



# ESP32-SU Specification

Version V1.0.0

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## Document resume

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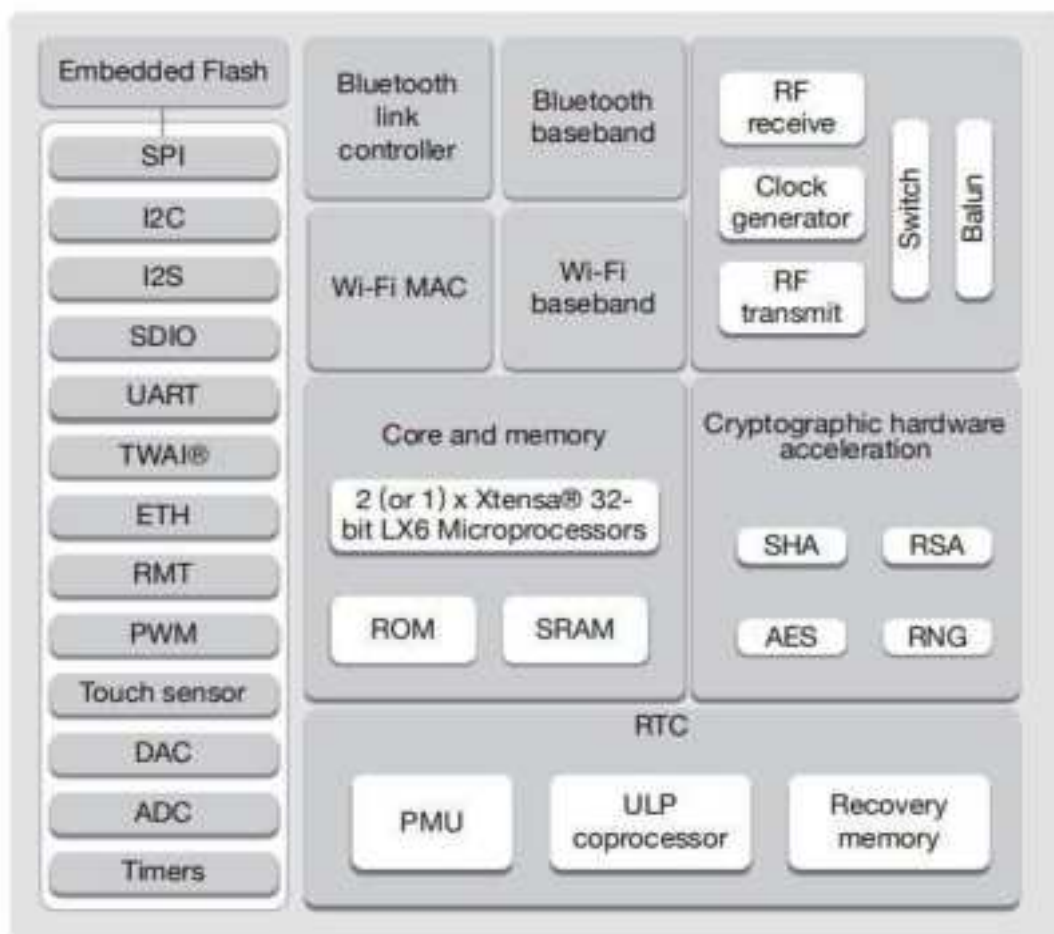
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## 1. Product Overview

ESP32-SU is a general type Wi-Fi + BT + BLE MCU module, powerful and versatile, can be used for low-power sensor networks and high standards tasks, such as voice encoding, audio streaming, and MP3 decoding.

The core of this module is the ESP32 chip, which has scalable, adaptive features. The chip is configured with two cores that can be controlled or powered alone. The user can cut off the CPU and use a low-power co-processor to continuously monitor state changes in the peripherals or whether certain analog quantities exceed the threshold. The ESP32 also incorporates rich peripherals, including a capacitive touch sensor, Hall sensor, low-noise sensing amplifier, SD card interface, Ethernet interface, high-speed SDIO / SPI, UART, I2S, and I2C. ESP32-SU module with built-in Xtensa® 32-bit LX6 dual-core processor supports main frequency for 80MHz, 160MHz, and 240MHz.



