ESP-C20

Product Specification

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

Version: 1.0 Date: Feb.20, 2023

Features

- **General**
  - Chip: ESP32-C3
  - Module Size:18mm*20mm*3mm
  - 4MByte embedded flash (default)
  - 384KB ROM
  - 400KB SRAM
- **Wi-Fi Features**
  - IEEE 802.11 b/g/n-compliant
  - Center frequency range of operating channel: 2412 ~ 2484 MHz
  - Supports 20 MHz, 40 MHz bandwidth in 2.4 GHz band
  - 1T1R mode with data rate up to 150 Mbps
  - TX/RX A-MPDU, TX/RX A-MSDU
  - Immediate Block ACK
  - Fragmentation and defragmentation
  - Automatic Beacon monitoring (hardware TSF)
  - 4 X virtual Wi-Fi interfaces
  - Simultaneous support for Infrastructure BSS in Station mode, Soft-AP mode, Station + Soft-AP mode, and promiscuous mode
- **Bluetooth Features**
  - Bluetooth LE: Bluetooth 5, Bluetooth mesh
  - Speed: 125 Kbps, 500 Kbps, 1 Mbps, 2 Mbps
  - Advertising extensions
  - Multiple advertisement sets
  - Channel selection algorithm #2
- **Peripheral Interfaces**
  - GPIO * 15;
  - UART * 2;
  - IIC ;
  - SPI;
  - EN ;
  - PWM x 6 ;
  - ADC;
- **Working Temperature:** -40℃-85℃

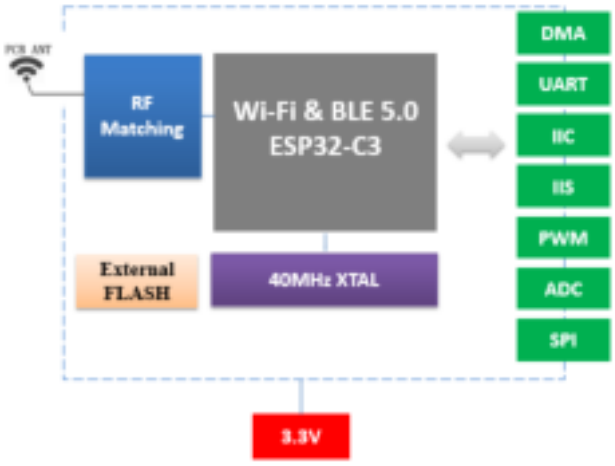
Applications

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

Module Type

Name	Antenna Type
ESP-C20	PCB ANT
ESP-C20-E	U.FL Ipex

Module Structure



Update Record

Date	Version	Update
2023-02-20	V1.0	First released

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1. Introduction

ESP-C20 Wi-Fi and BLE coexistence Module is a highly integrated single-chip low power 802.11bgn Wireless LAN (WLAN) network controller. It combines a RISC 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.

ESP-C20 Module use ESP32-C3 as Wi-Fi and BLE coexistence SOC chip.

ESP-C20 Module integrates internal memories for complete Wi-Fi protocol functions. The embedded memory configuration also provides convenient application developments.

ESP-C20 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. Anyway, ESP-C20 Wi-Fi module provides many probabilities with the best price.

