Ra-01S-P Specification

Version V1.0.0

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Document resume

Version	Date	Develop/revise content	Edition	Approve
V1.0.0	2024.09.24	First Edition	Pengfei Dong	Ning Guan

Content

1. Product overview

Ra-01S-P is a LoRa series module designed and developed by Shenzhen Ai-Thinker Technology Co., Ltd. This module is used for ultra-long distance spread spectrum communication. Its RF chip SX1268 mainly uses LoRa™ long-range modem for ultra-long distance spread spectrum communication, with strong anti-interference and the ability to minimize current consumption. With the help of SEMTECH's LoRa™ patented modulation technology, the module has built-in power amplifier (PA) and low noise amplifier (LNA) on this basis, with a high sensitivity of more than -137dBm, +29dBm transmission power, long transmission distance and high reliability. At the same time, compared with traditional modulation technology, LoRa™ modulation technology also has obvious advantages in anti-blocking and selection, solving the problem that traditional design solutions cannot take into account distance, anti-interference and power consumption at the same time.

It can be widely used in automatic meter reading, home building automation, security systems, remote irrigation systems, etc.

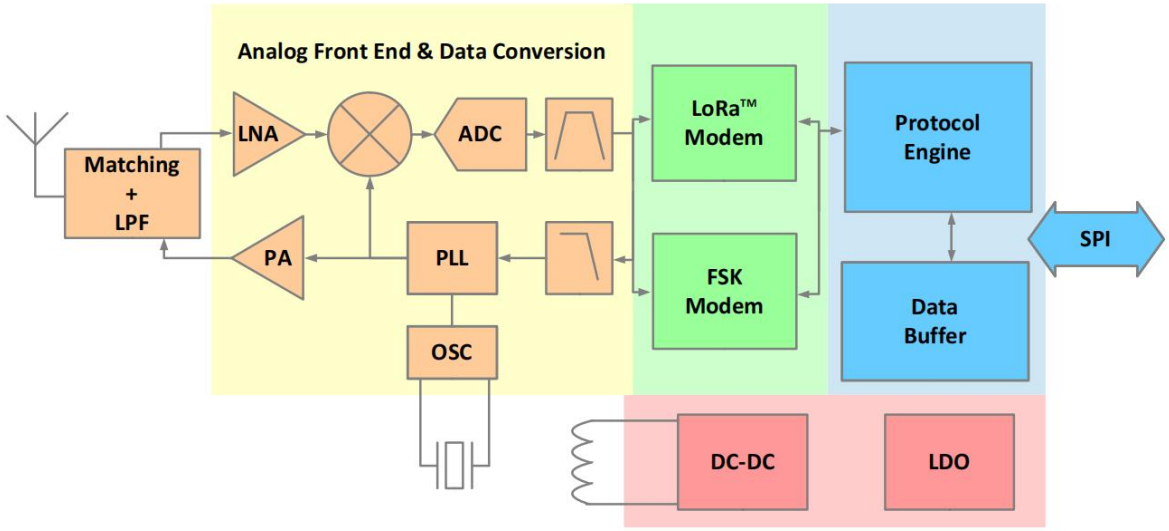

Figure 1 Main chip architecture diagram

1.1. Characteristic

- Support FSK、GFSK、LoRa® modulation
- Support frequency band: 410MHz~525MHz
- Maximum transmit power +29dBm, operating current 700mA
- High sensitivity: as low as -137dBm@SF10 125KHz
- Extremely small size 17*16*3.2(±0.2)MM, double row stamp hole patch package
- Support spreading factors SF5/SF6/SF7/SF8/SF9/SF10/SF11/SF12
- It has low power consumption in receiving state, and the minimum receiving current is 11mA
- The module uses SPI interface, half-duplex communication, CRC, and up to 256 bytes of data packet engine
- Support a variety of antenna installation methods, compatible with half-hole pads/through-hole pads/IPEX connector

2. Main parameters

Table 1 Description of the main parameters

Model	Ra-01S-P
Package	SMD-16
Size	17*16*3.2(±0.2)mm
Antenna	Compatible with half-hole pad/through-hole pad/IPEX connector
Frequency	410MHz~525MHz
Operating temperature	-40℃~ 85℃
Storage temperature	-40℃~ 125℃, < 90%RH
Power supply	Supply voltage 3.0~3.6V, typical value 3.3V, current＞1A
Interface	SPI
Programmable bit rate	Up to 300kbps

2.1. Static electricity requirement

Ra-01S-P is an electrostatic sensitive device. Therefore, you need to take special precautions when carrying it.

