



THE DATASHEET OF ESP32-WROOM-32U-N4



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

Datasheet

NOT RECOMMENDED
FOR NEW DESIGNS
(NRND)



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Espressif Systems
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About This Document

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

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Revision History

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

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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.

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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 ~ 2484 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

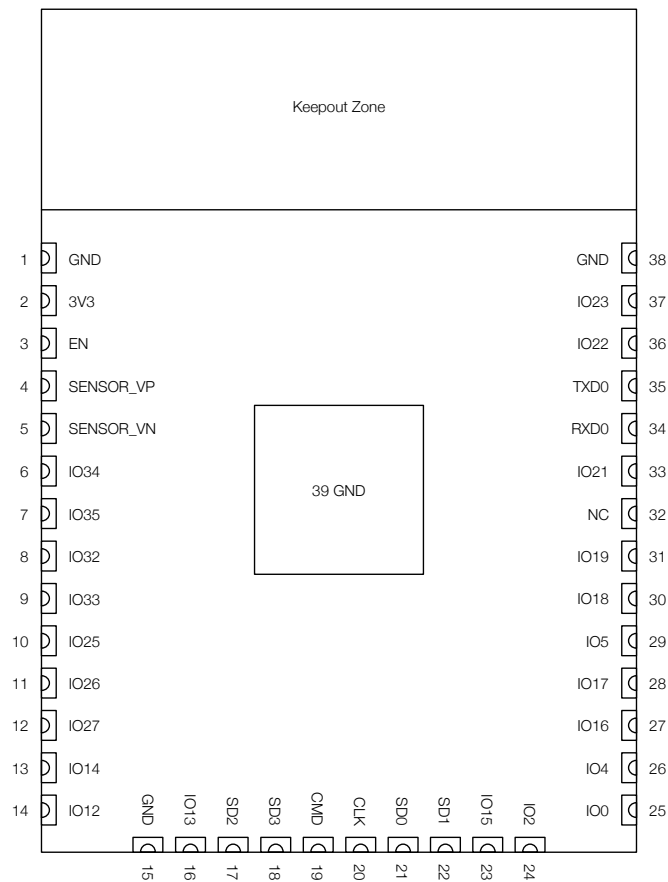


Figure 1: ESP32-WROOM-32D Pin Layout (Top View)

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 |

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| 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.

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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.

The illustration below shows the setup and hold times for the strapping pins before and after the CHIP_PU signal goes high. Details about the parameters are listed in Table 5.

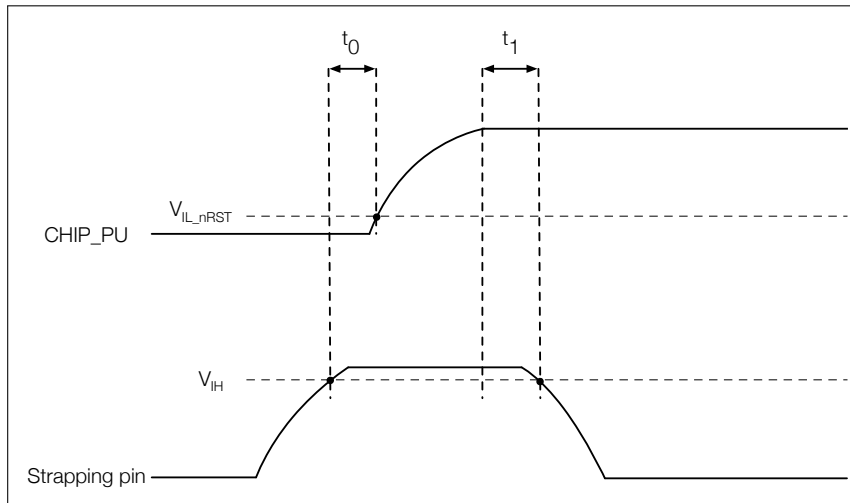


Figure 2: Setup and Hold Times for the Strapping Pins

Table 5: Parameter Descriptions of Setup and Hold Times for the Strapping Pins

| Parameters | Description | Min. | Unit |
|------------|---|------|------|
| t_0 | Setup time before CHIP_PU goes from low to high | 0 | ms |
| t_1 | Hold time after CHIP_PU goes high | 1 | ms |

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 6 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 6: 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 7: 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 8: 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 ($VDD^1 = 3.3$ V, $V_{OH} \geq 2.64$ 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 |

