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);

  - Built-in 1M SPI flash byte;

- **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

- 2*UART;

- 1*En;

- 1*ADC;

- 1*wakeup pin;

- 1*HSPI;

- 1*I2C;

- 1*I2S;

- MAX 10* GPIOs;

- **Working temperature:** -40℃-105℃

- **Module size**:

  12.3*mm*15mm; (ESP-M1)
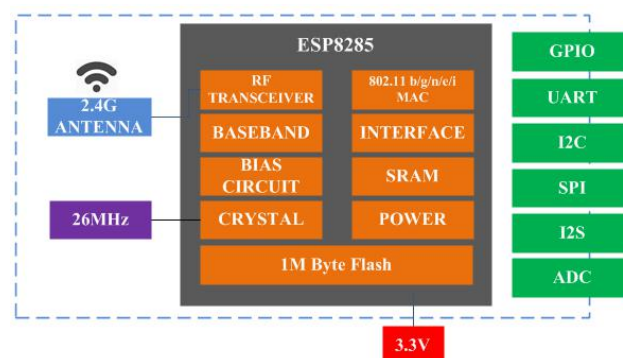
  12.3*mm*20mm; (ESP-M2)

Application

- 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-M1	IPEX external antenna
ESP-M2	PCB antenna on board

Module Structure

Update Record

Date	Version	Update
2017-3-14	V1.0	Initial version
2017-3-18	V1.1	Add PCB design
2018-5-18	V1.2	Add system design

Table of Contents

1. Introduction

The WiFi module ESP-Mx is manufactured by using a high-performance chip named ESP8285. This small chip is encapsulated an enhanced Tensilica's L106 diamond series 32-bit kennel CPU with a SRAM. Thus, ESP8285 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 ESP8285 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-Mx 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-Mx 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-Mx module provides many probabilities with the best price.
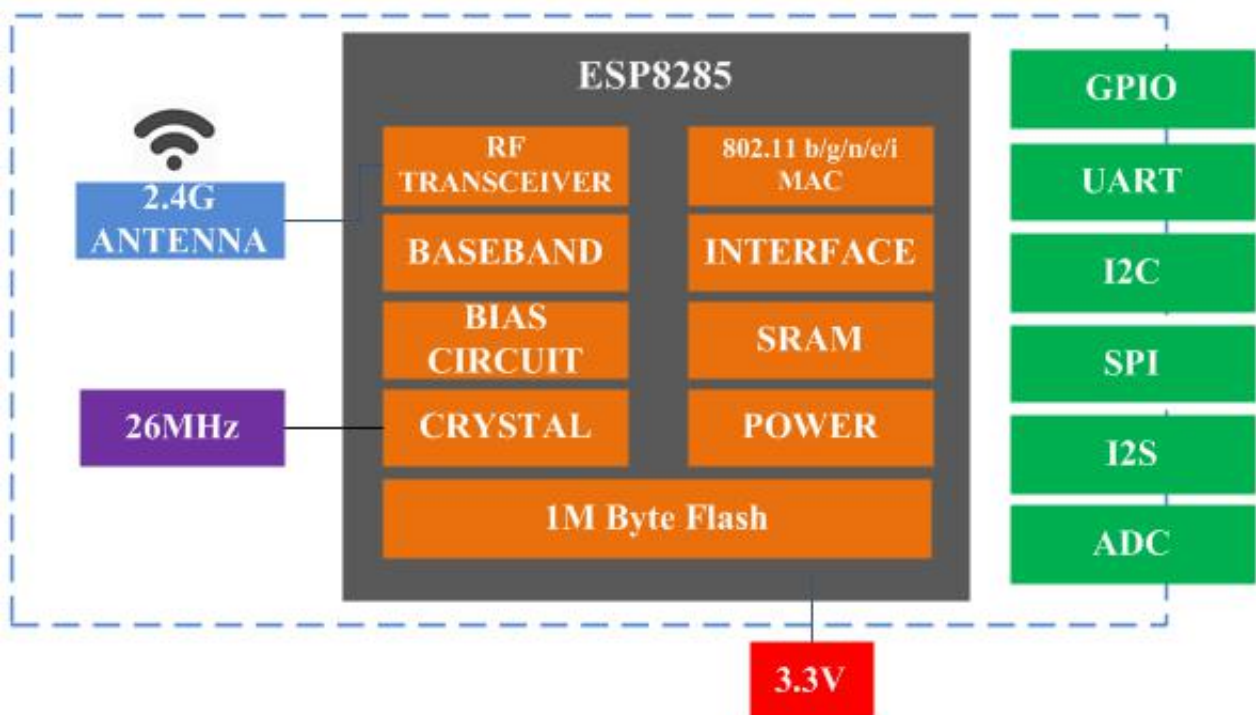

Fig. 1.1 ESP-Mx Module Structure

Technical parameters for ESP-Mx are listed as follows.