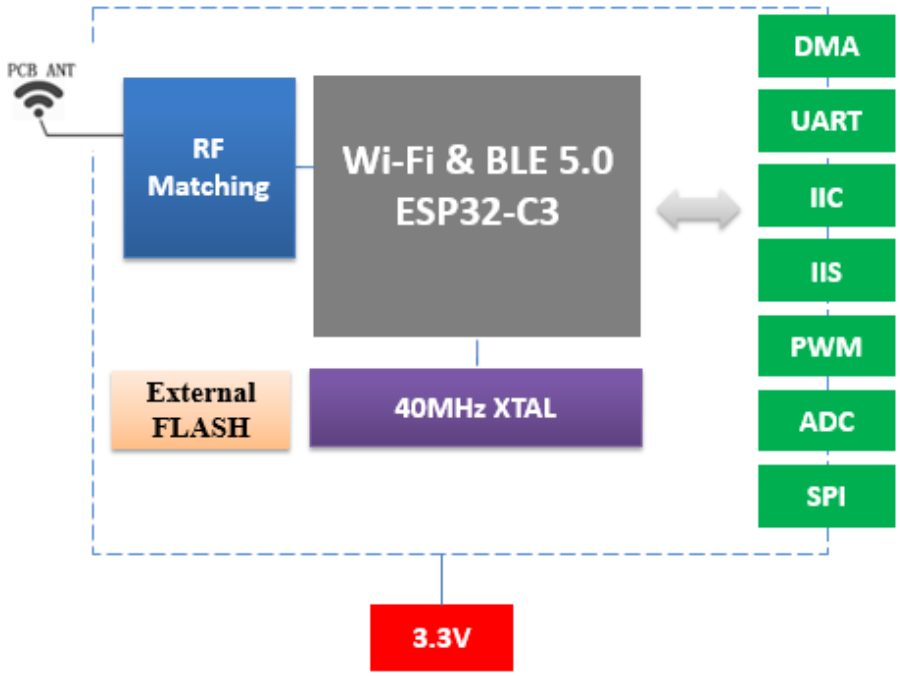


Fig.1.1 ESP-C20 Module Structure

Technical parameters for ESP-C20 are listed as follows.

Table.1.1 ESP-C20 Parameters

Type	Item	Parameter
Wi-Fi	Frequency	2.4G~2.5G (2412M~2484M)
	Transmit power	802.11b: +18.0 dBm
		802.11g: +21.0 dBm
		802.11n: +21.0 dBm
	Receiver sensitivity	802.11b: -89 dBm (11Mbps)
		802.11g: -77 dBm（54Mbps）
		802.11n: -74 dBm（MCS7）
	EVM	-25dB @802.11b,11Mbps @18dBm
		-28dB @802.11n,54Mbps @21dBm
		-30dB @802.11n,HT40,MCS7 @21dBm
	Antenna	PCB antenna / U.FL
BLE	RF power control range	-27~18dBm
Hardware	CPU	32-bit RISC CPU
	Interface	UART/SDIO/SPI/I2C/GPIO/PWM
	Working voltage	3.0V ~ 3.6V
	Working temperature	-40°C ~ 85°C
	Environment temperature	-40°C ~ 105°C
	Shape	18mm x 20mm 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