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| 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 | - | $k\Omega$ |
| R_{PD} | Resistance of internal pull-down resistor | - | 45 | - | $k\Omega$ |
| V_{IL_nRST} | Low-level input voltage of CHIP_PU to shut down 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 9: Wi-Fi Radio Characteristics

| Parameter | Condition | Min | Typical | Max | Unit |
|--|-----------------|------|---------------|------|----------|
| Center frequency range of operating channel <i>note1</i> | - | 2412 | - | 2484 | MHz |
| Output impedance <i>note2</i> | - | - | <i>note 2</i> | - | Ω |
| TX power <i>note3</i> | 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 10: 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 = F0 + 1 MHz | - | -5 | - | dB |
| | F = F0 - 1 MHz | - | -5 | - | dB |
| | F = F0 + 2 MHz | - | -25 | - | dB |
| | F = F0 - 2 MHz | - | -35 | - | dB |
| | F = F0 + 3 MHz | - | -25 | - | dB |
| | F = F0 - 3 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 |

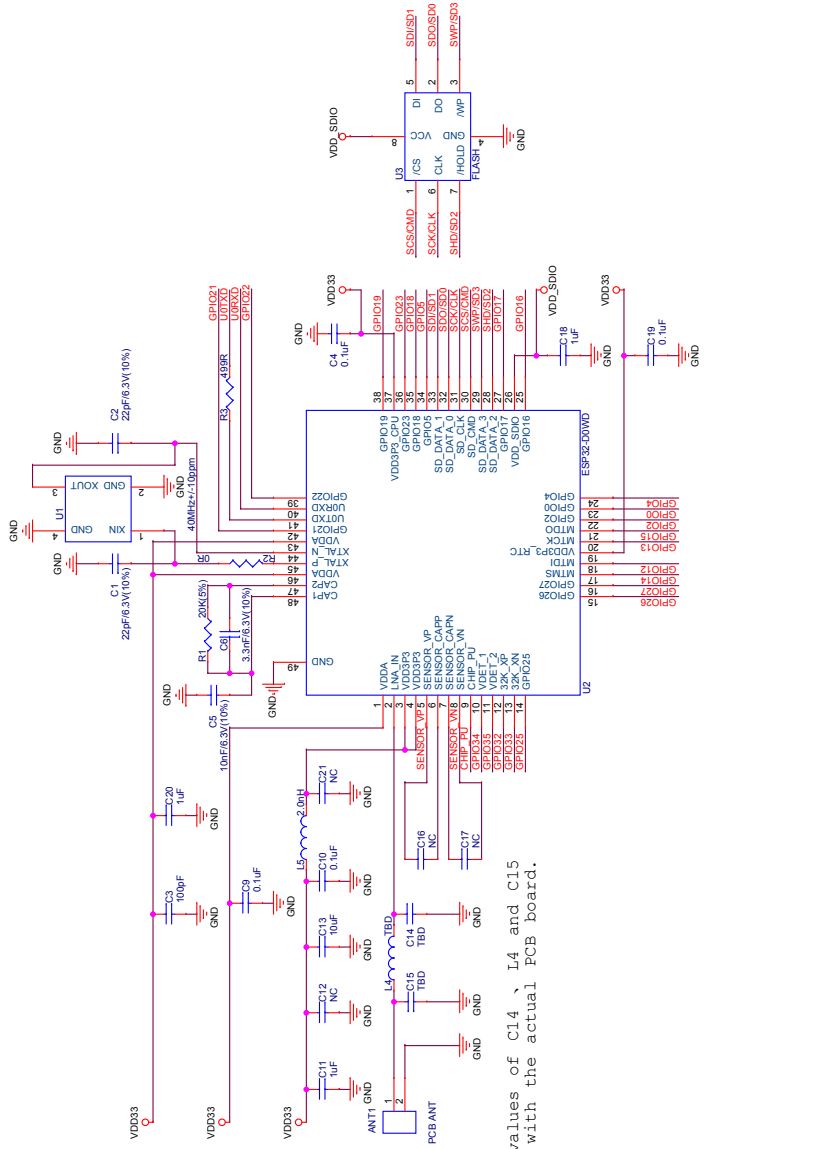
5.5.2 Transmitter

Table 11: 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 = F0 ± 2 MHz | - | -52 | - | dBm |
| | F = F0 ± 3 MHz | - | -58 | - | dBm |
| | F = F0 ± > 3 MHz | - | -60 | - | dBm |
| Δf_{1avg} | - | - | - | 265 | kHz |
| Δf_{2max} | - | 247 | - | - | kHz |
| $\Delta f_{2avg}/\Delta f_{1avg}$ | - | - | -0.92 | - | - |
| ICFT | - | - | -10 | - | kHz |
| Drift rate | - | - | 0.7 | - | kHz/50 μ s |
| Drift | - | - | 2 | - | kHz |

