

ESP32-WROOM-32D & ESP32-WROOM-32U

Datasheet

NOT RECOMMENDED
FOR NEW DESIGNS
(NRND)



Version 2.4
Espressif Systems
Copyright © 2023

About This Document

This document provides the specifications for the ESP32-WROOM-32D and ESP32-WROOM-32U modules.

Document Updates

Please always refer to the latest version on <https://www.espressif.com/en/support/download/documents>.

Revision History

For revision history of this document, please refer to the [last page](#).

Documentation Change Notification

Espressif provides email notifications to keep customers updated on changes to technical documentation.

Please subscribe at www.espressif.com/en/subscribe. Note that you need to update your subscription to receive notifications of new products you are not currently subscribed to.

Certification

Download certificates for Espressif products from www.espressif.com/en/certificates.

Contents

1	Overview	6
2	Pin Definitions	8
2.1	Pin Layout	8
2.2	Pin Description	8
2.3	Strapping Pins	10
3	Functional Description	12
3.1	CPU and Internal Memory	12
3.2	External Flash and SRAM	12
3.3	Crystal Oscillators	12
3.4	RTC and Low-Power Management	13
4	Peripherals and Sensors	14
5	Electrical Characteristics	15
5.1	Absolute Maximum Ratings	15
5.2	Recommended Operating Conditions	15
5.3	DC Characteristics (3.3 V, 25 °C)	15
5.4	Wi-Fi Radio	16
5.5	Bluetooth LE Radio	17
	5.5.1 Receiver	17
	5.5.2 Transmitter	17
5.6	Reflow Profile	18
6	Schematics	19
7	Peripheral Schematics	21
8	Physical Dimensions	23
9	Recommended PCB Land Pattern	25
10	Dimensions of External Antenna Connector	27
11	U.S. FCC Statement	28
12	Related Documentation and Resources	31
	Revision History	32

List of Tables

1	ESP32-WROOM-32D vs. ESP32-WROOM-32U	6
2	ESP32-WROOM-32D and ESP32-WROOM-32U Specifications	7
3	Pin Definitions	8
4	Strapping Pins	10
5	Absolute Maximum Ratings	15
6	Recommended Operating Conditions	15
7	DC Characteristics (3.3 V, 25 °C)	15
8	Wi-Fi Radio Characteristics	16
9	Receiver Characteristics – Bluetooth LE	17
10	Transmitter Characteristics – Bluetooth LE	17

List of Figures

1	ESP32-WROOM-32D Pin Layout (Top View)	8
2	Reflow Profile	18
3	ESP32-WROOM-32D Schematics	19
4	ESP32-WROOM-32U Schematics	20
5	ESP32-WROOM-32D & ESP32-WROOM-32U Peripheral Schematics	21
6	Physical Dimensions of ESP32-WROOM-32D	23
7	Physical Dimensions of ESP32-WROOM-32U	24
8	Recommended PCB Land Pattern of ESP32-WROOM-32D	25
9	Recommended PCB Land Pattern of ESP32-WROOM-32U	26
10	Dimensions of External Antenna Connector of ESP32-WROOM-32U	27

1 Overview

ESP32-WROOM-32D and ESP32-WROOM-32U are powerful, generic Wi-Fi + Bluetooth + Bluetooth LE MCU modules that target a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming and MP3 decoding.

ESP32-WROOM-32U is different from ESP32-WROOM-32D in that ESP32-WROOM-32U integrates a connector to connect an external antenna. For detailed information of the connector please see Chapter 10. Note that the information in this data sheet is applicable to both modules. Any differences between them will be clearly specified in the course of this document. Table 1 lists the difference between ESP32-WROOM-32D and ESP32-WROOM-32U.

Table 1: ESP32-WROOM-32D vs. ESP32-WROOM-32U

Module	ESP32-WROOM-32D	ESP32-WROOM-32U
Core	ESP32-D0WD	ESP32-D0WD
SPI flash	32 Mbits, 3.3 V	32 Mbits, 3.3 V
Crystal	40 MHz	40 MHz
Antenna	on-board PCB antenna	external antenna connector (which needs to be connected to an external antenna)
Dimensions (Unit: mm)	18 × 25.5 × 3.1 (See Figure 6 for details)	18 × 19.2 × 3.2 (See Figure 7 for details)
Schematics	See Figure 3 for details.	See Figure 4 for details.

At the core of the two modules is the ESP32-D0WD chip that belongs to the ESP32 series* of chips. The chip embedded is designed to be scalable and adaptive. There are two CPU cores that can be individually controlled, and the CPU clock frequency is adjustable from 80 MHz to 240 MHz. The chip also has a low-power coprocessor that can be used instead of the CPU to save power while performing tasks that do not require much computing power, such as monitoring of peripherals. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, SD card interface, Ethernet, high-speed SPI, UART, I2S and I2C.

Note:

* For details on the part numbers of the ESP32 family of chips, please refer to the document [ESP32 Datasheet](#).

The integration of Bluetooth®, Bluetooth LE and Wi-Fi ensures that a wide range of applications can be targeted, and that the module is all-around: using Wi-Fi allows a large physical range and direct connection to the Internet through a Wi-Fi router, while using Bluetooth allows the user to conveniently connect to the phone or broadcast low energy beacons for its detection. The sleep current of the ESP32 chip is less than 5 μ A, making it suitable for battery powered and wearable electronics applications. The module supports a data rate of up to 150 Mbps, and 20 dBm output power at the antenna to ensure the widest physical range. As such the module does offer industry-leading specifications and the best performance for electronic integration, range, power consumption, and connectivity.

The operating system chosen for ESP32 is freeRTOS with LwIP; TLS 1.2 with hardware acceleration is built in as well. Secure (encrypted) over the air (OTA) upgrade is also supported, so that users can upgrade their products even after their release, at minimum cost and effort.

Table 2 provides the specifications of ESP32-WROOM-32D and ESP32-WROOM-32U.

[Not Recommended For New Designs \(NRND\)](#)

Table 2: ESP32-WROOM-32D and ESP32-WROOM-32U Specifications

Categories	Items	Specifications
Certification	RF Certification	See certificates for ESP32-WROOM-32D and ESP32-WROOM-32U
	Wi-Fi Certification	Wi-Fi Alliance
	Bluetooth certification	BQB
	Green Certification	REACH/RoHS
Test	Reliability	HTOL/HTSL/uHAST/TCT/ESD
Wi-Fi	Protocols	802.11 b/g/n (802.11n up to 150 Mbps)
		A-MPDU and A-MSDU aggregation and 0.4 μ s guard interval support
	Center frequency range of operating channel	2412 ~ 2462 MHz
Bluetooth	Protocols	Bluetooth v4.2 BR/EDR and Bluetooth LE specification
	Radio	NZIF receiver with -97 dBm sensitivity
		Class-1, class-2 and class-3 transmitter
		AFH
	Audio	CVSD and SBC
Hardware	Module interfaces	SD card, UART, SPI, SDIO, I2C, LED PWM, Motor PWM, I2S, IR, pulse counter, GPIO, capacitive touch sensor, ADC, DAC, Two-Wire Automotive Interface (TWAI®), compatible with ISO11898-1 (CAN Specification 2.0)
	Integrated crystal	40 MHz crystal
	Integrated SPI flash ¹	4 MB
	Operating voltage/Power supply	3.0 V ~ 3.6 V
	Operating current	Average: 80 mA
	Minimum current delivered by power supply	500 mA
	Recommended operating ambient temperature range ²	-40 °C ~ +85 °C
	Moisture sensitivity level (MSL)	Level 3

Notice:

1. ESP32-WROOM-32D and ESP32-WROOM-32U with 8 MB flash or 16 MB flash are available for custom order.
2. ESP32-WROOM-32D and ESP32-WROOM-32U with high temperature range (-40 °C ~ +105 °C) option are available for custom order. 4 MB SPI flash is supported on the high temperature range version.
3. For detailed ordering information, please see [ESP Product Selector](#).

