Ra-09H Specification

Version V1.0.0

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Document Resume

Version	Date	Develop/revise content	Edition	Approve
V1.0.0	2024.01.11	First Edition	Shengzin Zou	Ning Guan

Content

1. Product Overview

Ra-09H is a LoRa module designed and developed by Shenzhen Ai-Thinker Technology Co., Ltd. This module is used for ultra-long distance spread spectrum communication. Its chip STM32WLE5CCU6 is a general-purpose LPWAN wireless communication SoC that integrates RF transceivers, modems and 32 -bit Arm® Cortex®-M4 MCU. The MCU uses an ARM core and operates at a frequency of up to 48MHz. The Ra-09H module supports LoRa modulation and traditional (G)FSK modulation under LPWAN use cases; at the same time, the transmitter also supports BPSK modulation and (G)MSK modulation, and the receiver supports (G)MSK modulation.

The Ra-09H module provides ultra-long range and ultra-low power communication for LPWAN applications and can be widely used in smart meters, supply chain and logistics, home building automation, security systems, remote irrigation systems and other scenarios.
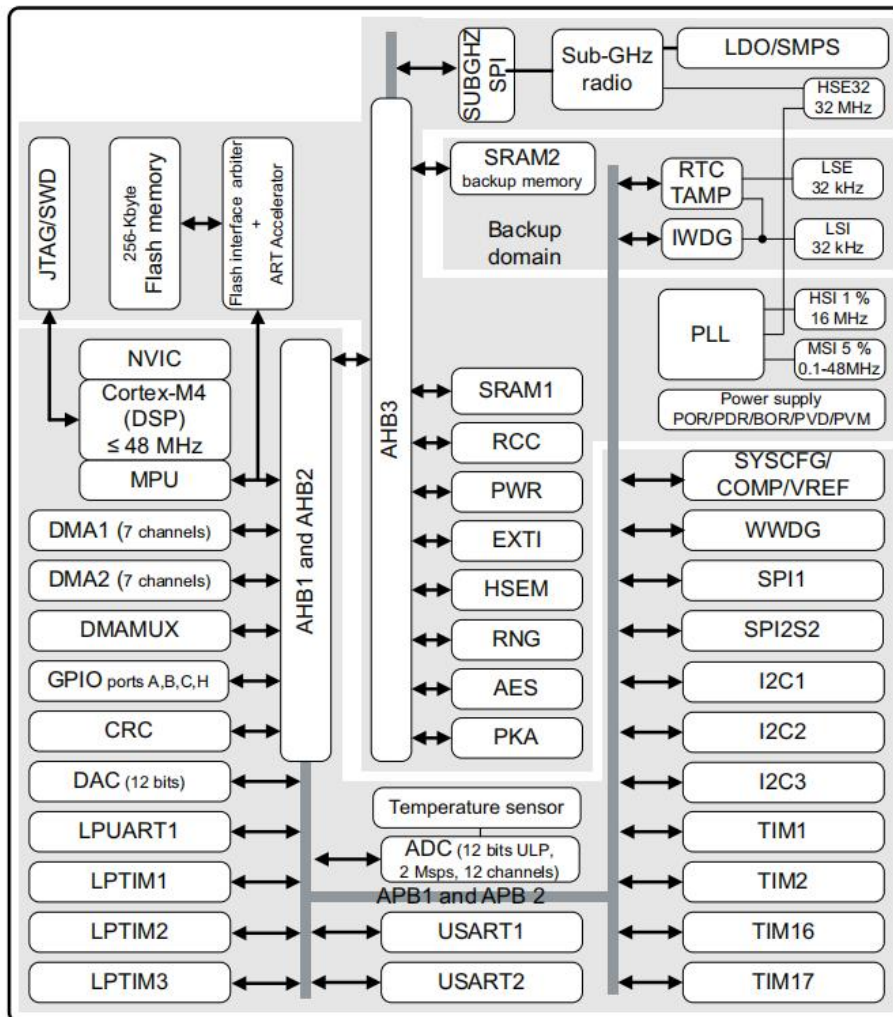
Figure 1 Main chip architecture diagram

1.1. Characteristic

- SMD- 48 package

- Supported frequency bands: 803MHz- 930MHz

- Working voltage is 3.3V, theoretical maximum transmit power +22dBm

- High sensitivity: -140dBm @125K H z SF12

- Support spreading factor SF5/SF6/SF7/SF8/SF9/SF10/SF11/SF12

- Embedded memory, 256KB FLASH, 64KB RAM

- Support LoRa/(G)FSK/BPSK/(G)MSK modulation

- The antenna interface is a half-hole pad and IPEX connector, which supports a variety of external antenna connection methods and supports more solution selections.

