



ESP-12S Specification

Version V1.1

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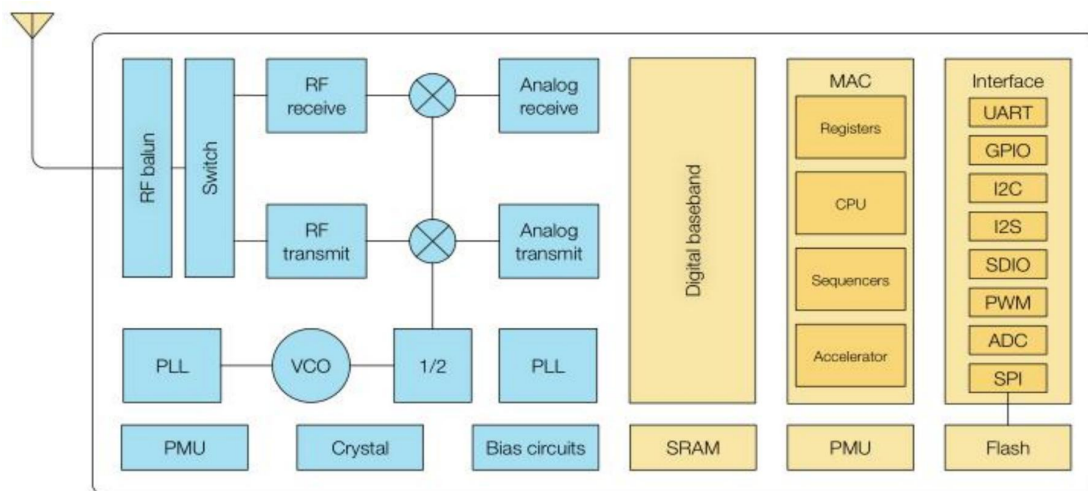
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1 Product Overview

The ESP-12S is a Wi-Fi module developed by Ai-Thinker Technology. Its core processor, ESP8266, integrates the industry-leading Tensilica L106 ultra-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-12S 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.