2 Pin Definitions

2.1 Pin Layout

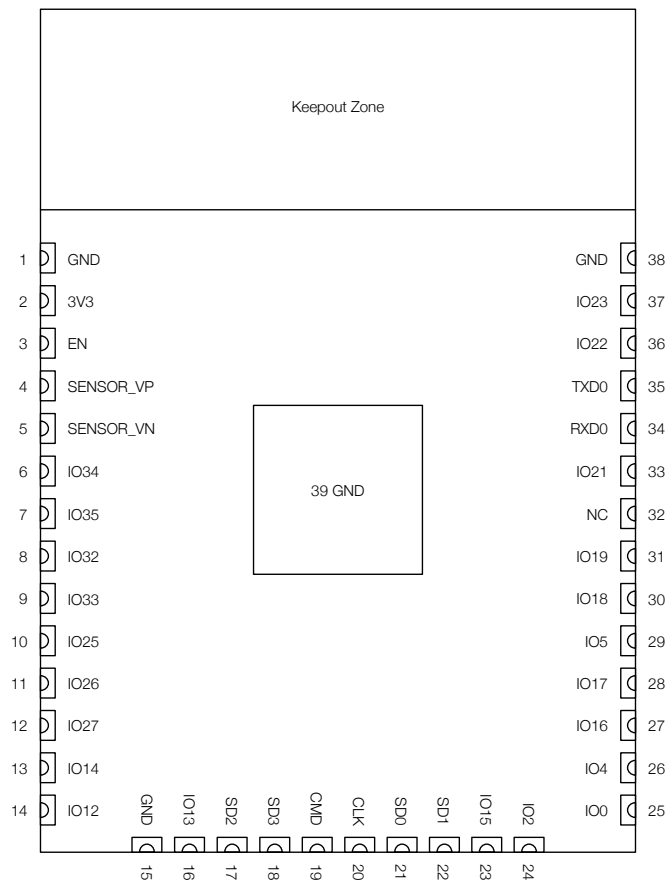


Figure 1: ESP32-WROOM-32D Pin Layout (Top View)

Note:

The pin layout of ESP32-WROOM-32U is the same as that of ESP32-WROOM-32D, except that ESP32-WROOM-32U has no keepout zone.

2.2 Pin Description

The ESP32-WROOM-32D and ESP32-WROOM-32U have 38 pins. See pin definitions in Table 3.

Table 3: Pin Definitions

Name	No.	Type	Function
GND	1	P	Ground
3V3	2	P	Power supply
EN	3	I	Module-enable signal. Active high.
SENSOR_VP	4	I	GPIO36, ADC1_CH0, RTC_GPIO0
SENSOR_VN	5	I	GPIO39, ADC1_CH3, RTC_GPIO3
IO34	6	I	GPIO34, ADC1_CH6, RTC_GPIO4
IO35	7	I	GPIO35, ADC1_CH7, RTC_GPIO5

[Not Recommended For New Designs \(NRND\)](#)

Name	No.	Type	Function
IO32	8	I/O	GPIO32, XTAL_32K_P (32.768 kHz crystal oscillator input), ADC1_CH4, TOUCH9, RTC_GPIO9
IO33	9	I/O	GPIO33, XTAL_32K_N (32.768 kHz crystal oscillator output), ADC1_CH5, TOUCH8, RTC_GPIO8
IO25	10	I/O	GPIO25, DAC_1, ADC2_CH8, RTC_GPIO6, EMAC_RXD0
IO26	11	I/O	GPIO26, DAC_2, ADC2_CH9, RTC_GPIO7, EMAC_RXD1
IO27	12	I/O	GPIO27, ADC2_CH7, TOUCH7, RTC_GPIO17, EMAC_RX_DV
IO14	13	I/O	GPIO14, ADC2_CH6, TOUCH6, RTC_GPIO16, MTMS, HSPICLK, HS2_CLK, SD_CLK, EMAC_TXD2
IO12	14	I/O	GPIO12, ADC2_CH5, TOUCH5, RTC_GPIO15, MTDI, HSPIQ, HS2_DATA2, SD_DATA2, EMAC_TXD3
GND	15	P	Ground
IO13	16	I/O	GPIO13, ADC2_CH4, TOUCH4, RTC_GPIO14, MTCK, HSPID, HS2_DATA3, SD_DATA3, EMAC_RX_ER
SHD/SD2*	17	I/O	GPIO9, SD_DATA2, SPIHD, HS1_DATA2, U1RXD
SWP/SD3*	18	I/O	GPIO10, SD_DATA3, SPIWP, HS1_DATA3, U1TXD
SCS/CMD*	19	I/O	GPIO11, SD_CMD, SPICS0, HS1_CMD, U1RTS
SCK/CLK*	20	I/O	GPIO6, SD_CLK, SPICLK, HS1_CLK, U1CTS
SDO/SD0*	21	I/O	GPIO7, SD_DATA0, SPIQ, HS1_DATA0, U2RTS
SDI/SD1*	22	I/O	GPIO8, SD_DATA1, SPID, HS1_DATA1, U2CTS
IO15	23	I/O	GPIO15, ADC2_CH3, TOUCH3, MTDO, HSPICS0, RTC_GPIO13, HS2_CMD, SD_CMD, EMAC_RXD3
IO2	24	I/O	GPIO2, ADC2_CH2, TOUCH2, RTC_GPIO12, HSPIWP, HS2_DATA0, SD_DATA0
IO0	25	I/O	GPIO0, ADC2_CH1, TOUCH1, RTC_GPIO11, CLK_OUT1, EMAC_TX_CLK
IO4	26	I/O	GPIO4, ADC2_CH0, TOUCH0, RTC_GPIO10, HSPICLK, HS2_DATA1, SD_DATA1, EMAC_TX_ER
IO16	27	I/O	GPIO16, HS1_DATA4, U2RXD, EMAC_CLK_OUT
IO17	28	I/O	GPIO17, HS1_DATA5, U2TXD, EMAC_CLK_OUT_180
IO5	29	I/O	GPIO5, VSPICS0, HS1_DATA6, EMAC_RX_CLK
IO18	30	I/O	GPIO18, VSPICLK, HS1_DATA7
IO19	31	I/O	GPIO19, VSPIQ, U0CTS, EMAC_TXD0
NC	32	-	-
IO21	33	I/O	GPIO21, VSPIHD, EMAC_TX_EN
RXD0	34	I/O	GPIO3, U0RXD, CLK_OUT2
TXD0	35	I/O	GPIO1, U0TXD, CLK_OUT3, EMAC_RXD2
IO22	36	I/O	GPIO22, VSPIWP, U0RTS, EMAC_TXD1
IO23	37	I/O	GPIO23, VSPID, HS1_STROBE
GND	38	P	Ground

Notice:

* Pins SCK/CLK, SDO/SD0, SDI/SD1, SHD/SD2, SWP/SD3 and SCS/CMD, namely, GPIO6 to GPIO11 are connected to the integrated SPI flash integrated on the module and are not recommended for other uses.

Not Recommended For New Designs (NRND)

2.3 Strapping Pins

ESP32 has five strapping pins, which can be seen in Chapter 6 Schematics:

- MTDI
- GPIO0
- GPIO2
- MTDO
- GPIO5

Software can read the values of these five bits from register “GPIO_STRAPPING”.

During the chip’s system reset release (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. The strapping bits configure the device’s boot mode, the operating voltage of VDD_SDIO and other initial system settings.

Each strapping pin is connected to its internal pull-up/pull-down during the chip reset. Consequently, if a strapping pin is unconnected or the connected external circuit is high-impedance, the internal weak pull-up/pull-down will determine the default input level of the strapping pins.

To change the strapping bit values, users 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 ESP32.

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

Refer to Table 4 for a detailed boot-mode configuration by strapping pins.

