



Ra-03SCH Specification

Version V1.0.0

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1. Product overview

Ra-03SCH is a LoRa module developed by Shenzhen Ai-Thinker Technology Co., Ltd. This module is used for ultra-long-distance spread-spectrum communication. Its RF chip LLCC68 mainly uses LoRa™ remote modem for ultra-long-distance spread-spectrum communication. It has strong anti-interference and can minimize current consumption. With SEMTECH's LoRa™ patented modulation technology, LLCC68 has a high sensitivity of over -129dBm, a transmit power of +22dBm, a 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, which solves the problem that traditional design schemes cannot take into account distance, anti-interference and power consumption at the same time.

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

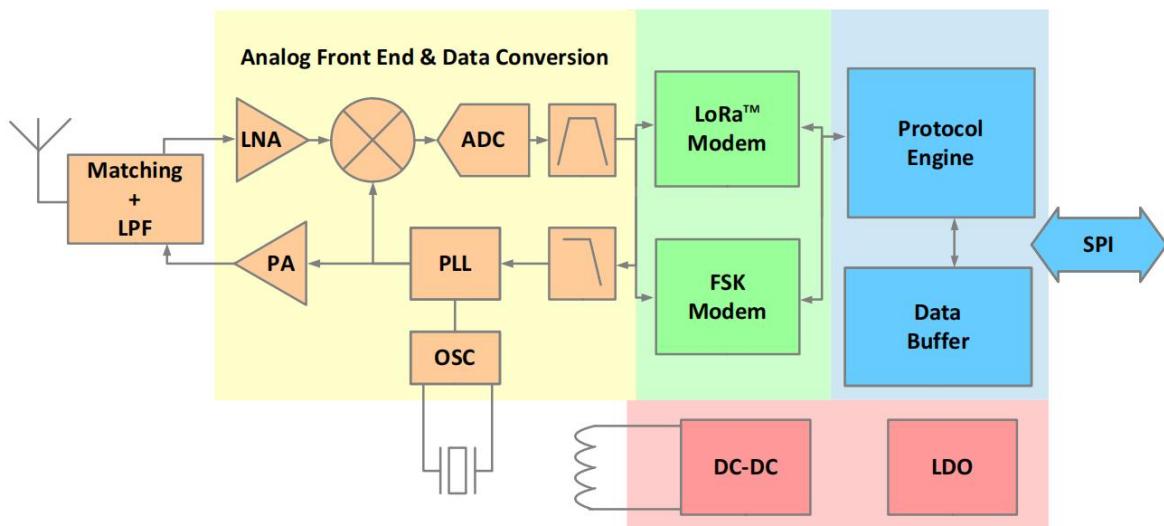


Figure 1 Main chip architecture diagram

1.1. Characteristics

- Support FSK、GFSK、LoRa® modulation method
- Support frequency band 803MHz~930MHz
- The working voltage is 3.3V, the maximum output power is +22dBm, and the maximum working current is 140mA
- Low power consumption in the receiving state, the minimum receiving current is 4.2mA, and the standby current is 0.6mA

- High sensitivity: as low as -129dBm
- Support spreading factor SF5/SF6/SF7/SF8/SF9/SF10/SF11
- Small-volume dual-stamp hole SMD package
- The module adopts SPI interface, using half-duplex communication, with CRC, up to 256 bytes packet engine
- The antenna interface is in the form of a half-hole pad, which can be connected to the motherboard for external antenna

2. Main parameters

Table 1 Description of Main Parameters

Model	Ra-03SCH
Package	SMD-14
Size	18.4*18.4*2.6(±0.2)mm
Antenna	Half Hole Pad
Frequency	803MHz~930MHz
Operating temperature	-40°C ~ 85°C
Storage temperature	-40°C ~ 125°C, < 90%RH
Power supply	Power supply voltage 2.7~3.6V, Typical value 3.3V, Current>200mA
Interface	SPI
Programmable bit rate	Up to 300kbps

2.1. Electrostatic requirements

Ra-03SCH are electrostatic sensitive equipment, special precautions need to be taken when handling.



Figure 2 ESD preventive measures

Tip:

The Ra-03SCH module is an Electrostatic Sensitive Device (ESD) that requires special ESD precautions and should normally be applied to ESD sensitive components. Proper ESD handling and packaging procedures must be employed throughout the handling, shipping and handling of any application incorporating the Ra-03SCH module. Do not touch the module with your hands or use a non-antistatic soldering iron to avoid damage to the module.

