ESPC6-32E

Product Specification

2.4GHz Wi-Fi 6 & BLE5.0 & 802.15.4 Coexistence Module

Version: 1.0 Date: Feb.20, 2024

Features

- General
  - Chip: ESP32-C6
  - Module Size:18mm x 25.5mm x 3mm
  - RISC-V single-core microprocessor 160MHz
  - 320KB ROM
  - 512KB HP SRAM+16KB LP SRAM
- Wi-Fi Features
  - IEEE 802.11 b/g/n/ax-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® 5 (LE)
  - Speed: 125 Kbps, 500 Kbps, 1 Mbps, 2 Mbps
  - Advertising extensions
  - Multiple advertisement sets
  - Channel selection algorithm #2
- IEEE 802.15.4
  - Compliant with IEEE 802.15.4-2015 protocol
  - OQPSK PHY in 2.4 GHz band
  - Data rate: 250 Kbps
  - Thread 1.3
  - ZigBee 3.0
- Peripheral Interfaces
  - GPIO * 23;
  - I2C;
  - I2S;
  - SDIO;
  - TWAI (CAN 2.0);
  - SPI;
  - EN;
  - MCPWM;
  - ADC;
  - LED PWM;
- Working Temperature: -40℃~85℃

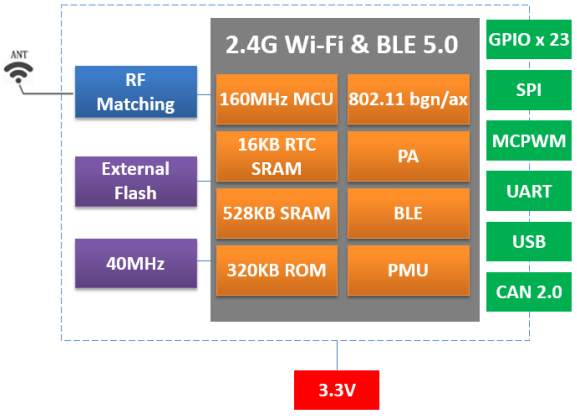
Applications

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

Module Type

Name	Flash	Antenna
ESPC6-32E-N4	32M bit	IPEX
ESPC6-32E-N8	64M bit	IPEX
ESPC6-32E-N16	128M bit	IPEX

Module Structure



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Update Record

Date	Version	Update
2024-02-20	V1.0	First released

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1. Introduction

ESPC6-32E Wi-Fi and BLE coexistence Module is a highly integrated single-chip low power 802.11b/g/n/ax Wireless LAN (WLAN) network controller. It combines a 160MHz 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.

ESPC6-32E integrates rich peripherals, including SPI, parallel IO, ADC, UART, I2C, I2S, RMT (TX/RX), LED pulse width modulation, USB serial port, JTAG controller, MCPWM, SDIO2.0 slave controller, GDMA, Twai ®controller, on-chip JTAG debugging function, event task matrix. And up to 23 GPIO and so on.

ESPC6-32E includes an IEEE Standard 802.15.4 subsystem that integrates PHY and MAC layer. It supports various software stacks including Thread, ZigBee, Matter, HomeKit, MQTT and so on.

ESPC6-32E module use ESP32-C6 as Wi-Fi and BLE coexistence SOC chip.

ESPC6-32E module integrates internal memories for complete Wi-Fi protocol functions. The embedded memory configuration also provides convenient application developments.

ESPC6-32E module supports the standard IEEE802.11 b/g/n/ax 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.

