User Mannual

ESP-32S

VER:V1.1 2018-3-18 NUM：ESP32SCN

Features

- SOC features
  - Built-in Tensilica L106 ultra-low power consumption 32-bit cpu, the main frequency can be 80MHz and 160MHz, also support RTOS;
  - Built-in TCP/IP protocol stack;
  - Built-in 1 channel 10-bit high precision ADC;
  - Interfaces include HSPI, UART, I2C, I2S, IR Remote Control, PWM, GPIO;
  - 20uA deep-sleep current, less than 5uA cut-off current;
  - 2ms wake-up time;
  - 1.0mW consume power (DTIM3 and standby state);
- Wi-Fi features
  - Support 802.11 b/g/n/e/i
  - Support three modes: Station, SoftAP, and SoftAP+STA;
  - Support Wi-Fi Direct (P2P);
  - Support hardware acceleration for CCMP (CBC-MAC, computation mode), TKIP (MIC, RC4), WAPI(SMS4), WEP(RC4), CRC;
  - P2P detection, P2P GO mode/GC mode and P2P power management;
  - WPA/PA2 PSK and WPS;
  - Support 802.11 i security: pre-certification and TSN;
  - Support 802.11n (2.4 GHz);
  - 802.1h/RFC1042 frame encapsulation;
  - Support seamless roam;
  - Support AT remote upgrade and cloud OTA upgrade;
  - Support SmartConfig function for Android and iOS device.

Module Interface

- 2xUART
- 1xADC
- 1xEn
- 1xWakeup pin
- 1xHSPI
- 1xI2C
- 1xI2S
- 11xGPIOs
- 4M SPI Flash

- **Working temperature：** -40°C-105°C
- **Module size：** 16mm×24mm

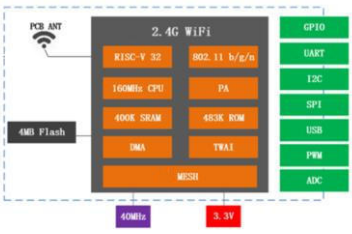
Applications

- Serial transparent transmission;
- WiFi prober;
- Smart power plug/Smart LED light;
- Mesh networks;
- Sensor networks;
- Wireless location recognition;● Wireless location system beacon;
- Industrial wireless control.

Module Type

Name	Antenna Type
ESP-32S	PCB Antenna

Module Structure



Update Record

Date	Version	Update
2017-3-14	V1.0	Initial version
2017-3-18	V1.1	Add system design

Table of Contents

1. Introduction

The WiFi module ESP-32S is manufactured by using a high-performance chip named ESP8266. This small chip is encapsulated an enhanced Tensilica's L106 diamond series 32-bit kennel CPU with a SRAM. Thus, ESP8266 has the complete function Wi-Fi function; it can be applied independently, and also can be used as a slaver working with other host CPU. When ESP8266 is applied as a slaver, it can start from the onboard flash. The built-in high-speed buffer is not only benefit to improve the system performance, but optimize the store system. In addition, ESP-32S WiFi module can be used as Wi-Fi adapter by SPI/SDIO or I2C/UART interface, when it is applied to other MCU design.

The ESP-32S WiFi module supports the standard IEEE802.11 b/g/n/e/i protocol and the complete TCP/IP protocol stack. User can use it to add the WiFi function for the installed devices, and also can be viewed as a independent network controller. Anyway, ESP-32S module provides many probabilities with the best price.

