E80-xxxM2212S User Manual

LR2021

Sub-1GHz/2.4GHz

LoRa Dual-Band Wireless Module



Chengdu Ebyte Electronic Technology Co.,Ltd.

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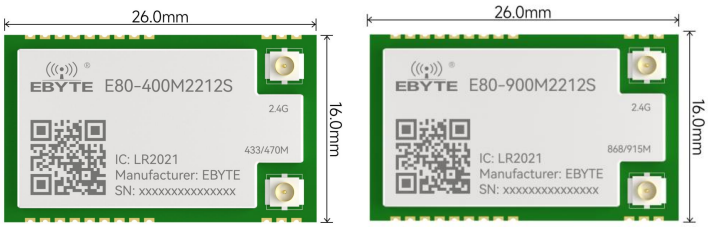
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1 Product Overview

1.1 Product Introduction



E80-xxxM2212S[①] is a dual-band patch-type LoRa hardware SPI wireless module independently developed based on SEMTECH's LoRa Plus fourth-generation LoRa® IP—LR2021 chip , with transmit powers of 22 dBm and 12 dBm respectively . The module integrates an industrial-grade 32 MHz high-precision active temperature-compensated crystal oscillator.

The LR2021 is the first chip in Semtech's LoRa Plus series. This transceiver integrates fourth-generation LoRa® IP , supporting Sub-GHz, 2.4GHz ISM bands, and licensed S-band terrestrial and satellite communication networks. The LR 2021 is designed to be fully compatible with the SX126x, SX127x, SX128x, and LR11xx series chips, enabling seamless integration and interoperability with existing systems using these chips to meet diverse application requirements and proprietary protocols.

* *Since this module is a purely hardware-based RF module, it requires user programming before it can be used.*

* *E80-xxxM2212S[①]: Detailed model numbers include* ***E80-400M2212S and E80-900M2212S .***

1.2 Features and Functions

- Low-power, high-sensitivity LoRa/(G)FSK half-duplex RF transceiver;
- The global ISM band support ranges from Sub- GHz and 2.4 GHz to the 2.1 GHz s band , and the bands can be customized as needed ;
- Compatible with multiple low-power wireless protocols: AmazonSidewalk , WirelessM-BUS , Wi-SUNFSK , and Z-Wave , etc.
- Built-in low-noise-figure RX front end enhances LoRa / (G) FSK sensitivity;
- Maximum transmit power 20 dBm / 22 dBm @ Sub-GHz, 12 dBm @ 2.4GHz , software - adjustable in multiple levels ;
- Under ideal conditions, the communication distance can reach 5.0 km @ 433 MHz / 5.0 km @ 930 MHz , and 2.2 km @ 2.4 GHz ;
- Supports multiple modulation schemes including FLRC, LoRa, FSK, OOK, O-QPSK, and LR-FHSS;
- Transmission rates up to 2.6Mbps@FLRC, 200kbps@LoRa;
- The chip has a built-in LR-FHSS modulator , which supports remote frequency hopping spread spectrum in the 2.4 GHz band ;
- It can support multi-regional BOMs worldwide, and the circuit can adaptively match the network to meet regulatory restrictions .
- Under Sub-GHz communication, it is fully compatible with devices such as SX126x and SX127x , and conforms to LoRa standards. [The] LoRaWAN® standard defined [by] Alliance® ;
- In 2.4GHz communication, it is compatible with SX12 8x devices (except for FLRC modulation) and conforms to LoRa standards. The LoRa standard defined [by] Alliance® ;
- The hardware supports AES-128-based encryption/decryption algorithms ;
- 32 MHz high-precision active temperature-compensated crystal oscillator ;
- Industrial-grade standard design, supporting long-term use at temperatures ranging from -40 to +85°C;
- Dual antennas are optional (IPEX/stamp hole), allowing users to choose according to their needs ;

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1.3 Application scenarios

- Smart meters
- Smart Factory
- 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

2 Specifications

2.1 Product Selection Comparison

category	Product Model	Chip solutions	Carrier frequency ① Hz	Transmit power ② dBm	Test distance ③ km	Product dimensions (mm)	Antenna type ④
433/470 MHz band module	E80-400M2212S	LR2021	410～4 93M	20	5	16*26	IPEX -1 / Stamp Hole
			2400 ~ 2500M	12	2.2		
868/915MHz band module	E80-900M2212S	LR2021	850 ~ 930 M	twenty two	5	16*26	IPEX -1 / Stamp Hole
			2400 ~ 2500M	12	2.2		

Note:

(1)Carrier frequency ① : Frequency band range supports user customization , dual-band module ;

(2)Transmit power ② : 20/ 22dBm @Sub-1GHz, 12dBm@2.4GHz, the output power can be adjusted by the user through programming ;

(3)Test distance ③ : 5km@Sub-1GHz, 2.2km@2.4GHz, clear and open terrain, airspeed 2.4kbps, antenna height 2 meters (for reference only, actual testing is recommended);

(4)Antenna type ④ : Equivalent impedance approximately 50Ω;

(5)The two modules differ only in frequency band; their package pins are identical .

