



Ra-08 Specification

Version V1.1.0

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Document resume

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1. Product Overview

Ra-08 is an LoRa module designed and developed by Shenzhen Ai-Thinker Technology Co., Ltd. The module is used for ultra-long distance spread spectrum communications. Its chip ASR6601 is a universal LPWAN wireless communication SOC, integrated with RF transceivers, modems, and a 32-bit RISC MCU. The MCU adopts an ARM core with a working frequency of 48MHz. The Ra-08 module supports LoRa modulation and traditional (G) FSK modulation under the LPWAN. At the same time, the transmitter also supports BPSK modulation and (G) MSK modulation, receiver support (G) MSK modulation.

The Ra-08 module provides long-range and ultra-low power communications for LPWAN applications, which can be widely used in smart meters, supply chain and logistics, home building automation, security system, remote irrigation system and other scenes.

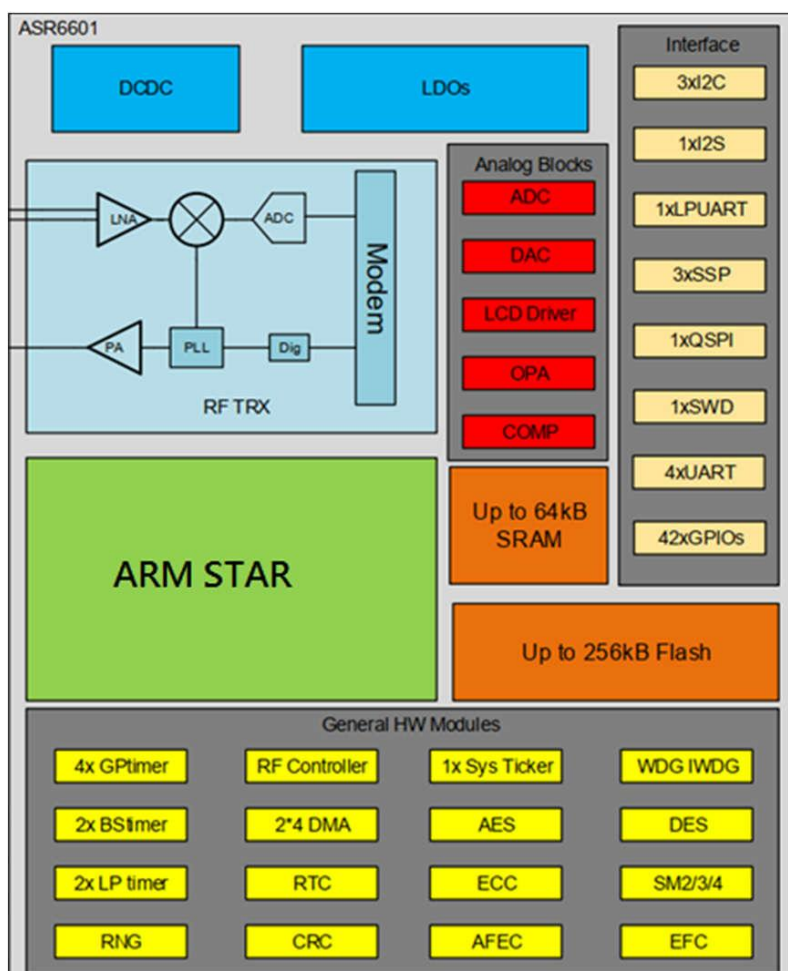


Figure 1 Main chip architecture diagram

1.1. Characteristic

- Adopt SMD-18 package
- Support frequency: 411MHz-525MHz
- Working voltage is 3.3V, theoretical maximum transmit power: +22dBm
- High sensitivity: -138dBm @125Kz SF12
- Support spread spectrum factor: SF5/SF6/SF7/SF8/SF9/SF10/SF11/SF12
- Embedded memory, 128KB FLASH,16KB SRAM
- Support LoRa/(G)FSK/BPSK/(G)MSK modulation
- Antenna interface is compatible with stamp holes / circular holes and IPEX, etc., support more option selection
- Support multiple sleep modes: depth sleep current is low to 0.9uA

2. Main parameters

Table 1 Description of the main parameters

Model	Ra-08
Package	SMD-18
Size	16.0*16.0*3.2(±0.2)mm
Antenna	half-hole pad / through-hole pad / IPEX
Frequency	411-525MHz
Operating temperature	-40 °C ~ 85 °C
Storage temperature	-40 °C ~ 125 °C, < 90%RH
Power supply	Voltage 2.7V ~ 3.6V, Current >500mA
Interface	UART/GPIO/ADC/DAC/I2C/I2S/SPI/PWM
IO	IO2,IO4,IO5,IO8,IO9,IO11,IO14,IO15
UART rate	Support 110 ~ 4608000 bps, Default 115200 bps
Crystal frequency	32MHz
SPI Flash	128KB
Transfer Protocol	LoRaWAN, LinkWAN

2.1. Static electricity requirements

Ra-08 is an electrostatic sensitive device, and special precautions must be taken when handling it.



