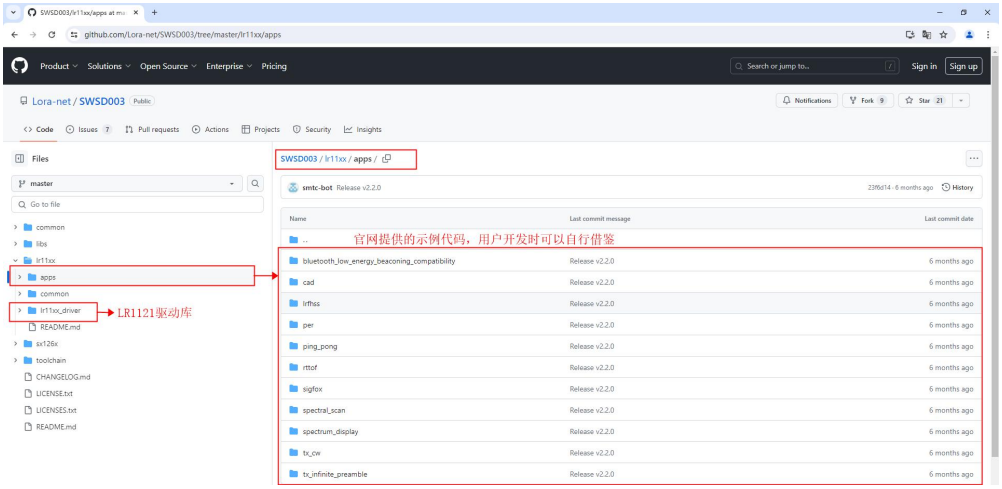
**Software development is divided into two parts: one is the SEMTECH official original SDK usage tutorial, and the other is the Ebyte custom SDK example usage tutorial**

● LR1121 Official SDK

①Download link: https://github.com/Lora-net/SWSD003




②SDK structure description




The sample code provided by the official website can be used as a reference for users to develop

③Use keil to open the official website project;

Download the SDK package "SWSD003" from the official website, open it and select the "lr11xx" folder, and select the required sample project under the internal app file.

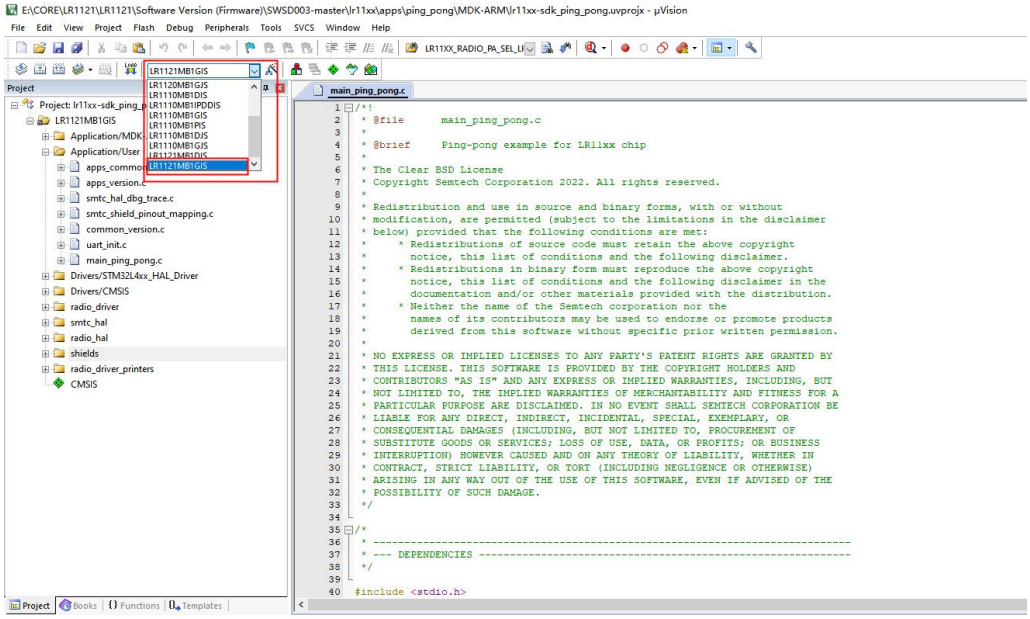
For our demonstration example, temporarily select "ping-pong" > "MDK-ARM"

