



# Ra-01SCH Specification

Version V1.1.0

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## Document resume

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## Content

1. Product overview .....	4
1.1. Characteristic .....	5
2. Main parameters .....	6
2.1. Static electricity requirement .....	6
2.2. Electrical characteristics .....	7
3. Appearance Dimensions .....	8
4. Pin definition .....	9
5. Schematic diagram .....	10
6. Design guidance .....	11
6.1. Application circuit .....	11
6.2. Recommend PCB footprint size .....	12
6.3. Installation of antenna .....	12
6.4. Power supply .....	12
6.5. GPIO level switch .....	13
6.6. Software program .....	14
7. FAQ .....	14
7.1. Factors affecting transmission distance .....	14
7.2. Precautions for use of modules .....	15
7.3. Factors that interfere with the module .....	15
8. Storage condition .....	16
9. Reflow welding curve diagram .....	16
10. Product packaging information .....	17
11. Contact us .....	17
Disclaimer and copyright notice .....	18
Notice .....	18

## 1. Product overview

Ra-01SCH is a LoRa series module designed and developed by Ai-Thinker Technology. The module is used for ultra-long-range extended frequency communication, and its radio frequency chip LLCC68 mainly uses LoRa™ remote modem, which is used for ultra long range extended frequency communication. It has strong anti-interference resistance and can minimize current consumption. With the help of SEMTECH's LoRa™ patented modulation technology, the LLCC68 has high sensitivity over-129dBm, + 22dBm transmission power, long range transmission , and high reliability. At the same time, compared with the traditional modulation technology, LoRa™ modulation technology also has obvious advantages in anti-blocking and selection, which solves the problem that the traditional design scheme can not take into account the distance, anti-interference and power consumption simultaneously.

This module can be widely used in automatic meters reading, home building automation, security system, remote irrigation system, etc.

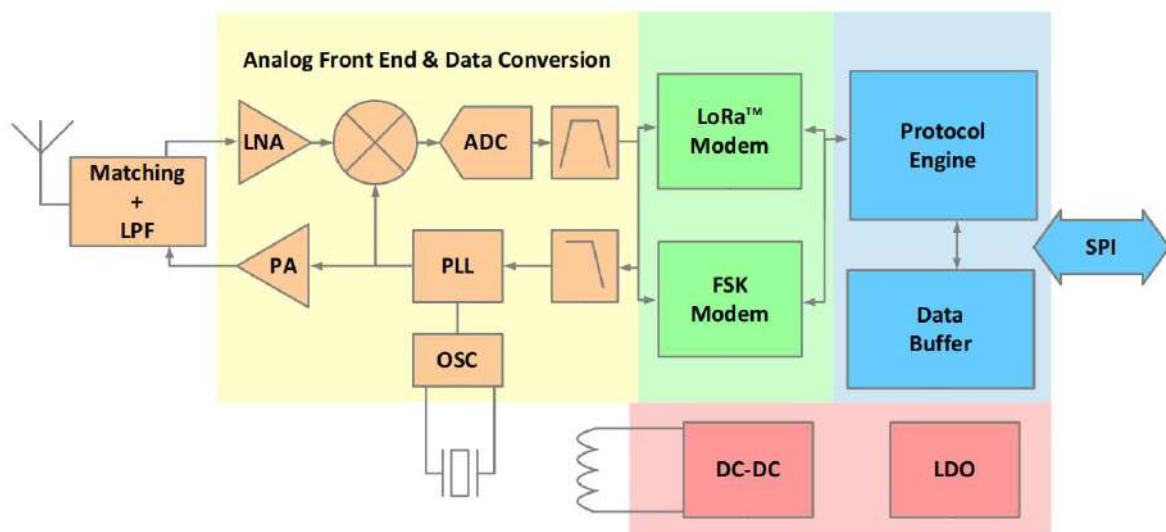


Figure 1 Main chip block diagram

## 1.1. Characteristic

- Support FSK, GFSK, and LoRa® modulation mode
- Support frequency range 803MHz~930MHz
- The operating voltage is 3.3V, the maximum output power is + 22dBm, and the maximum working current is 120mA
- The RX state has low power consumption characteristics, the lowest RX current is 4.2mA, and the standby current is 0.6mA
- High sensitivity: as low as -129dBm
- Support for the expansion factor SF5/SF6/SF7/SF8/SF9/SF10/SF11
- Small volume double-column stamp hole patch package
- The module adopts an SPI interface, half-duplex communication, and with CRC, a packet engine of up to 256 bytes
- The antenna interface is compatible with stamp hole /through-hole and IPEX, which support more scheme selection

