

# ESP32-WROVER-B/ESP32-WROVER-IB

## Datasheet

Version 1.0



Espressif Systems

## About This Guide

This document provides the specifications for the ESP32-WROVER-B/ESP32-WROVER-IB modules.

## Revision History

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

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# 1. Overview

ESP32-WROVER-B is a powerful, generic WiFi-BT-BLE MCU module that targets 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.

At the core of this module is the ESP32-D0WD chip\*. ESP32-WROVER-B has an additional SPI Pseudo static RAM (PSRAM) of 64 Mbits. As such, ESP32-WROVER-B features both 4 MB external SPI flash and 8 MB external PSRAM.

The ESP32-WROVER-B module has a PCB antenna, while the ESP32-WROVER-IB uses an IPEX antenna. For dimensions of the IPEX connector, please see Chapter 9. **The information in this datasheet is applicable to both of the two modules.**

**Table 1: ESP32-WROVER-B/ESP32-WROVER-IB**

| Module          | Chip embedded | Flash | PSRAM | Antenna      | Dimensions (mm)                 |
|-----------------|---------------|-------|-------|--------------|---------------------------------|
| ESP32-WROVER-B  | ESP32-D0WD    | 4 MB  | 8 MB  | PCB antenna  | (18±0.15)x(31.4±0.2)x(3.5±0.15) |
| ESP32-WROVER-IB | ESP32-D0WD    | 4 MB  | 8 MB  | IPEX antenna | (18±0.15)x(31.4±0.2)x(3.5±0.15) |

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 240 MHz. The user may also power off the CPU and make use of the low-power co-processor to constantly monitor the peripherals for changes or crossing of thresholds. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, SD card interface, Ethernet, high-speed SPI, UART, I2S and I2C.

**Note:**

\* For details on the part number of the ESP32 series, 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 future proof: 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  $\mu$ A, making it suitable for battery powered and wearable electronics applications. ESP32 supports a data rate of up to 150 Mbps, and 20.5 dBm output power at the antenna to ensure the widest physical range. As such the chip 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 developers can continually upgrade their products even after their release.

Table 2 provides the specifications of ESP32-WROVER-B/ESP32-WROVER-IB.

**Table 2: ESP32-WROVER-B/ESP32-WROVER-IB Specifications**

| Categories | Items                                     | Specifications   |
|------------|---|--|
| Wi-Fi      | Protocols                                 | 802.11 b/g/n20/n40   |
|            |   | A-MPDU and A-MSDU aggregation and 0.4 $\mu$ s guard interval support     |
|            | Frequency range                           | 2412-2462MHz(802.11b/g/n-HT20),2422-2452MHz(802.11n-HT40)                |
| Bluetooth  | Protocols                                 | Bluetooth v4.2 BR/EDR and BLE specification                              |
|            | Radio                                     | NZIF receiver with -97 dBm sensitivity                                   |
|            |   | Class-1, class-2 and class-3 transmitter                                 |
|            |   | AFH  |
|            | Audio                                     | CVSD and SBC   |
| Hardware   | Module interface                          | SD card, UART, SPI, SDIO, I2C, LED PWM, Motor PWM, I2S, IR               |
|            |   | GPIO, capacitive touch sensor, ADC, DAC                                  |
|            | On-chip sensor                            | Hall sensor  |
|            | On-board clock                            | 40 MHz crystal   |
|            | Operating voltage/Power supply            | 2.7 ~ 3.6V   |
|            | Operating current                         | Average: 80 mA   |
|            | Minimum current delivered by power supply | 500 mA   |
|            | Recommended operating temperature range   | -40°C ~ 85°C   |
|            | Package size                              | (18±0.15) mm x (31.4±0.2) mm x (3.5±0.15) mm                             |
| Software   | Wi-Fi mode                                | Station/SoftAP/SoftAP+Station/P2P  |
|            | Security                                  | WPA/WPA2/WPA2-Enterprise/WPS   |
|            | Encryption                                | AES/RSA/ECC/SHA  |
|            | Firmware upgrade                          | UART Download / OTA (via network) / download and write firmware via host |
|            | Software development                      | Supports Cloud Server Development / SDK for custom firmware development  |
|            | Network protocols                         | IPv4, IPv6, SSL, TCP/UDP/HTTP/FTP/MQTT                                   |
|            | User configuration                        | AT instruction set, cloud server, Android/iOS app                        |

