



# SPARKLEIOT ESP-12F Ultra-low Power WiFi Module User Manual

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**SPARKLEIOT ESP-12F Ultra-low Power WiFi Module**



## 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

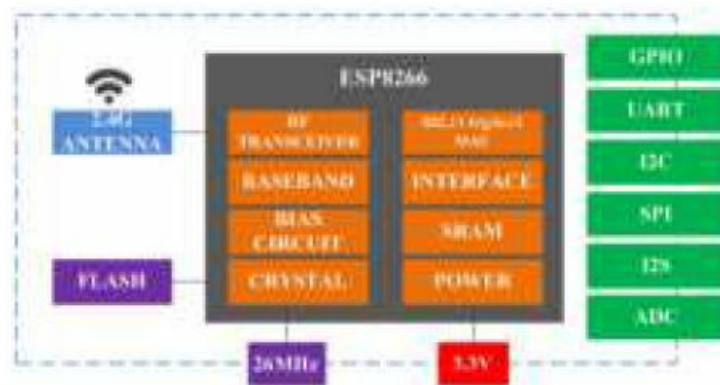
## Applications

- 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-12F	PCB Antenna

## Module Structure



## Update Record

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

## Introduction

The WiFi module ESP-12F is manufactured by using a high-performance chip named ESP8266. This small chip is

encapsulated an enhanced Tensilica’s L106 diamond series 32-bit kernel 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-12F 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-12F 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-12F module provides many probabilities with the best price.