## 2. Main parameters

**Table 1 Description of the main parameters**

<b>Model</b>	Ra-01SCH
<b>Package</b>	SMD-16
<b>Size</b>	17.0*16.0*3.2(±0.2)mm
<b>Antenna</b>	Compatible with half-hole pad / through-hole pad (welded antenna required) / IPEX holder
<b>Frequency range</b>	803MHz~930MHz
<b>Operating temperature</b>	-40°C ~ 85°C
<b>Storage temperature</b>	-40°C ~ 125°C, < 90%RH
<b>Power supply</b>	Power supply voltage is 2.7~3.6V, the typical value is 3.3V, and the current is greater than 200mA
<b>Interface</b>	SPI
<b>Programmable bit rate</b>	Up to300kbps

### 2.1. Static electricity requirement

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



**Figure 2 ESD preventive measures**

Note:

The Ra-01SCH module is a static-sensitive device (ESD) that requires special ESD precautions and should usually be applied to ESD-sensitive components. The correct ESD processing and packaging procedures must be used throughout the entire processing, transportation, and operation of any application of the Ra-01SCH module. Do not touch the module by hand or use non-antistatic soliron to avoid damage to the module.

## 2.2. Electrical characteristics

**Table 2 Electrical characteristics table**

Parameters	Min.	Typical value	Max.	Unit
Supply voltage VCC	2.7	3.3	3.6	V
IO Output High Level (VOH)	2.4	-	-	V
IO Output Low Level (VOL)	-	-	0.4V	V
IO Input High Level (VIH)	2.0	-	3.6	V
IO Input Low Level (VIL)	-0.3	-	0.8	V

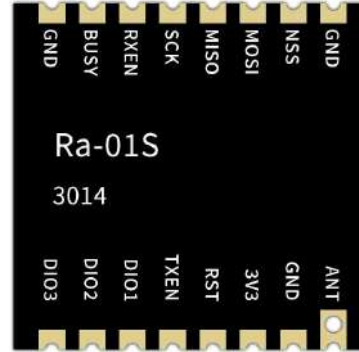
**Tble 3 SPI interface features**

Name	Description	Conditions	Min.	Typical value	Max.	Unit
Fsck	SCK frequency	-	-	-	10	MH
tch	SCK high-level time	-	50	-	-	ns
tcl	SCK low-level time	-	50	-	-	ns
trise	SCK rise time	-	-	5	-	ns
tfall	SCK drop time	-	-	5	-	ns
tsetup	MOSI setting time	Change from MOSI to rising edge of SCK rising	30	-	-	ns
thold	MOSI maintenance time	From SCK rising edge to MOSI change	20	-	-	ns
tnsetup	NSS setting time	From NSS falling edge to SCK rising edge	30	-	-	ns
tnhold	NSS maintenance time	From SCK falling edge to NSS rising edge, normal mode	100	-	-	ns
tnhigh	The NSS high-level interval time for the spi access	-	20	-	-	ns
T_DATA	DATA Maintenance and the setting time	-	250	-	-	ns
Fsck	SCK frequency	-	-	-	-	ns