**Figure 1 Main chip architecture diagram**

## 1.1. Characteristic

- Complete 802.11b/g/n Wi-Fi + BT + BLE SoC module
- A low-power dual-core 32-bit CPU is used as an application processor
- The main frequency is up to 240MHz, and the computing power is up to 600DMIPS
- Built-in for 520KB SRAM
- Support for interfaces such as UART / SPI / I2C / PWM / ADC / DAC
- SMD-38 package for easy welding and testing
- Multiple sleep modes are supported
- The STA / AP / STA + AP pattern and confounding patterns are supported
- Support for Android, IOS of SmartConfig (APP) / AirKiss (wechat) one-click distribution network
- Support for serial local upgrade and remote Firmware upgrade (FOTA)
- Universal AT instructions can be used easy and quickly
- Embedded Lwip and FreeRTOS

## 2. Main parameters

**Table 1 Description of the main parameters**

<b>Model</b>	ESP32-SU
<b>Package</b>	SMD-38
<b>Size</b>	18*19.2*3.1(±0.2)mm
<b>Antenna</b>	IPEX(external antenna)
<b>Frequency</b>	2400~2483.5MHz
<b>Operating temperature</b>	-40°C~85°C
<b>Storage temperature</b>	-40°C~125°C,<90%RH
<b>Power supply</b>	Voltage 3.0V~3.6V current>500mA
<b>Interface</b>	UART/GPIO/ADC/PWM/I2C/I2S/SPI/SDIO/DAC
<b>IO</b>	26
<b>UART rate</b>	Support 300~4608000bps default 115200bps
<b>Bluetooth</b>	Bluetooth 4.2BR/EDR and BLE standard
<b>Security</b>	WEP/WPA-PSK/WPA2-PSK
<b>SPI Flash</b>	4MByte☒default

### 2.1. Static electricity requirements

ESP32-SU 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

Parameters		Conditions	Min.	Typical value	Max.	Unit
Power supply voltage		VDD	3.0	3.3	3.6	V
I/O	$V_{IL}/V_{IH}$	-	-0.3/0.75V DD	-	0.25VDD/VDD +0.3	V
	$V_{OL}/V_{OH}$	-	N/0.8VIO	-	0.1VIO/N	V
	$I_{MAX}$	-	-	-	12	mA

## 2.3. Wi-Fi RF performance

Table 3 WiFi RF performance table

Description	Typical values	Unit
Operating frequency	2412-2462	MHz
Output power		
11n MCS7	17±2	dBm
11g 54Mbps	17±2	dBm
11b mode	17±2	dBm
Receiving sensitivity ☒ typical value		
11b 1Mbps	-97	dBm
11b 11Mbps	-88	dBm
11g 6Mbps	-93	dBm
11g 54Mbps	-75	dBm
11n HT20(MCS7)	-72	dBm
11n HT40(MCS7)	-69	dBm

## 2.4. BLE RF performance

**Table 4 BLE RF performance table**

Description	Typical values	Unit
<b>Output power</b>		
Transmitting power	1±2	dBm
<b>Receiving sensitivity Low power consumption Bluetooth (typical value)</b>		
Sensitivity@30.8%PER	-93	dBm

## 2.5. Power consumption

The following power consumption data are based on a 3.3V power supply, ambient temperature of 25°C and measured using an internal regulator.

- All measurements were completed without the SAW filter at the antenna interface.
- All emission data were based on a 50% duty cycle, as measured in the mode of continuous emission.

**Table 5 Power consumption table**

Mode	Min.	Average value	Max.	Unit
Tx 802.11b DSSS1Mbps POUT=+19.5dBm	-	240	-	mA
Tx 802.11g OFDM54Mbps POUT=+14dBm	-	190	-	mA
Tx 802.11n MCS7 POUT=+13dBm	-	183	-	mA
Rx 802.11b/g/n	-	112	-	mA
Rx 802.11n 40MHz	-	118	-	mA
Light-Sleep	-	1.4	-	mA
Deep-Sleep	-	60	-	μA





## 4. Pin definition

ESP32-SU has a total of 38 interfaces. As shown in below pin diagram, the pin function definition table is the interface definition.

