**ESP32-xx family:**

**ESP32**

* Xtensa single-/dual-core 32-bit LX6 microprocessor(s)
* Supports single-precision Floating Point Unit (FPU)
* Wi-Fi: 802.11 b/g/n
* Bluetooth: v4.2 BR/EDR and BLE (shares the radio with Wi-Fi)
* 34 × programmable GPIOs
* 12-bit SAR ADC up to 18 channels
* 2 x 8-bit DAC

**ESP32-S2**

* Single-core Xtensa LX7 CPU, up to 240 MHz (With ULP Co-Processor Running at 20Mhz)
* NO Floating Point Unit (no FPU)
* 320 KiB SRAM, 128 KiB ROM, and 16 KiB RTC SRAM
* Wi-Fi 2.4 GHz (IEEE 802.11b/g/n)
* No Bluetooth
* 43 programmable GPIOs
* 2 × 13-bit SAR ADCs, up to 20 channels
* USB OTG

**ESP32-S3**

* Dual-core Xtensa LX7 CPU, up to 240 MHz, and supporting single-precision FPU
  + Added instructions to accelerate machine learning applications
* 512 KiB SRAM, 384 KiB ROM, and 16 KiB RTC SRAM
* Capable of connecting to external PSRAM and Flash via Quad SPI or Octal SPI, and share the same 32 MiB address space
* Ultra-low power RISC-V (RV32IMC) coprocessor clocked at 17.5 MHz approximately
* Ultra-low power FSM coprocessor similar to previous ESP32 and ESP32-S2
* Wi-Fi 2.4 GHz (IEEE 802.11 b/g/n)
* Bluetooth 5 (LE)
* 45 programmable GPIOs
* No integrated Ethernet MAC
* 2 × 12-bit SAR ADCs, up to 20 channels
* USB OTG

**ESP32-C2**

* 32-bit RISC-V single-core processor that operates at up to 120 MHz, implementing RV32IMC ISA
* State-of-the-art power and RF performance
* 576 KB ROM, 272 KB SRAM (16 KB for cache) on the chip
* 14 programmable GPIOs: SPI, UART, I2C, LED PWM controller, General DMA controller (GDMA), SAR ADC, Temperature sensor

**ESP32-C3**

* NodeMCU board with an ESP32-C3-32S
* Single-core 32-bit RISC-V CPU, up to 160 MHz
* 400 KiB SRAM, 384 KiB ROM, and 8 KiB RTC SRAM
* Wi-Fi 2.4 GHz (IEEE 802.11b/g/n)
* Bluetooth 5 (LE)
* 22 / 16 programmable GPIOs
* 2 ADC-12bit
* Pin compatible with ESP8266

**ESP32-C6**

* High performance 32-bit RISC-V CPU, up to 160 MHz, implementing RV32IMAC
* Low power 32-bit RISC-V CPU, up to 20 MHz, implementing RV32IMAC
* 512 KiB SRAM and 320 KiB ROM
* IEEE 802.11ax (Wi-Fi 6) on 2.4 GHz, supporting 20 MHz bandwidth in 11ax mode, 20 or 40 MHz bandwidth in 11b/g/n mode
* IEEE 802.15.4 (Thread + Zigbee)
* Bluetooth 5.3 (LE)
* 30 (QFN40) / 22 (QFN32) programmable GPIOs

**ESP32-H2**

* Single-core 32-bit RISC-V CPU, up to 96 MHz
* 256 KB SRAM
* IEEE 802.15.4 (Thread + Zigbee)
* Bluetooth 5.3 (LE)
* No Wi-Fi support.
* 19 programmable GPIOs

**ESP32-C5**

* Single-core 32-bit RISC-V CPU, up to 240 MHz
* 384 KB SRAM and 320 KB ROM
* IEEE 802.11ax (Wi-Fi 6) on 2.4 and 5 GHz, supporting 20 MHz bandwidth in 11ax mode, 20 or 40 MHz bandwidth in 11b/g/n mode
* IEEE 802.15.4 (Thread + Zigbee)
* Bluetooth 5 (LE)
* 20 programmable GPIOs