### 3. Appearance Dimensions

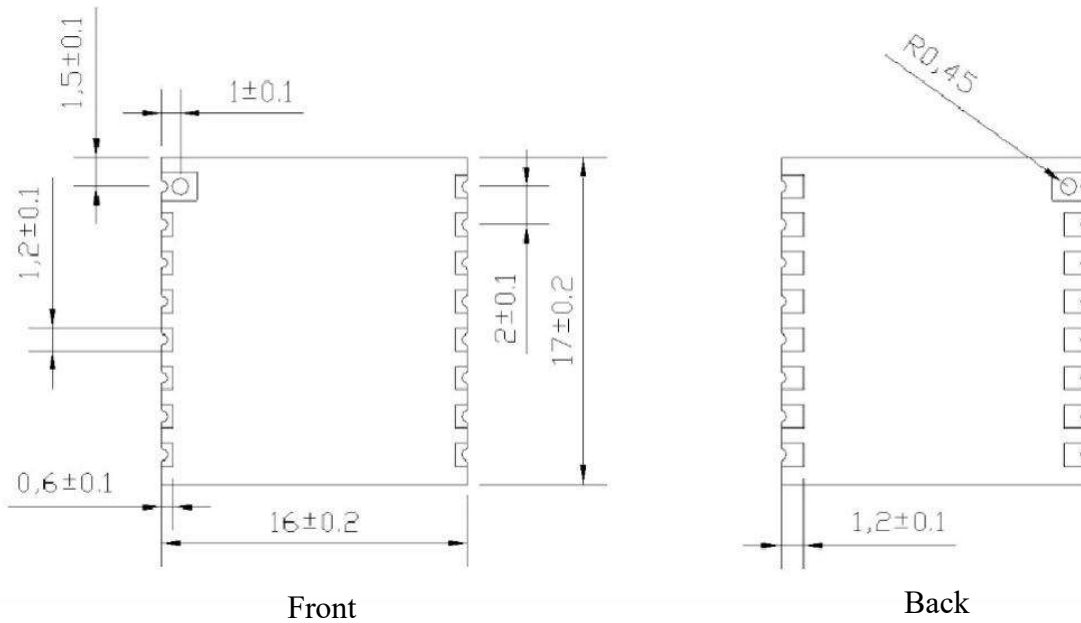


Front



Back

**Figure 3 Appearance diagram(rendering is for reference only, subject to physical objects)**



Front

Back

**Figure 4 Size diagram**



## 4. Pin definition

Ra-01SCH module is connected with a total of 16 pins, as shown in the pin schematic diagram, pin function definition table is the interface definition.



**Figure 5 Schematic diagram of module pins**

**Table 4 Pin function definition table**

No.	Name	Function
1	ANT	Connect antenna
2	GND	Ground
3	3.3V	Typical power supply value 3.3V
4	RESET	Reset pin
5	TXEN	RF control port
6	DIO1	Digital IO1 software configuration
7	DIO2	Digital IO2 software configuration
8	DIO3	Digital IO3 software configuration
9	GND	Ground
10	BUSY	Status indicator pins, which must be connected to the IO port of the master MCU
11	RXEN	RF control port
12	SCK	SPI clock input
13	MISO	SPI data output
14	MOSI	SPI data input
15	NSS	SPI selection input
16	GND	Ground