6 Schematics

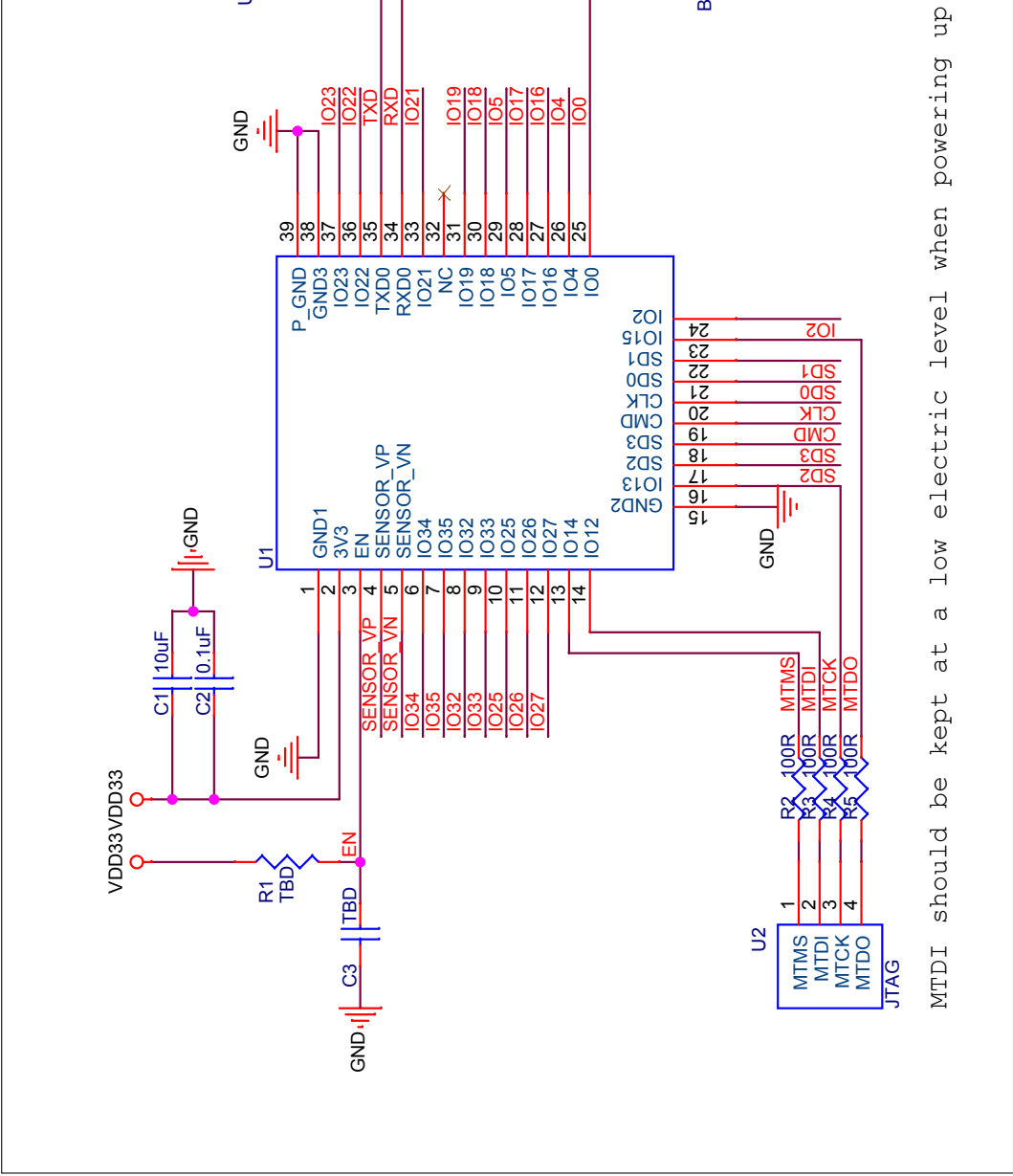
The values of C1 and C2 vary with the selection of the crystal.



The values of C14, L4 and C15 vary with the actual PCB board.