ESP-C20 Wi-Fi & BLE module interface definition is shown as below。

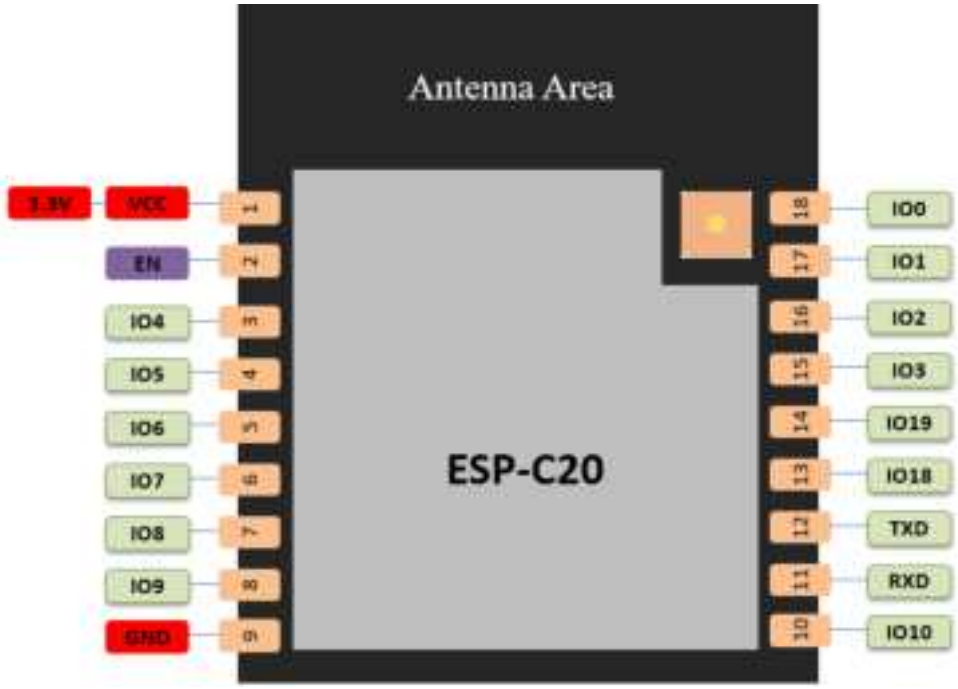


Fig.2.1 ESP-C20 Pins Definition

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

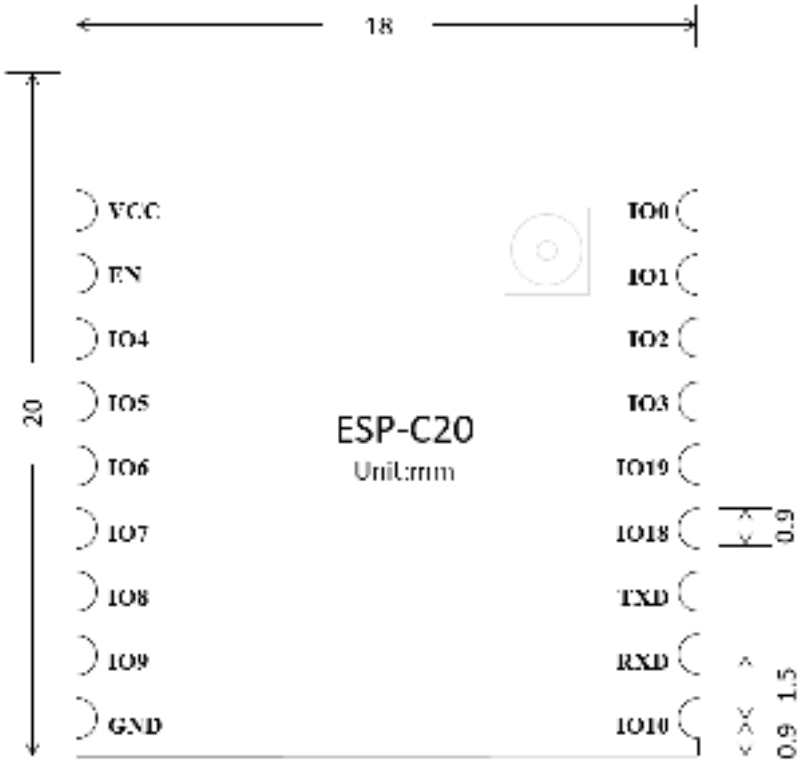
Num.	Pin Name	Type	Function
8	VCC	P	Power, 3.3V/500mA Recommended
3	EN	I/O	Chip enable; Internal Pull-up. HIGH: enable the chip
6	IO4	I/O	GPIO4, ADC1_CH4, MTMS, FSPIHD
7	IO5	I/O	GPIO5, ADC2_CH0, MTDI, FSPIWP
12	IO6	I/O	GPIO6,FSPICLK,MTCK
13	IO7	I/O	GPIO7,FSPID,MTDO

16	IO8	I/O	GPIO8
18	IO9	I/O	GPIO9
15	GND	P	Power, 3.3V/500mA Recommended
17	IO10	I/O	GPIO10, FSPICS0. When the value of eFuse bit EFUSE_JTAG_SEL_ENABLE is 0, JTAG signals cannot be used. 1, if IO10 is 0, JTAG signals come from chip pins; if IO10 is 1, JTAG signals cannot be used
21	RXD	I/O	GPIO20,U0RXD
22	TXD	I/O	GPIO21,U0TXD
19	IO18	I/O	GPIO18,USB-D-
20	IO19	I/O	GPIO19,USB-D+
5	IO3	I/O	GPIO3, ADC1_CH3
4	IO2	I/O	GPIO2, ADC1_CH2, FSPIQ, Internal Pull-up
2	IO1	I/O	GPIO1,ADC1_CH1, XTAL_32K_N
1	IO0	I/O	GPIO0,ADC1_CH1,XTAL_32K_P

3. Size and Layout

Size for ESP-C20 can be shown as follows.