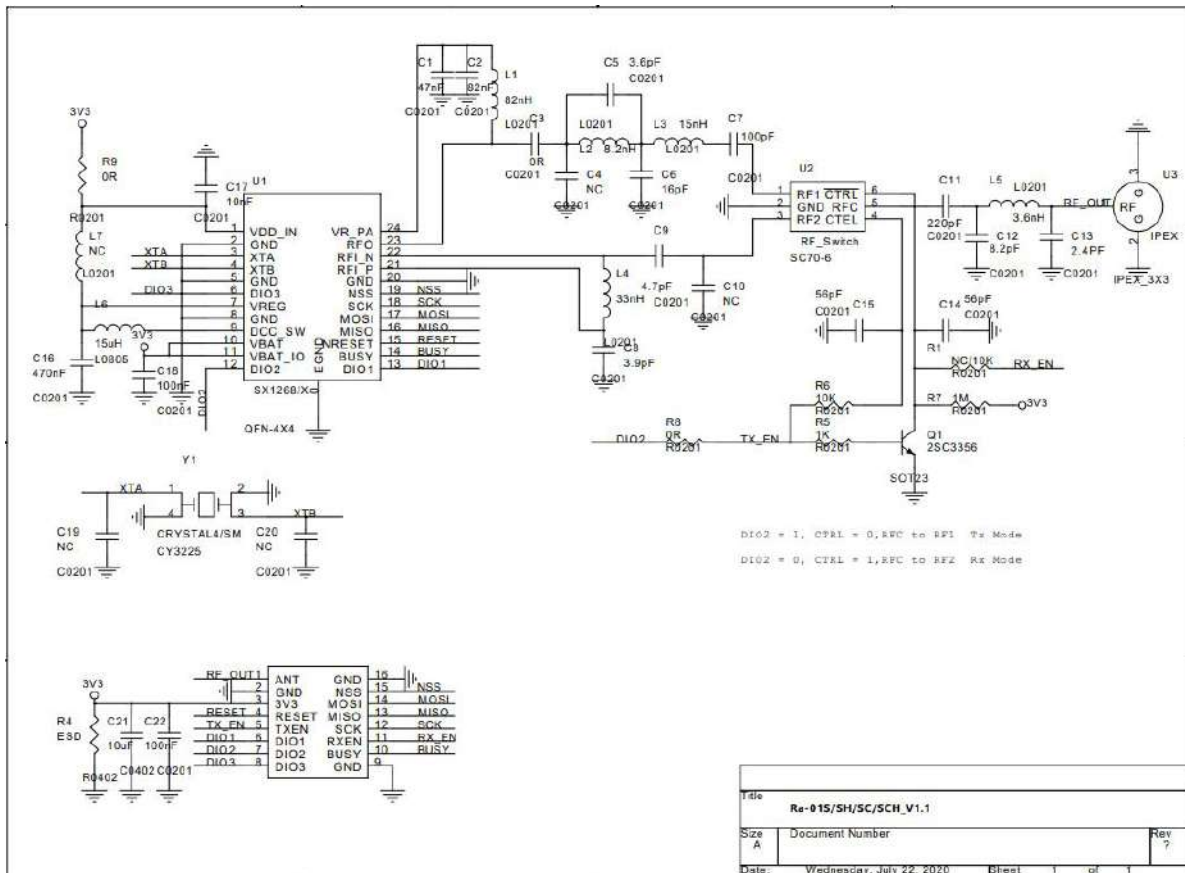
All 3 universal IO pins for LLCC68 are available in LoRa™ mode. Their mapping relationship depends on the configuration of the two registers, RegDioMapping1 and RegDioMapping2.

**Table 5 IO port functional 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 diagram

**Figure 6 Schematic diagram**



## 6. Design guidance

### 6.1. Application circuit

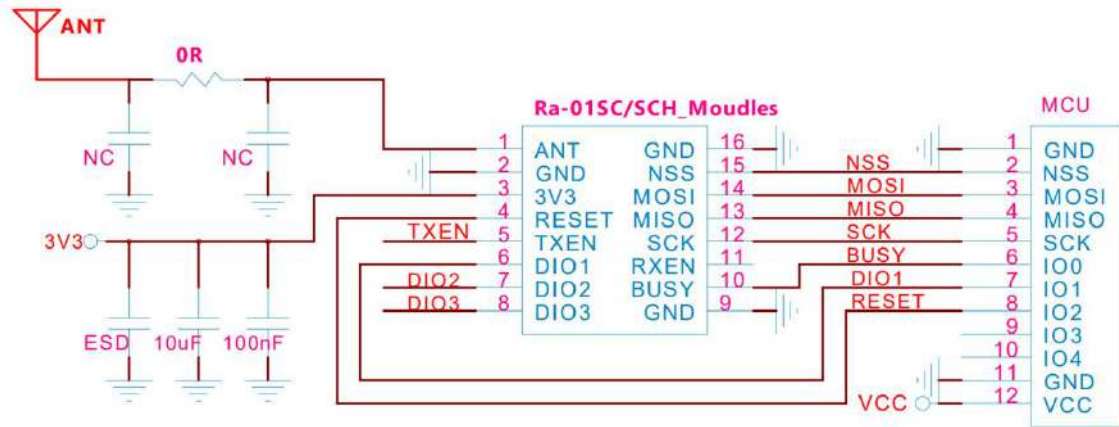


Figure 7 Application circuit diagram

- Communication interface to the master MCU, besides the SPI interface, also require to connect the BUSY / DIO1 to the IO port of the master MCU.