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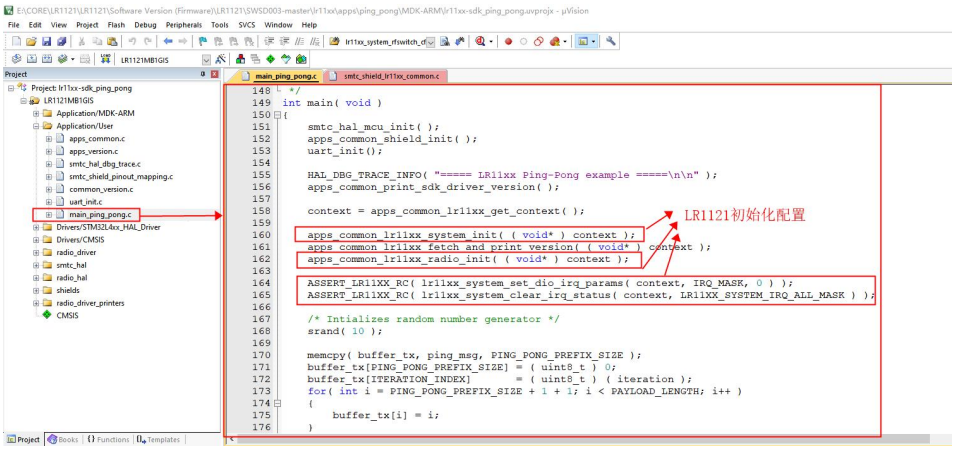

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④Select a workspace;



⑤ main function entry analysis;

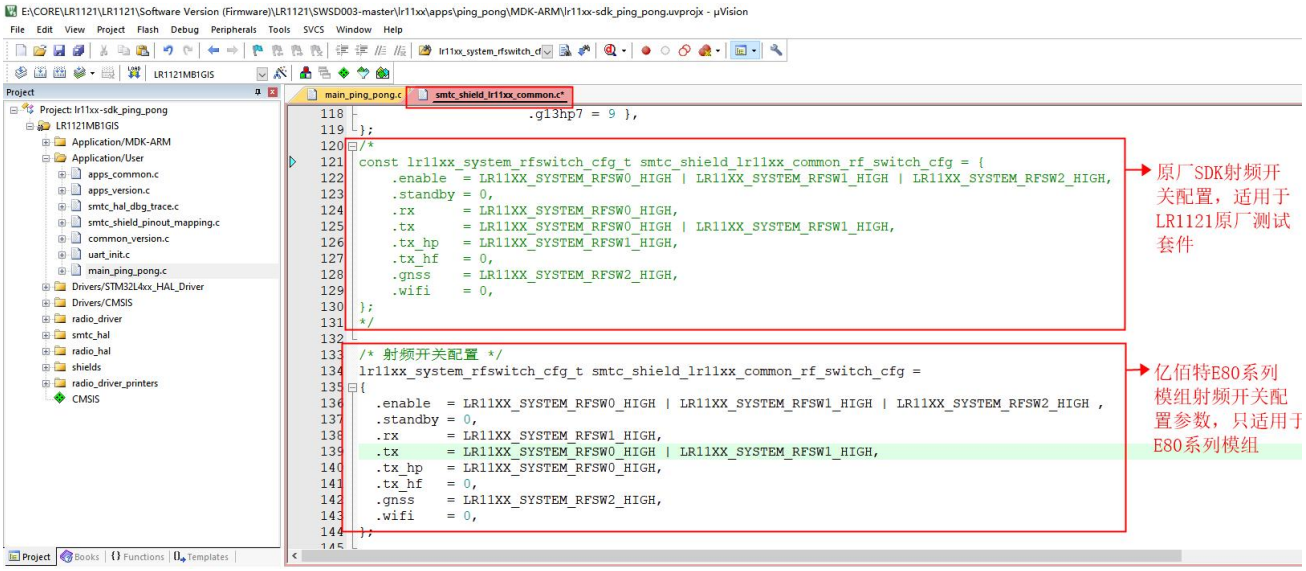



LR1221 Initial configuration

⑥Key parameter configuration-RF switch;