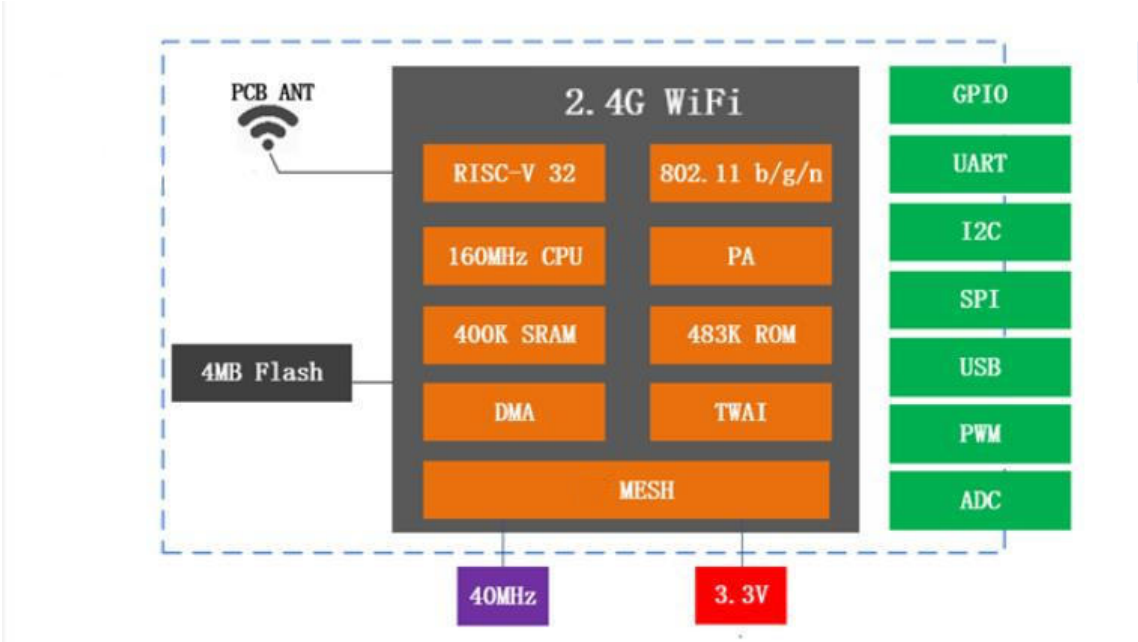


Fig. 1.1 ESP-32S Module Structure

Technical parameters for ESP-32S are listed as follows.

Table 1.1 ESP-32S Parameters

Types	Items	Parameters
Wi-Fi	Frequency	2.4G~2.5G(2400M~2483.5M)
	Transmit power	802.11b: +15 dBm
		802.11g: +14 dBm
		802.11n: +14 dBm
	Receiver sensitivity	802.11b: -91 dbm (11Mbps)
		802.11g: -75 dbm（54Mbps）
		802.11n: -72 dbm（MCS7）
	Antenna	PCB antenna / U.F.L antenna
Hardware	CPU	Tensilica L106 32 bit MCU
	Interface	UART/SDIO/SPI/I2C/I2S/IR control
		GPIO/ADC/PWM/SPI/I2C/I2S
	Working voltage	2.5V ~ 3.6V
	Working current	Average current: 80 mA,Peak current: >200mA
	Working temperature	-40°C ~105°C
	Environment temperature	-40°C ~ 105°C
	Shape	16*24*3mm
Software Types	Wi-Fi working mode	Station/SoftAP/SoftAP+Station
	Security mode	WPA/WPA2
	Encryption type	WEP/TKIP/AES
	Update firmware	UART Download/OTA
	Software develop	Non-RTOS/RTOS/Arduino IDE etc.
	Network protocol	IPv4, TCP/UDP/HTTP/FTP/MQTT

