1. 1. Introduction

ESP-12E WiFi module is a low-power and cost-effective embedded wireless network control module. It can meet the needs of Internet of Things applications such as smart grid, building automation, security, smart home, telemedicine and so on.

The core processor ESP8266 integrates the industry-leading Tensilica L106 ultra-low power 32-bit micro MCU with 16-bit streamlined mode, main frequency of 80 MHz and 160 MHz, supports RTOS, integrates Wi-Fi MAC/BB/RF/PA/LNA, and on-board antenna.

This module supports standard IEEE802.11 b/g/n protocol and complete TCP/IP protocol stack. Users can use this module to add networking functions to existing devices, or to build independent network controllers.

2. 2. Main Features

3. 2.1 Structure

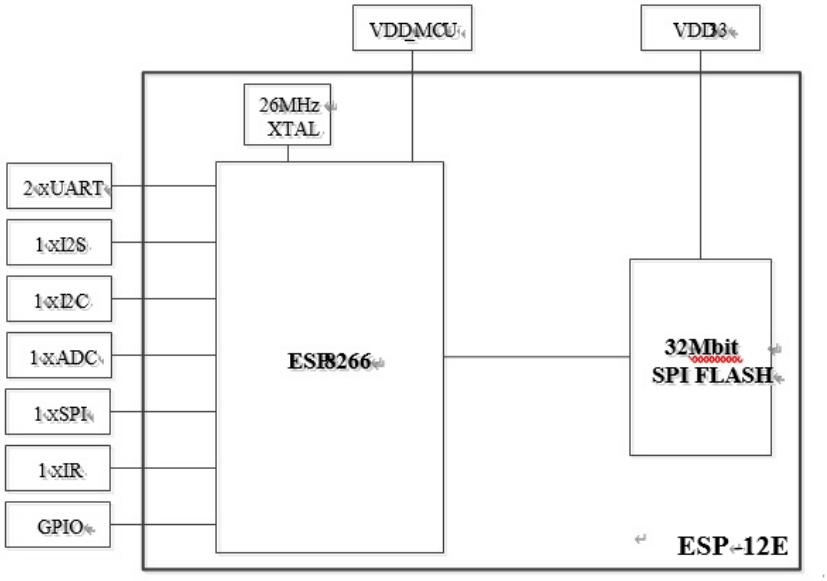


Figure Module Structure

4. 2.2 Hardware parameters

- Operating voltage: 3.3V (3.0-3.6V)
- Work environment temperature: - 40 - 85 degrees C
- CPU Tensilica L106
    - RAM 50KB (available)
    - Flash 32Mbit
- System
    - 802.11 b/g/n
    - Frequency Range 2.4 GHz to 2.5 GHz (2400 MHz to 2483.5 MHz)
    - Built-in Tensilica L106 ultra-low power 32-bit micro MCU with 16-bit streamlined mode, main frequency support 80 MHz and 160 MHz
    - MHz, RTOS support
    - WIFI@2.4 GHz, supporting WPA/WPA2 security mode
    - Support UART, I2C, GPIO, PWM, SDIO, SPI, ADC, PWM, IR
    - Built-in 10 bit high precision ADC
    - Support TCP, UDP, HTTP, FTP
    - Built-in TR switches, balun, LNA, power amplifiers and matching networks
    - Output power of + 20 dBm in 802.11b mode with built-in PLL, regulator and power management module
    - Average working current 80 mA, deep sleep holding current 20 uA, turn-off current less than 5 uA
    - Can be used as application processor SDIO 2.0, SPI, UART
    - Wake up, connect and transfer data packets within o 2ms
    - Standby state power consumption is less than 1.0 mW (DTIM3)

- Support local serial port burning, cloud upgrade, host download burning
- Supporting Station/SoftAP/SoftAP+Station Wireless Network Mode