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2.2 Basic parameters

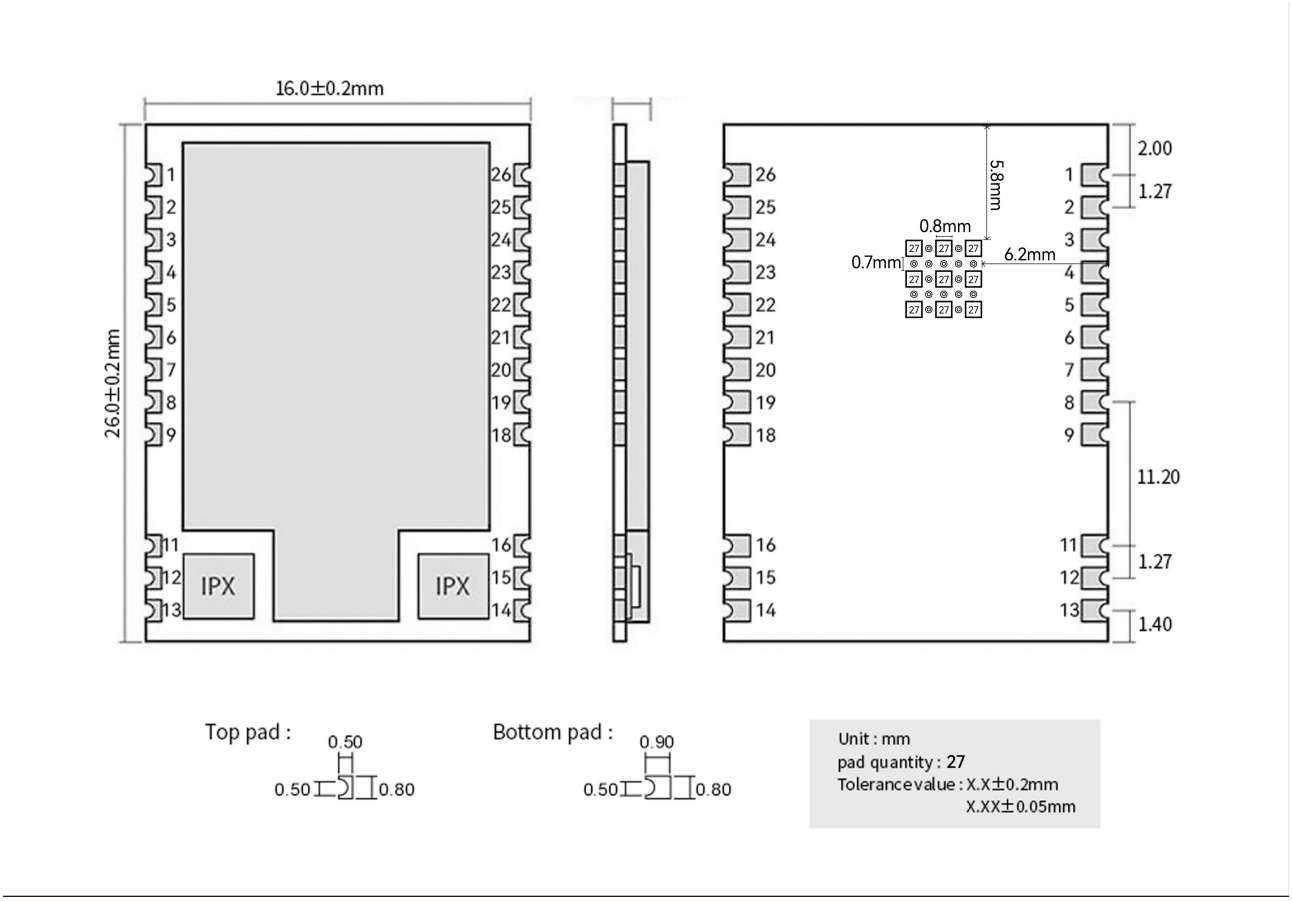
Conditions: Tc = 25℃, VCC = 3.3 V, 433MHz/ 470MHz/ 868MHz/915MHz /2.4GHz

parameter	describe
Chip solutions	LR2021
Interface method	1.27mm stamp perforation
Communication interface	SPI communication level is 1.8-3.7V, but 3.3V is recommended to ensure data reliability.
Crystal oscillator frequency	32 MHz , high-precision active temperature-compensated crystal oscillator
Antenna type	IPEX-1/Stamp Hole, Sub-GHz/2.4GHz Dual Antenna Interface Design
size	26.0*16.0*3.0mm, tolerance ±0.2mm. See 3 for detailed dimensions.
Packaging method	patch
Work environment	
Operating temperature	-40℃～+85℃, industrial grade standard
Operating humidity	10–90% RH , no condensation
Storage temperature	-40℃～+125℃
RF parameters	
Transmit power	20–22 dBm, @Sub-GHz, user-programmable output power.
	≤12 dBm, @2.4 GHz, user-programmable output power.
Operating frequency band	between 410 MHz and 493 MHz, this module is compatible with the E80-400M2212S and can be programmed to operate at different frequencies , supporting frequency band customization .
	at 850MHz to 930MHz, this module is compatible with the E80-900M2212S and can be programmed to operate at different frequencies , supporting frequency band customization.
	Both modules are suitable for frequencies ranging from 2400 to 2500 MHz. Users can program the modules to operate at different frequencies , supporting frequency band customization.
Receiver sensitivity	-142dBm@LoRa 125 kHz sub-GHz
	-111dBm@100kbps DSSS O-QPSK
	-111dBm@FLRC 260 kbps sub-GHz
	-103.5dBm@FLRC 1Mbps, -100.5dBm@1.95Mbps
	-103dBm@802.15.4 DSSS O-QPSK 250kbps
	-100dBm@GMSK 1Mbps, -97dBm@2Mbps
Transmission rate	2.6Mbps@FLRC, 125 kbps@LoRa
Transmission distance	≈5km, @Sub-GHz, clear and open environment, antenna gain 3.5dBi, antenna height 2.5m, air speed 2.4kbps
	≈2.2km, @2.4GHz, clear and open environment, antenna gain 5dBi, antenna height 2.5m, air speed 2.4kbps
Electrical parameters	
Power supply voltage	is 2.5 to 3.7 V. When the operating voltage is ≥3V, the output power requirement can be met. However, there is a risk of burnout if the operating voltage exceeds 3.7V.
Communication level	Using 5V TTL with a 3.3V connection carries a risk of damage; users should use the conversion circuit appropriately.
Emission current	≈102mA, 433MHz, instantaneous power consumption
	≈114mA, 915MHz, instantaneous power consumption
	≈27mA, 2.4GHz, instantaneous power consumption
Received current	≈ 7.4 mA , 433MHz
	≈ 6.8 mA , 915MHz
	≈ 7.1 mA, 2.4 GHz
Dormant current	≈ 2 uA, 433MHz , all radio frequencies are not working.
	≈ 2 uA , 915MHz , all radio frequencies are not working.