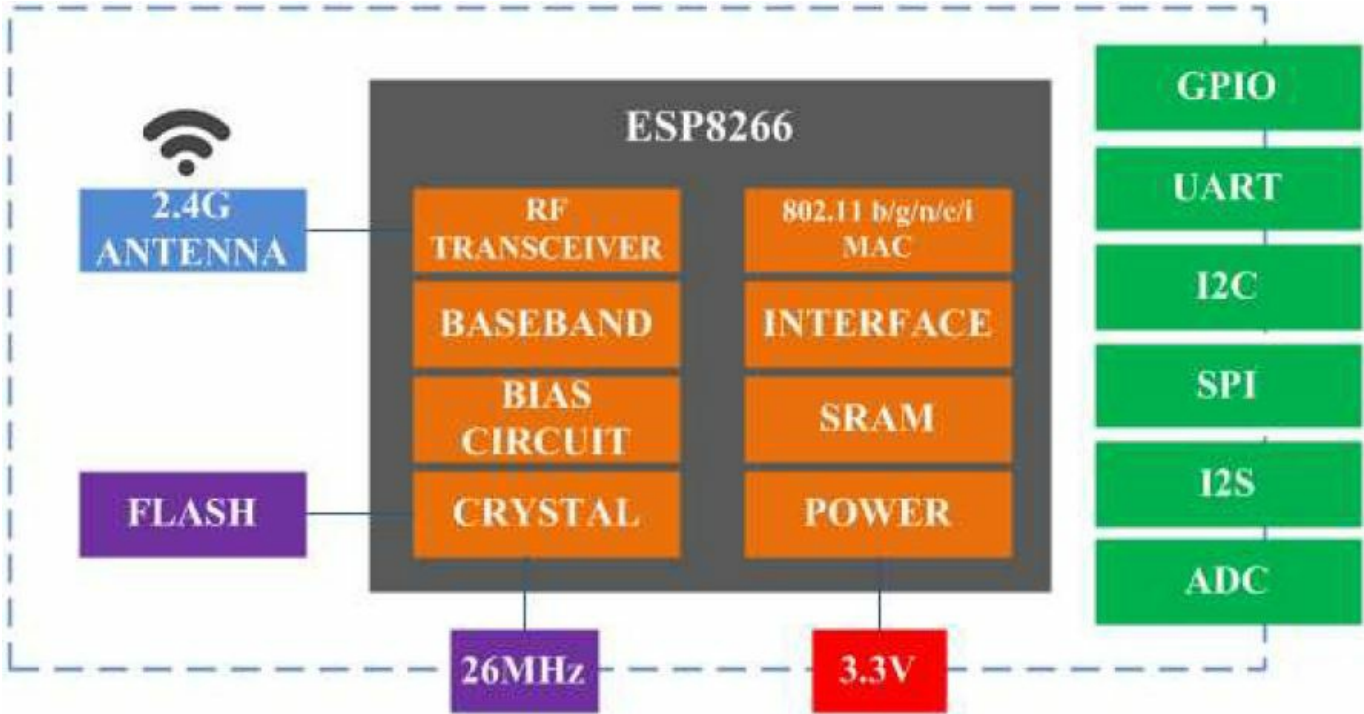


Fig. 1.1 ESP-12F Module Structure