Fig.3.1 Shape for ESP-C20 12E



(a) Vertical View

(b) Side View

Fig.3.2 Size for ESP-C20

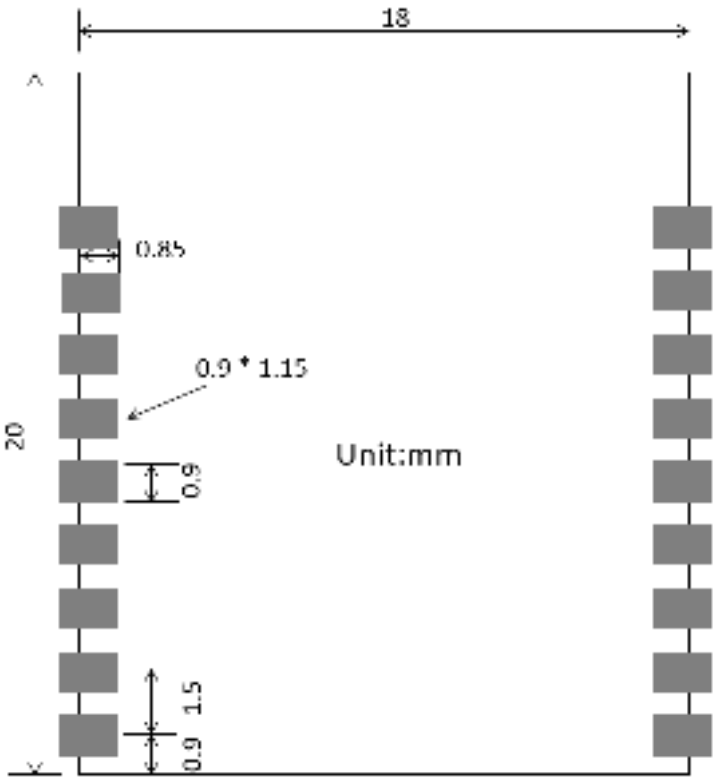


Fig. 3.3 PCB Layout for ESP-C20

4. Electronica Characteristics

Table.4.1 Electronica Characteristics

Parameter		Condition	Min	Classical	Max	Unit
Store Temperature		-	-40	Normal	150	℃
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

Parameter	Min	Classical	Max	Unit
RX 11b /g/n, HT20	-	-	82	mA
RX 11n, HT40		-	84	mA
TX 11b, 1Mbps @21dBm		-	350	mA
TX 11g, 54Mbps @19dBm	-	-	295	mA
TX 11n, HT20, MCS7, @18.5dBm	-	-	290	mA
TX 11n, HT40, MCS7, @18.5dBm	-	-	290	mA
Modem-sleep, CPU is powered on @80MHz	-	15	-	mA
Light-sleep	-	130	-	uA
Deep-sleep, RTC timer + RTC memory	-	5	-	uA
Power off, CHIP_PU is set to low level	-	1	0	uA

The peak current consumption of ESP-C20 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

Parameter	Min	Classical	Max	Unit
Input frequency	2412	-	2484	MHz

802.11b @1Mbps,11Mbps	-	20.5	-	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@19dBm	-	-28	-	dBm
EVM @11n,MCS7@18.5dBm	-	-30	-	dBm
EVM @11n, HT40, MCS7@18.5dBm	-	-30.5	-	dBm

Table.6.2 Wi-Fi RX Sensitivity

Parameter	Min	Classical	Max	Unit
802.11b,1Mbps	-	-98	-	dBm
802.11b,11Mbps	-	-88	-	dBm
802.11g,6Mbps	-	-92	-	dBm
802.11g,54Mbps	-	-76	-	dBm
802.11n,HT20,MCS0	-	-92	-	dBm
802.11n,HT20,MCS3	-	-85	-	dBm
802.11n,HT20,MCS7	-	-74	-	dBm
802.11n,HT40,MCS0	-	-90	-	dBm
802.11n,HT40,MCS3	-	-81	-	dBm
802.11n,HT40,MCS7	-	-71	-	dBm

Table.6.3 Wi-Fi RX Characteristics

Parameter	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

7. Bluetooth LE Radio

Table.7.1 TX Transmitter General Characteristics

Parameter	Min	Classical	Max	Unit
Gain control power	-	3	-	dBm
RF power control range	-27	-	18	dBm
In-band emissions @F-F0±3MHz, LE 1M	-	-41.95	-	dBm
In-band emissions @F-F0±>3MHz, LE 1M	-	-44.48	-	dBm
Modulation characteristics @ △f1avg, LE 1M	-	245	-	kHz
Modulation characteristics @△f2max, LE 1M	-	208	-	kHz
Carrier frequency offset, LE 1M	-	-9	-	kHz
In-band emissions @F-F0±5MHz, LE 2M	-	-45.26	-	dBm
In-band emissions @F-F0±>5MHz, LE 2M	-	-47	-	dBm
Modulation characteristics @ △f1avg, LE 2M	-	497	-	kHz
Modulation characteristics @△f2max, LE 2M	-	398	-	kHz
Carrier frequency offset, LE 2M	-	-9	-	kHz
In-band emissions @F-F0±3MHz, LE 500K	-	-41.3	-	dBm
In-band emissions @F-F0±>3MHz, LE 500K	-	-42.8	-	dBm
Modulation characteristics @ △f1avg, LE 500K	-	220	-	kHz
Modulation characteristics @△f2max, LE 500K	-	205	-	kHz
Carrier frequency offset, LE 500K	-	-11.9	-	kHz