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3 Mechanical Dimensions and Pin Definitions



Pin number	Pin Name	Pin direction	Pin Applications
1	GND	power supply	-
2	DIO5	Input/Output	DIO 5 " of LR2021 . Leave it floating if not in use. Please refer to the chip
3	MISO	Output	The SPI interface pin connects to the " MISO " pin of the LR2021. Please
4	MOSI	enter	The SPI interface pin connects to the " MOSI " pin of the LR2021. Please
5	SCK	enter	The SPI interface pin connects to the " SCK " pin of the LR2021. Please refer
6	NSS	enter	The SPI interface pin connects to the " NSS " pin of the LR2021. Please refer
7	BUSY	Output	The module is "Busy" indicating a connection to the LR2021. For details,
8	GND	-	Pin ground
9	DIO6	Input/Output	DIO 6 " of LR2021 . Leave it floating if not in use. Please refer to the chip
10	none	none	Reserved space for future expansion
11	GND	power supply	-
12	ANT	Input/Output	Sub-GHz antenna interface
13	GND	power supply	-
14	GND	power supply	-
15	ANT	Input/Output	2.4GHz antenna interface
16	GND	power supply	-
17	none	none	Reserved space for future expansion
18	DIO11	Input/Output	Connect to " DIO 11 " on the LR2021. Leave it floating if not in use. Please
19	GND	power supply	-
20	DIO10	Input/Output	Connect " DIO 10 " to the LR2021. Leave it floating if not in use. Please

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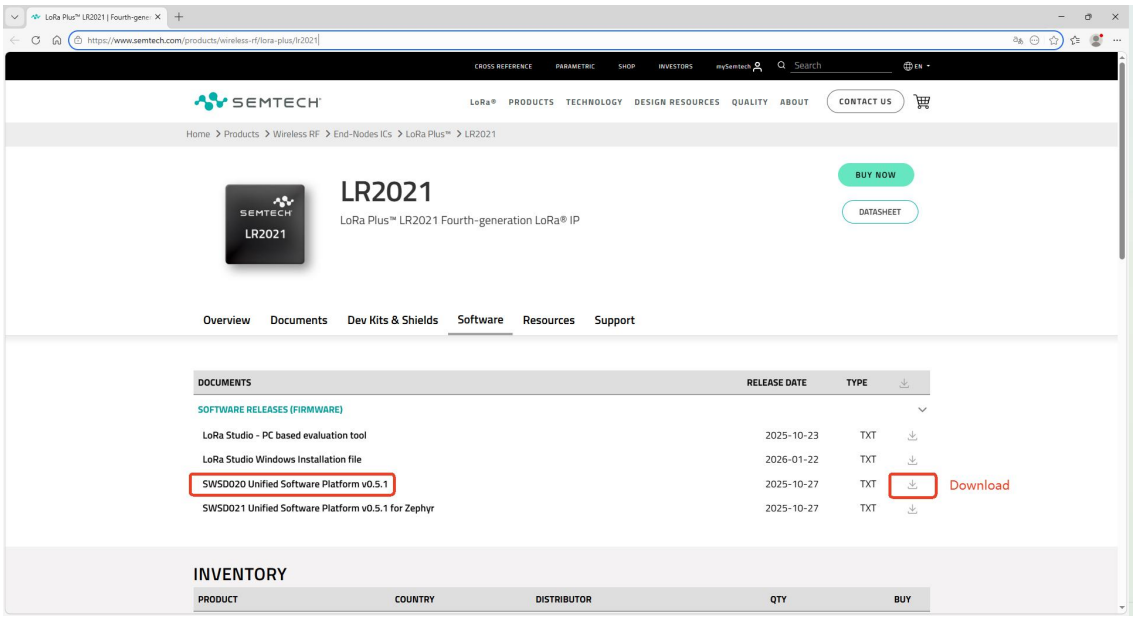
twenty one	LR_NRESET	enter	The module reset pin is active low and is connected to the "NRESET" pin of
twenty two	DI O 9	Input/Output	DIO 9 " of LR2021 . Leave it floating if not in use. Please refer to the chip
twenty three	DI O 8	Input/Output	DIO 8 " of LR2021 . Leave it floating if not in use. Please refer to the chip
twenty four	DI O 7	Input/Output	Connect " DIO 7 " to the LR2021. Leave it floating if not in use. Please refer
25	VCC	Power input	-
26	GND	power supply	-
27	GND	power supply	-

4 Software development and use

The software development consists of two parts: one is the SEMTECH official SDK usage tutorial, and the other is the EBITECH custom SDK example usage tutorial.