2.2. Electrical characteristics

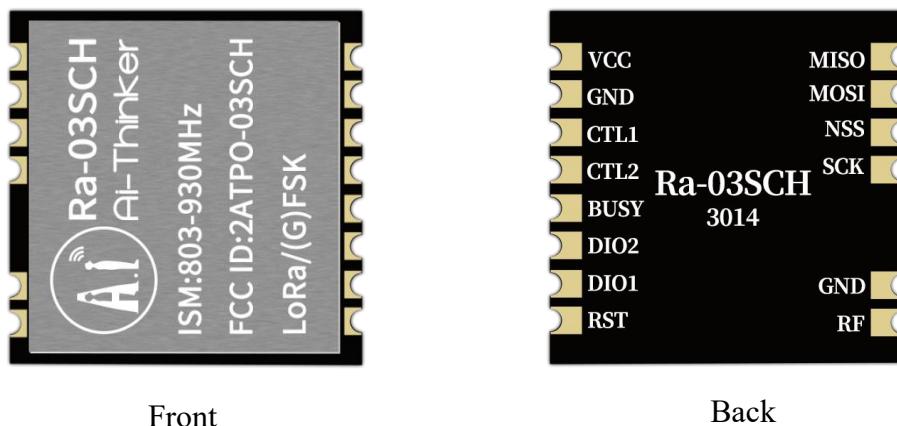
Table 2 Table of Electrical Characteristics

Parameters	Min.	Typical value	Max.	Unit
Supply voltage VCC	2.7	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

Table 3 SPI Interface Features

Symbol	Description	Condition	Min.	Typical	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 build 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 establishment 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 level time of spi access interval	-	20	-	-	ns
T_DAT_A	DATAmaintain and establish time	-	250	-	-	ns
Fsck	SCK frequency	-	-	-	-	ns

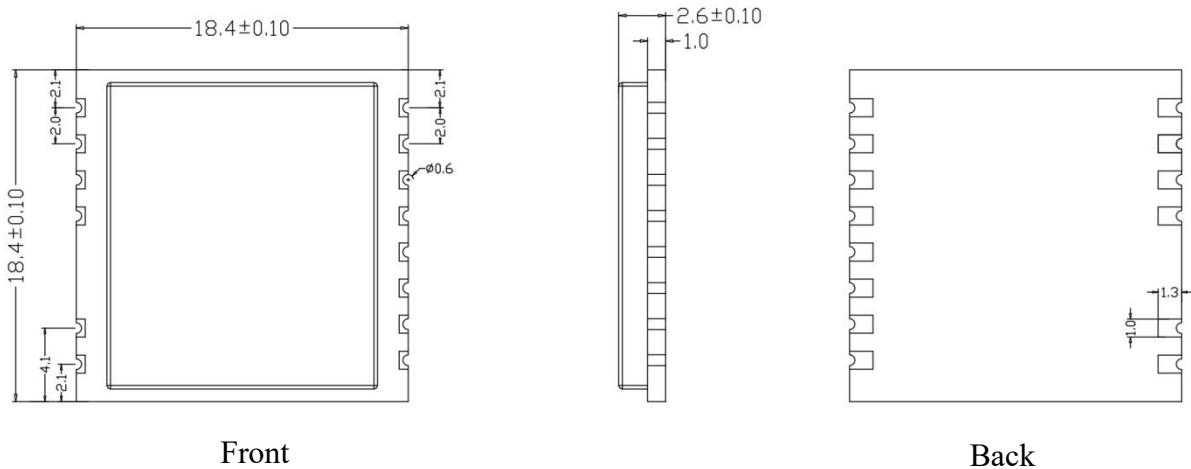
3. Appearance size



Front

Back

Figure 3 appearance diagram (Rendering diagram is for reference only, subject to actual objects)



