ESP-01S Specification

Version V1.1

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Document Revision History

Version	Date	Description of Changes	Authored by	Approved by
V0.9	2015/06/08	First edition	Yang Xiaofei	Guan Ning
V1.0	2019/10/29	Update data	Xie Yiji	Guan Ning
V1.1	2025/08/02	Correct dimension descriptions	Xu Hong	Xu Hong

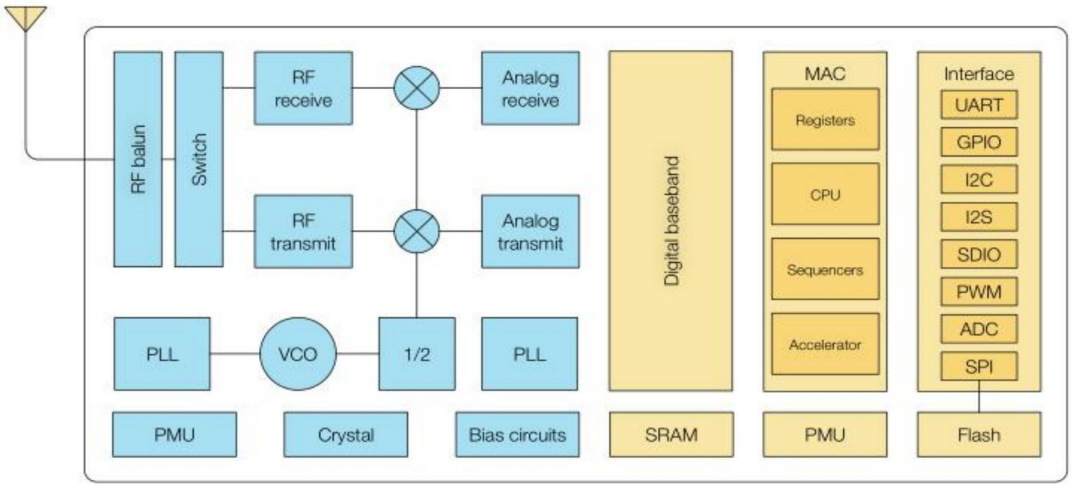
Contents

1 Product Overview

The ESP-01S is a Wi-Fi module developed by Ai-Thinker Technology. Its core processor, ESP8266, integrates the industry-leading Tensilica L106 low-power 32-bit MCU in a compact package. It features a 16-bit reduced instruction mode, supports clock frequencies of 80 and 160 MHz, supports RTOS, and integrates Wi-Fi MAC/BB/RF/PA/LNA.

The ESP-01S Wi-Fi module supports the standard IEEE 802.11 b/g/n protocol and a full TCP/IP protocol stack. Users can use this module to add networking capabilities to existing devices or to build standalone network controllers.

The ESP8266 is a high-performance wireless SoC, offering maximum utility at the lowest cost and providing limitless possibilities for embedding Wi-Fi functionality into other systems.



The ESP8266 features complete and self-contained Wi-Fi networking capabilities, allowing it to be used standalone or as a slave device integrated into a master MCU for operation. When operating in standalone mode, the ESP8266 can boot directly from an external flash. The built-in high-speed cache memory helps to improve system performance and optimize the storage system.

Alternatively, the ESP8266 can function as a Wi-Fi adapter via SPI/SDIO or UART interfaces, making it applicable to designs based on any microcontroller.

With its powerful on-chip processing and storage capabilities, the ESP8266 enables the integration of sensors and other application-specific devices via GPIO ports, significantly reducing the upfront development costs.

Features

- Complete 802.11b/g/n Wi-Fi SoC module
- Built-in ultra-low-power 32-bit Tensilica L106 micro MCU, supporting clock frequencies of 80 and 160 MHz, with RTOS support
- Built-in 1-channel 10-bit high-precision ADC
- Supports UART/GPIO/PWM interfaces
- Adopts DIP-8 package
- Integrates Wi-Fi MAC/BB/RF/PA/LNA
- Supports various sleep modes with standby power consumption as low as 1.0 mW
- Maximum UART baud rate up to 4 Mbps
- Embedded LwIP protocol stack
- Supports STA/AP/STA+AP operation modes
- Supports one-click network configuration for Android/iOS via Smart Config (APP) / AirKiss (WeChat)
- Supports local upgrade via UART and remote firmware upgrade (FOTA)
- Universal AT commands for quick start
- Supports secondary development; integrated Windows and Linux development environments