Figure 2 ESD preventive measures

Notice:

The Ra-01S-P module is an electrostatic sensitive device (ESD) and requires special ESD precautions that should normally be applied to ESD sensitive groups. Proper ESD handling and packaging procedures must be used throughout the handling, transportation, and operation of any application incorporating the Ra-01S-P module. Do not touch the module with your hands or use a non-antistatic soldering iron for soldering to avoid damaging the module.

2.2. Electrical characteristics

Table 2 Electrical characteristics table

Parameters	Min.	Typical value	Max.	Unit
Power supply voltage 3V3	3.0	3.3	3.6	V
IO Output High Level (VOH)	0.9*VDDIO	-	VDDIO	V
IO Output Low Level (VOL)	0	-	0.1*VDDIO	V
IO Input High Level (VIH)	0.7*VDDIO	-	VDDIO+0.3	V
IO Input Low Level (VIL)	-0.3	-	0.3*VDDIO	V
(RF_EN/CPS)IO Input High Level	1.2	-	3.6	V
(RF_EN/CPS)IO Input Low Level	0	-	0.3	V

Table 3 SPI interface characteristics

Symbol	Description	Condition	Min.	Typical value	Max.	Unit
Fsck	SCK frequency	-	-	-	10	MHz
tch	SCK high level time	-	50	-	-	ns
tcl	SCK low level time	-	50	-	-	ns
trise	SCK rise time	-	-	5	-	ns
tfall	SCK fall time	-	-	5	-	ns
tsetup	MOSI setup time	From MOSI change to SCK rising edge	30	-	-	ns
thold	MOSI hold time	From SCK rising edge to MOSI change	20	-	-	ns
tnsetup	NSS setup time	From NSS falling edge to SCK rising edge	30	-	-	ns
tnhold	NSS hold time	From SCK falling edge to NSS rising edge, normal mode	100	-	-	ns
tnhigh	NSS high time of SPI access interval	-	20	-	-	ns
T_DATA	DATA hold and setup time	-	250	-	-	ns
Fsck	SCK frequency	-	-	-	-	ns

3. Appearance dimensions

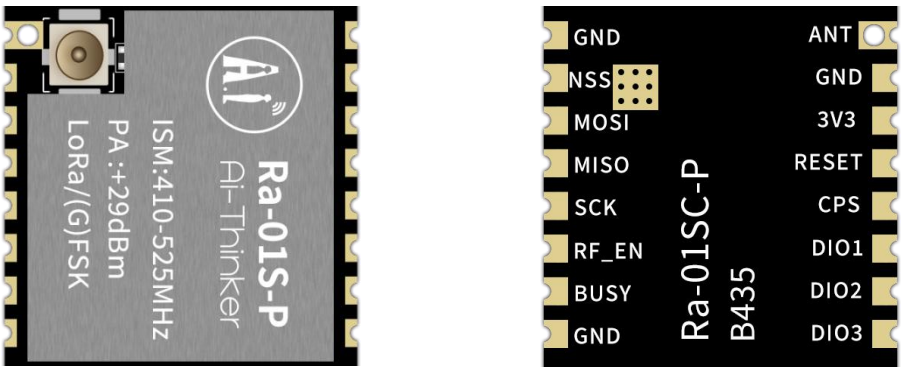

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Figure 3 Appearance (rendering is for reference only, the actual object shall prevail)

