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
Chengdu Ebyte Electronic Technology Co.,Ltd.

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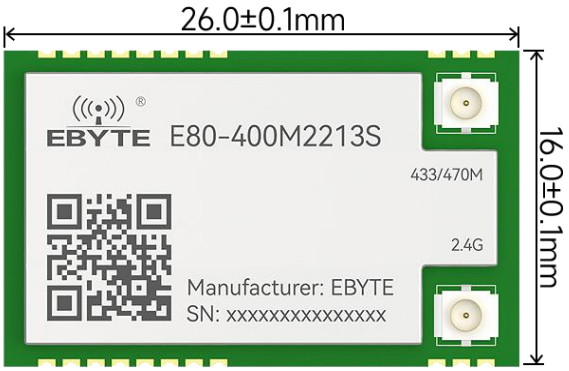
Chapter 1 Product Overview

1.1 Product Introduction

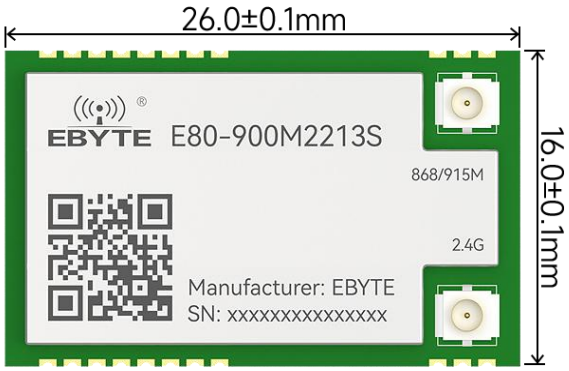
E80 -xxxM2213S is a dual-frequency SMD LoRa hardware SPI wireless module independently developed based on SEMTECH LoRa Connect™ LR1121 chip for multi-band global connectivity, with a transmit power of 22 dBm and 13 dBm respectively . The module integrates an industrial-grade 48MHz high-precision low-temperature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