Main Parameters

Table 1 Main Parameters Specifications

Model	ESP-01S
Package	DIP-8
Dimensions	24.6*14.4*11.2(±0.2) mm Note: 11.2 mm is the pin header height
Antenna Type	On-board PCB antenna
Frequency Range	2400~2483.5 MHz
Operating Temperature	-20 ℃~70 ℃
Storage Conditions	-40 ℃~125 ℃, < 90% RH
Power Supply Range	Supply voltage: 3.0 V~ 3.6 V， supply current: >500 mA
Supported Interfaces	UART/GPIO/PWM
Available I/Os	2
UART Baud Rate	Supports 110~4,608,000 bps, default 115200 bps
Security	WEP/WPA-PSK/WPA2-PSK
SPI Flash	Default 8 Mbit
Certification	RoHS

2 Electrical Parameters

Electrical Characteristics

Parameter		Condition	Min	Typ	Max	Unit
Supply Voltage		VDD	3.0	3.3	3.6	V
I/O	V_{IL}/V_{IH}	-	-0.3/0.75VIO	-	0.25VIO/3.6	V
	V_{OL}/V_{OH}	-	N/0.8VIO	-	0.1VIO/N	V
	I_{MAX}	-	-	-	12	mA

RF Performance

Description	Typ	Unit
Frequency Range	2400~2483.5	MHz
Output Power		
11n mode HT20, PA output	13±2	dBm
11g mode, PA output power	14±2	dBm
11b mode, PA output power	16±2	dBm
Receiver Sensitivity		
CCK, 1 Mbps	< =-90	dBm
CCK, 11 Mbps	< =-85	dBm
6 Mbps (1/2 BPSK)	< =-88	dBm
54 Mbps (3/4 64-QAM)	< =-70	dBm
HT20 (MCS7)	< =-67	dBm

Power Consumption

The following power consumption data is measured based on a 3.3 V power supply, an ambient temperature of 25 ℃, and using an internal voltage regulator.

- All measurements are performed at the antenna interface without a SAW filter.
- All transmission data is measured under continuous transmission mode with a 90% duty cycle.

Mode	Min	Typ	Max	Unit
TX 802.11b, CCK 11 Mbps, POUT=+17 dBm	-	170	-	mA
TX 802.11g, OFDM 54 Mbps, POUT=+15 dBm	-	140	-	mA
TX 802.11n, MCS7, POUT =+13 dBm	-	120	-	mA
RX 802.11b, Packet Length 1024 bytes, -80 dBm	-	50	-	mA
RX 802.11g, Packet Length 1024 bytes, -70 dBm	-	56	-	mA
RX 802.11n, Packet Length 1024 bytes, -65 dBm	-	56	-	mA
Modem-sleep ①	-	20	-	mA
Light-sleep ②	-	2	-	mA
Deep-sleep ③	-	20	-	μA
Power Off	-	0.5	-	μA

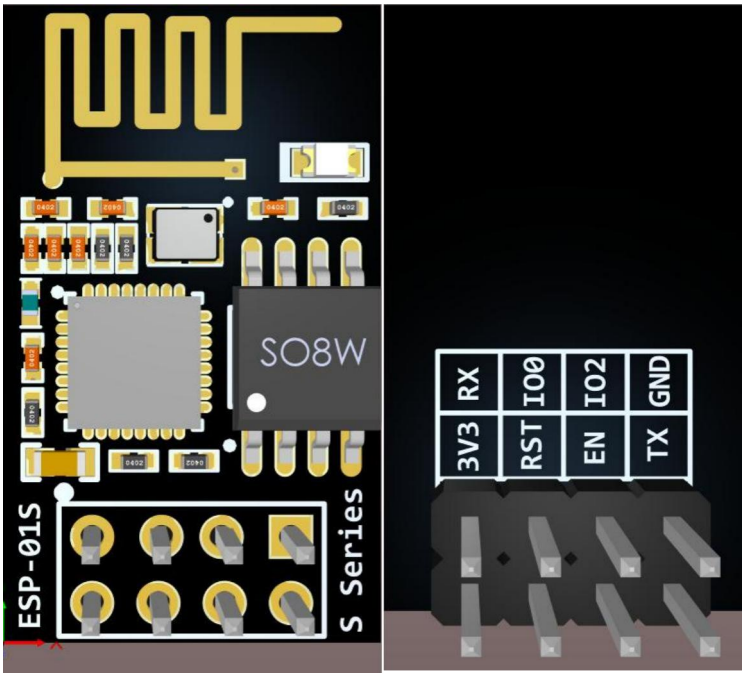
Instructions:

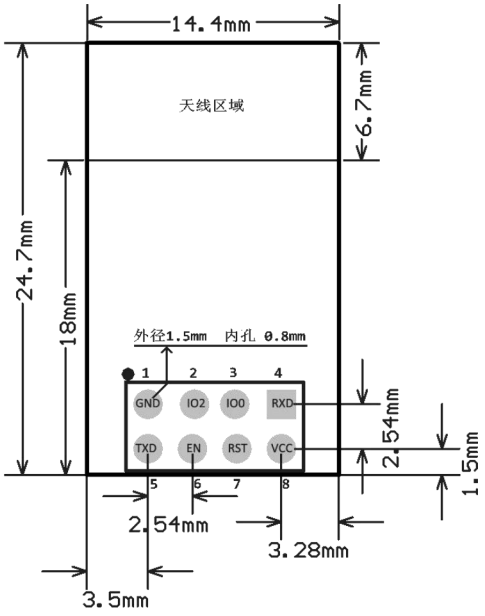
- Modem-sleep is used for applications requiring the CPU to remain active, such as PWM or I2S applications. While maintaining a Wi-Fi connection, if there is no data transmission, the Wi-Fi modem circuit can be turned off according to the 802.11 standard (e.g., U-APSD) to save power. For example, during DTIM3, every 300 ms of sleep, the system wakes up for 3 ms to receive the AP's Beacon packets, resulting in an overall average current of approximately 20 mA.
- Light-sleep is used for applications where the CPU can be paused, such as Wi-Fi

switches. While maintaining a Wi-Fi connection, if there is no data transmission, the Wi-Fi modem circuit can be turned off according to the 802.11 standard (e.g., U-APSD) to save power. For example, during DTIM3, every 300 ms of sleep, the system wakes up for 3 ms to receive the AP's Beacon packet, resulting in an overall average current of approximately 2 mA

- Deep-sleep is used for applications that do not require constant Wi-Fi connectivity and only transmit data packets infrequently, such as temperature sensors that take measurements every 100 seconds. For example, after waking up every 300 seconds, it takes 0.3 to 1 seconds to connect to the AP (Access Point) and send data, so the overall average current can be much less than 1 mA. The current value of 20 μA is measured at 2.5 V.

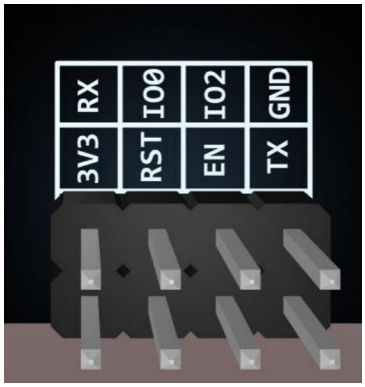
3 Appearance and Dimensions





4 Pin Definition

The ESP-01S module exposes a total of 8 pins, as shown in the pin diagram. The pin function definition table provides the detailed interface specifications.