Maximum received signal @30.8% PER	-	10	-	dBm

Table.7.2 RX Transmitter General Characteristics

Parameter		Min	Classical	Max	Unit
1M	Sensitivity @30.8% PER	-	-96	-	dBm
	Maximum received signal @30.8% PER	-	10	-	dBm
	Co-channel C/I	-	8	-	dB
	Image frequency	-	-29	-	dB
	Adjacent channel to image frequency @F =F_{image}+1	-	-38	-	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	-	-3	-	dB
	Adjacent channel selectivity @ F ≥F0+3	-	-	-	dB
	Adjacent channel selectivity @ F ≤F0-3	-	-39	-	dB
2M	Sensitivity @30.8% PER	-	-93	-	dBm
	Maximum received signal @30.8% PER	-	0	-	dBm
	Co-channel C/I	-	10	-	dB
	Image frequency	-	-27	-	dB
	Adjacent channel to image frequency @F =F_{image}+2	-	-39	-	dB
	Adjacent channel to image frequency @F =F_{image}-2	-	-	-	dB
	Adjacent channel selectivity @ F =F0+2	-	-7	-	dB
	Adjacent channel selectivity @ F =F0-2	-	-7	-	dB
	Adjacent channel selectivity @ F ≥F0+6	-	-39	-	dB
	Adjacent channel selectivity @ F ≤F0-6	-	-39	-	dB
125K	Sensitivity @30.8% PER	-	-104	-	dBm
	Maximum received signal @30.8% PER	-	10	-	dBm
	Co-channel C/I	-	2	-	dB
	Image frequency	-	-34	-	dB
	Adjacent channel to image frequency @F =F_{image}+1	-	-44	-	dB
	Adjacent channel to image frequency @F =F_{image}-1	-	-37	-	dB
	Adjacent channel selectivity @ F =F0+2	-	-40	-	dB

	Adjacent channel selectivity @ F =F0-2	-	-42	-	dB
	Adjacent channel selectivity @ F ≥F0+3	-	-	-	dB
	Adjacent channel selectivity @ F ≤F0-3	-	-46	-	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℃

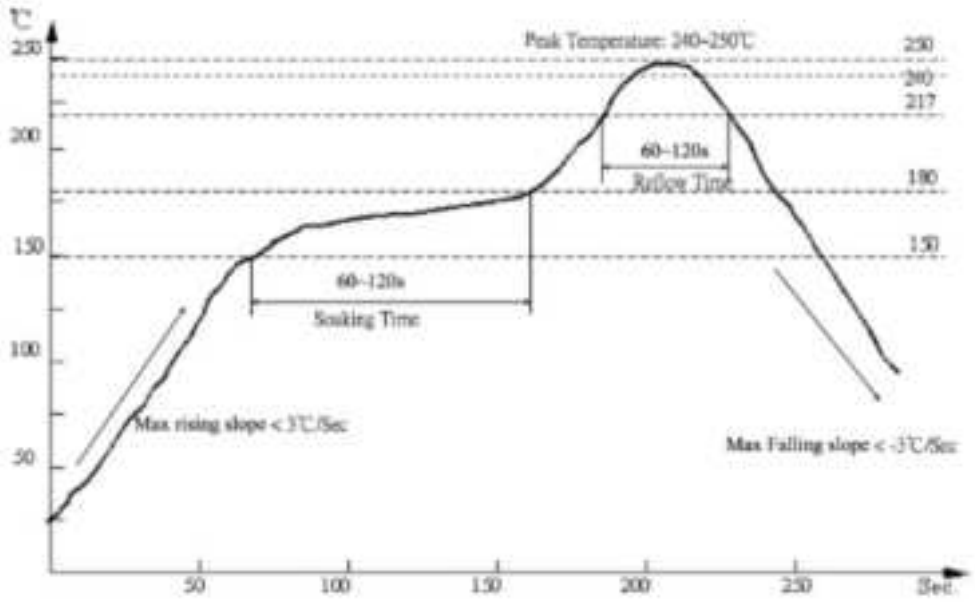


Fig.8.1 Recommended Reflow Profile

9. Minimum User System

This module can work just at 3.3V voltage condition:

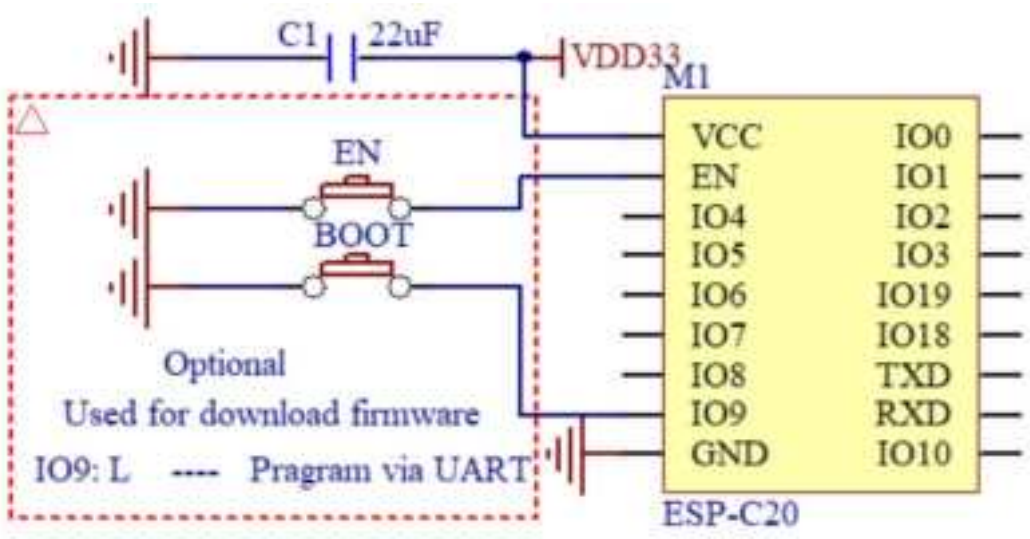


Fig.9.1 Minimum System

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: 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.

10. Recommended Layout Design

ESP-C20 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.