5. 3 Pins Definition

6. 3.1 Interface Definition

Table 2.2 Pins Function

PIN NAME	ILLUSTRATION	
1	RST	reset
2	ADC	ADC , input voltage scope: 0 - 1V, value: 0 - 1024
3	EN	Chip enabling high level: effective, module working properly; low level: chip off, low current;
4	IO16	GPIO16；Wake up deep sleep when receiving RST pins
5	IO14	GPIO14；HSPI_CLK
6	IO12	GPIO12；HSPI_MISO
7	IO13	GPIO13； HSPI_MOSI；UART0_CTS
8	VCC	3.3V Power Supply (VDD) Note: The maximum output current of external power supply is recommended to be more than 500 mA.
9	CS0	Chip seleted
10	MISO	Slave output host input
11	IO9	GPIO9
12	IO10	GPIO10
13	MOSI	Host output slave input
14	SCLK	Clock
15	GND	GND
16	IO15	GPIO15；MTDO；HSPICS；UART0_RTS
17	IO2	GPIO2；UART1_TXD
18	IO0	GPIO0
19	IO4	GPIO4
20	IO5	GPIO5
21	RXD	UART0_RXD； GPIO3
22	TXD	UART0_TXD；GPIO1

7. 3.2 Shape and Size

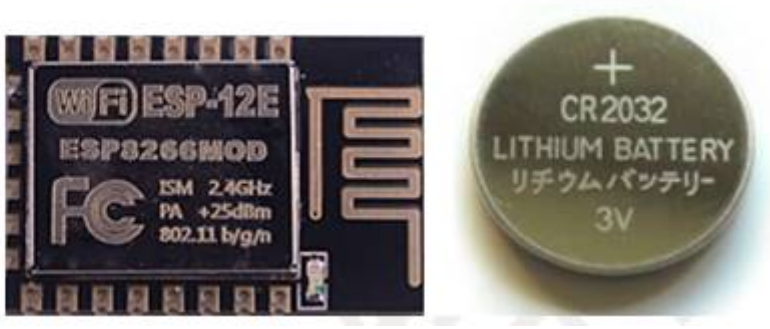


Fig 3.1 Shape of ESP-12E

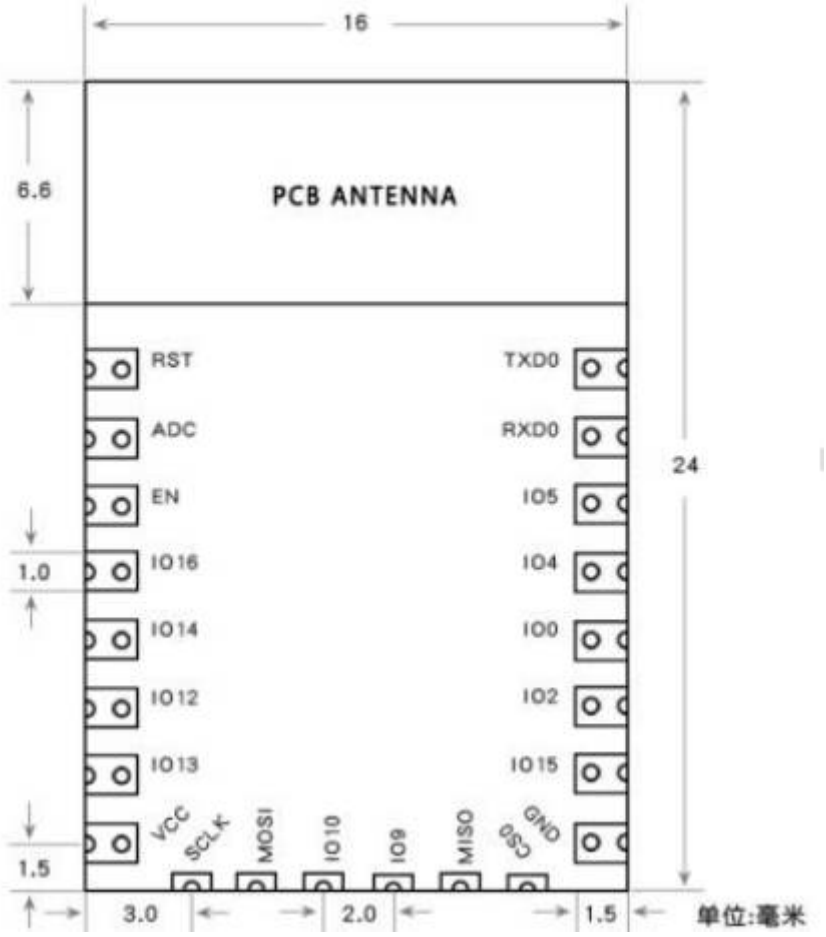


Fig. 3.2 Size for ESP-12E

Table 3.1 Size for ESP-12E

LENGTH	WIDTH	HEIGHT	PAD (TWO SIDES)	PINS DISTANCE
24mm	16mm	3.15mm	0.9 mm x 1.7mm	2.54mm

