

# ESP8684-WROOM-04C

## Datasheet

2.4 GHz Wi-Fi (802.11 b/g/n) and Bluetooth® 5 module

Built around ESP8684 series of SoC, RISC-V single-core microprocessor

2 MB/4 MB flash in chip package

14 GPIOs

On-board PCB antenna



ESP8684-WROOM-04C



Version 1.1  
Espressif Systems  
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# 1 Module Overview

## 1.1 Features

### CPU and On-Chip Memory

- ESP8684H2 or ESP8684H4 embedded, 32-bit RISC-V single-core processor, up to 120 MHz
- 576 KB ROM
- 272 KB SRAM (16 KB for cache)
- In-Package flash (see details in Table 1 [ESP8684-WROOM-04C Series Comparison](#))
- Access to flash accelerated by cache
- Supports flash in-Circuit Programming (ICP)

### Wi-Fi

- 802.11 b/g/n
- Center frequency range of operating channel: 2412 ~ 2484 MHz
- Supports 20 MHz bandwidth in 2.4 GHz band
- 1T1R mode with data rate up to 72.2 Mbps
- Wi-Fi Multimedia (WMM)
- TX/RX A-MPDU, TX/RX A-MSDU
- Immediate Block ACK
- Fragmentation and defragmentation
- Transmit opportunity (TXOP)
- Automatic Beacon monitoring (hardware TSF)
- 3 × virtual Wi-Fi interfaces
- Simultaneous support for Infrastructure BSS in Station mode, SoftAP mode, Station + SoftAP mode, and promiscuous mode

*Note that when ESP8684 series scans in Station mode, the SoftAP channel will change along with the Station channel*

### Bluetooth®

- Bluetooth LE: Bluetooth 5

- High power mode (20 dBm)
- Speed: 125 kbps, 500 kbps, 1 Mbps, 2 Mbps
- Advertising extensions
- Multiple advertisement sets
- Channel selection algorithm #2
- Internal co-existence mechanism between Wi-Fi and Bluetooth to share the same antenna

### Peripherals

- GPIO, SPI, UART, I2C, LED PWM controller, general DMA controller, temperature sensor, SAR ADC, timers and watchdog

#### Note:

\* Please refer to [ESP8684 Series Datasheet](#) for detailed information about the module peripherals.

### Integrated Components on Module

- 26 MHz crystal oscillator

### Antenna Options

- On-board PCB antenna

### Operating Conditions

- Operating voltage/Power supply: 3.0 ~ 3.6 V
- Operating ambient temperature: -40 ~ 105 °C

### Certification

- Bluetooth certification: [BQB](#)
- Green certification: RoHS/REACH

### Test

- HTOL/HTSL/uHAST/TCT/ESD/Latch-up

## 1.2 Description

ESP8684-WROOM-04C is a general-purpose Wi-Fi and Bluetooth LE module. The rich set of peripherals and high performance make this module an ideal choice for smart homes, industrial automation, health care, consumer electronics, etc.

ESP8684-WROOM-04C comes with a PCB antenna.

The series comparison for ESP8684-WROOM-04C is as follows:

**Table 1: ESP8684-WROOM-04C Series Comparison**

Ordering Code	In-Package Flash	Ambient Temp. <sup>1</sup> (°C)	Size <sup>2</sup> (mm)
ESP8684-WROOM-04C-H2	2 MB	-40 ~105	24.0 × 16.0 × 3.1
ESP8684-WROOM-04C-H4	4 MB		

<sup>1</sup> Ambient temperature specifies the recommended temperature range of the environment immediately outside the Espressif module.

<sup>2</sup> For details, refer to Section 8.1 *Physical Dimensions*.

The ESP8684H2 chip and the ESP8684H4 chip fall into the same category, namely ESP8684 chip series, which has a 32-bit RISC-V single-core processor.

ESP8684 integrates a rich set of peripherals including UART, I2C, LED PWM controller, general DMA controller, temperature sensor, and SAR ADC etc.

**Note:**

For more information on ESP8684, please refer to [ESP8684 Series Datasheet](#).

## 1.3 Applications

- Smart Home
  - Light control
  - Smart button
  - Smart plug
  - Indoor positioning
- Industrial Automation
  - Industrial robot
  - Industrial field bus
- Consumer Electronics
  - Smart watch and bracelet
  - Over-the-top (OTT) devices
  - Logger toys and proximity sensing toys
- Health Care
  - Health monitor
  - Baby monitor
- Smart Agriculture
  - Smart greenhouse
  - Smart irrigation
  - Agriculture robot
- Retail and Catering
  - POS machines
  - Service robot
- Generic Low-power IoT Sensor Hubs
- Generic Low-power IoT Data Loggers

# Contents

<b>1</b>	<b>Module Overview</b>	<b>2</b>
1.1	Features	2
1.2	Description	3
1.3	Applications	3
<b>2</b>	<b>Block Diagram</b>	<b>8</b>
<b>3</b>	<b>Pin Definitions</b>	<b>9</b>
3.1	Pin Layout	9
3.2	Pin Description	9
3.3	Strapping Pins	10
<b>4</b>	<b>Electrical Characteristics</b>	<b>13</b>
4.1	Absolute Maximum Ratings	13
4.2	Recommended Operating Conditions	13
4.3	DC Characteristics (3.3 V, 25 °C)	13
4.4	Current Consumption Characteristics	14
4.4.1	Current Consumption in Active Mode	14
<b>5</b>	<b>RF Characteristics</b>	<b>15</b>
5.1	Wi-Fi Radio (2.4 GHz)	15
5.1.1	Wi-Fi RF Transmitter (TX) Characteristics	15
5.1.2	Wi-Fi RF Receiver (RX) Characteristics	16
5.2	Bluetooth 5 (LE) Radio	17
5.2.1	Bluetooth LE RF Transmitter (TX) Characteristics	17
5.2.2	Bluetooth LE RF Receiver (RX) Characteristics	18
<b>6</b>	<b>Module Schematics</b>	<b>21</b>
<b>7</b>	<b>Peripheral Schematics</b>	<b>22</b>
<b>8</b>	<b>Physical Dimensions and PCB Land Pattern</b>	<b>23</b>
8.1	Physical Dimensions	23
8.2	Recommended PCB Land Pattern	24
<b>9</b>	<b>Product Handling</b>	<b>25</b>
9.1	Storage Conditions	25
9.2	Electrostatic Discharge (ESD)	25
9.3	Soldering Profile	25
9.3.1	Reflow Profile	25
9.4	Ultrasonic Vibration	26
<b>10</b>	<b>Related Documentation and Resources</b>	<b>27</b>

## Revision History

## List of Tables

1	ESP8684-WROOM-04C Series Comparison	3
2	Pin Definitions	10
3	Strapping Pins	11
4	Parameter Descriptions of Setup and Hold Times for the Strapping Pins	12
5	Absolute Maximum Ratings	13
6	Recommended Operating Conditions	13
7	DC Characteristics (3.3 V, 25 °C)	13
8	Current Consumption for Wi-Fi (2.4 GHz) in Active Mode	14
9	Current Consumption in Modem-sleep Mode	14
10	Current Consumption in Low-Power Modes	14
11	Wi-Fi RF Characteristics	15
12	TX Power with Spectral Mask and EVM Meeting 802.11 Standards	15
13	TX EVM Test	15
14	RX Sensitivity	16
15	Maximum RX Level	16
16	RX Adjacent Channel Rejection	17
17	Bluetooth LE RF Characteristics	17
18	Bluetooth LE - Transmitter Characteristics - 1 Mbps	17
19	Bluetooth LE - Transmitter Characteristics - 2 Mbps	17
20	Bluetooth LE - Transmitter Characteristics - 125 Kbps	18
21	Bluetooth LE - Transmitter Characteristics - 500 Kbps	18
22	Bluetooth LE - Receiver Characteristics - 1 Mbps	18
23	Bluetooth LE - Receiver Characteristics - 2 Mbps	19
24	Bluetooth LE - Receiver Characteristics - 125 Kbps	20
25	Bluetooth LE - Receiver Characteristics - 500 Kbps	20