● LR2021 Official SDK

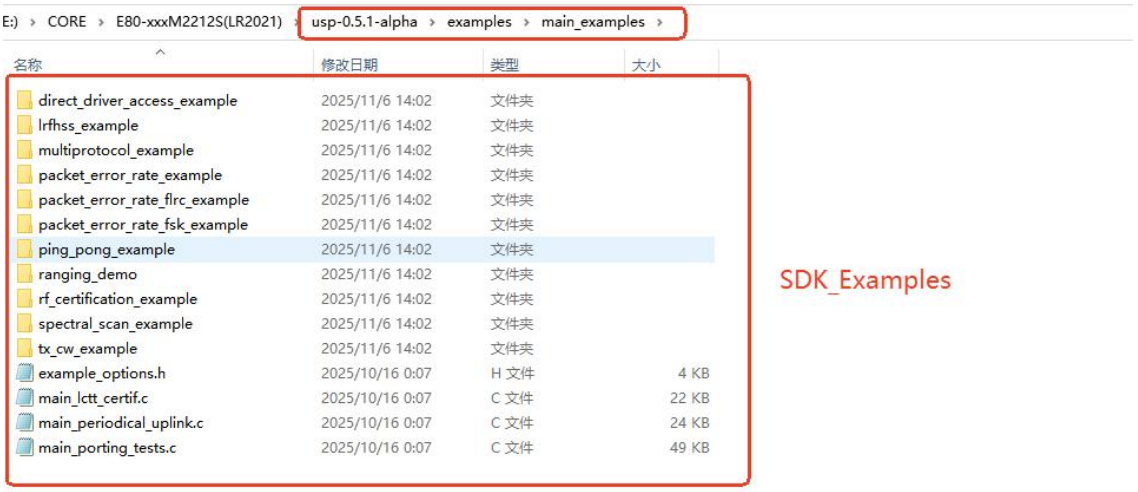
① Download link: https://www.semtech.com/products/wireless-rf/lora-plus/lr2021



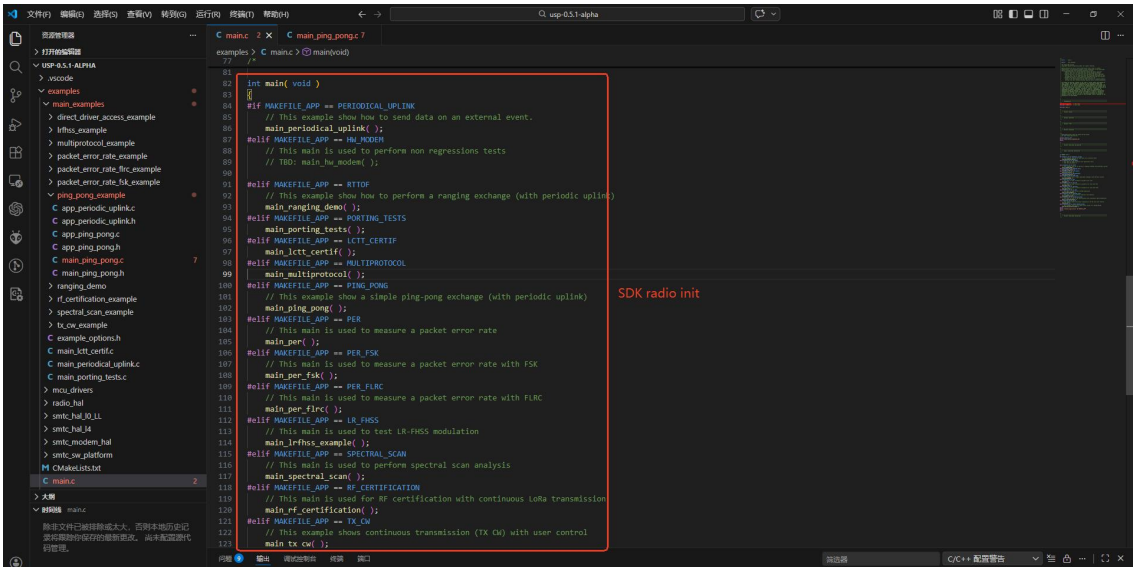
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②SDK Structure Description



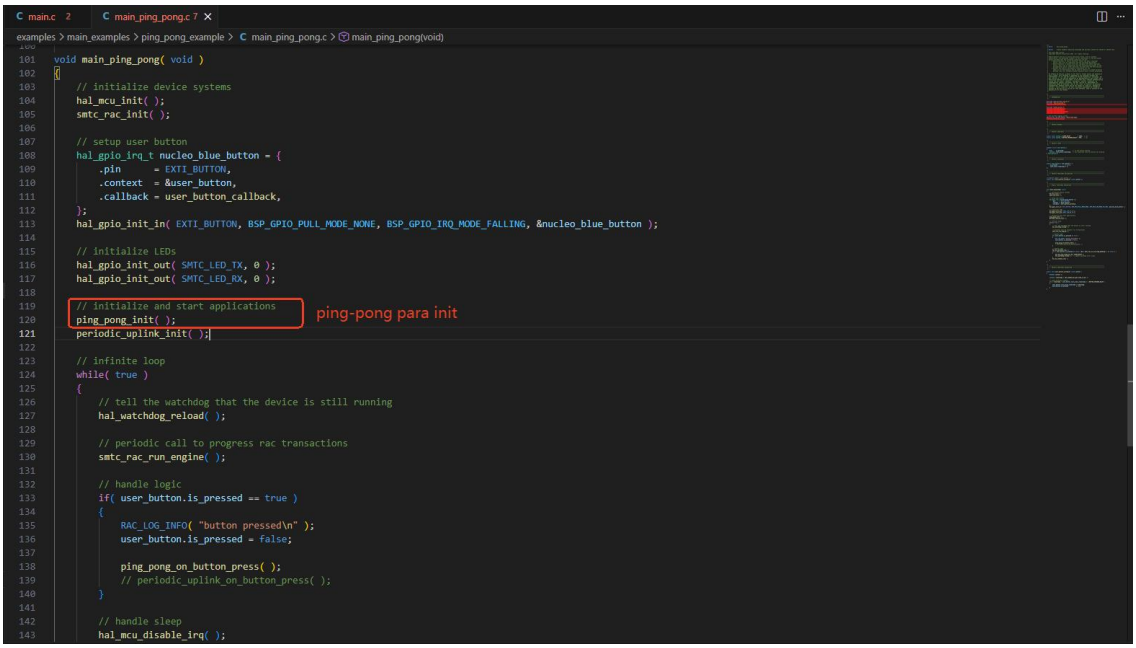
③ Open the official project (**usp-0.5.1-alpha**) using Visual Studio Code ;