Figure 3: ESP32-WROOM-32D Schematics

7 Peripheral Schematics



MTDI should be kept at a low electric level when powering up

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 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 usually $R = 10\text{ k}\Omega$ and $C = 1\ \mu\text{F}$. However, specific parameters should be adjusted based on the power-up timing of the module of the chip. For ESP32's power-up and reset sequence timing diagram, please refer to Section *Power Scheme* in [ESP32 Datasheet](#)

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8 Physical Dimensions

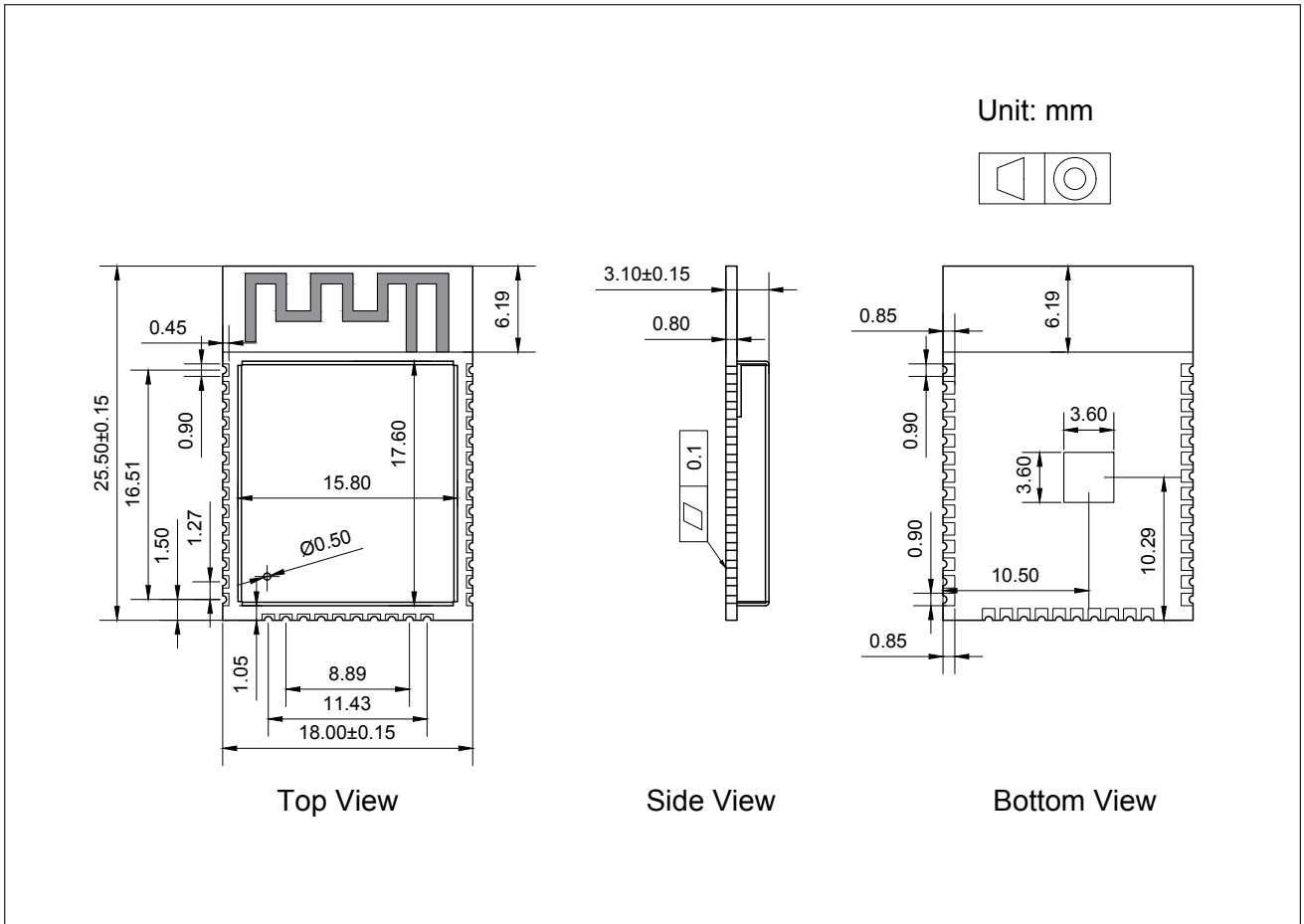


Figure 6: Physical Dimensions of ESP32-WROOM-32D

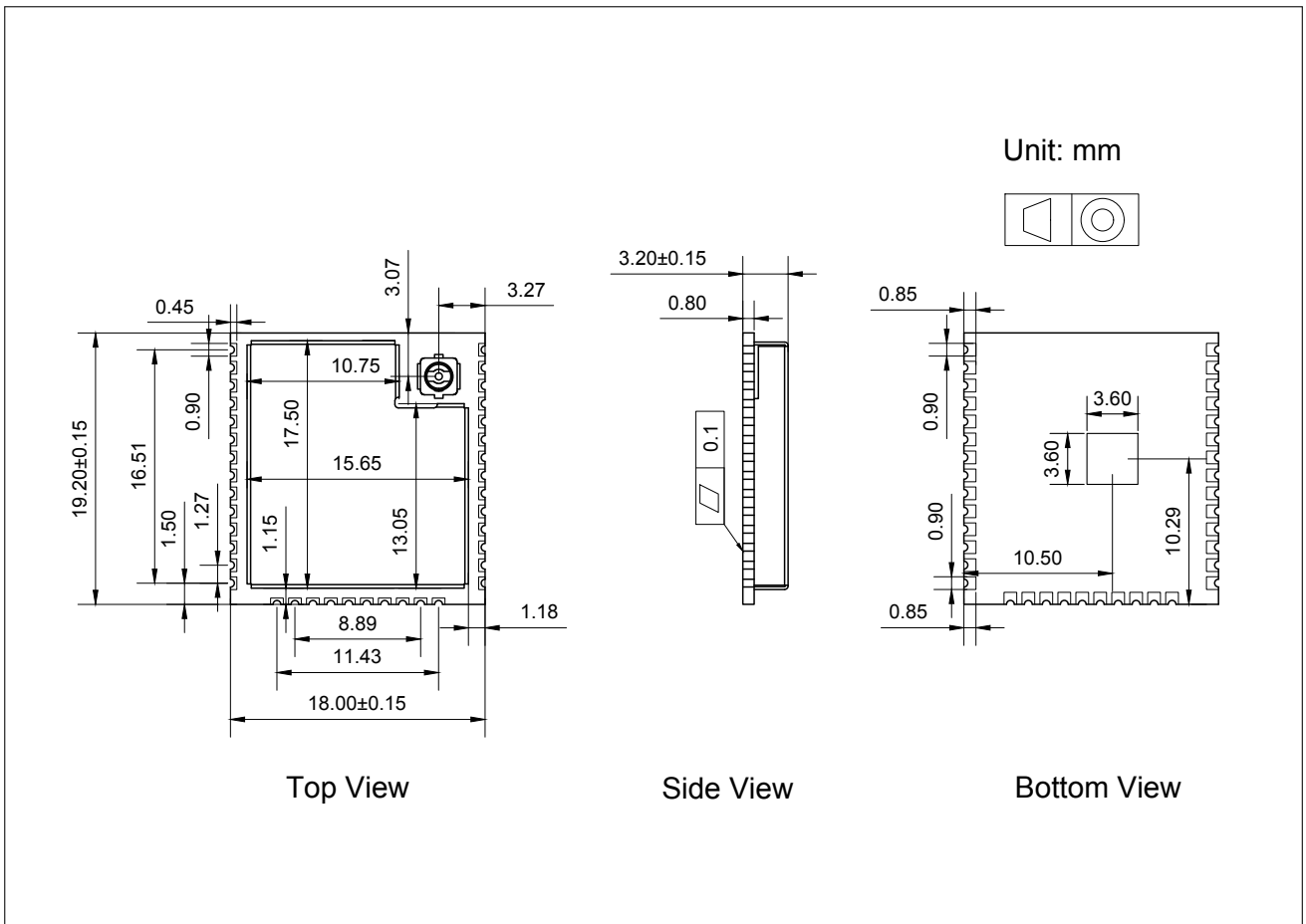


Figure 7: Physical Dimensions of ESP32-WROOM-32U

Note:

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

9 Recommended PCB Land Pattern

This section provides the following resources for your reference:

- Figures for recommended PCB land patterns with all the dimensions needed for PCB design. See Figure 8 *Recommended PCB Land Pattern of ESP32-WROOM-32D* and Figure 9 *Recommended PCB Land Pattern of ESP32-WROOM-32U*.
- Source files of recommended PCB land patterns to measure dimensions not covered in Figure 8 and Figure 9. You can view the source files for [ESP32-WROOM-32D](#) and [ESP32-WROOM-32U](#) with [Autodesk Viewer](#).
- 3D models of [ESP32-WROOM-32D](#). Please make sure that you download the 3D model file in .STEP format (beware that some browsers might add .txt).