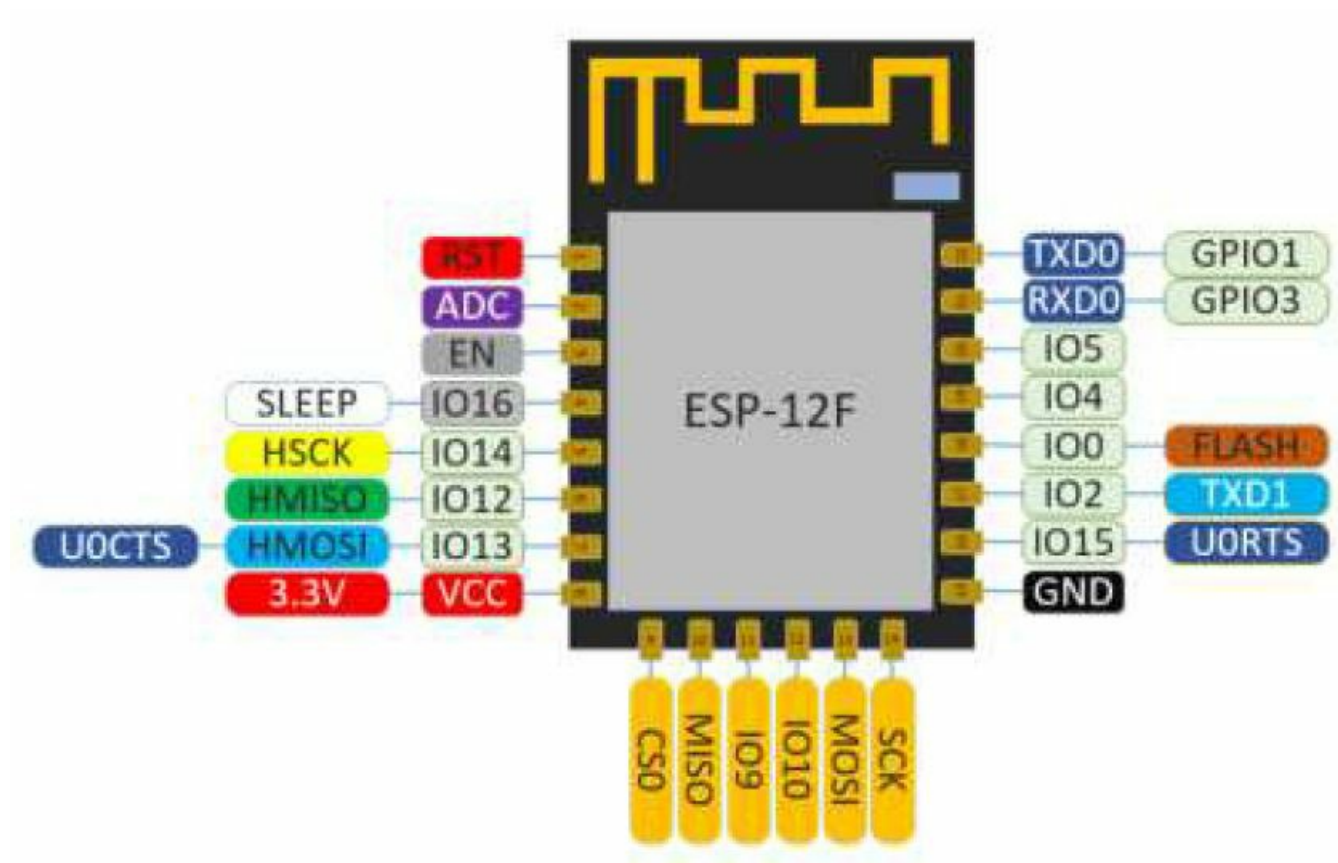
Technical parameters for ESP-12F are listed as follows.