8. 4. Function

9. 4.1 MCU

ESP8266EX built-in Tensilica L106 ultra-low power 32-bit micro MCU, with 16-bit streamlined mode, main frequency support 80MHz and 160MHz, support RTOS. At present, the WiFi protocol stack only uses 20% processing power, the rest can be used for application development. The MCU can work together with other parts of the chip through the following interfaces:

- Connect storage controllers, and can also be used to access the external Flash encoding RAM/ROM interface (iBus);
- Data RAM interface (dBus) connecting storage controller;
- The AHB interface of the access controller.

10. 4.2 Store

11. 4.2.1 Built-in SRAM 与 ROM

Based on the use of SRAM in Demo SDK, users can use the remaining SRAM space as follows:

- RAM < 50 kB (Heap + Data area can be approximately 50 kB after routing in Station mode).
- At present, there is no programmable ROM on ESP8266EX chip, and user programs are stored in SPI Flash.

12. 4.2.2 SPI Flash

- ESP8266EX chip supports external FLASH using SPI interface, and theory supports 16MB SPI Flash.

- ESP-01 module is equipped with 8Mbit SPI Flash, which can meet the needs of general customers.

13. 4.3 Interface Definition

Table Interface definition

INTERFACE	PIN	ILLUSTRATIONS
SPI	IO12(MISO),IO13(MOSI), IO14(CLK),IO15(CS)	It can be used as a host to read and write SPI slave device, or as a slave to communicate with external MCU. In overlap mode, you can share SPI pins with Flash and switch through different CS
PWM	IO12(R),IO15(G),IO13(B)	Official demo provides 4-way PWM (user-expandable 8-way), which can be used to control color lights, buzzers, relays and motors.
IR	IO14(IR_T), IO5(IR_R)	The interface of IR Remote Control is realized by software. The interface uses NEC coding and modem, and uses 38KHz modulated carrier.
ADC	TOUT	It can be used to detect the supply voltage of VDD3P3 (Pin3, Pin4) and the input voltage of TOUT (Pin6) (both can not be used simultaneously). It can be used in sensor and other applications.
I2C	IO14(SCL), IO2(SDA)	External sensors and display screens, etc.
UART	UART0: TXD(U0TXD),RXD(U0RXD) ,IO15(RTS),IO13(CTS)	Device with External UART Interface Download: U0TXD + U0RXD or GPIO2 + U0RXD communication (UART0): U0TXD, U0RXD, MTDO (U0RTS), MTCK (U0CTS) Debug: UART1_TXD (GPIO2) can be used as debug information printing.
	UART1: IO2(TXD)	UART0 will output some printing information by default when it is powered on ESP8266-12S. For this sensitive application, the internal pin switching function of UART can be used to exchange U0TXD and U0RXD with U0RTS and U0CTS respectively during

INTERFACE	PIN	ILLUSTRATIONS
		initialization. Hardware Connect MTDOMTCK to Serial Port Import Communication of Corresponding External MCU
I2S	I2S input: IO12 (I2SI_DATA); IO13 (I2SI_BCK); IO14 (I2SI_WS); I2S output IO15 (I2SO_BCK); IO3 (I2SO_DATA); IO2 (I2SO_WS);	It is mainly used for audio acquisition, processing and transmission.

14. 5. Electrical characteristics

14.1. 5.1 Power Consumption

DEEP SLEEP	20UA
Off	0.5uA
Normally work(average)	80mA
Transmit 801.11b，CCK 11Mbps，Pout=+17 dBm	170mA
Transmit 801.11g，OFDM 54Mbps，Pout=+15 dBm	140mA
Transmit 801.11n，MCS7，Pout=+13 dBm	120mA
Transmit 801.11b，package 1024 byte，-80 dBm	50mA
Transmit 801.11g，package 1024 byte，-70 dBm	56mA
Transmit 801.11n，package 1024 byte，-65 dBm	56mA

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.

