ESPS3-12

Product Specification

——2.4GHz Wi-Fi and BLE5.0 Coexistence Module

Version: 1.0 Date: July.20, 2022

Features

- **General**
  - Chip: ESP32-S3FH4R2
  - Module Size:16mm x 24mm x 3mm
  - Dual-Core 240MHz MCU
  - 4MByte embedded flash
  - 2MByte pSRAM
  - 384KB ROM
  - 512KB SRAM+16KB RTC SRAM
- **Wi-Fi Features**
  - IEEE 802.11 b/g/n-compliant
  - Center frequency range of operating channel: 2412 ~ 2484 MHz
  - 1T1R mode with data rate up to 150 Mbps
  - TX/RX A-MPDU, TX/RX A-MSDU
  - Immediate Block ACK
- **Bluetooth Features**
  - Bluetooth LE: Bluetooth 5
  - Speed: 125 Kbps, 500 Kbps, 1 Mbps, 2 Mbps
  - Advertising extensions
  - Multiple advertisement sets
  - Channel selection algorithm #2
- **Peripheral Interfaces**
  - GPIO * 37;
  - LCD interface;
  - Camera interface;
  - IIC + IIS;
  - USB 1.1 OTG;
  - USB Serial/JTAG;
  - SDIO;
  - GDMA;
  - TWAI (CAN 2.0);
  - SPI;
  - EN ;
  - MCPWM;
  - ADC;
  - LED PWM;
- **Working Temperature:** -40℃-105℃

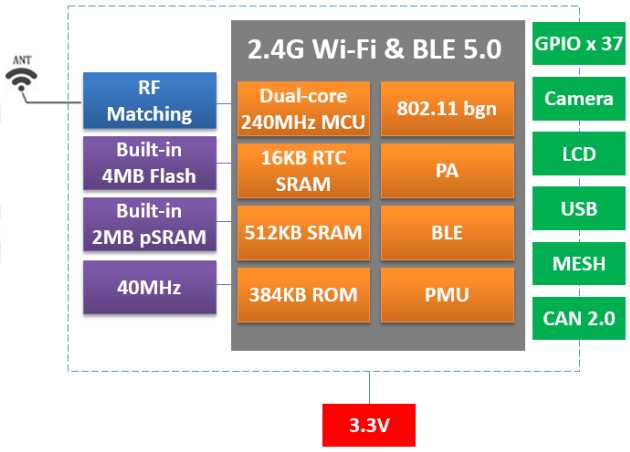
Applications

- Serial transparent transmission;
- Wi-Fi prober;
- Smart power plug/Smart LED light;
- Camera product;
- Sensor networks;
- Over-the-top (OTT) devices;
- Wireless location system beacon;
- Industrial field bus;

Module Type

Name	Antenna Type
ESPS3-12	PCB ANT
ESPS3-12E	U.F.L Ipex

Module Structure



Update Record

Date	Version	Update
2022-07-20	V1.0	First released

Table of Contents

1. Introduction

ESPS3-12 Wi-Fi and BLE coexistence Module is a highly integrated single-chip low power 802.11bgn Wireless LAN (WLAN) network controller. It combines a dual-core 240MHz CPU, WLAN MAC, a 1T1R capable WLAN baseband, RF, and Bluetooth in a single chip. It also provides a bunch of configurable GPIO, which are configured as digital peripherals for different applications and control usage.

ESPS3-12 module use ESP32-S3FH4R2 as Wi-Fi and BLE coexistence SOC chip.

ESPS3-12 module integrates internal memories for complete Wi-Fi protocol functions. The embedded memory configuration also provides convenient application developments.

ESPS3-12 module has camera interface and LCD interface, which can be used for AI applications.

ESPS3-12 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 Wi-Fi function for the installed devices, and also can be viewed as an independent network controller.