Table 1.1 ESP-12F Parameters

Types	Items	Parameters
Wi-Fi	Frequency	2.4G~2.5G(2400M~2483.5M)
	Transmit power	802.11b: +14 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

## Interface Definition

ESP-12F module interface definition is shown as below



Working mode and pin function is shown in Table 2.1.

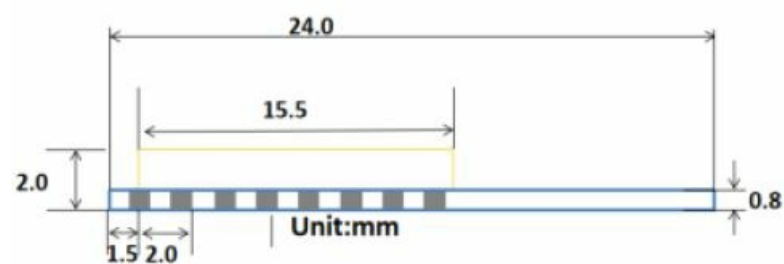
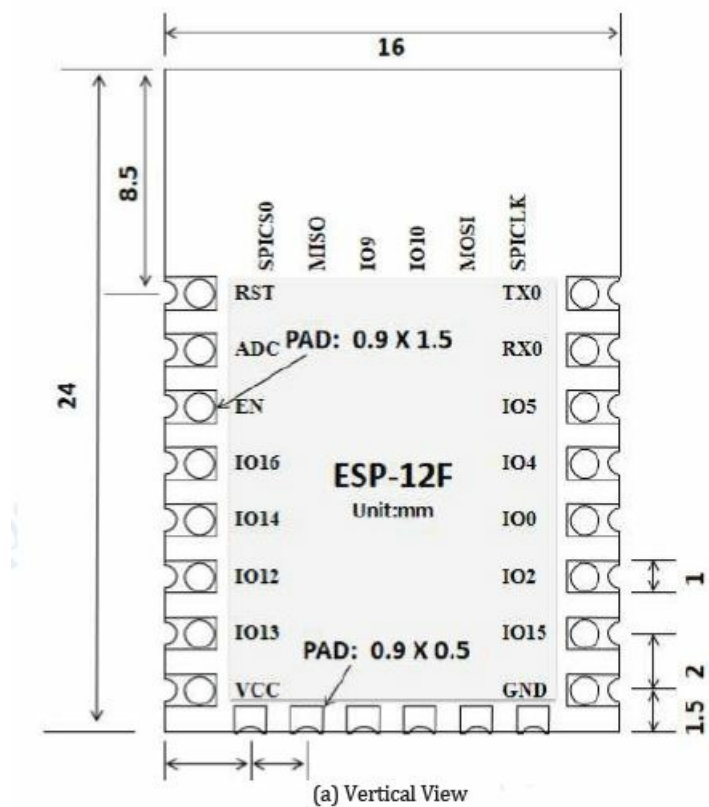
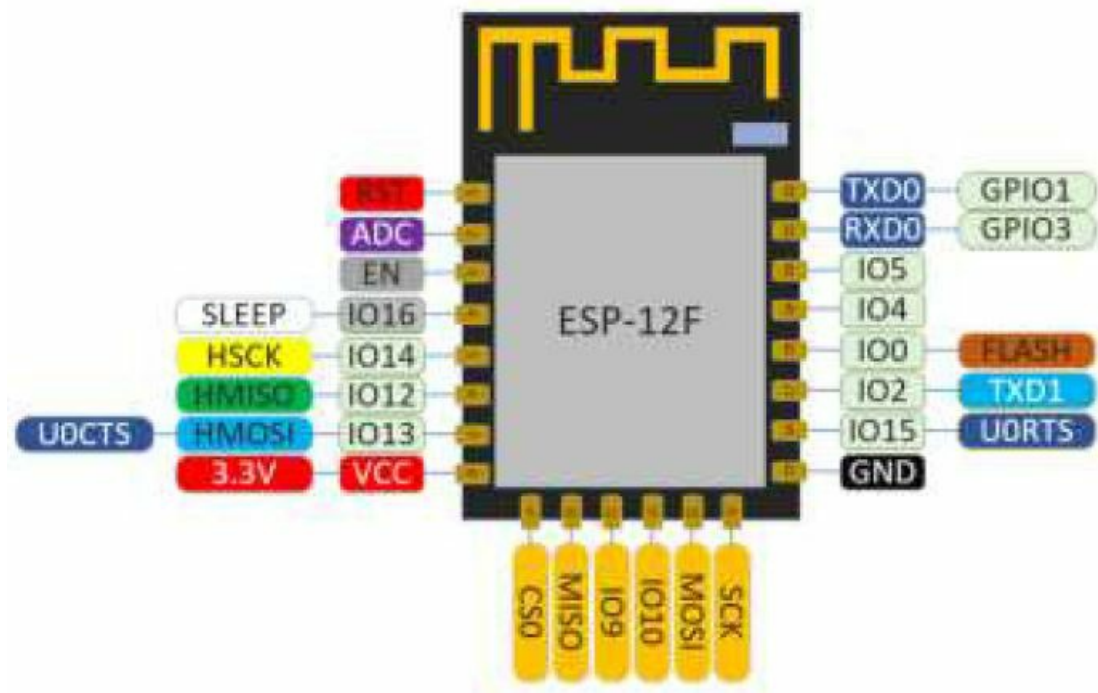
Mode	GPIO0 Level	GPIO2 Level
UART Download Mode	Low	High
Flash Boot Mode	High	High