15. 5.2 RF Features

Table RF parameters

ITEM	MIN	CLASSICAL	MAX	UNITE
Input frequency	2400	/	2483.5	MHz
Input impedance value	/	50	/	ohm
Input reflection value	/	/	-10	dB
PA output power 72.2 Mbps	15.5	16.5	17.5	dBm
11b mode, PA output power	19.5	20.5	21.5	dBm
		Sensitivity		
CCK，1Mbps	/	-98	/	dBm
CCK，11Mbps	/	-91	/	dBm
6Mbps（1/2 BPSK）	/	-93	/	dBm
54Mbps（3/4 64-QAM）	/	-75	/	dBm
HT20，MCS7（65Mbps，72.2Mbps）	/	-72	/	dBm
		Lead frequency suppression		
OFDM，6Mbps	/	37	/	dB
OFDM，54Mbps	/	21	/	dB
HT20，MCS0	/	37	/	dB
HT20，MCS7	/	20	/	dB

16. 5.3 Digital Port Characteristics

RATING VALUE	CONDITION		VALUE	UNITE
Store temperature	/	-40 to 125	°C	
Max sold temperature	/	260	°C	
voltage	IPC/JEDEC J-STD-020	+3.0 to +3.6	V	

17. 5.4 Digital Port Characteristics

Table Digital Port Characteristics

PORT	CLASSICAL	MIN	MAX	UNITE
Low input logic level	VIL	-0.3	0.25 VDD	V
High input logic level	VIH	0.75 VDD	VDD + 0.3	V
Low output logic level	VOL	N	0.1 VDD	V
High output logic level	VOH	0.8 VDD	N	V
power	IPC/JEDEC J-STD-020	+3.0 to +3.6	V	

18. 5.5 Ramp Up

Table ramp up

INTERFACE	ILLUSTRATION
Inclined heating rate（Ts Max. to TL）	max 3°C/s
Preheat Min temperature （Ts Min.） Classical temperature （Ts Typ.） Max temperature（Ts Max.） Time （Ts ）	150°C 175°C 200°C 60 ~ 180 s
Inclined heating rate（TL to Tp）	Max 3°C/s
The above duration：temperature （TL）/ time（TL）	270°C / 60 ~ 150 s
Temperature peak（Tp）	Maximum temperature 260 °C，10 s
Target temperature peak（Tp target）	260°C + 0 / -5°C
The duration within the duration peak（Tp）5°C	20 ~ 40 s
Inclined cooling rate（TsMax. To TL）	Max 6°C / s
Time required for peak modulation temperature from 25°C (t)	Max 8 minutes