**ESP32-P4**

* High performance dual-core 32-bit RISC-V CPU, up to 400 MHz
* Implementing RV32IMAFC\_Zicsr\_Zifencei and custom AI/vector instructions.
* Supports single-precision Floating Point Unit (FPU).
* Low performance single-core 32-bit RISC-V CPU, up to 40 MHz
* Implementing RV32IMAC\_Zicsr\_Zifencei ISA extensions.
* 768 KiB SRAM on high-performance core system.
* 8 KiB TCM on high-performance core system.
* 32 KiB SRAM on low-power subsystem.
* Support PSRAM.
* Integrated hardware accelerators for various media encoding protocols, including H.264.
* Wi-Fi and Bluetooth are not implemented.
* If a wireless connection is required, it can be easily connected to the ESP32-C/S/H series.
* More than 50 programmable GPIOs

ESP32 is housed in quad-flat no-leads (QFN) packages of varying sizes with 49 pads. Specifically, 48 connection pads along the sides and one large thermal pad (connected to ground) on the bottom.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Series** | **Identifier** | **Processor cores** | **Processor speed (MHz)** | **Embedded flash memory ([MiB](https://en.wikipedia.org/wiki/MiB" \o "MiB))** | **Embedded PSRAM memory ([MiB](https://en.wikipedia.org/wiki/MiB" \o "MiB))** | **GPIOs** | **Package size** | **Description** |
| **ESP32** |  |  |  |  |  |  |  |  |
| ESP31B | 2 | 240 | 0 | 0 | 34 | 6 mm×6 mm | Pre-release [SoC](https://en.wikipedia.org/wiki/System_on_a_chip" \o "System on a chip) used for beta testing; no longer available. |
| ESP32-D0WDQ6 | 2 | 240 | 0 | 0 | 34 | 6 mm×6 mm | Initial production release chip of the ESP32 series. Not Recommended for New Designs (NRND). |
| ESP32-D0WD | 2 | 240 | 0 | 0 | 34 | 5 mm×5 mm | Smaller physical package variation similar to ESP32-D0WDQ6. Not Recommended for New Designs (NRND). |
| ESP32-D0WDQ6-V3 | 2 | 240 | 0 | 0 | 34 | 6 mm×6 mm | Introduces some fixes to ESP32-D0WDQ6. Not Recommended for New Designs (NRND). |
| ESP32-D2WD | 2 | 160 | 2 | 0 | 34 | 5 mm×5 mm | 2 MiB (16 Mibit) embedded flash memory variation. Removed. Not Recommended for New Designs (NRND). |
| ESP32-S0WD | 1 | 160 | 0 | 0 | 34 | 5 mm×5 mm | Single-core processor variation. Not Recommended for New Designs (NRND). |
| ESP32-D0WD-V3 | 2 | 240 | 0 | 0 | 34 | 5 mm×5 mm | Introduces some fixes to ESP32-D0WD. |
| ESP32-D0WDR2-V3 | 2 | 240 | 0 | 2 | 34 | 5 mm×5 mm |  |