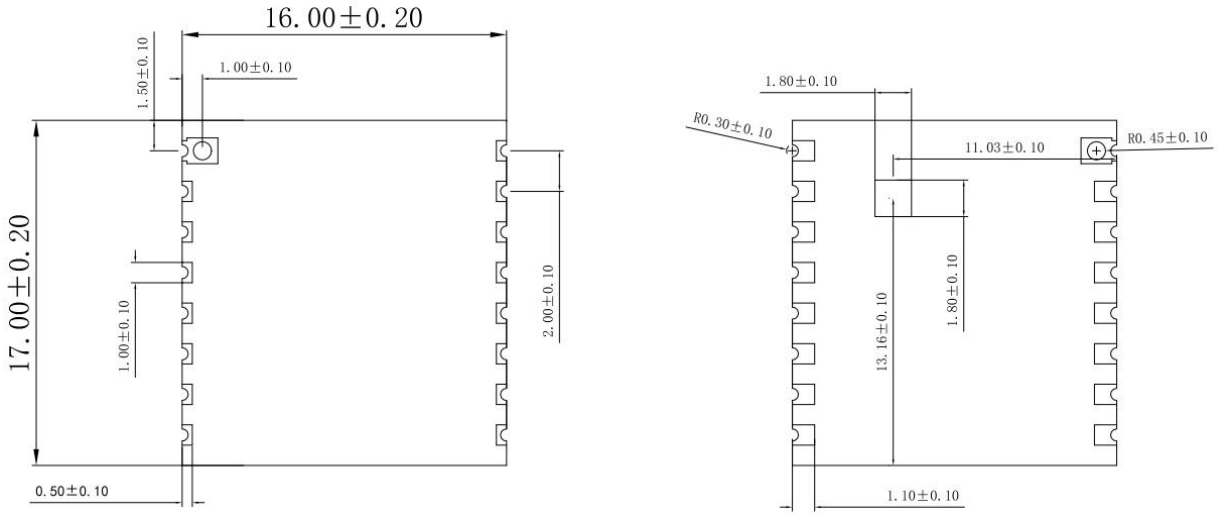

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Figure 4 Dimensions (unit: mm)

4. Pin definition

The Ra-01S-P module has a total of 16 pins, as shown in the pin diagram. The pin function definition table is the interface definition.

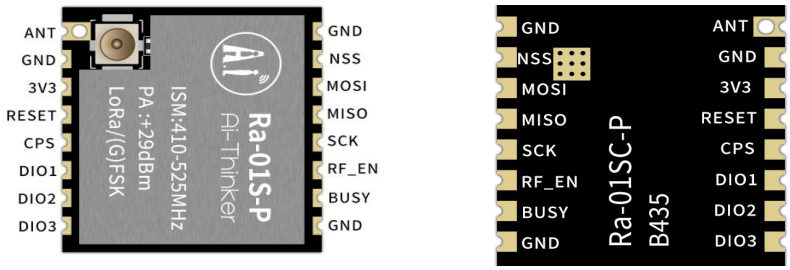

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Figure 5 Pin diagram

Table 4 Pin function definition table

No.	Name	Function
1	ANT	Connect antenna
2	GND	Ground
3	3V3	Typical value 3.3V power supply
4	RESET	Reset pin
5	CPS	FEM chip TX pass-through enable pin, in transmit mode, this pin is low level R F and is directly output without PA amplification, and is internally pulled up by default
6	DIO1	Digital IO1 software configuration
7	DIO2	Digital IO2 software configuration
8	DIO3	Digital IO3 software configuration
9	GND	Ground
10	BUSY	Status indication pin
11	RF_EN	FEM chip enable pin, high level is effective, the module is pulled up by default; High level is in working state, low level is in sleep state
12	SCK	SPI clock input
13	MISO	SPI data output
14	MOSI	SPI data input
15	NSS	SPI chip select input
16	GND	Ground
EPAD	GND	Ground, reliable grounding is required to facilitate heat dissipation

The general IO pins of SX1262 are available in LoRa™ mode. Their mapping relationship depends on the configuration of the two registers RegDioMapping1 and RegDioMapping2.