- Supports multiple sleep modes: deep sleep current 0.1μ A

2. Main Parameters

Table 1 Description of Main Parameters

Module Model	Ra-09H
Package	SMD-48
Size	18.0*18.0* 2.6 (±0.2)mm
Antenna Form	Compatible with half-hole pad/IPEX connector
Frequency Range	803-930 MHz
Operating Temperature	-40℃~85℃
Storage Environment	-40 ℃ ~ 125 ℃ , < 90%RH
Power supply range	Supply voltage 1.8 V ~ 3.6V, supply current >500mA
Support interface	UART/GPIO/ADC/DAC/I2C/I2S/SPI/PWM
IO	24
Serial port speed	Support 110 ~ 4608000 bps, default 9600bps
Crystal frequency	32MHz
Flash	256 KB
Transfer Protocol	LoRaWAN
Transmission distance	Open space with suction cup antenna can reach 4.8km

2.1. Static Electricity Requirements

Ra-09H module is an electrostatic sensitive device and requires special precautions when handling.

Figure 2 ESD preventive measures

2.2. Electrical Characteristics

Table 2 Electrical Characteristics Table

Parameter	Name		Min.	Typ.	Max.	Unit	Remark
Operating	TOPR		-40	25	85	℃	
Supply voltage	VDD		1.8	3.3	3.6	V	≥3.3V guarantees output power
Power consumption	Sleep mode	Power consumption1	-	0.113	-	μA	Deep Sleep (LDO and SMPS regulator off, MCU regulator off)
		Power consumption 2	-	0.2	-	μA	STANDBY (without RTC)
	Operating mode		-	3.83	-	mA	Power on
	Full load mode（TX:22dBm）		-	11 9	-	mA	DC-DC mode
	receive mode (RX:SF9)		-	5.15	-	mA	DC-DC mode

2.3. Digital Port Characteristics

Table 3 Digital Ports

Type	Name	Minimum value	Typical value	Maximum value	unit
IO level (VDD)	VIO	1.8	3.3	3.6	V
Input logic level is low	VIL	-	-	VDD*0.3	V
Input logic level is high	VIH	0.7*VDD	-	-	V
Output logic level is low	VOL	-	-	0.4 (| IO| = 8 mA, VDD ≥ 2.7 V)	V
Output logic level is low	VOL	-	-	1.3 (|IO | = 20 mA, VDD ≥ 2.7 V)	V
Output logic level is high	VOH	VDD-0.45	-	-	V

2.4. RF Parameters

Table 4 RF parameters

Output Power					
PA parameters	**Frequency band**	**Minimum value**	**Typical value**	**Maximum value**	**Unit**
Transmit power	870MHz	-	2 0.5	twenty two	dBm
Transmit power	890MHz	-	2 0.5	twenty two	dBm
Transmit power	91 0MHz	-	2 0.5	twenty two	dBm
Transmit power	925MHz	-	2 0.5	twenty two	dBm
Receive Sensitivity Modulation bandwidth 125kHz					
Model		**Minimum value**	**Typical value**	**Maximum value**	**Unit**
SF7		-	-123	-	dBm
SF8		-	-126	-	dBm
SF9		-	-128	-	dBm
SF10		-	-131	-	dBm
SF11		-	-135	-	dBm
SF12		-	-1 40	-	dBm