Figure 2 ESD anti-static diagram

2.2. Electrical characteristics

Table 2 Electrical characteristics table

Parameter	Name		Min.	Typical value	Max.	Unit	Remark
Operating temperature	TOPR		-40	25	85	°C	
Supply voltage	VDD		2.7	3.3	3.6	V	≥3.3V can guarantee output power
Power consumption	Sleep mode	Power consumption 1	-	0.9	-	uA	0.9uA@Without RF/MCU Retention, Without RTC
		Power consumption 2	-	1.3	-	uA	1.3uA@With RF/MCU Retention and RTC
	Operation mode		-	3.83	-	mA	Power on
	Full load mode (TX:21dBm)		-	115	-	mA	DC-DC mode
	Receive mode (RX:SF10)		-	9.5	-	mA	DC-DC mode

2.3. Digital port characteristics

Table 3 Digital port

port	name	Min.	Typical value	Max.	Unit
IO level	VIO	2.7	3.3	3.6	V
Enter logic level low	VIL	-	-	0.2	V
Enter logic level high	VIH	0.8	-	-	V
Output logic level low	VOL	-	-	0.1	V
Output logic level high	VOH	0.9	-	-	V

2.4. RF parameters

Table 4 RF parameters

Output Power					
Mode	Frequency band	Min.	Typical value	Max.	Unit
Transmit power	433MHz	-	21	-	dBm
Transmit power	470MHz	-	21	-	dBm
Transmit power	490MHz	-	21	-	dBm
Transmit power	510MHz	-	21	-	dBm
Receive sensitivity modulation bandwidth 125kHz					
Mode		Min.	Typical value	Max.	Unit
SF7		-	-123	-	dBm
SF8		-	-126	-	dBm
SF9		-	-128	-	dBm
SF10		-	-131	-	dBm
SF11		-	-135	-	dBm
SF12		-	-138	-	dBm

3. Appearance dimensions

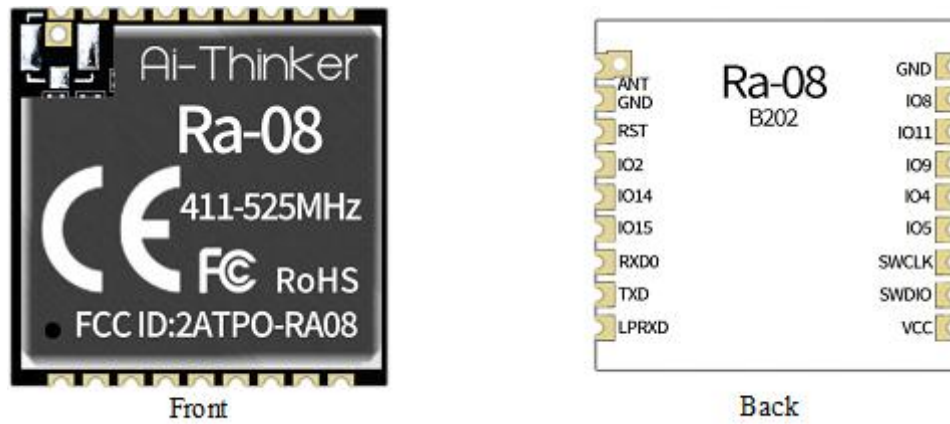


Figure 3 Appearance diagram pictures (for reference only)