Table 5 IO port function mapping table

Operation Mode	DIOx Mapping	DIO3	DIO2	DIO1
All	00	CadDone	Fhss Change Channel	RxRimeout
	01	Valid Header	Fhss Change Channel	Fhss Change Channel
	10	PayloadCrc Error	Fhss Change Channel	CadDetected
	11	-	-	-

5. Schematic

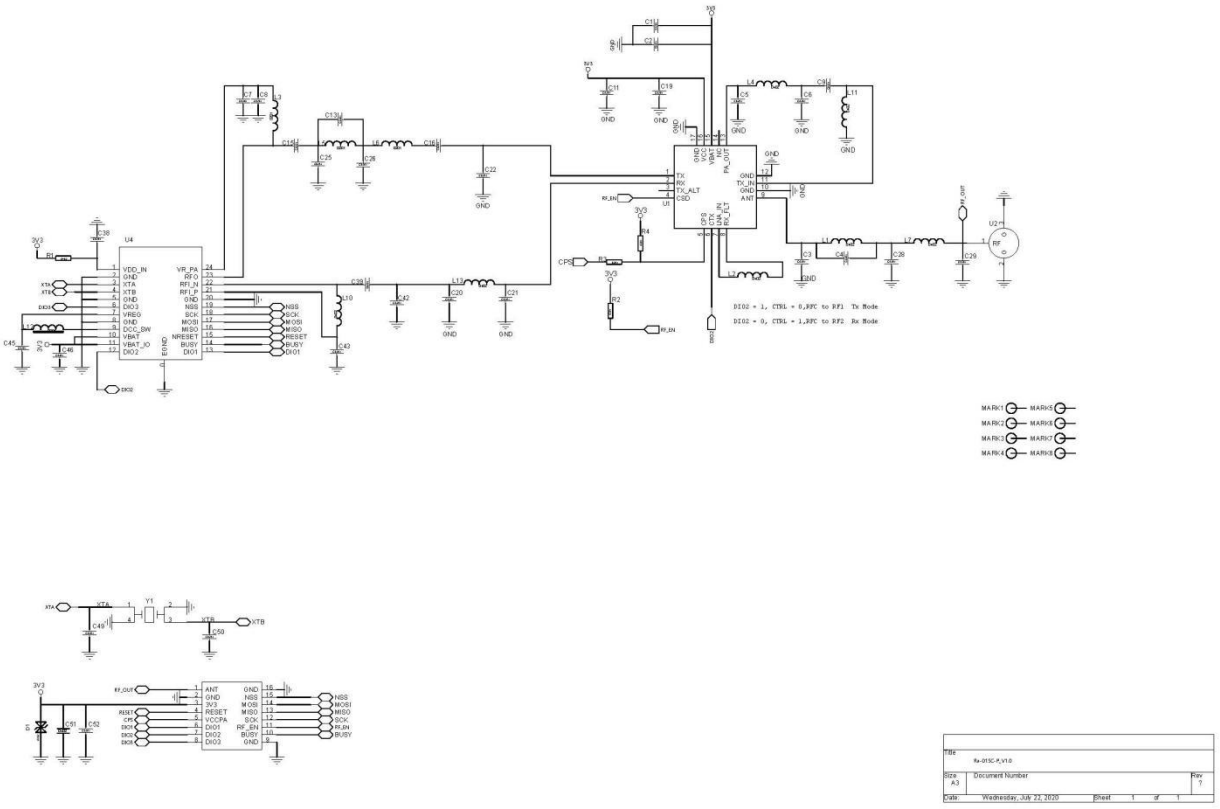

Figure 6 Schematic diagram

6. Design guidance

6.1. Application Guide Circuit

（1）Special pin description

■ About CPS pin

CPS is the TX pass-through control pin of the built-in PA chip of the module, with an internal pull-up resistor of 10K (that is, R F is in PA amplification output mode in the default transmission mode). When the module is in transmission mode:

✓ This pin is high level, and the module's R F is amplified and output by PA;

✓ When this pin is low level, the module's R F is directly output without being amplified by PA;

✓ The logic of this pin is invalid in the receiving state and needs to be set to a low level when low power consumption;

■ About RF_EN pin

RF_EN is the enable pin of the module's built-in PA chip. When the pin is high, the module's RF is in normal transceiver state; when the pin is low, the module's RF function is turned off, which can reduce the module's power consumption.