ESP-01S Pin Diagram

Pin Function Definition Table

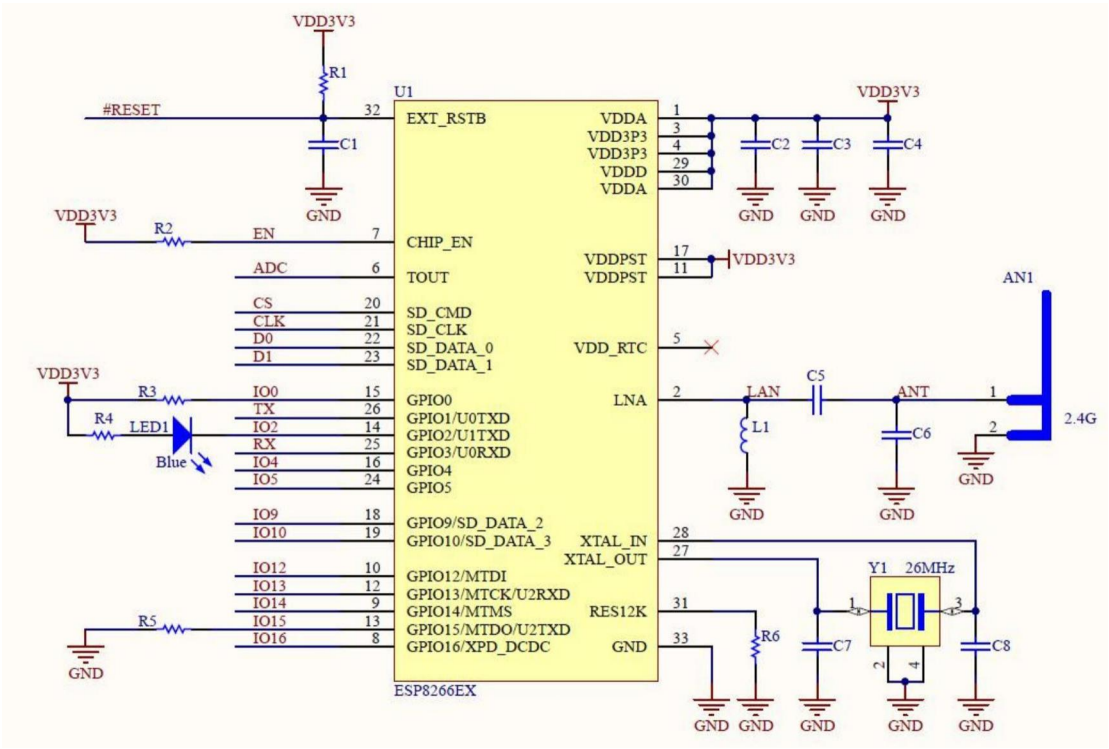
Pin No.	Name	Function Description
1	GND	Ground
2	IO2	GPIO2/UART1_TXD
3	IO0	GPIO0, download mode: externally pulled low, run mode: floating or externally pulled high
4	RXD	UART0_RXD/GPIO3
5	TXD	UART0_TXD/GPIO1
6	EN	Chip enable, active high
7	RST	Reset
8	VCC	3.3V power supply (VDD); external power supply output current is recommended to be above 500 mA

Module Boot Mode Description Table

Mode	CH_PD(EN)	RST	GPIO15	GPIO0	GPIO2	TXD0
Download Mode	High	High	Low	Low	High	High
Run Mode	High	High	Low	High	High	High

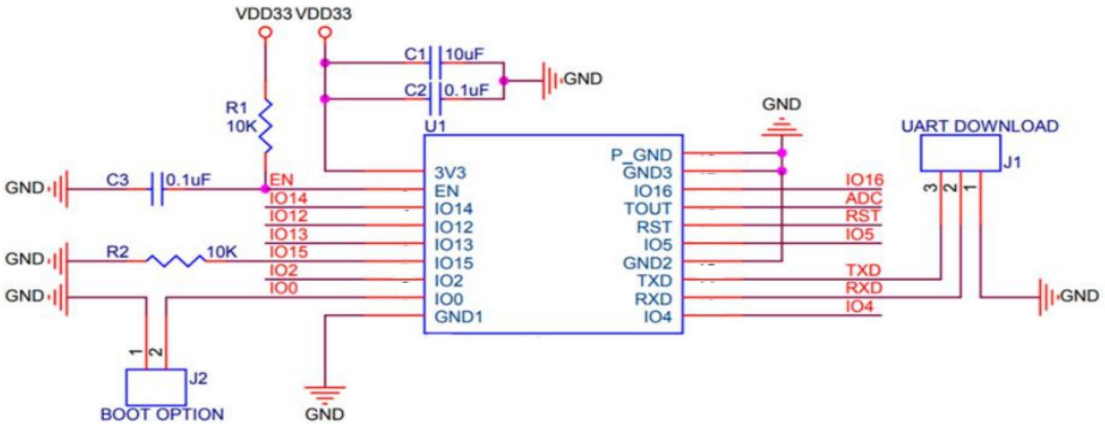
Note: Some pins have been internally pulled up; please refer to the schematic diagram.