## List of Figures

1	ESP8684-WROOM-04C Block Diagram	8
2	Pin Layout (Top View)	9
3	Setup and Hold Times for the Strapping Pins	12
4	ESP8684-WROOM-04C Schematics	21
5	Peripheral Schematics	22
6	Physical Dimensions	23
7	Recommended PCB Land Pattern	24
8	Reflow Profile	25

## 2 Block Diagram

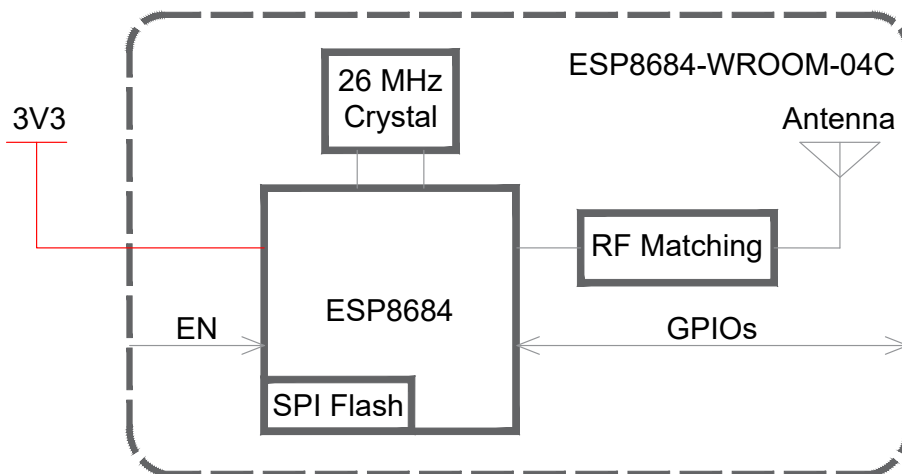


Figure 1: ESP8684-WROOM-04C Block Diagram



## 3 Pin Definitions

### 3.1 Pin Layout

The pin diagram below shows the approximate location of pins on the module. For the actual diagram drawn to scale, please refer to Figure 8.1 *Physical Dimensions*.

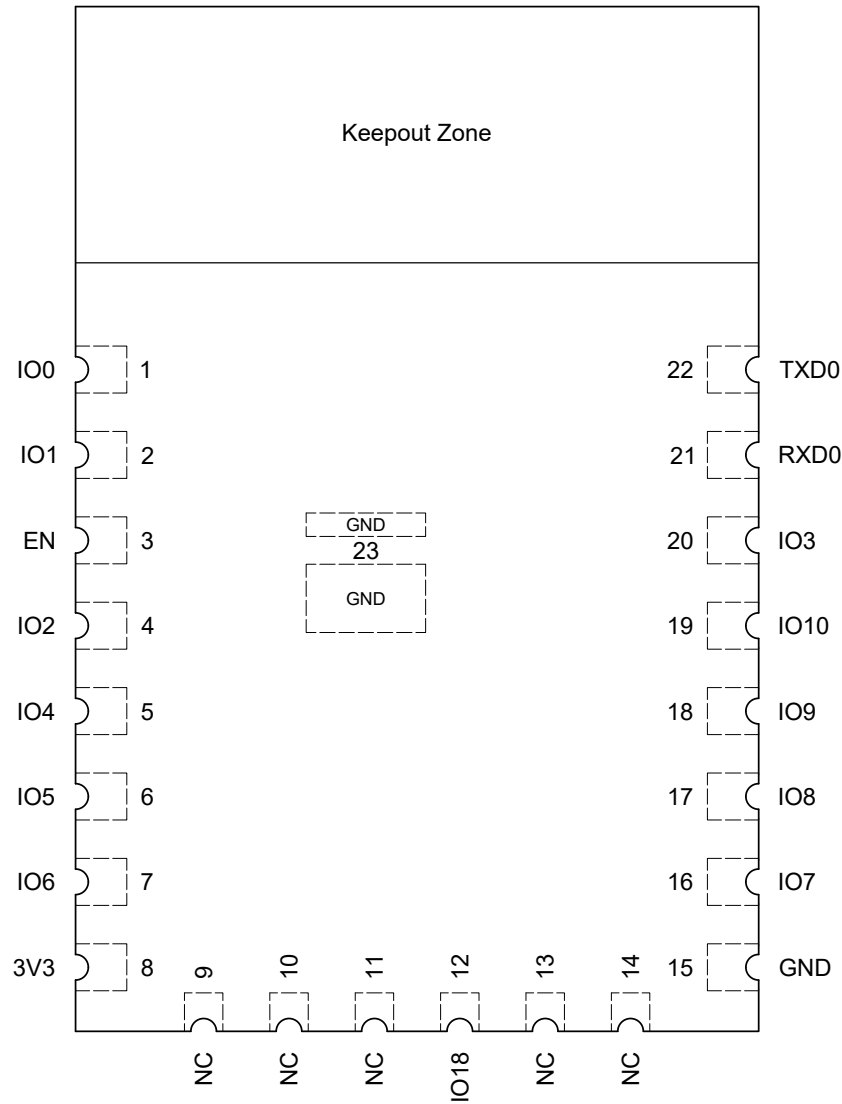


Figure 2: Pin Layout (Top View)

### 3.2 Pin Description

The module has 17 pins. See pin definitions in Table 2 *Pin Definitions*.

For peripheral pin configurations, please refer to [ESP8684 Series Datasheet](#).

Table 2: Pin Definitions

Name	No.	Type <sup>1</sup>	Function
IO0	1	I/O/T	GPIO0 ADC1_CH0
IO1	2	I/O/T	GPIO1, ADC1_CH1
EN	3	I	High: on, enables the chip. Low: off, the chip powers off. Default: internally pulled-up
IO2	4	I/O/T	GPIO2, ADC1_CH2, FSPIQ
IO4	5	I/O/T	GPIO4, ADC1_CH4, FSPIHD, MTMS, LED PWM
IO5	6	I/O/T	GPIO5, FSPIWP, MTDI, LED PWM
IO6	7	I/O/T	GPIO6, FSPICLK, MTCK, LED PWM
3V3	8	P	Power supply
NC	9-11, 13-14	—	NC
IO18	12	I/O/T	GPIO18
GND	15, 23	P	Ground
IO7	16	I/O/T	GPIO7, FSPID, MTDO, LED PWM
IO8	17	I/O/T	GPIO8
IO9	18	I/O/T	GPIO9
IO10	19	I/O/T	GPIO10, FSPICS0, LED PWM
IO3	20	I/O/T	GPIO3, ADC1_CH3, LED PWM
RXD0	21	I/O/T	GPIO19, U0RXD
TXD0	22	I/O/T	GPIO20, U0TXD

<sup>1</sup> P: power supply; I: input; O: output; T: high impedance.

**Note:**

IO0, IO1, IO3, IO5/MTDI pins have low-level glitches during chip power up. See details in section General Purpose Input / Output Interface (GPIO) of [ESP8684 Series Datasheet](#).