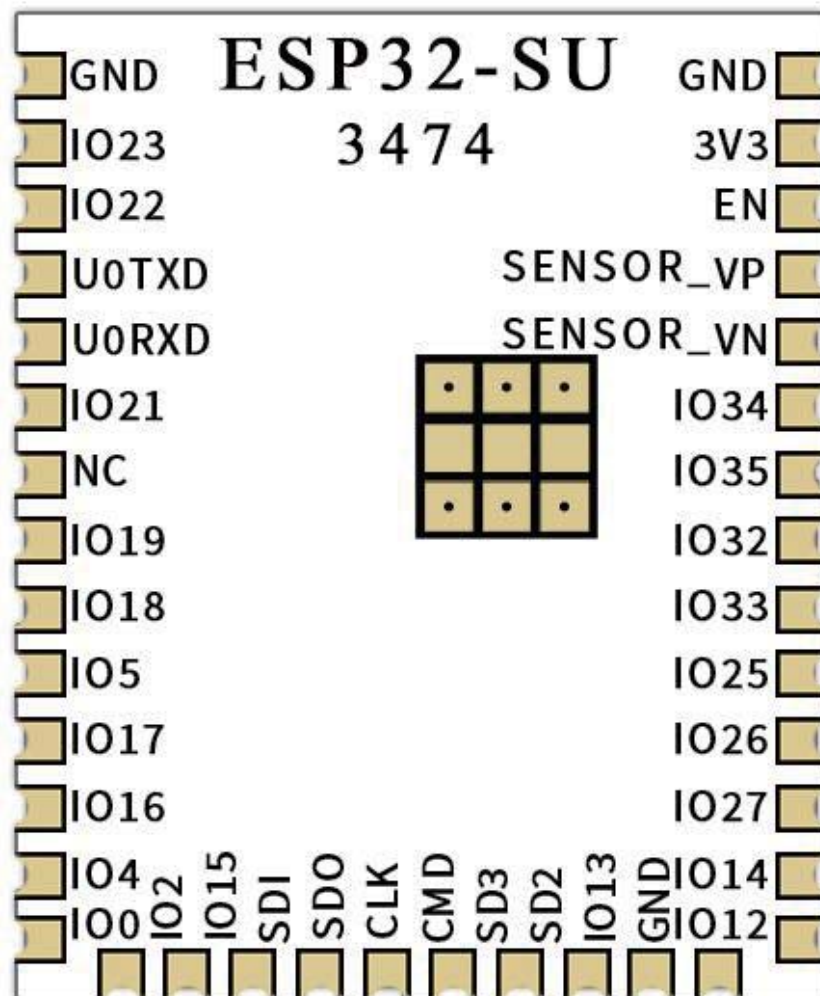


Figure 5 Schematic diagram of module pins (bottom view)

Table 6 Pin function definition table

No.	Name	Function
1	GND	Ground
2	3V3	For 3.3V power supply (VDD), the output current of the external power supply is recommended to be above 500mA
3	EN	Chip enables pin, high level effective
4	SENSOR_VP	GPIO36,SENSOR_VP,ADC_H,ADC1_CH0,RTC_GPIO0
5	SENSOR_VN	GPIO39,SENSOR_VN,ADC1_CH3,ADC_H,RTC_GPIO3
6	IO34	GPIO34,ADC1_CH6,RTC_GPIO4
7	IO35	GPIO35,ADC1_CH7,RTC_GPIO5
8	IO32	GPIO32,XTAL_32K_P(32.768kHz crystaloscillator input),ADC1_CH4,TOUCH9,RTC_GPIO9
9	IO33	GPIO33,XTAL_32K_N(32.768kHz crystaloscillator output),ADC1_CH5,TOUCH8,RTC_GPIO8
10	IO25	GPIO25,DAC_1,ADC2_CH8,RTC_GPIO6,EMAC_RXD0
11	IO26	GPIO26,DAC_2,ADC2_CH9,RTC_GPIO7,EMAC_RXD1
12	IO27	GPIO27,ADC2_CH7,TOUCH7,RTC_GPIO17,EMAC_RX_DV
13	IO14	GPIO14,ADC2_CH6,TOUCH6,RTC_GPIO16,MTMS,HSPICLK,HS2_CLK,SD_CLK,EMAC_TXD2
14	IO12	GPIO12,ADC2_CH5,TOUCH5,RTC_GPIO15,MTDI,HSPIQ,HS2_DATA2,SD_DATA2,EMAC_TXD3
15	GND	Ground
16	IO13	GPIO13,ADC2_CH4,TOUCH4,RTC_GPIO14,MTCK,HSPID,HS2_DATA3,SD_DATA3,EMAC_RX_ER
17	SHD/SD2	Do not use as an IO port,SD_DATA2,SPIHD,HS1_DATA2,U1RXD
18	SWP/SD3	Do not use as an IO port,SD_DATA3,SPIWP,HS1_DATA3,U1TXD
19	SCS/CMD	Do not use as an IO port,SD_CMD,SPICS0,HS1_CMD,U1RTS
20	SCK/CLK	Do not use as an IO port,SD_CLK,SPICLK,HS1_CLK,U1CTS
21	SDO/SD0	Do not use as an IO port,SD_DATA0,SPIQ,HS1_DATA0,U2RTS
22	SDI/SD1	Do not use as an IO port,SD_DATA1,SPID,HS1_DATA1,U2CTS
23	IO15	GPIO15,ADC2_CH3,TOUCH3,MTDO,HSPICS0,RTC_GPIO13,HS2_CMD,SD_CMD,EMAC_RXD3