| ESP32-U4WDH | 2 | 240 | 4 | 0 | 34 | 5 mm×5 mm | Single-core processor and 4 MiB (32 Mibit) embedded flash memory variation. Also 1 CPU 160MHz variant existed. |
| **ESP32-S2** |  |  |  |  |  |  |  |  |
| ESP32-S2 | 1 | 240 | 0 | 0 | 43 | 7 mm×7 mm | With USB OTG. |
| ESP32-S2R2 | 1 | 240 | 0 | 2 | 43 | 7 mm×7 mm | With USB OTG. |
| ESP32-S2FH2 | 1 | 240 | 2 | 0 | 43 | 7 mm×7 mm | With USB OTG. |
| ESP32-S2FH4 | 1 | 240 | 4 | 0 | 43 | 7 mm×7 mm | With USB OTG. |
| ESP32-S2FN4R2 | 1 | 240 | 4 | 2 | 43 | 7 mm×7 mm | With USB OTG. |
| **ESP32-S3** |  |  |  |  |  |  |  |  |
| ESP32-S3 | 2 | 240 | 0 | 0 | 45 | 7 mm×7 mm | With USB OTG. With 3.3V and 1.8V VDD\_SPI voltage. |
| ESP32-S3R2 | 2 | 240 | 0 | 2 | 45 | 7 mm×7 mm | With USB OTG. |
| ESP32-S3R8 | 2 | 240 | 0 | 8 | 45 | 7 mm×7 mm | With USB OTG. |
| ESP32-S3R8V | 2 | 240 | 0 | 8 | 45 | 7 mm×7 mm | With USB OTG. With 1.8V VDD\_SPI voltage. |
| ESP32-S3FN8 | 2 | 240 | 8 | 0 | 45 | 7 mm×7 mm | With USB OTG. |
| ESP32-S3FH4R2 | 2 | 240 | 4 | 2 | 45 | 7 mm×7 mm | With USB OTG. |
| **ESP32-C2** |  |  |  |  |  |  |  |  |
| ESP8684H1 | 1 | 120 | 1 | 0 | 14 | 4 mm×4 mm | With Bluetooth 5. |
| ESP8684H2 | 1 | 120 | 2 | 0 | 14 | 4 mm×4 mm | With Bluetooth 5. |
| ESP8684H4 | 1 | 120 | 4 | 0 | 14 | 4 mm×4 mm | With Bluetooth 5. |
| **ESP32-C3** |  |  |  |  |  |  |  |  |
| ESP32-C3 | 1 | 160 | 0 | 0 | 22 | 5 mm×5 mm | With Bluetooth 5. |
| ESP32-C3FN4 | 1 | 160 | 4 | 0 | 22 | 5 mm×5 mm | Not Recommended for New Designs (NRND). |
| ESP32-C3FH4 | 1 | 160 | 4 | 0 | 22 | 5 mm×5 mm | With Bluetooth 5. |
| ESP32-C3FH4AZ | 1 | 160 | 4 | 0 | 16 | 5 mm×5 mm | With Bluetooth 5. SPI0/SPI1 pins for flash connection are not bonded. |
| ESP8686H4 | 1 | - | 4 | 0 | - | 4 mm×4 mm | Not released. |
| ESP8685H2 | 1 | 160 | 2 | 0 | 15 | 4 mm×4 mm | With Bluetooth 5. |
| ESP8685H4 | 1 | 160 | 4 | 0 | 15 | 4 mm×4 mm | With Bluetooth 5. |
| **ESP32-C6** |  |  |  |  |  |  |  |  |
| ESP32-C6 | 1 | 160 | 0 | 0 | 30 | 5 mm×5 mm | With Wi-Fi 6 and Bluetooth 5. |
| ESP32-C6FH4 | 1 | 160 | 4 | 0 | 22 | 5 mm×5 mm | With Wi-Fi 6 and Bluetooth 5. |
| **ESP32-H2** |  |  |  |  |  |  |  |  |
| ESP32-H2FH2 | 1 | 96 | 2 | 0 | 19 | 4 mm×4 mm | With Bluetooth 5 and Bluetooth Mesh. |
| ESP32-H2FH4 | 1 | 96 | 4 | 0 | 19 | 4 mm×4 mm | With Bluetooth 5 and Bluetooth Mesh. |