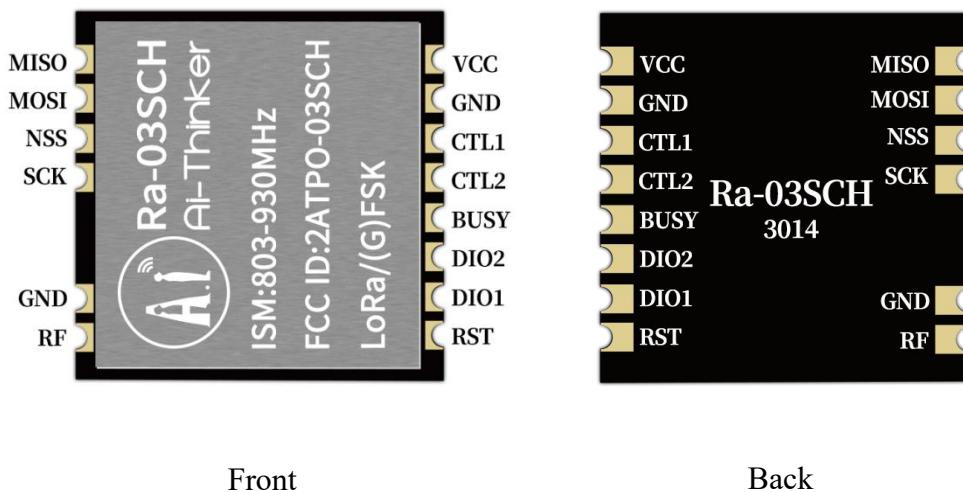
Front

Back

Figure 4 dimension diagram(unit: mm)

4. Pin definition

Ra-03SCH module is connected to 14 interfaces, as shown in the pin diagram, the pin function definition table is an interface definition.



Front

Back

Figure 5 pin diagram

Table 4 Pin Function Definition Table

No.	Name	Functional description
1	MISO	SPI data output
2	MOSI	SPI data input
3	NSS	SPI chip select input
4	SCK	SPI clock input
5	GND	Ground
6	RF	RF output
7	RST	Reset pin, active low
8	DIO1	Digital IO1 software configuration
9	DIO2	Digital IO2 software configuration
10	BUSY	Status indicator pin (Be sure to connect to the IO port of the master MCU)
11	CTL2	RF switch control pin: pin 2, TX:CTL1=0,CTL2=1 RX:CTL1=1,CTL2=0 Sleep:CTL1=0,CTL2=0
12	CTL1	RF switch control pin: pin 1, TX:CTL1=0,CTL2=1 RX:CTL1=1,CTL2=0 Sleep:CTL1=0,CTL2=0
13	GND	Ground
14	VCC	Typical value 3.3V

The general purpose IO pins of LLCC68 are all available in LoRaTM mode.

Their mapping relationship depends on the configuration of the two registers RegDioMapping1 and RegDioMapping2.

Table 5 IO port function mapping table

Operating Mode	DIOx Mapping	DIO2	DIO1
All	00	Fhss Change Channel	RxRimeout
	01	Fhss Change Channel	Fhss Change Channel
	10	Fhss Change Channel	CadDetected
	11	-	-