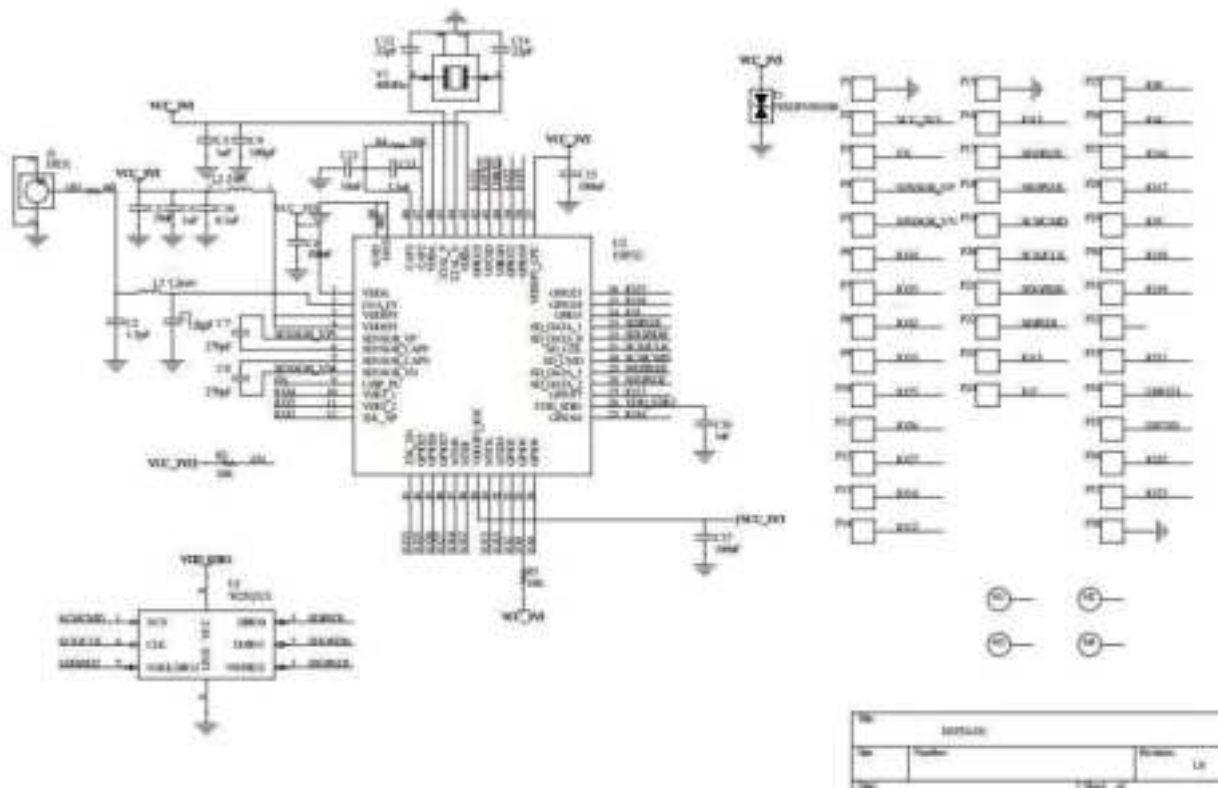
24	IO2	GPIO2,ADC2_CH2,TOUCH2,RTC_GPIO12,HSPIWP,HS2_DATA0,SD_DATA0
25	IO0	GPIO0,ADC2_CH1,TOUCH1,RTC_GPIO11,CLK_OUT1,EMAC_TX_CLK
26	IO4	GPIO4,ADC2_CH0,TOUCH0,RTC_GPIO10,HSPIHD,HS2_DATA1,SD_DATA1,EMAC_TX_ER
27	IO16	GPIO16,HS1_DATA4,U2RXD,EMAC_CLK_OUT
28	IO17	GPIO17,HS1_DATA5,U2TXD,EMAC_CLK_OUT_180
29	IO5	GPIO5,VSPICS0,HS1_DATA6,EMAC_RX_CLK
30	IO18	GPIO18,VSPICLK,HS1_DATA7
31	IO19	GPIO19,VSPIQ,U0CTS,EMAC_TXD0
32	NC	-
33	IO21	GPIO21,VSPIHD,EMAC_TX_EN
34	RXD0	GPIO3,U0RXD,CLK_OUT2
35	TXD0	GPIO1,U0TXD,CLK_OUT3,EMAC_RXD2
36	IO22	GPIO22,VSPIWP,U0RTS,EMAC_TXD1
37	IO23	GPIO23,VSPID,HS1_STROBE
38	GND	Ground