**Surface-mount module boards**

ESP32 based surface-mount printed circuit board modules directly contain the ESP32 SoC and are designed to be easily integrated onto other circuit boards. Meandered inverted-F antenna designs are used for the PCB trace antennas on the modules listed below. In addition to flash memory, some modules include pseudostatic RAM (pSRAM).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Vendor** | **Name** | **Antenna** | **Flash memory (MiB)** | **PSRAM (MiB)** | **Description** |
| **Espressif** | ESP-WROOM-03 | PCB trace | 4 | 0 | Discontinued. Limited distribution, pre-production module created by Espressif for beta testing purposes; this module used the ESP31B, the beta testing chip for the ESP32 series. FCC Part 15.247 tested (FCC ID: 2AC7Z-ESP32). |
| ESP32-WROOM-32 | PCB trace | 4 | 0 | First publicly available ESP32 module board created by Espressif. FCC Part 15.247 tested (FCC ID: 2AC7Z-ESPWROOM32). Based on ESP32-D0WDQ6 chip. Originally named "ESP-WROOM-32". |
| ESP32-WROOM-32E | PCB trace | 4,8,16 | 0 | Same as ESP32-WROOM-32 but with the Eco V3 processor revisions |
| ESP32-WROOM-32D | PCB trace | 4 | 0 | Revision of the ESP-WROOM-32 module which uses an ESP32-D0WD chip instead of an ESP32-D0WDQ6 chip. Originally named "ESP-WROOM-32D". |
| ESP32-SOLO-1 | PCB trace | 4 | 0 | Similar to the ESP32-WROOM-32D module, but uses the single-core ESP32-S0WD chip instead of the dual-core ESP32-D0WD. |
| ESP32-WROOM-32U | U.FL socket | 4 | 0 | Alternative to the ESP-WROOM-32D module which has a U.FL connector for external antenna in lieu of a PCB trace antenna. |
| ESP32-WROVER | PCB trace | 4 | 4 | ESP32 module board with 4 MiB pSRAM created by Espressif. FCC part 15.247 tested (FCC ID 2AC7Z-ESP32WROVER). Uses 40 MHz crystal oscillator. Does not include U.FL connector. Based on ESP32-D0WDQ6 chip. Since June 2018, new modules have been upgraded to 8 MiB pSRAM. |
| ESP32-WROVER-I | U.FL socket, PCB trace | 4 | 4 | Variation of ESP32-WROVER module configured to use an on-board U.FL compatible connector. PCB trace antenna not connected by default. |
| ESP32-WROVER-B | PCB trace | 4 | 8 | Revision of ESP32-WROVER module with 8 MiB pSRAM (instead of 4 MiB pSRAM) operating at 3.3V (instead of 1.8V in previous versions) and ESP32-D0WD (instead of ESP32-D0WDQ6). FCC part 15.247 tested (FCC ID 2AC7Z-ESP32WROVERB). Does not include U.FL connector. (Custom order option for flash capacity of 8 MiB or 16 MiB also available.) |
| ESP32-WROVER-IB | U.FL socket, PCB trace | 4 | 8 | Variation of ESP32-WROVER-B module configured to use an on-board U.FL compatible connector. PCB trace antenna not connected by default. |
| ESP32-WROVER-E | PCB trace | 4,8,16 | 2,8 | Revision of ESP32-WROVER module with 2 or 8 MiB pSRAM (instead of 4 MiB pSRAM) operating at 3.3V (instead of 1.8V in previous versions) and ESP32-D0WD-V3, or in 2MB pSRAM models, ESP32-D0WDR2-V3. FCC part 15.247 tested (FCC ID 2AC7Z-ESP32WROVERE). Does not include U.FL connector. (Custom order option for flash capacity of 2 MiB, 8 MiB, or 16 MiB also available.) |