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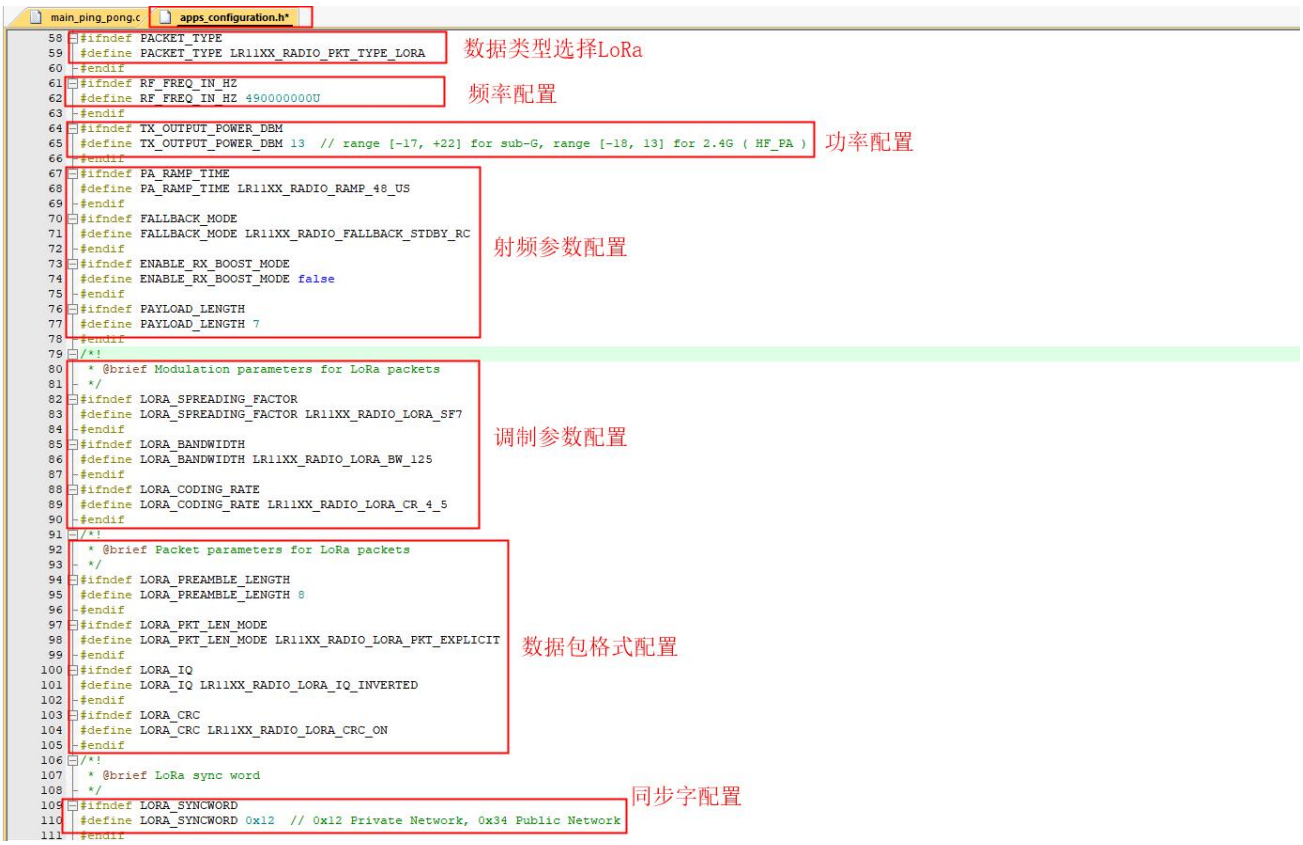

```
/*
const lr11xx_system_rfswitch_cfg_t smtc_shield_lr11xx_common_rf_switch_cfg = {
    .enable  = LR11XX_SYSTEM_RFSW0_HIGH | LR11XX_SYSTEM_RFSW1_HIGH | LR11XX_SYSTEM_RFSW2_HIGH,
    .standby = 0,
    .rx      = LR11XX_SYSTEM_RFSW0_HIGH,
    .tx      = LR11XX_SYSTEM_RFSW0_HIGH | LR11XX_SYSTEM_RFSW1_HIGH,
    .tx_hp   = LR11XX_SYSTEM_RFSW1_HIGH,
    .tx_hf   = 0,
    .gnss    = LR11XX_SYSTEM_RFSW2_HIGH,
    .wifi    = 0,
};
*/

/* 射频开关配置 */
lr11xx_system_rfswitch_cfg_t smtc_shield_lr11xx_common_rf_switch_cfg =
{
   .enable  = LR11XX_SYSTEM_RFSW0_HIGH | LR11XX_SYSTEM_RFSW1_HIGH | LR11XX_SYSTEM_RFSW2_HIGH ,
   .standby = 0,
   .rx      = LR11XX_SYSTEM_RFSW1_HIGH,
   .tx      = LR11XX_SYSTEM_RFSW0_HIGH | LR11XX_SYSTEM_RFSW1_HIGH,
   .tx_hp   = LR11XX_SYSTEM_RFSW0_HIGH,
   .tx_hf   = 0,
   .gnss    = LR11XX_SYSTEM_RFSW2_HIGH,
   .wifi    = 0,
};
```