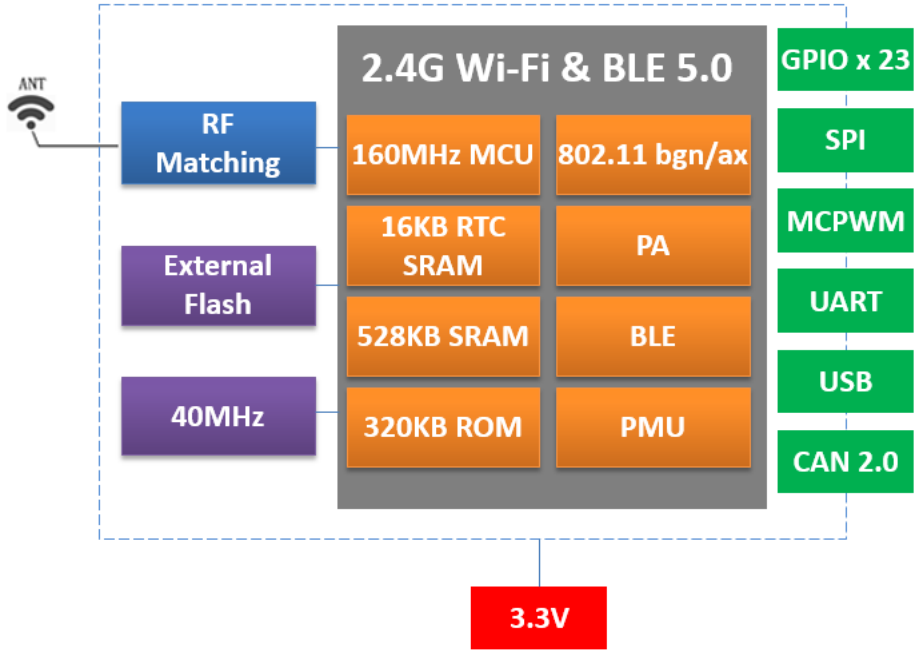


Fig.1.1 ESPC6-32E Module Structure

Technical parameters for ESPC6-32E are listed as follows.

Table.1.1 ESPC6-32E Parameters

Type	Item	Parameter
Wi-Fi	Frequency	2.4G~2.5G (2412M~2484M)
	Transmit power	802.11b: +19 dBm
		802.11g: +17 dBm
		802.11n: +13 dBm
		802.11ax: +13 dBm
	Receiver sensitivity	802.11b: -90 dBm (11Mbps)
		802.11g: -75 dBm（54Mbps）
		802.11n: -73 dBm（MCS7, HT20）
		802.11n: -70 dBm（MCS7, HT40）
		802.11ax: -68 dBm（MCS9, HE20）
	EVM	-25dB @802.11b,11Mbps @19dBm
		-28dB @802.11g,54Mbps @17dBm
		-29dB @802.11n,HT20,MCS7 @13dBm
		-29dB @802.11n,HT40,MCS7 @13dBm
		-33dB @802.11ax,HE20,MCS9 @13dBm
	Antenna	IPEX
BLE	RF power control range	-24~10dBm （2402 ~ 2480 MHz）
IEEE 802.15.4	RF power control range	-24~10dBm （2405 ~ 2480 MHz）
Hardware	CPU	RISC-V 32-bit single-core processor 160MHz
	Interface	UART/SDIO/SPI/I2C/GPIO
	Working voltage	3.3V
	Working temperature	-40°C ~ 85°C
	Environment temperature	-40°C ~ 105°C
	Shape	18mm x 25.5mm 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 develops	SDK
	Network protocol	IPv4, TCP/UDP/HTTP/FTP/MQTT