3. Dimension
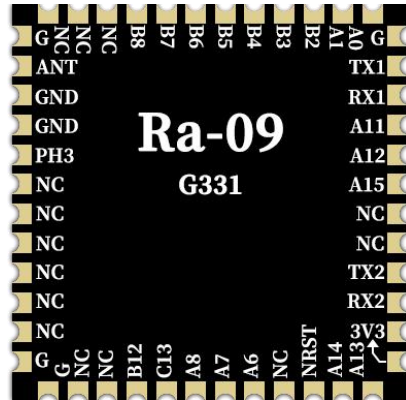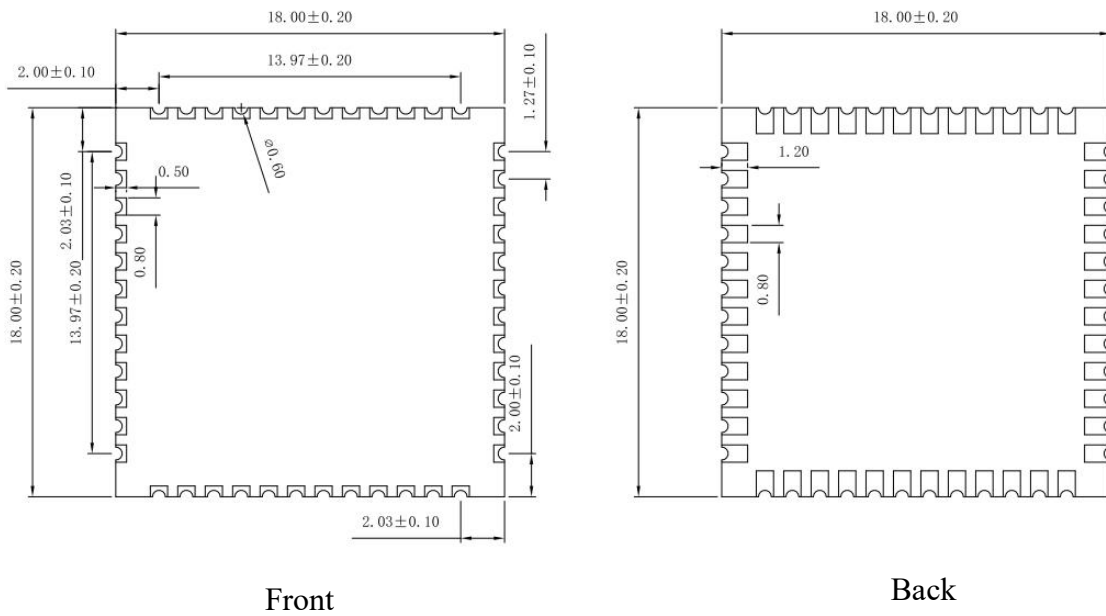

Front   Back

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

Front   Back

Figure 4 Module size diagram

4. Pin Definition

The Ra-09H module has a total of 48 pins, as shown in the pin diagram and the pin function definition table is the interface definition.
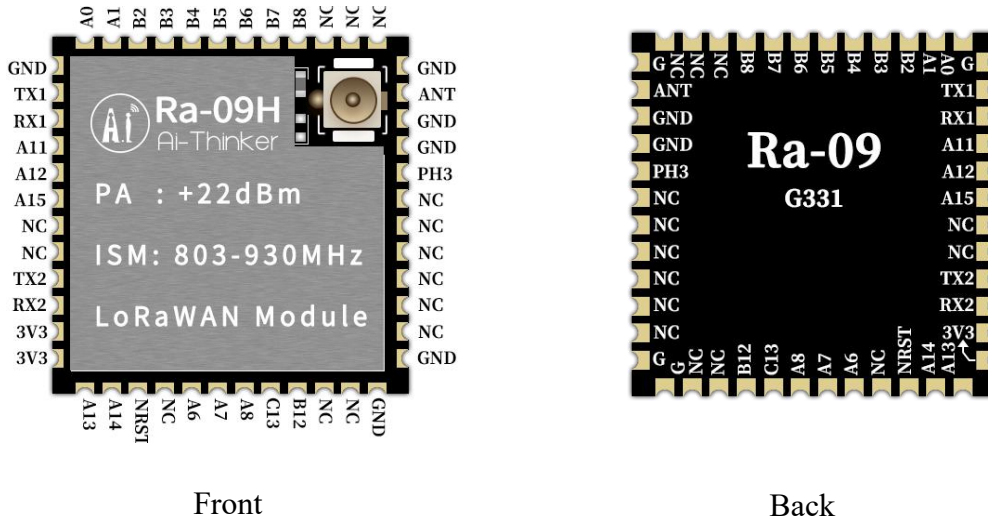

Front   Back

Figure 5 Module pin diagram

Table 5 Module startup mode description

System startup mode			
Pin	**Default**	**SPI boot mode**	**Download boot mode**
PH3	drop down	0	1

Note: Some pins have been pulled up internally, please refer to the schematic .