Table 1.1 ESP-Mx Parameters

Types	Items	Parameters
Wi-Fi	Frequency	2.4G~2.5G(2400M~2483.5M)
	Transmit power	802.11b: +15.12 dBm
		802.11g: +17.68 dBm
		802.11n: +17.17 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	12.3mm x 15mm x 3mm/12.3mmx20mmx3mm
Software	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
	Wi-Fi working mode	Station/SoftAP/SoftAP+Station

2. Interface Definition

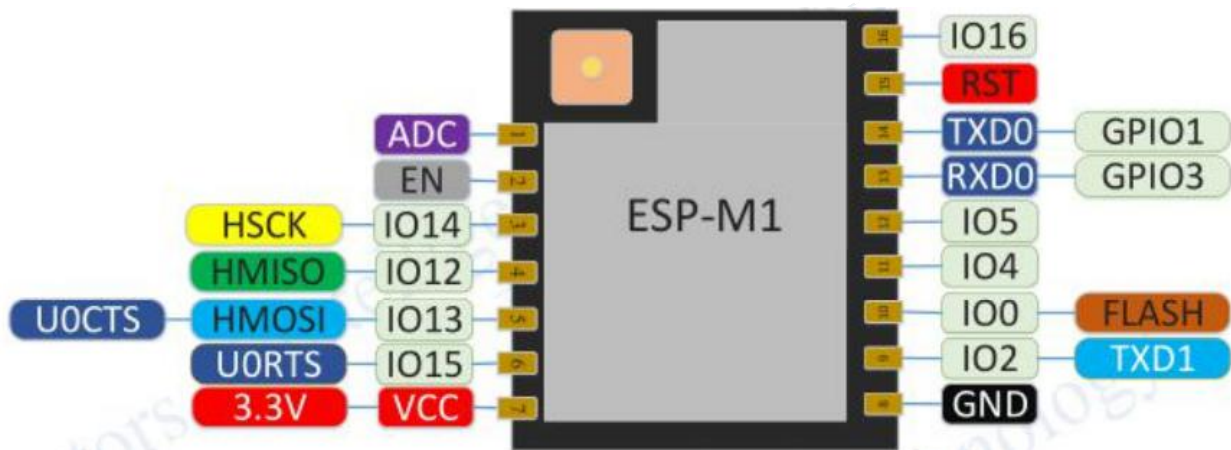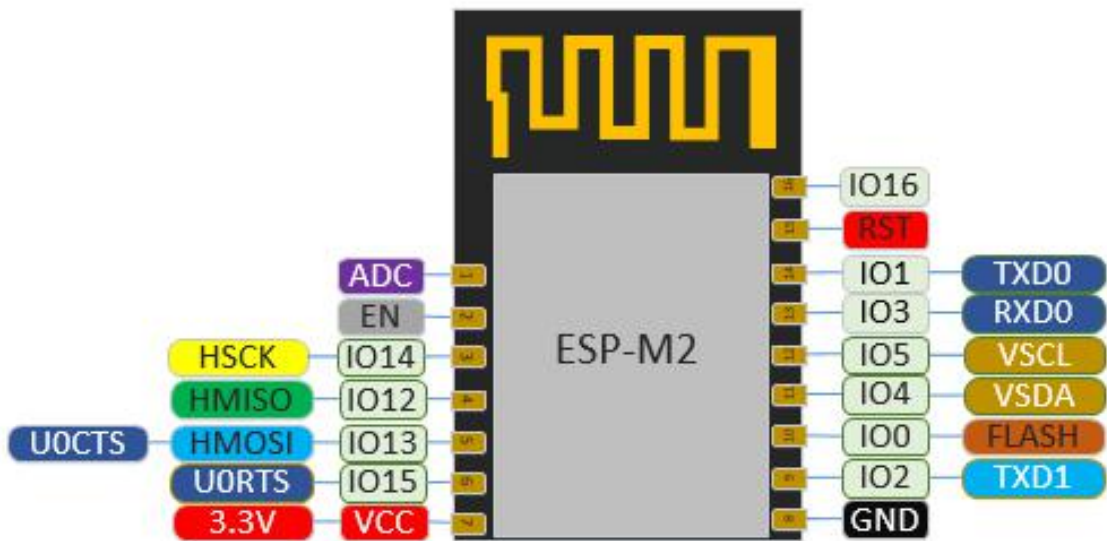ESP-Mx module interface definition is shown as below。

Fig. 2.1 ESP-M1 Pin Definition

Fig. 2.2 ESP-M2 Pin Definition

Working mode and pin function is shown in Table 2.1.