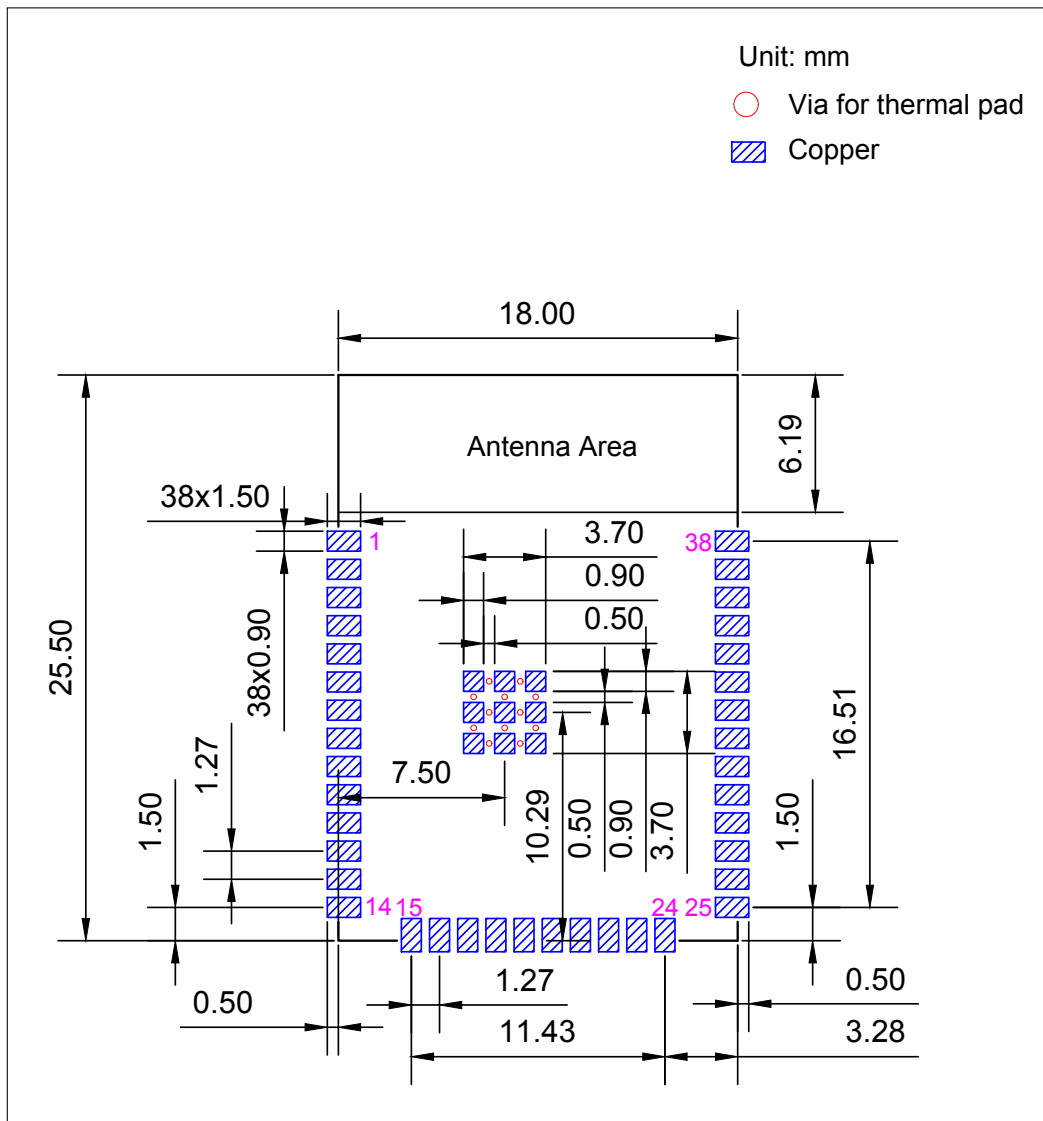


Figure 8: Recommended PCB Land Pattern of ESP32-WROOM-32D

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10 Dimensions of External Antenna Connector