Original SDK RF switch configuration, suitable for LR1121 original test kit

EBYTE E80 series module RF switch configuration parameters, only applicable to E80 series

⑦Key RF parameter configuration-LoRa modulation related parameters;




```
#ifndef PACKET_TYPE
#define PACKET_TYPE LR11XX_RADIO_PKT_TYPE_LORA
#endif
#ifndef RF_FREQ_IN_HZ
#define RF_FREQ_IN_HZ 490000000U
#endif
#ifndef TX_OUTPUT_POWER_DBM
#define TX_OUTPUT_POWER_DBM 13  // range [-17, +22] for sub-G, range [-18, 13] for 2.4G ( HF_PA )
#endif
#ifndef PA_RAMP_TIME
#define PA_RAMP_TIME LR11XX_RADIO_RAMP_48_US
#endif
#ifndef FALLBACK_MODE
#define FALLBACK_MODE LR11XX_RADIO_FALLBACK_STDBY_RC
#endif
#ifndef ENABLE_RX_BOOST_MODE
#define ENABLE_RX_BOOST_MODE false
#endif
#ifndef PAYLOAD_LENGTH
#define PAYLOAD_LENGTH 7
#endif
/*!
 * @brief Modulation parameters for LoRa packets
 */
#ifndef LORA_SPREADING_FACTOR
#define LORA_SPREADING_FACTOR LR11XX_RADIO_LORA_SF7
#endif
#ifndef LORA_BANDWIDTH
#define LORA_BANDWIDTH LR11XX_RADIO_LORA_BW_125
#endif
#ifndef LORA_CODING_RATE
#define LORA_CODING_RATE LR11XX_RADIO_LORA_CR_4_5
#endif
/*!
 * @brief Packet parameters for LoRa packets
 */
#ifndef LORA_PREAMBLE_LENGTH
#define LORA_PREAMBLE_LENGTH 8
#endif
#ifndef LORA_PKT_LEN_MODE
#define LORA_PKT_LEN_MODE LR11XX_RADIO_LORA_PKT_EXPLICIT
#endif
#ifndef LORA_IQ
#define LORA_IQ LR11XX_RADIO_LORA_IQ_INVERTED
#endif
#ifndef LORA_CRC
#define LORA_CRC LR11XX_RADIO_LORA_CRC_ON
#endif
/*!
 * @brief LoRa sync word
 */
#ifndef LORA_SYNCWORD
#define LORA_SYNCWORD 0x12  // 0x12 Private Network, 0x34 Public Network
#endif
```