5 Schematic Diagram



6 Design Guide

1. Application Circuit

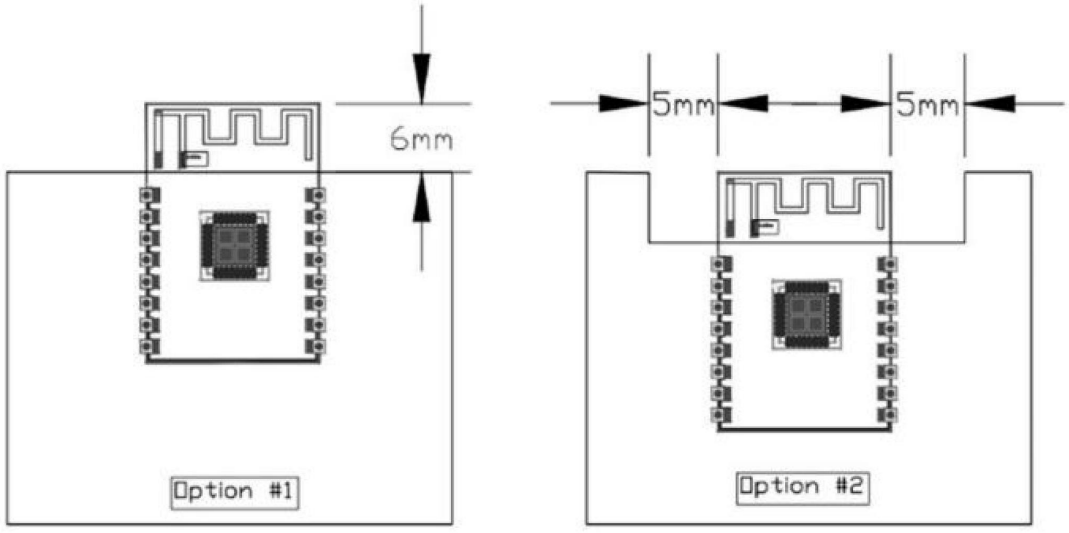


2. Antenna Layout Requirements

(1) For the installation position on the mainboard, the following two options are recommended:

- **Option 1:** Place the module at the edge of the mainboard, with the antenna area extending beyond the mainboard edge.
- **Option 2:** Place the module at the edge of the main board, and cut out a clearance area in the mainboard edge at the antenna position.

(2) To ensure optimal antenna performance of the onboard antenna, metal objects must not be placed near the antenna, and the antenna should be kept away from high-frequency devices.

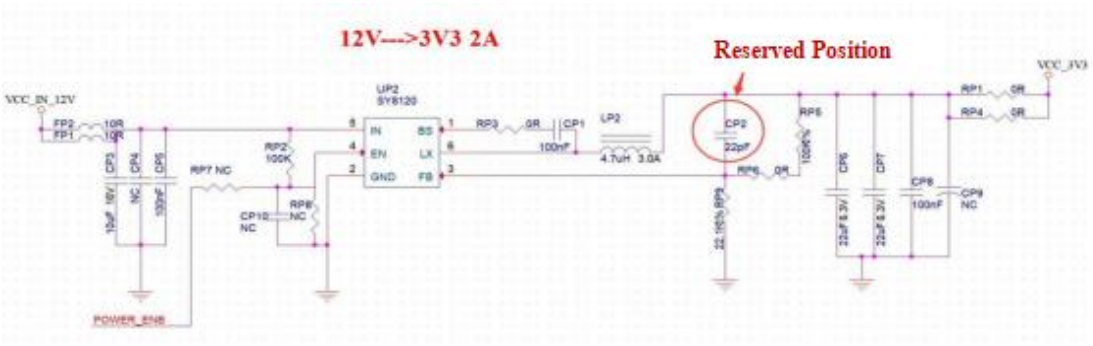


3. Power Supply

(1) A 3.3 V voltage is recommended, with a peak current of at least 500 mA.

(2) An LDO power supply is recommended; if using DC-DC, it is advised to control ripple within 30 mV.

(3) For the DC-DC power supply circuit, it is recommended to reserve space for a dynamic response capacitor, which can optimize output ripple under significant load variations.