Table 6 Pin function definition table

Pin	Name	Function Description
1, 2, 3, 19, 20, 28 , 34, 35, 38-43	NC	Not connected
4	PB8	PB8/I2C1_SCL/PWM
5	PB7	PB7/I2C1_SDA
6	PB6	PB6/I2C1_SCL
7	PB5	PB5/SPI1_MOSI
8	PB4	PB4/SPI1_MISO/ADC_IN3
9	PB3	PB3/ADC_IN2/SPI1_SCK
10	PB2	PB2/SPI1_NSS/ADC_IN4
11	PA1	PA1/SPI1_SCK
12	PA0	PA0
13，36-37，45-46，48	GND	Ground
14	TX1	PA9/UART1_TX/I2C1_SCL/SPI2_SCK/I2S2_CK
15	RX1	PA10/UART1_RX/DAC_OUT1/ADC_IN6/I2C1_SDA
16	PA11	PA11/I2C2_SDA/SPI1_MISO/PWM/ADC_IN7
17	PA12	PA12/I2C2_SCL/SPI1_MOSI/ADC_IN8
18	PA15	PA15/I2C2_SDA/SPI1_NSS/ADC_IN11
21	TX2	PA2/UART2_TX
22	RX2	PA3/ UA RT2_RX/I2S2_MCK
23-24	3V3	3.3V power supply, recommended power supply current
25	PA13	PA13/ADC_IN9
26	PA14	PA14/ADC_IN10
27	NRST	NRST external reset, active low
29	PA6	PA6/SPI1_MISO
30	PA7	PA7/I2C3_SCL/SPI1_MOSI/PWM
31	PA8	PA8/SPI2_SCK/I2S2_CK
32	PC13	PC13
33	PB12	PB 12/SPI2_NSS/I2S2_WS
4 4	PH3	PH3/BOOT0
47	ANT	Antenna interface