- 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

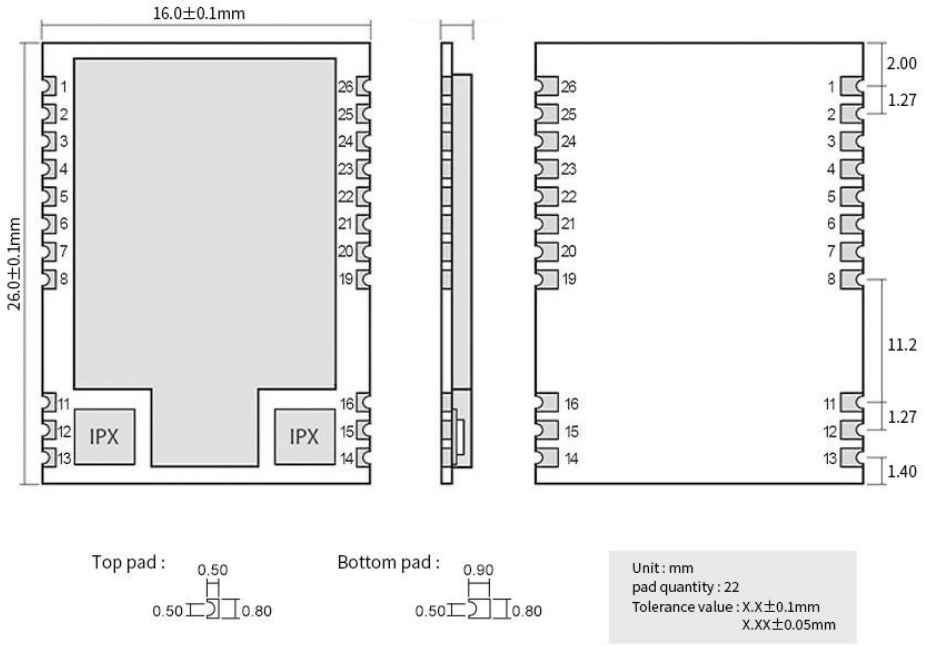
2.2 Electrical parameters

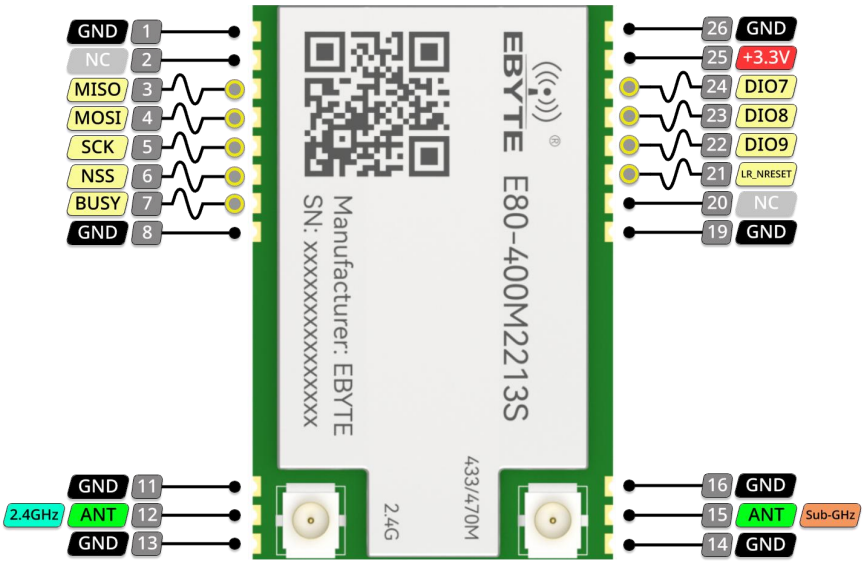
Electrical parameters	Minimum	Typical Value	Maximum	Remark
Operating voltage (V)	1.8	3.3	3. 7	≥3.3V can guarantee output power , more than 3.8V may cause burnout risk
Communication level (V)	-	3.3	-	Using 5V TTL may cause burnout , please use the conversion circuit reasonably
Emission current (mA)	-	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	-

Chapter 3 Mechanical Dimensions and Pin Definition





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.

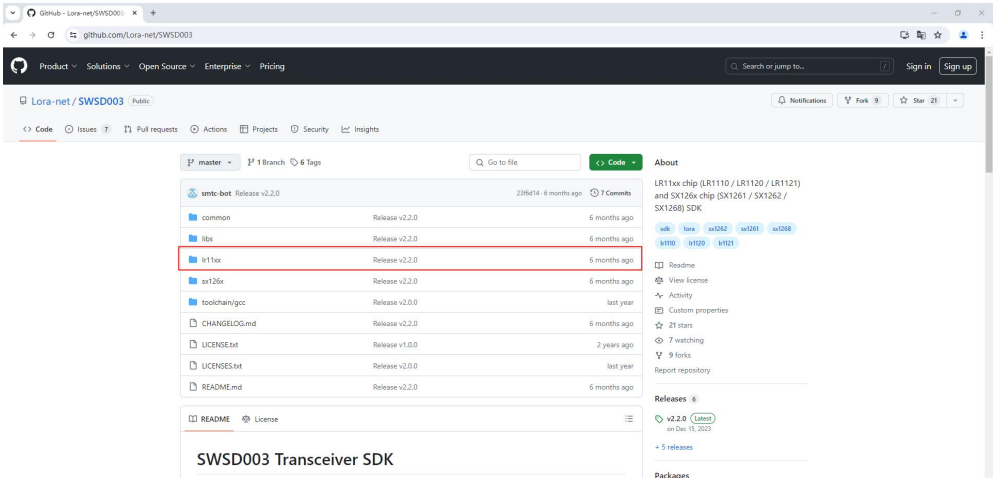
DIO5/RFSW0	DIO6/RFSW1	RF Status
0	0	RX
0	1	TX (Sub-1GHz low power mode)
1	0	TX (Sub-1GHz high power mode)
1	1	TX (2.4GHz)