2. Interface Definition

ESP-32S module interface definition is shown as below。

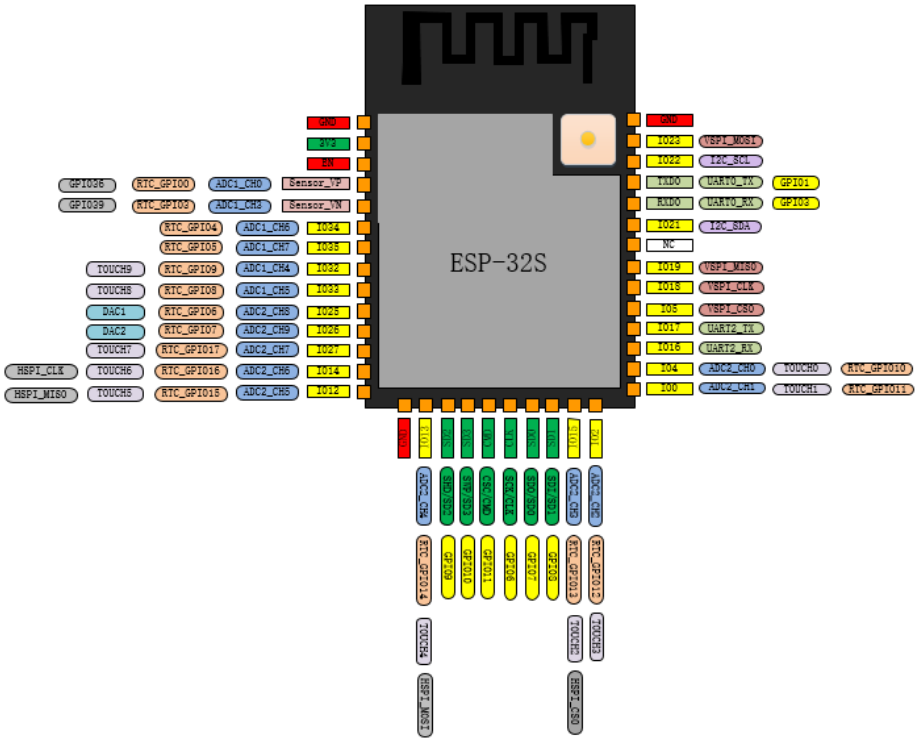


Fig. 2.1 ESP-32S Pin Definition

Working mode and pin function is shown in Table 2.1.

Table 2.1 Working mode

模式	GPIO
UART Download Mode	低
Flash Boot Mode	高

Table 2.2 Pin Function Definition

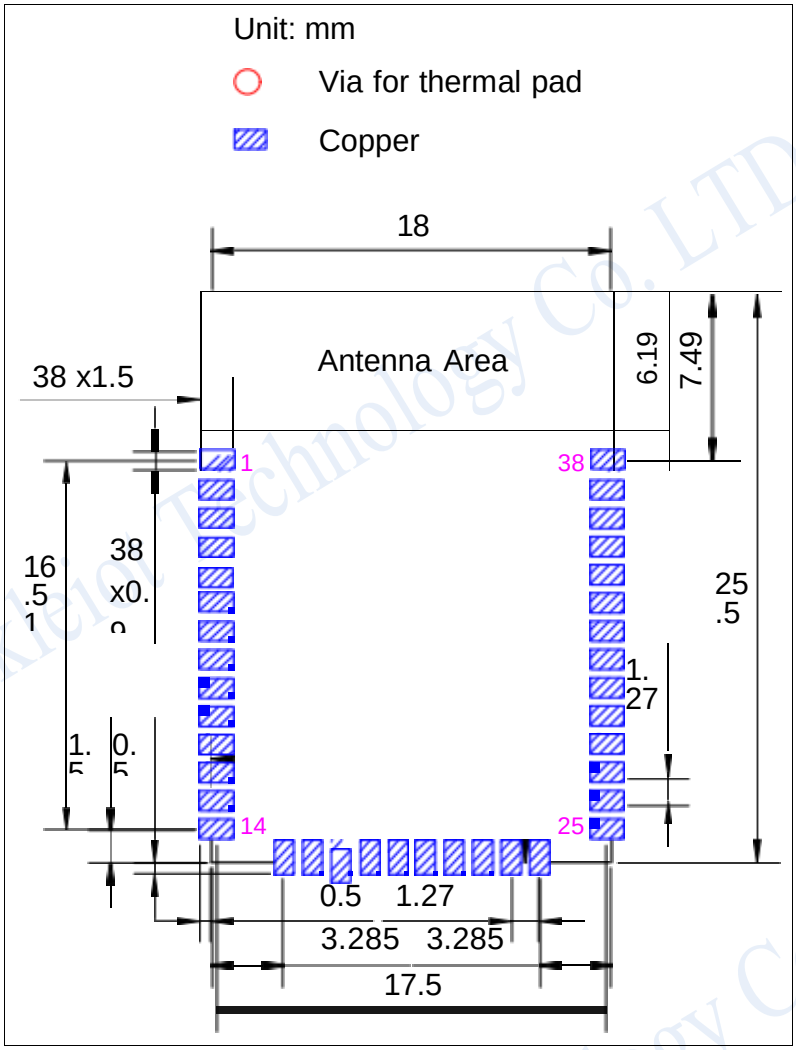
name	Serial number	Feature
GND	1	Ground connection
3V3	2	Power supply
EN	3	Enable chip, high level valid.
SENSOR_VP	4	GPI36, SENSOR_VP, ADC_H, ADC1_CH0, RTC_GPIO0
SENSOR_VN	5	GPI39, SENSOR_VN, ADC1_CH3, ADC_H, RTC_GPIO3
IO34	6	GPI34, ADC1_CH6, RTC_GPIO4
IO35	7	GPI35, ADC1_CH7, RTC_GPIO5
IO32	8	GPIO32, XTAL_32K_P (32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
IO33	9	GPIO33, XTAL_32K_N (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8
IO25	10	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
IO26	11	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
IO27	12	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV
IO14	13	GPIO14, ADC2_CH6, TOUCH6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
IO12	14	GPIO12, ADC2_CH5, TOUCH5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
GND	15	Ground connection
IO13	16	GPIO13, ADC2_CH4, TOUCH4, RTC_GPIO14, MTCK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
SHD/SD2	17	GPIO9, SD_DATA2, SPIHD, HS1_DATA2, U1RXD
SWP/SD3	18	GPIO10, SD_DATA3, SPIWP, HS1_DATA3, U1TXD
SCS/CMD	19	GPIO11, SD_CMD, SPICS0, HS1_CMD, U1RTS
SCK/CLK	20	GPIO6, SD_CLK, SPICLK, HS1_CLK, U1CTS
SDO/SD0	21	GPIO7, SD_DATA0, SPIQ, HS1_DATA0, U2RTS
SDI/SD1	22	GPIO8, SD_DATA1, SPID, HS1_DATA1, U2CTS
IO15	23	GPIO15, ADC2_CH3, TOUCH3, MTDO, HSPICS0, RTC_GPIO13, HS2_CMD, SD_CMD, EMAC_RXD3
IO2	24	GPIO2, ADC2_CH2, TOUCH2, RTC_GPIO12, HSPIWP, HS2_DATA0, SD_DATA (internal 12K resistance ground)
IO0	25	GPIO0, ADC2_CH1, TOUCH1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
IO4	26	GPIO4, ADC2_CH0, TOUCH0, RTC_GPIO10, HSPIHD, HS2_DATA1, SD_DATA1, EMAC_TX_ER
IO16	27	GPIO16, HS1_DATA4, U2RXD, EMAC_CLK_OUT