Table 6 RF switch truth table

Mode	RF_EN
FEM power off	0
FEM working	1

The module defaults to BOM, with an internal pull-up resistor of 10K (i.e., it is in normal amplification and transceiver state by default). If a low-power working scenario is required, please use an external MCU to control this pin to a low level state. When the level is low, the default pull-up resistor of this pin may have leakage current. If the built-in pull-up resistor is not required, please contact Ai-Thinker to modify the BOM.

In summary, the module has two BOM configurations.

Configuration 1. CPS and RF_EN have built-in pull-up resistors of 10K (default BOM configuration)

Configuration 2. CPS and RF_EN have built-in pull-up resistors without mounting, and require IO port control of the peripheral MCU

（2）Typical application circuit

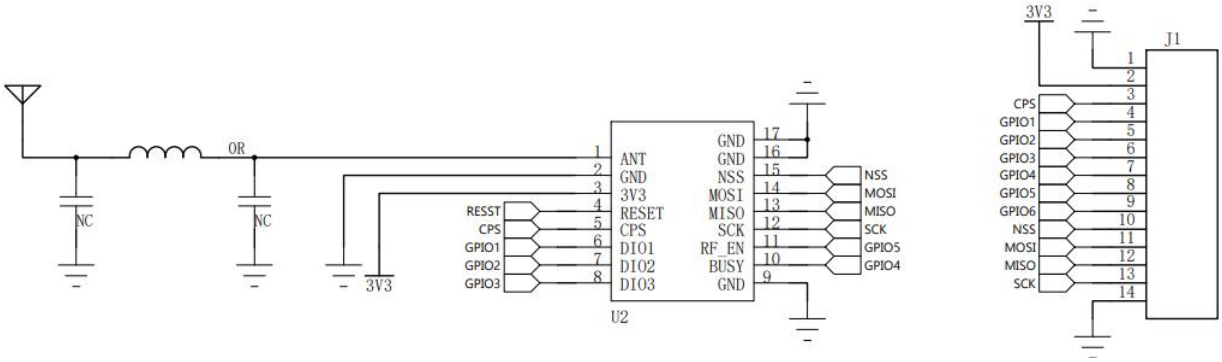

Figure 7 Typical application circuit

- It is recommended that the IO port of the external MCU control the RF_EN of the module to achieve low power consumption application scenarios

（3）Other instruction

- The communication interface with the master MCU, in addition to the SPI interface, also needs to connect BUSY/DIO1 to the IO port of the master MCU.

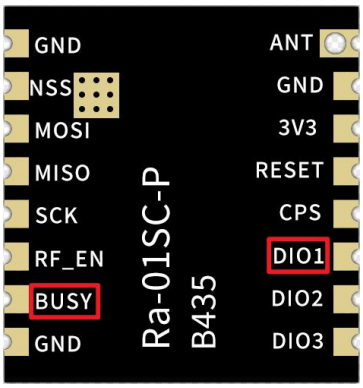

Figure 8 BUSY/DIO1 application considerations

- The antenna is soldered on the main control board. It is recommended to reserve a pie-shaped matching circuit at the antenna interface.

6.2. Recommended PCB package size

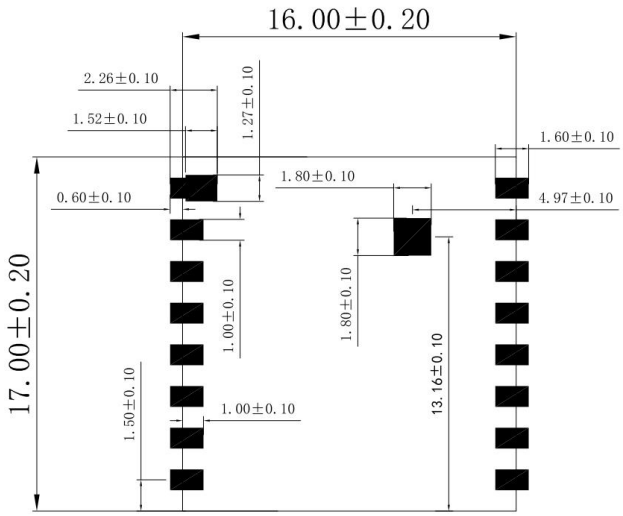

Figure 9 Recommended PCB package dimensions (unit: mm)