### 3.3 Strapping Pins

**Note:**

The content below is excerpted from Section Strapping Pins in [ESP8684 Series Datasheet](#). For the strapping pin mapping between the chip and modules, please refer to Chapter 6 [Module Schematics](#).

ESP8684 series has two strapping pins:

- GPIO8
- GPIO9

Software can read the values of GPIO8 and GPIO9 from GPIO\_STRAPPING field in GPIO\_STRAP\_REG register. For register description, please refer to Section GPIO Matrix Register Summary in [ESP8684 Technical Reference Manual](#).

During the chip's power-on reset, RTC watchdog reset, and brownout reset, the latches of the strapping pins sample the voltage level as strapping bits of "0" or "1", and hold these bits until the chip is powered down or shut down.

By default, GPIO9 is connected to the internal weak pull-up resistor. If GPIO9 is not connected or connected to an external high-impedance circuit, the latched bit value will be "1".

To change the strapping bit values, you can apply the external pull-down/pull-up resistances, or use the host MCU's GPIOs to control the voltage level of these pins when powering on ESP8684.

After reset, the strapping pins work as normal-function pins.

Table 3 lists detailed booting configurations of the strapping pins.

**Table 3: Strapping Pins**

Booting Mode <sup>1</sup>			
Pin	Default	SPI Boot	Download Boot
GPIO8	N/A	Don't care	1
GPIO9	Internal weak pull-up	1	0
Enabling/Disabling ROM Messages Print During Booting			
Pin	Default	Functionality	
GPIO8	N/A	When the value of eFuse field EFUSE_UART_PRINT_CONTROL is 0 (default), print is enabled and not controlled by GPIO8. 1, if GPIO8 is 0, print is enabled; if GPIO8 is 1, it is disabled. 2, if GPIO8 is 0, print is disabled; if GPIO8 is 1, it is enabled. 3, print is disabled and not controlled by GPIO8.	

<sup>1</sup> The strapping combination of GPIO8 = 0 and GPIO9 = 0 is invalid and will trigger unexpected behavior.

Figure 3 shows the setup and hold times for the strapping pins before and after the CHIP\_EN signal goes high. Details about the parameters are listed in Table 4.

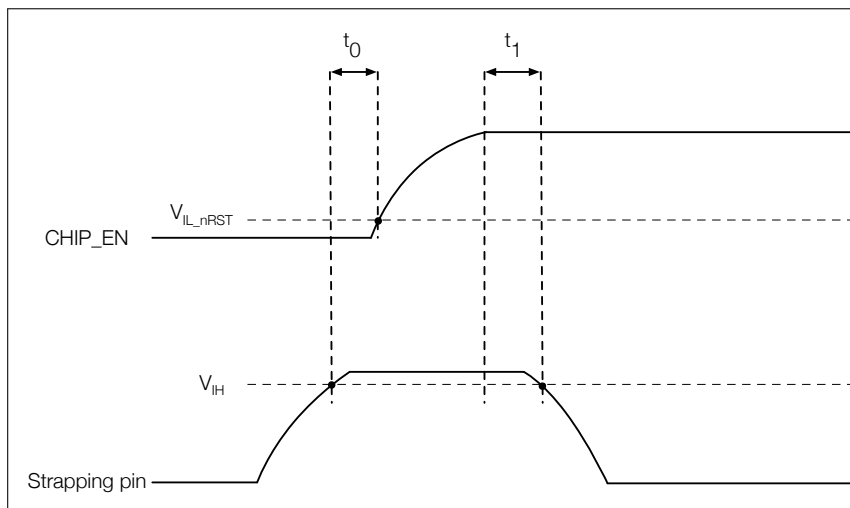


Figure 3: Setup and Hold Times for the Strapping Pins

Table 4: Parameter Descriptions of Setup and Hold Times for the Strapping Pins

Parameter	Description	Min (ms)
$t_0$	Setup time before CHIP_EN goes from low to high	0
$t_1$	Hold time after CHIP_EN goes high	3

## 4 Electrical Characteristics

### 4.1 Absolute Maximum Ratings

Stresses above those listed in Table 5 *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under Table 6 *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

**Table 5: Absolute Maximum Ratings**

Symbol	Parameter	Min	Max	Unit
VDD33	Power supply voltage	-0.3	3.6	V
T <sub>STORE</sub>	Storage temperature	-40	105	°C

### 4.2 Recommended Operating Conditions

**Table 6: Recommended Operating Conditions**

Symbol	Parameter	Min	Typ	Max	Unit
VDD33	Power supply voltage	3.0	3.3	3.6	V
I <sub>VDD</sub>	Current delivered by external power supply	0.5	—	—	A
T <sub>A</sub>	Operating ambient temperature	-40	—	105	°C

### 4.3 DC Characteristics (3.3 V, 25 °C)

**Table 7: DC Characteristics (3.3 V, 25 °C)**

Symbol	Parameter	Min	Typ	Max	Unit
C <sub>IN</sub>	Pin capacitance	—	2	—	pF
V <sub>IH</sub>	High-level input voltage	0.75 × VDD <sup>1</sup>	—	VDD <sup>1</sup> + 0.3	V
V <sub>IL</sub>	Low-level input voltage	-0.3	—	0.25 × VDD <sup>1</sup>	V
I <sub>IH</sub>	High-level input current	—	—	50	nA
I <sub>IL</sub>	Low-level input current	—	—	50	nA
V <sub>OH</sub> <sup>2</sup>	High-level output voltage	0.8 × VDD <sup>1</sup>	—	—	V
V <sub>OL</sub> <sup>2</sup>	Low-level output voltage	—	—	0.1 × VDD <sup>1</sup>	V
I <sub>OH</sub>	High-level source current (VDD <sup>1</sup> = 3.3 V, V <sub>OH</sub> ≥ 2.64 V, PAD_DRIVER = 3)	—	40	—	mA
I <sub>OL</sub>	Low-level sink current (VDD <sup>1</sup> = 3.3 V, V <sub>OL</sub> = 0.495 V, PAD_DRIVER = 3)	—	28	—	mA
R <sub>PU</sub>	Pull-up resistor	—	45	—	kΩ
R <sub>PD</sub>	Pull-down resistor	—	45	—	kΩ
V <sub>IH_nRST</sub>	Chip reset release voltage	0.75 × VDD <sup>1</sup>	—	VDD <sup>1</sup> + 0.3	V
V <sub>IL_nRST</sub>	Chip reset voltage	-0.3	—	0.25 × VDD <sup>1</sup>	V

<sup>1</sup> VDD is the I/O voltage for a particular power domain of pins.

<sup>2</sup> V<sub>OH</sub> and V<sub>OL</sub> are measured using high-impedance load.

## 4.4 Current Consumption Characteristics

### 4.4.1 Current Consumption in Active Mode

The current consumption measurements are taken with a 3.3 V supply at 25 °C ambient temperature.

TX current consumption is rated at a 100% duty cycle.

RX current consumption is rated when the peripherals are disabled and the CPU idle.

**Table 8: Current Consumption for Wi-Fi (2.4 GHz) in Active Mode**

Work Mode	RF Condition	Description	Peak (mA)
Active (RF working)	TX	802.11b, 1 Mbps, DSSS @21.0 dBm	364
		802.11g, 54 Mbps, OFDM @19.0 dBm	305
		802.11n, HT20, MCS7 @18.0 dBm	287
	RX	802.11b/g/n, HT20	63

**Note:**

The content below is excerpted from *Section Power Consumption in Other Modes* in [ESP8684 Series Datasheet](#).