Chapter 4 Software development and use

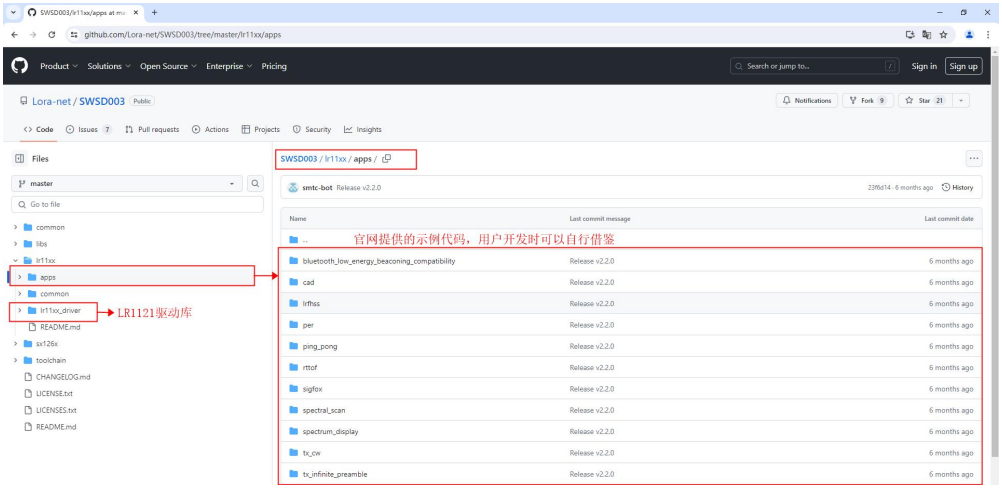
Software development is divided into two parts: one is the SEMTECH official original SDK usage tutorial, and the other is the Ebyte custom SDK example usage tutorial

● LR1121 Official SDK

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



②SDK structure description



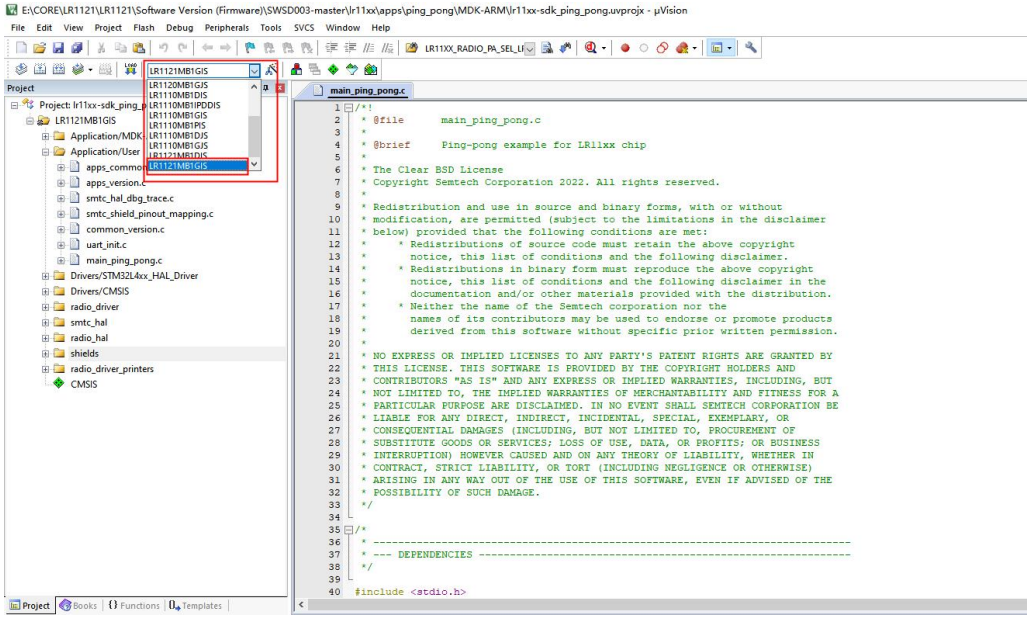
The sample code provided by the official website can be used as a reference for users to develop