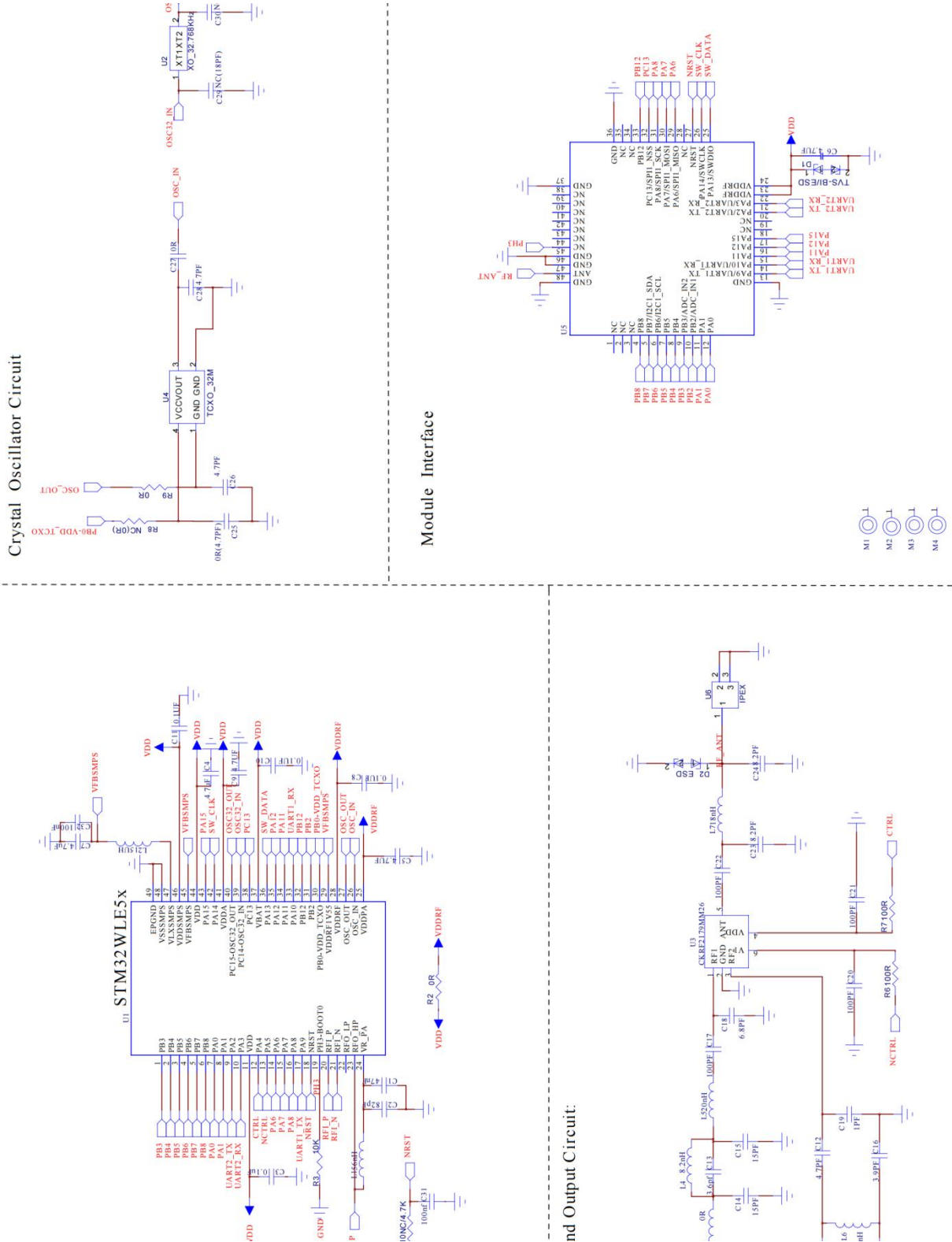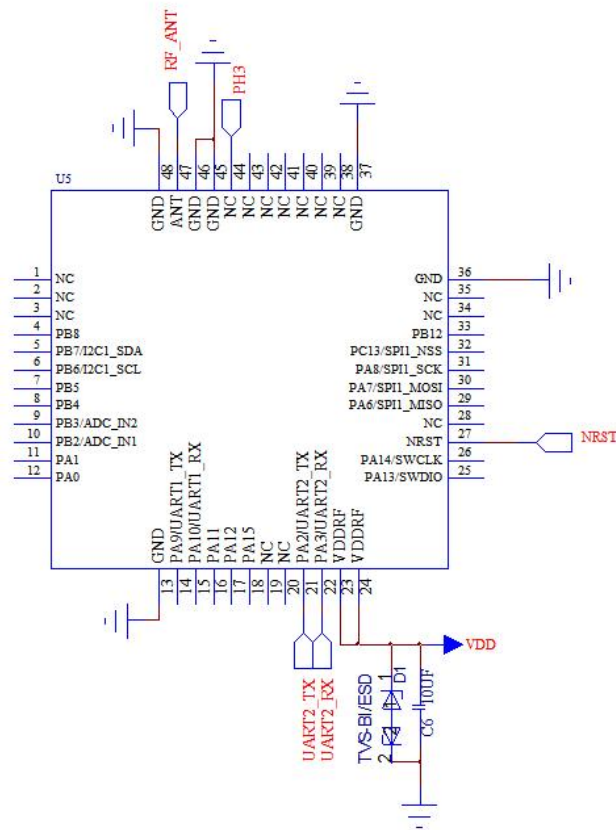# 5. Schematic Diagram

Figure 6 Module schematic diagram

6. Design Guidance

6.1. Module Application Circuit Guidance

(It is recommended to use DC-DC or LDO for independent power supply, with a current greater than 500mA)

Figure 7 Application circuit diagram

Notice:

■ PH3 is the startup control pin. It is in the normal working mode when the level is low, and it is in the firmware burning mode when the level is high. The chip internal default is low level.