**Table 9: Current Consumption in Modem-sleep Mode**

Work mode	Frequency (MHz)	Description	Typ <sup>1</sup> (mA)	Typ <sup>2</sup> (mA)
Modem-sleep <sup>3</sup>	80	WFI (Wait-for-Interrupt)	9.4	10.3
		CPU run at full speed	12.1	13.0
	120	WFI (Wait-for-Interrupt)	10.7	11.5
		CPU run at full speed	14.7	15.6

<sup>1</sup> Current consumption when all peripheral clocks are **disabled**.

<sup>2</sup> Current consumption when all peripheral clocks are **enabled**. In practice, the current consumption might be different depending on which peripherals are enabled.

<sup>3</sup> In Modem-sleep mode, Wi-Fi is clock gated, and the current consumption might be higher when accessing flash. For a flash rated at 80 Mbit/s, in SPI 2-line mode the consumption is 10 mA.

**Table 10: Current Consumption in Low-Power Modes**

Work mode	Description	Typ	Unit
Light-sleep	—	140	μA
Deep-sleep	Only RTC timer is powered on	5	μA
Power off	CHIP_EN is set to low level, and the chip is powered off	1	μA

## 5 RF Characteristics

This section contains tables with RF characteristics of the Espressif product.

The RF data is measured at the antenna port, where RF cable is connected, including the front-end loss.

Devices should operate in the center frequency range allocated by regional regulatory authorities. The target center frequency range and the target transmit power are configurable by software. See [ESP RF Test Tool and Test Guide](#) for instructions.

Unless otherwise stated, the RF tests are conducted with a 3.3 V ( $\pm 5\%$ ) supply at 25 °C ambient temperature.

### 5.1 Wi-Fi Radio (2.4 GHz)

**Table 11: Wi-Fi RF Characteristics**

Name	Description
Center frequency range of operating channel	2412 ~ 2484 MHz
Wi-Fi wireless standard	IEEE 802.11b/g/n

#### 5.1.1 Wi-Fi RF Transmitter (TX) Characteristics

**Table 12: TX Power with Spectral Mask and EVM Meeting 802.11 Standards**

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps, DSSS	—	21.0	—
802.11b, 11 Mbps, CCK	—	21.0	—
802.11g, 6 Mbps, OFDM	—	21.0	—
802.11g, 54 Mbps, OFDM	—	19.0	—
802.11n, HT20, MCS0	—	19.0	—
802.11n, HT20, MCS7	—	18.0	—

**Table 13: TX EVM Test<sup>1</sup>**

Rate	Min (dB)	Typ (dB)	Limit (dB)
802.11b, 1 Mbps, DSSS	—	-25.0	-10.0
802.11b, 11 Mbps, CCK	—	-25.0	-10.0
802.11g, 6 Mbps, OFDM	—	-25.0	-5.0
802.11g, 54 Mbps, OFDM	—	-30.0	-25.0
802.11n, HT20, MCS0	—	-29.0	-5.0
802.11n, HT20, MCS7	—	-31.0	-27.0

<sup>1</sup> EVM is measured at the corresponding typical TX power provided in [Table 12 TX Power with Spectral Mask and EVM Meeting 802.11 Standards](#) above.

## 5.1.2 Wi-Fi RF Receiver (RX) Characteristics

For RX tests, the PER (packet error rate) limit is 8% for 802.11b, and 10% for 802.11g/n.

**Table 14: RX Sensitivity**

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps, DSSS	—	-99.2	—
802.11b, 2 Mbps, DSSS	—	-96.4	—
802.11b, 5.5 Mbps, CCK	—	-93.2	—
802.11b, 11 Mbps, CCK	—	-89.4	—
802.11g, 6 Mbps, OFDM	—	-94.0	—
802.11g, 9 Mbps, OFDM	—	-92.0	—
802.11g, 12 Mbps, OFDM	—	-91.4	—
802.11g, 18 Mbps, OFDM	—	-89.0	—
802.11g, 24 Mbps, OFDM	—	-86.2	—
802.11g, 36 Mbps, OFDM	—	-82.2	—
802.11g, 48 Mbps, OFDM	—	-78.0	—
802.11g, 54 Mbps, OFDM	—	-76.4	—
802.11n, HT20, MCS0	—	-93.4	—
802.11n, HT20, MCS1	—	-91.2	—
802.11n, HT20, MCS2	—	-88.2	—
802.11n, HT20, MCS3	—	-84.6	—
802.11n, HT20, MCS4	—	-81.0	—
802.11n, HT20, MCS5	—	-77.4	—
802.11n, HT20, MCS6	—	-75.4	—
802.11n, HT20, MCS7	—	-74.0	—

**Table 15: Maximum RX Level**

Rate	Min (dBm)	Typ (dBm)	Max (dBm)
802.11b, 1 Mbps, DSSS	—	5	—
802.11b, 11 Mbps, CCK	—	5	—
802.11g, 6 Mbps, OFDM	—	5	—
802.11g, 54 Mbps, OFDM	—	0	—
802.11n, HT20, MCS0	—	5	—
802.11n, HT20, MCS7	—	-1	—



Table 16: RX Adjacent Channel Rejection

Rate	Min (dB)	Typ (dB)	Max (dB)
802.11b, 1 Mbps, DSSS	—	35	—
802.11b, 11 Mbps, CCK	—	35	—
802.11g, 6 Mbps, OFDM	—	31	—
802.11g, 54 Mbps, OFDM	—	20	—
802.11n, HT20, MCS0	—	31	—
802.11n, HT20, MCS7	—	16	—

## 5.2 Bluetooth 5 (LE) Radio

Table 17: Bluetooth LE RF Characteristics

Name	Description
Center frequency range of operating channel	2402 ~ 2480 MHz
RF transmit power range	-24.0 ~ 20.0 dBm

### 5.2.1 Bluetooth LE RF Transmitter (TX) Characteristics

Table 18: Bluetooth LE - Transmitter Characteristics - 1 Mbps

Parameter	Description	Min	Typ	Max	Unit
Carrier frequency offset and drift	Max. $ f_n _{n=0, 1, 2, 3, \dots, k}$	—	1.4	—	kHz
	Max. $ f_0 - f_n _{n=2, 3, 4, \dots, k}$	—	1.7	—	kHz
	Max. $ f_n - f_{n-5} _{n=6, 7, 8, \dots, k}$	—	0.9	—	kHz
	$ f_1 - f_0 $	—	1.0	—	kHz
Modulation characteristics	$\Delta F1_{avg}$	—	250.2	—	kHz
	Min. $\Delta F2_{max}$ (for at least 99.9% of all $\Delta F2_{max}$ )	—	238.2	—	kHz
	$\Delta F2_{avg}/\Delta F1_{avg}$	—	1.00	—	—
In-band emissions	$\pm 2$ MHz offset	—	-32	—	dBm
	$\pm 3$ MHz offset	—	-38	—	dBm
	$> \pm 3$ MHz offset	—	-41	—	dBm

Table 19: Bluetooth LE - Transmitter Characteristics - 2 Mbps

Parameter	Description	Min	Typ	Max	Unit
Carrier frequency offset and drift	Max. $ f_n _{n=0, 1, 2, 3, \dots, k}$	—	4.0	—	kHz
	Max. $ f_0 - f_n _{n=2, 3, 4, \dots, k}$	—	1.6	—	kHz
	Max. $ f_n - f_{n-5} _{n=6, 7, 8, \dots, k}$	—	1.0	—	kHz
	$ f_1 - f_0 $	—	0.7	—	kHz