Select Lora for data type

Frequency configuration

Power configuration

RF parameter configuration

Modulation parameter configuration

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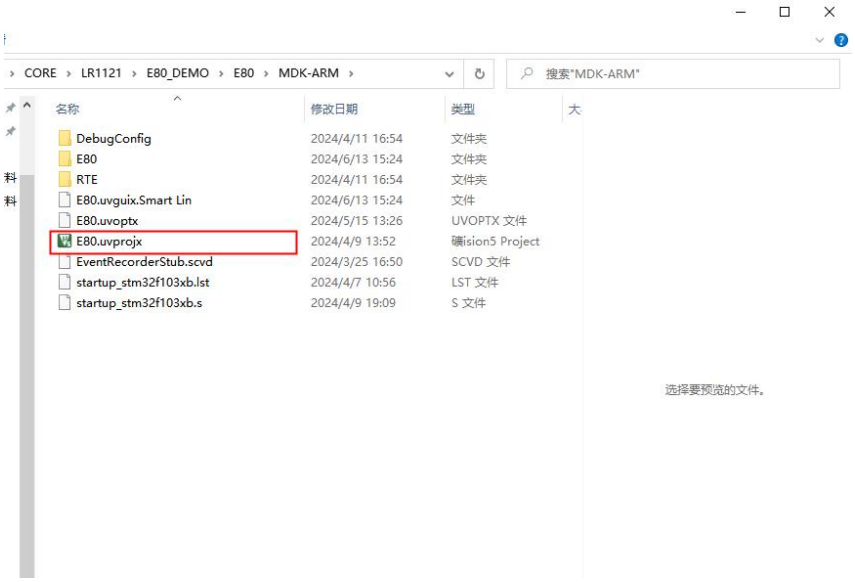
Data packet format configuration

Sync word configuration

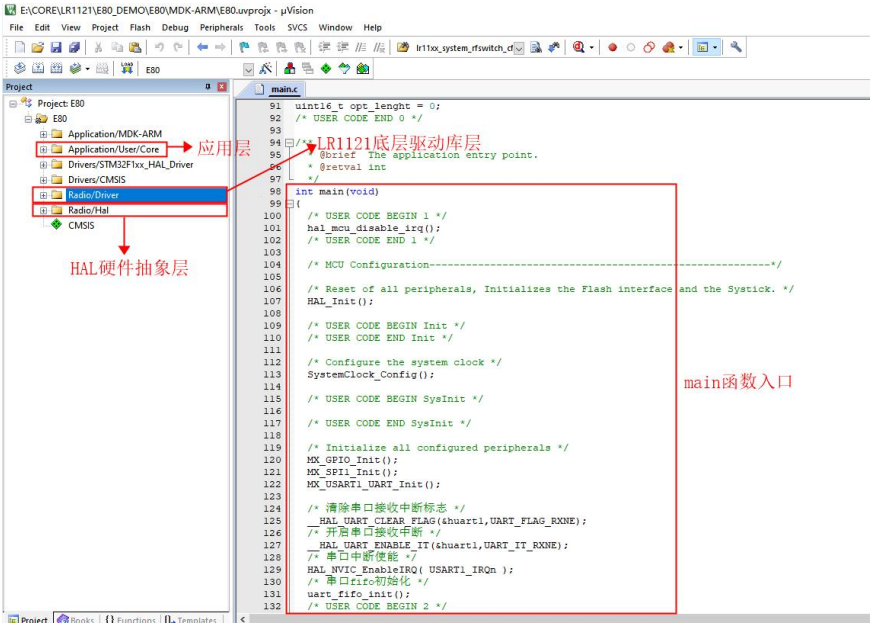
- E80 - xxxM2213S Ebyte Custom SDK (Since the DEMO code has detailed comments, the software operation process will not be explained in detail)

①Download "E80_DEMO.zip" from Ebyte official website and unzip it to the English path;

②Use Keil to open the project;




③E80_DEMO SDK structure description;