Table 4: Strapping Pins

Voltage of Internal LDO (VDD_SDIO)					
Pin	Default	3.3 V		1.8 V	
MTDI	Pull-down	0		1	
Bootling Mode					
Pin	Default	SPI Boot		Download Boot	
GPIO0	Pull-up	1		0	
GPIO2	Pull-down	Don't-care		0	
Enabling/Disabling Debugging Log Print over U0TXD During Bootling					
Pin	Default	U0TXD Active		U0TXD Silent	
MTDO	Pull-up	1		0	
Timing of SDIO Slave					
Pin	Default	FE Sampling FE Output	FE Sampling RE Output	RE Sampling FE Output	RE Sampling RE Output
MTDO	Pull-up	0	0	1	1
GPIO5	Pull-up	0	1	0	1

Note:

- Firmware can configure register bits to change the settings of "Voltage of Internal LDO (VDD_SDIO)" and "Timing of SDIO Slave" after booting.
- Both ESP32-WROOM-32D and ESP32-WROOM-32U integrate a 3.3 V SPI flash, so the pin MTDI cannot be set to 1 when the modules are powered up.

3 Functional Description

This chapter describes the modules and functions integrated in ESP32-WROOM-32D and ESP32-WROOM-32U.

3.1 CPU and Internal Memory

ESP32-D0WD contains a dual-core Xtensa® 32-bit LX6 MCU. The internal memory includes:

- 448 KB of ROM for booting and core functions.
- 520 KB of on-chip SRAM for data and instructions.
- 8 KB of SRAM in RTC, which is called RTC FAST Memory and can be used for data storage; it is accessed by the main CPU during RTC Boot from the Deep-sleep mode.
- 8 KB of SRAM in RTC, which is called RTC SLOW Memory and can be accessed by the co-processor during the Deep-sleep mode.
- 1 Kbit of eFuse: 256 bits are used for the system (MAC address and chip configuration) and the remaining 768 bits are reserved for customer applications, including flash-encryption and chip-ID.

3.2 External Flash and SRAM

ESP32 supports multiple external QSPI flash and SRAM chips. More details can be found in Chapter SPI in the [ESP32 Technical Reference Manual](#). ESP32 also supports hardware encryption/decryption based on AES to protect developers' programs and data in flash.

ESP32 can access the external QSPI flash and SRAM through high-speed caches.

- The external flash can be mapped into CPU instruction memory space and read-only memory space simultaneously.
 - When external flash is mapped into CPU instruction memory space, up to 11 MB + 248 KB can be mapped at a time. Note that if more than 3 MB + 248 KB are mapped, cache performance will be reduced due to speculative reads by the CPU.
 - When external flash is mapped into read-only data memory space, up to 4 MB can be mapped at a time. 8-bit, 16-bit and 32-bit reads are supported.
- External SRAM can be mapped into CPU data memory space. Up to 4 MB can be mapped at a time. 8-bit, 16-bit and 32-bit reads and writes are supported.

Both ESP32-WROOM-32D and ESP32-WROOM-32U integrate a 4 MB of external SPI flash. The integrated SPI flash is connected to GPIO6, GPIO7, GPIO8, GPIO9, GPIO10 and GPIO11. These six pins cannot be used as regular GPIOs.

3.3 Crystal Oscillators

The module uses a 40-MHz crystal oscillator.

3.4 RTC and Low-Power Management

With the use of advanced power-management technologies, ESP32 can switch between different power modes.

For details on ESP32's power consumption in different power modes, please refer to section "RTC and Low-Power Management" in [ESP32 Datasheet](#).

4 Peripherals and Sensors

Please refer to Section Peripherals and Sensors in [ESP32 Datasheet](#).

Note:

External connections can be made to any GPIO except for GPIOs in the range 6-11. These six GPIOs are connected to the module's integrated SPI flash. For details, please see Section [6 Schematics](#).

5 Electrical Characteristics

5.1 Absolute Maximum Ratings

Stresses beyond the absolute maximum ratings listed in Table 5 below may cause permanent damage to the device. These are stress ratings only, and do not refer to the functional operation of the device that should follow the [recommended operating conditions](#).

Table 5: Absolute Maximum Ratings

Symbol	Parameter	Min	Max	Unit
VDD33	Power supply voltage	-0.3	3.6	V
I_{output}^1	Cumulative IO output current	-	1,100	mA
T_{store}	Storage temperature	-40	105	°C

1. The module worked properly after a 24-hour test in ambient temperature at 25 °C, and the IOs in three domains (VDD3P3_RTC, VDD3P3_CPU, VDD_SDIO) output high logic level to ground. Please note that pins occupied by flash and/or PSRAM in the VDD_SDIO power domain were excluded from the test.
2. Please see Appendix IO_MUX of [ESP32 Datasheet](#) for IO's power domain.

5.2 Recommended Operating Conditions

Table 6: Recommended Operating Conditions

Symbol	Parameter	Min	Typical	Max	Unit
VDD33	Power supply voltage	3.0	3.3	3.6	V
I_{VDD}	Current delivered by external power supply	0.5	-	-	A
T	Operating ambient temperature	-40	-	85	°C

5.3 DC Characteristics (3.3 V, 25 °C)

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

Symbol	Parameter		Min	Typ	Max	Unit
C_{IN}	Pin capacitance		-	2	-	pF
V_{IH}	High-level input voltage		$0.75 \times VDD^1$	-	$VDD^1 + 0.3$	V
V_{IL}	Low-level input voltage		-0.3	-	$0.25 \times VDD^1$	V
I_{IH}	High-level input current		-	-	50	nA
I_{IL}	Low-level input current		-	-	50	nA
V_{OH}	High-level output voltage		$0.8 \times VDD^1$	-	-	V
V_{OL}	Low-level output voltage		-	-	$0.1 \times VDD^1$	V
I_{OH}	High-level source current ($VDD^1 = 3.3\text{ V}$, $V_{OH} \geq 2.64\text{ V}$, output drive strength set to the maximum)	VDD3P3_CPU power domain ^{1, 2}	-	40	-	mA
		VDD3P3_RTC power domain ^{1, 2}	-	40	-	mA
		VDD_SDIO power domain ^{1, 3}	-	20	-	mA

[Not Recommended For New Designs \(NRND\)](#)

Symbol	Parameter	Min	Typ	Max	Unit
I_{OL}	Low-level sink current ($V_{DD}^1 = 3.3\text{ V}$, $V_{OL} = 0.495\text{ V}$, output drive strength set to the maximum)	-	28	-	mA
R_{PU}	Resistance of internal pull-up resistor	-	45	-	k Ω
R_{PD}	Resistance of internal pull-down resistor	-	45	-	k Ω
V_{IL_nRST}	Low-level input voltage of CHIP_PU to power off the chip	-	-	0.6	V

Notes:

1. Please see Appendix IO_MUX of [ESP32 Datasheet](#) for IO's power domain. VDD is the I/O voltage for a particular power domain of pins.
2. For VDD3P3_CPU and VDD3P3_RTC power domain, per-pin current sourced in the same domain is gradually reduced from around 40 mA to around 29 mA, $V_{OH} \geq 2.64\text{ V}$, as the number of current-source pins increases.
3. Pins occupied by flash and/or PSRAM in the VDD_SDIO power domain were excluded from the test.

5.4 Wi-Fi Radio

Table 8: Wi-Fi Radio Characteristics

Parameter	Condition	Min	Typical	Max	Unit
Center frequency range of operating channel ^{note1}	-	2412	-	2462	MHz
Output impedance ^{note2}	-	-	<i>note 2</i>	-	Ω
TX power ^{note3}	11n, MCS7	12	13	14	dBm
	11b mode	17.5	18.5	20	dBm
Sensitivity	11b, 1 Mbps	-	-98	-	dBm
	11b, 11 Mbps	-	-89	-	dBm
	11g, 6 Mbps	-	-92	-	dBm
	11g, 54 Mbps	-	-74	-	dBm
	11n, HT20, MCS0	-	-91	-	dBm
	11n, HT20, MCS7	-	-71	-	dBm
	11n, HT40, MCS0	-	-89	-	dBm
	11n, HT40, MCS7	-	-69	-	dBm
Adjacent channel rejection	11g, 6 Mbps	-	31	-	dB
	11g, 54 Mbps	-	14	-	dB
	11n, HT20, MCS0	-	31	-	dB
	11n, HT20, MCS7	-	13	-	dB

1. Device should operate in the center frequency range of operating channel allocated by regional regulatory authorities. Target center frequency range of operating channel is configurable by software.
2. For the modules that use external antennas, the output impedance is 50 Ω . For other modules without external antennas, users do not need to concern about the output impedance.
3. Target TX power is configurable based on device or certification requirements.