## 2. Pin Definitions

### 2.1 Pin Layout

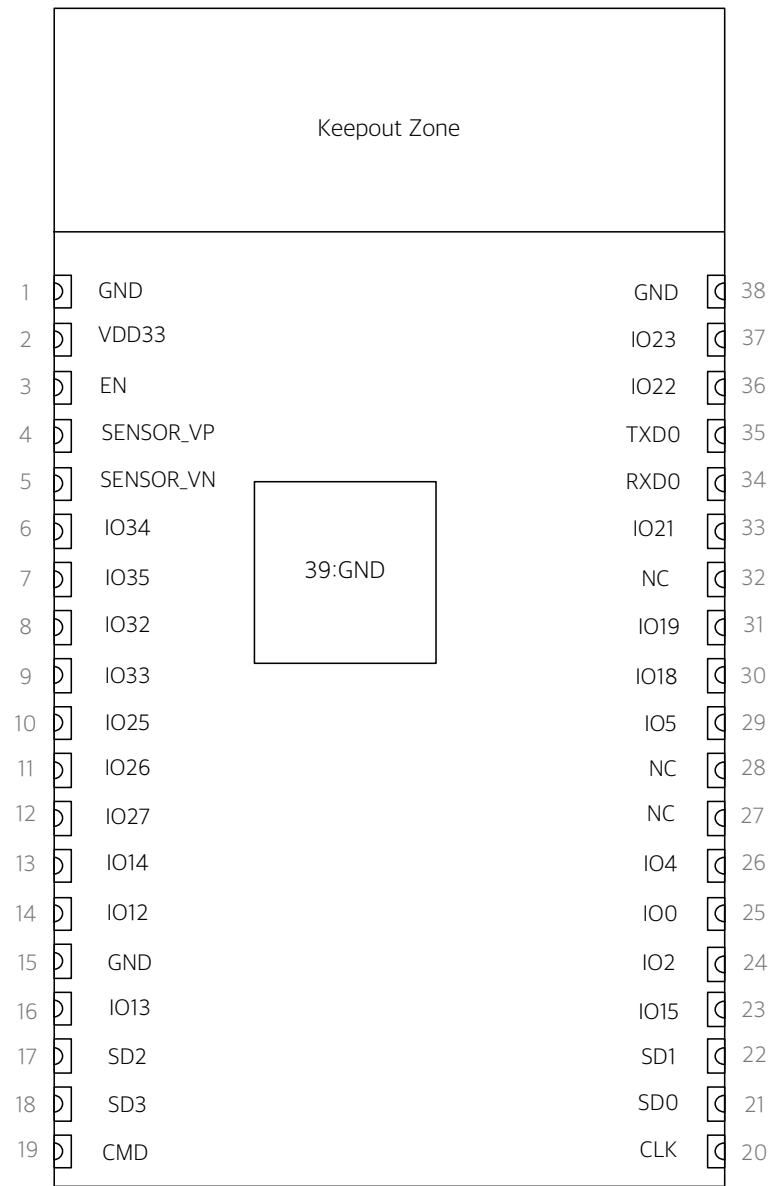


Figure 1: ESP32-WROVER-B/ESP32-WROVER-IB Pin Layout



## 2.2 Pin Description

ESP32-WROVER-B/ESP32-WROVER-IB has 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    | Chip-enable signal. Active high.   |
| SENSOR_VP | 4   | I    | GPIO36, ADC_H, ADC1_CH0, RTC_GPIO0   |
| SENSOR_VN | 5   | I    | GPIO39, ADC1_CH3, ADC_H, RTC_GPIO3   |
| IO34      | 6   | I    | GPIO34, ADC1_CH6, RTC_GPIO4  |
| IO35      | 7   | I    | GPIO35, ADC1_CH7, RTC_GPIO5  |
| 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, HSPWP, 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, HSPHD, HS2_DATA1, SD_DATA1, EMAC_TX_ER            |
| NC1       | 27  | -    | -  |
| NC2       | 28  | -    | -  |
| 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  |

| Name | No. | Type | Function                          |
|------|-----|------|-----------------------------------|
| 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                            |

## 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 (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, 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   | 3.3V           | 1.8V          |
| 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 Toggling | U0TXD Silent  |
| MTDO  | Pull-up   | 1              | 0             |

| Timing of SDIO Slave |         |   |  |  |   |
|----------------------|---------|---|--|--|---|
| Pin                  | Default | Falling-edge Input<br>Falling-edge Output | Falling-edge Input<br>Rising-edge Output | Rising-edge Input<br>Falling-edge Output | Rising-edge Input<br>Rising-edge 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.
- Internal pull-up resistor for MTDI is not populated in the module, as the flash and SRAM in ESP32-WROVER-B/ESP32-WROVER-IB only support a power voltage of 3.3V (output by VDD\_SDIO).