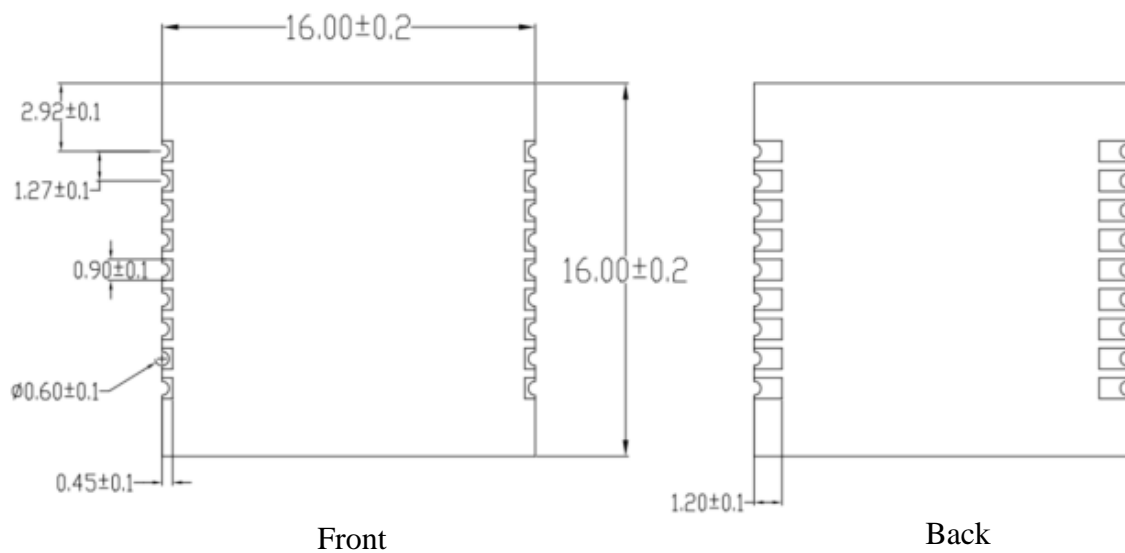


Figure 4 Module size diagram

4. Pin definition

Ra-08 has a total of 18 interfaces. As shown in below pin diagram, the pin function definition table is the interface definition.

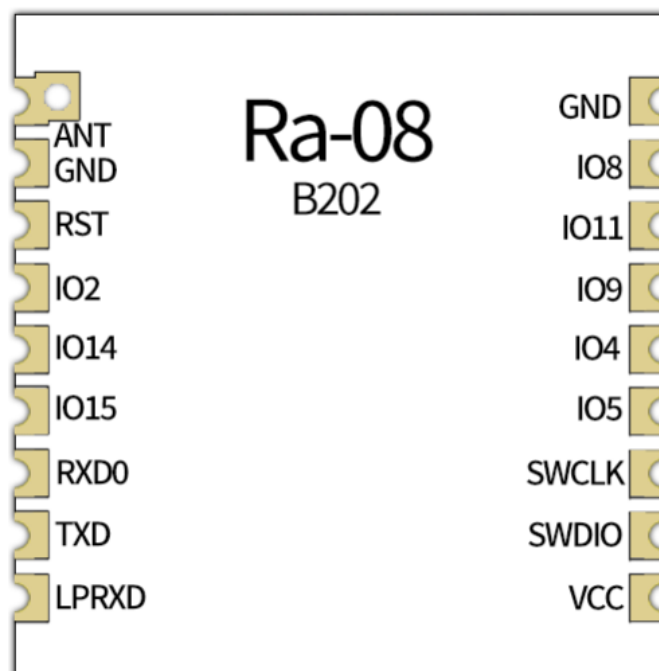


Figure 5 Schematic diagram of module pins

Table 6 Pin function definition table

No.	Name	Function
1 , 17	GND	Ground
2	IO8	GPIO8/ADC_IN1
3	IO11	GPIO11/ADC_IN0
4	IO9	GPIO9/DAC_OUT
5	IO4	GPIO4/SSP1_CLK
6	IO5	GPIO5/SSP1_NSS
7	SWCLK	GPIO7/SWD_CLK
8	SWDIO	GPIO6/SWD_DATA
9	VCC	3.3V power supply, recommended supply current $\geq 500\text{mA}$
10	LPRXD	GPIO60/LPUART-RX, Communication serial port
11	TXD	GPIO17/UART TX
12	RXD0	GPIO16/UART RX, Burning port
13	IO15	GPIO15/I2C_SDA
14	IO14	GPIO14/I2C_SCL
15	IO2	GPIO2/BOOT
16	RST	RSTN_IN external reset, low power is effective
18	ANT	Antenna interface