IO17	28	GPIO17, HS1_DATA5, U2TXD, EMAC_CLK_OUT_180
IO5	29	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK
IO18	30	GPIO18, VSPICLK, HS1_DATA7
IO19	31	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
NC	32	-
IO21	33	GPIO21, VSPIHD, EMAC_TX_EN
RXD0	34	GPIO3, U0RXD, CLK_OUT2
TXD0	35	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
IO22	36	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
IO23	37	GPIO23, VSPID, HS1_STROBE
GND	38	Ground connection

3. Shape and Size

Shape and size for ESP-32S can be shown as follows.The Flash of ESP-32S is 32 Mbits（4M Bytes）.

Fig.3.1 Shape for ESP-32S



(a) Vertical View

(b) Side View

Fig. 3.1 Size for ESP-32S

Table 3.1 Size for ESP-32S

Length	Width	Height	PAD Size (bottom)	Distance between Pins
25.5 mm	18 mm	3 mm	0.45 mm x 0.9 mm	0.8 ± 0.1 mm

4. Electronical Characteristics

Table 4.1 Electronical Characteristics

Parameters		Condition	Min	Classical	Max	Unite
Store Temperature		-	-40	Normal	125	℃
Sold Temperature		IPC/JEDEC J-STD-020	-	-	260	℃
Working Voltage		-	2.5	3.3	3.6	V
I/O	V_{IL}/V_{IH}	-	-0.3/0.75V_{IO}	-	0.25V_{IO}/3.6	I/O
	V_{OL}/V_{OH}	-	N/0.8V_{IO}	-	0.1V_{IO}/N	
	I_{MAX}	-	-	-	12	
Electrostatic release quantity (Human model)		TAMB=25℃	-	-	2	KV
Electrostatic release quantity (Human model)		TAMB=25℃	-	-	0.5	KV