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2. Interface Definition

ESPC6-32E Wi-Fi & BLE module interface definition is shown as below。

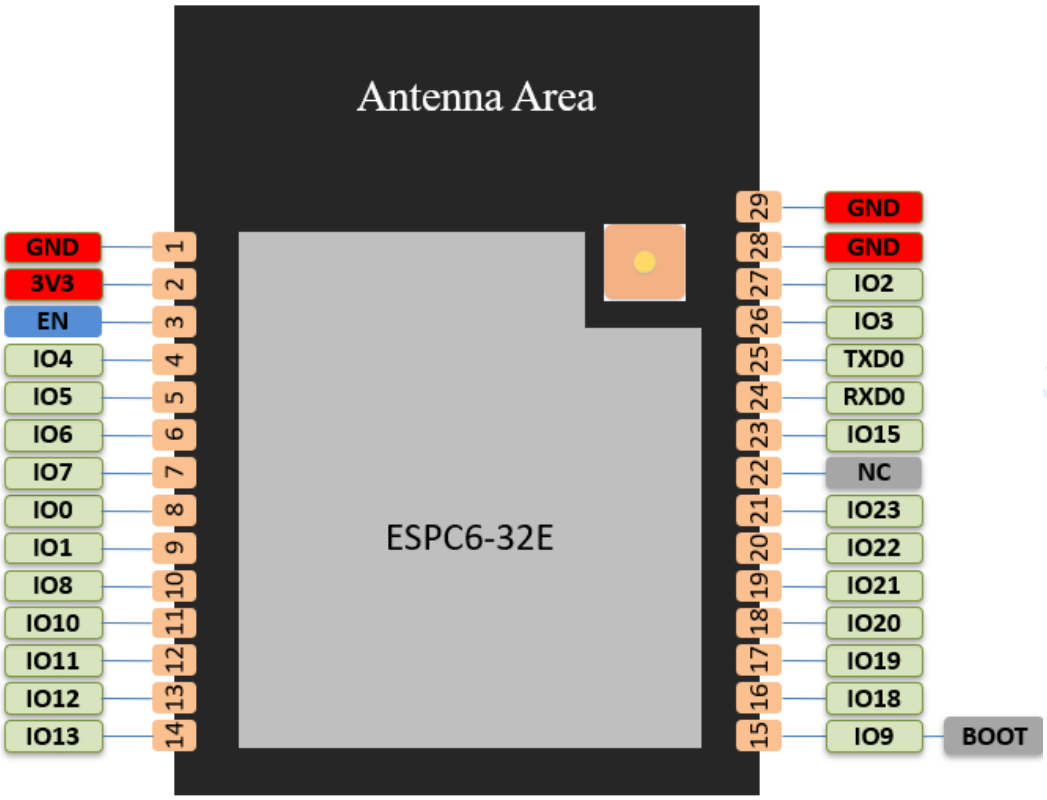


Fig.2.1 ESPC6-32E Pins Definition（Top view）

Working modes and pins function is shown in Table 2.1.

Table.2.1Working Mode

Mode	IO9 Voltage Level
UART Download Mode	LOW
Flash Boot Mode	HIGH (Default)

Table.2.2 Pins Function Definition

Num.	Pin Name	Type	Function
1	GND	P	Ground
2	3V3	P	Power supply
3	EN	I	Chip enable; Internal Pull-up. HIGH: enable the chip
4	IO4	I/O	MTMS, GPIO4, LP_GPIO4, LP_UART_RXD, ADC1_CH4, FSPIHD

5	IO5	I/O	MTDI, GPIO5, LP_GPIO5, LP_UART_TXD, ADC1_CH5, FSPIWP
6	IO6	I/O	MTCK, GPIO6, LP_GPIO6, LP_I2C_SDA, ADC1_CH6, FSPICLK
7	IO7	I/O	MTDO, GPIO7, LP_GPIO7, LP_I2C_SCL, FSPID
8	IO0	I/O	GPIO0, XTAL_32K_P, LP_GPIO0, LP_UART_DTRN, ADC1_CH0
9	IO1	I/O	GPIO1, XTAL_32K_N, LP_GPIO1, LP_UART_DSRN, ADC1_CH1
10	IO8	I/O	GPIO8
11	IO10	I/O	GPIO10
12	IO11	I/O	GPIO11
13	IO12	I/O	GPIO12, USB_D-
14	IO13	I/O	GPIO13, USB_D+
15	IO9	I/O	IO9
16	IO18	I/O	GPIO18, SDIO_CMD, FSPICS2
17	IO19	I/O	GPIO19, SDIO_CLK, FSPICS3
18	IO20	I/O	GPIO20, SDIO_DATA0, FSPICS4
19	IO21	I/O	GPIO21, SDIO_DATA1, FSPICS5
20	IO22	I/O	GPIO22, SDIO_DATA2
21	IO23	I/O	GPIO23, SDIO_DATA3
22	NC	—	NC
23	IO15	I/O	GPIO15
24	RXD0	I/O	U0RXD, GPIO17, FSPICS1
25	TXD0	I/O	U0TXD, GPIO16, FSPICS0
26	IO3	I/O	GPIO3, LP_GPIO3, LP_UART_CTSN, ADC1_CH3
27	IO2	I/O	GPIO2, LP_GPIO2, LP_UART_RTSN, ADC1_CH2, FSPIQ
28	GND	P	GND
29	EPAD	P	GND