③Use keil to open the official website project;

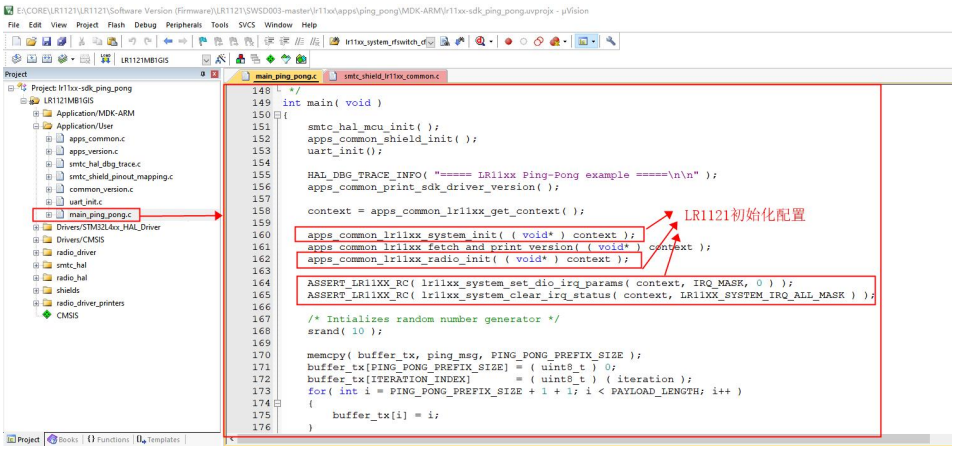
Download the SDK package "SWSD003" from the official website, open it and select the "lr11xx" folder, and select the required sample project under the internal app file.

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

④Select a workspace;

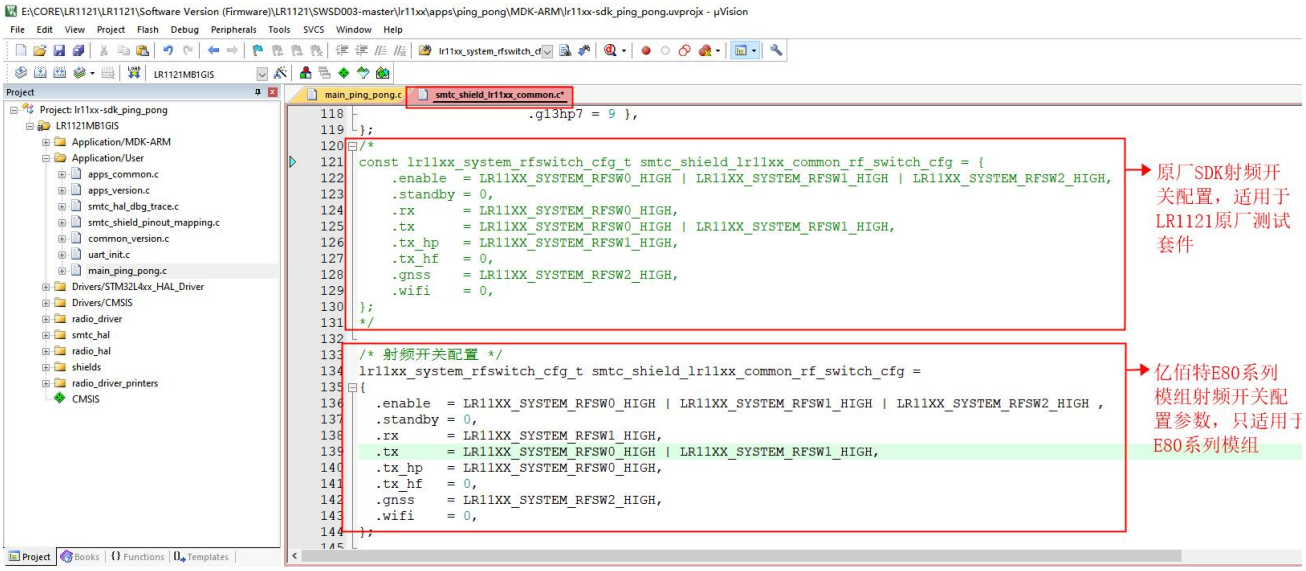


⑤ main function entry analysis;