## 3. Functional Description

This chapter describes the modules and functions integrated in ESP32-WROVER-B/ESP32-WROVER-IB.

### 3.1 CPU and Internal Memory

ESP32-D0WD contains two low-power Xtensa® 32-bit LX6 microprocessors. 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.

- Up to 16 MB of 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. SRAM up to 8 MB is supported and up to 4 MB can be mapped at a time. 8-bit, 16-bit and 32-bit reads and writes are supported.

ESP32-WROVER-B/ESP32-WROVER-IB integrates 4 MB of external SPI flash. The 4-MB SPI flash can be memory-mapped onto the CPU code space, supporting 8, 16 and 32-bit access. Code execution is supported.

In addition to the 4 MB SPI flash, ESP32-WROVER-B/ESP32-WROVER-IB also integrates 8 MB PSRAM for more memory space.

### 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.

- Power modes
  - Active mode: The chip radio is powered on. The chip can receive, transmit, or listen.
  - Modem-sleep mode: The CPU is operational and the clock is configurable. The Wi-Fi/Bluetooth base-band and radio are disabled.
  - Light-sleep mode: The CPU is paused. The RTC memory and RTC peripherals, as well as the ULP co-processor are running. Any wake-up events (MAC, host, RTC timer, or external interrupts) will wake up the chip.
  - Deep-sleep mode: Only RTC memory and RTC peripherals are powered on. Wi-Fi and Bluetooth connection data are stored in the RTC memory. The ULP co-processor is functional.
  - Hibernation mode: The internal 8-MHz oscillator and ULP co-processor are disabled. The RTC recovery memory is powered down. Only one RTC timer on the slow clock and certain RTC GPIOs are active. The RTC timer or the RTC GPIOs can wake up the chip from the Hibernation mode.

The power consumption varies with different power modes and work statuses of functional modules. Please see Table 5 for details.

**Table 5: Power Consumption by Power Modes**

| Power mode          | Description  | Power consumption                                 |
|---------------------|--|---|
| Active (RF working) | Wi-Fi Tx packet                                      | Please refer to <a href="#">ESP32 Datasheet</a> . |
|                     | Wi-Fi / BT Tx packet                                 |   |
|                     | Wi-Fi / BT Rx and listening                          |   |
| Modem-sleep         | The CPU is powered on.                               | Max speed 240 MHz: 30 mA ~ 50 mA                  |
|                     |  | Normal speed 80 MHz: 20 mA ~ 25 mA                |
|                     |  | Slow speed 2 MHz: 2 mA ~ 4 mA                     |
| Light-sleep         | -  | 0.8 mA  |
| Deep-sleep          | The ULP co-processor is powered on.                  | 150 $\mu$ A                                       |
|                     | ULP sensor-monitored pattern                         | 100 $\mu$ A @1% duty                              |
|                     | RTC timer + RTC memory                               | 10 $\mu$ A  |
| Hibernation         | RTC timer only                                       | 5 $\mu$ A   |
| Power off           | CHIP_PU is set to low level, the chip is powered off | 0.1 $\mu$ A                                       |

**Note:**

- When Wi-Fi is enabled, the chip switches between Active and Modem-sleep mode. Therefore, power consumption changes accordingly.
- In Modem-sleep mode, the CPU frequency changes automatically. The frequency depends on the CPU load and the peripherals used.
- During Deep-sleep, when the ULP co-processor is powered on, peripherals such as GPIO and I2C are able to operate.
- When the system works in the ULP sensor-monitored pattern, the ULP co-processor works with the ULP sensor periodically; ADC works with a duty cycle of 1%, so the power consumption is 100  $\mu$ A.

## 4. Peripherals and Sensors

Please refer to Section 4 Peripherals and Sensors in [ESP32 Datasheet](#).

