Ai-SG01-P Specification

Version V1.1.0

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Document resume

Version	Date	Develop/revise content	Edition	Approve
V1.1.0	2025.11.25	First Edition	Rongxin Qiao	Ning Guan

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1. Product Overview

Ai-SG01-P is an independently developed ultra-high-performance RF front-end module based on PANCHIP's new-generation PAN3210 RF chip, designed for long-range, low-power, and high-reliability IoT and Industry 4.0 wireless sensor networks. Its core advantages lie in its extremely miniaturized packaging, robust RF performance, and exceptional stability even under impedance mismatch and no-load conditions. Through optimized collaborative design of the power amplifier, low-noise amplifier, filter, and peripheral matching network, it achieves high output power, low loss, and strong anti-interference capabilities, while also meeting mainstream global regulatory certifications.

Ai-SG01-P module supports flexible configuration of multiple frequency bands (420-445MHz, 470-510MHz optional), and is suitable for scenarios with dual requirements of size and distance, such as remote meter reading, smart home terminals, industrial monitoring, medical wearables, and industrial remote control.

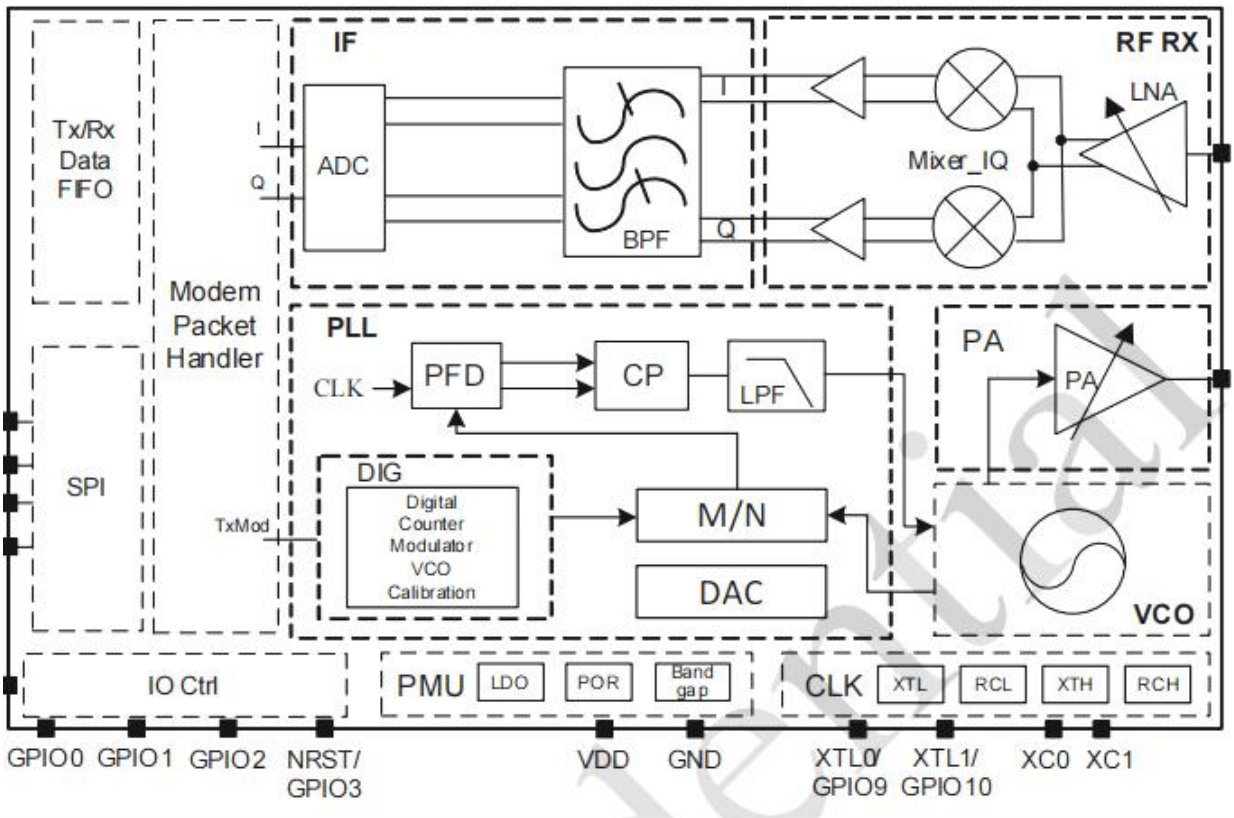


Figure 1 Main chip architecture diagram

1.1. Characteristic

- Ultra-small 17mm*16mm*3.2mm size in an SMD-16 package
- Operating frequency band: 420-445MHz, 470-510MHz (frequency band selectable, switchable via hardware and software configuration)
- The module's maximum transmit power can reach 30dBm (1W)@3.3V@DPC30dBm, and it supports DPC (7~30dBm) in 1dB steps.
- Module receiver sensitivity: -113dBm@50kbps (the lower the data rate, the lower the receiver sensitivity, down to -126dBm@2.4kbps)
- Low spurious design: Harmonic suppression ≤ -70dBc (2nd/3rd harmonics) at full load transmission (30dBm), still meeting the requirements of CE, FCC and other regulations, solving the pain point of traditional modules having serious excessive spurious emissions at high power full load transmission (excessive spurious emissions can easily interfere with nearby communication equipment).
- Low ACPR design: Built-in predistortion engine achieves ≤-55dBc (50kbps FSK) at +30dBm output.
- PAE up to 41% (@30dBm, @25℃@24H) Full-load transmitter module surface temperature as low as 32-45℃, no risk of heat accumulation during long-term operation