6.2. Antenna Interface

■ The Ra-09H module requires an external antenna. The antenna has two wiring methods, which are compatible with half-hole pads and IPEX sockets. The module has a standard IPEX socket interface. The dimensions of the IPEX seat are as follows:
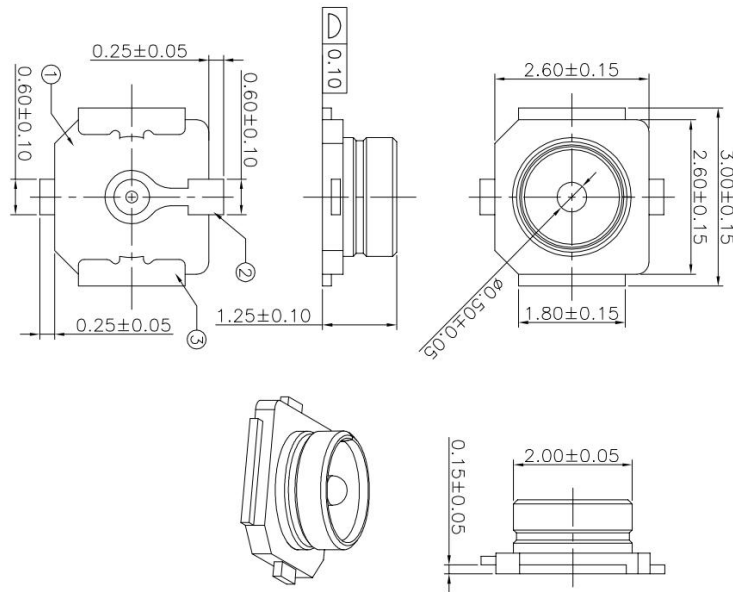
Figure 8 Dimensional drawing of the IPEX seat at the board end

6.3. Power Supply

■ Recommended voltage is 3.3V, peak current is above 500mA.

■ It is recommended to use LDO for power supply; if DC-DC is used, it is recommended that the ripple be controlled within 30mV.

■ It is recommended to reserve the position of dynamic response capacitor in DC-DC power supply circuit, which can optimize the output ripple when the load changes greatly.

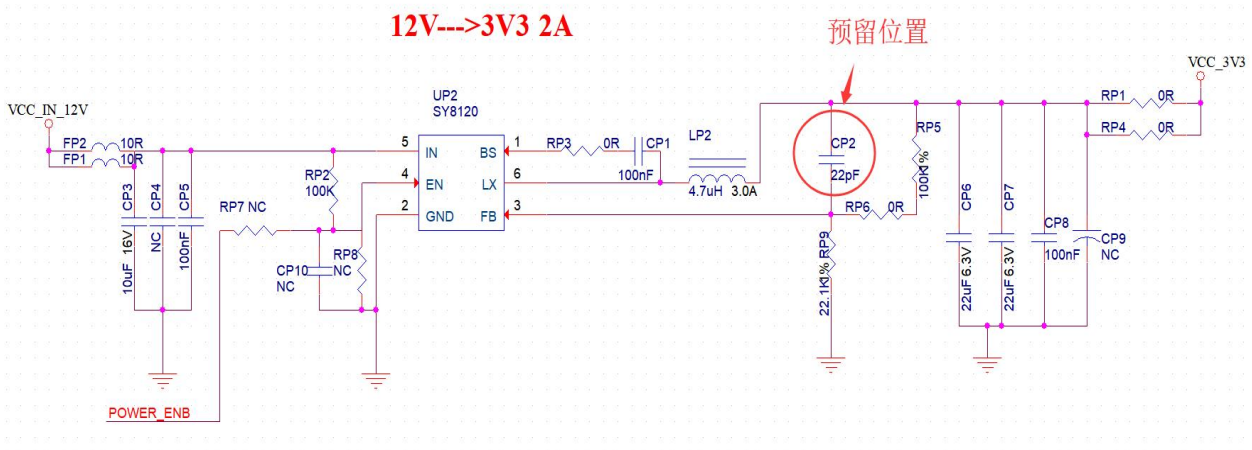■ It is recommended to add ESD devices to the 3.3V power interface.