**Note:**

External connections can be made to any GPIO except for GPIOs in the range 6-11, 16, or 17. GPIOs 6-11 are connected to the module's integrated SPI flash and PSRAM. GPIOs 16 and 17 are connected to the module's integrated PSRAM. For details, please see Section 6 Schematics.

## 5. Electrical Characteristics

### 5.1 Absolute Maximum Ratings

Stresses beyond the absolute maximum ratings listed in the table below may cause permanent damage to the device. These are stress ratings only, and do not refer to the functional operation of the device.

**Table 6: Absolute Maximum Ratings**

| Symbol             | Parameter           | Min  | Max | Unit |
|--------------------|---------------------|------|-----|------|
| VDD33              | -                   | -0.3 | 3.6 | V    |
| T <sub>store</sub> | Storage temperature | -40  | 150 | °C   |

### 5.2 Recommended Operating Conditions

**Table 7: Recommended Operating Conditions**

| Symbol           | Parameter                                  | Min | Typical | Max | Unit |
|------------------|--|-----|---------|-----|------|
| VDD33            | -  | 2.7 | 3.3     | 3.6 | V    |
| I <sub>VDD</sub> | Current delivered by external power supply | 0.5 | -       | -   | A    |
| T                | Operating temperature                      | -40 | -       | 85  | °C   |

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

**Table 8: DC Characteristics**

| 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 + 0.3  | V    |
| V <sub>IL</sub>      | Low-level input voltage   | -0.3                    | -   | 0.25 × VDD | 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>      | High-level output voltage   | 0.8 × VDD               | -   | -          | V    |
| V <sub>OL</sub>      | Low-level output voltage  | -                       | -   | 0.1 × VDD  | V    |
| I <sub>OH</sub>      | High-level source current (VDD = 3.3V, V <sub>OH</sub> = 2.64V, PAD_DRIVER = 3) | -                       | 40  | -          | mA   |
| I <sub>OL</sub>      | Low-level sink current (VDD = 3.3V, V <sub>OH</sub> = 0.495V, PAD_DRIVER = 3)   | -                       | 28  | -          | mA   |
| R <sub>PU</sub>      | Pull-up resistor  | -                       | 45  | -          | k    |
| R <sub>PD</sub>      | Pull-down resistor  | -                       | 45  | -          | k    |
| V <sub>IL_nRST</sub> | Low-level input voltage of EN to reset the module                               | -                       | 0.6 | -          | V    |

1. VDD is the I/O voltage for a particular power domain of pins. More details can be found in Appendix IO\_MUX of [ESP32 Datasheet](#).

## 5.4 Wi-Fi Radio

Table 9: Wi-Fi Radio Characteristics

| Description                     | Min  | Typical | Max  | Unit     |
|---------------------------------|------|---------|------|----------|
| Input frequency                 | 2412 | -       | 2462 | MHz      |
| Output impedance*               | -    | *       | -    | $\Omega$ |
| Tx power                        |      |         |      |          |
| Output power of PA for 11b mode | 22   | 23      | 24   | dBm      |
| Sensitivity                     |      |         |      |          |
| DSSS, 1 Mbps                    | -    | -98     | -    | dBm      |
| CCK, 11 Mbps                    | -    | -91     | -    | dBm      |
| OFDM, 6 Mbps                    | -    | -93     | -    | dBm      |
| OFDM, 54 Mbps                   | -    | -75     | -    | dBm      |
| HT20, MCS0                      | -    | -93     | -    | dBm      |
| HT20, MCS7                      | -    | -73     | -    | dBm      |
| HT40, MCS0                      | -    | -90     | -    | dBm      |
| HT40, MCS7                      | -    | -70     | -    | dBm      |
| MCS32                           | -    | -89     | -    | dBm      |
| Adjacent channel rejection      |      |         |      |          |
| OFDM, 6 Mbps                    | -    | 37      | -    | dB       |
| OFDM, 54 Mbps                   | -    | 21      | -    | dB       |
| HT20, MCS0                      | -    | 37      | -    | dB       |
| HT20, MCS7                      | -    | 20      | -    | dB       |

\*For the module that uses an IPEX antenna, the output impedance is 50 $\Omega$ .