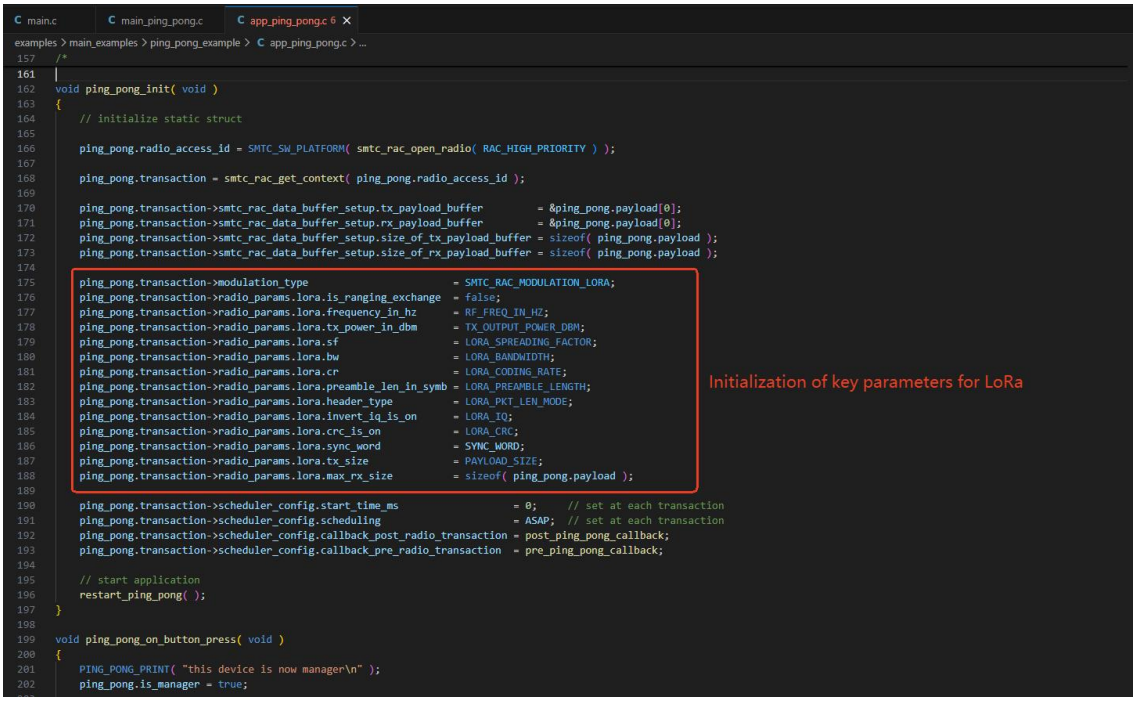
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④ Using ping_pong as a practical example to illustrate key parameter configuration ;



⑤ Key RF parameter configuration - LoRa modulation related parameters;



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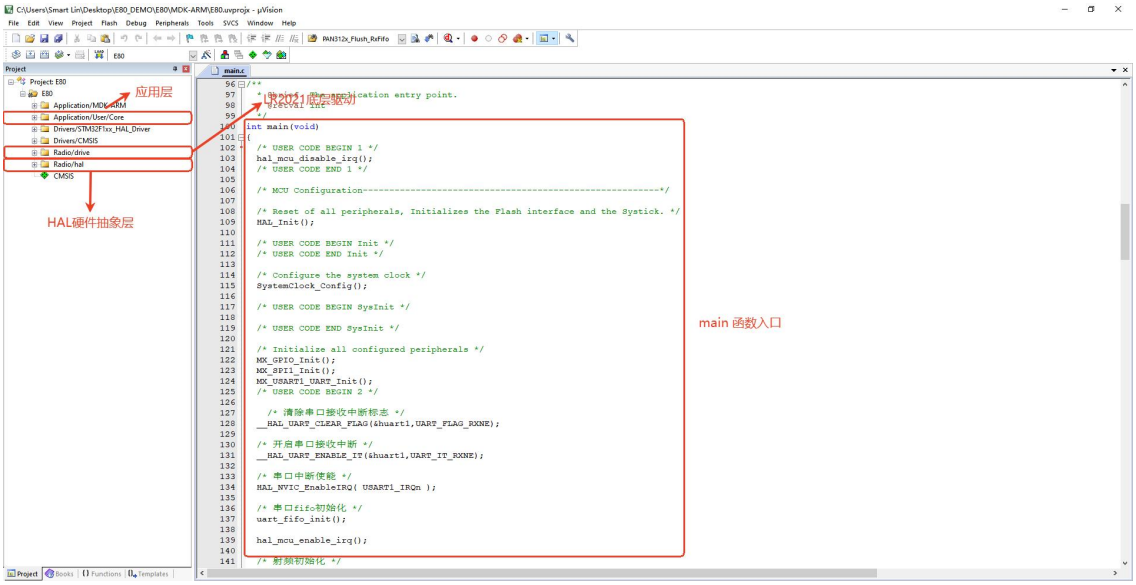
- E80-xxxM2212S Ebitech Custom SDK (Since the DEMO code has detailed comments, the software business process will not be explained in detail below).