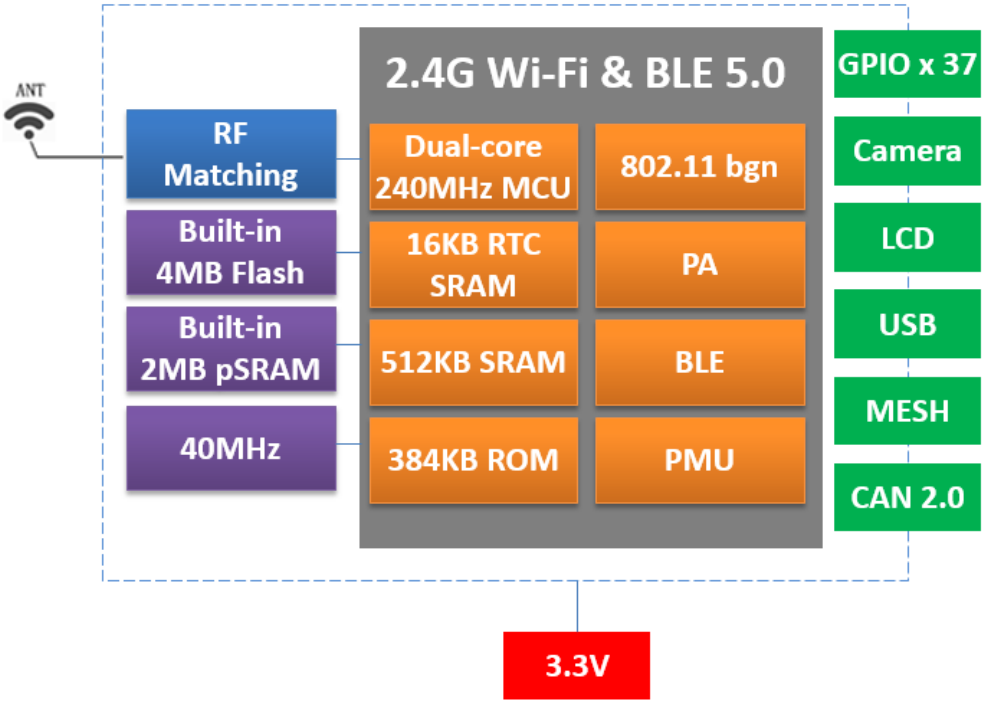


Fig.1.1 ESPS3-12 Module Structure

Technical parameters for ESPS3-12 are listed as follows.

Table.1.1 ESPS3-12 Parameters

Type	Item	Parameter
Wi-Fi	Frequency	2.4G~2.5G (2412M~2484M)
	Transmit power	802.11b: +20 dBm
		802.11g: +20 dBm
		802.11n: +18 dBm
	Receiver sensitivity	802.11b: -88 dBm (11Mbps)
		802.11g: -76 dBm（54Mbps）
		802.11n: -74 dBm（MCS7, HT20）
		802.11n: -71 dBm（MCS7, HT40）
	EVM	-24dB @802.11b,11Mbps @20dBm
		-28dB @802.11n,54Mbps @18dBm
		-30dB @802.11n,HT20,MCS7 @17dBm
		-30dB @802.11n,HT40,MCS7 @17dBm
	Antenna	PCB antenna
BLE	RF power control range	-25~20dBm
Hardware	CPU	Xtensa dual-core 240MHz
	Interface	CAMERA/LCD/UART/SDIO/SPI/I2C/GPIO
	Working voltage	3.0V ~ 3.6V
	Working temperature	-40°C ~ 105°C
	Environment temperature	-40°C ~ 105°C
	Shape	16mm x 24mm x 3mm
Software	Wi-Fi working mode	STA, Soft-AP and sniffer modes
	Security mode	WPS / WEP / WPA / WPA2 / WPA3
	Update firmware	UART Download
	Software develop	SDK
	Network protocol	IPv4, TCP/UDP/HTTP/FTP/MQTT