5.5 Bluetooth LE Radio

5.5.1 Receiver

Table 9: Receiver Characteristics – Bluetooth LE

Parameter	Conditions	Min	Typ	Max	Unit
Sensitivity @30.8% PER	-	-	-97	-	dBm
Maximum received signal @30.8% PER	-	0	-	-	dBm
Co-channel C/I	-	-	+10	-	dB
Adjacent channel selectivity C/I	$F = F_0 + 1 \text{ MHz}$	-	-5	-	dB
	$F = F_0 - 1 \text{ MHz}$	-	-5	-	dB
	$F = F_0 + 2 \text{ MHz}$	-	-25	-	dB
	$F = F_0 - 2 \text{ MHz}$	-	-35	-	dB
	$F = F_0 + 3 \text{ MHz}$	-	-25	-	dB
	$F = F_0 - 3 \text{ MHz}$	-	-45	-	dB
Out-of-band blocking performance	30 MHz ~ 2000 MHz	-10	-	-	dBm
	2000 MHz ~ 2400 MHz	-27	-	-	dBm
	2500 MHz ~ 3000 MHz	-27	-	-	dBm
	3000 MHz ~ 12.5 GHz	-10	-	-	dBm
Intermodulation	-	-36	-	-	dBm

5.5.2 Transmitter

Table 10: Transmitter Characteristics – Bluetooth LE

Parameter	Conditions	Min	Typ	Max	Unit
RF transmit power	-	-	0	-	dBm
Gain control step	-	-	3	-	dBm
RF power control range	-	-12	-	+9	dBm
Adjacent channel transmit power	$F = F_0 \pm 2 \text{ MHz}$	-	-52	-	dBm
	$F = F_0 \pm 3 \text{ MHz}$	-	-58	-	dBm
	$F = F_0 \pm > 3 \text{ MHz}$	-	-60	-	dBm
$\Delta f_{1\text{avg}}$	-	-	-	265	kHz
$\Delta f_{2\text{max}}$	-	247	-	-	kHz
$\Delta f_{2\text{avg}}/\Delta f_{1\text{avg}}$	-	-	-0.92	-	-
ICFT	-	-	-10	-	kHz
Drift rate	-	-	0.7	-	kHz/50 μs
Drift	-	-	2	-	kHz

5.6 Reflow Profile

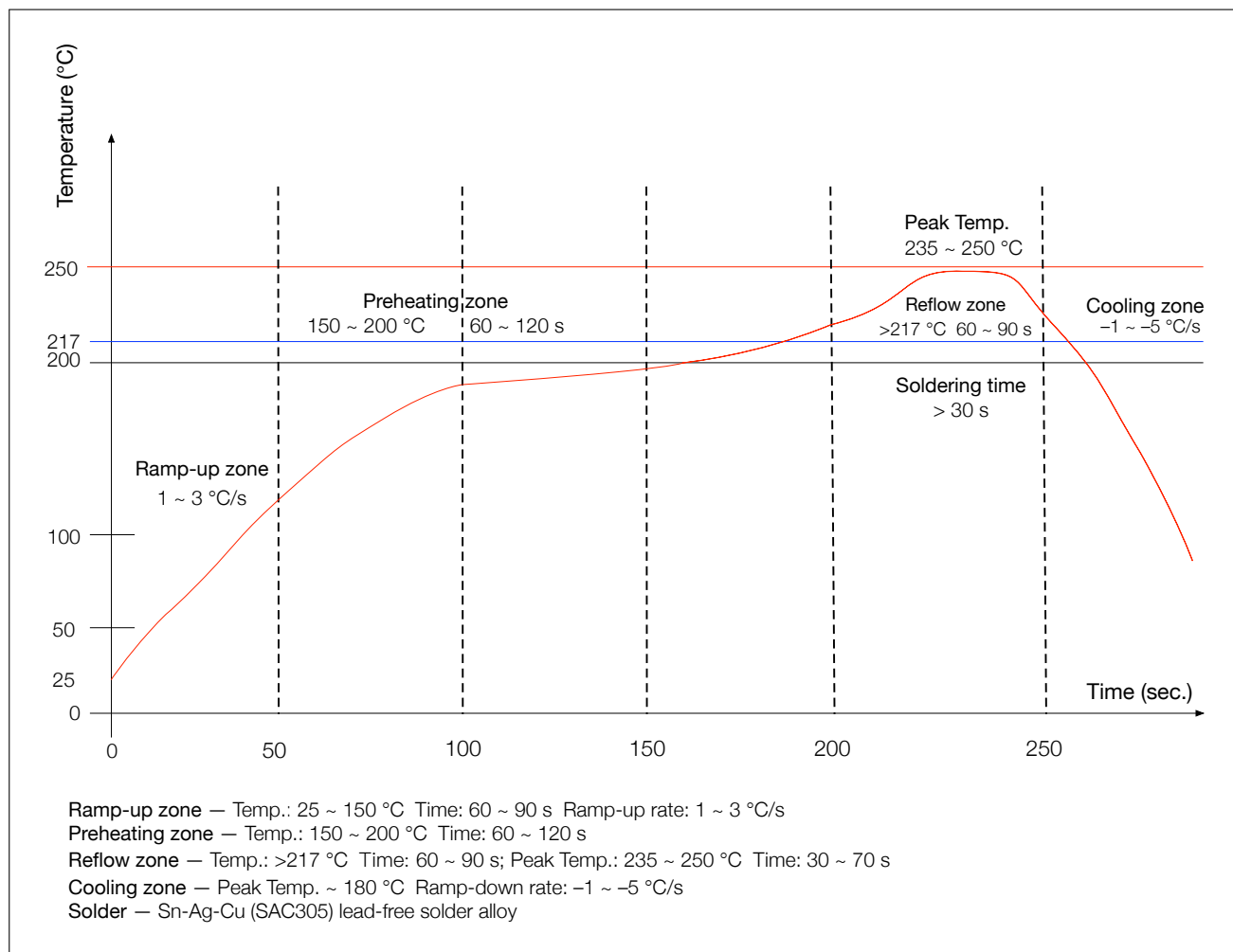


Figure 2: Reflow Profile

Note:

Solder the module in a single reflow.