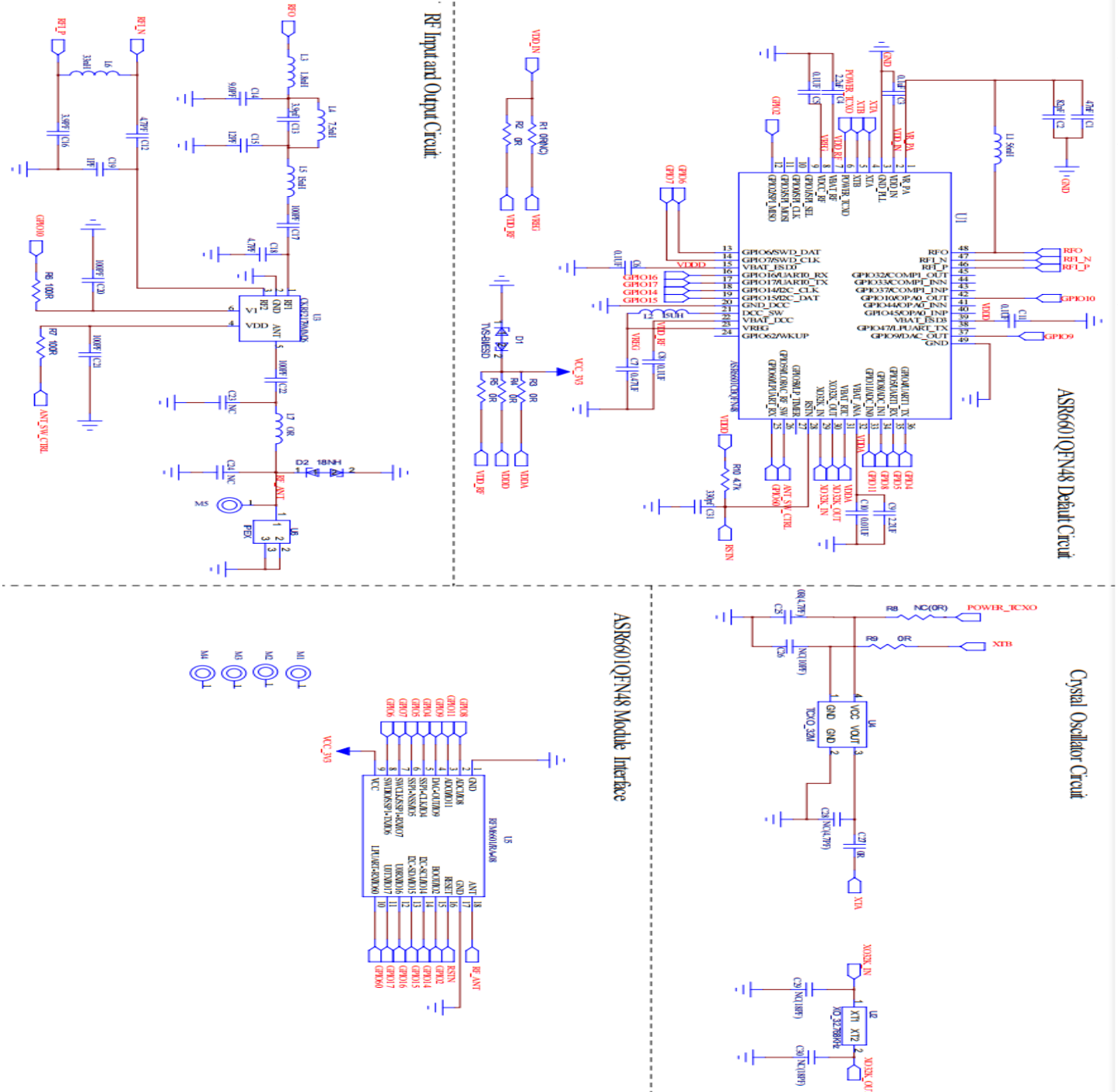
Table 7 Module Start Mode Description

System start mode			
Pin	Default	SPI startup mode	Download start mode
IO2	drop down	0	1

