ESP-WROOM-02

Datasheet

About This Guide

This document introduces the user to the specification of ESP-WROOM-02 hardware, including the following topics

Chapter	Title	Subject
Chapter 1	Overview	Provides overview introduction to ESP-WROOM-02, including dimensions and specifications .
Chapter 2	Pin Definitions	Provides introduction to pin layout and the relevant description.
Chapter 3	Functional Description	Describes major functional modules and protocols applied on ESP32 including CPU, flash and memory,and interfaces.
Chapter 4	Electrical Specifications	Lists the electrical data of ESP-WROOM-02.
Chapter 5	Schematics	Provides ESP-WROOM-02 schematics

Release Notes

Date	Version	Release notes
2015.12	V0.6	

Table of Contents

1.   Overview

Espressif provides SMD module – ESP-WROOM-02 which ESP8266EX is embedded. It is recommended to use these modules for test or further development.

The external size of the module is 18 x 20mm. The type of flash used on this module is an SPI flash with package size SOP8-150mil. The antenna applied on this module is a 3DBi PCB-on-board antenna.
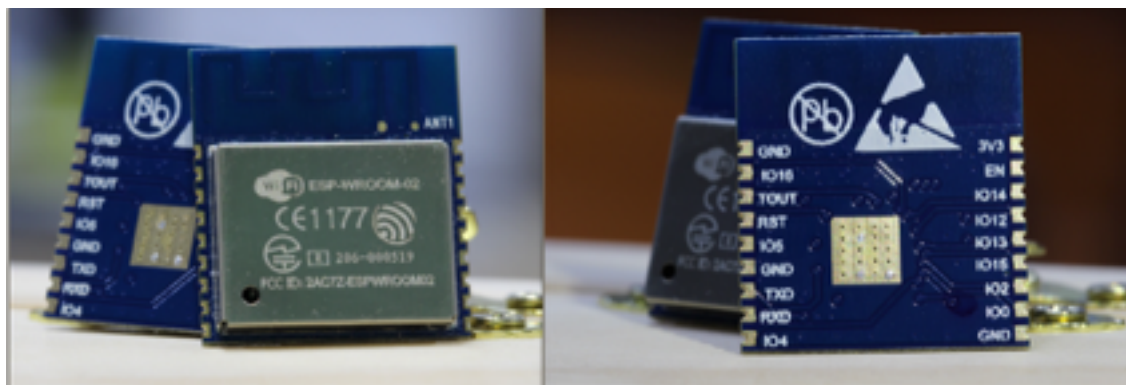

Figure 1-1. ESP-WROOM-02 module

Table 1-1. ESP-WROOM-02 specifications

Categories	Items	Specifications
Wi-Fi	Standards	FCC/CE/TELEC
	Wi-Fi protocols	802.11 b/g/n
	Frequency range	2.4GHz - 2.5GHz (2400M-2483.5M)
Hardware	Peripheral interface	UART/HSPI/I2C/I2S/Ir Remote Contorl
		GPIO/PWM
	Operating voltage	3.0~3.6V
	Operating current	Average: 80mA
	Operating temperature range	-40° - 125°
	Ambient temperature range	Normal temperature
	Package size	18mm x 20mm x 3mm
	External interface	-
Software	Wi-Fi mode	station/softAP/SoftAP+station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware upgrade	UART Download / OTA (via network) / download and write firmware via host
	Software development	Supports Cloud Server Development / SDK for custom firmware development
	Network protocols	IPv4, TCP/UDP/HTTP/FTP
	User configuration	AT Instruction Set, Cloud Server, Android/iOS App

2. Pin Descriptions

The pin distribution of the SMD Module is illustrated in Figure 2-1.