Table 2.1 Working mode

Mode	GPIO0 Level	GPIO2 Level
UART Download Mode	Low	High
Flash Boot Mode	High	High

Table 2.2 Pin Function Definition

Num	Pin Name	Type	Function
1	ADC	I	A/D pin. Voltage Range: 0-1V. 10bit resolution
2	EN	I	Effective: High level. Used to enable the module
3	IO14	I/O	GPIO14;HSPI_CLK
4	IO12	I/O	GPIO12;HSPI_MISO
5	IO13	I/O	GPIO13;HSPI_MOSI; UART0_CTS
6	IO15	I/O	GPIO15; MTDO;HSPICS;UART0_RTS; Internal Pull-down
7	VCC	P	POWER：3.3V
8	GND	P	GND
9	IO2	I/O	GPIO2; UART1_TXD;
10	IO0	I/O	GPIO0; SPI_CS2;
11	IO4	I/O	GPIO4
12	IO5	I/O	GPIO5
13	RXD	I/O	GPIO3; UART Rxd
14	TXD	I/O	GPIO1; UART Txd
15	RST	I	Effective: Low level. Used to reset the module. Internal Pull-up.
16	GND	P	GND

3. Shape and Size

Shape and size for ESP-Mx can be shown as follows.。 The Flash of ESP-Mx is 4 Mbits.
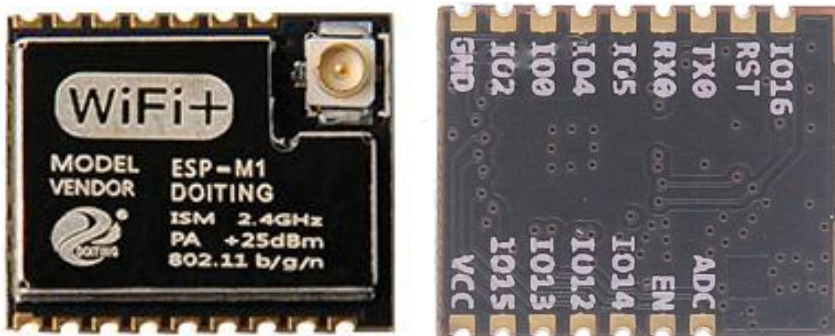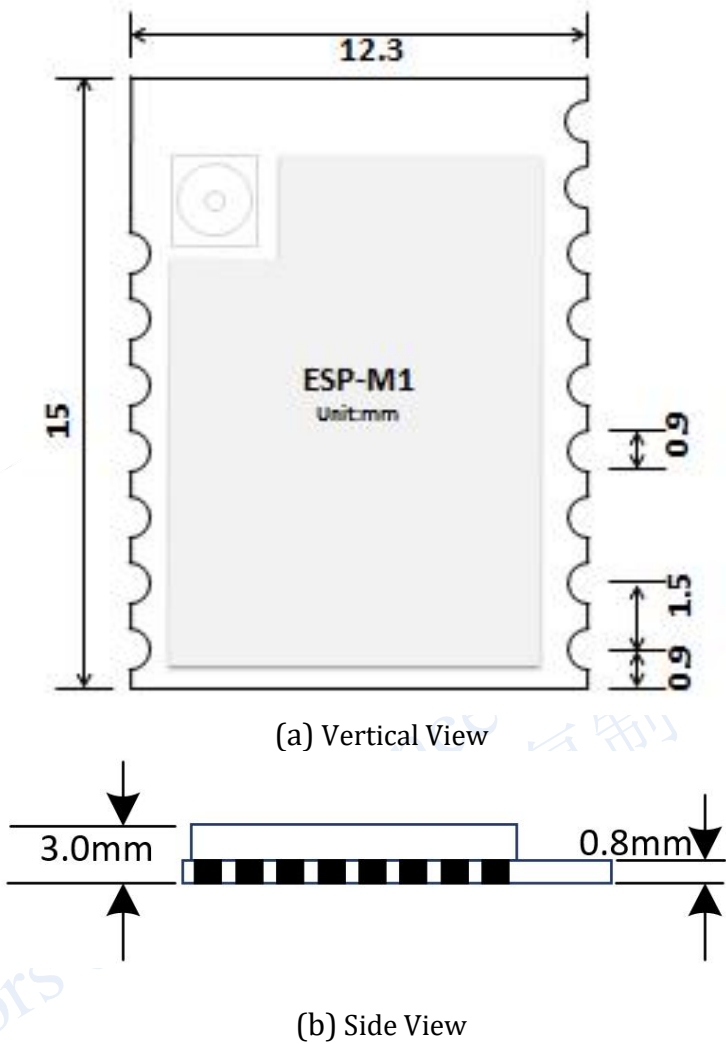