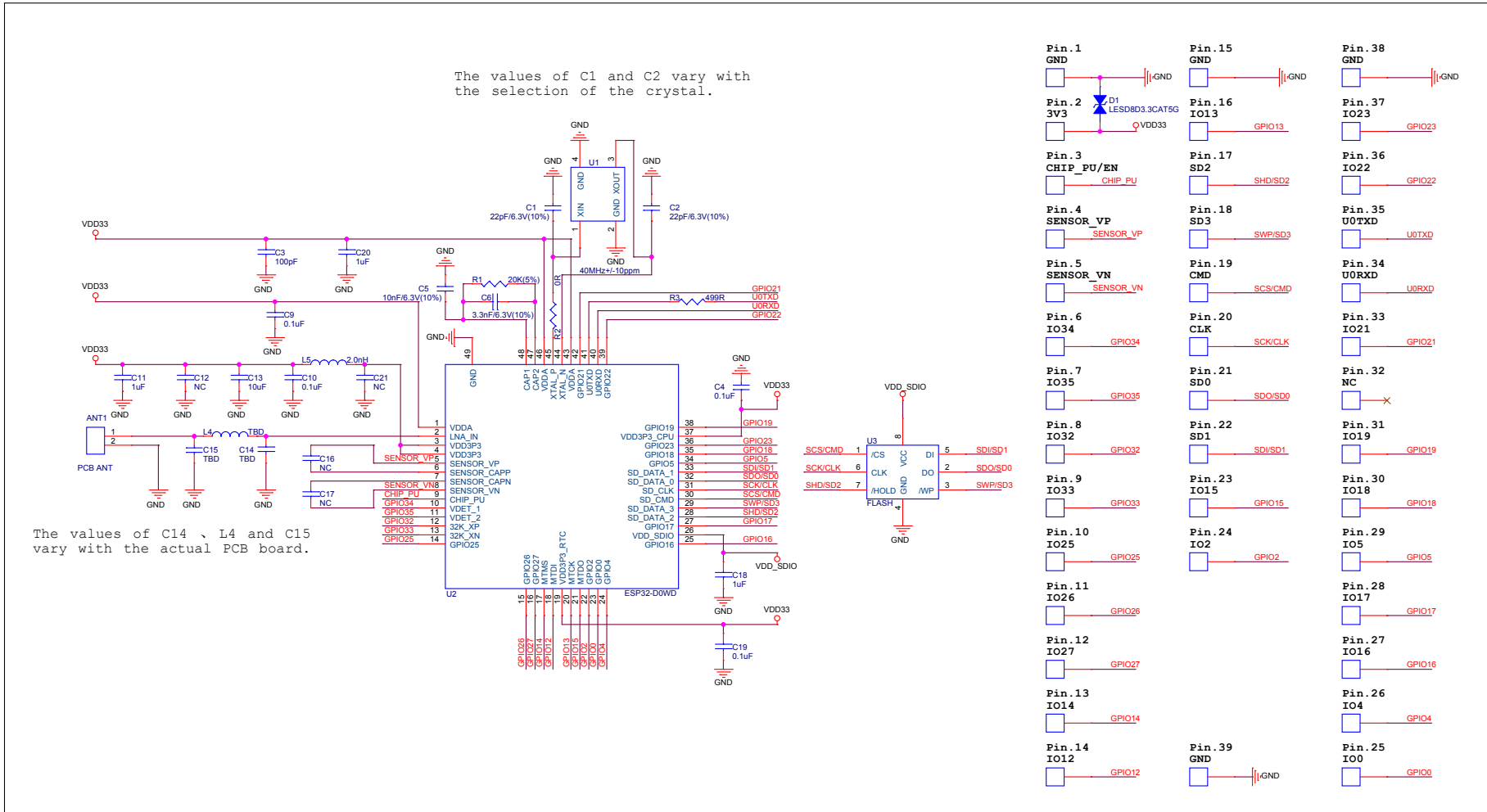


Figure 3: ESP32-WROOM-32D Schematics

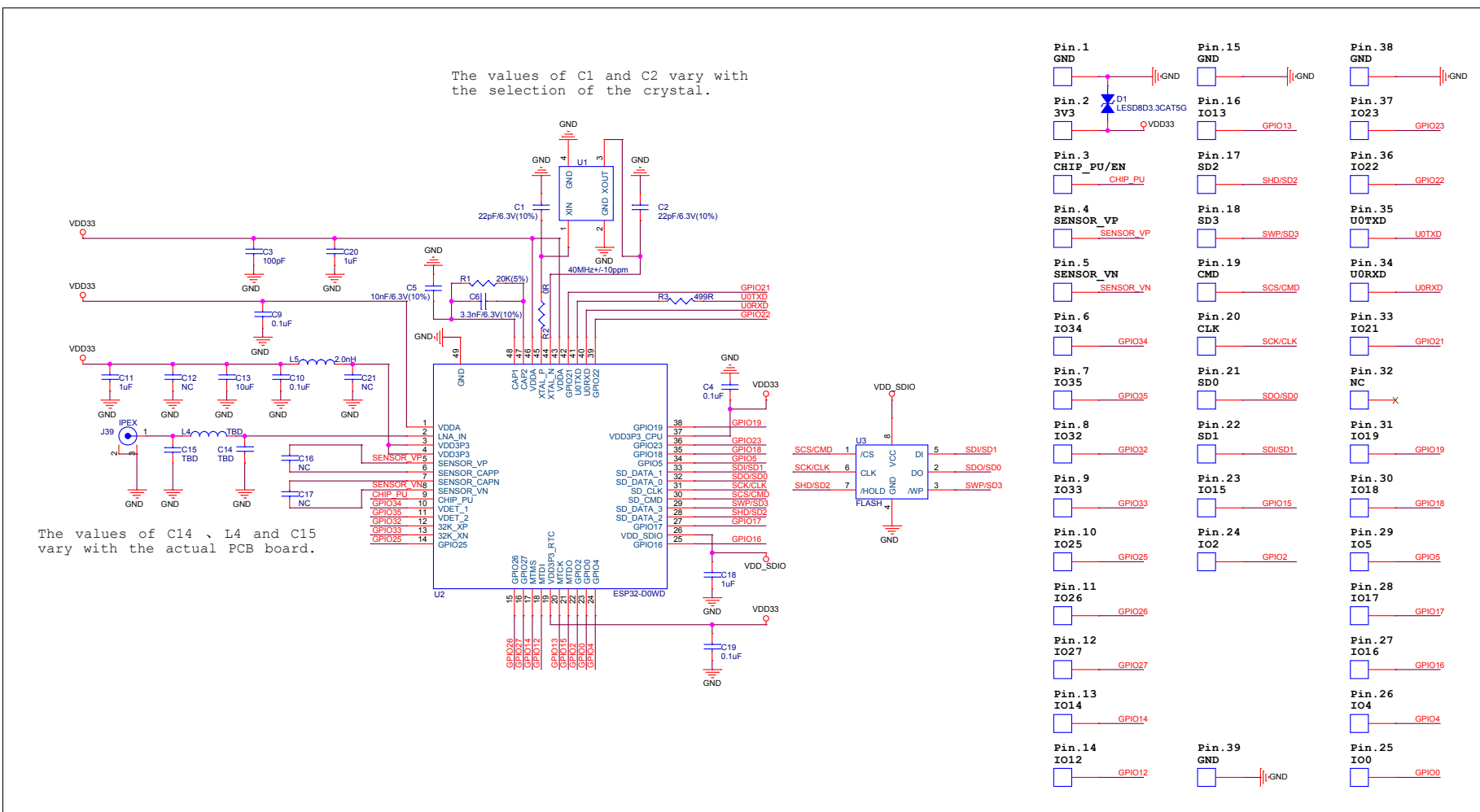


Figure 4: ESP32-WROOM-32U Schematics

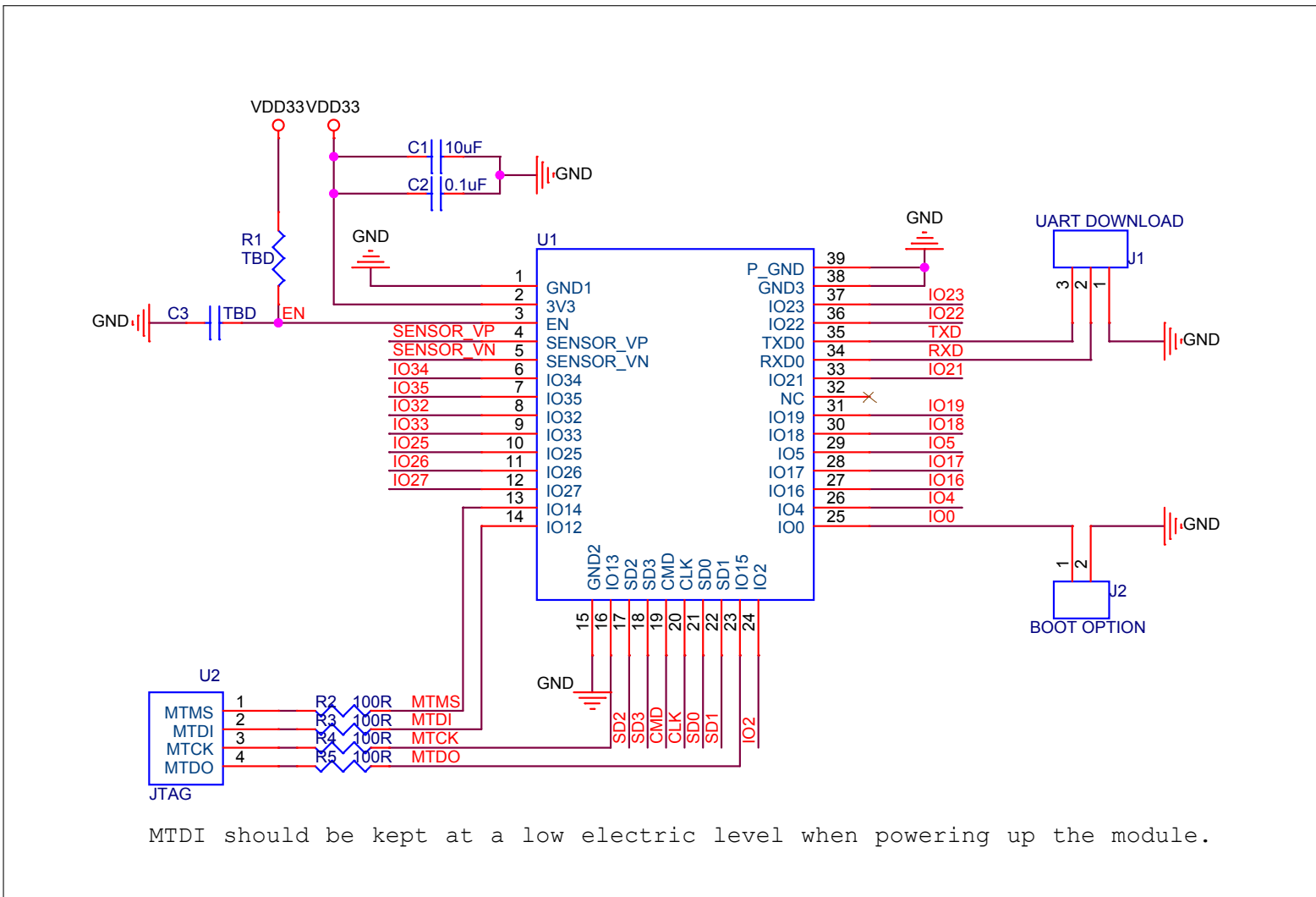


Figure 5: ESP32-WROOM-32D & ESP32-WROOM-32U Peripheral Schematics

Note:

- Soldering Pad 39 to the Ground is not necessary for a satisfactory thermal performance. If users do want to solder it, they need to ensure that the correct quantity of soldering paste is applied.