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Table 19 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit
Modulation characteristics	$\Delta F1_{avg}$	—	497.4	—	kHz
	Min. $\Delta F2_{max}$ (for at least 99.9% of all $\Delta F2_{max}$ )	—	477.5	—	kHz
	$\Delta F2_{avg}/\Delta F1_{avg}$	—	1.00	—	—
In-band emissions	$\pm 4$ MHz offset	—	-40	—	dBm
	$\pm 5$ MHz offset	—	-43	—	dBm
	$> \pm 5$ MHz offset	—	-44	—	dBm

Table 20: Bluetooth LE - Transmitter Characteristics - 125 Kbps

Parameter	Description	Min	Typ	Max	Unit
Carrier frequency offset and drift	Max. $ f_n _{n=0, 1, 2, 3, \dots, k}$	—	0.5	—	kHz
	Max. $ f_0 - f_n _{n=1, 2, 3, \dots, k}$	—	0.4	—	kHz
	$ f_0 - f_3 $	—	0.2	—	kHz
	Max. $ f_n - f_{n-3} _{n=7, 8, 9, \dots, k}$	—	0.6	—	kHz
Modulation characteristics	$\Delta F1_{avg}$	—	249.8	—	kHz
	Min. $\Delta F1_{max}$ (for at least 99.9% of all $\Delta F1_{max}$ )	—	238.9	—	kHz
In-band emissions	$\pm 2$ MHz offset	—	-32	—	dBm
	$\pm 3$ MHz offset	—	-38	—	dBm
	$> \pm 3$ MHz offset	—	-41	—	dBm

Table 21: Bluetooth LE - Transmitter Characteristics - 500 Kbps

Parameter	Description	Min	Typ	Max	Unit
Carrier frequency offset and drift	Max. $ f_n _{n=0, 1, 2, 3, \dots, k}$	—	0.5	—	kHz
	Max. $ f_0 - f_n _{n=1, 2, 3, \dots, k}$	—	0.5	—	kHz
	$ f_0 - f_3 $	—	0.2	—	kHz
	Max. $ f_n - f_{n-3} _{n=7, 8, 9, \dots, k}$	—	0.6	—	kHz
Modulation characteristics	$\Delta F2_{avg}$	—	250.9	—	kHz
	Min. $\Delta F2_{max}$ (for at least 99.9% of all $\Delta F2_{max}$ )	—	236.8	—	kHz
In-band emissions	$\pm 2$ MHz offset	—	-32	—	dBm
	$\pm 3$ MHz offset	—	-38	—	dBm
	$> \pm 3$ MHz offset	—	-41	—	dBm

## 5.2.2 Bluetooth LE RF Receiver (RX) Characteristics

Table 22: Bluetooth LE - Receiver Characteristics - 1 Mbps

Parameter	Description	Min	Typ	Max	Unit
Sensitivity @30.8% PER	—	—	-98.0	—	dBm

Cont'd on next page

Table 22 – cont'd from previous page

Parameter	Description	Min	Typ	Max	Unit	
Maximum received signal @30.8% PER	—	—	8	—	dBm	
C/I and receiver selectivity performance	Co-channel	$F = F_0$ MHz	—	8	—	dB
	Adjacent channel	$F = F_0 + 1$ MHz	—	-1	—	dB
		$F = F_0 - 1$ MHz	—	-3	—	dB
		$F = F_0 + 2$ MHz	—	-26	—	dB
		$F = F_0 - 2$ MHz	—	-28	—	dB
		$F = F_0 + 3$ MHz	—	-34	—	dB
		$F = F_0 - 3$ MHz	—	-33	—	dB
		$F \geq F_0 + 4$ MHz	—	-33	—	dB
	$F \leq F_0 - 4$ MHz	—	-31	—	dB	
Image frequency	—	—	-33	—	dB	
Adjacent channel to image frequency	$F = F_{image} + 1$ MHz	—	-32	—	dB	
	$F = F_{image} - 1$ MHz	—	-34	—	dB	
Out-of-band blocking performance	30 MHz ~ 2000 MHz	—	-23	—	dBm	
	2003 MHz ~ 2399 MHz	—	-30	—	dBm	
	2484 MHz ~ 2997 MHz	—	-10	—	dBm	
	3000 MHz ~ 12.75 GHz	—	-17	—	dBm	
Intermodulation	—	—	-31	—	dBm	

Table 23: Bluetooth LE - Receiver Characteristics - 2 Mbps

Parameter	Description	Min	Typ	Max	Unit	
Sensitivity @30.8% PER	—	—	-94.0	—	dBm	
Maximum received signal @30.8% PER	—	—	8	—	dBm	
C/I and receiver selectivity performance	Co-channel	$F = F_0$ MHz	—	9	—	dB
	Adjacent channel	$F = F_0 + 2$ MHz	—	-11	—	dB
		$F = F_0 - 2$ MHz	—	-7	—	dB
		$F = F_0 + 4$ MHz	—	-35	—	dB
		$F = F_0 - 4$ MHz	—	-30	—	dB
		$F = F_0 + 6$ MHz	—	-35	—	dB
		$F = F_0 - 6$ MHz	—	-29	—	dB
		$F \geq F_0 + 8$ MHz	—	-39	—	dB
	$F \leq F_0 - 8$ MHz	—	-33	—	dB	
Image frequency	—	—	-35	—	dB	
Adjacent channel to image frequency	$F = F_{image} + 2$ MHz	—	-35	—	dB	
	$F = F_{image} - 2$ MHz	—	-11	—	dB	
Out-of-band blocking performance	30 MHz ~ 2000 MHz	—	-30	—	dBm	
	2003 MHz ~ 2399 MHz	—	-34	—	dBm	
	2484 MHz ~ 2997 MHz	—	-19	—	dBm	
	3000 MHz ~ 12.75 GHz	—	-28	—	dBm	
Intermodulation	—	—	-33	—	dBm	

Table 24: Bluetooth LE - Receiver Characteristics - 125 Kbps

Parameter	Description	Min	Typ	Max	Unit	
Sensitivity @30.8% PER	—	—	-105.0	—	dBm	
Maximum received signal @30.8% PER	—	—	8	—	dBm	
C/I and receiver selectivity performance	Co-channel	$F = F_0$ MHz	—	3	—	dB
	Adjacent channel	$F = F_0 + 1$ MHz	—	-7	—	dB
		$F = F_0 - 1$ MHz	—	-5	—	dB
		$F = F_0 + 2$ MHz	—	-35	—	dB
		$F = F_0 - 2$ MHz	—	-34	—	dB
		$F = F_0 + 3$ MHz	—	-38	—	dB
		$F = F_0 - 3$ MHz	—	-37	—	dB
		$F \geq F_0 + 4$ MHz	—	-41	—	dB
		$F \leq F_0 - 4$ MHz	—	-45	—	dB
	Image frequency	—	—	-41	—	dB
Adjacent channel to image frequency	$F = F_{image} + 1$ MHz	—	-43	—	dB	
	$F = F_{image} - 1$ MHz	—	-38	—	dB	

Table 25: Bluetooth LE - Receiver Characteristics - 500 Kbps

Parameter	Description	Min	Typ	Max	Unit	
Sensitivity @30.8% PER	—	—	-101.0	—	dBm	
Maximum received signal @30.8% PER	—	—	8	—	dBm	
C/I and receiver selectivity performance	Co-channel	$F = F_0$ MHz	—	4	—	dB
	Adjacent channel	$F = F_0 + 1$ MHz	—	-6	—	dB
		$F = F_0 - 1$ MHz	—	-5	—	dB
		$F = F_0 + 2$ MHz	—	-29	—	dB
		$F = F_0 - 2$ MHz	—	-32	—	dB
		$F = F_0 + 3$ MHz	—	-31	—	dB
		$F = F_0 - 3$ MHz	—	-36	—	dB
		$F \geq F_0 + 4$ MHz	—	-34	—	dB
		$F \leq F_0 - 4$ MHz	—	-33	—	dB
	Image frequency	—	—	-34	—	dB
Adjacent channel to image frequency	$F = F_{image} + 1$ MHz	—	-37	—	dB	
	$F = F_{image} - 1$ MHz	—	-31	—	dB	

# 6 Module Schematics

This is the reference design of the module.