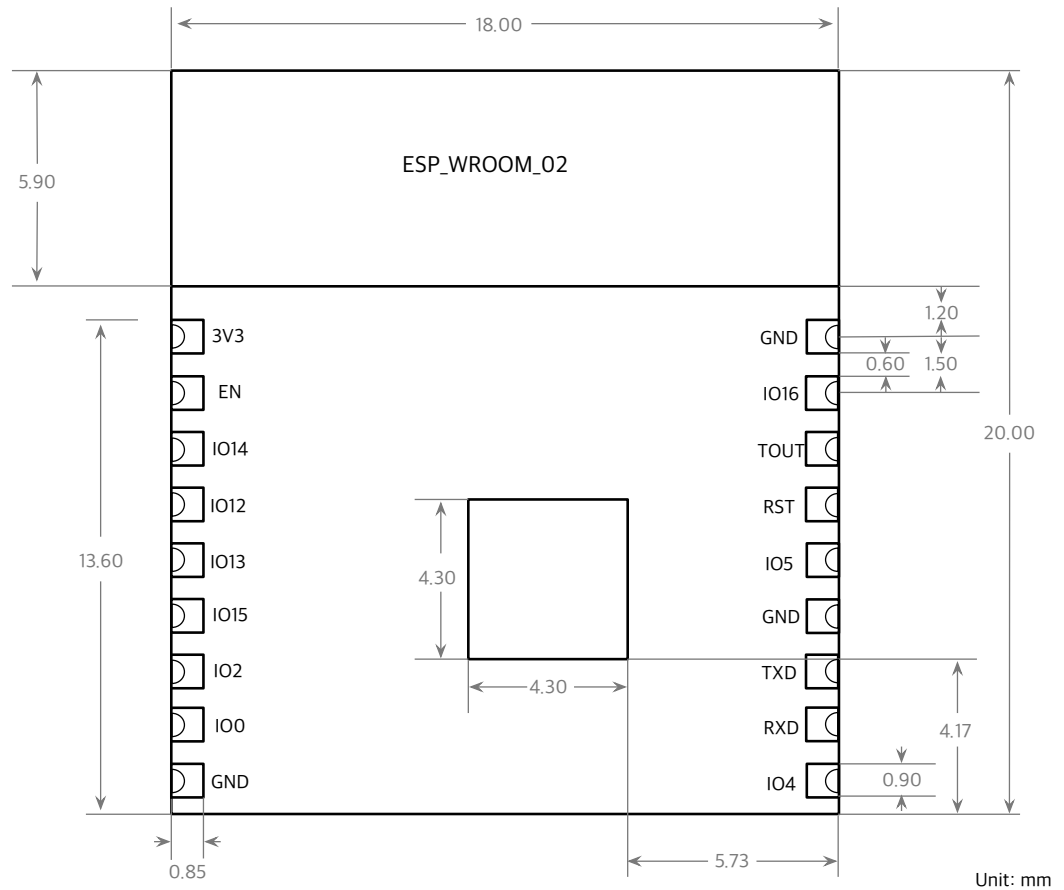

Figure 2-1. Top view of ESP-WROOM-02

Table 2-1. ESP-WROOM-02 dimensions

Length	Width	Height	PAD size (bottom)	Pin pitch
18 mm	20 mm	3 mm	0.9 mm x 1.7 mm	1.5 mm

ESP-WROOM-02 has 18 pins, see the pin definitions in Table 2-2.

Table 2-2. ESP-WROOM-02 pin definitions

No.	Pin name	Functional description
1	3V3	3.3V power supply (VDD)
2	EN	Chip enable pin. Active high
3	IO14	GPIO14; HSPI_CLK
4	IO12	GPIO12; HSPI_MISO
5	IO13	GPIO13; HSPI_MOSI; UART0_CTS
6	IO15	GPIO15; MTDO; HSPICS; UART0_RTS
7	IO2	GPIO2; UART1_TXD
8	IO0	GPIO0
9	GND	GND
10	IO4	GPIO4
11	RXD	UART0_RXD; GPIO3
12	TXD	UART0_TXD; GPIO1
13	GND	GND
14	IO5	GPIO5
15	RST	Reset
16	TOUT	It can be used to test the power-supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin 6). These two functions cannot be used simultaneously.
17	IO16	GPIO16; Wake up the chipset from deep sleep mode when connected to RST pin.
18	GND	GND

Table 2-3. UART Download mode

GPIO15	GPIO0	GPIO2
Low	Low	High

Table 2-4. Flash Boot mode

GPIO15	GPIO0	GPIO2
Low	High	High

3.   Functional Descriptions

3.1.   MCU

ESP8266EX is embedded with Tensilica L106 32-bit micro controller (MCU), which features extra low power consumption and 16-bit RSIC. The CPU clock speed ranges 80 MHz to 160 MHz.