LR1221 Initial configuration

⑥Key parameter configuration-RF switch;



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;

Select Lora for data type

Frequency configuration

Power configuration

RF parameter configuration

Modulation parameter configuration

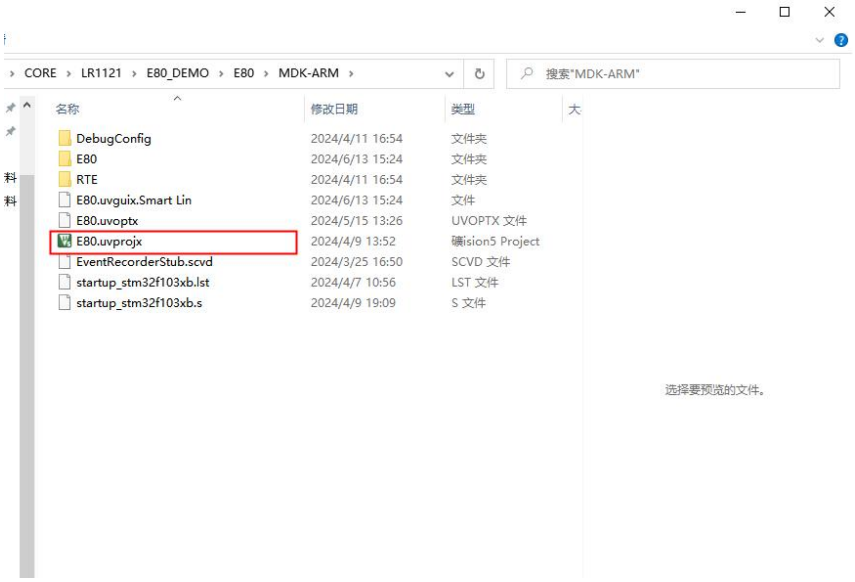
Data packet format configuration

Sync word configuration

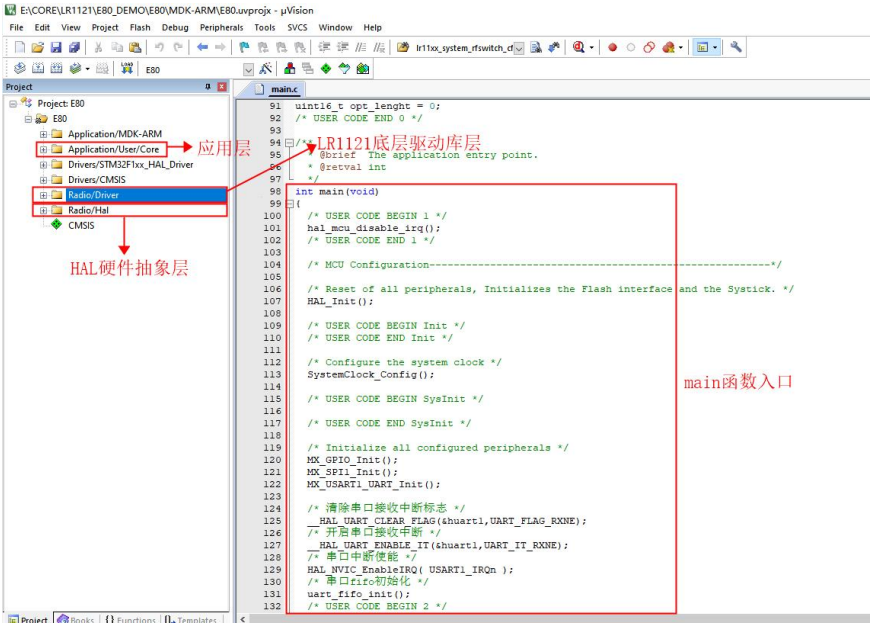
- E80 - xxxM2213S Ebyte Custom SDK (Since the DEMO code has detailed comments, the software operation process will not be explained in detail)