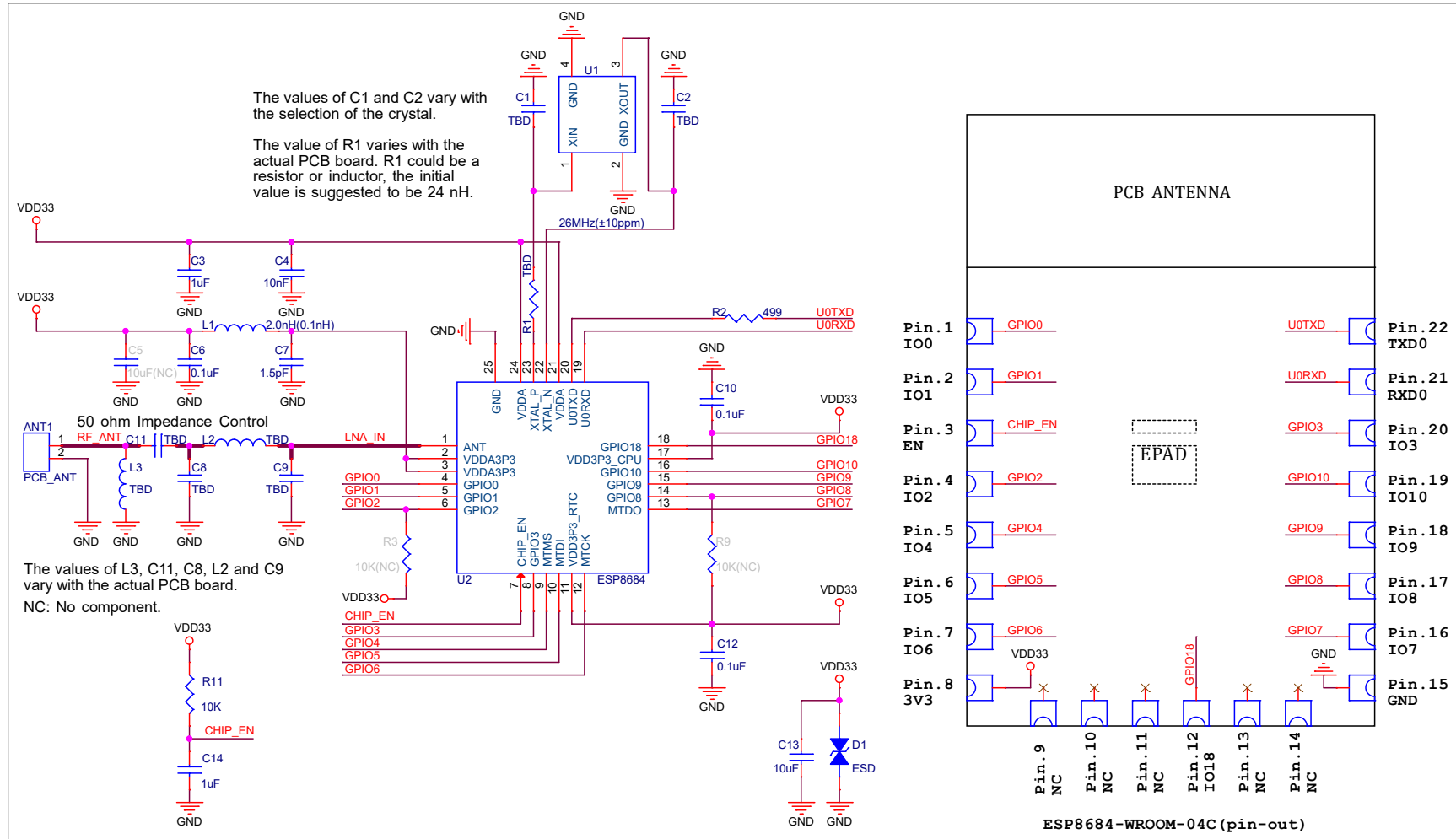


Figure 4: ESP8684-WROOM-04C Schematics

## 7 Peripheral Schematics

This is the typical application circuit of the module connected with peripheral components (for example, power supply, antenna, reset button, JTAG interface, and UART interface).

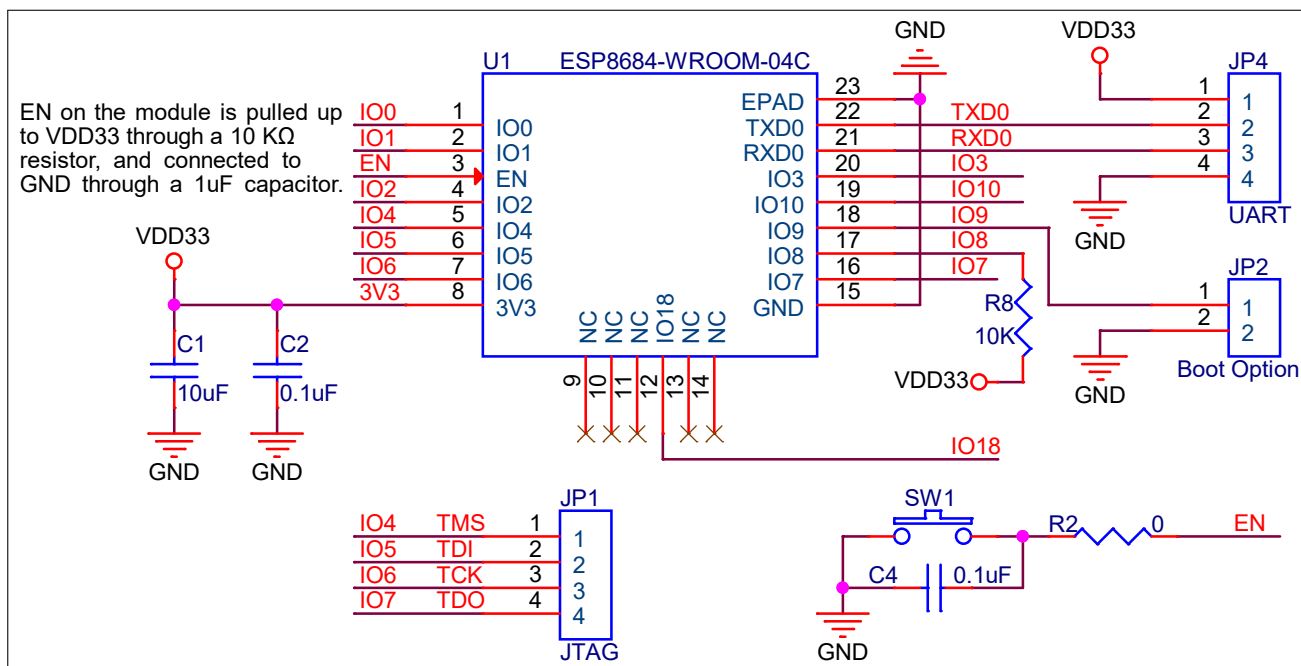


Figure 5: Peripheral Schematics

- Soldering the EPAD to the ground of the base board is not a must, however, it can optimize thermal performance. If you choose to solder it, please apply the correct amount of soldering paste. Too much soldering paste may increase the gap between the module and the baseboard. As a result, the adhesion between other pins and the baseboard may be poor.
- To ensure that the power supply to the ESP8684 chip is stable during power-up, it is advised to add an RC delay circuit at the EN pin. The recommended setting for the RC delay circuit is usually  $R = 10\text{ k}\Omega$  and  $C = 1\ \mu\text{F}$  (such RC delay circuit has already been built into the module). However, specific parameters should be adjusted based on the power-up timing of the module and the power-up and reset sequence timing of the chip. For ESP8684's power-up and reset sequence timing diagram, please refer to Section *Power Scheme* in [ESP8684 Series Datasheet](#).