5. Power Consumption

Table 5.1 Power Consumption

Parameters	Min	Classical	Max	Unit
Tx802.11b, CCK 11Mbps, POUT=+17dBm	-	170	-	mA
Tx802.11g, OFDM 54 Mbps, POUT =+15dBm	-	140	-	mA
Tx802.11n,MCS7,POUT =+13dBm	-	120	-	mA
Rx 802.11b，1024 Bytes, -80dBm	-	50	-	mA
Rx 802.11g，1024 Bytes, -70dBm	-	56	-	mA
Rx 802.11n，1024 Bytes, -65dBm	-	56	-	mA
Modem-sleep①	-	15	-	mA
Light-sleep②	-	0.9	-	mA
Deep-sleep③	-	20	-	μA

Note

①: Modem-Sleep mode can be used for the case that CPU is always working, e.g., PWM or I2S etc. If WiFi is connected and no data is to transmitted, in this case, WiFi modem can be closed to save power energy. For example, if at DTIM3 status, keep asleep at 300ms, Then, the module can wake up to receive the Beacon package within 3ms and the current being 15mA.

②: Light-Sleep mode can used for the case that CUP can stop the application temporally, e.g., Wi-Fi Switch . If Wi-Fi is connected and there is no data packet to transmitted, by the 802.11 standard (e.g., U-APSD), module can close Wi-Fi Modem and stop CPU to save power. For example, at DTIM3, keep up sleeping at 300ms, it would receive the Beacon package from AP after each 3ms, then the whole average current is about 0.9mA.

③ Deep-Sleep mode is applied to the case that Wi-Fi is not necessary to connect all the time, just send a data packet after a long time (e.g., transmit one temperate data each 100s) . it just need 0.3s-1s to connect AP after each 300s, and the whole average current is much smaller 1mA.

6. Wi-Fi RF Characteristics

The data in the following Table is gotten when voltage is 3.3V and 1.1V in the indoor temperature environment.

Table 6.1 Wi-Fi RF Characteristics

Parameters	Min	Classical	Max	Unite
Input frequencey	2412	-	2484	MHz
Input impedance	-	50	-	Ω
Input reflection	-	-	-10	dB
At 72.2Mbps, output power consumption for PA	15.5	16.5	17.5	dBm
At 11b mode, output power consumption for PA	19.5	20.5	21.5	dBm
Sensibility	-	-	-	-
DSSS, 1Mbps	-	-98	-	dBm
CCK11, Mbps	-	-91	-	dBm
6Mbps(1/2 BPSK)	-	-93	-	dBm
54Mbps(3/4 64-QAM)	-	-75	-	dBm
HT20, MCS7(65 Mbps, 72.2 Mbps)	-	-72	-	dBm
Adjacent Inhibition				
OFDM, 6Mbps	-	37	-	dB
OFDM, 54Mbps	-	21	-	dB
HT20, MCS0	-	37	-	dB
HT20, MCS7	-	20	-	dB