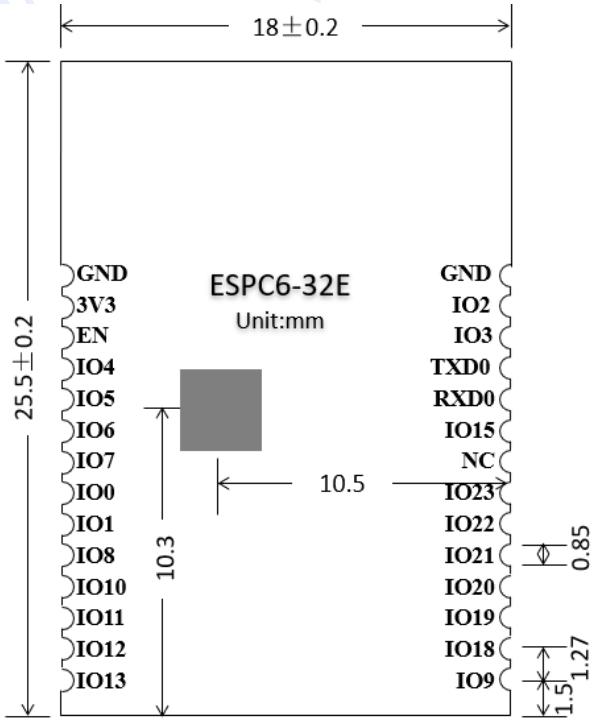
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3. Size and Layout

Size for ESPC6-32E can be shown as follows.