Application layer

HAL hardware abstraction layer

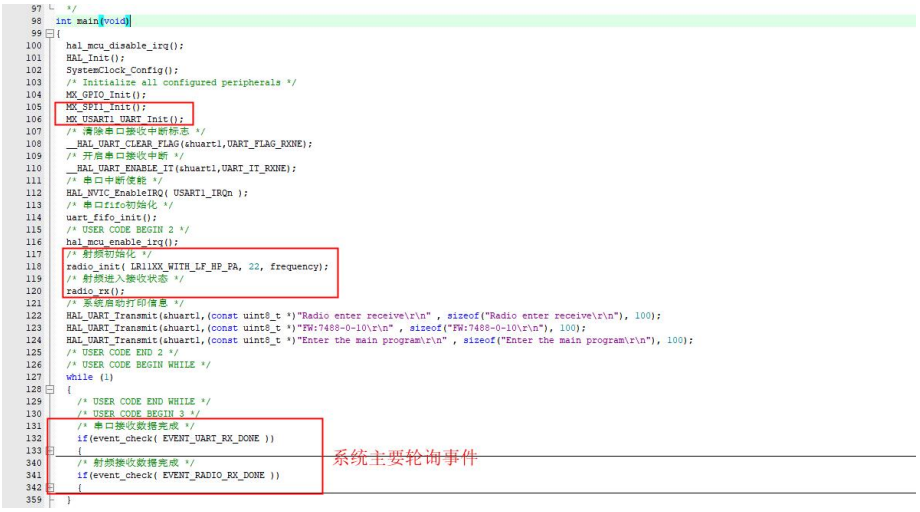
LR121 underlying driver library layer

main function entry

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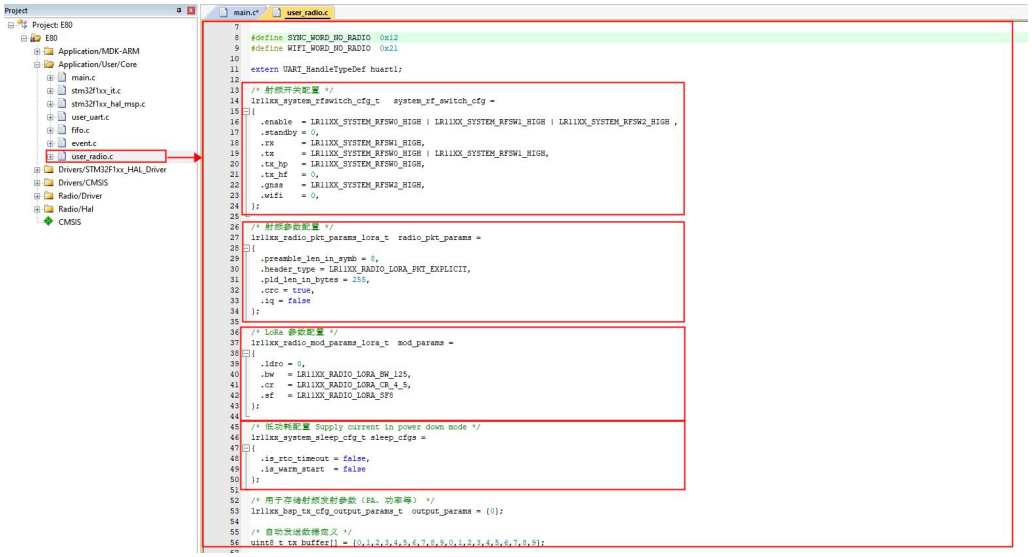

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④ E80_DEMO main function entry ;




System main polling events

⑤ E80_DEMO key RF parameter configuration;