2. Interface Definition

ESPS3-12 Wi-Fi & BLE module interface definition is shown as below。

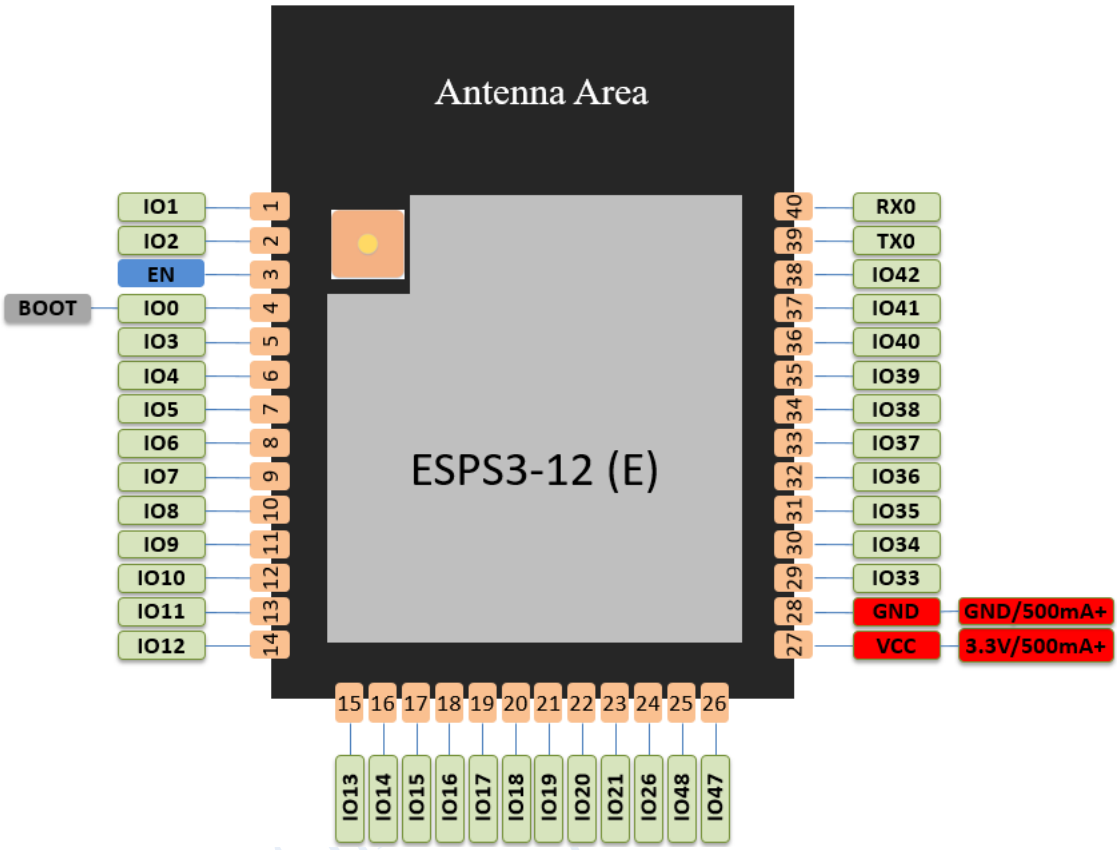


Fig.2.1 ESPS3-12 Pins Definition

Working modes and pins function is shown in Table 2.1.

Table.2.1Working Mode

Mode	IO0 Voltage Level
UART Download Mode	LOW
Flash Boot Mode	HIGH (Default)

Table.2.2 Pins Function Definition

Num.	Pin Name	Type	Function
1	IO1	I/O	GPIO1, TOUCH1,ADC1_CH0
2	IO2	I/O	GPIO2, TOUCH2,ADC1_CH1
3	EN	I	Chip enable; Internal Pull-up. HIGH: enable the chip
4	IO0	I/O	GPIO0,BOOT

5	IO3	I/O	GPIO3, TOUCH3, ADC1_CH2
6	IO4	I/O	GPIO4, TOUCH4, ADC1_CH3
7	IO5	I/O	GPIO5, TOUCH5, ADC1_CH4
8	IO6	I/O	GPIO6, TOUCH6, ADC1_CH5
9	IO7	I/O	GPIO7, TOUCH7, ADC1_CH6
10	IO8	I/O	GPIO8, TOUCH8, ADC1_CH7,SUBSPICS1
11	IO9	I/O	GPIO9, TOUCH9, ADC1_CH8, FSPIHD, SUBSPIHD
12	IO10	I/O	GPIO10, TOUCH10, ADC1_CH9, FSPICS0, FSPIIO4, SUBSPID
13	IO11	I/O	GPIO11, TOUCH11, ADC2_CH0, FSPID,FSPIIO5, SUBSPICLK
14	IO12	I/O	GPIO12, TOUCH12, ADC2_CH1, FSPICLK, FSPIIO6, SUBSPICLK
15	IO13	I/O	GPIO13, TOUCH13, ADC2_CH2, FSPIQ, FSPIIO7,SUBSPIQ
16	IO14	I/O	GPIO14, TOUCH14, ADC2_CH3, FSPIWP, FSPIDQS, SUBSPIWP
17	IO15	I/O	GPIO15, U0RTS, ADC2_CH4, XTAL_32K_P
18	IO16	I/O	GPIO16, U0CTS, ADC2_CH5, XTAL_32K_N
19	IO17	I/O	GPIO17, U1TXD, ADC2_CH6
20	IO18	I/O	GPIO18, U1RXD, ADC2_CH7, CLK_OUT3
21	IO19	I/O	GPIO19, U1RTS, ADC2_CH8, CLK_OUT2, USB_D-
22	IO20	I/O	GPIO20, U1CTS, ADC2_CH9, CLK_OUT1, USB_D+
23	IO21	I/O	GPIO21
24	IO26	I/O	SPICS1, GPIO26
25	IO48	I/O	SPICLK_N_DIFF, GPIO48, SUBSPICLK_N_DIFF
26	IO47	I/O	SPICLK_P_DIFF, GPIO47, SUBSPICLK_P_DIFF
27	VCC	P	Power, 3.3V/500mA Recommended
28	GND	P	Power, 3.3V/500mA Recommended
29	IO33	I/O	SPIIO4, GPIO33, FSPIHD, SUBSPIHD

30	IO34	I/O	SPIIO5, GPIO34, FSPICS0, SUBSPICS0
31	IO35	I/O	SPIIO6, GPIO35, FSPID, SUBSPID
32	IO36	I/O	SPIIO7, GPIO36, FSPICLK, SUBSPICLK
33	IO37	I/O	SPIDQS, GPIO37, FSPIQ, SUBSPIQ
34	IO38	I/O	GPIO38, FSPIWP, SUBSPIWP
35	IO39	I/O	MTCK, GPIO39, CLK_OUT3, SUBSPICS1
36	IO40	I/O	MTDO, GPIO40, CLK_OUT2
37	IO41	I/O	MTDI, GPIO41, CLK_OUT1
38	IO42	I/O	MTMS, GPIO42
39	TX0	I/O	GPIO43, CLK_OUT1
40	RX0	I/O	GPIO44, CLK_OUT2

3. Size and Layout

Size for ESPS3-12 can be shown as follows.