Fig. 3.1 Shape for ESP-M1

(a) Vertical View

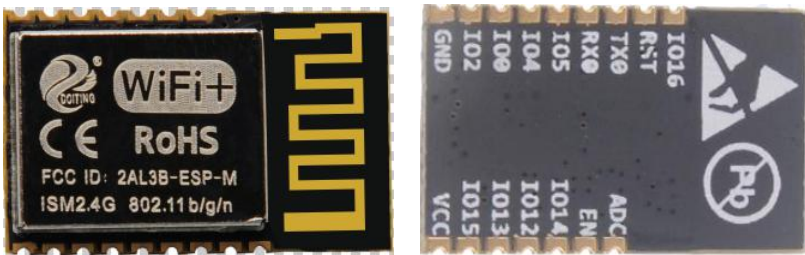(b) Side View

Fig. 3.2 Size for ESP-M1

Fig, 3.3 Shape for ESP-M2

(a) Vertical View

(b) Side View
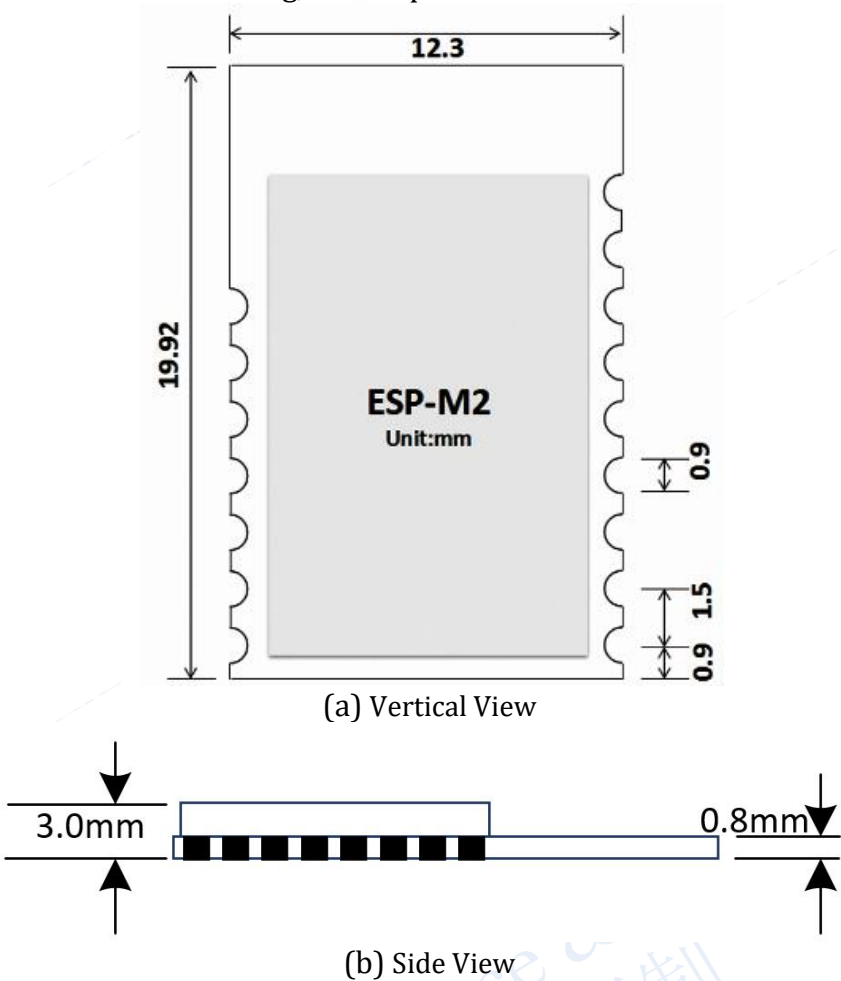
Fig. 3.4 Size for ESP-M2

Table 3.1 Size for ESP-M1

Length	Width	Height	PAD Size (bottom)	Distance between Pins
12.3mm	15mm	3 mm	0.9 mm x 1.7mm	1.5 mm