Fig.3.1 Shape for ESPC6-32E



(a) （Top view）



(b) Side View

Fig.3.2 Size for ESPC6-32E

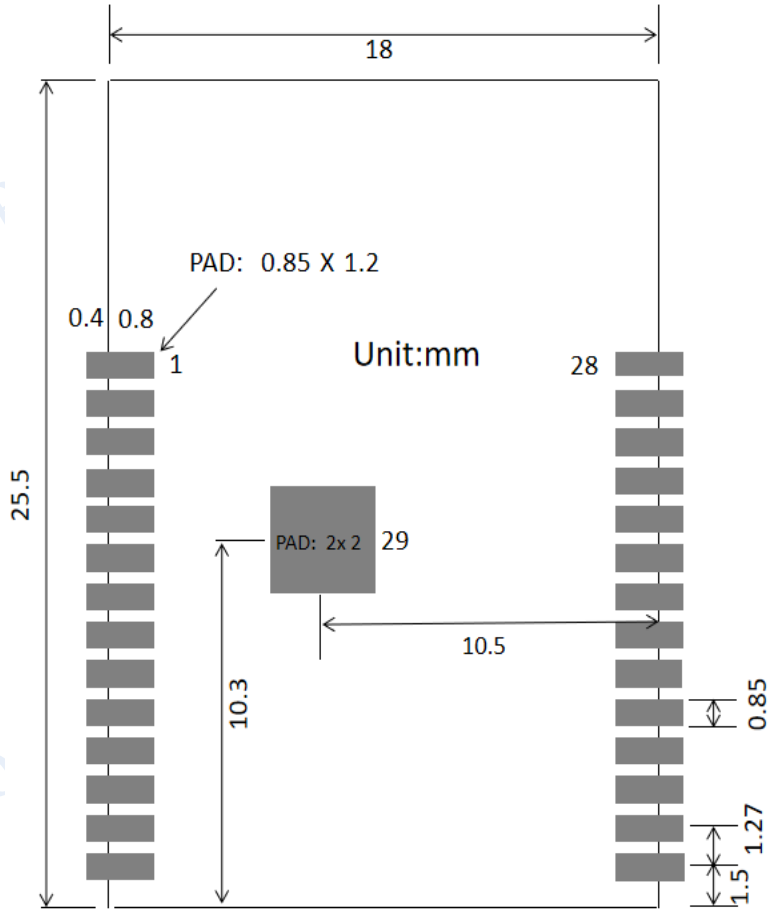


Fig. 3.3 PCB Layout for ESPC6-32E（Top view）

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 11n, HT20	-	-	78	mA
RX 11n, HT40	-	-	82	mA
RX 11ax, HE20	-	-	78	mA
TX 11b, 1Mbps @20dBm	-	-	350	mA
TX 11g, 54Mbps @17dBm	-	-	270	mA
TX 11n, HT20, MCS7, @13dBm	-	-	210	mA
TX 11n, HT40, MCS7, @13dBm	-	-	210	mA
TX 11ax, HE20, MCS9, @13dBm	-	-	210	mA
Modem-sleep, CPU is powered on @160MHz	-	38	-	mA
Light-sleep	-	180	-	uA
Deep-sleep, RTC timer + RTC memory	-	7	-	uA
Power off, CHIP_PU is set to low level	-	1	-	uA

The peak current consumption of ESPC6-32E exceed 500mA 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.

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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	-	19	-	dBm
802.11n,MCS7	-	13	-	dBm
802.11ax, MCS9	-	13	-	dBm

Table.6.2 Wi-Fi RX Sensitivity

Parameters	Min	Classical	Max	Unit
802.11b,1Mbps	-	-99	-	dBm
802.11b,11Mbps	-	-90	-	dBm
802.11g,6Mbps	-	-94	-	dBm
802.11g,54Mbps	-	-75	-	dBm
802.11n,HT20,MCS0	-	-93	-	dBm
802.11n,HT20,MCS7	-	-73	-	dBm
802.11n,HT40,MCS0	-	-91	-	dBm
802.11n,HT40,MCS7	-	-70	-	dBm
802.11ax, HE20, MCS0		-93		dBm
802.11ax, HE20, MCS9		-68		dBm

Table.6.3 Wi-Fi RX Characteristics

Parameters	Min	Classical	Max	Unit
ADJ Channel Rejection @11b, 1Mbps	-	38	-	dB
ADJ Channel Rejection @11b, 11Mbps	-	38	-	dB
ADJ Channel Rejection @11g, 6Mbps	-	31	-	dB
ADJ Channel Rejection @11g, 54Mbps	-	20	-	dB
ADJ Channel Rejection @11n,HT20,MCS0	-	31	-	dB
ADJ Channel Rejection @11n,HT20,MCS7	-	16	-	dB

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ADJ Channel Rejection @11n,HT40,MCS0	-	28	-	dB
ADJ Channel Rejection @11n,HT40,MCS7	-	10	-	dB
ADJ Channel Rejection @11ax,HE20,MCS0	-	25	-	dB
ADJ Channel Rejection @11ax,HE20,MCS9	-	2	-	dB

7. Bluetooth LE Radio

Table.7.1 TX Transmitter General Characteristics（Bluetooth Radio 2402 ~ 2480 MHz）

Parameters	Min	Classical	Max	Unit
RF power control range	-24	4	10	dBm
ADJ channel Transmit Power @F-F0±2MHz	-	-52	-	dBm
ADJ channel Transmit Power @F-F0±3MHz	-	-58	-	dBm
ADJ channel Transmit Power @F-F0±>3MHz	-	-60	-	kHz
△f1avg	-	-	265	kHz
△f2max	247	-	-	kHz
ICFT	-	-10	-	kHz

Table.7.2 RX Transmitter General Characteristics（Bluetooth Radio 2402 ~ 2480 MHz）

Parameters		Min	Classical	Max	Unit
BLE	Sensitivity @30.8% PER	-95		-106	dBm
	Maximum received signal @30.8% PER	0		-	dBm
	Co-channel C/I	-	10	-	dB

8. 802.15.4 Radio

Table.8.1 TX Transmitter General Characteristics（802.15.4 Radio 2405 ~ 2480 MHz）250 Kbps

Parameters	Min	Classical	Max	Unit
RF transmit power range	-24	4	10	dBm
EVM	-	-13.0%	-	dBm

Table.8.2 RX Transmitter General Characteristics（802.15.4 Radio 2405 ~ 2480 MHz）250 Kbps