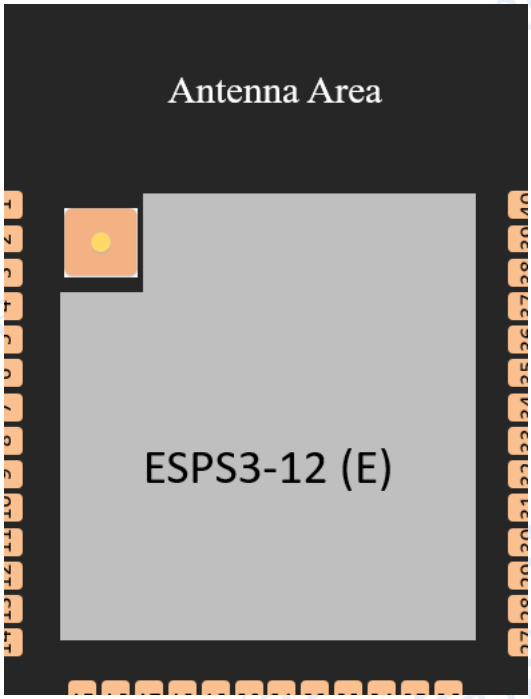
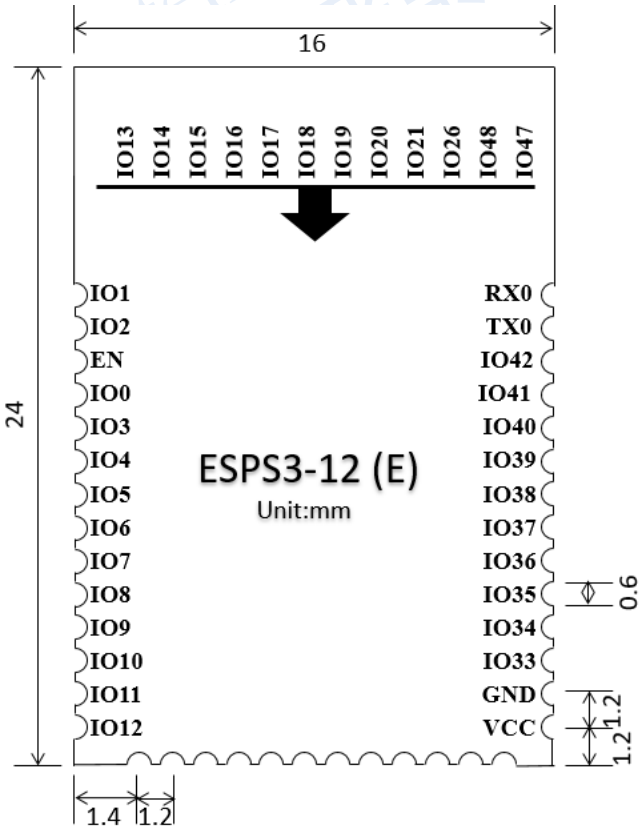


Fig.3.1 Shape for ESPS3-12



(a) Vertical View

(b) Side View

Fig.3.2 Size for ESPS3-12

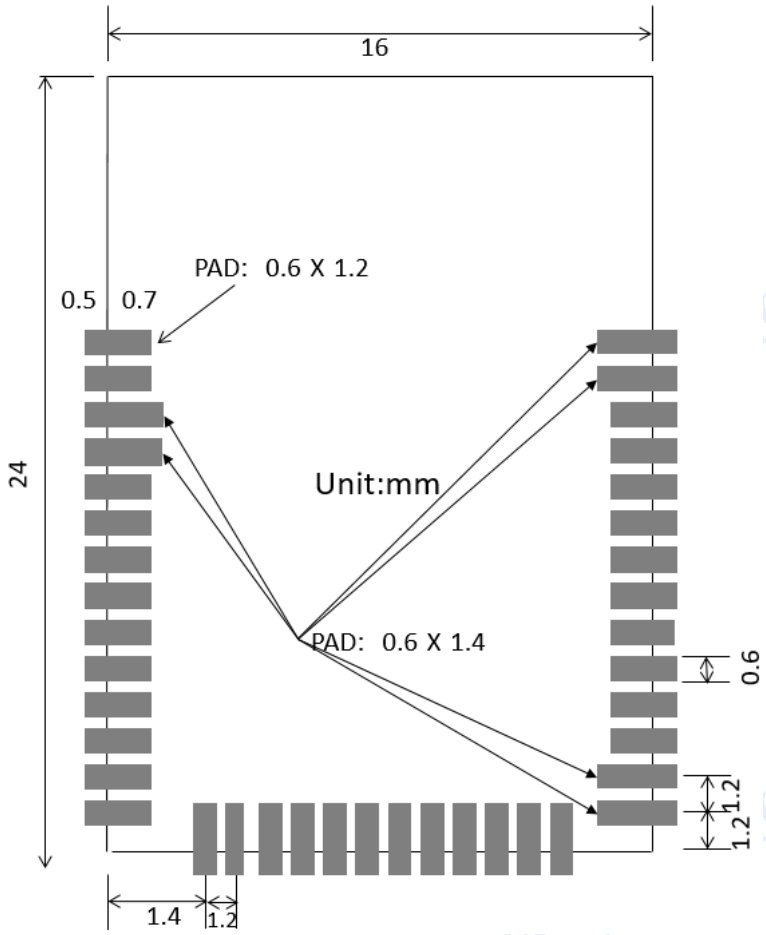


Fig. 3.3 PCB Layout for ESPS3-12

4. Electronica Characteristics

Table.4.1 Electronica Characteristics

Parameters		Condition	Min	Classical	Max	Unit
Store Temperature		-	-40	Normal	105	℃
Sold Temperature		IPC/JEDEC J-STD-020	-	-	260	℃
Working Voltage		-	3.0	3.3	3.6	V
I/O	V_{IL}	-	-0.3	-	0.25*VDD	V
	V_{IH}	-	0.75*VDD	-	VDD+0.3	
	V_{OL}	-	-	-	0.1*VDD	
	V_{OH}	-	0.8*VDD	-	-	