① Download "E80_DEMO.zip" from the E80 website and extract it to a path with an English path;

② Open the project using Keil;



③ Description of the E80_DEMO SDK structure;



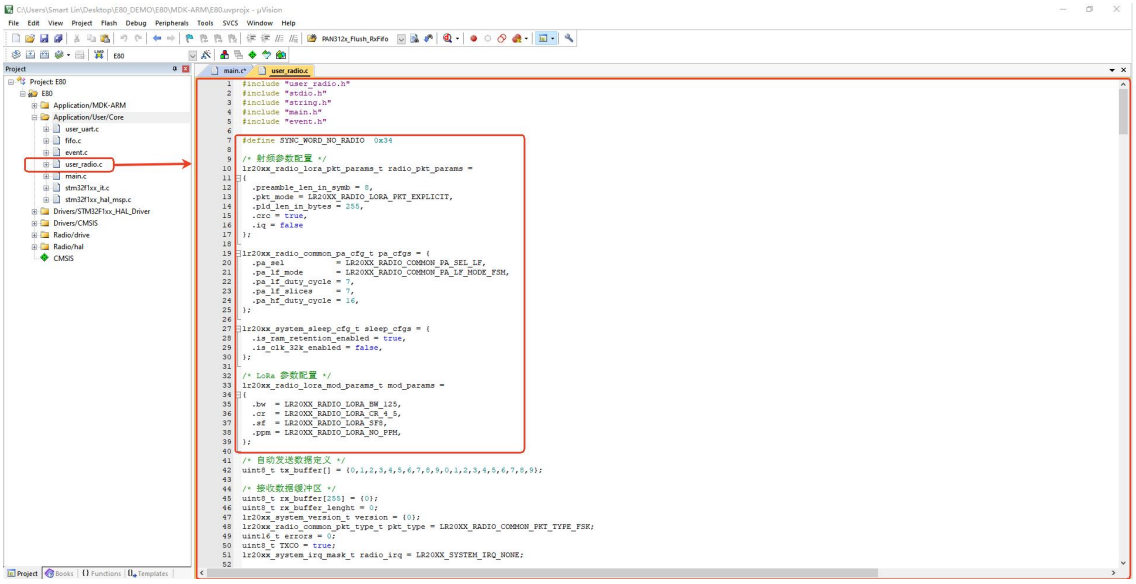
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④ The entry point of the E80_DEMO main function ;



⑤ E80_DEMO Key RF Parameter Configuration;



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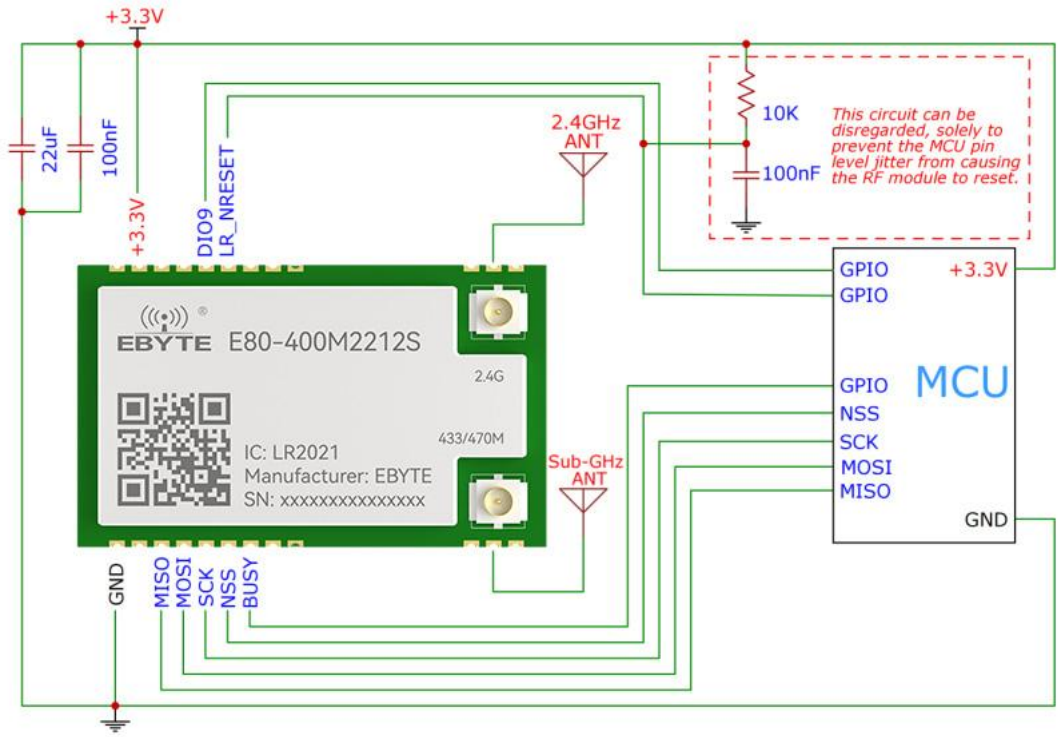
5 Hardware Design