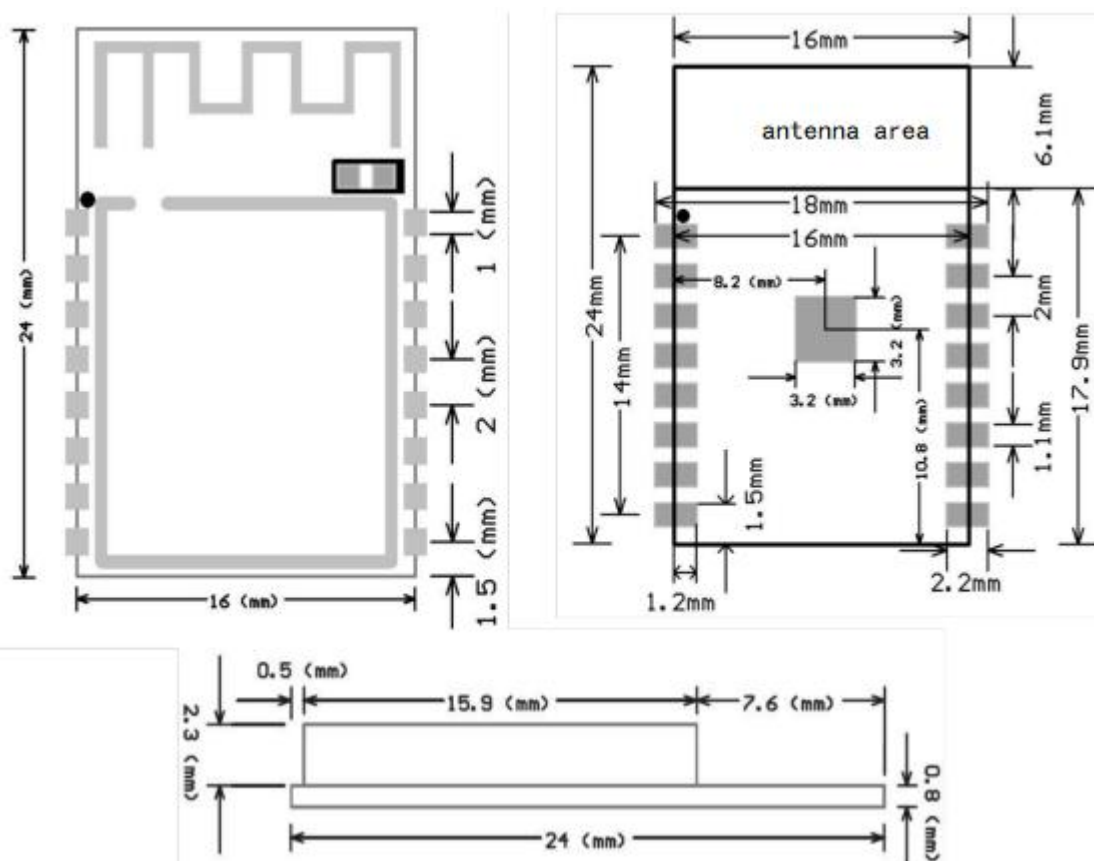
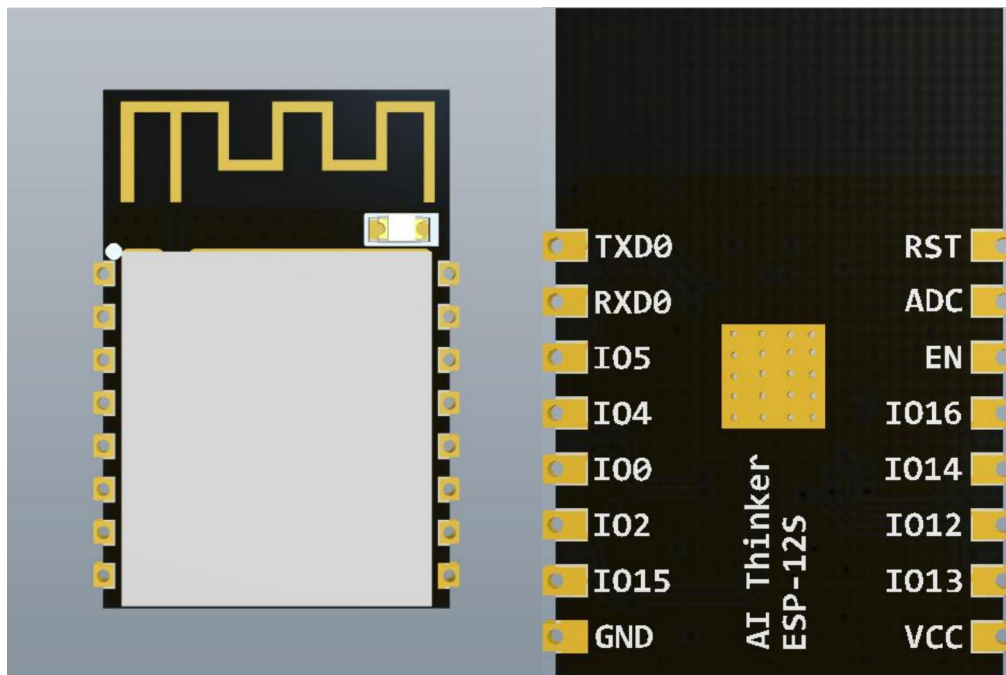
The ESP8266 features complete and self-contained Wi-Fi networking solution, allowing it to be used standalone or as a slave device integrated into a master MCU for operation. When ESP8266 is equipped with an application and serves as the sole application processor in a device, it can boot directly from an external flash memory. Its built-in high-speed cache memory helps to improve system performance and reduce memory requirements.

Alternatively, when the ESP8266 assumes the role of a Wi-Fi adapter for

wireless internet access, it can be easily integrated into any microcontroller-based design with minimal connection complexity, requiring only an SPI/SDIO interface or I2C/UART port.

With its powerful on-chip processing and storage capabilities, the ESP8266 can integrate sensors and other application-specific devices via its GPIO pins. This enables low upfront development effort and minimal system resource consumption during operation.