Table 3.2 Size for ESP-M2

Length	Width	Height	PAD Size (bottom)	Distance between Pins
12.3mm	20mm	3 mm	0.9 mm x 1.7mm	1.5 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
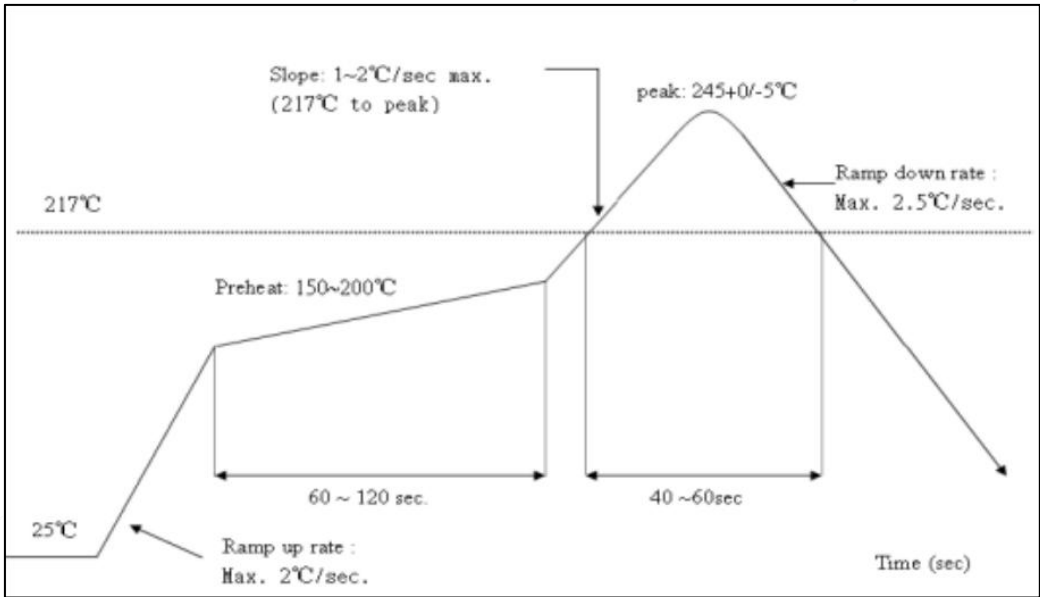
图 7. 1 Temperature Curve when sold