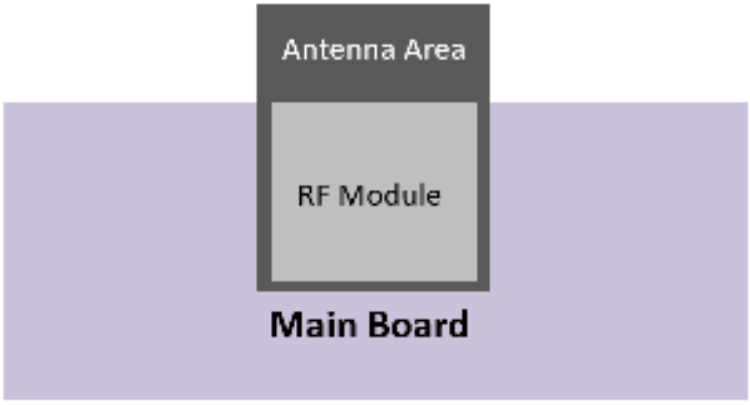


Fig.10.1 Solution 1

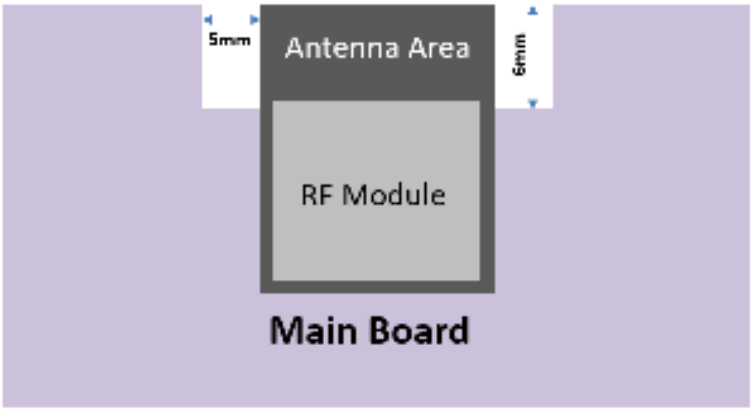


Fig.10.2 Solution 2

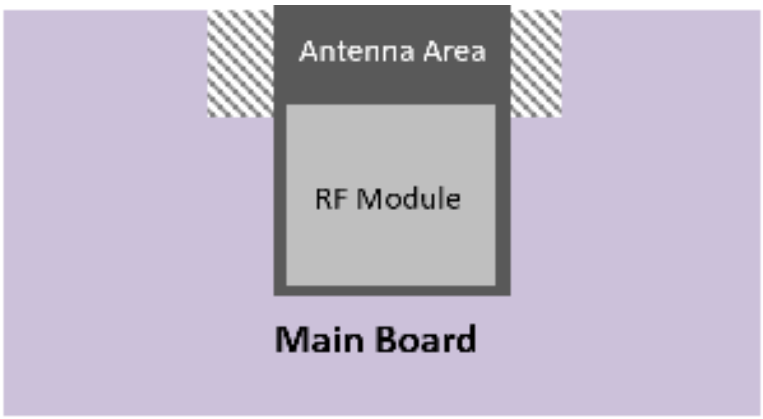


Fig.10.3 Solution 3

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.FL RF Connector

ESP-C20 module use U.FL type RF connector for external antenna connection. (IPEX V1.0).