7. The Recommended Sold Temperature Curve

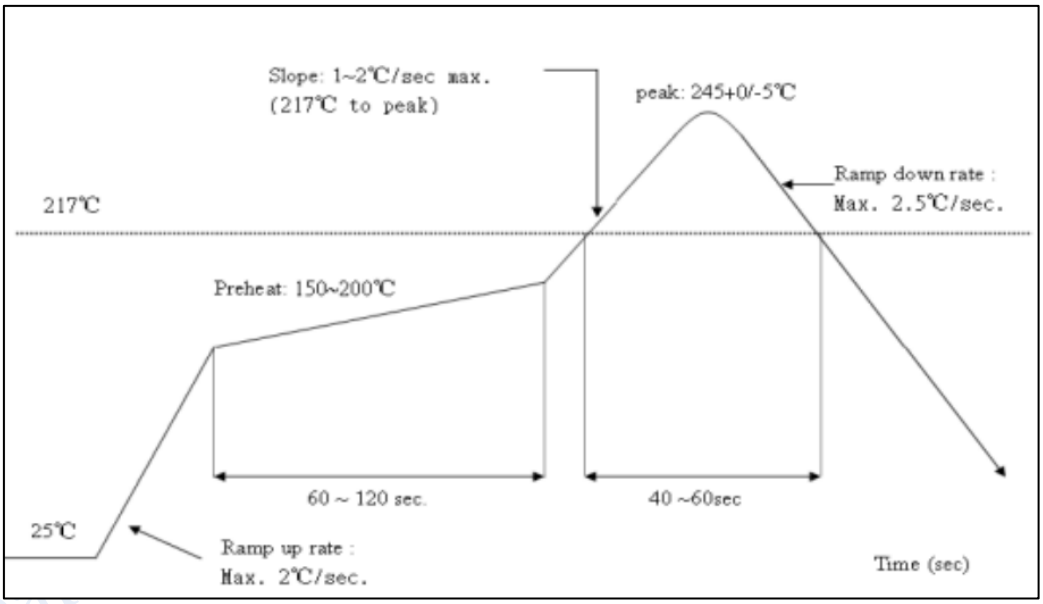


图 7. 1 Temperature Curve when sold

8. Module Schematic

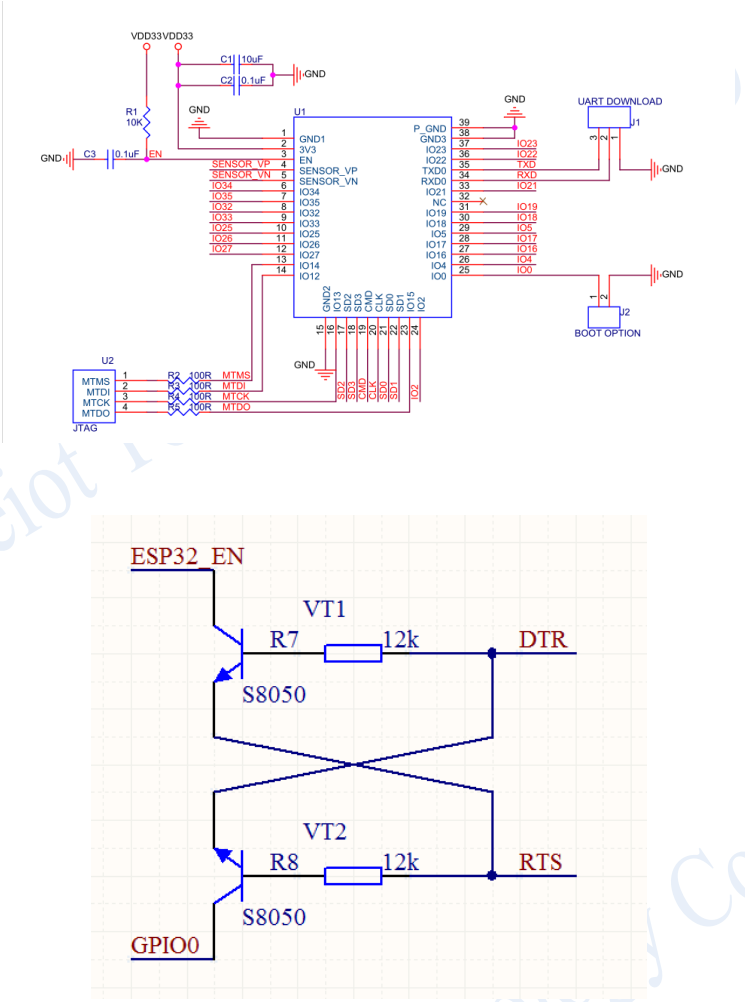


Fig. 8. 1 Module Schematic

Note

(1) the working voltage for module is DC 3.3V;

(2) the max current from IO of this module is 12mA;

(3) RST Pin is enabled when it is low level; and EN pin is enabled when it is high level;

(4) WiFi module is at update mode: GPIO0 is low level, then module reset to power; Wi-Fi module is at working mode: GPIO0 is at high level, and then reset to power;

(5) Wi-Fi module is connected to RXD of the other MCU, and TXD is connected to RXD of the other MCU.