- It is recommended to use a DC regulated power supply to power this module, with the power supply ripple coefficient as small as possible, and the module must be reliably grounded;
- Please ensure the correct connection of the power supply positive and negative terminals. Reversing the connection may cause permanent damage to the module.
- Please check the power supply and ensure it is within the recommended voltage range. Exceeding the maximum value will cause permanent damage to the module.
- Please check the power supply stability; the voltage should not fluctuate significantly or frequently.
- When designing power supply circuits for modules, it is often recommended to retain a margin of more than 30% to ensure long-term stable operation of the entire unit.
- The module should be kept as far away as possible from power supplies, transformers, high-frequency traces, and other parts with high electromagnetic interference.
- High-frequency digital traces, high-frequency analog traces, and power traces must avoid the area under the module. If it is absolutely necessary to run the traces under the module, assuming the module is soldered on the Top Layer, lay ground copper on the Top Layer of the module contact area (all copper and well grounded), and run the traces close to the digital part of the module on the Bottom Layer .
- Assuming the module is soldered or placed in the Top Layer, it is also wrong to arbitrarily route traces in the Bottom Layer or other layers, as this will affect the module's stray emissions and receiver sensitivity to varying degrees .
- If there are devices around the module that cause significant electromagnetic interference, it will greatly affect the module's performance. Depending on the intensity of the interference, it is recommended to keep them away from the module. If possible, appropriate isolation and shielding can be implemented.
- If there are traces around the module that cause significant electromagnetic interference (high-frequency digital, high-frequency analog, power supply traces), it will greatly affect the module's performance. Depending on the intensity of the interference, it is recommended to keep them away from the module. If possible, appropriate isolation and shielding can be implemented.
- Try to stay away from TTL protocols where the physical layer is also 2.4GHz;
- The antenna mounting structure has a significant impact on module performance; it is essential to ensure that the antenna is exposed and preferably vertically upward. When the module is installed inside the housing, a high-quality antenna extension cable can be used to extend the antenna to the outside of the housing.
- Antennas should never be installed inside a metal casing, as this will greatly reduce the transmission distance.

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6 Reference Circuits



※ The reference circuits for E80-400M2212S and E80-900M2212S are the same .

7 Frequently Asked Questions

7.1 Transmission distance is not ideal

- When there are obstacles in line-of-sight communication, the communication distance will be reduced accordingly ;
- Temperature, humidity, and co-channel interference can all lead to increased packet loss rates in communications .
- The ground absorbs and reflects radio waves, and the test results are poor when the ground is close to the ground .
- Seawater has a strong ability to absorb radio waves, so testing results are poor at the seaside .
- If there are metal objects near the antenna, or if it is placed inside a metal casing, the signal attenuation will be very severe .
- Power register settings are incorrect; air speed is set too high (the higher the air speed, the shorter the distance) .
- At room temperature, the power supply voltage is lower than the recommended value; the lower the voltage, the lower the power output .
- The antenna may be poorly matched with the module or have quality issues.

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7.2 Module is easily damaged .

- Please check the power supply and ensure it is within the recommended voltage range. Exceeding the maximum value will cause permanent damage to the module .
- Please check the power supply stability; the voltage should not fluctuate significantly or frequently .
- Please ensure anti-static operation during installation and use, as high-frequency devices are sensitive to electrostatic discharge .
- Please ensure that the humidity is not too high during installation and use, as some components are humidity-sensitive .
- Unless there are special requirements, it is not recommended to use it at excessively high or low temperatures.

7.3 Too high error rate

- If there is interference from a co-channel signal nearby, move away from the source of interference or change the frequency or channel to avoid the interference.
- An inadequate power supply can also cause garbled characters, so it is essential to ensure the reliability of the power supply.
- Poor quality or excessive length of extension lines or feeders can also lead to a high bit error rate.