## 8 Physical Dimensions and PCB Land Pattern

### 8.1 Physical Dimensions

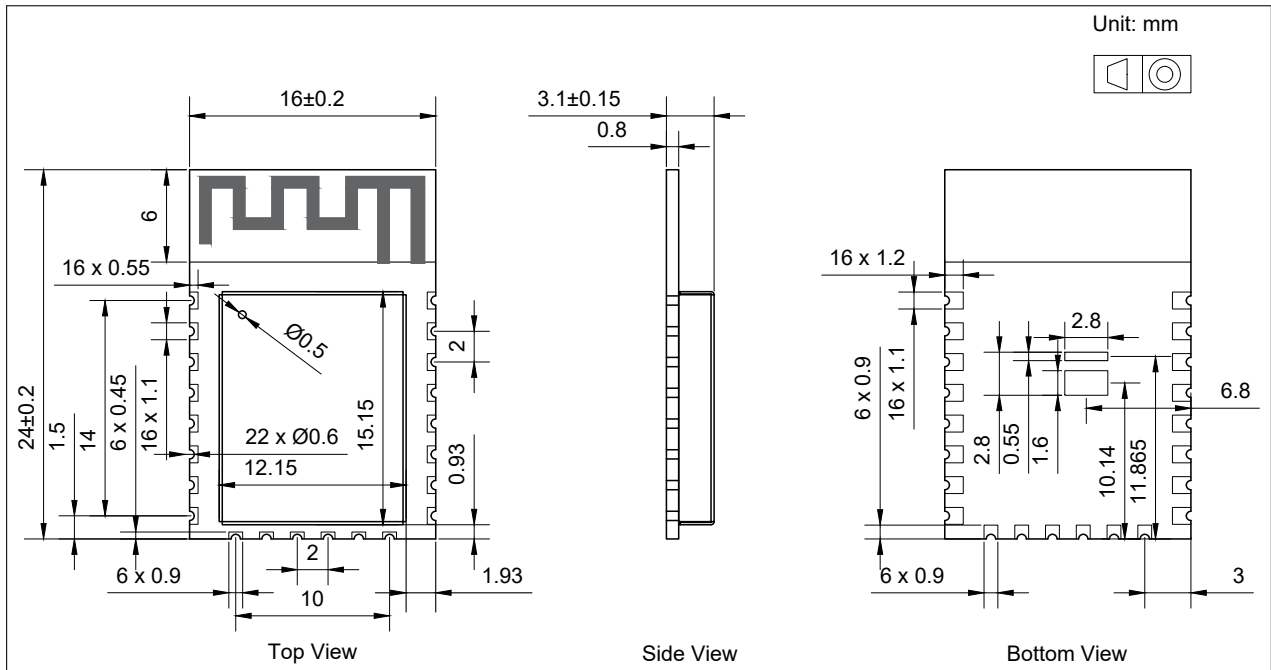


Figure 6: Physical Dimensions

**Note:**

For information about tape, reel, and product marking, please refer to [Espressif Module Packaging Information](#).

## 8.2 Recommended PCB Land Pattern

This section provides the following resources for your reference:

- Figure for the recommended PCB land pattern with all the dimensions needed for PCB design. See Figure 7 *Recommended PCB Land Pattern*.
- Source file of the recommended PCB land pattern to measure dimensions not covered in Figure 7. You can view the source files for [ESP8684-WROOM-04C](#) with [Autodesk Viewer](#).

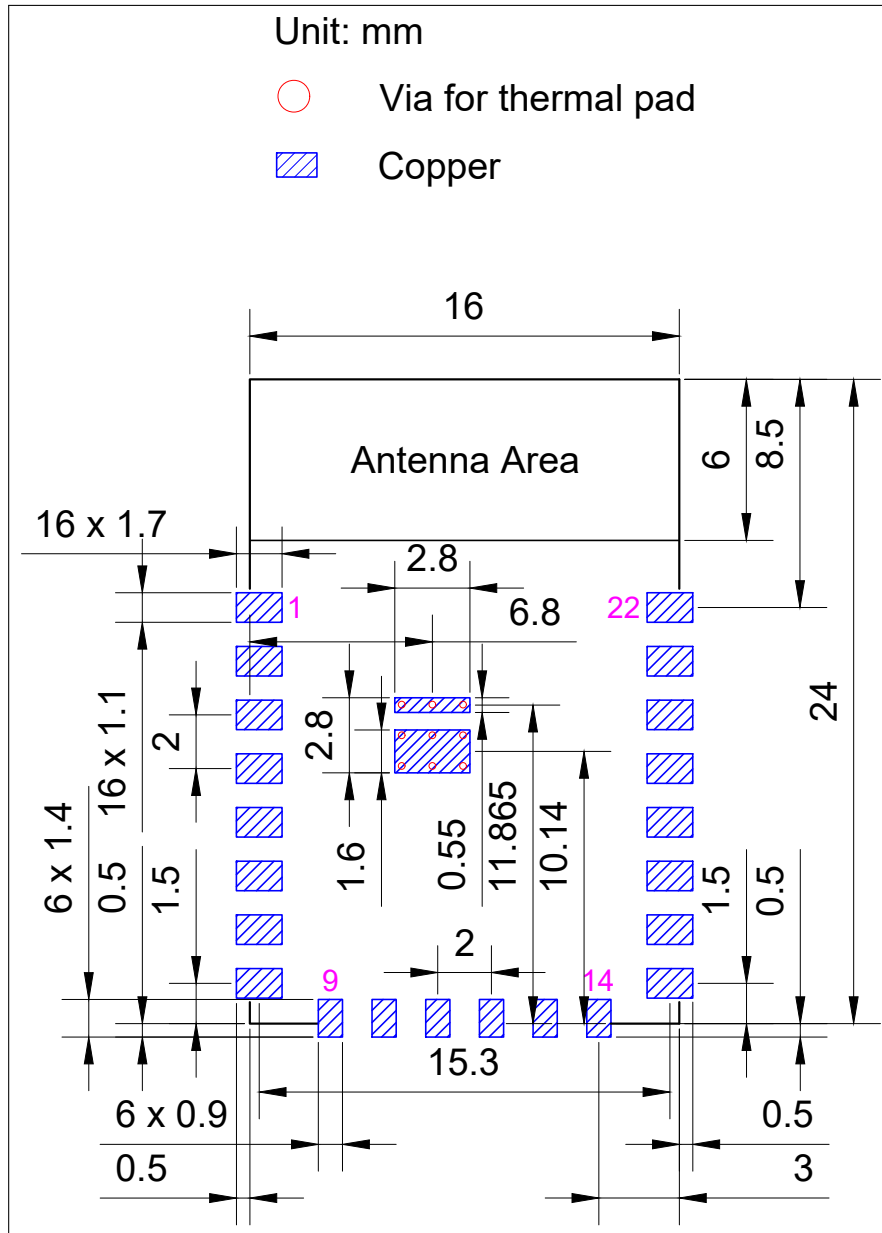


Figure 7: Recommended PCB Land Pattern



## 9 Product Handling

### 9.1 Storage Conditions

The products sealed in moisture barrier bags (MBB) should be stored in a non-condensing atmospheric environment of  $< 40\text{ }^{\circ}\text{C}$  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  $25\pm 5\text{ }^{\circ}\text{C}$  and 60%RH. If the above conditions are not met, the module needs to be baked.