9. The Recommended PCB Design (Take XH-C2F as an example)

ESP-32S Wi-Fi module can be sold on PCB board directly. For the high RF performance for the device, please notice the placement of the module. There are three ways to use the module.

Solution 1:optical solution. The WiFi module is placed on the side of the board, and the antennas are all exposed, and there is no metal material around the antenna, including wires, metal casings, weight plates, and the like.

Solution 2:suboptical solution. The WiFi module is placed on the side of the board, and the antenna below is hollowed out. There is a gap of not less than 5 mm reserved with the PCB, and there is no metal material around the antenna, including wires, metal casings, weight plates, and the like.

Solution 3: The WiFi module is placed on the side of the board, and the PCB area under the antenna is empty, and copper cannot be laid.

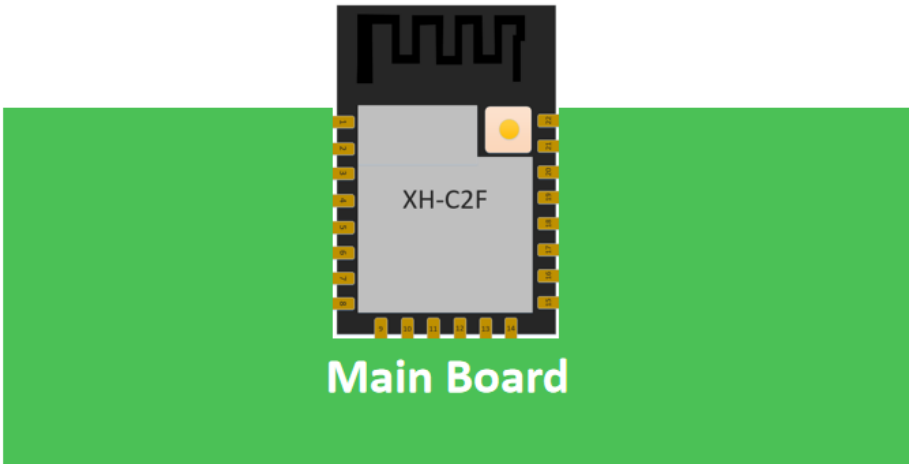


Fig.10.1 Solution 1

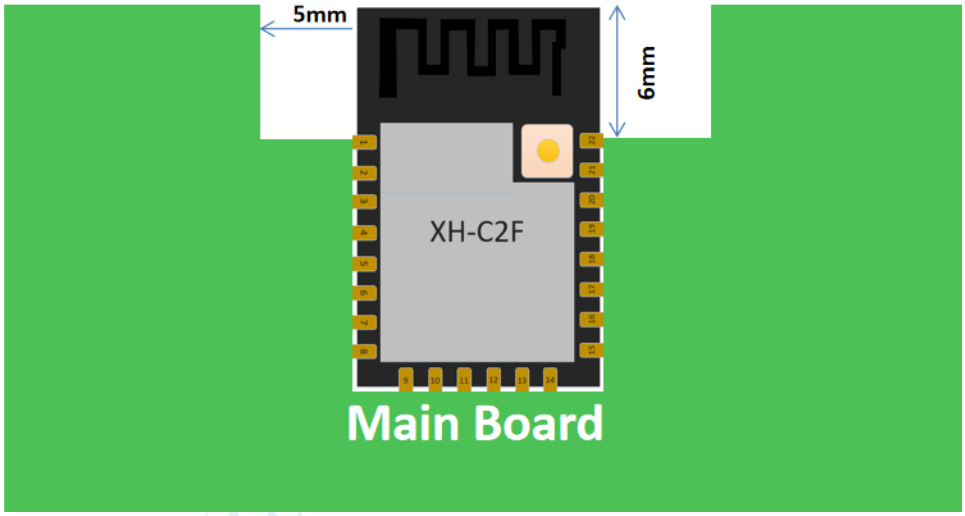


Fig.10.2 Solution 2

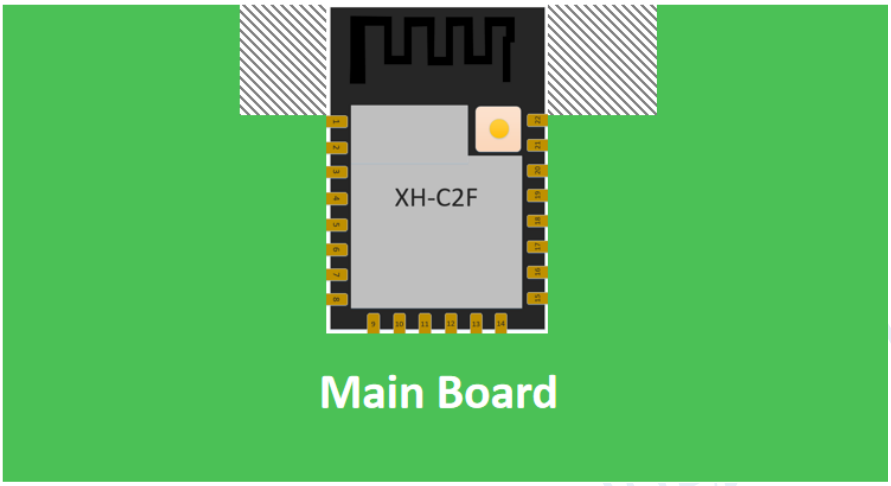


Fig.10.3 Solution 3

10. Peripheral Design Suggestion

Wi-Fi module is already integrated into high-speed GPIO and Peripheral interface, which may be generated the switch noise. If there is a high request for the power consumption and EMI characteristics, it is suggested to connect a serial 10~100 ohm resistance, which can suppress overshoot when switching power supply, and can smooth signal. At the same time, it also can prevent electrostatic discharge (ESD).

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Shenzhen Sparkleiot Technology Co., Ltd. is a national-level high-tech and innovative technology enterprise, focusing on R&D, production and sales of smart home and IOT products.

The company was established in 2014. At the beginning of its establishment, it was adhering to the concept of "science and technology change lives, and products enter thousands of households". After just a few years, the company has continuously launched the market's cost-effective 2.4G WiFi module, 2.4G WiFi module,.4GWiFi module, and quickly won unanimous praise in the market.

In 2018, the company established a smart home department, focusing on the smart electrical lighting industry. The company's products are exported to the Americas, Europe and other regions, and continue to receive praise from customers.

FCC Statement

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.