- Antenna impedance mismatch protection design: The Ai-SG01-P solves the "module burnout" problem caused by unconnected antennas or impedance mismatch in traditional modules, ensuring stable operation under various abnormal working conditions.
- The module's default data transmission rate ranges from 50 ~500 kbps, with optional speeds of 50 kbps ~ 2 Mbps and 50 kbps ~ 4 Mbps (three speed ranges that can be switched via hardware and software configuration).
- Industrial-grade standard design, operating temperature range -40~85℃ (optional -40~105℃).
- It features a rich set of interfaces, supporting 4-wire SPI, 3-wire SPI, and 4 GPIO pins.
- Extremely low sleep current as low as 1.3uA (hardware optional, with two externally allocated I/O ports for CPS and CSD pins), the module's default sleep current is 331.42uA.
- Special features: Supports RSSI and LQI, supports Automatic Frequency Control (AFC), supports built-in 32K RC clock and external 32K crystal oscillator, supports Duty Cycle reception and transmission, and supports automatic ACK.
- Supports functions such as whitening, FEC, CRC, and Manchester code.
- he stamp-hole interface facilitates secondary development and integration by users.

2. Main parameters

Table 1 Description of the main parameters

Model	Ai-SG01-P
Package	SMD-16
Size	17*16*3.2（mm）
Antenna	External antenna
Frequency	420-445MHz or 470-510MHz
Operating temperature	-40~85℃
Storage temperature	-40 ℃ ~ 125 ℃ , < 90%RH
Power supply	3.3V, does not support wide voltage supply; supply current ≥1A.
Interface	SPI
IO	4
SPI rate	Default 4.5MHz

2.1. Static electricity requirement

The Ai-SG01-P is an electrostatic discharge (ESD) sensitive device and requires special precautions during handling. It should generally be used with ESD-sensitive components. Proper ESD handling and packaging procedures must be followed throughout the handling, transportation, and operation of any application incorporating the Ai-SG01-P module. Do not touch the module with your hands or use a non-antistatic soldering iron for soldering, as this may damage the module.

Figure 2 ESD preventive measures

2.2. Electrical characteristics

Table 2 Electrical characteristics table

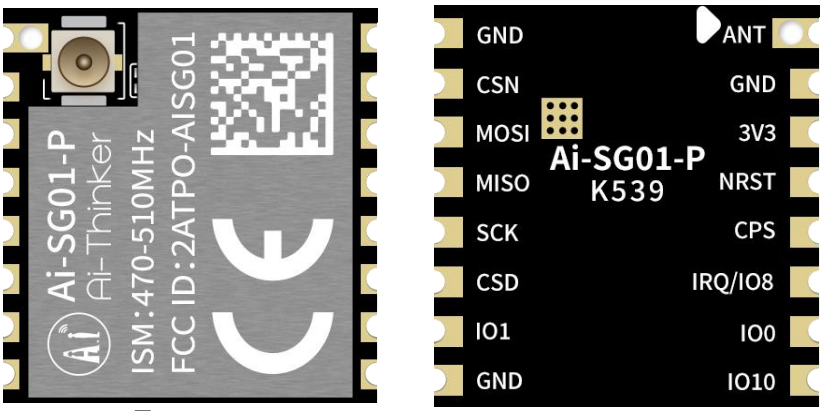
Parameters		Name	Min.	Typical value	Max.	Unit
Power supply voltage		3V3	3.0	3.3	3.6	V
Power consumption	Full load mode（TX:30dBm）	433MHz		153（T:50ms）	757.35	mA
		470MHz		153（T:50ms）	757.35	mA
		490MHz		153（T:50ms）	757.35	mA
		510MHz		153（T:50ms）	757.35	mA
	Sleep			331.85		uA
	Deep Sleep			331.42		uA