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

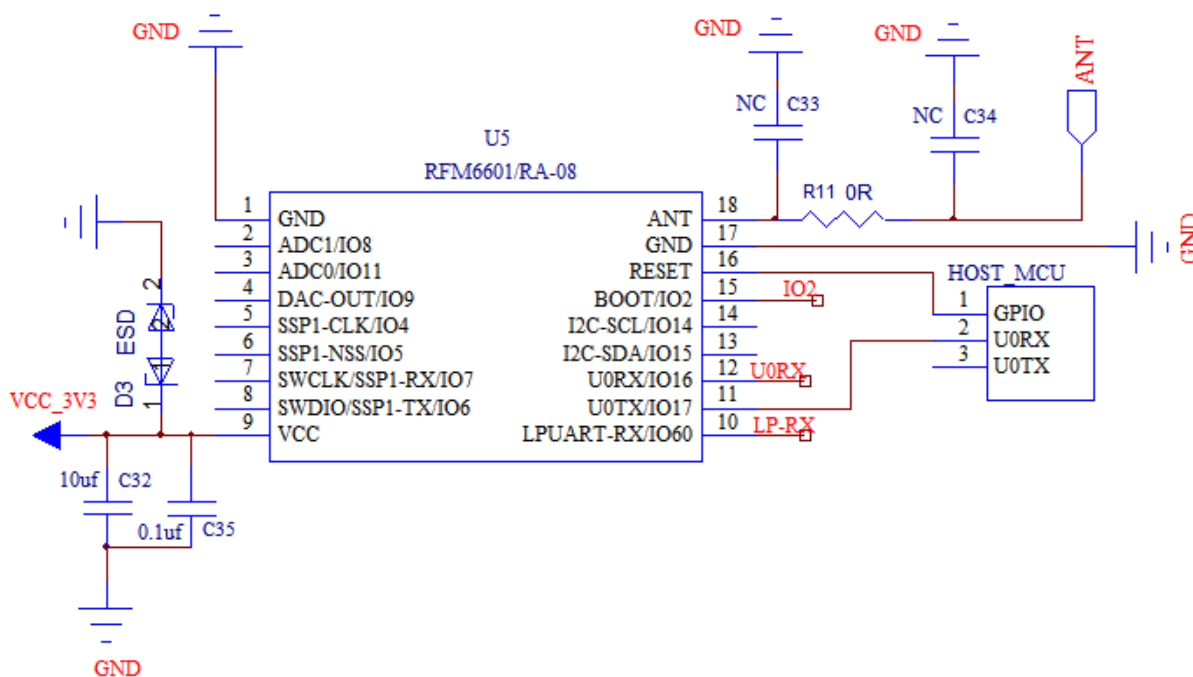
5. Schematic

Figure 6 Module Schematic



6. Design Guide

6.1. Module Application Guidance Circuit



It is recommended to use DC-DC or LDO to use independently, current is greater than 500mA

Figure 7 application circuit diagram

Notice:

- IO2 is in normal operating mode for starting control feet, low levels, and at high levels are in a burning firmware mode. The internal default is low.
- U0RX is a burning serial port, LPRXD is a communication serial port, and select it according to the requirements.

6.2. Antenna Interface

- The Ra-08 module requires an external antenna. The antenna has three wiring methods, compatible with a half-hole pad, a through hole pad, and an IPEX. A standard IPEX seat interface is left on the module. The size map of the IPEX seat is as follows:

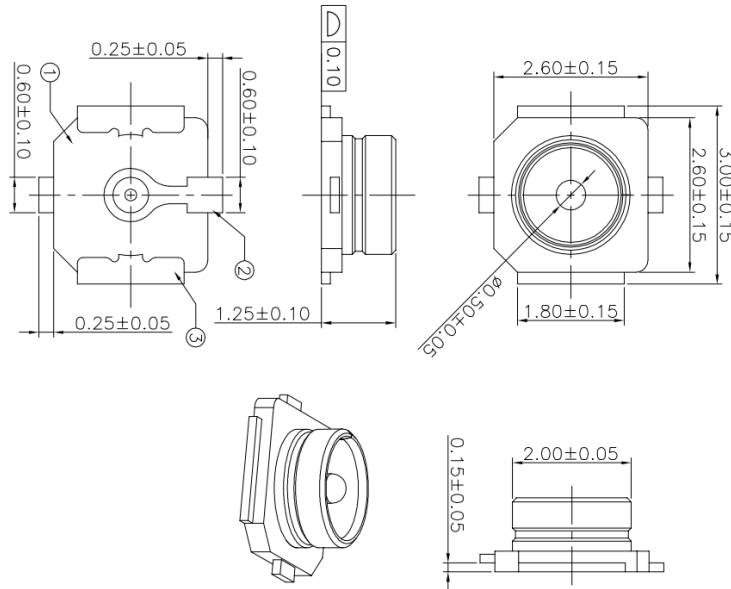


Figure 8 board end IPEX seat size diagram

6.3. Power supply

- Recommend 3.3V voltage, current peak $\geq 500\text{mA}$
- It is recommended to use LDO power; if the recommended ripple is within 30mV using DC-DC
- The DC-DC power supply circuit recommends that the position of the dynamic response capacitor can be optimized when the load changes, and the output ripple is optimized.
- 3.3V power interface suggestion increase ESD devices