- To ensure the power supply to the ESP32 chip 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 $C = 1\text{ }\mu\text{F}$. 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 ESP32's power-up and reset sequence timing diagram, please refer to Section *Power Scheme* in [ESP32 Datasheet](#).



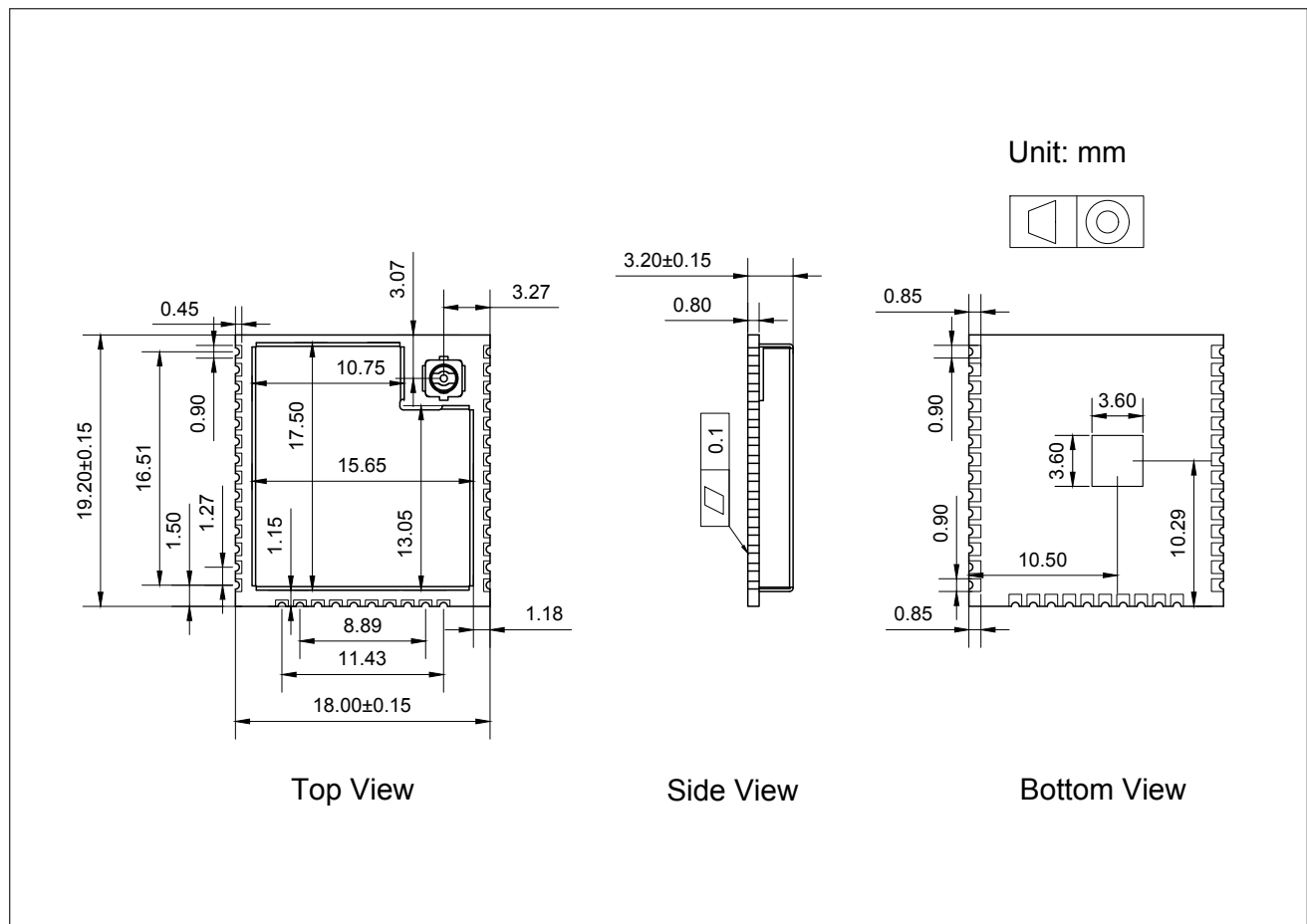


Figure 7: Physical Dimensions of ESP32-WROOM-32U

Note:

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

9 Recommended PCB Land Pattern

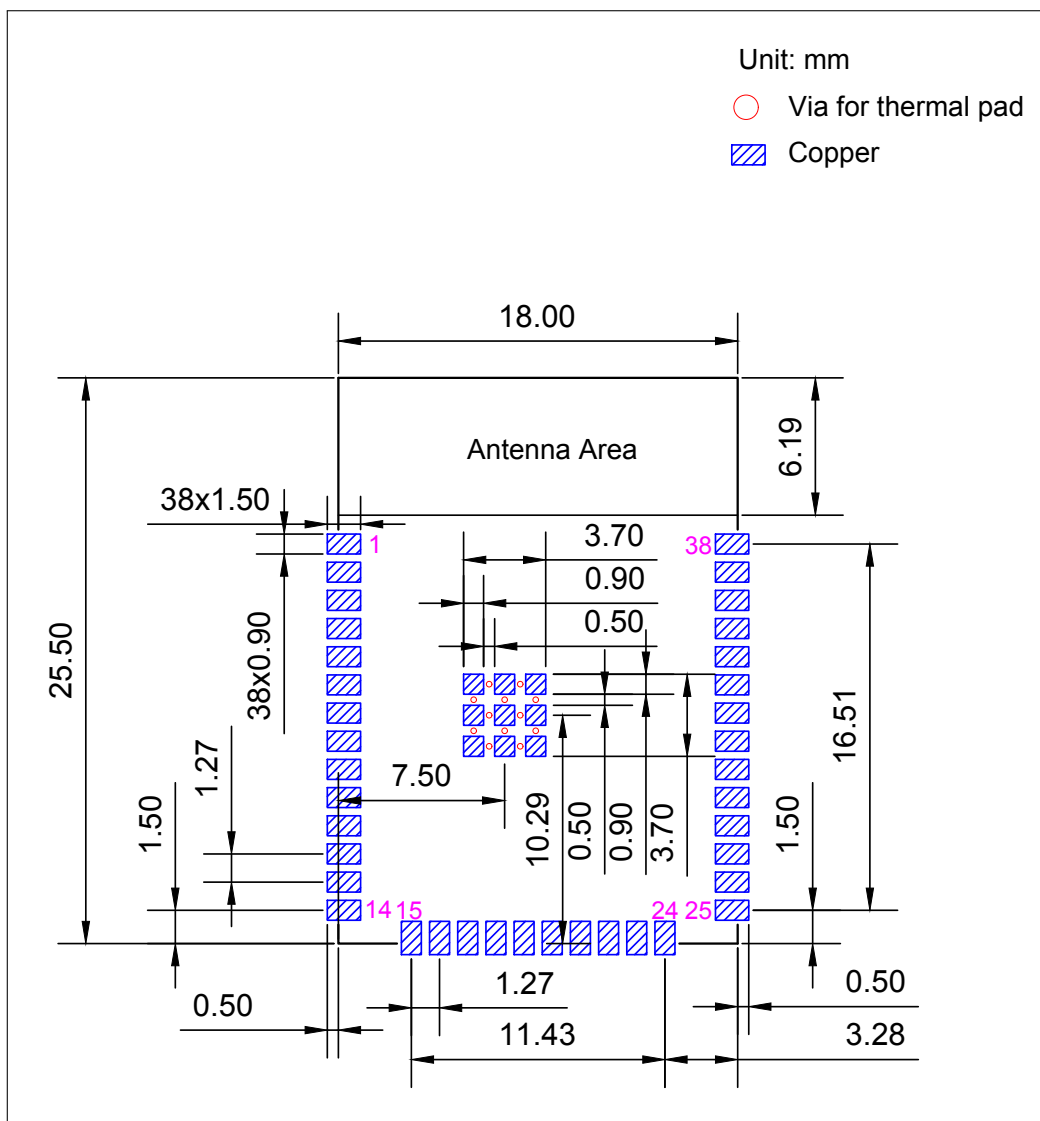


Figure 8: Recommended PCB Land Pattern of ESP32-WROOM-32D



10 Dimensions of External Antenna Connector

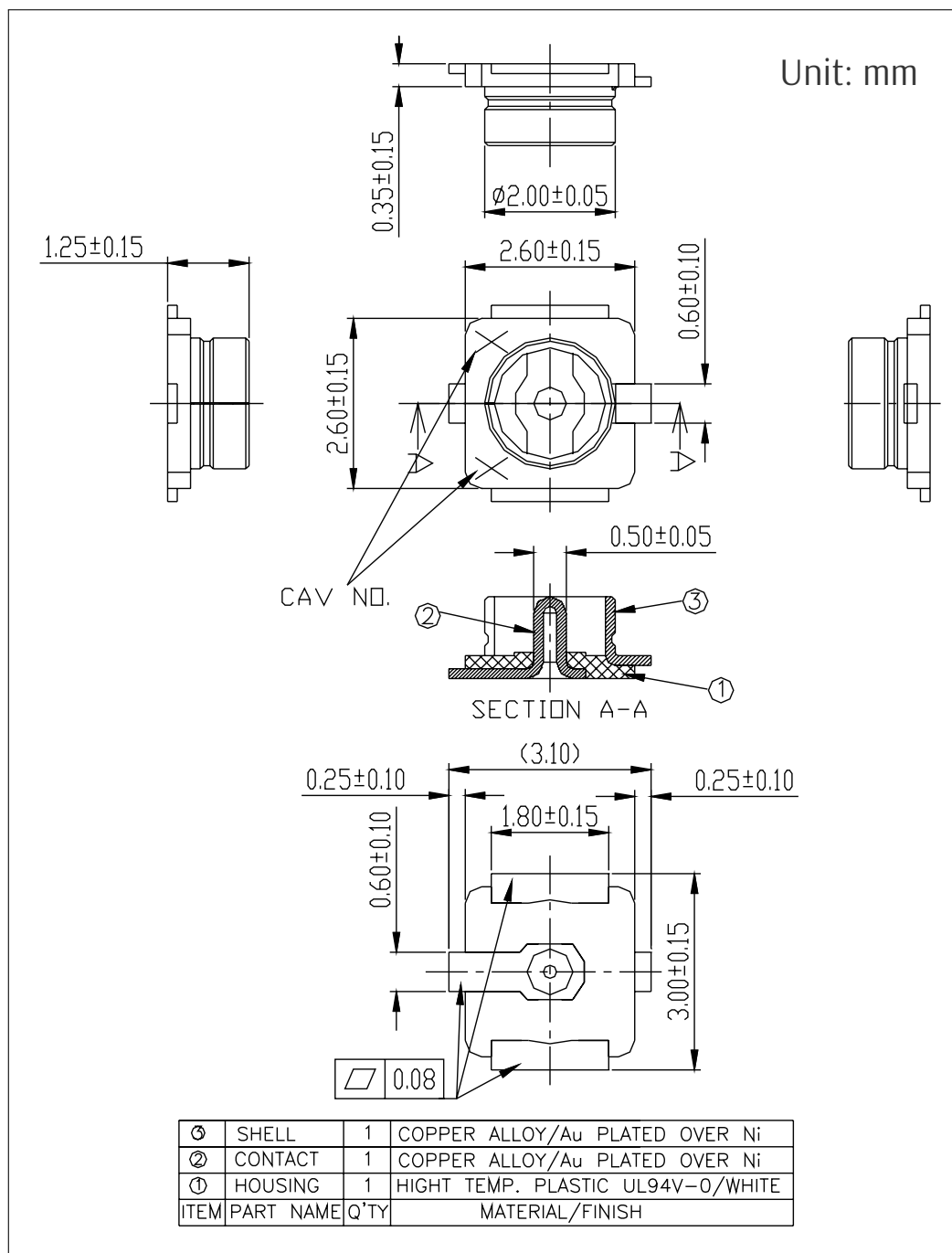


Figure 10: Dimensions of External Antenna Connector of ESP32-WROOM-32U

11 U.S. FCC Statement

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01:

1. List of applicable FCC rules

FCC Part 15 Subpart C 15.247 & 15.209

2. Specific operational use conditions

The module is a module with WiFi and BR,EDR,BLE function.

- Operation Frequency: WiFi: 2412 ~ 2462 MHz; BT: 2402 ~ 2480 MHz
- Number of Channel: WiFi: 12; BT: 40
- Modulation: WiFi: DSSS/OFDM; BT: GFSK/ π /4-DQPSK/8-DPSK
- Type: External Antenna
- Gain: 2.33 dBi Max.

The module can be used for IoT applications with a maximum 3.96 dBi antenna. The host manufacturer installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation. The host manufacturer 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 shown in this manual.

3. Limited module procedures

Not applicable. The module is a single module and complies with the requirement of FCC Part 15.212.

4. Trace antenna designs

Not applicable. The module has its own antenna, and does not need a host's printed board microstrip trace antenna, etc.

5. RF exposure considerations

The module must be installed in the host equipment such that at least 20cm is maintained between the antenna and users' body; and if RF exposure statement or module layout is changed, then the host product manufacturer required to take responsibility of the module through a change in FCC ID or new application. The FCC ID of the module cannot be used on the final product. In these circumstances, the host manufacturer will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

6. Antennas

Antenna Specification are as follows:

- Type: External Antenna
- Gain: 2.33 dBi

This device is intended only for host manufacturers under the following conditions:

- The transmitter module may not be co-located with any other transmitter or antenna.
- The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.
- The antenna must be either permanently attached or employ a 'unique' antenna coupler.

[Not Recommended For New Designs \(NRND\)](#)

As long as the conditions above are met, further transmitter test will not be required. However, the host manufacturer is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

7. Label and compliance information

Host product manufacturers need to provide a physical or e-label stating “Contains FCC ID: 2AC7Z ESP32WROOM32U” with their finished product.