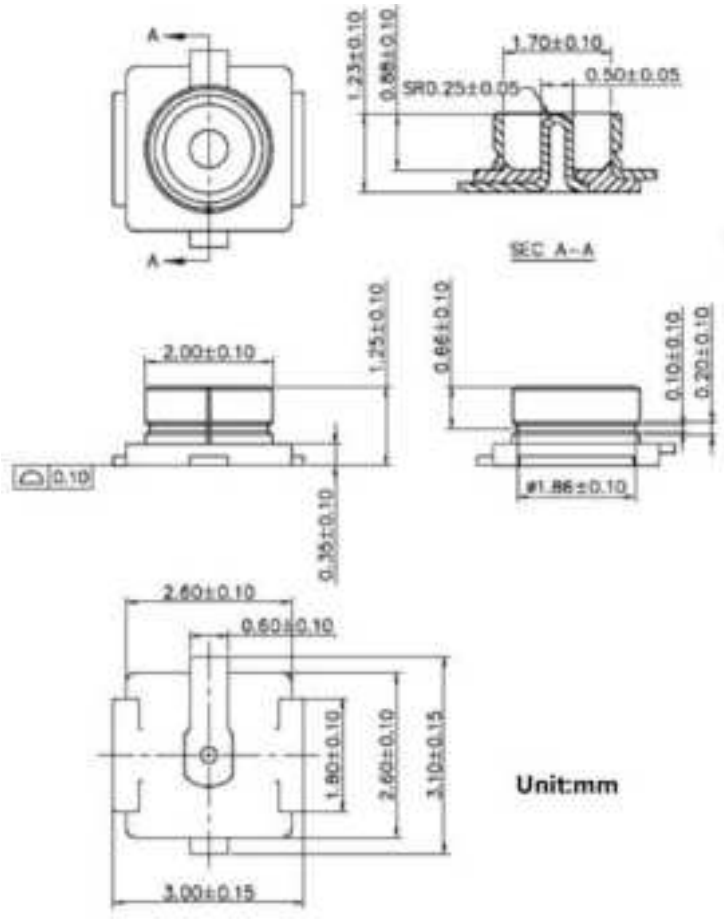


Fig.13.1 U.FL RF Connector

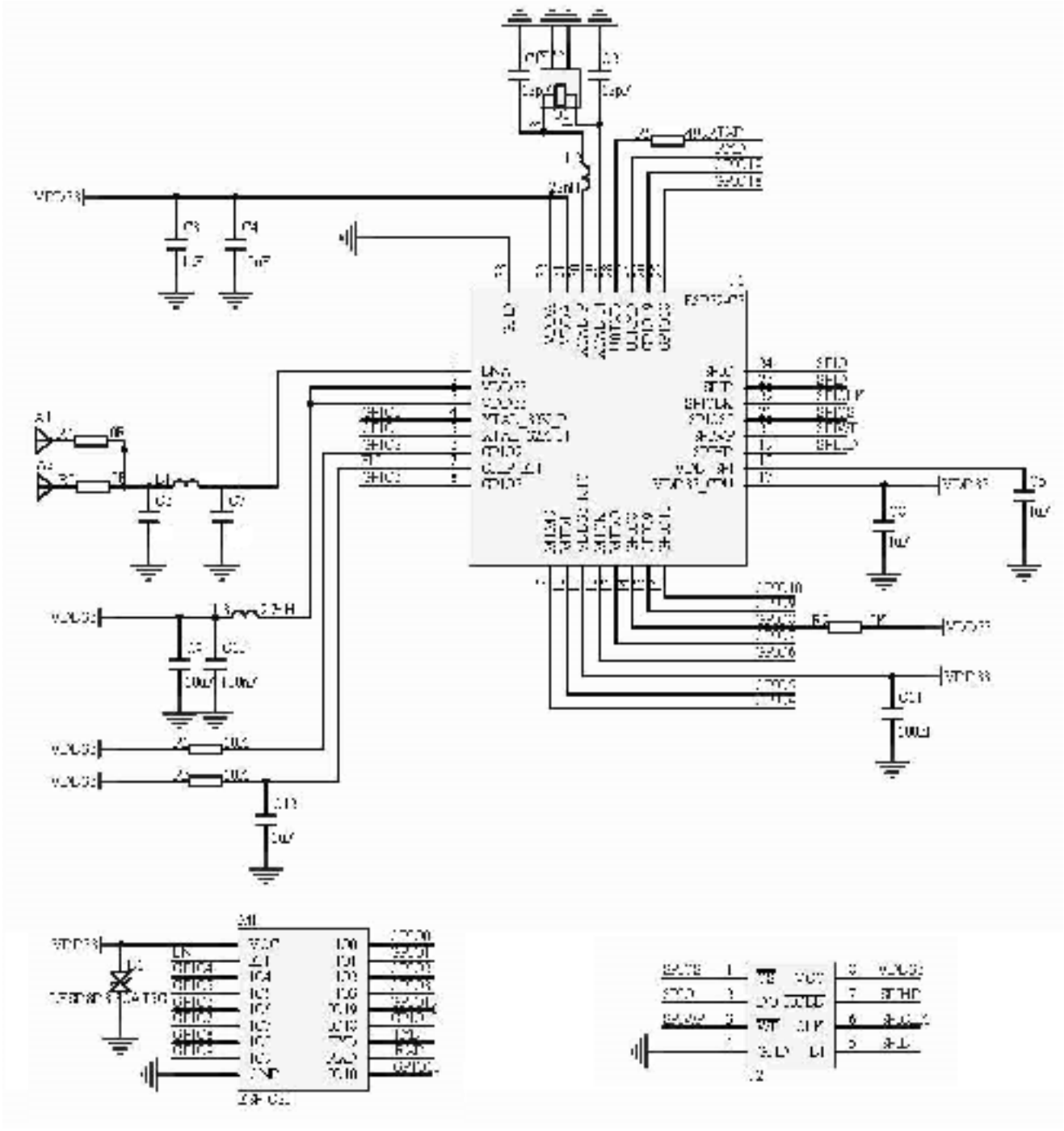
14. Packing Instruction

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 800 pieces module is in the box. And the outer box size is 355 x 375 x 325mm, including 5 single box which include 4000 pieces module.

Fig.14.1 Module Package

15. Module Schematic



FCC Statement

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) thi s device may not cause harmful interference, and (2) this device must accept any interference received, incl uding 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, pursua nt to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful inte rference in a residential installation. This equipment generates uses and can radiate radio frequency energy a nd, if not installed and used in accordance with the instructions, may cause harmful interference to radio com munications. 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 turn ing 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: **2BB77-ESP-C20**"

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

2.2 List of applicable FCC rules

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

2.3 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.

2.4 Limited module procedures

Not applicable

2.5 Trace antenna designs

Not applicable

2.6 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.

2.7 Antennas

This radio transmitter **FCC ID:2BB77-ESP-C20** 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:
BT/2.4GWiFi	/	PCB Antenna	3.57dBi for 2400-2500MHz;	

2.8 Label and compliance information

The final end product must be labeled in a visible area with the following" Contains **FCC ID:2BB77-ESP-C20**".

2.9 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.

2.10 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.