Electrostatic Release Quantity (Human model)	TAMB=25℃	-	-	2	KV
Electrostatic Release Quantity (Machine model)	TAMB=25℃	-	-	0.5	KV

5. Power Consumption

Table.5.1 Power Consumption

Parameters	Min	Classical	Max	Unit
RX 11b /g/n, HT20	-	-	95	mA
RX 11n, HT40	-	-	97	mA
TX 11b, 1Mbps @20dBm		-	355	
TX 11g, 54Mbps @18dBm	-	-	300	mA
TX 11n, HT20, MCS7, @17dBm	-	-	289	mA
TX 11n, HT40, MCS7, @17dBm	-	-	287	mA
Modem-sleep, CPU is powered on @240MHz	-	66	-	mA
Light-sleep	-	280	-	uA
Deep-sleep, RTC timer + RTC memory	-	48	-	uA
Power off, CHIP_PU is set to low level	-	41	0	uA

The peak current consumption of ESPS3-12 exceed 400mA when the module start work (RF calibration work consumes maximum current). Therefore, the recommended power supply is no less than 500mA.

Note:

1. Active Mode: CPU and RF are all turned on.

2. Modem-sleep Mode: CPU is turned on. RF and baseband are turned off, but the communication is still connected.

3. Light-sleep Mode: CPU is turned off. RTC/external interrupt/MAC can wake up the chip. The communication is still connected.

4. Deep-sleep Mode: Only RTC is turned on.

6. Wi-Fi RF Characteristics

The data in the following table is gotten when voltage is 3.3V in the indoor temperature environment.

Table.6.1 Wi-Fi TX Characteristics

Parameters	Min	Classical	Max	Unit
Input frequency	2412	-	2484	MHz
802.11b @1Mbps,11Mbps	-	20.0	-	dBm
802.11g @6Mbps	-	20.0	-	dBm
802.11g @54Mbps	-	18.0	-	dBm
802.11n,HT20 MCS0	-	19.0	-	dBm
802.11n,HT40 MCS0	-	18.5	-	dBm
EVM @11b,1Mbps@20dBm	-	-24.5	-	dBm
EVM @11g,54Mbps@18dBm	-	-29	-	dBm
EVM @11n,HT20, MCS7@18dBm	-	-30	-	dBm
EVM @11n, HT40, MCS7@18dBm	-	-30	-	dBm

Table.6.2 Wi-Fi RX Sensitivity

Parameters	Min	Classical	Max	Unit
802.11b,1Mbps	-	-98	-	dBm
802.11b,11Mbps	-	-88	-	dBm
802.11g,6Mbps	-	-93	-	dBm
802.11g,54Mbps	-	-76	-	dBm
802.11n,HT20,MCS0	-	-93	-	dBm
802.11n,HT20,MCS3	-	-84	-	dBm
802.11n,HT20,MCS7	-	-74	-	dBm
802.11n,HT40,MCS0	-	-90	-	dBm
802.11n,HT40,MCS3	-	-82	-	dBm
802.11n,HT40,MCS7	-	-71	-	dBm

Table.6.3 Wi-Fi RX Characteristics

Parameters	Min	Classical	Max	Unit
MAX RX Level @11b,1Mbps	-	5	-	dBm
MAX RX Level @11b,11Mbps	-	5	-	dBm

MAX RX Level @11g,6Mbps	-	5	-	dBm
MAX RX Level @11g,54Mbps	-	0	-	dBm
MAX RX Level @11n,HT20,MCS0	-	5	-	dBm
MAX RX Level @11n,HT20,MCS7	-	0	-	dBm
MAX RX Level @11n,HT40,MCS0	-	5	-	dBm
MAX RX Level @11n,HT40,MCS7	-	0	-	dBm
RX Adjacent Channel Rejection@11b,1Mbps	-	35	-	dB
RX Adjacent Channel Rejection@11b,11Mbps	-	35	-	dB
RX Adjacent Channel Rejection@11g,6Mbps	-	31	-	dB
RX Adjacent Channel Rejection@11g,54Mbps	-	14	-	dB
RX Adjacent Channel Rejection@11n,HT20,MCS0	-	31	-	dB
RX Adjacent Channel Rejection@11n,HT20,MCS7	-	13	-	dB
RX Adjacent Channel Rejection@11n,HT40,MCS0	-	19	-	dB
RX Adjacent Channel Rejection@11n,HT40,MCS7	-	8	-	dB