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 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 important announcement

Important Note:

Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator and your body.

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

Country Code selection feature to be disabled for products marketed to the US/Canada.

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. The transmitter module may not be co-located with any other transmitter or antenna,
3. For all products market in US, OEM has to limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change. (if modular only test Channel 1-11)

As long as the three conditions above are met, further transmitter testing will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

Important Note:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End Product Labeling

The final end product must be labeled in a visible area with the following" Contains FCC ID: **2BCLP-ESP-32S**"

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

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

2.2 List of applicable FCC rules

CFR 47 FCC PART 15 SUBPART C has been investigated. It is applicable to the modular transmitter

2.3 Specific operational use conditions

This module is stand-alone modular. If the end product will involve the Multiple simultaneously transmitting condition or different operational conditions for a stand-alone modular transmitter in a host, host manufacturer have to consult with module manufacturer for the installation method in end system.

2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

Not applicable

2.6 RF exposure considerations

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

2.7 Antennas

This radio transmitter **FCC ID:2BCLP-ESP-32S** has been approved by Federal Communications Commission to operate with the
antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Antenna No.	Model No. of antenna:	Type of antenna:	Gain of the antenna (Max.)	Frequency range:
2.4GWiFi	/	PCB Antenna	0.75dBi for 2412-2462MHz;	

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains **FCC ID:2BCLP-ESP-32S**".

2.9 Information on test modes and additional testing requirements

Host manufacturer is strongly recommended to confirm compliance with FCC requirements for the transmitter when the module is installed in the host.

2.10 Additional testing, Part 15 Subpart B disclaimer

Host manufacturer is responsible for compliance of the host system with module installed with all other applicable requirements for the system such as Part 15 B.