| ESP32-WROVER-IE | U.FL socket, PCB trace | 4,8,16 | 2,8 | Variation of ESP32-WROVER-E module configured to use an on-board U.FL compatible connector. PCB trace antenna not connected by default. |
| ESP32-PICO-V3-ZERO | PCB trace | 4 | 0 | Based on ESP32-PICO-V3 SiP. It is designed as a module for Alexa Connect Kit (ACK) and connecting with Amazon Alexa. |
| **Ai-Thinker** | ESP32-S | PCB trace | 4 | 0 | Ai-Thinker's equivalent to Espressif's ESP-WROOM-32 module. (Same form factor and general specifications.) Previously branded as "ESP-32S" with the hyphen before "32S", the initial release of the ESP-32S module replaced the previously announced, but never released, ESP3212 module. |
| ESP32-A1S | U.FL socket, PCB trace | 8 | 4 | Contains an extra AC101 audio codec IC whose IO-pins (line, mic, etc.) are led to the board pins. Comes separately or soldered onto a corresponding audio development board ("ESP32-Audio-Kit"). |
| **AnalogLamb** | ESP-32S-ALB | PCB trace | 4 | 0 | Clone of the ESP-32S module (ESP-WROOM-32 compatible footprint). Seen with a green solder mask coating. |
| ALB-WROOM | PCB trace | 16 | 0 | Variation of ESP-32S-ALB with 16 MiB of flash memory. |
| ALB32-WROVER | PCB trace | 4 | 4 | ESP32 module board with 4 MiB pSRAM with the same footprint as the ESP-WROOM-32 module. |
| **DFRobot** | ESP-WROOM-32 | PCB trace | 4 | 0 | Module board similar to Espressif Systems's ESP-WROOM-32, but is not FCC certified, and uses 26 MHz or 32 kHz crystal oscillator. |
| **eBox & Widora** | ESP32-Bit | Ceramic, U.FL socket | 4 | 0 | Module has a ceramic antenna and an U.FL antenna connector. This module has a different footprint than the ESP-WROOM-32/ESP-32S modules. |
| **Goouuu Tech** | ESP-32F | PCB trace | 4 | 0 | Module board similar to Espressif Systems's ESP-WROOM-32. FCC certified (ID 2AM77-ESP-32F). |
| **IntoRobot** | W32 | PCB trace | 4 | 0 | Module similar in appearance to Espressif's ESP-WROOM-32, but footprint pinout differs. |
| W33 | Ceramic, U.FL socket | 4 | 0 | Differs from IntoRobot W32 module in its antenna configuration. |
| **ITEAD** | PSH-C32 | PCB trace | 1 | 0 | Module has unusually small flash memory on board. Also, footprint is unique and differs from all other ESP32 modules. |
| **Pycom** | W01 | (Not included.) | 8 | 4 | OEM module version of the WiPy 2.0. Supports Wi-Fi and Bluetooth. FCC ID 2AJMTWIPY01R. |
| L01 | (Not included.) | 8 | 4 | OEM module version of the LoPy. Supports Wi-Fi, Bluetooth, and LoRa. FCC ID 2AJMTLOPY01R. |
| L04 | (Not included.) | 8 | 4 | OEM module version of the LoPy4. Supports Wi-Fi, Bluetooth, LoRa, and Sigfox. |
| S01 | (Not included.) | 8 | 4 | Discontinued. OEM module version of the SiPy. Supports Wi-Fi, Bluetooth, and Sigfox (14 dBm and 22 dBm). |
| G01 | (Not included.) | 8 | 4 | OEM module version of the GPy. Supports Cellular LTE-CAT M1/NB1, Wi-Fi and Bluetooth. |
| **u-blox** | NINA-W131 | (Not included.) | 2 | 0 | Belongs to the u-blox NINA-W13 series of Wi-Fi modules. |
| NINA-W132 | PIFA | 2 | 0 | Belongs to the u-blox NINA-W13 series of Wi-Fi modules. On board planar inverted-F antenna (PIFA) is shaped (cut & bent) metal, not a PCB trace. |