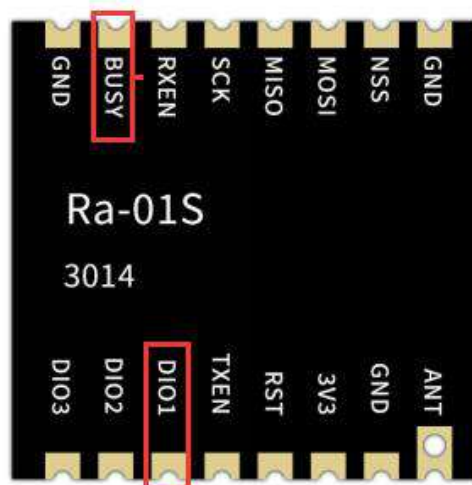


Figure 8 BUSY/DIO1 Application notes

- If the antenna is welded to the main panel, it is recommended to reserve a  $\pi$  type matching circuit at the antenna interface.

## 6.2. Recommend PCB footprint size

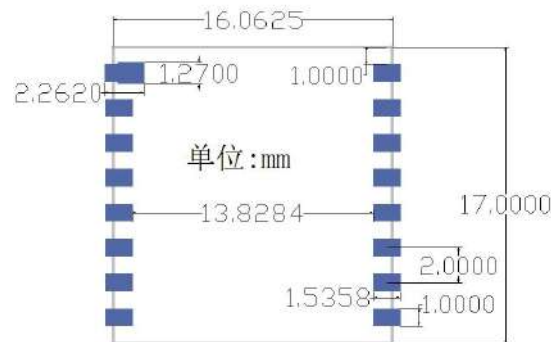


Figure 9 Recommend PCB footprint size

## 6.3. Installation of antenna

- The Ra-01SCH requires a welding antenna, and the module is compatible with a half-hole disc /through-hole disc and an IPEX holder.
- In order to achieve the optimal effect, the antenna assembly should be located far away from the metal parts.
- The antenna installation structure has a great impact on the performance of the module, so make sure that the antenna is exposed, preferably vertical upward. When the module is mounted inside the enclosure, a high-quality antenna extension line can be used to extend the antenna to the outside of the enclosure.
- The antenna must not be installed inside the metal shell, which greatly weakens the transmission distance.

## 6.4. Power supply

- Recommended 3.3V voltage, peak current above 200mA.
- Suggest to use LDO for power supply; if use DC-DC recommend to control the ripple within 30mV.
- The DC-DC power supply circuit proposes to reserve the position of the dynamic response capacitor to optimize the output ripple when the load changes greatly.
- It is recommended to add ESD devices to the 3.3V power interface.
- When designing the power supply circuit for the module, it is recommended to reserve

more than 30% of the power supply current, so that the whole machine can work stably for a long time;

- Please pay attention to the correct connection of the positive and negative poles of the power supply, such as reverse connection may cause permanent damage to the module;