19. 6. Schematic Diagram

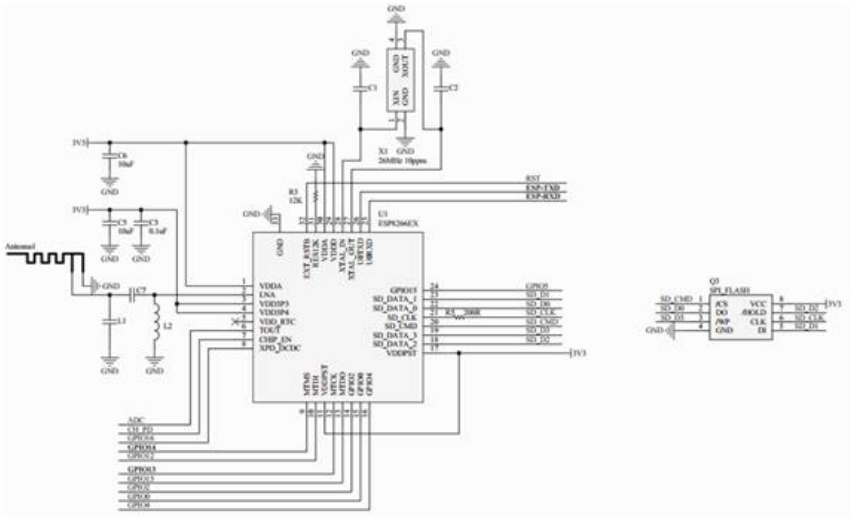


Figure ESP-07 Schematic Diagram

20. 7. Minimum System

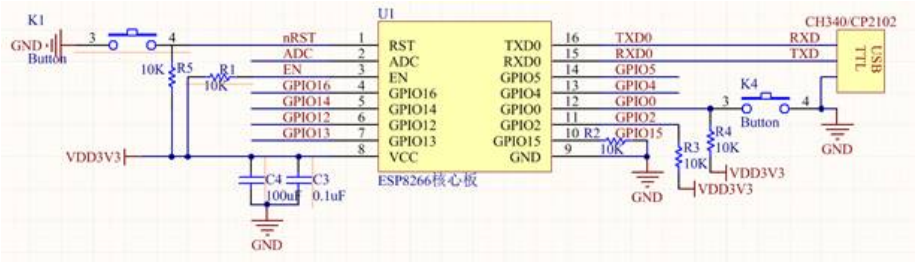


Figure Minimum system

Note

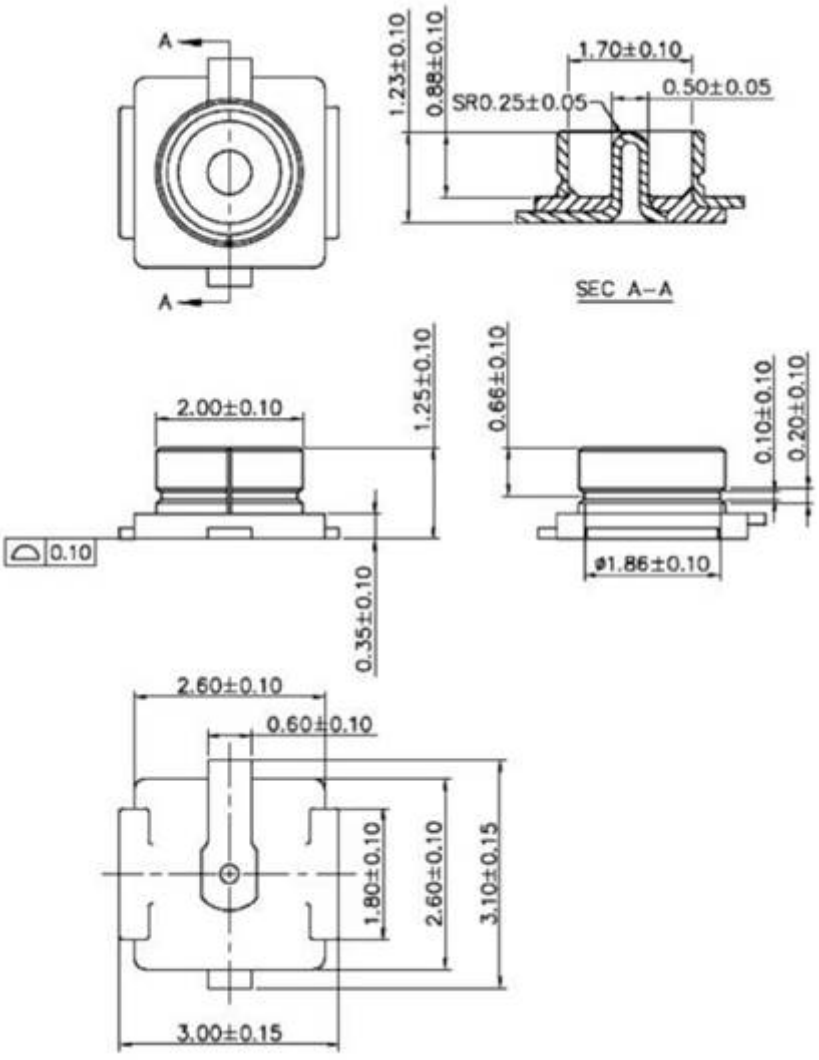
- The maximum output current of module IO is 12 mA.
- The typical value of module power supply is 3.3 V DC.
- Module low level reset is effective;
- Module firmware online upgrade needs to meet 3) conditions, IO0 pull down and reset module; after firmware upgrade is completed, IO0 is released.
- And reset module;
- RXD of module is connected with TXD of MCU, TXD of module is connected with RXD of MCU;

21. 8. Peripheral Routing Suggestions

ESP-07 module can be welded to PCB board. In order to obtain the best RF performance of the terminal product, please pay attention to the reasonable design of the module and antenna placement on the bottom board in accordance with this guide.