**Modules**

In 2022 the ESP32-S3-PICO-1 module was introduced with USB OTG and internal PSRAM.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Identifier** | **Processor cores** | **Processor speed (MHz)** | **Embedded flash memory (MiB)** | **Embedded PSRAM memory (MiB)** | **GPIOs** | **Package size** | **Description** |
| **ESP32-PICO-D4** | 2 | 240 | 4 | 0 | 34 | 7 mm×7 mm | Includes ESP32 chip, crystal oscillator, flash memory, filter capacitors, and RF matching links. |
| **ESP32-PICO-V3** | 2 | 240 | 4 | 0 | 31 | 7 mm×7 mm | Based on ESP32 with ECO V3 wafer. |
| **ESP32-PICO-V3-02** | 2 | 240 | 8 | 2 | 29 | 7 mm×7 mm | Based on ESP32 with ECO V3 wafer. |
| **ESP32-S3-PICO-1-N8R2** | 2 | 240 | 8 | 2 | 39 | 7 mm×7 mm | Includes USB OTG. |
| **ESP32-S3-PICO-1-N8R8** | 2 | 240 | 8 | 8 | 39 | 7 mm×7 mm | Includes USB OTG. |

**Development and other boards**

Development and break-out boards extend wiring and may add functionality, often building upon ESP32 module boards and making them easier to use for development purposes, especially with breadboards.

|  |  |  |  |
| --- | --- | --- | --- |
| **Vendor** | **Name** | **Surface-mount module used** | **Description** |
| **Espressif** | ESP\_Module\_Testboard | ESP-WROOM-03 | Break-out board included with ESP-WROOM-03 beta modules. |
| ESP32\_Demo Board\_V2 | ESP-WROOM-32 | Development & demonstration board created by Espressif. |
| ESP32-DevKitC | ESP32-WROOM-32, v4 comes with ESP32-WROOM-DA(Dual Antenna), ESP32-WROVER or ESP32-Solo (Single core variant) | Compact development board created by Espressif. Silkscreen labeling on PCB reads "Core Board". |
| ESP-WROVER-KIT | ESP-WROOM-32 or ESP32-WROVER | Large development board created by Espressif. Previously named ESP32-DevKitJ. |
| ESP32-PICO-KIT | ESP32-PICO-D4 | Small development board with micro usb and two header rows of 17 pins. FCC ID 2AC7Z-ESP32PICOKIT. |
| **Adafruit** | HUZZAH32 | ESP-WROOM-32 | Also referred to as the "ESP32 Feather Board", the HUZZAH32 is a compact development board/module that is compatible with the Adafruit Feather family of products. |
| **Ai-Thinker** | NodeMCU-32S | ESP-32S | NodeMCU-like development board. |
| ESP32-CAM | ESP32-S | Compact (27 mm x 40.5 mm) board with ribbon cable Camera Serial Interface with support for 1600 x 1200 pixel OV2640 or 640 x 480 OV7670 camera. Has 9 usable IO pins and microSD card slot. |
| **AnalogLamb** | ESP32 Development Board | ESP-32S-ALB or ALB-WROOM | Development board similar to Espressif's ESP32-DevKitC with on board a CP2102 USB/serial bridge. 4 MiB variation uses ESP-32S-ALB; 16 MiB variation uses ALB-WROOM module. |
| Maple ESP32 | ESP-32S-ALB | Development board with Arduino-style connections and CP2104 USB/serial interface. |
| **April Brother** | ESPea32 | - | Development board with perfboard area that may be optionally cut-off. |
| **ArduCAM** | ESP32 UNO | ESP-32S | Arduino Uno-like development board based on ESP32 IoT UNO framework with support for SPI ArduCAM, battery pins and uSD card slot. |
| **Arduino** | Arduino Nano ESP32 | U-Blox NORA-W106-10B (based on ESP32-S3 IC) | Arduino Nano footprint |
| **Banana pi** | BPI:bit | ESP-32S | a development for Webduino and Arduino |
| BPI-UNO32 | ESP32-S | a development board for Arduino |
| **DoIT** | ESPduino32 | ESP-WROOM-32 | Full-featured Arduino Uno-like development board compatible with Arduino Shields. It also adds additional SPI & IO pins. The board is a clone of WeMos D1 R32 with a USB Type B socket. |