2.3. RF Performance

Table 3 RF performance

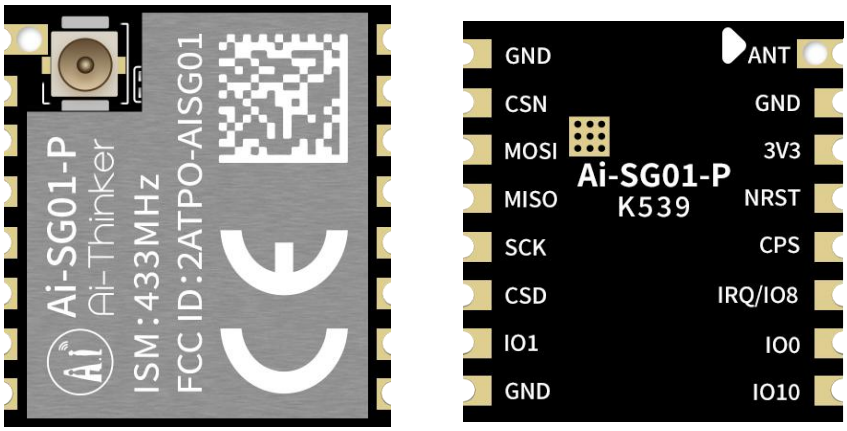
Output Power				
Mode	**Min.**	**Typical**	**Max.**	**Unit**
433MHz		29@30DB		dBm
470MHz		30@30DB		dBm
490MHz		30@30DB		dBm
510MHz		30@30DB		dBm
Receive Sensitivity				
Mode	**Min.**	**Typical**	**Max.**	**Unit**
433.9MHz		-112@50kb		dBm
470.9MHz		-113@50kb		dBm
490.9MHz		-113@50kb		dBm
505.9MHz		-113@50kb		dBm

3. Appearance Dimensions



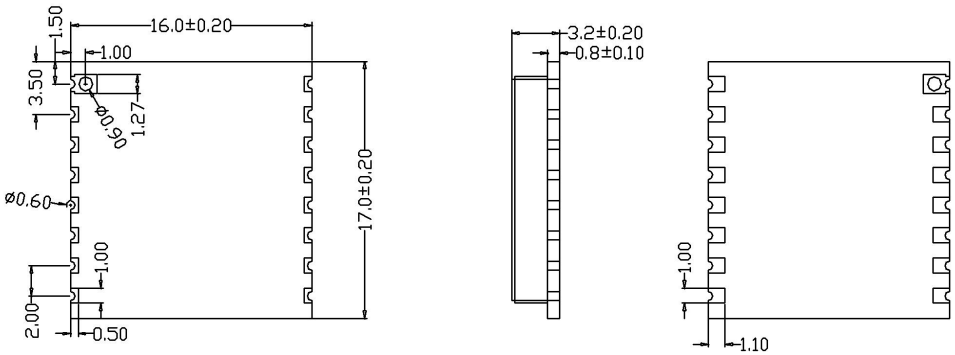
Front Back

Figure 3: Appearance of the 470-510MHz module (rendering is for reference only, the actual product shall prevail)



Front Back

Figure 4: Appearance of the 433MHz module (rendering is for reference only, the actual product shall prevail)

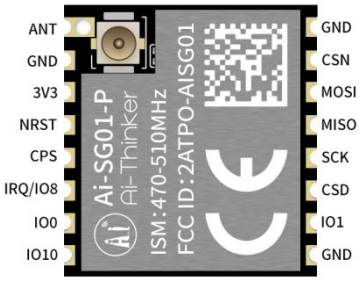


Front Side Back

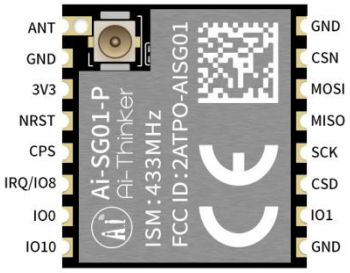
Figure 5 Dimensions

4. Pin Definition

Ai-SG01-P module has a total of 16 pins, as shown in the pin diagram. The pin function definition table is the interface definition.