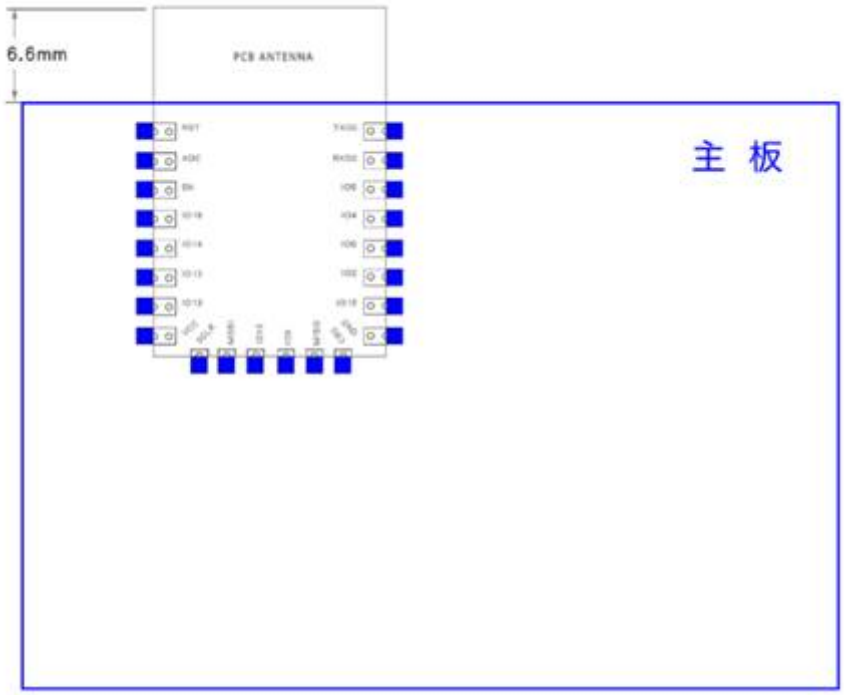
22. 9. Peripheral Routing Suggestions

ESP-01 integrates high-speed GPIO and peripheral interfaces, which may cause serious switching noise. If some applications are for power consumption and EMI features require higher requirements. It is recommended that 10 - 100 ohms of resistance be connected in series on digital I / O lines. This can suppress the overshoot and make the signal smooth when switching on the power supply. Series resistance can also prevent ESD to some extent.

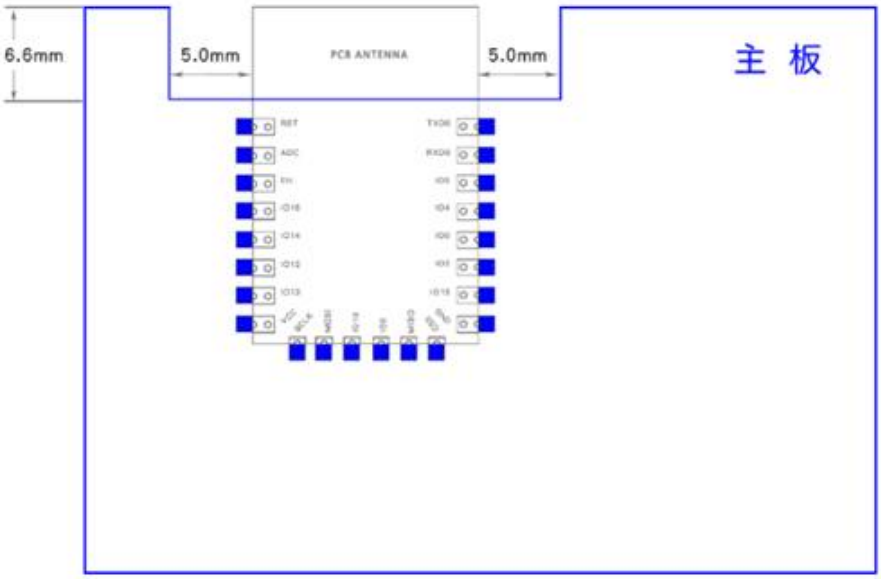


It is suggested that the module be placed along the edge of PCB board, and the antenna be placed outside or along the edge of the board and hollowed out below, with reference to scheme 1 and scheme 2.