Appearance and Dimensions



Features

- Ultra-small 802.11b/g/n Wi-Fi SoC module
- Built-in ultra-low-power 32-bit Tensilica L106 MCU, supporting clock frequencies of 80 and 160 MHz, with RTOS support
- Built-in 1-channel 10-bit high-precision ADC
- Supports UART/GPIO/ADC/PWM/IIC interfaces
- Adopts SMD-16 package
- Integrates Wi-Fi MAC/BB/RF/PA/LNA
- Supports various sleep modes, with deep sleep current as low as 20 μ A
- Maximum UART baud rate up to 4 Mbps
- Embedded LwIP protocol stack
- Supports STA/AP/STA+AP operating 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 1.1 Main Parameter Specifications

Model	ESP-12S
Package	SMD-16
Dimensions	24*16*3 (±0.2) mm
Certification	FCC, CE, SRRC, RoHs
SPI Flash	Default 32 Mbit
Supported Interfaces	UART/GPIO/ADC/PWM
Available I/Os	9
UART Baud Rate	Supports 300–4,608,000 bps, default 115,200 bps
Frequency Range	2412–2484 MHz
Antenna Type	On-board PCB antenna
Output Power	802.11b: 16±2 dBm (@11 Mbps) 802.11g: 14±2 dBm (@54 Mbps) 802.11n: 13±2 dBm (@HT20, MCS7)
Receiver Sensitivity	CCK, 1 Mbps: -90d Bm CCK, 11 Mbps: -85 dBm 6 Mbps (1/2 BPSK): -88d Bm 54 Mbps (3/4 64-QAM): -70 dBm HT20, MCS7 (65 Mbps, 72.2 Mbps): -67d Bm
Power Consumption (Typical Value)	Continuous transmission => Avg: ~71 mA, peak: 300 mA Modem sleep: ~20 mA Light sleep: ~2 mA Deep sleep: ~0.02 mA
Security	WEP/WPA-PSK/WPA2-PSK
Power Supply Range	Supply voltage: 3.0–3.6 V, supply current: >500 mA
Operating Temperature	-20–85 °C
Storage Conditions	-40–85 °C, < 90% RH
Weight	1.45 (±0.1) g

2 Pin Definition

The ESP-12S module exposes a total of 16 pins, as shown in the Figure 2.1. The Table 2.2 provides the detailed interface definitions.

Figure 2.1 ESP-12S Pin Diagram

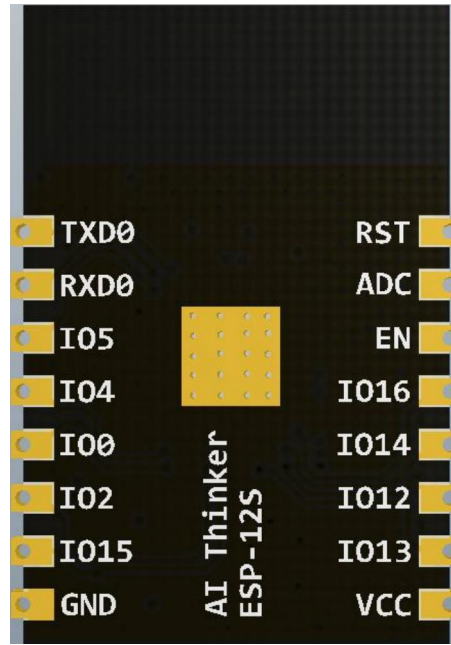


Table 2.2 Pin Function Definition

Pin No	Name	Function Description (The pin counts and pin No. for each module are inconsistent.)
1	RST	Reset pin, active low
2	ADC	A/D conversion result, input voltage range: 0–1 V, value range: 0–1024
3	EN	Chip enable, active high
4	IO16	GPIO16; can be used for deep sleep wake-up when connected to the RST pin
5	IO14	GPIO14; HSPI_CLK, IR_T, IC_SCL, I2SI_WS
6	IO12	GPIO12; HSPI_MISO
7	IO13	GPIO13; HSPI_MOSI; UART0_CTS

8	VCC	3.3 V VDD; external power supply output current is recommended to be above 500 mA
9	GND	Ground
10	IO15	GPIO15; I2SO_BCK; HSPICS; UART0_RTS
11	IO2	GPIO2; UART1_TXD; I2C_SDA I2SO_WS
12	IO0	GPIO0; download mode: externally pulled low, run mode: floating or externally pulled high
13	IO4	GPIO4
14	IO5	GPIO5; IR_R
15	RXD	UART0_RXD; GPIO3; I2SO_DATA
16	TXD	UART0_TXD; GPIO1

Table 2.3 ESP Series Module Boot Mode Description

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.