Figure 9 DC-DC step-down circuit diagram

6.4. Use of GPIO port

■ 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 to the IO port. This can suppress overshoot and make the levels on both sides more stable. Helps with both EMI and ESD.

■ For the up and down pull-down of the special IO port, please refer to the instructions in the specification sheet, 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 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 pin header, it is recommended to reserve ESD devices near the terminals in the IO port wiring.
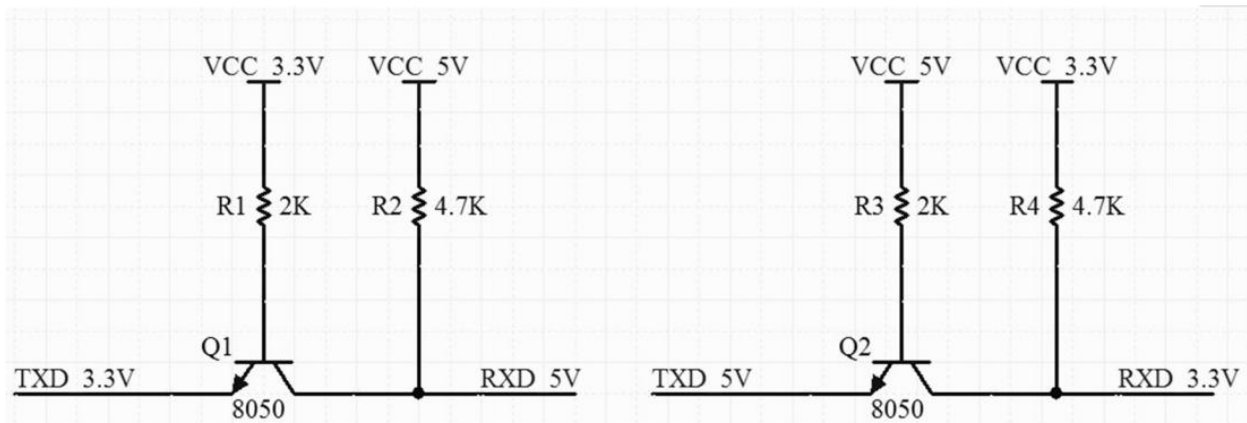

Figure 10 Level conversion circuit

7. FAQ

7.1. Factors Affecting Transmission Distance

(1) When there are straight-line communication obstacles, the communication distance will be correspondingly attenuated;

(2) Temperature, humidity, and co-channel interference will cause the communication packet loss rate to increase;

(3) The ground absorbs and reflects radio waves, and the test effect is poor when close to the ground;

(4) Seawater has a strong ability to absorb radio waves, so the seaside test results are poor;

(5) If there are metal objects near the antenna, or if it is placed in a metal case, the signal attenuation will be very serious;

(6) The power register setting is wrong and the air rate is set too high . The higher the air rate, the closer the distance;

(7) The low voltage of the power supply at room temperature is lower than the recommended value. The lower the voltage, the smaller the transmit power;

(8) There is a poor match between the antenna and the module or there is a quality problem with the antenna itself .

7.2. Precautions for using the module

(1) Check the power supply to ensure that it is within the recommended power supply voltage. If it exceeds the maximum value, it will cause permanent damage to the module;

(2) Check the stability of the power supply. The voltage cannot fluctuate greatly and frequently;

(3) Ensure anti-static operation during installation and use, and high-frequency devices are electrostatically sensitive;

(4) Ensure that the humidity during installation and use should not be too high, as some components are humidity-sensitive devices;

(5) If there are no special needs, it is not recommended to use it at too high or too low temperature .

7.3. Factors causing interference to the module

(1) If there is co-channel signal interference nearby, stay away from the interference source or modify the frequency or channel to avoid interference;

(2) The clock waveform on SPI is not standard. Check whether there is interference on the SPI line. The SPI bus line should not be too long;

(3) Unsatisfactory power supply may also cause garbled code, so be sure to ensure the reliability of the power supply;

(4) Poor quality or too long extension cords and feeders can also cause a high bit error rate .