**Table 2.2 Pin Function Definition**

Num	Name	Type	Function
1	RST	I	Effective: Low level. Used to reset the module
2	ADC	I	A/D pin. Voltage Range: 0-1V. 10bit resolution
3	EN	I	Effective: High level. Used to enable the module
4	IO16	I/O	GPIO16. Used to wake up the module
5	IO14	I/O	GPIO14; HSPI_CLK
6	IO12	I/O	GPIO12;HSPI_MISO
7	IO13	I/O	GPIO13;HSPI_MOSI; UART0_CTS
8	VCC	P	POWER 3.3V
9	CS0	I/O	GPIO11; SD_CMD; SPI_CS0
10	MISO	I/O	GPIO7; SD_D0, SPI_MSIO
11	IO9	I/O	GPIO9; SD_D2 PIHD; HSPIHD
12	IO10	I/O	GPIO10; SD_D3; SPIWP; HSPIWP1
13	MOSI	I/O	GPIO8; SD_D1; SPI_MOSI1
14	SCLK	I/O	GPIO6; SD_CLK; SPI_CLK
15	GND	P	GND
16	IO15	I/O	GPIO15; MTDO;HSPICS;UART0_RTS
17	IO2	I/O	GPIO2; UART1_TXD
18	IO0	I/O	GPIO0; SPI_CS2
19	IO4	I/O	GPIO4
20	IO5	I/O	GPIO5
21	RXD	I/O	GPIO3; UART Rxd
22	TXD	I/O	GPIO1; UART Txd

## Shape and Size

- Shape and size for ESP-12F can be shown as follows.The Flash of ESP-12F is 32 Mbits 4M Bytes .



#### Side View

- Fig. 3.1 Size for ESP-12F
- Table 3.1 Size for ESP-12F

Length	Width	Height	PAD Size (bottom)	Distance between Pins
16 mm	24 mm	3 mm	0.9 mm x 1.7mm	2 mm

## Electronical Characteristics

**Table 4.1 Electronical Characteristics**

Parameters		Condition	Min	Classical	Max	Unite
Store Temperature		—	-40	Normal	125	°C
Sold Temperature		IPC/JEDEC J-STD-020	—	—	260	°C
Working Voltage		—	2.5	3.3	3.6	V
I/O	VIL/VIH	—	-0.3/0.75VIO	—	0.25VIO/3.6	I/O
	VOL/VOH	—	N/0.8VIO	—	0.1VIO/N	
	IMAX	—	—	—	12	
Electrostatic release quantity (Human model)		TAMB=25°C	—	—	2	KV
Electrostatic release quantity (Human model)		TAMB=25°C	—	—	0.5	KV

## 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 be 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 be used for the case that CPU can stop the application temporarily, e.g., Wi-Fi Switch . If Wi-Fi is connected and there is no data packet to be transmitted, by the 802.11 standard (e.g., UAPSD), 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 temperature data each 100s) . it just need 0.3s-1s to connect AP after each 300s, and the whole average current is much smaller 1mA.