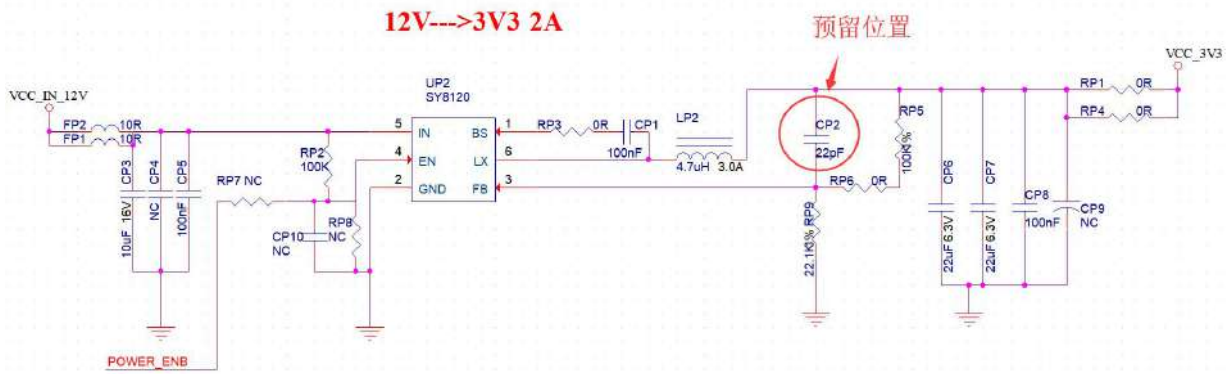


Figure 10 DC-DC step-down circuit

### 6.5. GPIO level switch

- There are some IO ports on the periphery of the module. If you need to use it, it is recommended to connect a 10-100 ohm resistor in series with the IO port. This suppresses overshoot and makes the level on both sides smoother. Helps with both EMI and ESD.
- For the up-down and down-down of the special IO port, please refer to the instruction manual of the specification, which will affect the startup configuration of the module.
- The IO port of the module is 3.3V. If the level of the main control and the IO port of the module does 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 pin header, it is recommended to reserve an ESD device near the terminal of the IO port trace.

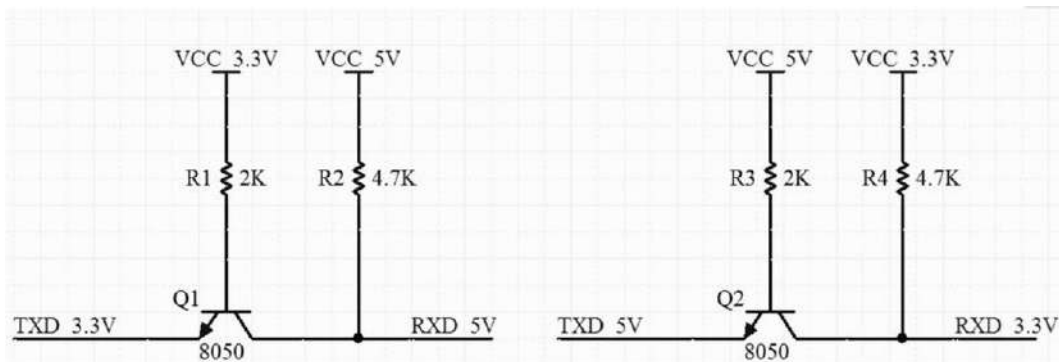


Figure 11 Level convert circuit

## 6.6. Software program

- This module is LLCC68+ peripheral circuit, users can operate according to LLCC68 chip manual.
- DIO1/DIO2/DIO3 are general IO ports, which can be configured into various functions.
- The control of the RF switch TX/RX is done by the internal circuit of the module by default. However, an interface is reserved in the design, which can realize external MCU control. If external MCU control is required, please contact Ai-Thinker technicians to replace the module BOM.

- Differences between LLCC68 and SX1262/SX1268:

(1)、SX1262/SX1268 spreading factor supported SF5,SF6,SF7,SF8,SF9,SF10,SF11,SF12;  
SX1262/SX1268 configurable spreading factor and receive bandwidth:

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

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

(2)、LLCC68 spreading factor supported SF5,SF6,SF7,SF8,SF9,SF10,SF11;  
LLCC68 configurable spreading factor and receive 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-channel interference will increase the communication packet loss rate;
- The ground absorbs and reflects radio waves, and the test effect close to the ground is poor;
- Seawater has a strong ability to absorb radio waves, so the seaside test effect is poor.

- There are metal objects near the antenna, or 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 low voltage of the power supply at room temperature is lower than the recommended value, the lower the voltage, the lower the output power:
- The use of the antenna and the module has poor matching degree or the quality of the antenna itself.

## 7.2. Precautions for use of modules

- Check the power supply to ensure that it is between the recommended supply voltages, if exceeding the maximum value will cause permanent damage to the module.
- Check the stability of the power supply, the voltage should not fluctuate greatly and frequently.
- Ensure anti-static operation during installation and use, and electrostatic sensitivity of high-frequency components.
- 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. Factors that interfere with the module

- There is co-frequency signal interference nearby, stay away from the interference source or modify the frequency and 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 characters, be sure to ensure the reliability of the power supply;
- Poor quality or too long extension lines and feeders will also cause a high bit error rate;

## 8. Storage condition

Products sealed in moisture-proof bags should be stored in a non-condensing atmosphere <math><40^{\circ}\text{C}/90\%\text{RH}</math>.