8 Welding Operation Instructions

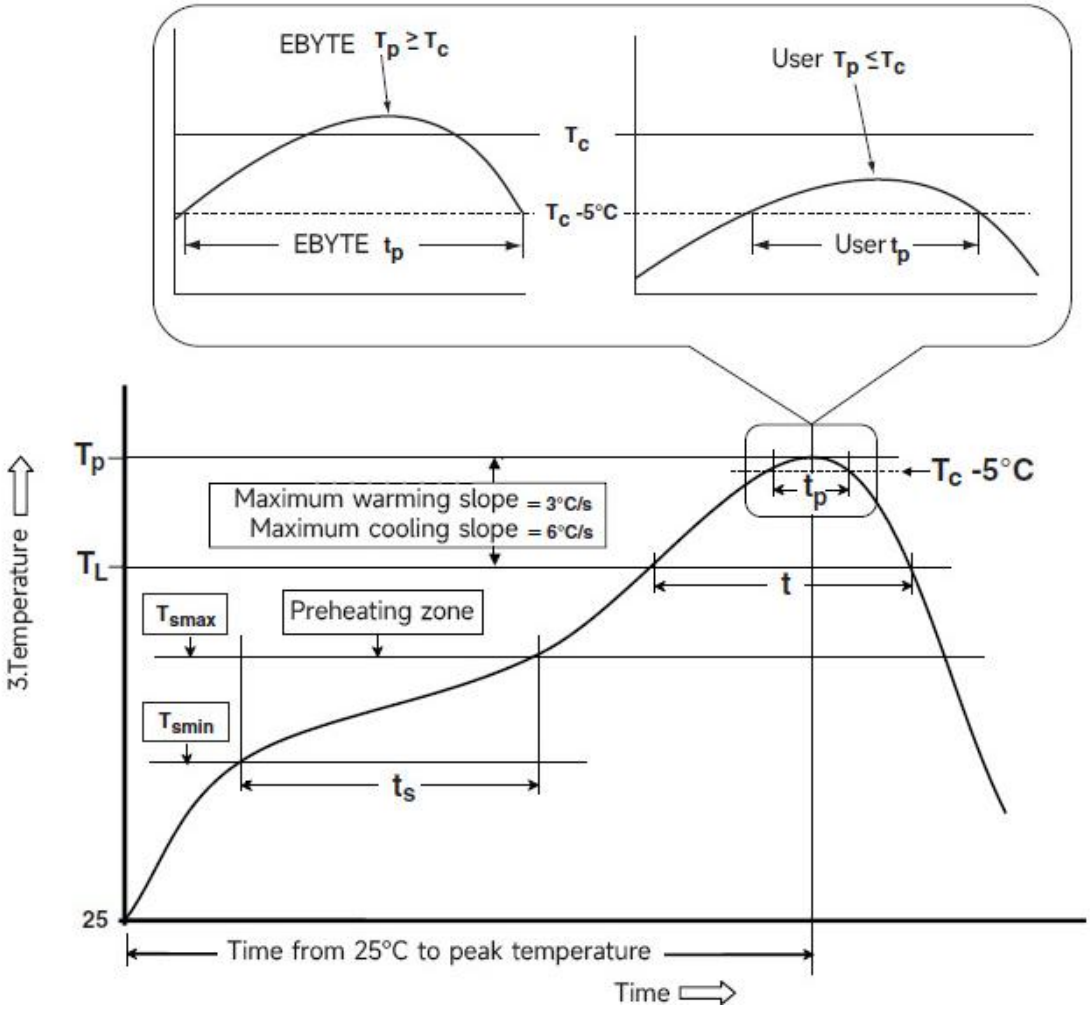
8.1 Reflow soldering temperature

Reflow soldering profile characteristics		Lead-based assembly	Lead-free assembly
Preheating/Insulation	Minimum temperature (Tsmin)	100℃	150℃
	Maximum temperature (T _{smax})	150℃	200℃
	Time (T smin ~ T smin)	60-120 seconds	60-120 seconds
Temperature rise slope (TL ~ Tp)		3℃/second, maximum value	3℃/second, maximum value
Liquid phase temperature (TL)		183℃	217℃
T L above the holding time		60~ 90 seconds	60~ 90 seconds
Package peak temperature Tp		Users must not exceed the temperature specified on the product's "humidity sensitivity" label.	Users must not exceed the temperature specified on the product's "humidity sensitivity" label.
Tp) within 5°C of the specified grading temperature (Tc) is shown in the figure below.		20 seconds	30 seconds
Cooling slope (Tp ~ TL)		6℃/second, maximum value	6℃/second, maximum value
Time from room temperature to peak temperature		6 minutes, the longest	8 minutes, the longest
* The peak temperature (Tp) tolerance of the temperature profile is defined as the user's upper limit.			

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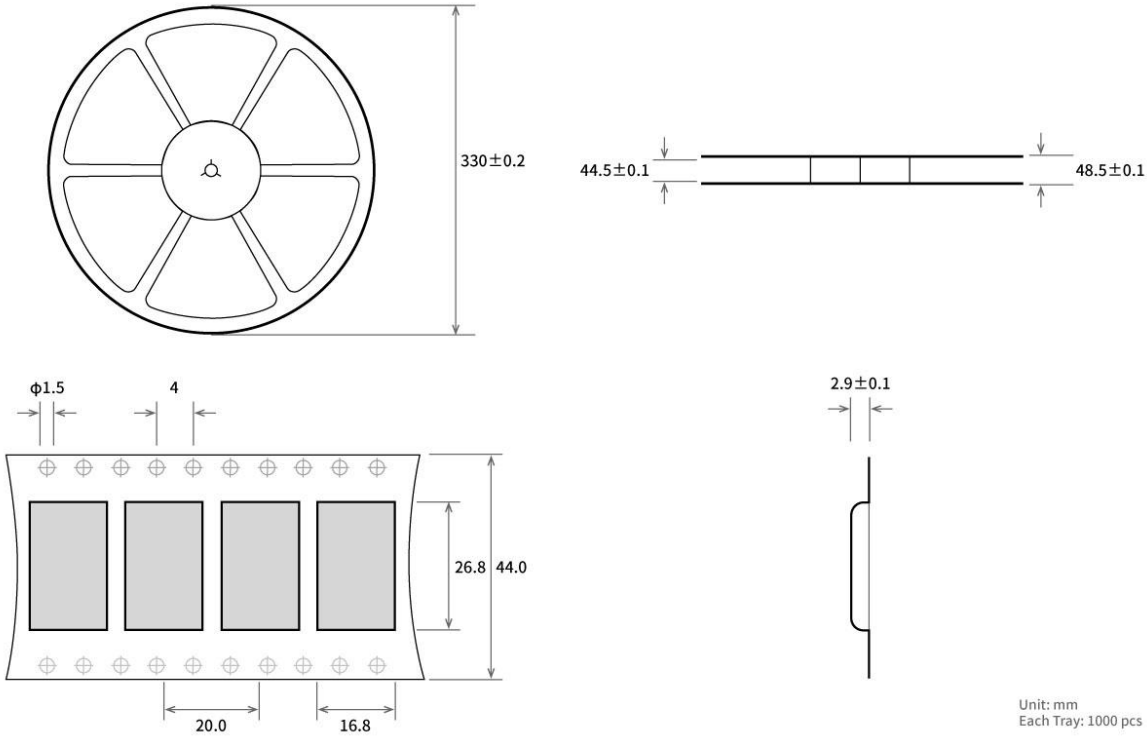
8.2 Reflow Soldering Profile



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9 Packaging



10 Revision History

Version	Revision Date	Revision Notes	maintainer
1.0	2026-3-5	first edition	Hao
1.1	2026-7-16	Modify the pin size diagram and pin description	Hao

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