Parameters	Description	Min	Classical	Max	Unit
Sensitivity @1% PER	-	-	-104	-	dBm
Maximum received signal @1%	-	-	8	-	dBm

PER						
Relative jamming level	Adjacent channel	F = F0 + 5 MHz	-	27	-	dB
		F = F0 -5 MHz	-	32	-	dB
	Adjacent channel	F = F0 + 10 MHz	-	47	-	dB
		F = F0 -10 MHz	-	50	-	dB

9. 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℃

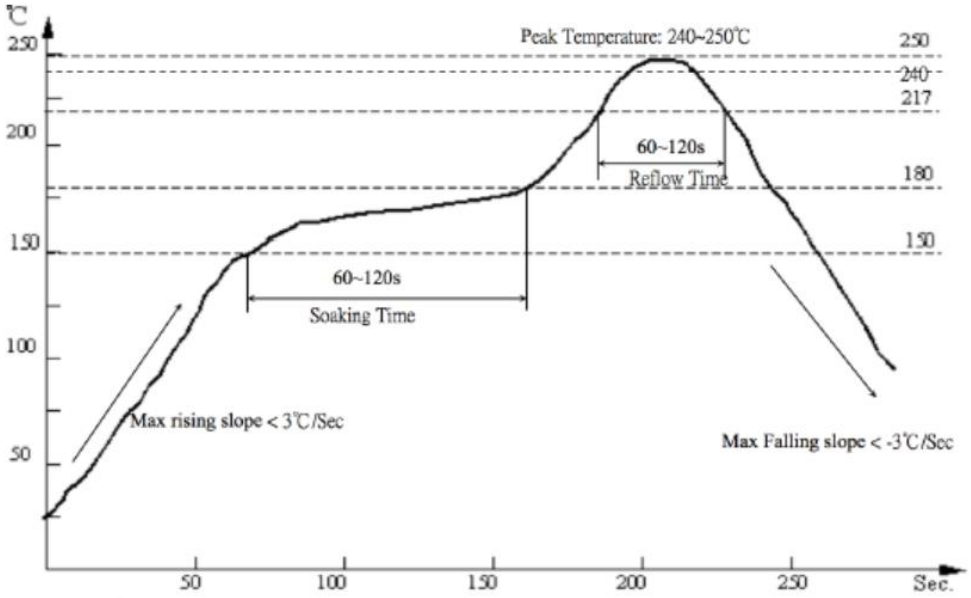


Fig.9.1 Recommended Reflow Profile

10. Minimum User System

This module can work just at 3.3V voltage condition:

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: IO9 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.

11. U.FL RF Connector

ESPC3-12E module use U.FL type RF connector for external antenna connection. (IPEX V1.0).