### 9.2 Electrostatic Discharge (ESD)

- Human body model (HBM):  $\pm 2000\text{ V}$
- Charged-device model (CDM):  $\pm 500\text{ V}$

### 9.3 Soldering Profile

#### 9.3.1 Reflow Profile

Solder the module in a single reflow.

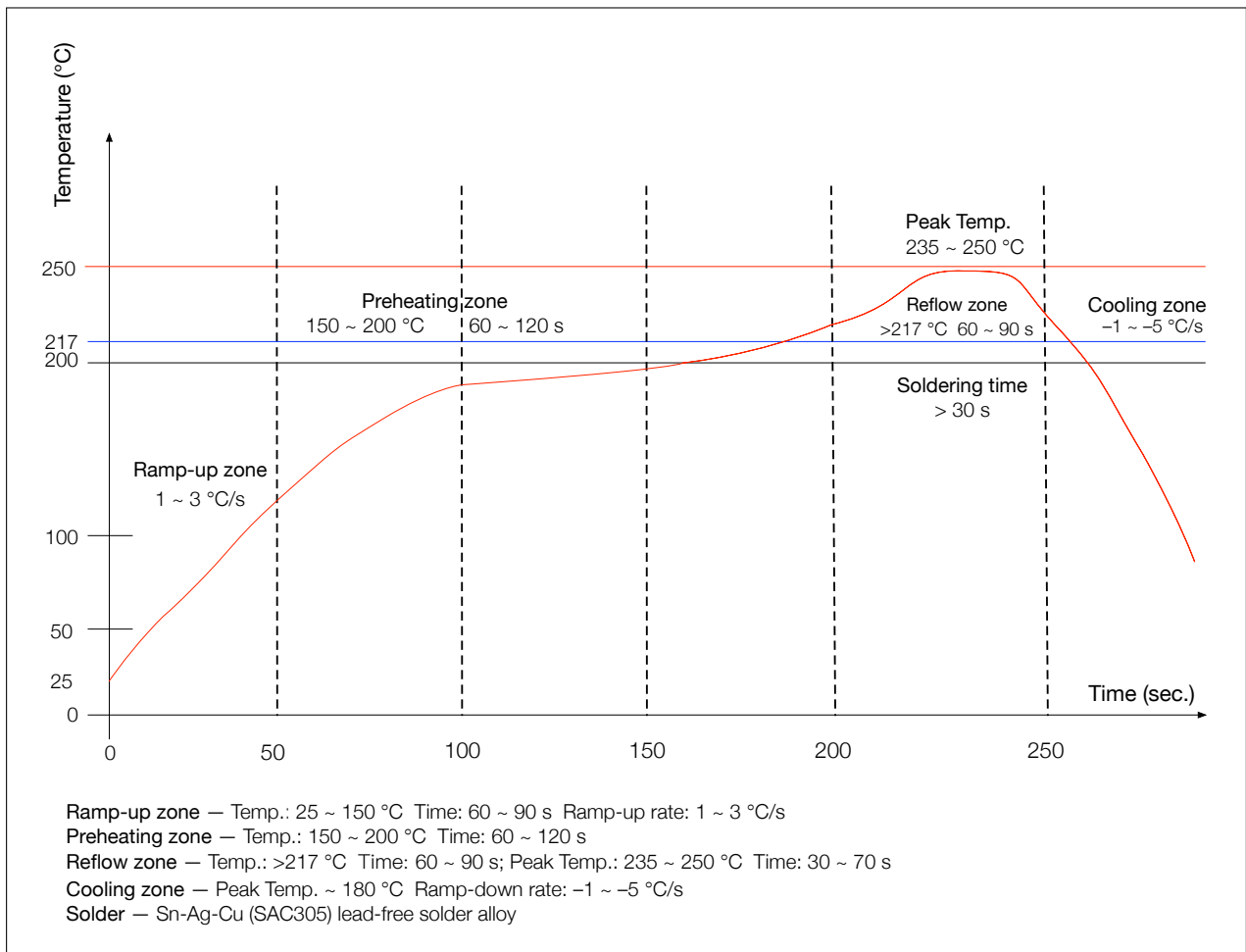


Figure 8: Reflow Profile

## 9.4 Ultrasonic Vibration

Avoid exposing Espressif modules to vibration from ultrasonic equipment, such as ultrasonic welders or ultrasonic cleaners. This vibration may induce resonance in the in-module crystal and lead to its malfunction or even failure. As a consequence, **the module may stop working or its performance may deteriorate.**

## 10 Related Documentation and Resources

### Related Documentation

- [ESP8684 Series Datasheet](#) – Specifications of the ESP8684 hardware.
- [ESP8684 Technical Reference Manual](#) – Detailed information on how to use the ESP8684 memory and peripherals.
- [ESP8684 Hardware Design Guidelines](#) – Guidelines on how to integrate the ESP8684 into your hardware product.
- *Certificates*  
<https://espressif.com/en/support/documents/certificates>
- *ESP8684 Product/Process Change Notifications (PCN)*  
<https://espressif.com/en/support/documents/pcns?keys=ESP8684>
- *Documentation Updates and Update Notification Subscription*  
<https://espressif.com/en/support/download/documents>

### Developer Zone

- [ESP-IDF Programming Guide for ESP8684](#) – Extensive documentation for the ESP-IDF development framework.
- *ESP-IDF* and other development frameworks on GitHub.  
<https://github.com/espressif>
- *ESP32 BBS Forum* – Engineer-to-Engineer (E2E) Community for Espressif products where you can post questions, share knowledge, explore ideas, and help solve problems with fellow engineers.  
<https://esp32.com/>
- *The ESP Journal* – Best Practices, Articles, and Notes from Espressif folks.  
<https://blog.espressif.com/>
- See the tabs *SDKs and Demos, Apps, Tools, AT Firmware*.  
<https://espressif.com/en/support/download/sdks-demos>

### Products

- *ESP8684 Series SoCs* – Browse through all ESP8684 SoCs.  
<https://espressif.com/en/products/socs?id=ESP8684>
- *ESP8684 Series Modules* – Browse through all ESP8684-based modules.  
<https://espressif.com/en/products/modules?id=ESP8684>
- *ESP8684 Series DevKits* – Browse through all ESP8684-based devkits.  
<https://espressif.com/en/products/devkits?id=ESP8684>
- *ESP Product Selector* – Find an Espressif hardware product suitable for your needs by comparing or applying filters.  
<https://products.espressif.com/#/product-selector?language=en>

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## Revision History

Date	Version	Release notes
2023-06-26	v1.1	<ul style="list-style-type: none"><li>• Updated <a href="#">6 Module Schematics</a></li><li>• Updated <a href="#">7 Peripheral Schematics</a></li><li>• Updated <a href="#">8.1 Physical Dimensions</a></li></ul>
2023-06-15	v1.0	<ul style="list-style-type: none"><li>• Updated Chapter <a href="#">1.1 Features</a></li><li>• Updated Chapter <a href="#">8.2 Recommended PCB Land Pattern</a></li></ul>
2022-05-15	v0.5	Preliminary release
2022-11-15	v0.1	Draft



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