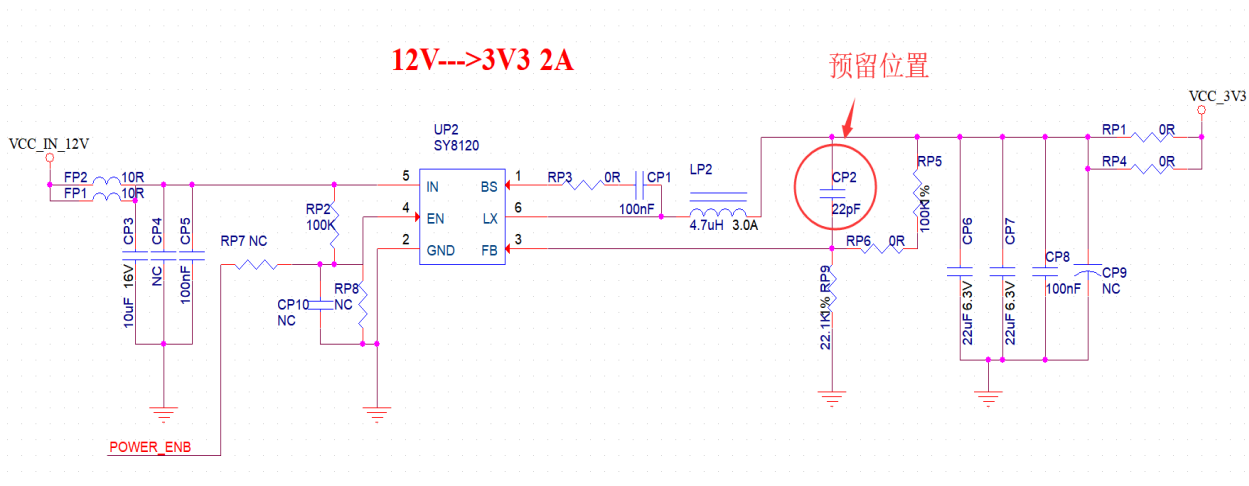


Figure 9 DC-DC step-down circuit diagram

6.4. GPIO

- The outer circumference of the module has taken some IO ports, and if you need to use it is recommended on the 10-100 ohms on the IO port. This can suppress overshoot, so that the two levels are more stable. Help for EMI and ESD.
- The top and pull-down of the special IO port will refer to the instructions of the specification, which will affect the startup configuration of the module.
- The IO port of the module is 3.3V. If the main control is not mismatched with the IO level of the module, it is necessary to increase the level conversion circuit.
- If the IO port is directly connected to the peripheral interface, or the pin and other terminals are recommended to reserve ESD devices at the IO port trace.

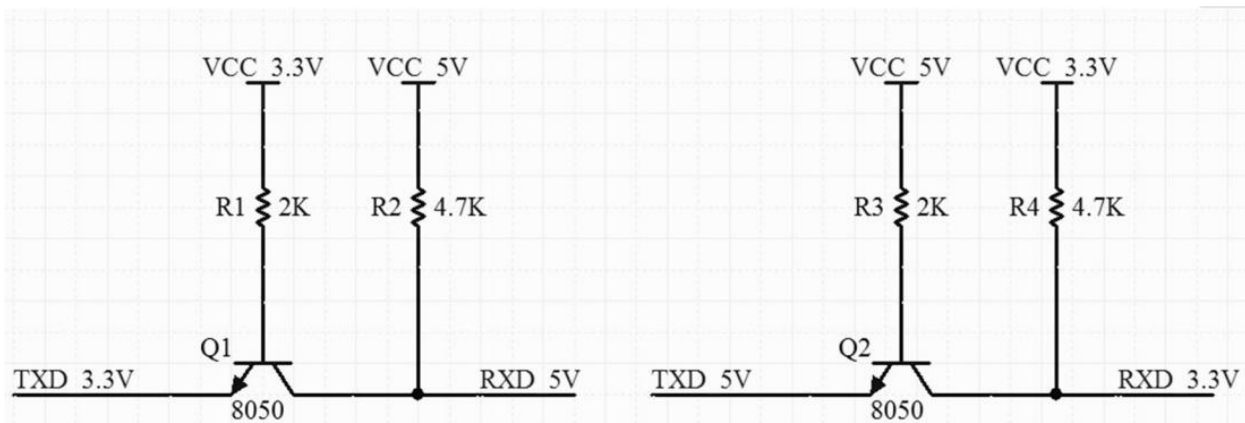


Figure 10 Level conversion circuit

7. Common issues

7.1. Effect of transmission distance factors

- (1) When there is a straight communication barrier, the communication distance will attenuate
- (2) Temperature, humidity, same frequency interference, can cause communication packet loss rate
- (3) Ground absorption, reflective radio waves, close to the ground test effect
- (4) Seawater has a very strong absorption of radio wave, so the test effect is poor in seaside.
- (5) There are metal objects near the antenna, or in the metal shell, the signal attenuation is very serious
- (6) Power register setting error, the air rate is too high (the higher the air rate, the closer distance)
- (7) Low pressure at room temperature is lower than the recommended value, the lower the voltage, the smaller the power
- (8) Use antenna and module matching degree or antenna itself quality problem

7.2. Attention item for using module

- (1) Check the power supply, make sure that between the recommended supply voltage. If the power supply exceeds the maximum, the module is permanently damaged.
- (2) Check the power stability, the voltage cannot fluctuate significantly.
- (3) Make sure the installation process anti-static operation, high frequency device electrostatic sensitivity.
- (4) Make sure the installation process is not too high, some components are humidity sensitive devices.
- (5) If there is no special demand, it is not recommended to use in too high or too low temperatures.