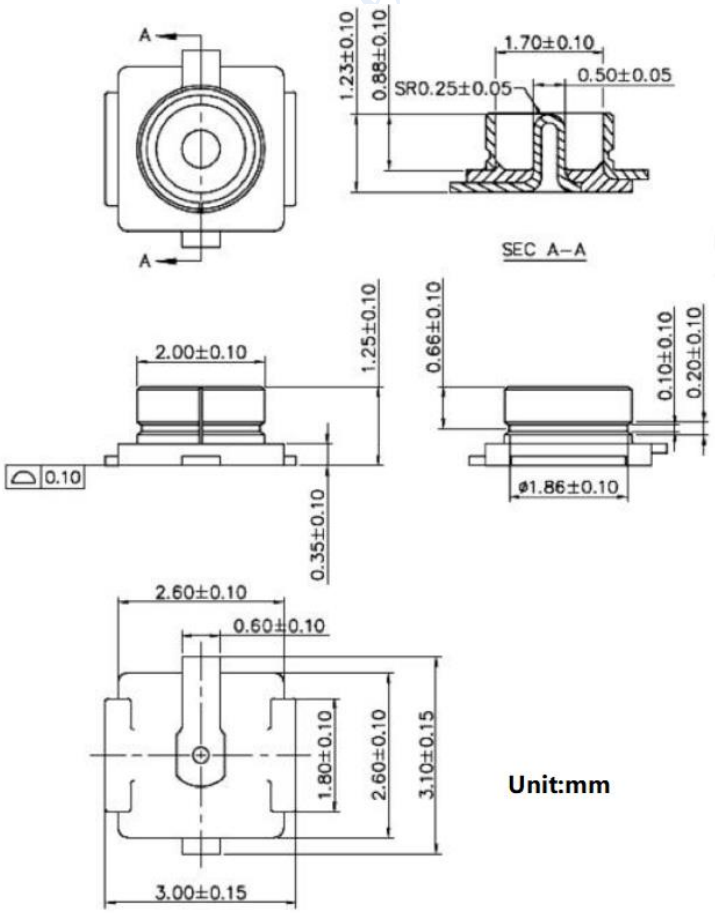


Fig.11.1 U.FL RF Connector

12. 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).

13. Product Handling

13.1 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.

13.2 Electrostatic Discharge (ESD)

• Human body model (HBM): ±2000 V

• Charged-device model (CDM): ±500 V

14. Packing Instruction

The product is packed in a tray, as shown in the following figure.

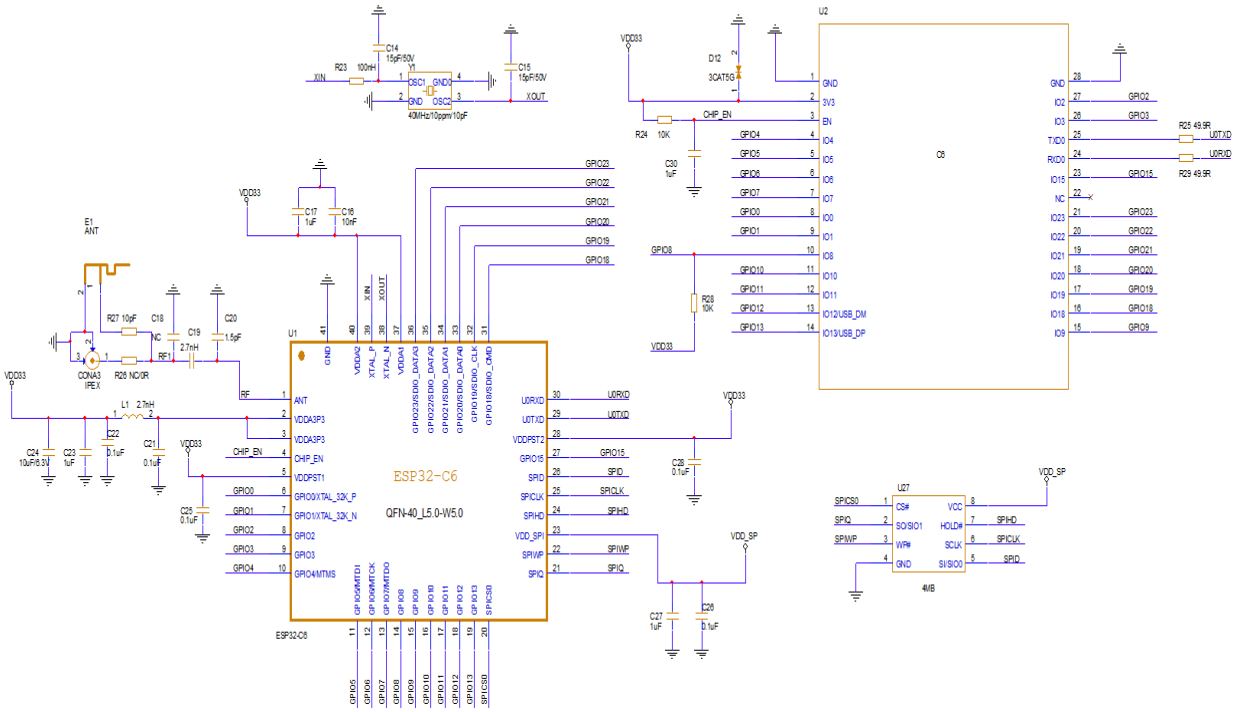
The size of the single box is: 340 x 360 x 60mm, and 550 pieces module is in the box. And the outer box size is 355 x 375 x 325mm, including 5 single box which include2750 pieces module.



Fig.14.1 Module Package

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Appendix: Module Schematic



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