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

**Table 7 System Start-up Mode**

System start-up mode			
Pin	Default	SPI start-up mode	Download mode
IO0	Pull up	1	0
IO2	Pull down	N/C	0

## 5. Schematic



## 6. Design guidance

### 6.1. Module application circuit

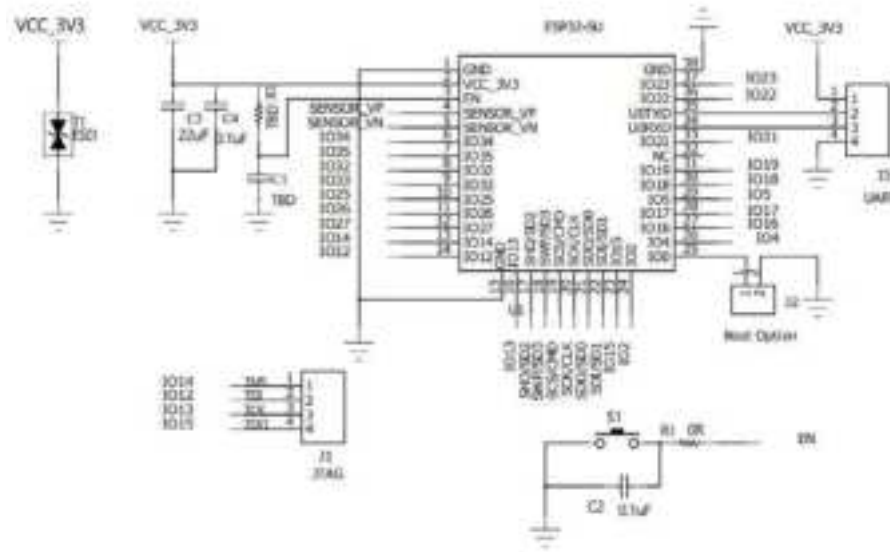


Figure 7 Application circuit diagram

#### Note

- IO0 for start control pin normal operating mode is at high level, in flash firmware mode at low level. Inside the chip default high level.
- To ensure the normal power supply when powered on the chip, the RC delay circuit needs to be added at the EN pin. The EN pin inside the module already has a 10k pull up resistance.

### 6.2. Power supply

- Recommended voltage of 3.3V, peak current above 500mA.
- LDO is recommended; DC-DC ripple within 30mV.
- The DC-DC power supply circuit proposes to reserve the dynamic response capacitance to optimize the output ripple with large load changes.

- 

**Figure 8 DC-DC anti-hypertensive circuit diagram**

### 6.3. GPIO

- Some IO ports are lead outside the module, if using, a proposed resistance of 10-100 ohms on the IO port. This suppresses the overshoot and enables smoother levels on both sides, helping for both EMI and ESD.
- The up and down of the special IO port should refer to the use instructions of the specification, which will affect the start-up configuration of the module.
- The IO port of the module is 3.3V, if the main control does not match the IO port level of the module, the level conversion circuit should be increased.
- If the IO port is directly connected to the peripheral interface, or terminals such as pin header, it is recommended to reserve ESD devices at the IO port line near the terminal.