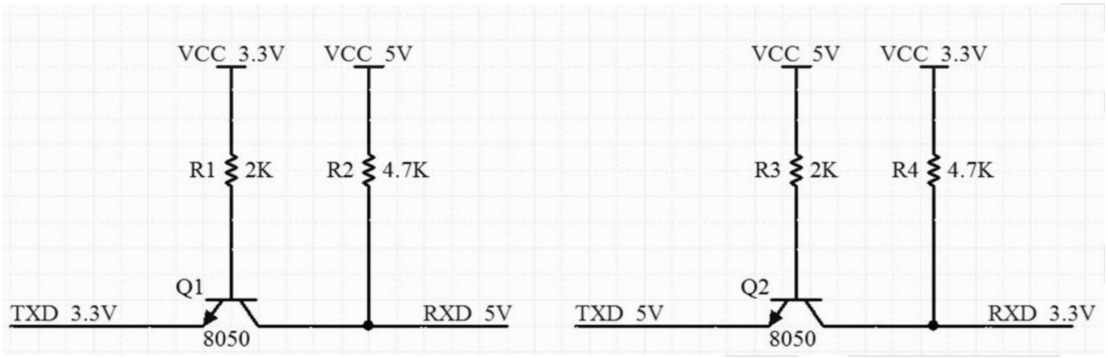
4. GPIO

(1) Some I/O pins are exposed on the module periphery. To use these I/O pins, it is recommended to connect a 10-100 Ω resistor in series on each I/O pin. This helps suppress overshoot, stabilize signal levels, and benefits both EMI (Electromagnetic Interference) and ESD (Electrostatic Discharge) protection.

(2) The pull-up/pull-down configuration for specific I/O pins must follow the guidelines in the specification, as it affects the module's boot configuration.

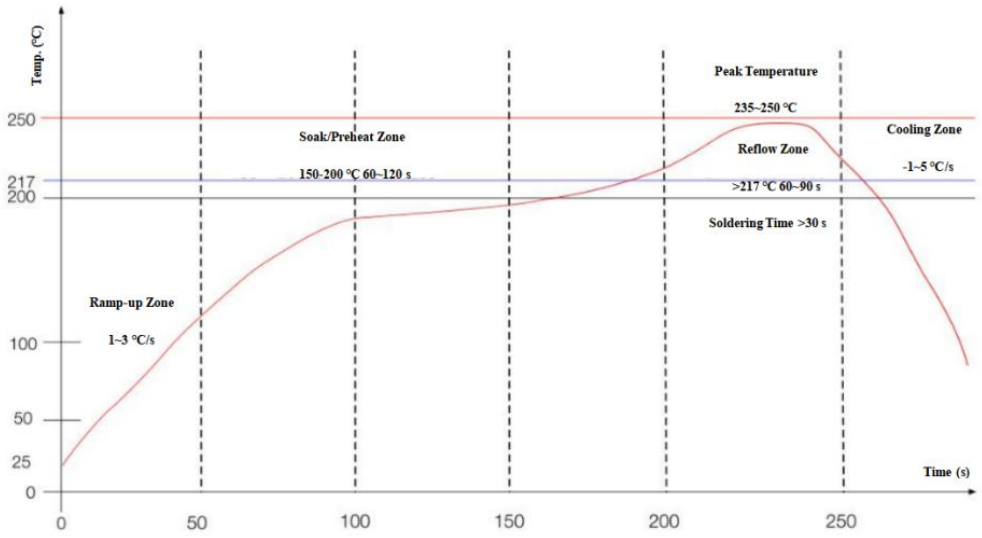
(3) The module's I/O pins operate at 3.3 V. If the IO voltage level of the main controller and the module do not match, a level-shifting circuit must be added.

(4) If an I/O pin is directly connected to a peripheral interface or pin headers, it is recommended to reserve space for an ESD protection device near the connector on the IO trace.



Level-shifting Circuit Diagram

7 Reflow Soldering Profile



Ramp-up Zone: Temperature: 25~150 ℃ | Time: 60~90 s | Ramp Rate: 1~3 ℃/s

Soak/Preheat Zone: Temperature: 150~200 ℃ | Time: 60~120 s

Reflow Zone: Temperature: >217 ℃ | Time: 60~90 s Peak Temperature: 235~250 ℃ | Time at Peak: 30~70 s

Cooling Zone: Temperature: Peak Temperature: ~180 ℃ | Cooling Rate: -1~-5 ℃/s

Solder: Tin-Silver-Copper Lead-free Solder (SAC305)

8 Packaging Information

As shown in the figure below, ESP-01S is packaged in trays. (The figure below is a schematic illustration.)

9 Contact Information

Official Website: https://www.ai-thinker.com

Develop DOCS: https://docs.ai-thinker.com

Official Forum: http://bbs.ai-thinker.com

Sample Purchase: https://anxinke.taobao.com

Business Cooperation: sales@aithinker.com

Technical Support: support@aithinker.com

Company Address: Room 410, Block C, Huafeng Smart Innovation Port, Gusu Xixiang, Bao'an District, Shenzhen City, Guangdong Province, China

Contact Hotline: 0755-29162996