7.3. Factors that cause interference to the module

- (1) If there are similar signal interference nearby, pls away from interference or modified frequencies, channel avoidance interference

- (2) If the clock waveform is not standard on the SPI, please check if there is interference on the SPI line, and the SPI bus line should not be too long.
- (3) Power supply is not ideal or may result in garbled, be sure to ensure the reliability of the power supply.
- (4) Extending the line, the quality is poor or too long, and the error rate is high.

8. Flow welding curve diagram

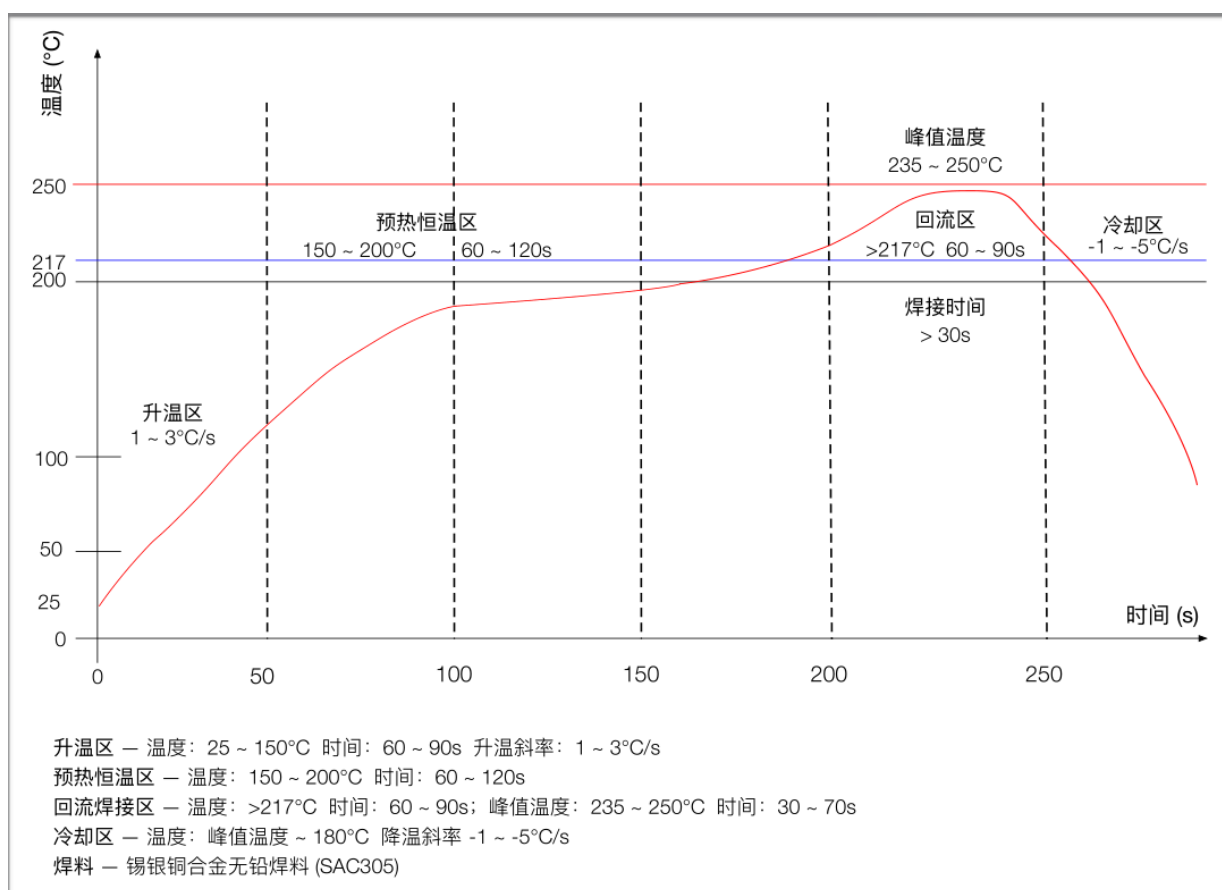


Figure 11 Flow welding diagram

9. Product related models

Table 8 Product related models

Model	Chip	Frequency band	Transmit power	Package	Size	Antenna
Ra-01	SX1278	411~525MHz	20dBm	SMD16	17*16 mm	Posts stamp pad/IPEX
Ra-01H	SX1276	803~930MHz	20dBm	SMD16	17*16 mm	Posts stamp pad/IPEX
Ra-08	SX1268	411~525MHz	22dBm	SMD16	17*16 mm	Posts stamp pad/IPEX
Ra-08H	SX1262	803~930MHz	22dBm	SMD16	17*16 mm	Posts stamp pad/IPEX
Ra-08C	LLCC68	411~525MHz	22dBm	SMD16	17*16 mm	Posts stamp pad/IPEX
Ra-02	SX1278	411~525MHz	20dBm	SMD16	17*16 mm	IPEX
Ra-06	SX1278	411~525MHz	20dBm	SMD20	22.8*16 mm	Posts stamp pad/IPEX
Ra-08H	ASR6601	803~930MHz	22dBm	SMD18	16*16 mm	Posts stamp pad/IPEX
Ra-08	ASR6601	411~525MHz	22dBm	SMD18	16*16 mm	Posts stamp pad/IPEX
Product related information: https://docs.ai-thinker.com						

10. Product packaging information

Ra-08 module was packaged in a tape, 750pcs/ reel. As shown in the below image:



Figure 12 Package and packing diagram

11. Contact us

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Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01

2.2 List of applicable FCC rules

The Ra-08 is an LoRa Module with digitally modulated systems using an LoRa/FSK/OOK modulation.

It operates on the 411-525MHz band and, therefore, is within U.S. FCC part 15.231 standard

2.3 Specific operational use conditions

The EUT is a LoRa Module

Operation Frequency: 411-525MHz

Modulation Type: LoRa/FSK/OOK

Number Of Channel: 115CH

Antenna Designation: Spring Antenna

Antenna Gain: 2.0dBi

Ai-Thinker lora Series Module (Ra-08) designed and developed by Ai-Thinker .This module is used for long distance spread spectrum communication. Its RF chip ASR6501 (as show as figure 1) Mainly used LoRa™ remote modem, for ultra-long-distance spread spectrum communication, strong anti-interference, can minimize current consumption. With the help of the SEMTECH the patent technology of LoRa™, ASR6501 with -137dBm high sensitive, long range transmission, high reliability Meantime, relative traditional modulation technique, LoRa™ modulation technique has obvious advantages in anti-blocking and selection, It solves the problem that traditional design scheme cannot consider distance, anti-interference and power consumption simultaneously.