470-510MHz Pin



433MHz Pin

Figure 6 Pin diagram

Table 4 Pin function definition table

No.	Name	Function
1	ANT	RF signal input/output, connected to an antenna with a VSWR < 2:1 (covering the operating frequency band of the coverage module).
2	GND	Ground
3	3V3	3.3V power supply (ensure stable power supply, avoid overvoltage and undervoltage)
4	NRST	Chip hardware reset pin
5	CPS	FEM pass-through (non-amplified) enable pin (externally high during deep sleep), internally already pulled up by default
6	IRQ/I	Interrupt signal pin, directly connected to chip GPIO8
7	IO0	Digital I/O, software configurable, directly connected to chip GPIO0
8	IO10	Digital I/O, software configurable, directly connected to chip GPIO10
9	GND	Ground
10	IO1	Digital I/O, software configurable, directly connected to chip GPIO1. FEM chip enable pin:
11	CSD	Digital I/O, software configurable, directly connected to chip GPIO1. FEM chip enable pin: high level indicates operation; internal pull-up is configured within the module. Low level disables operation. SPI clock input. SPI data output. SPI data input. SPI chip select input.
12	SCK	Digital I/O, software configurable, directly connected to chip GPIO1. FEM chip enable pin:
13	MISO	Digital I/O, software configurable, directly connected to chip GPIO1. FEM chip enable pin:
14	MOSI	Digital I/O, software configurable, directly connected to chip GPIO1. FEM chip enable pin:
15	CSN	Digital I/O, software configurable, directly connected to chip GPIO1. FEM chip enable pin:
16	GND	Ground