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;



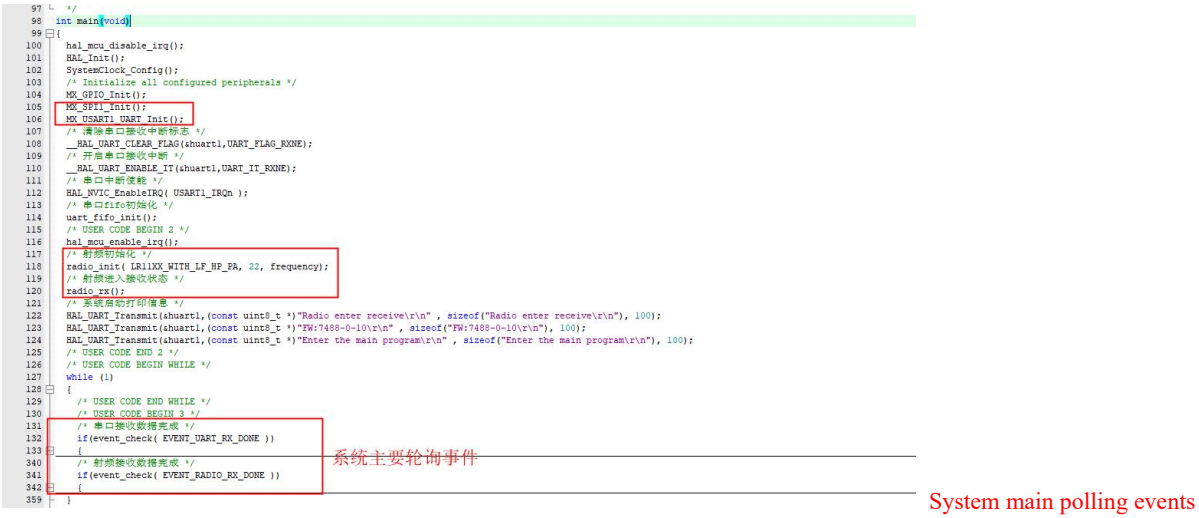
Application layer

HAL hardware abstraction layer

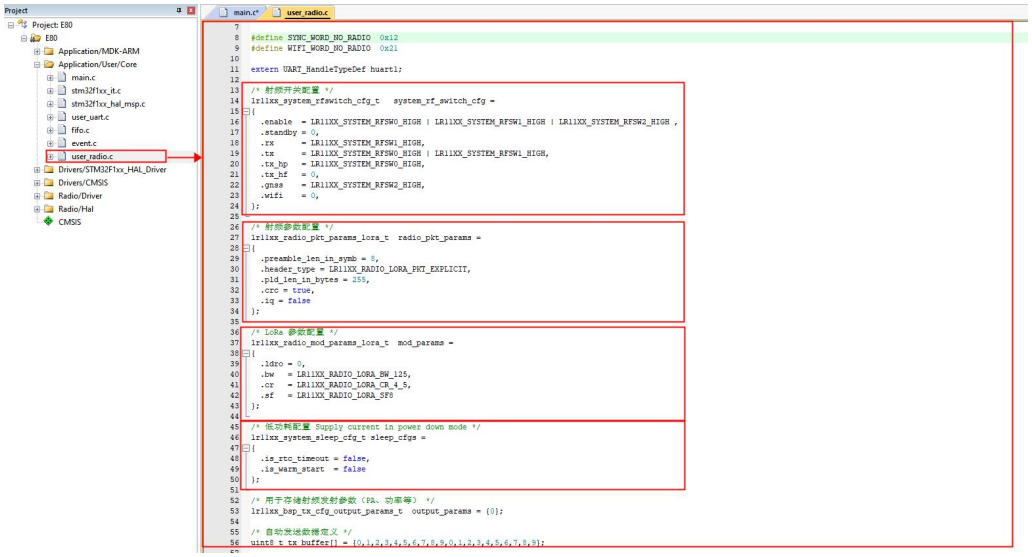
LR121 underlying driver library layer

main function entry

④ E80_DEMO main function entry ;