# Chapter 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, which is

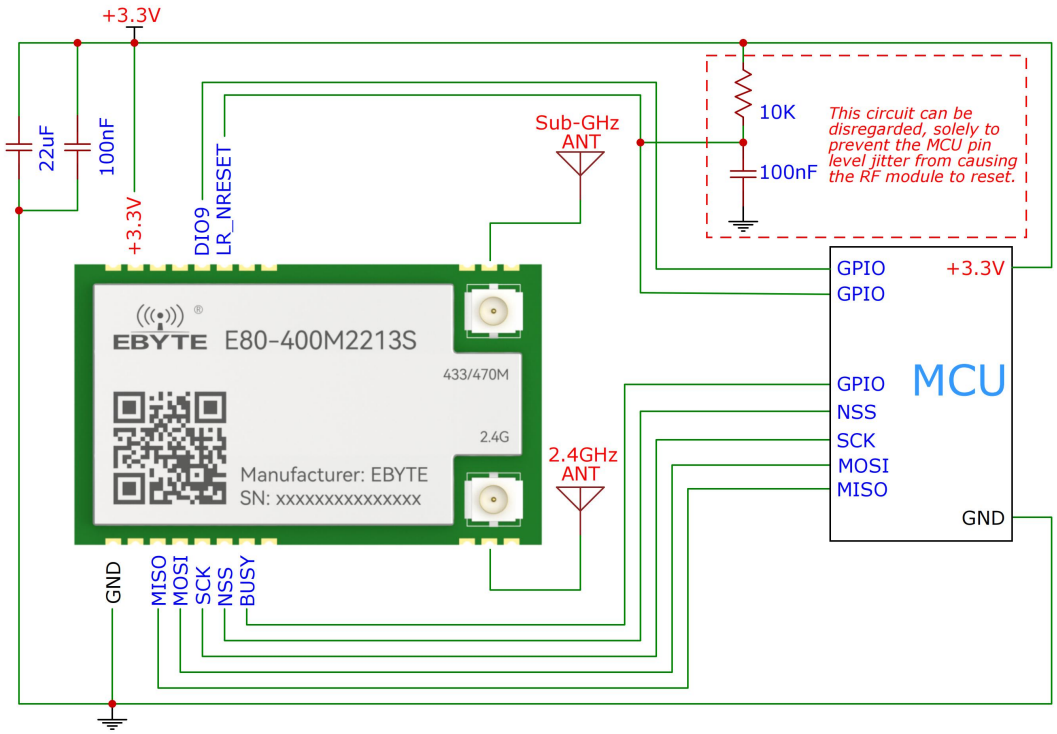
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conducive to long-term stable operation of the whole machine;

- 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 should be laid on the Top Layer of the module contact part (all copper should be 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 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.
- 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 performance of the module. Make sure the antenna is exposed and preferably vertically upward. When the module is installed inside the housing, use a high-quality antenna extension cable to extend the antenna to the outside of the housing;
- The antenna must not be installed inside a metal shell, as this will greatly reduce the transmission distance.

# Chapter 6 Reference Circuit




※ The reference circuits of E80-400M2213S and E80-900M2213S are the same ※

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# Chapter 7 Frequently Asked Questions

## 7.1The 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 power output .
- The antenna used does not match the module well or the antenna itself has quality issues.

## 7.2 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.

## 7.3 The 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.

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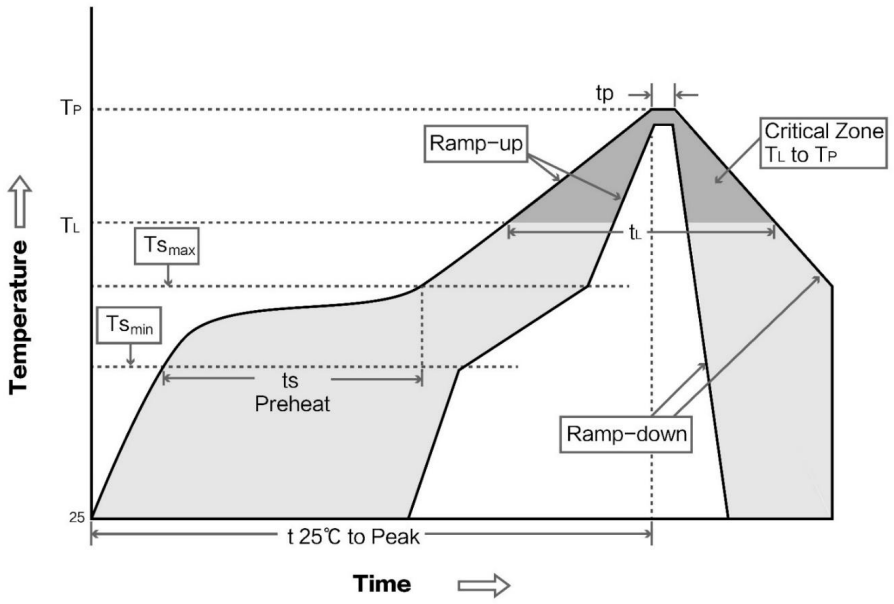