5. Schematic

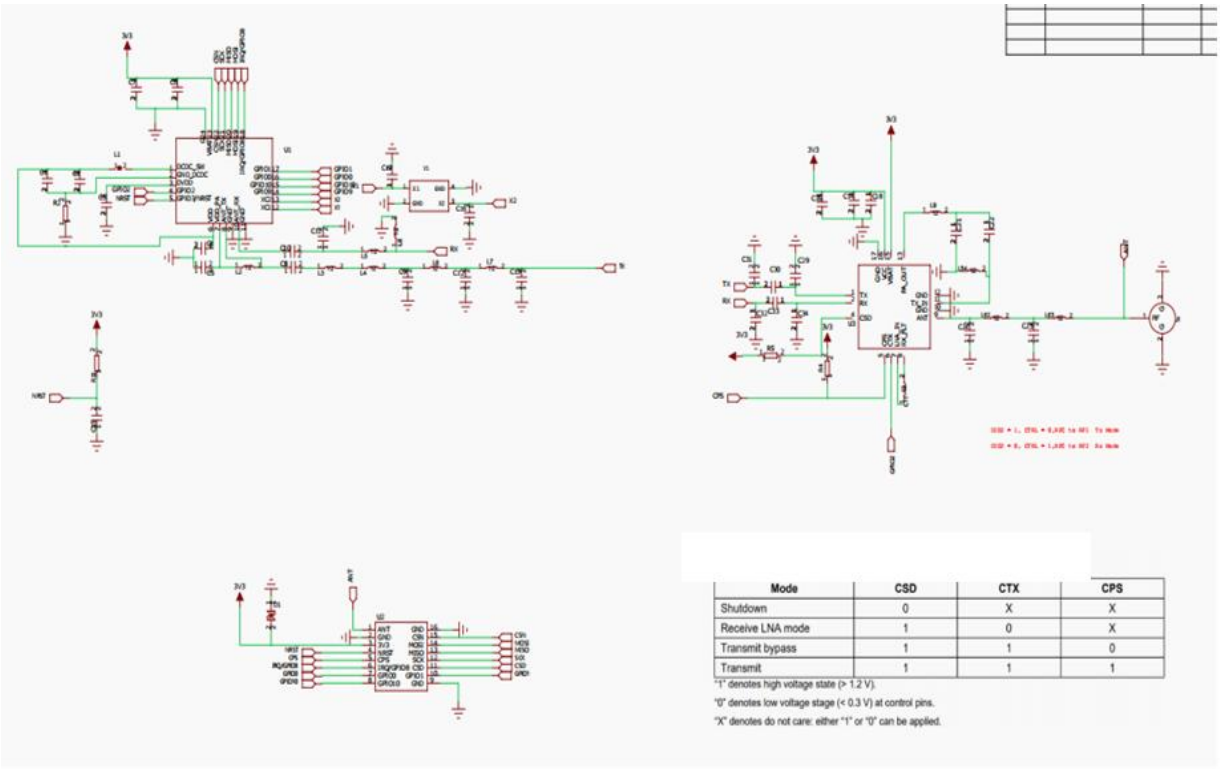


Figure 7 Module schematic

6. Design Guidance

6.1. Application Guidance Circuit

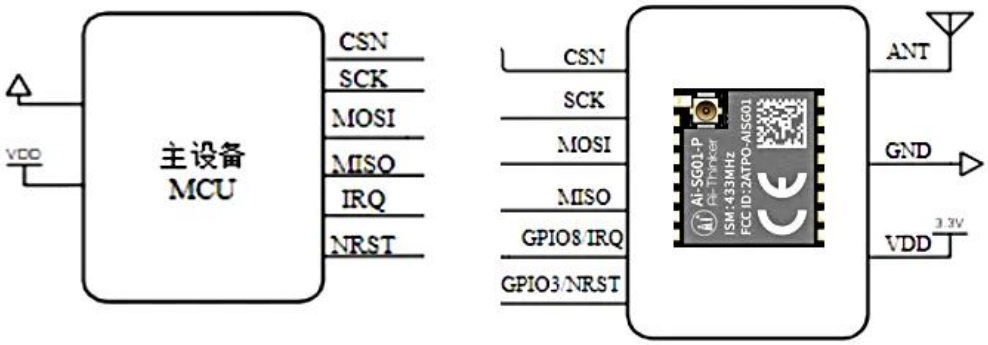


Figure 8 Application guidance circuit

- If the communication interface uses 3-wire SPI, the MISO pin does not need to be connected.
- The module is a pure RF transceiver module and requires MCU drivers or a dedicated SPI debugging tool.
- The heatsink pads on the back of the module must be reliably grounded.
- High-frequency digital traces, high-frequency analog traces, and power traces must avoid the area under the module. If it is absolutely necessary to route them under the module, assuming the module is soldered on the Top Layer, a ground copper layer must be laid on the Top Layer of the module's contact area (all copper and well grounded), close to the digital section of the module and routed on the Bottom Layer.
- Unless there are specific requirements, it is not recommended to use the module at excessively high or low temperatures; otherwise, the transmit power must be reduced to avoid damaging the module.

6.2. Recommended PCB package size

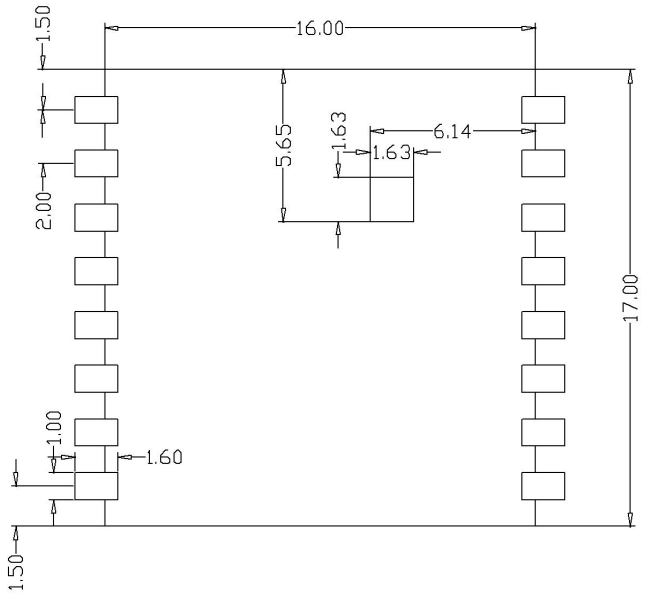


Figure 9 Recommended PCB package size

6.3. Antenna Layout Requirements

- This module requires an external antenna. A half-hole pad on the module allows connection to the motherboard.
- To ensure antenna performance, no metal components should be placed around the antenna, and it should be kept away from high-frequency devices.
- The antenna mounting structure significantly impacts module performance; ensure the antenna is exposed, ideally vertically upwards. When the module is installed inside the housing, a high-quality antenna extension cable can be used to extend the antenna to the outside of the housing.
- Never install the antenna inside a metal casing, as this will drastically reduce transmission distance.