ESP8266EX is often integrated with external sensors and other specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

3.2.   Memory

3.2.1.   Internal SRAM and ROM

ESP8266EX Wi-Fi SoC is embedded with memory controller including SRAM and ROM. MCU can visit the memory units through iBus, dBus, and AHB interfaces. All memory units can be visited upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor.

According to our current version of SDK provided, SRAM space that is available to users is assigned as below:

- RAM size < 50KB, that is, when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible to user in heap + data section is around 50KB.)

- There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash.

3.2.2.   External SPI Flash

ESP-WROOM-02 is mounted with a 2MB or 4MB external SPI flash to store user programs. If larger definable storage space is required, a SPI flash with larger memory size is preferred. Theoretically speaking, up to 16 MB memory capacity can be supported.

- OTA is disabled: the minimum flash memory that can be supported is 512 kB

- OTA is enabled: the minimum flash memory that can be supported is 1 MB

Several SPI modes can be supported, including Standard SPI, Dual SPI, and Quad SPI.

Therefore, select the correct SPI mode when downloading programs into the flash, otherwise firmwares/programs that you downloaded may not work in the right way.

> ⚠ Notice:
>
> Select the correct SPI mode when downloading programs into the flash, otherwise error might be caused.

3.3. Crystal Oscillators

The frequency of crystal oscillators supported include 40MHz, 26MHz and 24MHz. The accuracy of crystal oscillators applied should be ±10PPM, and the operating temperature range should be between -20℃ and 85℃.

When using the downloading tools, remember to select the right crystal oscillator type. In circuit design, capacitors C1 and C2, which are connected to the earth, are added to the input and output terminals of the crystal oscillator respectively. The values of the two capacitors can be flexible, ranging from 6pF to 22pF, however, the specific capacitive values of C1 and C2 depend on further testing and adjustment on the overall performance of the whole circuit. Normally, the capacitive values of C1 and C2 are within 10pF if the crystal oscillator frequency is 26 MHz, while the values of C1 and C2 are 10pF<C1, C2<22pF if the crystal oscillator frequency is 40 MHz.

3.4. Interface Description

Table 3-1. Interface description

Interface	Pin	Functional description
HSPI	IO12(MISO), IO13(MOSI), IO14(CLK), IO15(CS)	SPI Flash 2, display screen, and MCU can be connected using HSPI interface.
PWM	IO12(R), IO15(G),IO13(B)	Currently the PWM interface has four channels, but users can extend the channels according to their own needs. PWM interface can be used to control LED lights, buzzers, relays, electronic machines, and so on.
IR	IO14(IR_T), IO5(IR_R)	The functionality of Infrared remote control interface can be implemented via software programming. NEC coding, modulation, and demodulation are used by this interface. The frequency of modulated carrier signal is 38KHz.
ADC	TOUT	ESP8266EX integrates a 10-bit analog ADC. It can be used to test the power- supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin 6). However, these two functions cannot be used simultaneously. This interface is typically used in sensor products.
I2C	IO14(SCL), IO2(SDA)	I2C interface can be used to connect external sensor products and display screens, etc.
UART	UART0: TXD(U0TXD), RXD(U0RXD), IO15(RTS), IO13(CTS) UART1: IO2(TXD)	Devices with UART interfaces can be connected with the module. Downloading: U0TXD+U0RXD or GPIO2+U0RXD Communicating: UART0: U0TXD, U0RXD, MTDO (U0RTS), MTCK (U0CTS) Debugging: UART1_TXD (GPIO2) can be used to print debugging information. By default, UART0 will output some printed information when the device is powered on and is booting up. If this issue exerts influence on some specific applications, users can exchange the inner pins of UART when initializing, that is to say, exchange U0TXD, U0RXD with U0RTS, U0CTS.
I2S	I2S input: IO12 (I2SI_DATA) ; IO13 (I2SI_BCK); IO14 (I2SI_WS); I2S output: IO15 (I2SO_BCK); IO3 (I2SO_DATA); IO2 (I2SO_WS).	I2S interface is mainly used for collecting, processing, and transmission of audio data.