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# Chapter 8 Welding Operation Instructions

## 8.1 Reflow 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 (Tsmin) | Minimum preheating temperature | 100℃ | 150℃ |
| Preheat temperature max (Tsmax) | Maximum preheating 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 ascent rate | 3℃/second max | 3℃/second max |
| Liquid 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℃ |
| Average ramp-down rate (Tp to Tsmax) | Average descent rate | 6℃/second max | 6℃/second max |
| Time 25℃ to peak temperature | Time from 25℃ to peak temperature | 6 minutes max | 8 minutes max |

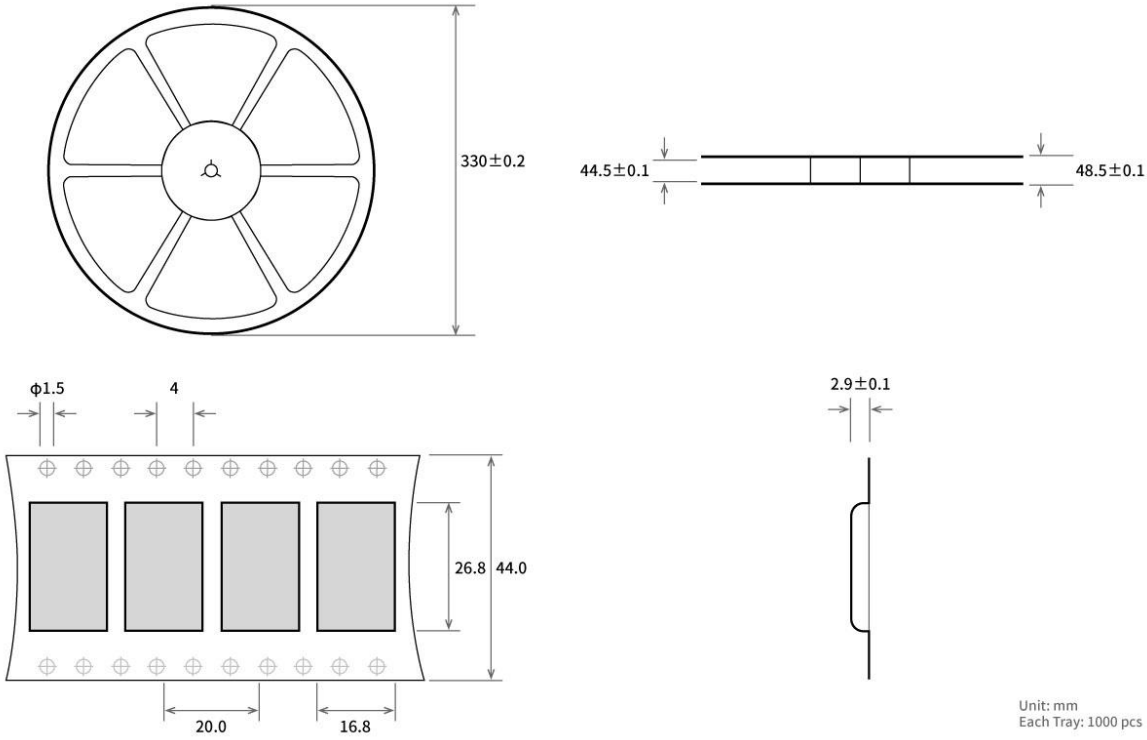
## 8.2 Reflow soldering curve




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# Chapter 9 Bulk Packaging Methods




# Revision history

| Version | Revision Date | Revision Notes | Maintenance man |
|---|---|---|---|
| 1.0 | 2024-6-25 | First edition | Ning |
| 1.1 | 2025-5-28 | Add description of low frequency crystal oscillator. Update the DIO9 description and reference circuit. | Ning |

# About Us

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