5. Schematic diagram

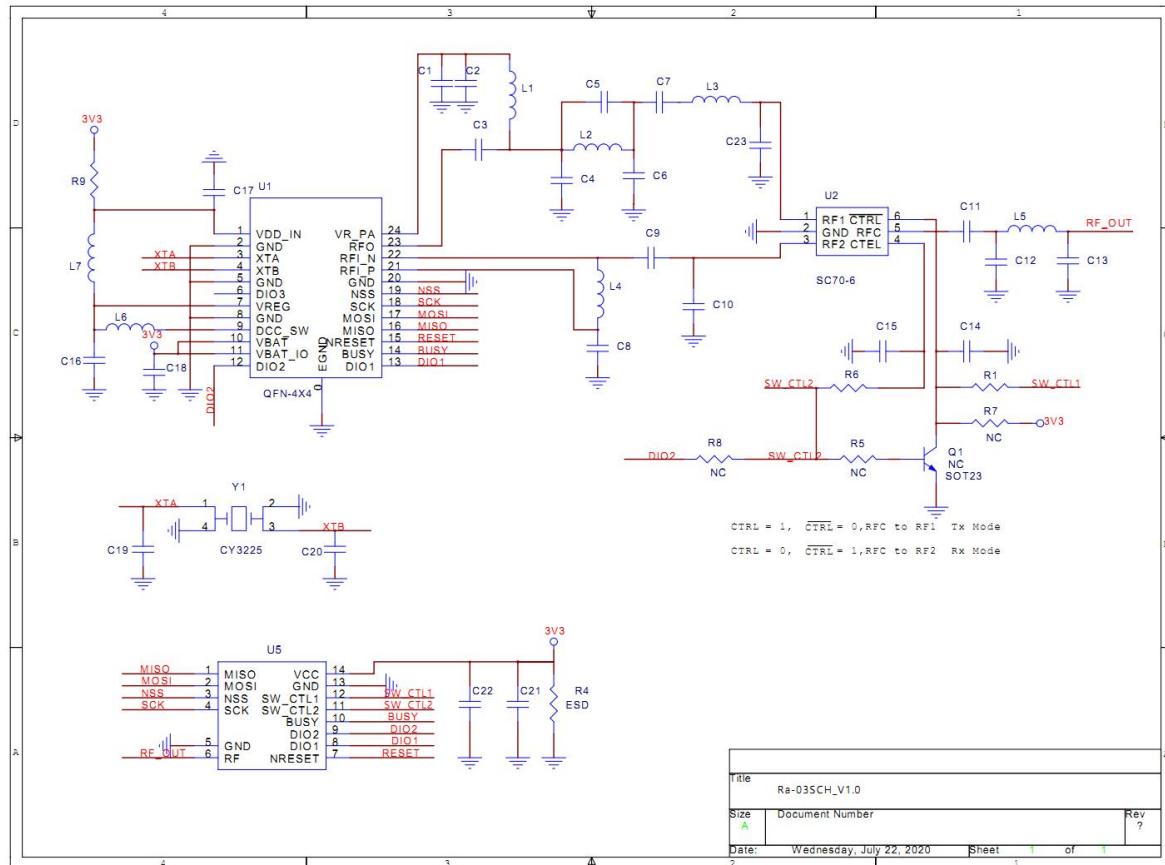


Figure 6 schematic diagram

6. Design guidance

6.1. Application Circuit

(1) Typical application circuit one

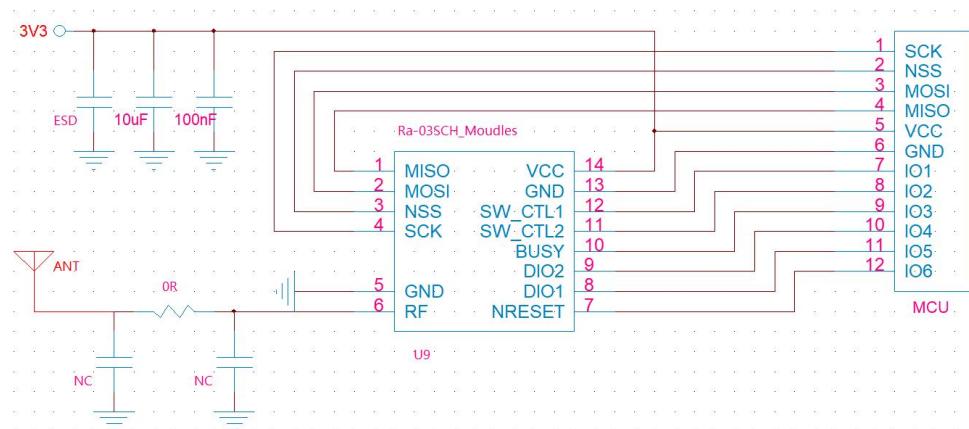


Figure 7 Typical Application Circuit 1

- The RF switch of this circuit is completely controlled by the IO port of the external MCU.

Table 6 RF switch truth table

Model	CTL1	CTL2
Transmit	0	1
Receive	1	0

(2) Typical application circuit two

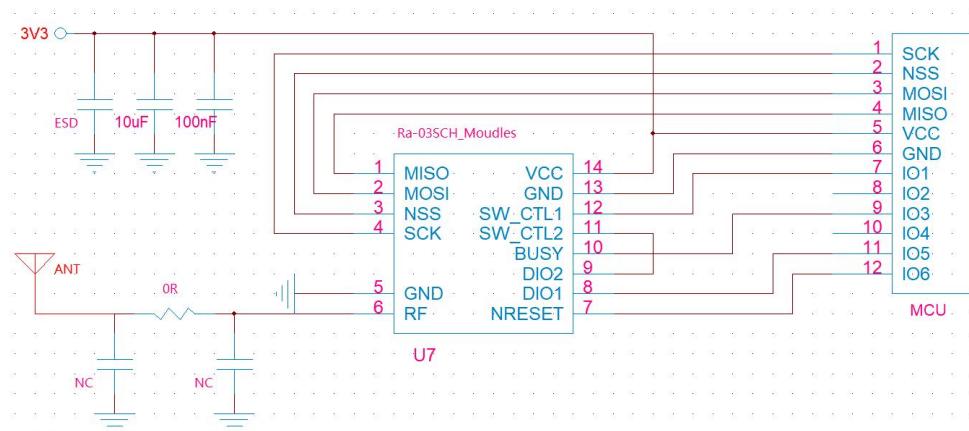


Figure 8 Typical application circuit 2

- The RF switch of this circuit is controlled by the IO port of the external MCU and the DIO2 of the LLCC68. DIO2 needs to be mapped to the SetDIO2AsRfSwitchCtrl function.