4. Electrical Characteristics

4.1. Absolute Maximum Ratings

Table 4-1. Absolute Maximum Ratings

Rating	Condition	Value	Unit
Storage temperatue	-	-40 - 125	℃
Maximum soldering temperature	-	260	℃
Supply voltage	IPC/JEDEC J-STD-020	+3.0 - +3.6	V

4.2. Recommended Operating Conditions

Table 4-2. Recommended operating conditions

Operating condition	Symbol	Min	Typ	Max	Unit
Operating temperature	-	-40	20	125	℃
Supply voltage	VDD	3.0	3.3	3.6	V

4.3. Digital Terminal Characteristics

(VDD = 3.3V, TA = 20°C, unless otherwise specified)

Table 4-3. Digital terminal characteristics

Terminals	Symbol	Min	Typ	Max	Unit
Input logic level low	V_{IL}	-0.3	-	0.25VDD	V
Input logic level high	V_{IH}	0.75VDD	-	VDD+0.3	V
Output logic level low	V_{OL}	N	-	0.1VDD	V
Output logic level high	V_{OH}	0.8VDD	-	N	V

4.4. RF Performance

Table 4-4. RF performance

Description	Min	Typ	Max	Unit
Input frequency	2400	–	2483.5	MHz
Input impedance	–	50	–	ohm
Input reflection	–	–	-10	dB
Output power of PA for 72.2Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
CCK, 1 Mbps	–	-98	–	dBm
CCK, 11 Mbps	–	-91	–	dBm
6 Mbps (1/2 BPSK)	–	-93	–	dBm
54 Mbps (3/4 64-QAM)	–	-75	–	dBm
HT20, MCS7 (65 Mbps, 72.2 Mbps)	–	-72	–	dBm
Adjacent channel rejection				
OFDM, 6 Mbps	–	37	–	dB
OFDM, 54 Mbps	–	21	–	dB
HT20, MCS0	–	37	–	dB
HT20, MCS7	–	20	–	dB

4.5. Power Consumption

Table 4-5. Power consumption

Modes	Min	Typ	Max	Unit
Tx 802.11b, CCK 11Mbps, P_{OUT}=+17dBm	–	170	–	mA
Tx 802.11g, OFDM 54Mbps, P_{OUT} =+15dBm	–	140	–	mA
Tx 802.11n, MCS7, P_{OUT} =+13dBm	–	120	–	mA

Modes	Min	Typ	Max	Unit
Rx 802.11b, 1024 bytes packet length , -80dBm	-	50	-	mA
Rx 802.11g, 1024 bytes packet length , -70dBm	-	56	-	mA
Rx 802.11n, 1024 bytes packet length , 65dBm	-	56	-	mA
Modem-Sleep①	-	15	-	mA
Light-Sleep②	-	0.9	-	mA
Deep-Sleep③	-	10	-	uA
Power Off	-	0.5	-	uA

①: Modem-Sleep requires the CPU to be working, as in PWM or I2S applications. According to 802.11 standards (like U-APSD), it saves power to shut down the Wi-Fi Modem circuit while maintaining a Wi-Fi connection with no data transmission. E.g. in DTIM3, to maintain a sleep 300ms- wake 3ms cycle to receive AP's Beacon packages, the current is about 15mA.

②: During Light-Sleep, the CPU may be suspended in applications like Wi-Fi switch. Without data transmission, the Wi-Fi Modem circuit can be turned off and CPU suspended to save power according to the 802.11 standard (U-APSD). E.g. in DTIM3, to maintain a sleep 300ms-wake 3ms cycle to receive AP's Beacon packages, the current is about 0.9mA.

③: Deep-Sleep does not require Wi-Fi connection to be maintained. For application with long time lags between data transmission, e.g. a temperature sensor that checks the temperature every 100s, sleep 300s and waking up to connect to the AP (taking about 0.3~1s), the overall average current is less than 1mA.