6.4. Power supply

- A stable 3.3V VDD power supply is required, with no overvoltage or undervoltage, and a peak current exceeding 1A.
- An LDO power supply is recommended; if using a DC-DC converter, ripple should be controlled below 30mV.
- The DC-DC power supply circuit should ideally have space reserved for a dynamic response capacitor to optimize output ripple under significant load variations.
- An ESD device is recommended for the 3.3V power interface.

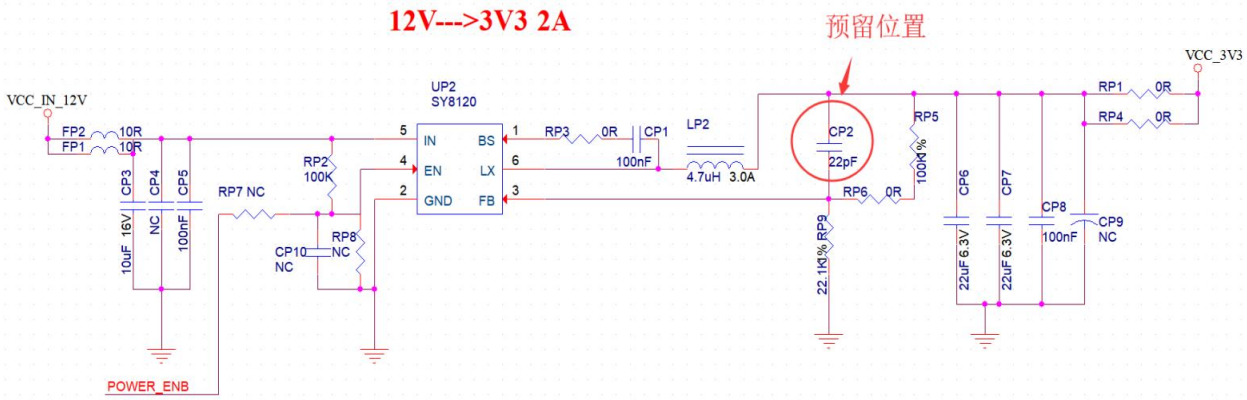


Figure 10 DC-DC buck circuit diagram

6.5. GPIO

- The module has several external I/O ports. If needed, it is recommended to connect a 10-100 ohm resistor in series with each I/O port. This helps suppress overshoot and makes the voltage levels smoother, which is beneficial for EMI and ESD protection.
- For pull-up/pull-down resistors on special I/O ports, please refer to the datasheet instructions, as this will affect the module's startup configuration.
- The module's I/O ports are 3.3V. If the voltage levels of the main controller and the module's I/O ports are incompatible, a level conversion circuit is required.
- If the I/O ports are directly connected to external interfaces or pin headers, it is recommended to provide ESD protection near the terminals on the I/O port traces.

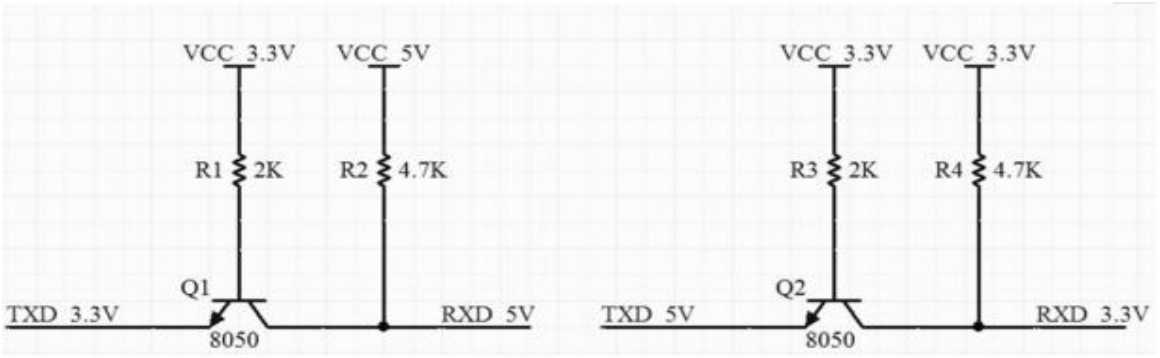


Figure 11 Level conversion circuit

7. Storage conditions

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

The module's moisture sensitivity rating (MSL) is 3.