⑤ E80_DEMO key RF parameter configuration;



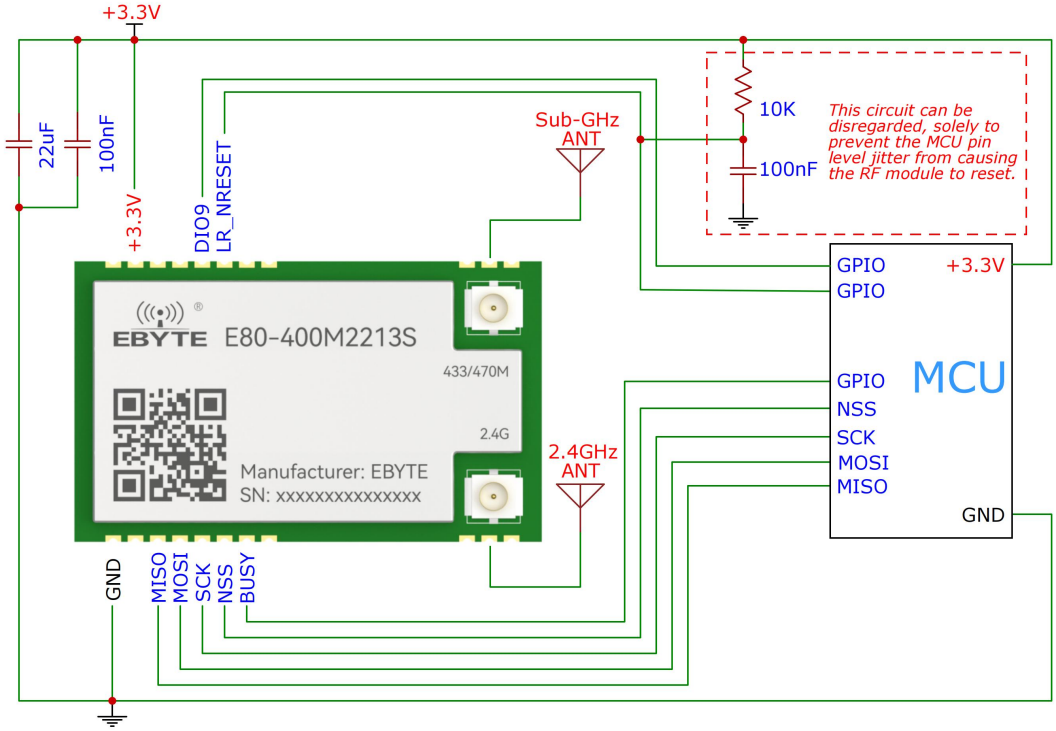
Chapter 5 Hardware Design

- 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

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 ※

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

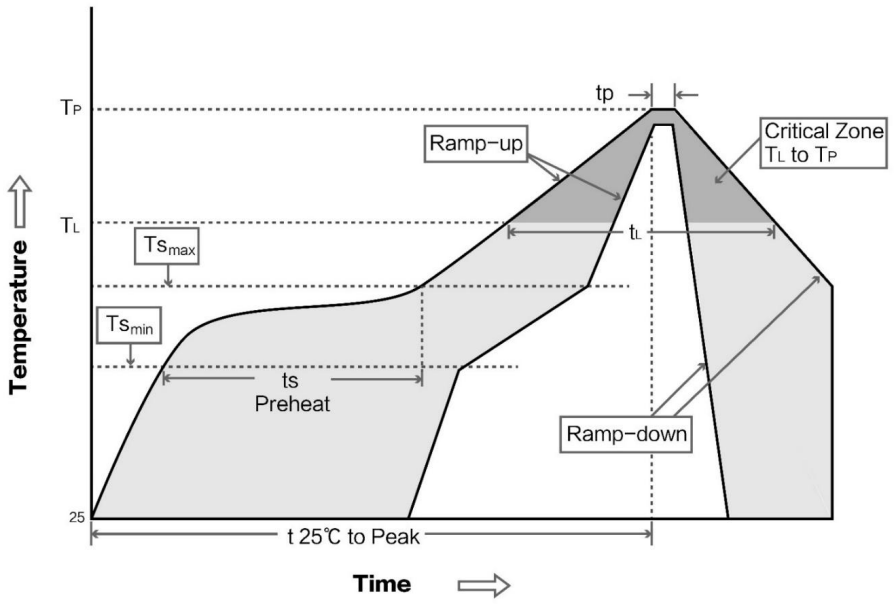
- There is interference from the same frequency signal nearby. Stay away from the interference source or change the frequency or channel to avoid interference.
- An unsatisfactory power supply may also cause garbled characters, so the reliability of the power supply must be ensured;
- Extension cables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