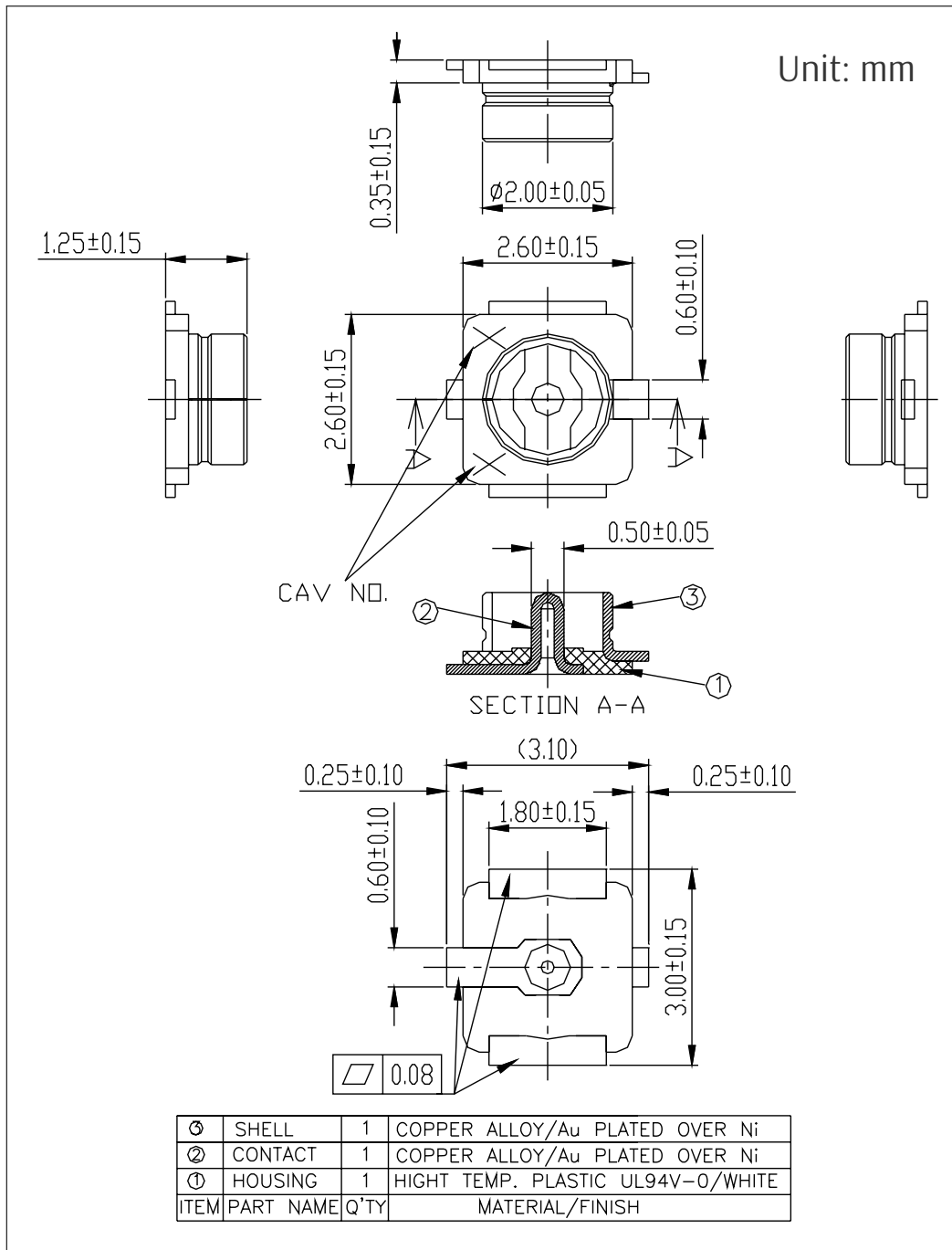


Figure 10: Dimensions of External Antenna Connector of ESP32-WROOM-32U

11 Product Handling

11.1 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.

11.2 Electrostatic Discharge (ESD)

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

11.3 Reflow Profile

Solder the module in a single reflow.