## 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 frequency	2412	–	2484	MHz
Input impedance	–	50	–	$\Omega$
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

## The Recommended Sold Temperature Curve

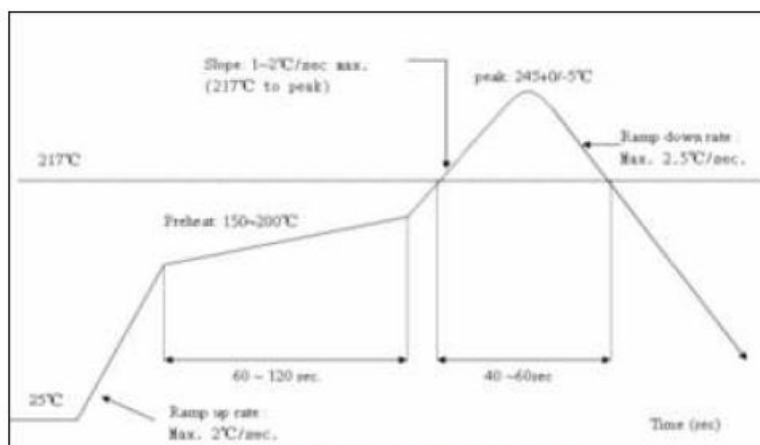


图 7.1 Temperature Curve when sold

## Module Schematic

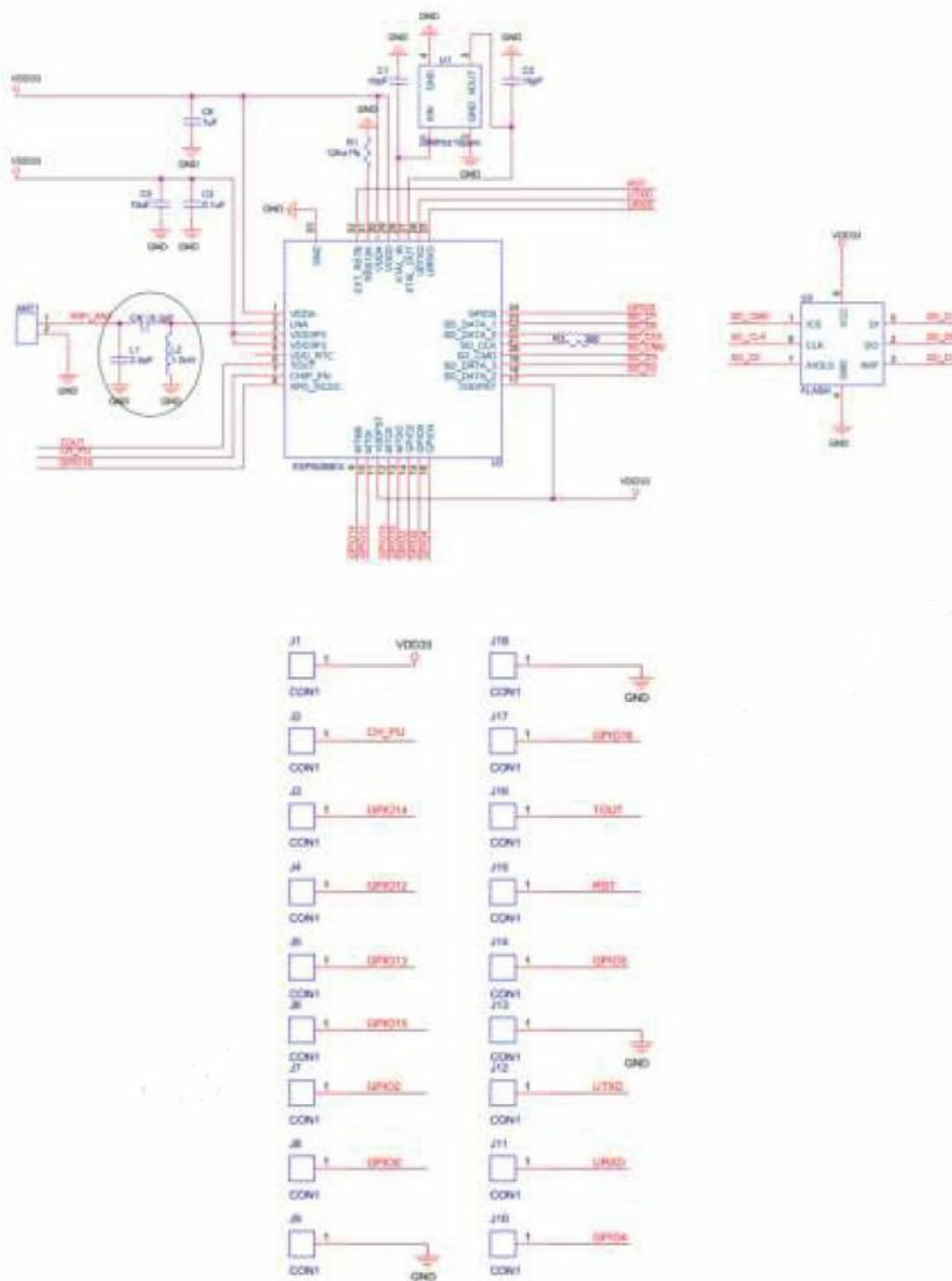
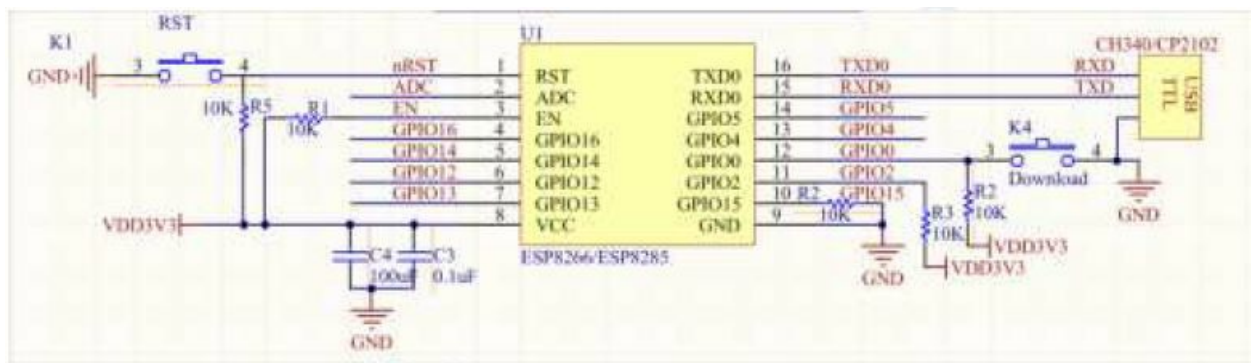