6.3. Antenna Installation

- Ra-01S-P requires an external antenna. There is a half-hole pad on the module that can be connected to the mainboard.
- In order for the antenna to achieve the best effect, the antenna should be installed away from metal parts.
- The antenna installation structure has a great impact 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 casing, which will greatly reduce the transmission distance.

6.4. Power supply

- Recommend 3.3V voltage, peak current above 1A.
- If using DC-DC, it is recommended to control the ripple within 100mV.
- It is recommended to reserve a position for dynamic response capacitors in the DC-DC power supply circuit, which can optimize the output ripple when the load changes greatly.
- It is recommended to add ESD devices to the 3.3V power supply interface.
- When designing the power supply circuit for the module, it is recommended to retain more than 30% of the power supply current margin, which is conducive to long-term stable operation of the whole machine.
- 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.

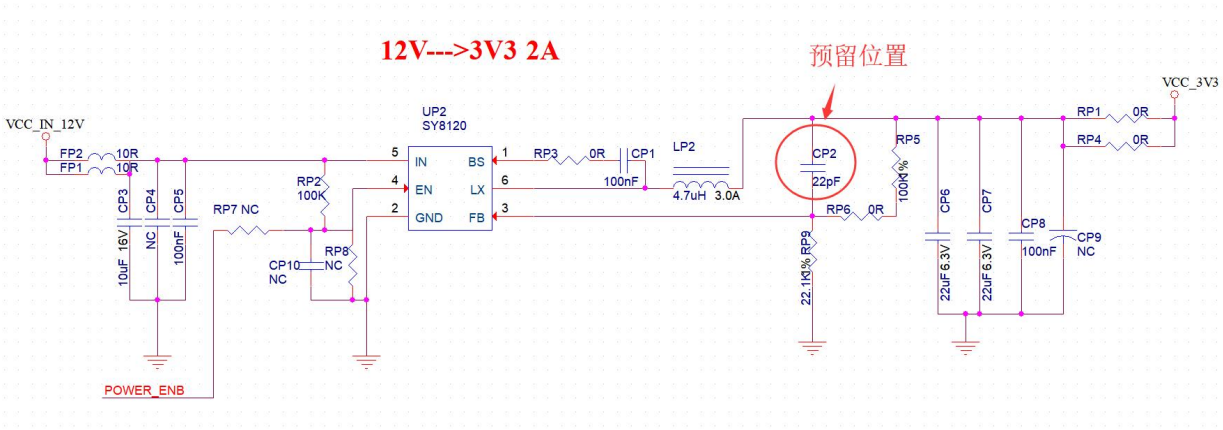

Figure 10 DC-DC buck circuit

6.5. GPIO level conversion

- Some IO ports are led out from the periphery of the module. If you need to use them, it is recommended to connect a 10-100 ohm resistor in series on the IO port. This can suppress overshoot and make the levels on both sides more stable. It is helpful for EMI and ESD.
- For the pull-up and pull-down of special IO ports, please refer to the instructions in the specification, which will affect the startup configuration of the module.
- The IO port of the module is 3.3V. If the IO port level of the main control and the module does not match, a level conversion circuit needs to be added.
- If the IO port is directly connected to the peripheral interface, or terminals such as pin headers, it is recommended to reserve ESD devices near the terminals of the IO port routing.