## 5.5 BLE Radio

### 5.5.1 Receiver

Table 10: Receiver Characteristics – BLE

| 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   |



| Parameter                        | Conditions          | Min | Typ | Max | Unit |
|----------------------------------|---------------------|-----|-----|-----|------|
| 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 – BLE**

| Parameter                                       | Conditions                    | Min | Typ         | Max | Unit                 |
|---|-------------------------------|-----|-------------|-----|----------------------|
| RF transmit power                               | -                             | -   | <b>1.59</b> | -   | dBm                  |
| Gain control step                               | -                             | -   | -           | -   | dBm                  |
| RF power control range                          | -                             | -1  | -           | +2  | 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 $\mu\text{s}$ |
| Drift   | -                             | -   | 2           | -   | kHz                  |

## 6 Dimensions

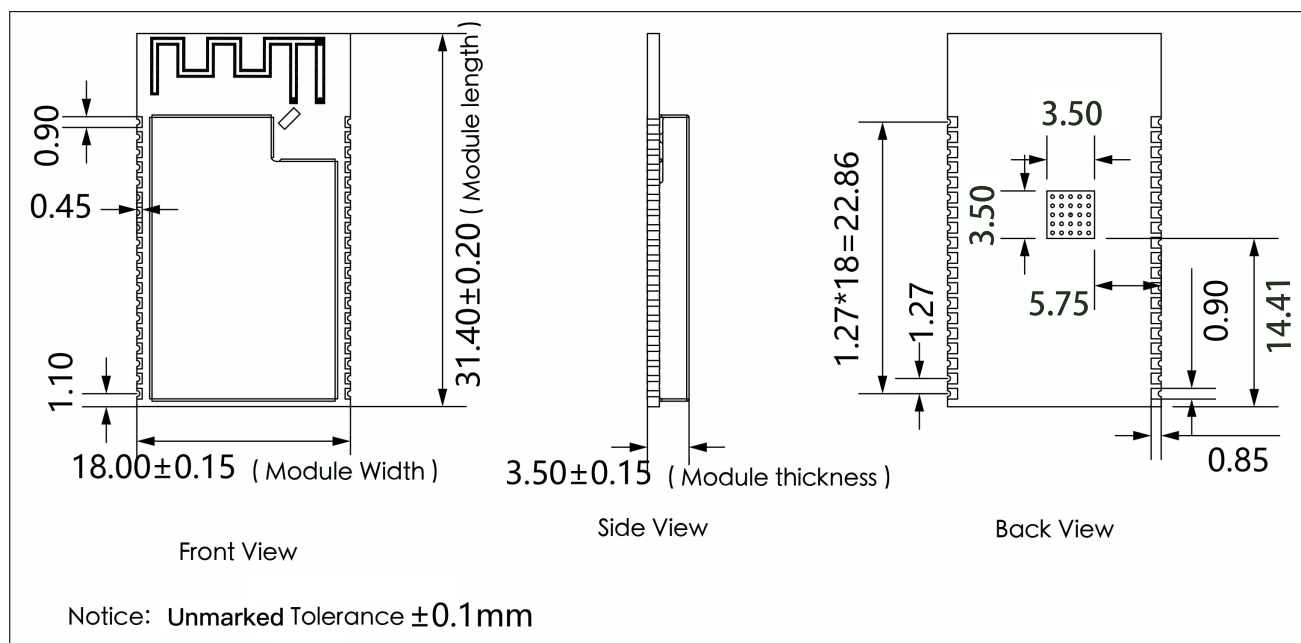


Figure 4: ESP32-WROVER-B Dimensions

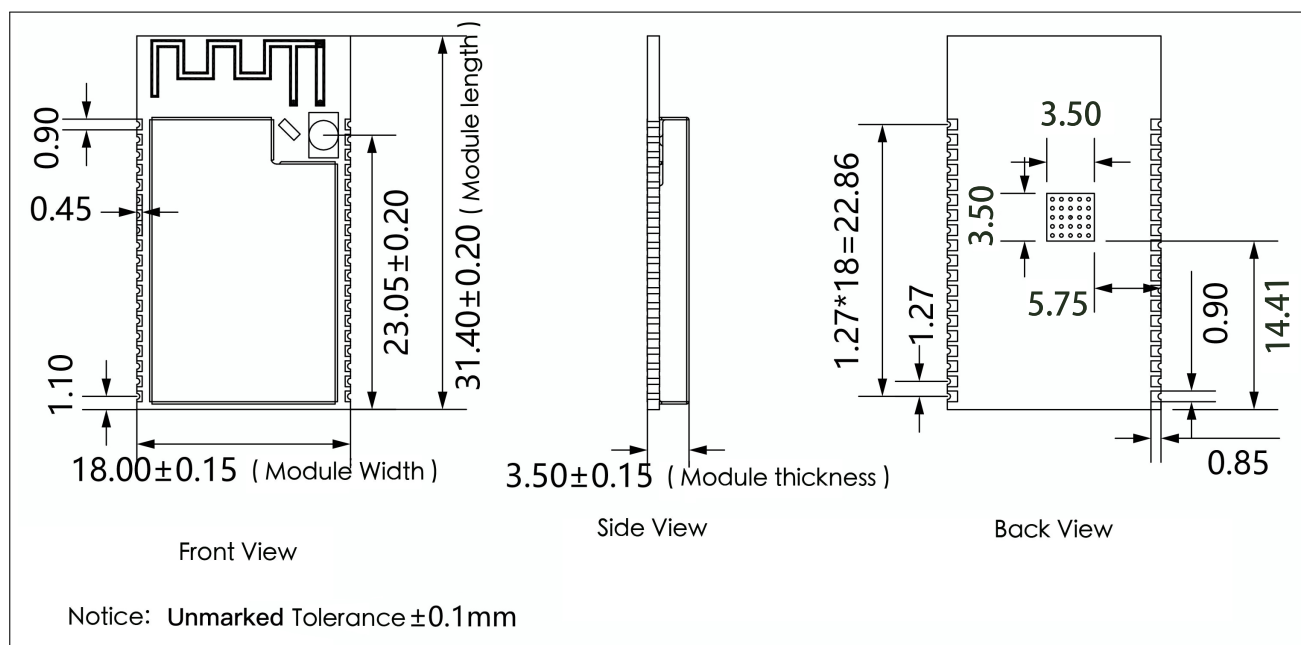


Figure 5: ESP32-WROVER-IB Dimensions

## 7. U.FL Connector Dimensions

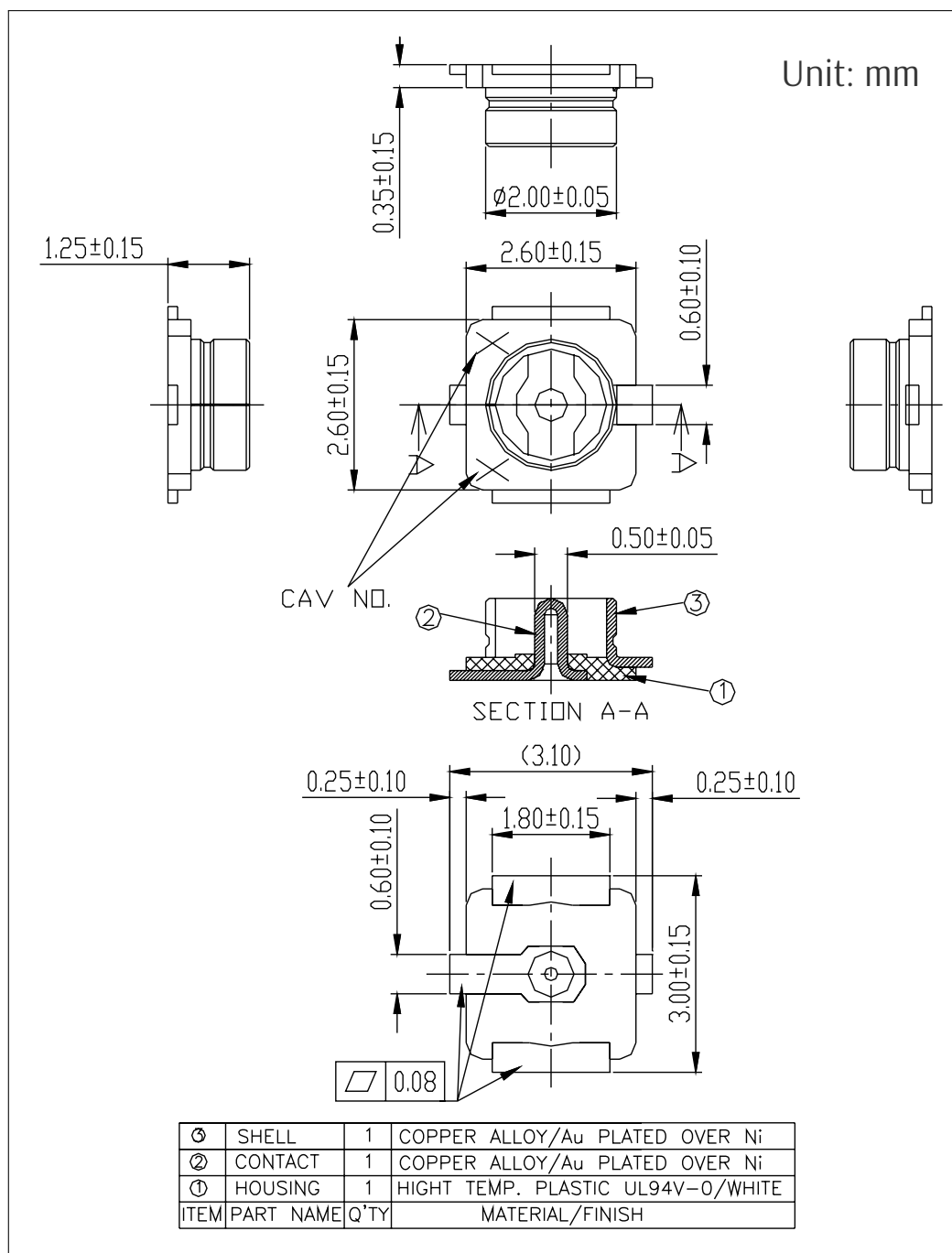


Figure 6: ESP32-WROVER-B/ESP32-WROVER-IB U.FL Connector Dimensions

## 8. Learning Resources

### 8.1 Must-Read Documents

The following link provides documents related to ESP32.