| ESP32 DEVKIT V1 | ESP-WROOM-32 | The ESP32 DevKit V1 is probably the most popular among hobbyists and educators for its ease of use and versatility in various electronic projects. The pinout. It's one of the most copied. |
| **EzSBC** | ESP32-01 Breakout and Development Board | ESP-WROOM-32 | Full-featured development board with two tri-color LEDs and fits on a breadboard. |
| **Gravitech & MakerAsia** | Nano32 | - | Development board that directly incorporates the ESP32 chip. |
| **HydraBus** | HydraESP32 | ESP-WROOM-32 or ESP-32S | HydraESP32 HydraBus v1.1 Rev1 shield/breakout board for ESP-WROOM-32 or ESP-32S. This shield can be used with or without a HydraBus board. |
| **Noduino** | Quantum | - | Arduino-style development board that directly incorporates the ESP32 chip. |
| **Olimex** | ESP32-Gateway | ESP32-WROOM32 | Wi-Fi/Bluetooth/Ethernet |
| ESP32-DevKit-LiPo | ESP32-WROOM-32 | pin compatible with ESP32-CoreBoard, but adds Lipo charger and ability to work on LiPo. |
| ESP32-POE-ISO | ESP32-WROOM-32/UE | Wi-Fi/Bluetooth/Ethernet development board with Power over Ethernet and 2W of isolated DC power |
| ESP32-POE | ESP32-WROOM-32 | Wi-Fi/Bluetooth/Ethernet development board with Power over Ethernet |
| ESP32-PRO | - | Wi-Fi/Bluetooth and PIC32MX270F256DT microcontroller and 32 Mb SPI flash and 32 Mb PSRAM. ESP32-PRO-C includes external crypto engine with ATECC508A |
| ESP32-EVB | ESP32-WROOM32 | Wi-Fi/Bluetooth/Ethernet development board with MicroSD, CAN, IR, LiPo, and two relays. |
| ESP32-ADF | ESP32-WROVER-B | audio development framework board with stereo microphones, speakers, audio output jack. |
| **Pycom** | WiPy | - | MicroPython programmable Wi-Fi & Bluetooth IoT development platform with a 1 km Wi-Fi range. WiPy versions 2.0 and 3.0 use ESP32. |
| LoPy | - | Triple network Pycom board featuring LoRa, Wi-Fi (1 km range), and BLE. |
| LoPy4 | - | Quadruple network Pycom board featuring LoRa, Sigfox, Wi-Fi (1 km range), and BLE. |
| SiPy | - | Triple network Pycom board featuring Sigfox, Wi-Fi (1 km range), and BLE. |
| GPy | - | Triple network Pycom board featuring LTE-M, Wi-Fi (1 km range), and BLE. |
| FiPy | - | Quintuple network Pycom board featuring LTE-M, LoRa, Sigfox, Wi-Fi (1 km range), and BLE. |
| **SparkFun** | ESP32 Thing | - | Compact development board with FTDI FT231x USB/serial interface and LiPo charger built-in. |
| **SunDUINO** | ESP32 MiniBoard | ESP-WROOM-32 | Breakout compatible with the Espressif ESP32-DevKitC. Lacks on-board USB-UART. |
| ESP32 MiniBoard v2 | ESP32-Wrover-B/IB | Breakout board with Silabs CP2102, battery charger. Compatible with Espressif DEVkit. |
| ESP32 SunDUINO | ESP-WROOM-32 or ESP-32S | Arduino-style development board. Lacks on-board USB-UART. |
| **SwitchDoc Labs** | BC24 | ESP-WROOM-32 | ESP32 Breakout with 24 SK6812RGBW LEDs with Grove Connectors for easy prototyping. Comes with USB-UART and Feather compatible pinout. |
| **Watterott** | ESP-WROOM32-Breakout | ESP-WROOM-32 | Breakout which is compatible with the Espressif ESP32-DevKitC. |
| **WEMOS** | LOLIN32 [Retired] | ESP-WROOM-32 |  |
| LOLIN32 Lite [Retired] | - | ESP32-D0WDQ6 |
| LOLIN32 Pro [Retired] | ESP32-WROVER | MicroSD card slot (supports SD and SPI mode) |
| LOLIN D32 | ESP-WROOM-32 |  |
| LOLIN D32 Pro | ESP32-WROVER | I2C port, TFT port and Micro SD Card slot (support SPI mode) |
| **Widora** | Air | - | Compact ESP32 development board. |
| **MagicBit** | Magic Bit Core | ESP-WROOM-32 | Compact ESP32 development board with displays and several sensors onboard to make learning embedded development convenient. |