8. Minimum User System
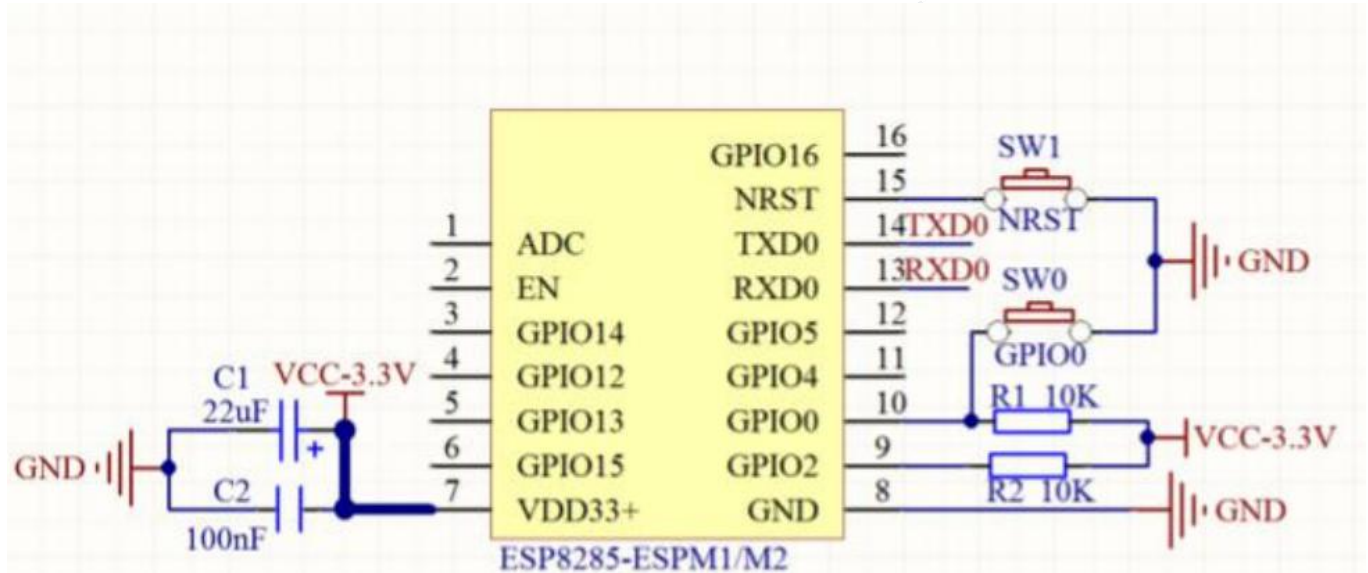
This module can work just at 3.3V working voltage:

Fig.8.1 minimum system

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 ESP-M2 as an Example)