7. Bluetooth LE Radio

Table.7.1 TX Transmitter General Characteristics

Parameters	Min	Classical	Max	Unit
RF power control range	-24	3	20	dBm
In-band emissions @F-F0±3MHz, LE 1M	-	-42	-	dBm
In-band emissions @F-F0±>3MHz, LE 1M	-	-42	-	dBm
Modulation characteristics @ △f1avg, LE 1M	-	249	-	kHz
Modulation characteristics @△f2max, LE 1M	-	198	-	kHz
In-band emissions @F-F0±5MHz, LE 2M	-	-44	-	dBm
In-band emissions @F-F0±>5MHz, LE 2M	-	-47	-	dBm
Modulation characteristics @ △f1avg, LE 2M	-	499	-	kHz
Modulation characteristics @△f2max, LE 2M	-	416	-	kHz
In-band emissions @F-F0±3MHz, LE 500K	-	-42	-	dBm
In-band emissions @F-F0±>3MHz, LE 500K	-	-44	-	dBm
Modulation characteristics @ △f1avg, LE 500K	-	213	-	kHz

Modulation characteristics @△f2max, LE 500K	-	196	-	kHz

Table.7.2 RX Transmitter General Characteristics

Parameters		Min	Classical	Max	Unit
1M	Sensitivity @30.8% PER	-	-96.5	-	dBm
	Maximum received signal @30.8% PER	-	8	-	dBm
	Co-channel C/I	-	8	-	dB
	Image frequency	-	-36	-	dB
	Adjacent channel to image frequency @F =F_{image}+1	-	-39	-	dB
	Adjacent channel to image frequency @F =F_{image}-1	-	-34	-	dB
	Adjacent channel selectivity @ F =F0+1	-	4	-	dB
	Adjacent channel selectivity @ F =F0-1	-	4	-	dB
	Adjacent channel selectivity @ F ≥F0+3	-	-36	-	dB
	Adjacent channel selectivity @ F ≤F0-3	-	-37	-	dB
2M	Sensitivity @30.8% PER	-	-92	-	dBm
	Maximum received signal @30.8% PER	-	3	-	dBm
	Co-channel C/I	-	8	-	dB
	Image frequency	-	-27	-	dB
	Adjacent channel to image frequency @F =F_{image}+2	-	-38	-	dB
	Adjacent channel to image frequency @F =F_{image}-2	-	4	-	dB
	Adjacent channel selectivity @ F =F0+2	-	4	-	dB
	Adjacent channel selectivity @ F =F0-2	-	4	-	dB
	Adjacent channel selectivity @ F ≥F0+6	-	-41	-	dB
	Adjacent channel selectivity @ F ≤F0-6	-	-41	-	dB
125K	Sensitivity @30.8% PER	-	-103	-	dBm
	Maximum received signal @30.8% PER	-	8	-	dBm
	Co-channel C/I	-	4	-	dB
	Image frequency	-	-42	-	dB
	Adjacent channel to image frequency @F =F_{image}+1	-	-43	-	dB
	Adjacent channel to image frequency @F =F_{image}-1	-	-36	-	dB
	Adjacent channel selectivity @ F =F0+2	-	-26	-	dB

	Adjacent channel selectivity @ F =F0-2	-	-26	-	dB
	Adjacent channel selectivity @ F ≥F0+3	-	-42	-	dB
	Adjacent channel selectivity @ F ≤F0-3	-	-43	-	dB

8. Recommended Sold Temperature Curve

(1) Reflow Times <= 2 times (Max.)

(2) Max Rising Slope: 3℃/sec

(3) Max Falling Slope: -3℃/sec

(4) Over 217℃ Time: 60~120sec

(5) Peak Temp:240℃~250℃

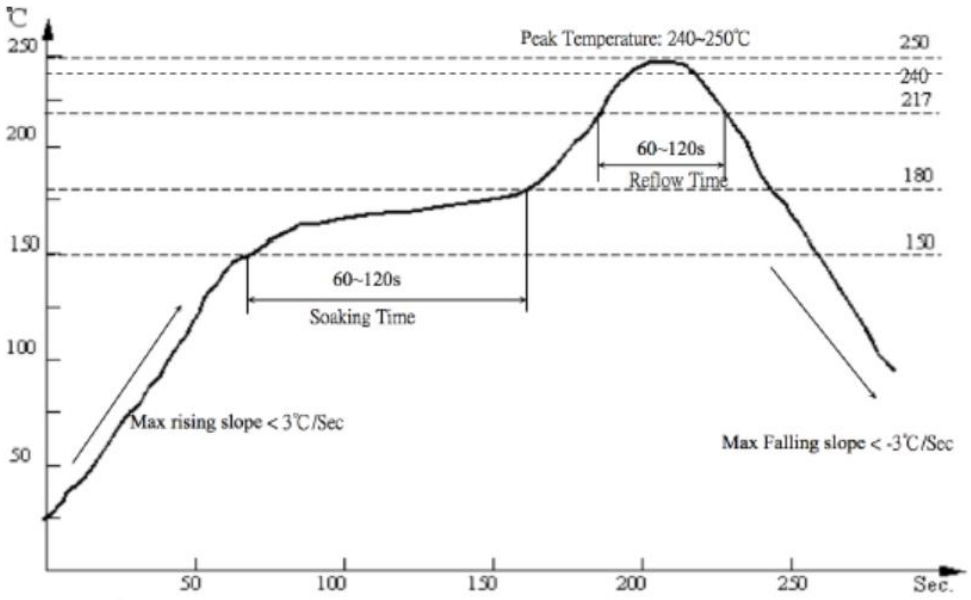


Fig.8.1 Recommended Reflow Profile

9. Minimum User System

This module can work just at 3.3V voltage condition:

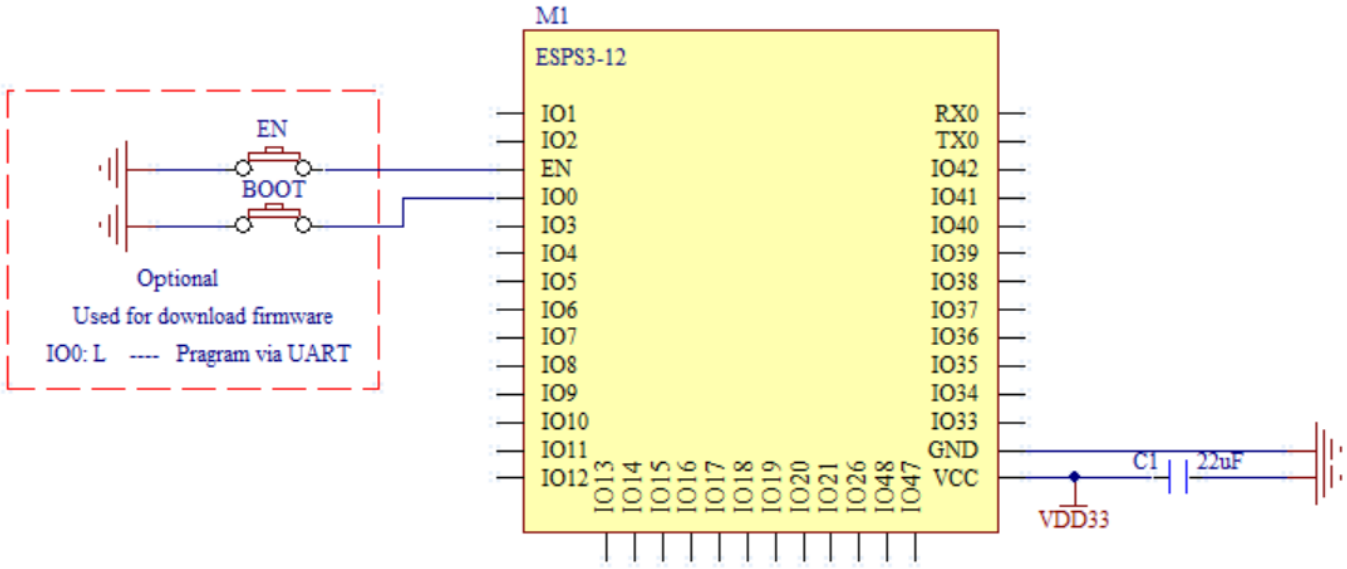


Fig.9.1 Minimum System

Note:

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

(2) The max current from IO of this module is 40mA;

(3) Wi-Fi module is at download mode: IO0 is LOW level, then module reset to power;

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

10. Recommended Layout Design

ESPS3-12 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 for Wi-Fi Module with PCB antenna.

Solution 1: optical solution. The Wi-Fi 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: sub-optical solution. The Wi-Fi 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 Wi-Fi module is placed on the side of the board, and the PCB area under the antenna is empty, and copper cannot be laid.