8. Storage Conditions

Products sealed in moisture-proof bags should be stored in a non-condensing atmospheric environment <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 will need to be baked before it can be put online again.

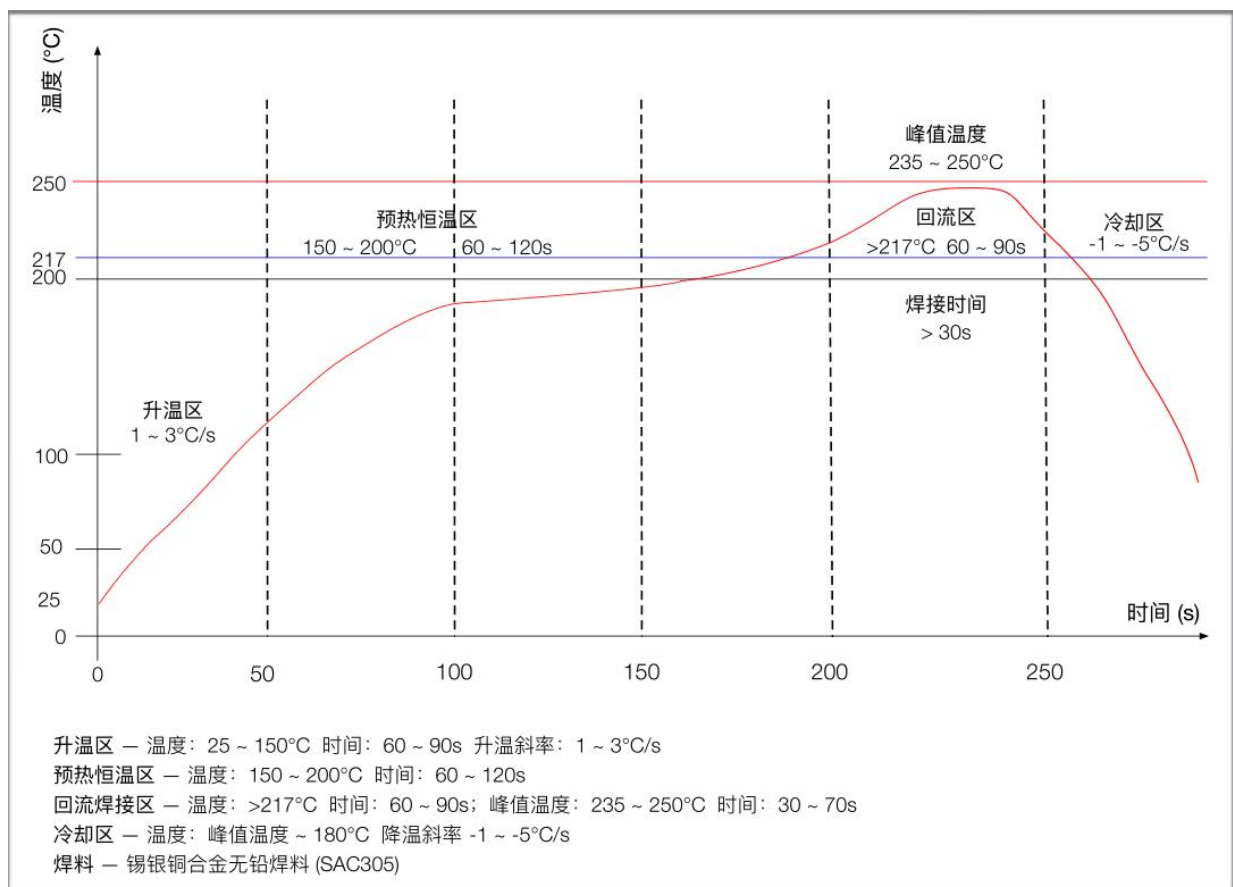# 9. Reflow Soldering Curve

Figure 11 Reflow soldering curve

10.Product Packaging Information

Ra-09H module is packed in tape, 900pcs/tray. As shown below:

Figure 12 Packaging and taping diagram

11.Contact Us

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