ESP-Mx 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.
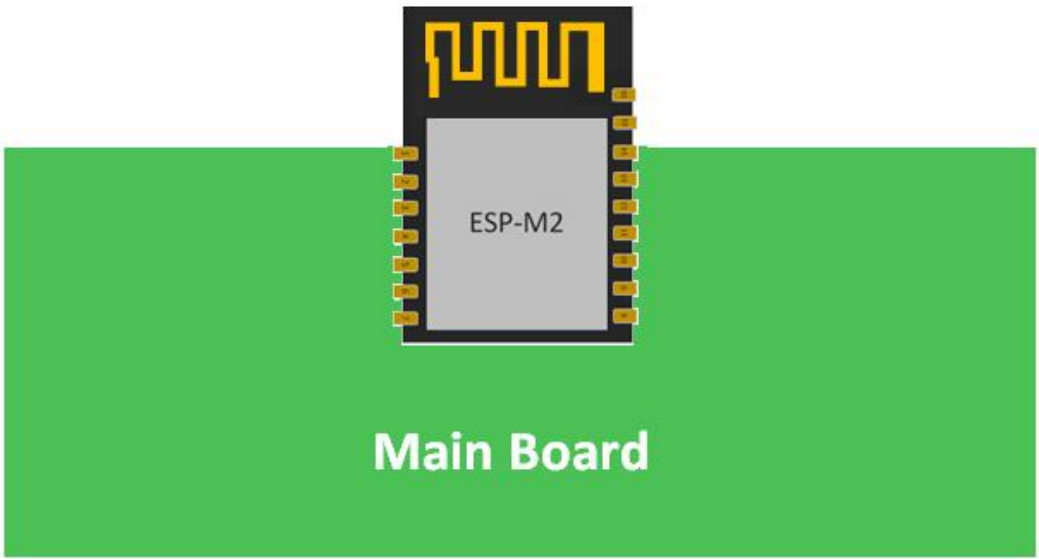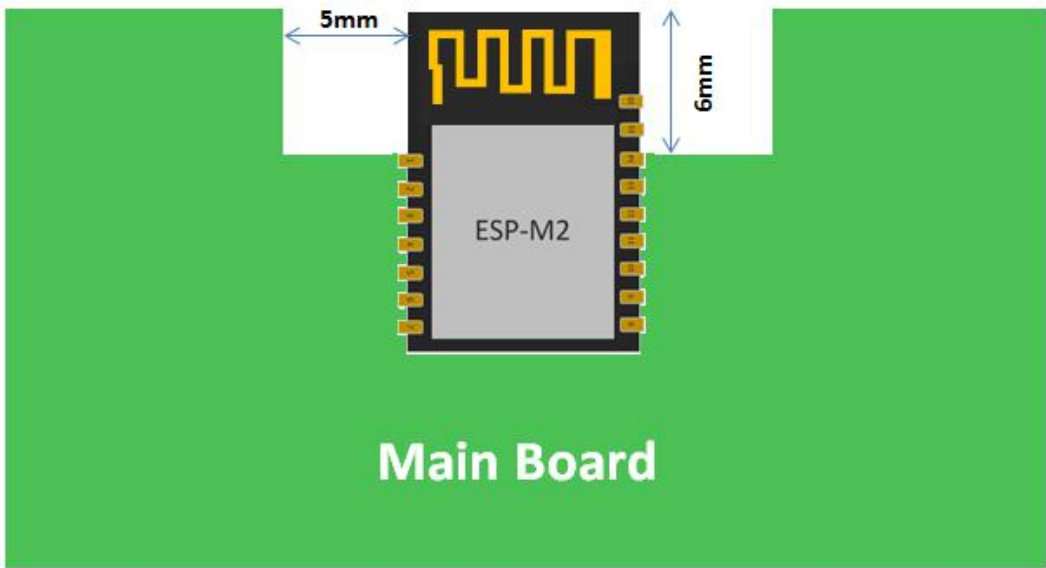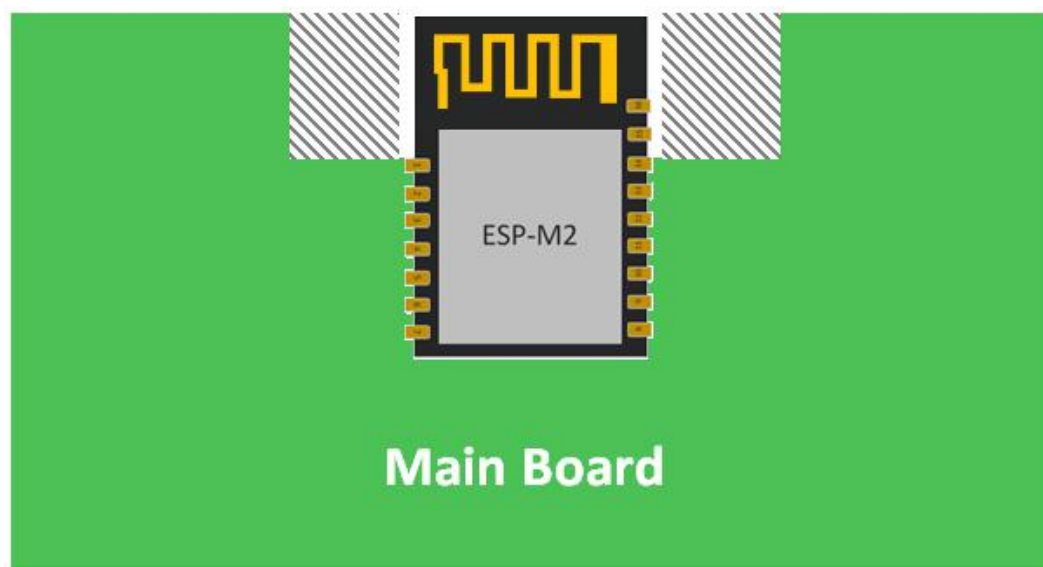
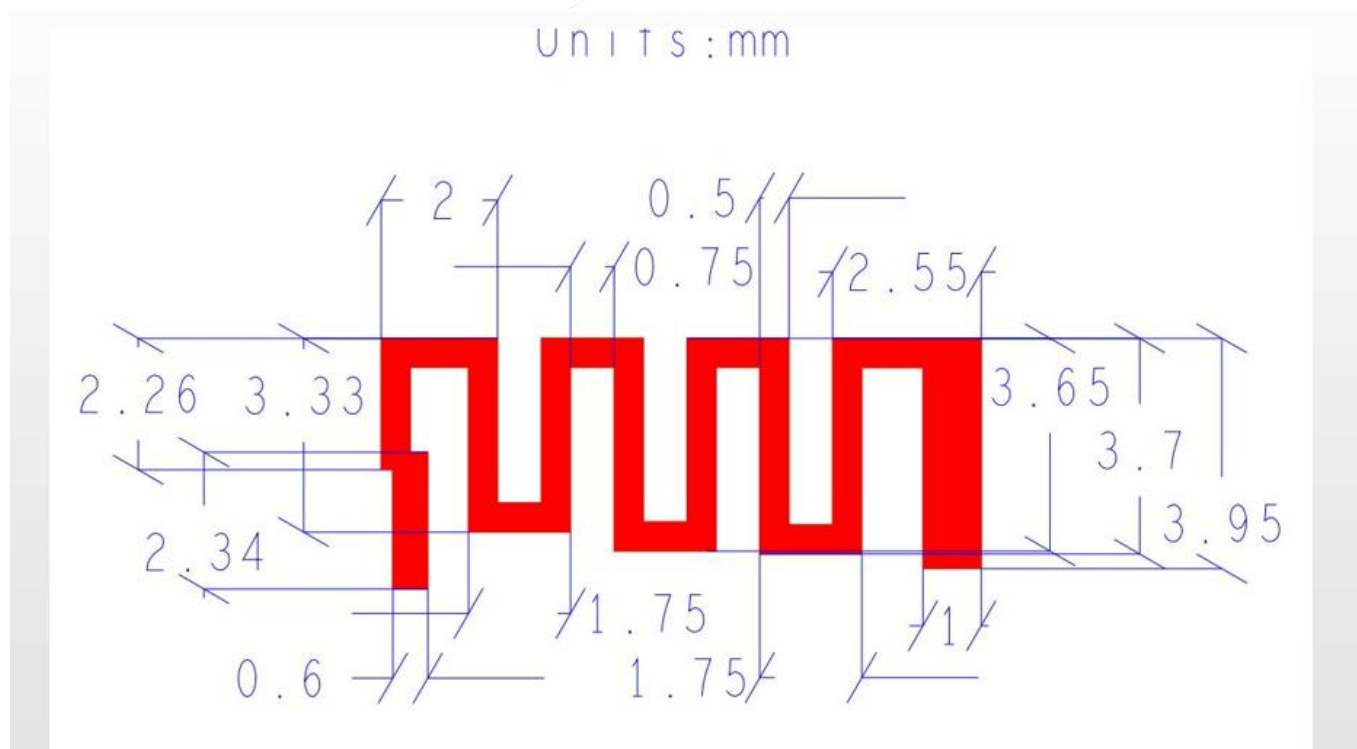Fig.9.1 Solution 1