Table 7 RF switch truth table

Model	CTL1
Transmit	0
Receive	1

(3) Other instructions

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

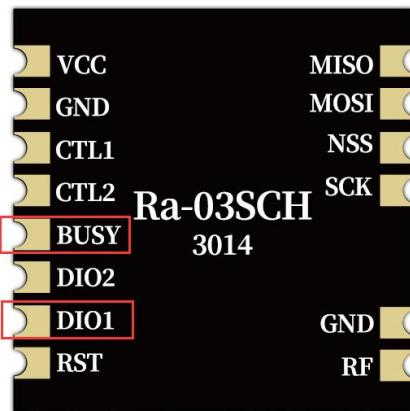


Figure 9 BUSY/DIO1 application notes

- The antenna is welded on the main control board, it is recommended to reserve a pie-type matching circuit at the antenna interface.

6.2. Recommended PCB package size

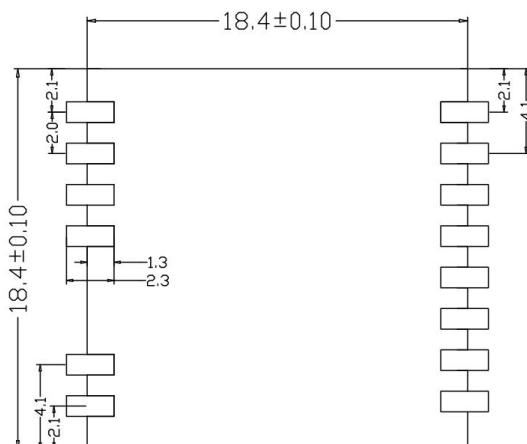


Figure 10 Recommended PCB package dimensions (unit: mm)

6.3. Antenna installation

- Ra-03SCH needs to be used for soldering antennas, the module is compatible with half-hole pads and round-hole pads;
- In order to meet the best antenna effect, the location of the antenna assembly should be far away from the metal parts;
- The antenna installation structure has a great influence on the performance of the module. Make sure that the antenna is exposed, preferably vertically upward. When the module is installed inside the case, you can use a high-quality antenna extension cable to extend the antenna to the outside of the case
- The antenna must not be installed inside the metal shell, which will greatly reduce the transmission distance.

6.4. Power Supply

- Recommended voltage 3.3 V, Peak:Current over 200mA .
- It is recommended to use the LDO power supply; If DC-DC is used, the ripple is controlled within 30 mV.;
- DC-DC power supply circuit is recommended to reserve the position of the dynamic response capacitor, and the output ripple can be optimized when the load change is large.;
- 3.3V power jack advise to add ESD components.;
- When designing the power supply circuit for the module, it is recommended to reserve more than 30% of the power supply current, which is conducive to the 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.