***Comparison Table Of The ESP32 Variants:***

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Variant** | **Processor** | **Connectivity** | **RAM** | **Flash** | **Antenna Types** | **Peripherals** | **Use Cases** |
| **ESP32** | Dual-core Xtensa LX6 | Wi-Fi 2.4 GHz, Bluetooth Classic + BLE | 520 KB SRAM | External (4–16 MB) | Internal PCB / External U.FL | 34 GPIOs, 18 ADC (12-bit), 2 DAC (8-bit), capacitive touch (10), SPI, I2C, I2S, UART, PWM, Hall Sensor | General-purpose IoT, audio, smart devices |
| **ESP32-S2** | Single-core Xtensa LX7 | Wi-Fi 2.4 GHz | 320 KB SRAM | External (up to 128 MB) | Internal PCB / External U.FL | 43 GPIOs, 20 ADC (12-bit), USB OTG, capacitive touch (14), SPI, I2C, I2S, UART, PWM, enhanced security | Secure IoT, USB-based devices |
| **ESP32-S3** | Dual-core Xtensa LX7 | Wi-Fi 2.4 GHz, BLE 5.0 | 512 KB SRAM | External (supports PSRAM) | Internal PCB / External U.FL | 44 GPIOs, 20 ADC (12-bit), USB OTG, AI/ML extensions, SPI, I2C, I2S, UART, PWM, capacitive touch (14) | AI/ML, edge computing, IoT devices |
| **ESP32-C2** | Single-core RISC-V | Wi-Fi 2.4 GHz, BLE 5.0 | 272 KB SRAM | Integrated (4 MB) | Internal PCB | Fewer GPIOs, simplified peripherals | Low-cost IoT applications |
| **ESP32-C3** | Single-core RISC-V | Wi-Fi 2.4 GHz, BLE 5.0 | 400 KB SRAM | Integrated (up to 4 MB) | Internal PCB / External U.FL | 22 GPIOs, 6 ADC, SPI, I2C, I2S, UART, PWM, secure boot, Flash encryption | ESP8266 replacement, IoT devices |
| **ESP32-C6** | Single-core RISC-V | Wi-Fi 6 (2.4 GHz), BLE 5.0, Zigbee/Thread | 400 KB SRAM | External (supports PSRAM) | Internal PCB / External U.FL | Advanced Wi-Fi 6 features, Zigbee/Thread mesh support | Advanced IoT, smart cities, mesh networking |
| **ESP32-H2** | Single-core RISC-V | Zigbee/Thread, BLE 5.0 | 256 KB SRAM | Integrated | Internal PCB / External U.FL | Simplified GPIOs, Zigbee/Thread features | Zigbee/Thread IoT, smart lighting, mesh apps |

**ESP32 variants based on Wi-Fi type and range:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variant** | **Wi-Fi Type** | **Antenna Type** | **Range (Approx.)** | **Best For** |
| ESP32-WROOM | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) or External | Up to 50m (internal), 100m+ (external) | General-purpose IoT with medium to long range. |
| ESP32-WROVER | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) or External | Up to 50m (internal), 100m+ (external) | AI/ML applications, streaming, and IoT. |
| ESP32-S2 | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) | Up to 50m | Cost-effective secure IoT with moderate range. |
| ESP32-S3 | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) or External | Up to 50m (internal), 100m+ (external) | AI/ML and vision-based IoT applications. |
| ESP32-C3 | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) | Up to 50m | Entry-level IoT devices with BLE and Wi-Fi. |
| ESP32-H2 | No Wi-Fi | N/A | N/A | Focused on Zigbee/Thread for mesh networks. |
| ESP32-PICO | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) | Up to 50m | Compact IoT devices with moderate range. |
| ESP32-MINI | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) or External | Up to 50m (internal), 100m+ (external) | Small IoT devices needing extended range. |
| ESP32-CAM | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) | Up to 50m | Camera-enabled IoT projects. |
| ESP32-Solo | 2.4 GHz Wi-Fi (802.11 b/g/n) | PCB (Internal) | Up to 50m | Cost-sensitive applications with moderate range. |

* Short to Medium Range (Indoor Use): ESP32-WROOM, ESP32-C3, ESP32-S2, ESP32-PICO.
* Long Range (Outdoor or Large Areas): ESP32-WROOM-32U, ESP32-S3 with external antennas.
* No Wi-Fi (Mesh Networks): ESP32-H2 for Zigbee/Thread.