3 Electrical Parameters

Electrical Characteristics

Parameter		Condition	Min	Typ	Max	Unit
Storage Temperature		-	-40	Room temperature	85	°C
Operating Temperature		-	-20	20	85	°C
Max Soldering Temperature		IPC/JEDEC J-STD-020	-	-	260	°C
Supply Voltage		VDD	2.7	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

Wi-Fi RF

Description	Min	Typ	Max	Unit
Input Frequency	2400	-	2483.5	MHz
Input Reflection	-	-	-10	dB
Output Power				
72.2 Mbps, PA output power	15.5	16.5	17.5	dBm
11b mode, PA output power	19.5	20.5	21.5	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 (65Mbps, 72.2 Mbps)		-67		dBm
Adjacent Channel Rejection				
OFDM, 6 Mbps		37		dB
OFDM, 54 Mbps		21		dB
HT20, MCS0		37		dB
HT20, MCS7		20		dB

Power Consumption

The following power consumption data is measured based on a 3.3 V power supply, an ambient temperature of 25 °C, 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.

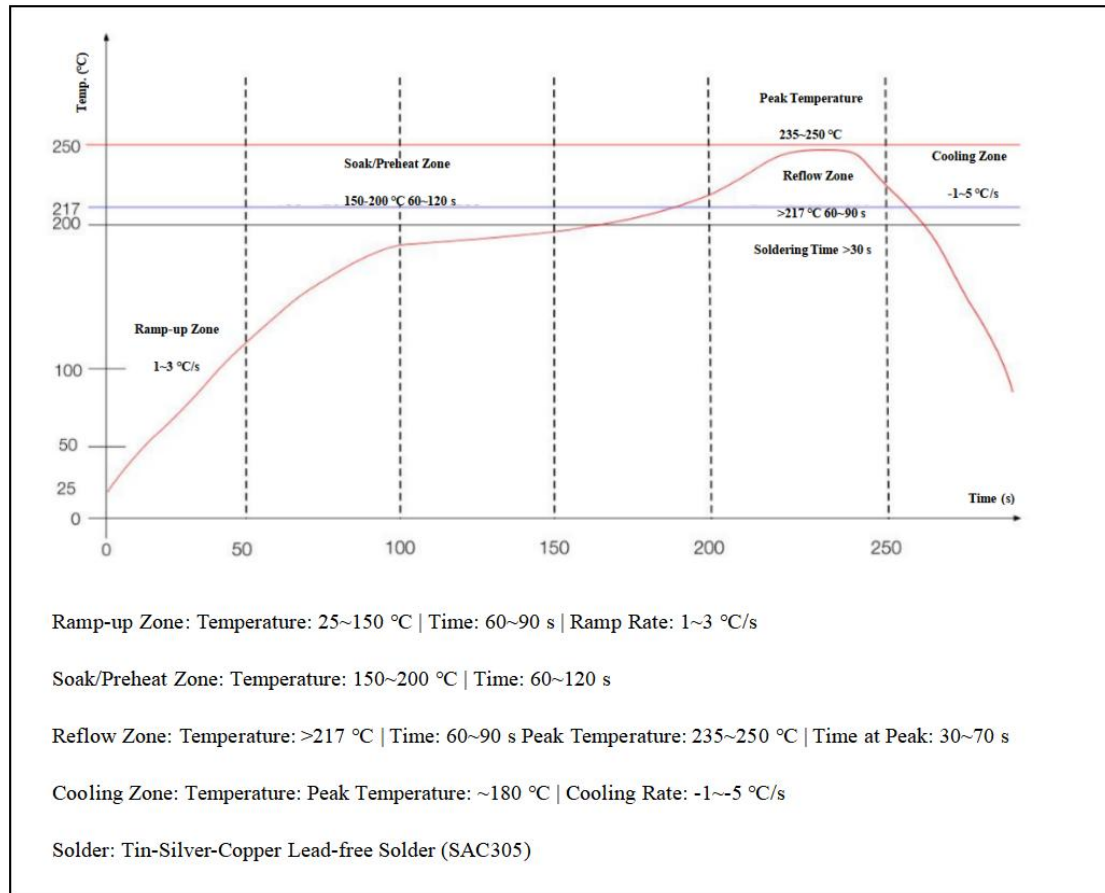
Mode	Min	Typ	Max	Unit
TX 802.11b, CCK 11 Mbps, POUT=+17 dBm	-	170	-	mA
TX 802.11g, OFDM 54 Mbps, POUT=+15 dBm	-	140	-	mA
TX 802.11n, MCS7, POUT =+13 dBm	-	120	-	mA
RX 802.11b, Packet Length 1024 bytes, -80 dBm	-	50	-	mA
RX 802.11g, Packet Length 1024 bytes, -70 dBm	-	56	-	mA
RX 802.11n, Packet Length 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:

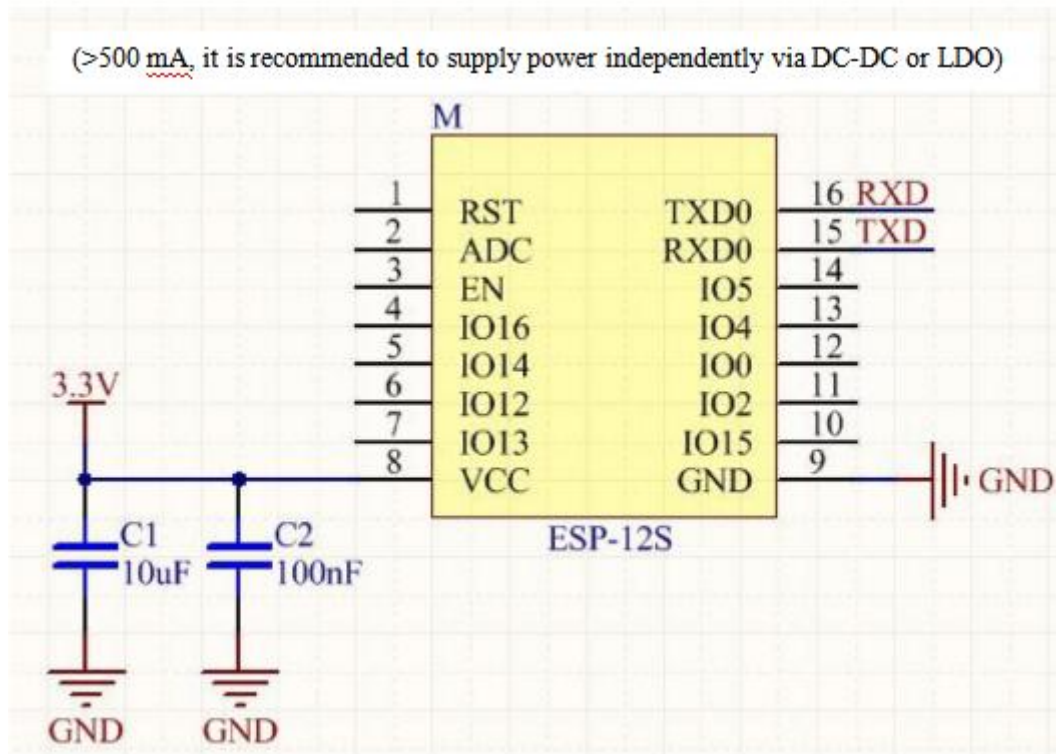
- Modem-sleep is used for applications requiring the CPU to remain active, such as PWM or I2S applications. While maintaining a Wi-Fi connection, if there is no data transmission, the Wi-Fi modem circuit can be turned off according to the 802.11 standard (e.g., U-APSD) to save power. For example, during 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 μ A is measured at 2.5 V.