Once the vacuum bag is opened, the product must be used within 168 hours at 25±5℃ /60%RH; otherwise, it must be baked before being reused.

8. Reflow welding curve diagram

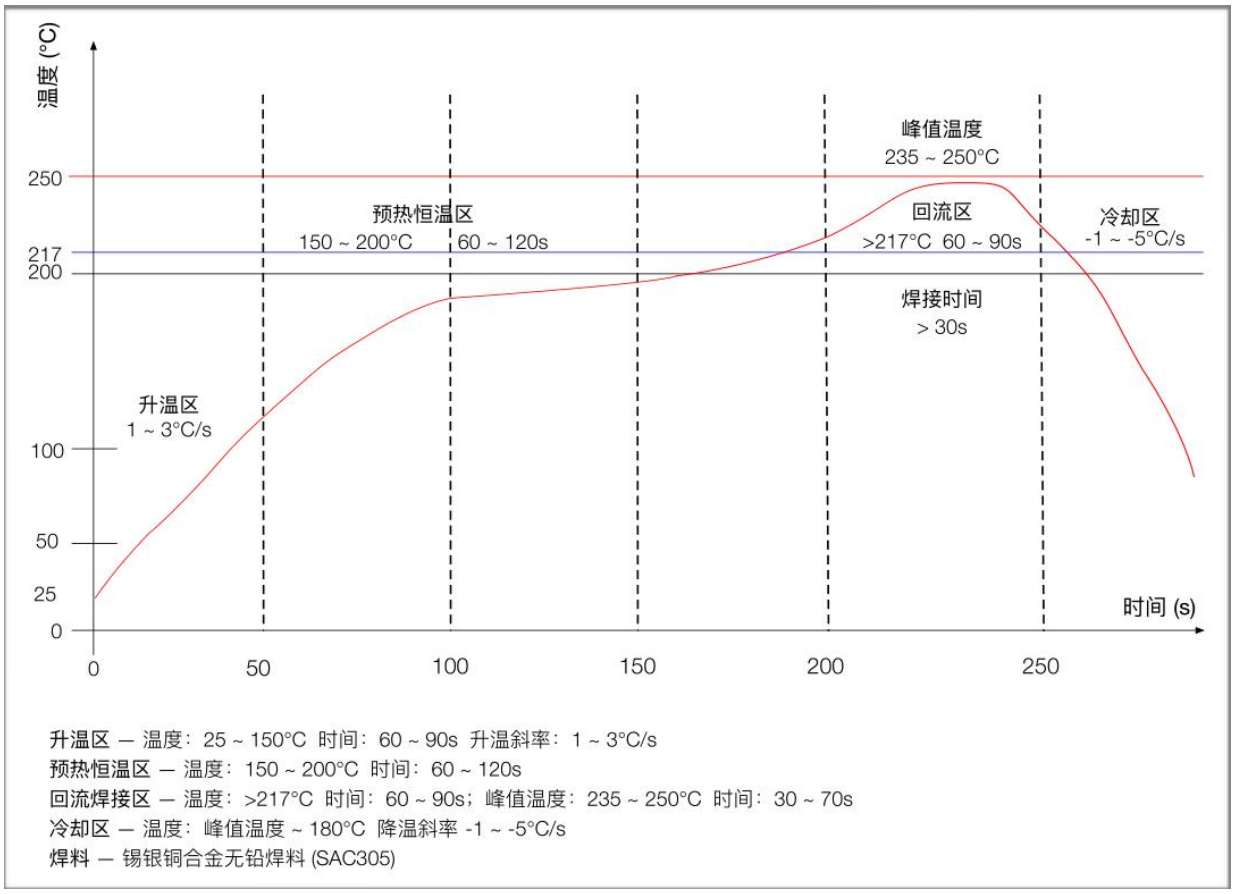


Figure 12 Reflow curve

9. Product Packaging Information

Ai-SG01-P modules are packaged in tape, 1000 pieces per tray. As shown in the following figure:

Figure 13 Packaging tape diagram

10.Contact us

Ai-Thinker official website　Office forum　Develop DOCS

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