The module's moisture sensitivity level MSL is level 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 will need to be baked before going online again.

## 9. Reflow welding curve diagram

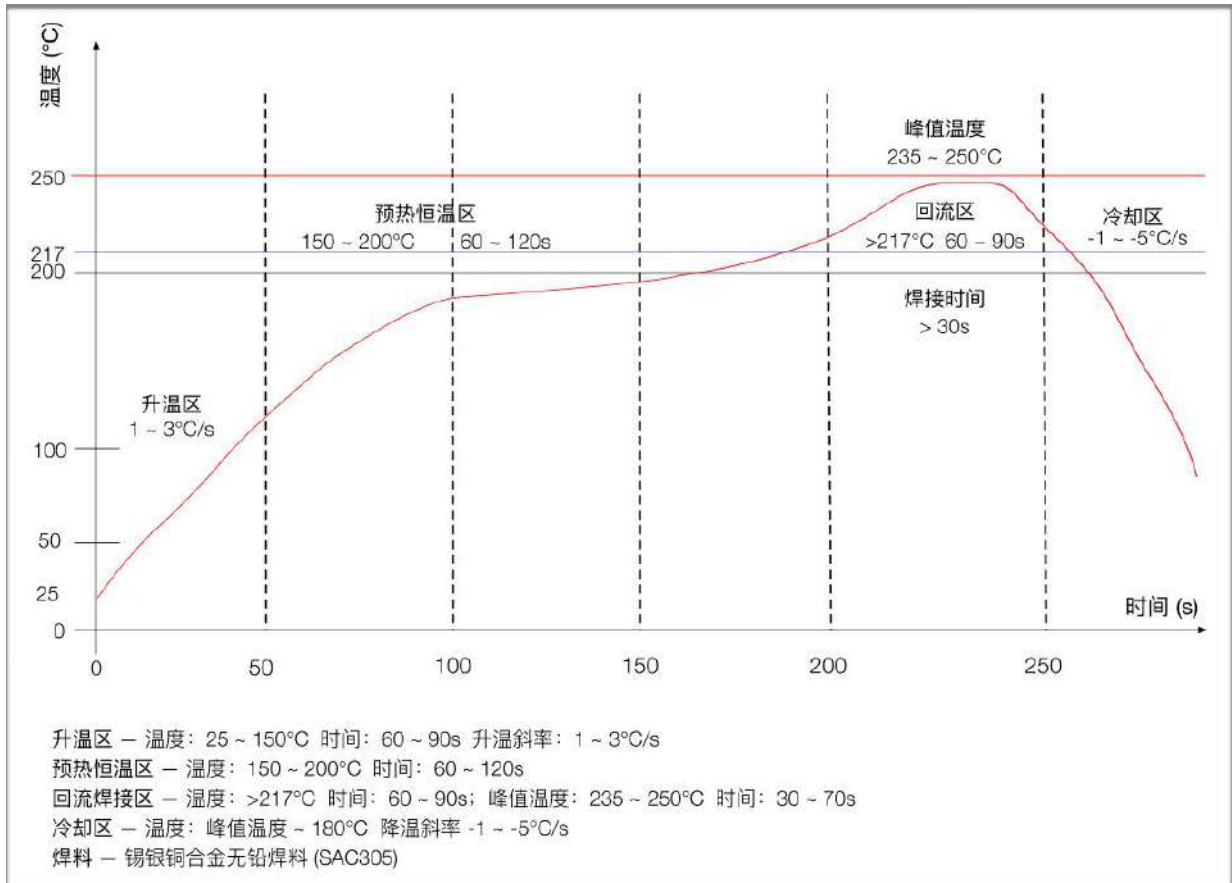


Figure 12 Reflow welding diagram



## 10. Product packaging information

Ra-01SCH module was packaged in a tape, 800pcs/reel. As shown in the below image:



Figure 13 Package and packing diagram

## 11. Contact us

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