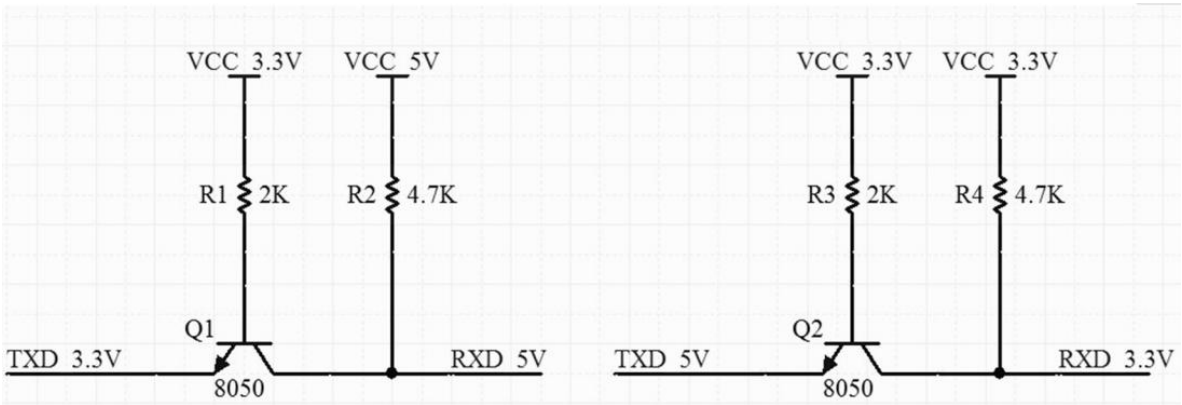

Figure 11 Level conversion circuit

6.6. Software Writing

- The maximum input power of the FEM chip cannot exceed +5dBm, otherwise the FEM chip will be burned. Users need to strictly configure the output power of SX1268, 3dBm-5dBm is recommended.
- This module is SX1268+peripheral circuit, users can operate it completely according to the SX1268 chip manual.
- DIO1/DIO2 is a general IO port that can be configured for multiple functions.
- The control of the RF switch TX/RX can be controlled by an external MCU; it can also be jointly controlled by an external MCU and DIO2 of SX1262.
- Differences between LLCC68 and SX1262/SX1268:

(1) SX1262/SX1268 supports spreading factors SF5, SF6, SF7, SF8, SF9, SF10, SF11, SF12;

SX1262/SX1268 can set the spreading factor and receiving bandwidth

LoRa@ Rx/Tx, BW = 7.8 - 500 kHz,

SF5 TO SF12, BR = 0.018 - 62.5 Kb/S

(2) LLCC68 supports spreading factors SF5, SF6, SF7, SF8, SF9, SF10, SF11;

LLCC68 can set the spreading factor and receiving bandwidth

LoRa@ Rx/Tx，BW = 125 - 250 - 500 kHz,

LoRa@，SF=5-6-7-8-9 for BW=125kHz,

LoRa@, SF=5-6-7-8-9-10 for BW =250 kHz,

LoRa@，SF=5-6-7-8-9-10-11 for BW=500 kHz.

7. FAQ

7.1. Factors affecting transmission distance

- When there is a straight-line communication obstacle, the communication distance will be attenuated accordingly.
- Temperature, humidity, and co-frequency interference will lead to an increase in the communication packet loss rate.
- The ground absorbs and reflects radio waves, so the test effect is poor near the ground.
- Seawater has a strong ability to absorb radio waves, so the test effect is poor at the seaside.
- If there are metal objects near the antenna, or it 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 power supply low voltage at room temperature is lower than the recommended value. The lower the voltage, the lower the power.
- The antenna used is poorly matched with the module or the antenna itself has quality problems.

7.2. Module usage precautions

- 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.
- Check the stability of the power supply. The voltage cannot fluctuate frequently and significantly.
- Ensure anti-static operation during installation and use, and high-frequency components are electrostatically sensitive.
- Ensure that the humidity during installation and use is not too high. 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. Factors that interfere with the module

- There is interference from the same frequency signal nearby, stay away from the interference source or change the frequency or 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.
- Unsatisfactory power supply may also cause garbled code, so the reliability of the power supply must be ensured.
- Poor or too long extension line or feeder line will also cause a high bit error rate.

8. Storage conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere of <40℃/90%RH.

The module's moisture sensitivity level MSL is level 3.