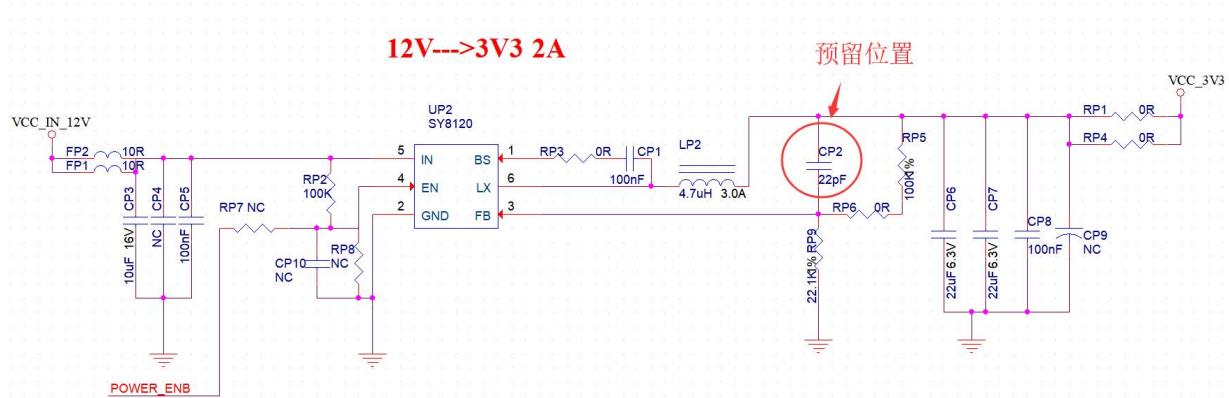


Figure 11 DC-DC step-down circuit

6.5. GPIO

- There are some GPIO ports on the periphery of the module. If you need to use a 10-100 ohm resistor in series with the IO port, it can suppress overshoot and make the levels on both sides more stable, which 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 main control and the IO level of the module do not match, a level conversion circuit needs to be added
- If the IO port is directly connected to a peripheral interface, or a terminal such as a header, it is recommended to reserve an ESD device near the terminal of the IO trace.

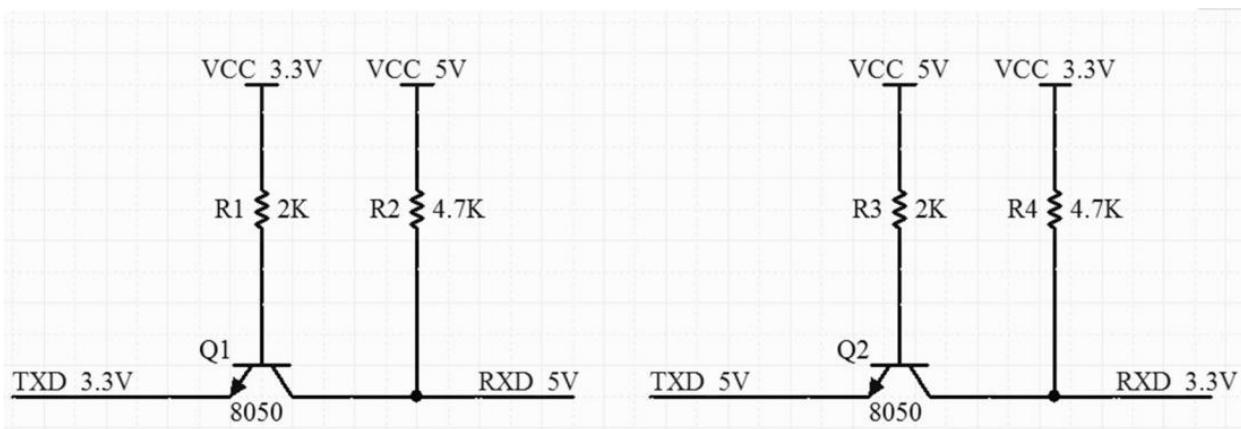


Figure 12 Level conversion circuit

6.6. Software writing

- This module is LLCC68+ peripheral circuit, users can operate according to LLCC68 chip manual
- DIO1/DIO2 are general-purpose IO ports, which can be configured into multiple functions
- The control of the radio frequency switch TX/RX can be controlled by an external MCU; it can also be jointly controlled by an external MCU and DIO2 of LLCC68.
- Different between LLCC68 and SX1262/SX1268:

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

SX1262/SX1268 configurable 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 support spreading factor SF5,SF6,SF7,SF8,SF9,SF10,SF11;

LLCC68 configurable 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 increase the communication packet loss rate.
- The ground absorbs and reflects radio waves, the test effect is poor when it is close to the ground.
- Sea water has a strong ability to absorb radio waves, so the seaside test results are poor.
- If there is a metal object near the antenna or placed in a metal shell, the signal attenuation will be serious.
- Incorrectly set the power register, and the air speed is set too high (the higher the air speed, the closer the distance).
- The low voltage of the power supply at room temperature is lower than the recommended value, the lower the voltage, the lower the power output.
- The poor matching degree of the antenna and the module or the quality of the antenna itself.