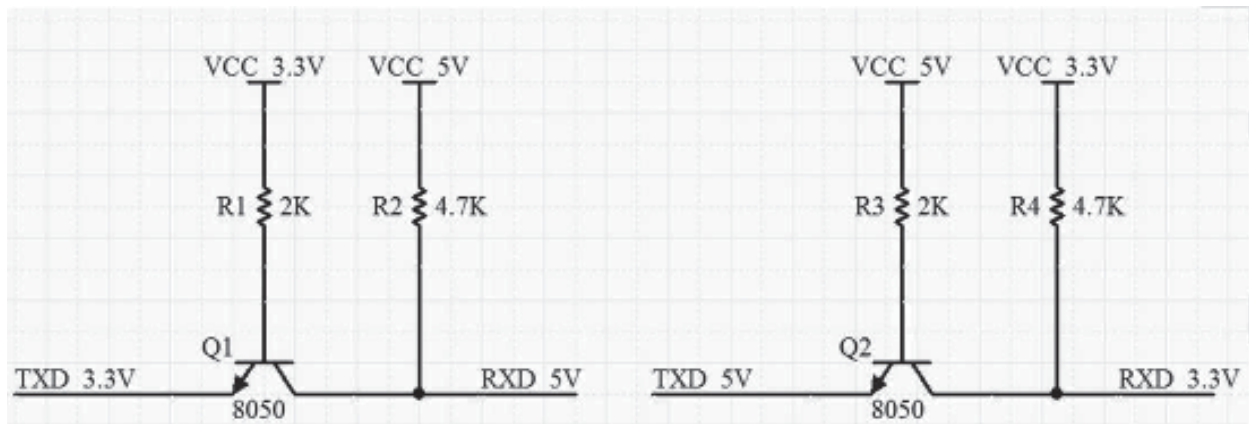


Figure 9 Level convert circuit



## 7. Flow welding curve diagram

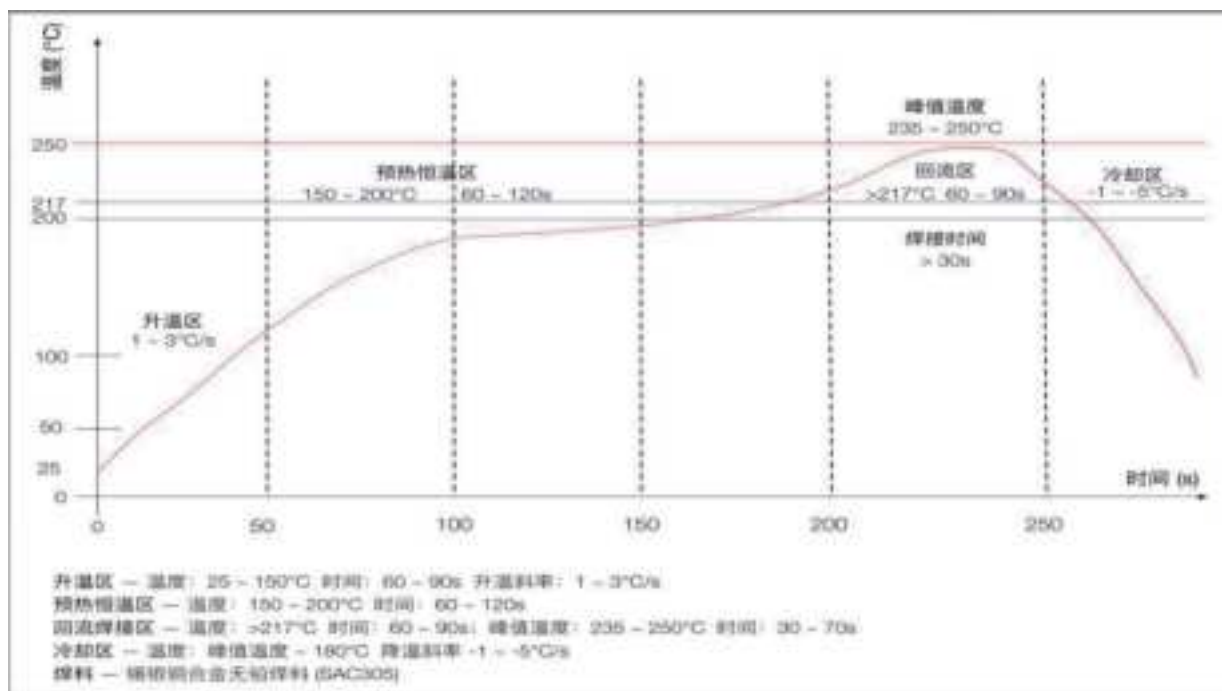


Figure 10 Flow welding diagram

## 8. Product related models

**Table 7 Product related model list**

Model name	Package	Size	Antenna
ESP32-SU	SMD-38	19.2*18.0*3.0(±0.2)mm	IPEX
ESP32-S	SMD-38	25.5*18.0*3.0(±0.2)mm	On-board PCB antenna /IPEX
NodeMCU-32 ☒match with ESP32-S	DIP-30	48.26*25.4(±0.2)mm	On-board PCB antenna /IPEX
Product related information <a href="https://docs.ai-thinker.com">https://docs.ai-thinker.com</a>			

## 9. Product packaging information

ESP32-SU module was packaged in a tape, 700pcs /pcs. As shown in the below image:



Figure 11 Package and packing diagram

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## FCC WARNING

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

This device complies with Part 15 of the 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.

This device and its antenna(s) must not be co-located or operating in conjunction with any other antenna or transmitter.

15.105 Information to the user.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

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 generates, 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.

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20

cm between the radiator and your body.

Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment.

This transmitter must not be co-located or operating in conjunction with any other

antenna or transmitter.

The availability of some specific channels and/or operational frequency bands are country dependent and are firmware programmed at the factory to match the intended destination.

The firmware setting is not accessible by the end user.

The final end product must be labelled in a visible area with the following:

“Contains Transmitter Module “2ATPO-ESP32-SU”

## **Requirement per KDB996369 D03**

### **2.2 List of applicable FCC rules**

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.<sup>3</sup>

**Explanation:** This module meets the requirements of FCC part 15C (15.247).it Specifically identified AC Power Line Conducted Emission, Radiated Spurious emissions, Band edge and RF Conducted Spurious Emissions, Conducted Peak Output Power, Bandwidth, Power Spectral Density, Antenna Requirement.

Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

Explanation: host Equipment modification module can only be used in the situation where the distance from the human body is more than 20cm and the antenna antenna gain is less than 1dBi.

If a modular transmitter is approved as a "limited module," then the module manufacturer is responsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.

A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited

module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.

This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

**Explanation:** The module is a single module.

## **2.6 RF exposure considerations**

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information: (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person's body); and (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility of the module through a change in FCC ID (new application).

**Explanation:** The module complies with FCC radiofrequency radiation exposure limits for uncontrolled environments. The device is installed and operated with a distance of more than 20 cm between the radiator and your body." This module follows FCC statement design, FCC ID : 2ATPO-ESP32-SU

### **Antennas**

A list of antennas included in the application for certification must be provided in the instructions. For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that for example an "omni-directional antenna" is not considered to be a specific "antenna type")).

For situations where the host product manufacturer is responsible for an external connector, for example with an RF pin and antenna trace design, the integration instructions shall inform the installer that unique antenna connector must be used on the Part 15 authorized transmitters used in the host product.



The module manufacturers shall provide a list of acceptable unique connectors.

**Explanation:** The OEM host can equipped an antenna which antenna gain shall not greater than 1dBi.

## **2.7 Label and compliance information**

Grantees are responsible for the continued compliance of their modules to the FCC rules. This

includes advising host product manufacturers that they need to provide a physical or e-label stating "Contains FCC ID" with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

**Explanation:** The host system using this module, should have label in a visible area indicated the following texts: "Contains FCC ID: 2ATPO-ESP32-SU.

## **2.8 Information on test modes and additional testing requirements<sup>5</sup>**

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer's determination that a module as installed in a host complies with FCC requirements.

**Explanation:** Shenzhen Ai-Thinker Technology Co., Ltd. can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

## **2.9 Additional testing, Part 15 Subpart B disclaimer**

The grantee should include a statement that the modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product

as being Part 15

Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

**Explanation:** The module without unintentional-radiator digital circuitry, so the module does not require an evaluation by FCC Part 15 Subpart B. The host should be evaluated by the FCC Subpart B.