8. Information on test modes and additional testing requirements

- Operation Frequency: WiFi: 2412 ~ 2462 MHz; BT: 2402 ~ 2480 MHz
- Number of Channel: WiFi: 12; BT: 40
- Modulation: WiFi: DSSS/OFDM; BT: GFSK/ π /4-DQPSK/8-DPSK

Host manufacturer must perform test of radiated & conducted emission and spurious emission, etc., according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product. Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

9. Additional testing, Part 15 Subpart B compliant

The modular transmitter is only FCC authorized for FCC Part 15 Subpart C 15.247 & 15.209 and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuitry), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. 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 turning the equipment off and on, the user is encouraged to try to correct the interference by one 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.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- This device may not cause harmful interference.
- This device must accept any interference received, including interference that may cause undesired operation.

Caution:

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter. The antennas used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM Integration Instructions

This device is intended only for OEM integrators under the following conditions:

- The transmitter module may not be co-located with any other transmitter or antenna.
- The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as the conditions above are met, further transmitter test 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 (for example, digital device emissions, PC peripheral requirements, etc.).

Validity of Using the Module Certification

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module 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 Transmitter Module FCC ID: 2AC7Z ESP32WROOM32U".

12 Related Documentation and Resources

Related Documentation

- [ESP32 Series Datasheet](#) – Specifications of the ESP32 hardware.
- [ESP32 Technical Reference Manual](#) – Detailed information on how to use the ESP32 memory and peripherals.
- [ESP32 Hardware Design Guidelines](#) – Guidelines on how to integrate the ESP32 into your hardware product.
- [ESP32 ECO and Workarounds for Bugs](#) – Correction of ESP32 design errors.
- *Certificates*
<https://espressif.com/en/support/documents/certificates>
- *ESP32 Product/Process Change Notifications (PCN)*
<https://espressif.com/en/support/documents/pcns>
- *ESP32 Advisories* – Information on security, bugs, compatibility, component reliability.
<https://espressif.com/en/support/documents/advisories>
- *Documentation Updates and Update Notification Subscription*
<https://espressif.com/en/support/download/documents>

Developer Zone

- [ESP-IDF Programming Guide for ESP32](#) – 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

- *ESP32 Series SoCs* – Browse through all ESP32 SoCs.
<https://espressif.com/en/products/socs?id=ESP32>
- *ESP32 Series Modules* – Browse through all ESP32-based modules.
<https://espressif.com/en/products/modules?id=ESP32>
- *ESP32 Series DevKits* – Browse through all ESP32-based devkits.
<https://espressif.com/en/products/devkits?id=ESP32>
- *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>

Contact Us

- See the tabs *Sales Questions*, *Technical Enquiries*, *Circuit Schematic & PCB Design Review*, *Get Samples* (Online stores), *Become Our Supplier*, *Comments & Suggestions*.
<https://espressif.com/en/contact-us/sales-questions>

Revision History

Date	Version	Release notes
2022.03	v2.3	Updated Table 1 Added a link to RF certificates in Table 2 Updated Table 5 Added a note below Figure 7 Updated the description to the connector Added Section 12: <i>Related Documentation and Resources</i>
2021.08	v2.2	Replaced Espressif Product Ordering Information with ESP Product Selector Updated the description of TWAI in Table 1 Labeled this document as (Not Recommended For New Designs)
2021.02	V2.1	Updated Figure 6: <i>Physical Dimensions of ESP32-WROOM-32D</i>, Figure 7: <i>Physical Dimensions of ESP32-WROOM-32U</i>, Figure 8: <i>Recommended PCB Land Pattern of ESP32-WROOM-32D</i>, and Figure 9: <i>Recommended PCB Land Pattern of ESP32-WROOM-32U</i>. Modified the note below Figure 2: <i>Reflow Profile</i>. Modified the note below Figure 5: <i>ESP32-WROOM-32D & ESP32-WROOM-32U Peripheral Schematics</i>. Updated the trade mark from TWAI™ to TWAI®.
2020.11	V2.0	Added TWAI™ in Table 1; Added a note under Figure 2: Reflow Profile; Updated the C value in RC delay circuit from 0.1 μF to 1 μF; Provided feedback link.
2019.09	V1.9	- Changed the supply voltage range from 2.7 V ~ 3.6 V to 3.0 V ~ 3.6 V; - Added Moisture sensitivity level (MSL) 3 in Table 2 <i>ESP32-WROOM-32D and ESP32-WROOM-32U Specifications</i>; - Added notes about "Operating frequency range" and "TX power" under Table 8 <i>Wi-Fi Radio Characteristics</i>; - Updated Section 7 <i>Peripheral Schematics</i> and added a note about RC delay circuit under it; - Updated Figure 8 and Figure 9 <i>Recommended PCB Land Pattern</i>.
2019.01	V1.8	Changed the RF power control range in Table 10 from -12 ~ +12 to -12 ~ +9 dBm.
2018.10	V1.7	Added notice on module custom options under Table 2; Added "Cumulative IO output current" entry to Table 5: Absolute Maximum Ratings; Added more parameters to Table 7: DC Characteristics.
2018.09	V1.6	Updated the hole diameter in the shield from 1.00 mm to 0.50 mm, in Figure 6.
2018.08	V1.5	- Added certifications and reliability test items the module has passed in Table 2: ESP32-WROOM-32D and ESP32-WROOM-32U Specifications, and removed software-specific information; - Updated section 3.4: RTC and Low-Power Management; - Changed the modules' dimensions; - Updated Figure 8 and 7: Physical Dimensions; - Updated Table 8: Wi-Fi Radio.

Date	Version	Release notes
2018.06	V1.4	- Deleted Temperature Sensor in Table 2: ESP32-WROOM-32D & ESP32-WROOM-32U Specifications; - Updated Chapter 3: Functional Description; - Added notes to Chapter 7: Peripheral Schematics; - Added Chapter 8: Recommended PCB Land Pattern; Changes to electrical characteristics: - Updated Table 5: Absolute Maximum Ratings; - Added Table 6: Recommended Operating Conditions; - Added Table 7: DC Characteristics; - Updated the values of "Gain control step", "Adjacent channel transmit power" in Table 10: Transmitter Characteristics - BLE.
2018.04	V1.3	Updated Figure 4 ESP32-WROOM-32U Schematics and Figure 3 ESP32-WROOM-32D Schematics.
2018.02	V1.2	Update Figure 4 ESP32-WROOM-32U Schematics.
2018.02	V1.1	Updated Chapter 6 Schematics. Deleted description of low-noise amplifier. Replaced the module name ESP-WROOM-32D with ESP32-WROOM-32D. Added information about module certification in Table 2. Updated the description of eFuse bits in Section 3.1.
2017.11	V1.0	First release.



Disclaimer and Copyright Notice

Information in this document, including URL references, is subject to change without notice.

ALL THIRD PARTY'S INFORMATION IN THIS DOCUMENT IS PROVIDED AS IS WITH NO WARRANTIES TO ITS AUTHENTICITY AND ACCURACY.

NO WARRANTY IS PROVIDED TO THIS DOCUMENT FOR ITS MERCHANTABILITY, NON-INFRINGEMENT, FITNESS FOR ANY PARTICULAR PURPOSE, NOR DOES ANY WARRANTY OTHERWISE ARISING OUT OF ANY PROPOSAL, SPECIFICATION OR SAMPLE.

All liability, including liability for infringement of any proprietary rights, relating to use of information in this document is disclaimed. No licenses express or implied, by estoppel or otherwise, to any intellectual property rights are granted herein.

The Wi-Fi Alliance Member logo is a trademark of the Wi-Fi Alliance. The Bluetooth logo is a registered trademark of Bluetooth SIG.

All trade names, trademarks and registered trademarks mentioned in this document are property of their respective owners, and are hereby acknowledged.

Copyright © 2023 Espressif Systems (Shanghai) Co., Ltd. All rights reserved.

[Not Recommended For New Designs \(NRND\)](#)