Fig.9.2 Solution 2

Fig.9.3 Solution 3

10. Antenna

Antenna Type: PCB Antenna
Antenna Gain(Peak): 2.07 dBi

Antenna size chart:

11. 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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FCC regulatory information

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.

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

End Device Labelling

Please notice that if the FCC identification number is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following: "Contains FCC ID: 2A2P9-ESP-M2" any similar wording that expresses the same meaning may be used.

RF Exposure Compliance

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Installation Notice

The module is limited to OEM installation ONLY. The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.

The module is limited to installation in mobile application; A separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and difference antenna configurations.

We use the bottom plate to assist the test, but the bottom plate is not needed when the module is installed, and it can be directly installed on the product.

FCC Part 15B Compliance of End Device

The OEM integrator is responsible for ensuring that the host product which is installed and operating with the module is in compliant with Part 15B unintentional Radiator requirements, please note that For a Class B digital device or peripheral, the instructions furnished the user manual of the end-user product 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.

List of applicable FCC rules：FCC Part15 Subpart C, Section 15.247
Information on test modes and additional testing requirements
To investigate the maximum EMI emission characteristics generates from EUT, the test system was pre-scanning tested base on the consideration of following EUT operation mode or test configuration mode which possible have effect on EMI emission level. Each of these EUT operation mode(s) or test configuration mode(s) mentioned above was evaluated respectively.
RADIATED EMISSION TEST (BELOW 1GHz):
Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports (if EUT with antenna diversity

architecture).

For the test results, only the worst case was shown in test report.

RADIATED EMISSION TEST (ABOVE 1GHz):

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates, XYZ axis and antenna ports (if EUT with antenna diversity architecture).

Additional testing Part15SubpartB disclaimer

The grantee should include a statement that the modular transmitter is only FCC authorized forthe specific rule parts (i.e.，FCC transmitter rules)listedonthegrant，and that the host productmanufacturer is responsible for compliance to any other FCC rules that apply to the host notcovered by the modular transmitter grant of certification .If the grantee markets their product asbeing Part 15SubpartBcompliant(when it also contains unintentional - radiator digital circuit y)，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 .

FCC 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 & your body.

FCC INFORMATION (additional)

OEM INTEGRATION INSTRUCTIONS:

This device is intended only for OEM integrators under the following conditions: The module must be installed in the host equipment such that 20 cm is maintained between the antenna and users, and the transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the internal antenna(s) that has been originally tested and certified with this module. As long as 3 conditions above are met, further transmitter test 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 (for example, digital device emissions, PC peripheral requirements, etc.).

Validity of using the module certification:

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module 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.

Module label:

FCC ID: 2A2P9-ESP-M2

The final end product must be labeled in a visible area with the following: "Contains FCC ID:2A2P9-ESP-M2 ". Information that must be placed in the end user manual:

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.

The module not applicable Limited module procedures. The module is a Single module and complies with the requirement of FCCPart15.247

The module has its own antenna ，anddoesn'tneedahost's printed board microstriptrace antenna etc, Not applicable Trace antenna designs

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