4.6. Reflow Profile

Table 4-6. Reflow profile

T_S max to TL (Ramp-up Rate)	3℃/second max
Preheat Temperature Min. (T_S Min.) Temperature Typ. (T_S Typ.) Temperature Min. (T_S Max.) Time (T_S)	150℃ 175℃ 200℃ 60~180 seconds
Ramp-up rate (T_L to T_P)	3℃/second max
Time maintained above: --Temperature(T_L)/ Time(T_L)	217℃/60 - 150 seconds
Peak temperature (T_P)	260℃ max , for 10 seconds
Target peak temperature (T_P Target)	260℃ +0/-5℃
Time within 5℃ of actual peak(t_P)	20~40 second
T_S max to T_L (Ramp-down Rate)	6℃/second max

Tune 25℃ to Peak Temperature (t)	8 minutes max

5.   Schematics
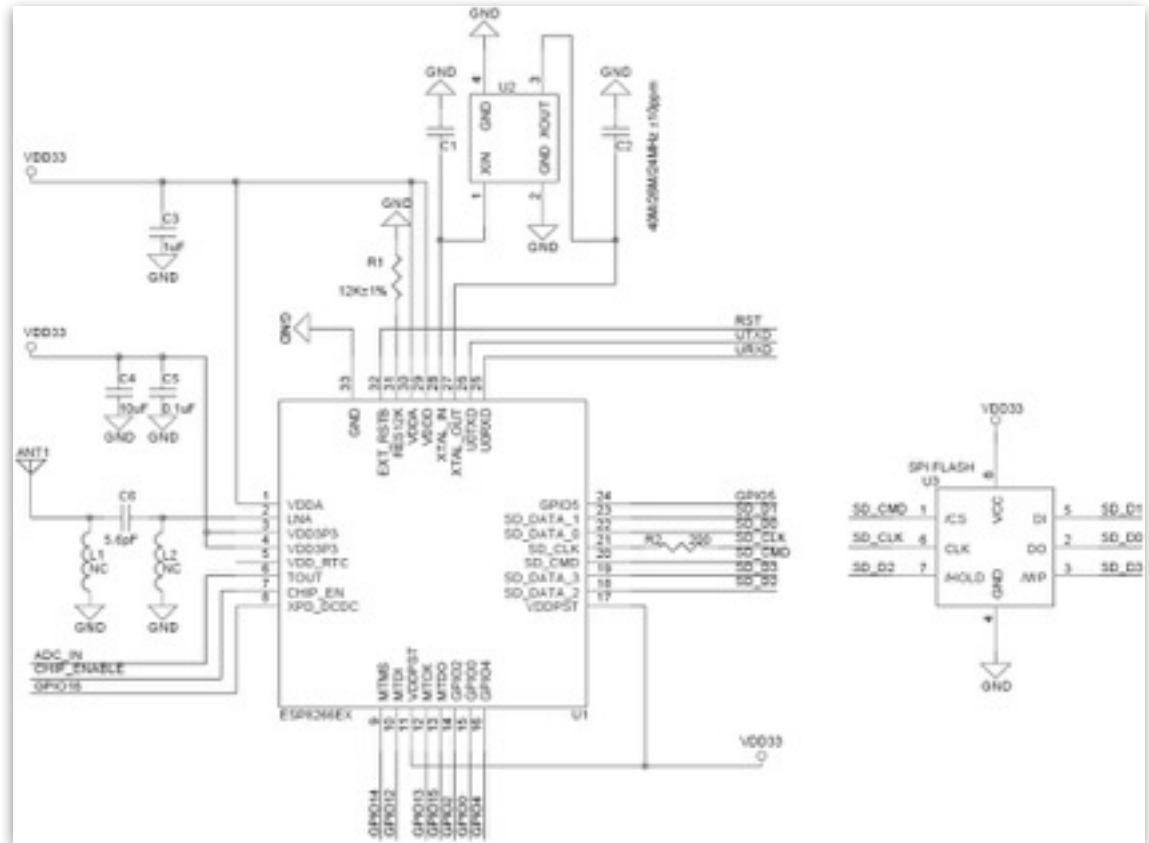
Figure 5-1. ESP-WROOM-02 schematics

Espressif System

IOT Team

http://bbs.espressif.com