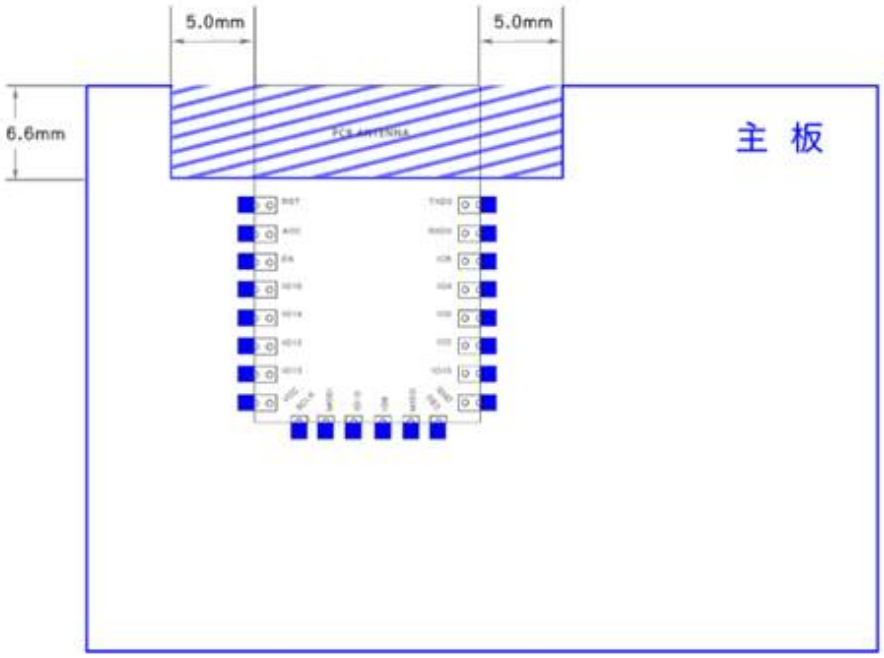
PCB antenna is also allowed on the floor, as long as there is no copper under the antenna, reference scheme 3.



Scheme 1: The antenna is outside the frame.



Scheme 2: Antennas are placed along the edge of the plate and hollowed underneath.



Solution 3: Antennas are placed along the edge of the plate and not covered with copper underneath.

23. 10. The Recommended Sold Temperature Curve

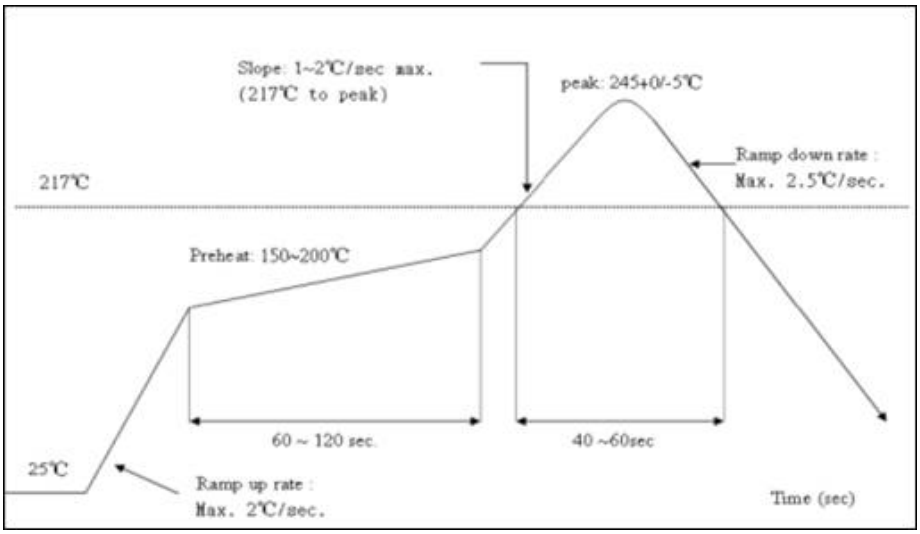


Fig. 7.1 Temperature Curve when Sold

24. Contact

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