7.2. Module use reminder

- Check the power supply to ensure that it is between the recommended supply voltages. If it exceeds the maximum value, it will cause permanent damage to the module.
- Check the stability of the power supply, and the voltage should not fluctuate significantly and frequently.
- Ensure the anti-static operation during installation and use, and the electrostatic sensitivity of high-frequency devices.
- Ensure that the humidity during installation and use should not be too high, and 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. Interfering factors

- There is co-channel signal interference nearby, please stay away from the interference source or modify the frequency and channel to avoid interference.
- The clock waveform on SPI is not standard, please 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 codes, so the reliability of the power supply must be ensured.
- Extension cords and feeders are of poor quality or too long, which 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 at $<40^{\circ}\text{C}/90\%\text{RH}$.

The moisture sensitivity level MSL of the module is 3.

After the vacuum bag is unpacked, it must be used within 168 hours at $25 \pm 5^{\circ}\text{C}/60\%\text{RH}$, otherwise it needs to be baked before it can be put online again.

9. Reflow Soldering Curve

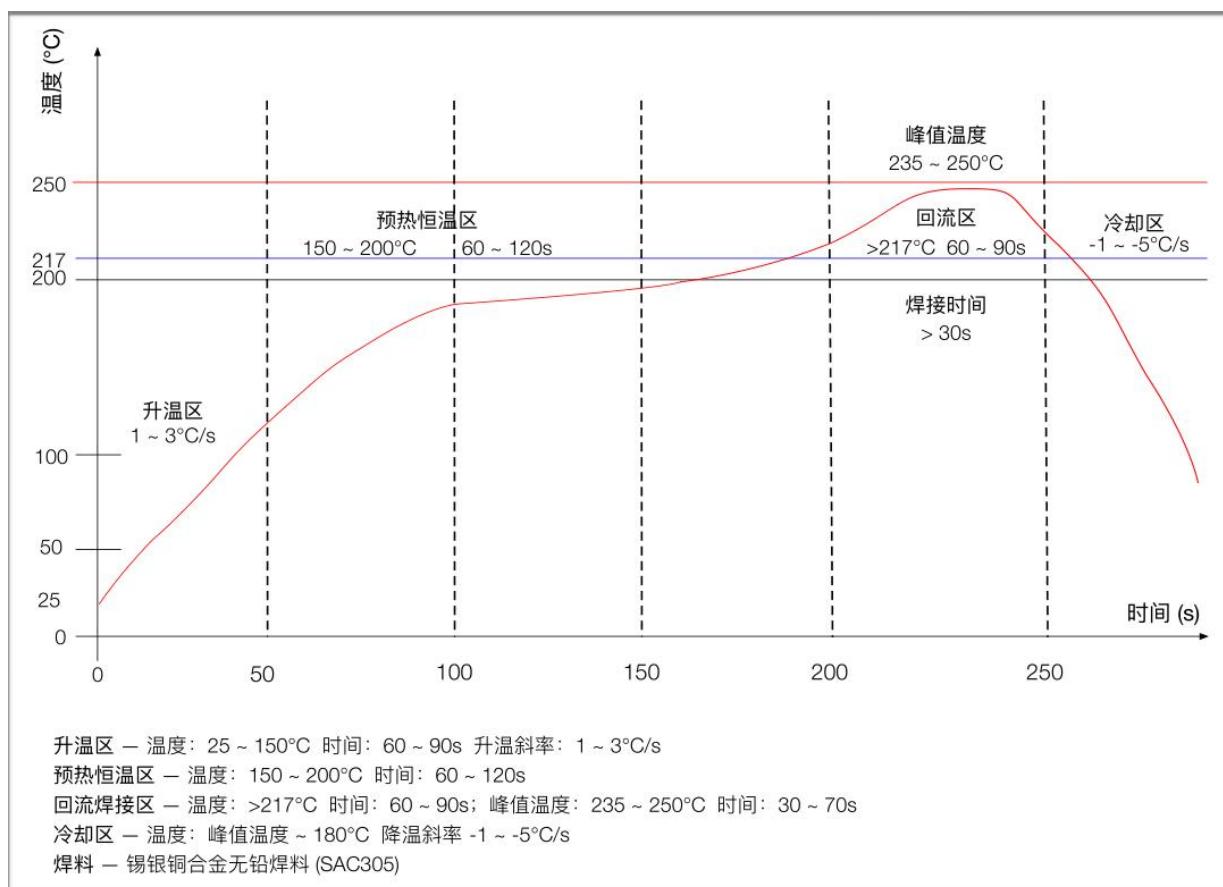


Figure 13 reflow soldering graph

10. Product packaging information

The Ra-03SCH module adopts braided packaging, 800 pcs/disk. As shown in the following figure:



Figure 14 packing tape drawing

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