- [ESP32 Datasheet](#)  
This document provides an introduction to the specifications of the ESP32 hardware, including overview, pin definitions, functional description, peripheral interface, electrical characteristics, etc.
- [ESP-IDF Programming Guide](#)  
It hosts extensive documentation for ESP-IDF ranging from hardware guides to API reference.
- [ESP32 Technical Reference Manual](#)  
The manual provides detailed information on how to use the ESP32 memory and peripherals.
- [ESP32 Hardware Resources](#)  
The zip files include the schematics, PCB layout, Gerber and BOM list of ESP32 modules and development boards.
- [ESP32 Hardware Design Guidelines](#)  
The guidelines outline recommended design practices when developing standalone or add-on systems based on the ESP32 series of products, including ESP32, the ESP-WROOM-32 module, and ESP32-DevKitC—the development board.
- [ESP32 AT Instruction Set and Examples](#)  
This document introduces the ESP32 AT commands, explains how to use them, and provides examples of several common AT commands.
- [Espressif Products Ordering Information](#)

### 8.2 Must-Have Resources Here

are the ESP32-related must-have resources.

- [ESP32 BBS](#)  
This is an Engineer-to-Engineer (E2E) Community for ESP32 where you can post questions, share knowledge, explore ideas, and help solve problems with fellow engineers.
- [ESP32 GitHub](#)  
ESP32 development projects are freely distributed under Espressif's MIT license on GitHub. It is established to help developers get started with ESP32 and foster innovation and the growth of general knowledge about the hardware and software surrounding ESP32 devices.
- [ESP32 Tools](#)  
This is a webpage where users can download ESP32 Flash Download Tools and the zip file "ESP32 Certification and Test".
- [ESP-IDF](#)  
This webpage links users to the official IoT development framework for ESP32.
- [ESP32 Resources](#)  
This webpage provides the links to all available ESP32 documents, SDK and tools.

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[illegible]

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment .This equipment should be installed and operated with minimum distance 20cm between the radiator& your body.

**ISED RSS Warning:**

Le présent appareil est conforme aux CNR d'ISED applicables aux appareils radio exempts de licence.  
L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil ne doit pas produire de brouillage, et  
(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

**ISED RF exposure statement:**

This equipment complies with ISED radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Le rayonnement de la classe b respecte l'ISEC fixant un environnement non contrôlé. L'installation et la mise en œuvre de ce matériel doivent respecter une distance minimale entre 20 cm et le corps. Les lanceurs ou ne peuvent pas coexister cette antenne ou capteurs avec d'autres.

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FCC ID:2AC7Z-ESP32WROVERB,IC:21098-ESPWROVERB” Any similar wording that expresses the same meaning may be used.