After the vacuum bag is unsealed, it must be used within 168 hours at 25±5℃/60%RH, otherwise it needs to be baked before it can be put online again.

9. Reflow soldering curve

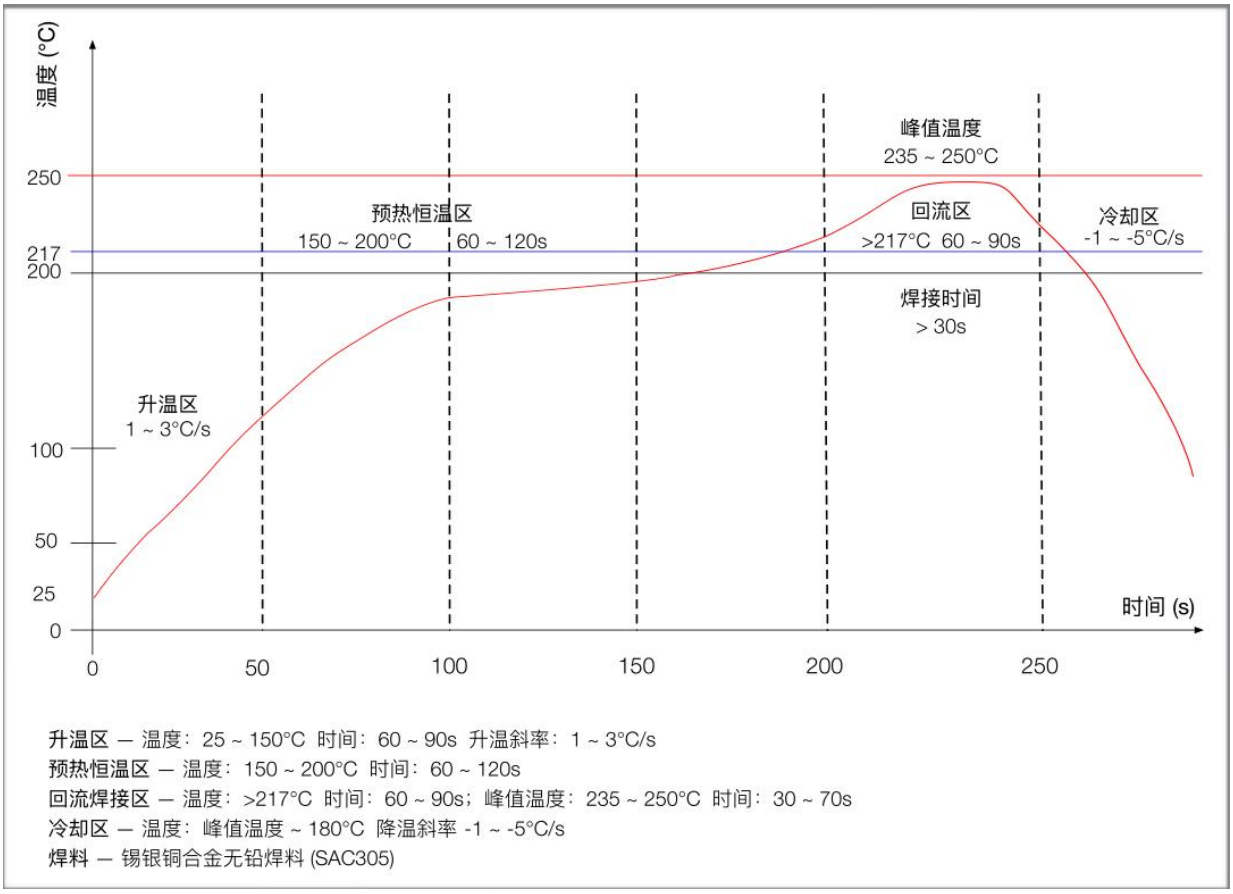

Figure 12 Reflow soldering curve

10. Product packaging information

As shown in the figure below, the packaging of Ra-01S-P is braided tape, 800pcs/reel. As shown in the figure below:

13 Packaging and taping diagram

11.Contact us

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