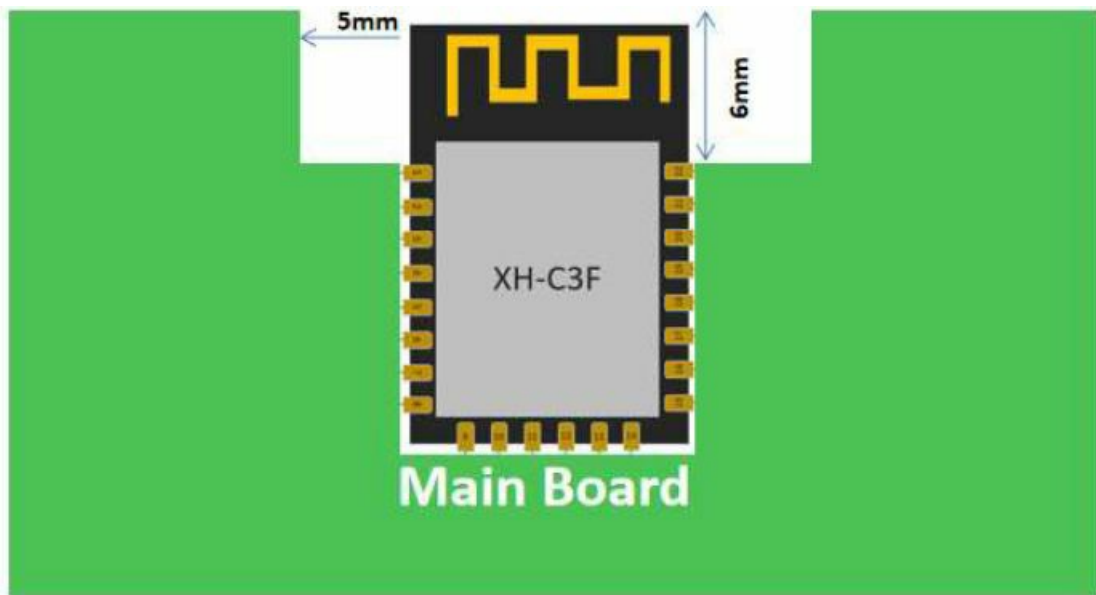
Fig. 8. 1 Module Schematic

## Minimum User System

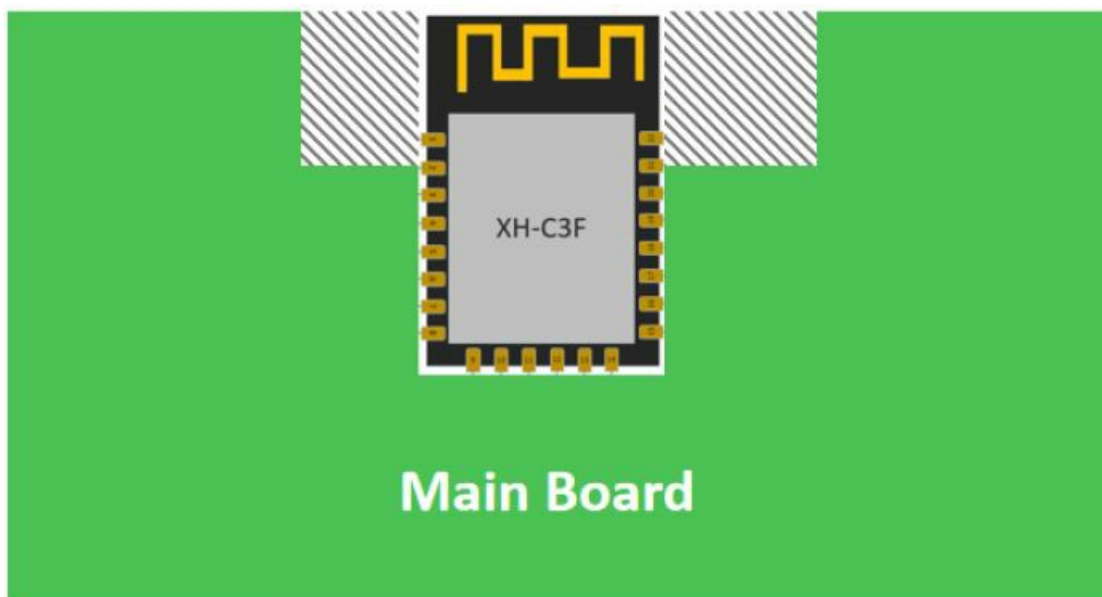
This module can work just at 3.3V working voltage:



**Fig.10.1 Solution 1**



**Fig.10.2 Solution 2**



**Fig.10.3 Solution 3**

### **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 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-12F"

**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

**List of applicable FCC rules**

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

**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.

**Limited module procedures**

Not applicable

**Trace antenna designs**

Not applicable

**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.

**Antennas**

This radio transmitter FCC ID:2BCLP-ESP-12F 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	0.8dBi for 2412-2462MHz;	

**Label and compliance information**

The final end product must be labeled in a visible area with the following" Contains FCC ID:2BCLP-ESP-12F".


**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.

**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.

**Documents / Resources**



[SPARKLEIOT ESP-12F Ultra-low Power WiFi Module](#) [pdf] User Manual  
2BCLP-ESP-12F, 2BCLPESP12F, ESP-12F Ultra-low Power WiFi Module, Ultra-low Power WiFi Module, WiFi Module

**References**

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