Chapter 8 Welding Operation Instructions

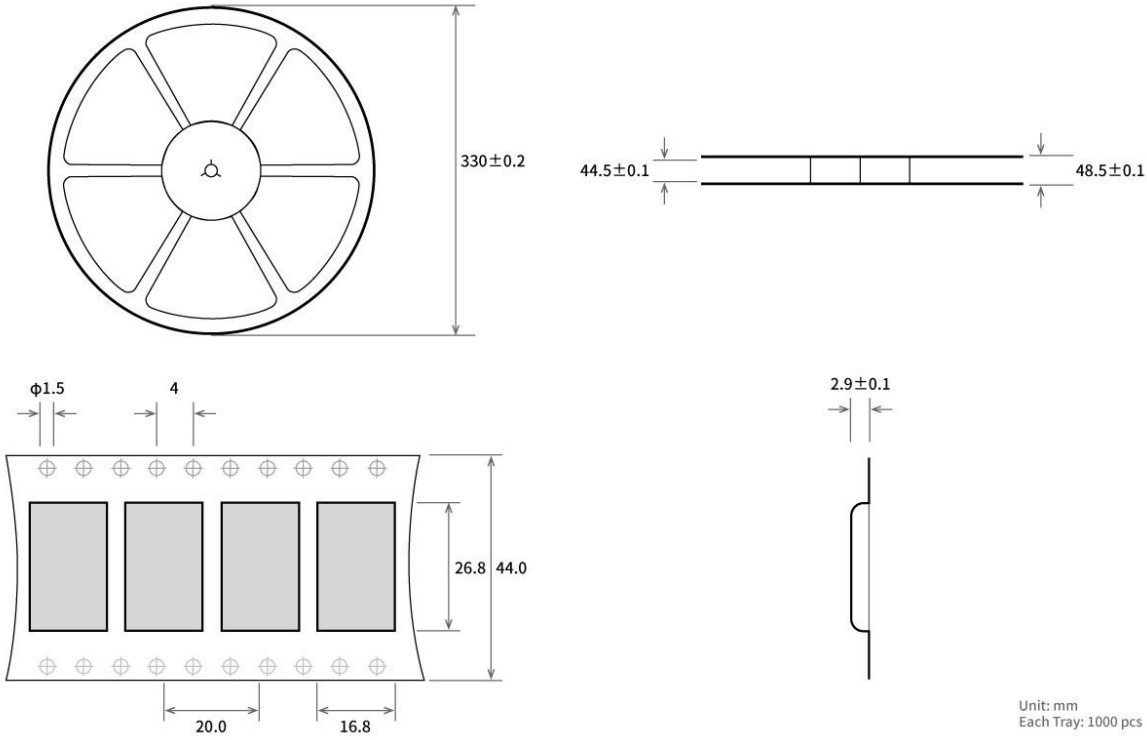
8.1 Reflow temperature

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



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

Sales hotline: 4000-330-990 Company phone: 028 -61399028

Technical support : support@cdebyte.com Official website: www.cdebyte.com

Company Address: 2nd Floor, Building B2, No. 199, Xiqu Avenue, High-tech Zone, Chengdu, Sichuan

成都亿佰特电子科技有限公司
Chengdu Ebyte Electronic Technology Co.,Ltd.