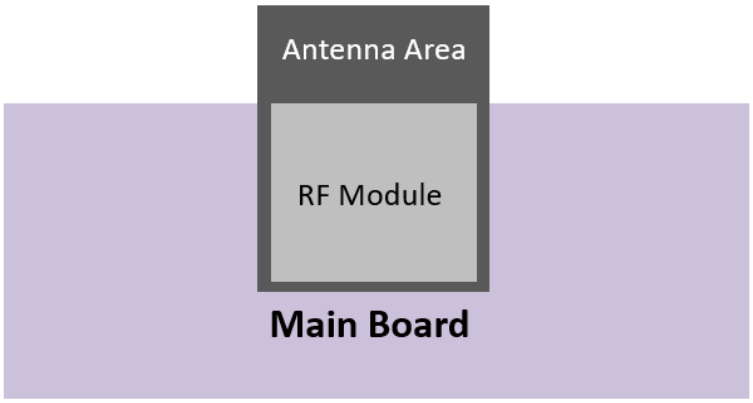


Fig.10.1 Solution 1

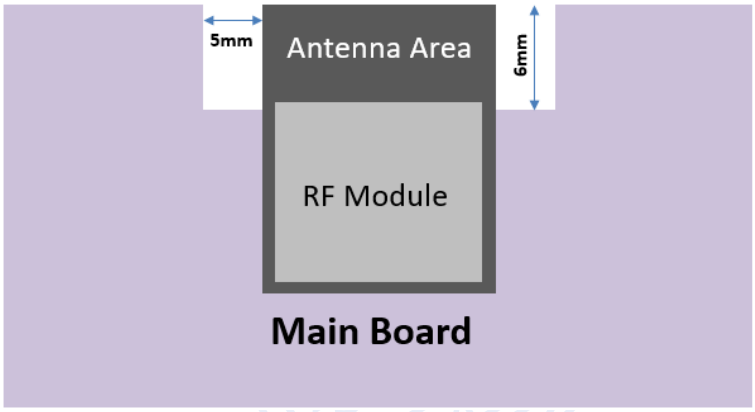


Fig.10.2 Solution 2

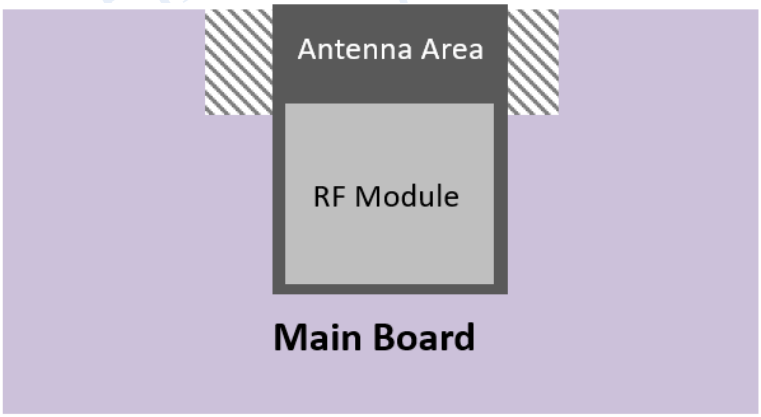


Fig.10.3 Solution 3

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).

12. Product Handling

12.1 Storage Conditions

The products sealed in moisture barrier bags (MBB) should be stored in a non-condensing atmospheric environment of < 40 °C and 90%RH. The module is rated at the moisture sensitivity level (MSL) of 3. After unpacking, the module must be soldered within 168 hours with the factory conditions 25±5 °C and 60%RH. If the above conditions are not met, the module needs to be baked.

12.2 Electrostatic Discharge (ESD)

• Human body model (HBM): ±2000 V

• Charged-device model (CDM): ±500 V

13. U.F.L RF Connector

ESPS3-12 module use U.F.L type RF connector for external antenna connection. (IPEX V1.0).

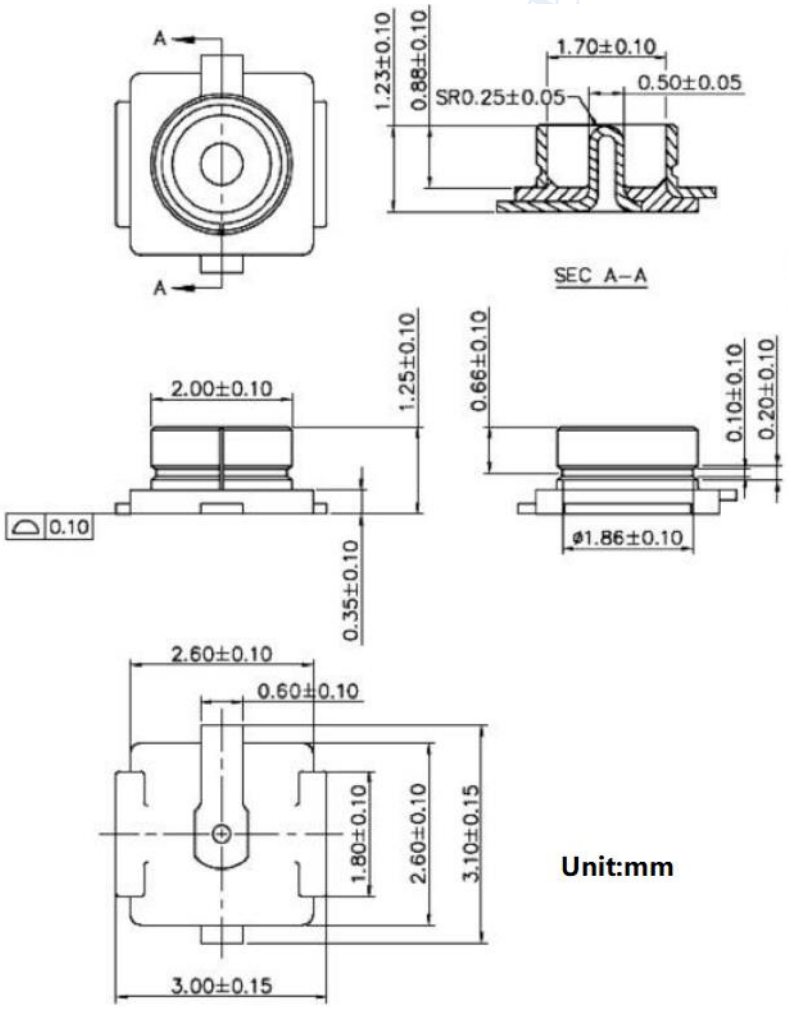


Fig.13.1 U.F.L RF Connector