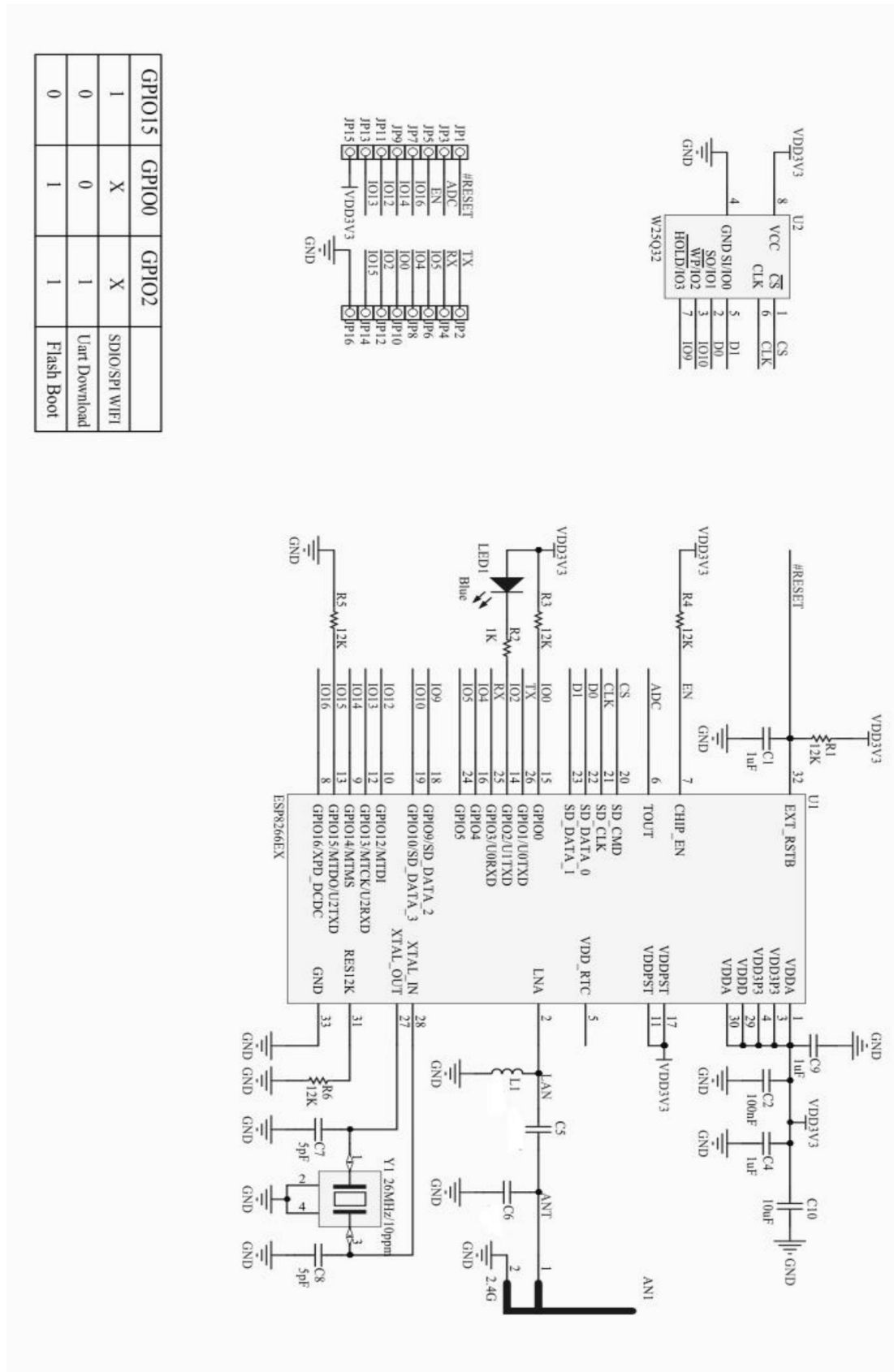
4 Reflow Soldering Profile



5 Application Circuit



6 Schematic Diagram



7 Packaging Information

As shown in the figure below, ESP-12S is packaged in tape and reel.



8 Contact Information

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

Develop Wiki: <http://wiki.ai-thinker.com/>

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

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