Its application can be automatic meter reading, home building automation, security system, remote irrigation system.

2.4 Limited module procedures

not applicable; Single Modular Approval Request

2.5 Trace antenna designs

Not applicable;

2.6 RF exposure considerations

To maintain compliance with FCC's RF Exposure guidelines, This equipment should be installed and operated with minimum distance between 20cm the radiator your body: Use only the supplied antenna.

2.7 Antennas

The Ra-08 is an LoRa Module beams signals and communicates with its antenna, which is Spring Antenna. The Spring Antenna gain is 2.0dBi. Antenna could not be in no-load state when module is working. During debugging, it is suggested to add 50 ohms load to the antenna port to avoid damage or performance degradation of the module under long-time no-load condition.

2.8 Label and compliance information

The final end product must be label in a visible area with the following Host must Contains FCC ID: 2ATPO-RA08. If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of FCC rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

2.9 Information on test modes and additional testing requirements

Data transfer module demo board can control the EUT work in RF test mode at specified test channel.

2.10 Additional testing, Part 15 Subpart B disclaimer

The module without unintentional-radiator digital circuit, so the module does not required an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.

ATTENTION

This device is intended only for OEM integrators under the following conditions:

- 1) The antenna must be installed such that 20 cm is maintained between the antenna and users, and
- 2) This device and its antenna(s) must not be co - located with any other transmitters except in accordance with FCC multi - transmitter product procedures. Referring to the multi - transmitter policy, multiple transmitter(s) and module(s) can be operated simultaneously without C2P.
- 3) For all products market in US, OEM has to limit the Operating Frequency: 411-525MHz by supplied firmware programming tool. OEM shall not supply any tool or info to the end - user regarding to Regulatory Domain change.

USERS MANUAL OF THE END PRODUCT:

In the user manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio - frequency exposure guidelines for an uncontrolled environment can be satisfied. The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

If the size of the end product is smaller than 8x10cm, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of FCC rules.

Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC WARNING

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generate, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.

If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.