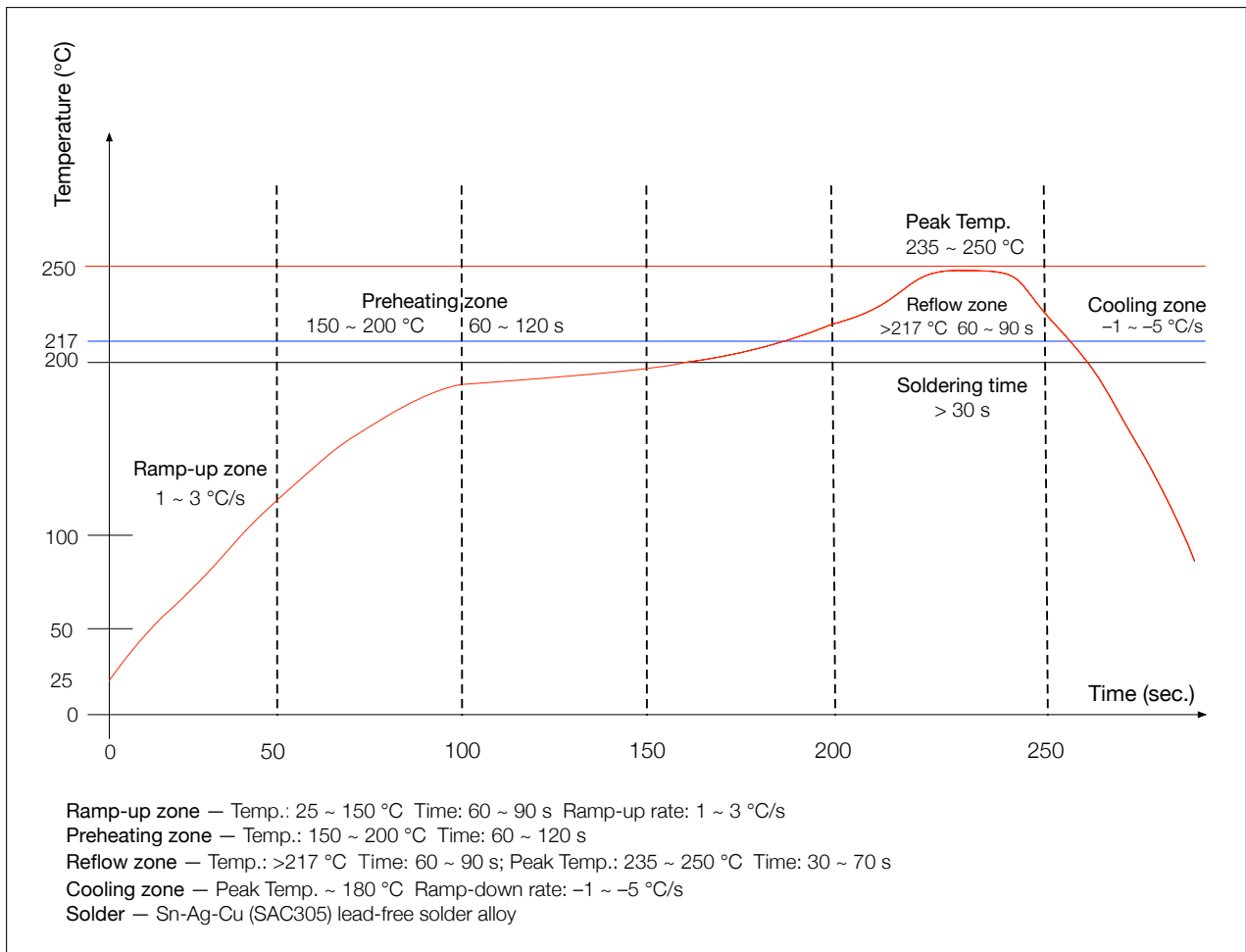


Figure 11: Reflow Profile

11.4 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.**

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>

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<https://espressif.com/en/contact-us/sales-questions>

Revision History

| Date | Version | Release notes |
|---------|---------|---|
| 2023.02 | v2.4 | Major updates: <ul style="list-style-type: none"> Removed contents about hall sensor according to PCN20221202 Added Section 11: <i>Product Handling</i> Other updates: <ul style="list-style-type: none"> Added strapping pin timing in Section 2.3: <i>Strapping Pins</i> Added source files of PCB land patterns and 3D models of the modules (if available) in Section 9: <i>Recommended PCB Land Pattern</i> |
| 2022.03 | v2.3 | Updated Table 1 Added a link to RF certificates in Table 2 Updated Table 6 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: Reflow Profile. 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: Reflow Profile; Updated the C value in RC delay circuit from 0.1 μF to 1 μF; Provided feedback link. |
| 2019.09 | V1.9 | <ul style="list-style-type: none"> 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 9 <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 11 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 6: Absolute Maximum Ratings; Added more parameters to Table 8: DC Characteristics. |
| 2018.09 | V1.6 | Updated the hole diameter in the shield from 1.00 mm to 0.50 mm, in Figure 6. |

| Date | Version | Release notes |
|---------|---------|---|
| 2018.08 | V1.5 | <ul style="list-style-type: none"> 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 9: Wi-Fi Radio. |
| 2018.06 | V1.4 | <ul style="list-style-type: none"> 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; <p>Changes to electrical characteristics:</p> <ul style="list-style-type: none"> Updated Table 6: Absolute Maximum Ratings; Added Table 7: Recommended Operating Conditions; Added Table 8: DC Characteristics; Updated the values of "Gain control step", "Adjacent channel transmit power" in Table 11: 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 | <p>Updated Chapter 6 Schematics.</p> <p>Deleted description of low-noise amplifier.</p> <p>Replaced the module name ESP-WROOM-32D with ESP32-WROOM-32D.</p> <p>Added information about module certification in Table 2.</p> <p>Updated the description of eFuse bits in Section 3.1.</p> |
| 2017.11 | V1.0 | First release. |



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