



the INTERNET of THINGS with ESP32

Created by Espressif Systems, ESP32 is a low-cost, low-power system on a chip (SoC) series with Wi-Fi & dual-mode Bluetooth capabilities! The ESP32 series of chips presently includes ESP32-D0WDQ6 (and ESP32-D0WD), ESP32-D2WD, and ESP32-S0WD. At its heart, there's a dual-core (or single-core) Tensilica Xtensa LX6 microprocessor with a clock rate of up to 240 MHz. ESP32 is highly integrated with built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power management modules. Engineered for mobile devices, wearable electronics, and IoT applications, ESP32 achieves ultra-low power consumption through power saving features including fine resolution clock gating, multiple power modes, and dynamic power scaling.

➞ For news and information, follow @ESP32net on Twitter! ⚡

FEATURES & SPECIFICATIONS

See [ESP32 Datasheet](#) for complete information.

Processors

- **Main Processor:** Tensilica Xtensa 32-bit LX6 microprocessor
 - **Cores:** 2 or 1 (depending on variation)
All chips in the ESP32 series are dual-core except for ESP32-S0WD, which is single-core.
 - **Clock Frequency:** up to 240 MHz
 - **Performance:** up to 600 DMIPS
- **Low Power Co-Processor:** Low power options utilize the **ULP co-processor** to ensure that you can still do ADC conversions, computation, and level thresholds while in deep sleep.

Wireless Connectivity

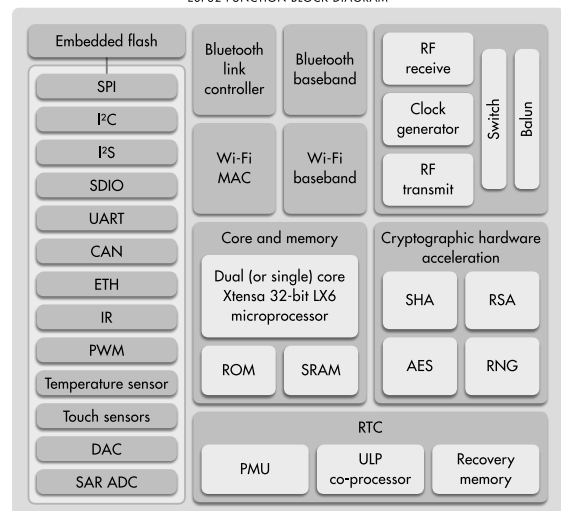
- **Wi-Fi:** 802.11 b/g/n/e/i (802.11n @ 2.4 GHz up to 150 Mbit/s)
- **Bluetooth:** v4.2 BR/EDR and Bluetooth Low Energy (BLE)

Memory

Internal Memory

- **ROM:** 448 KiB
For booting and core functions.
- **SRAM:** 520 KiB
For data and instruction.
- **RTC Slow SRAM:** 8 KiB
For co-processor accessing during deep-sleep mode.
- **RTC Fast SRAM:** 8 KiB
For data storage and main CPU during RTC Boot from the deep-sleep mode.
- **eFuse:** 1 Kibit
Of which 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.
- **Embedded Flash:** 0 MiB or 2 MiB (depending on variation)
ESP32-D2WD has 2 MiB of embedded flash, internally connected via GPIO16, GPIO17, SD_CMD, SD_CLK, SD_DATA_0 and SD_DATA_1. The other chips in the ESP32 series have no embedded flash.
- **External Flash and SRAM:** ESP32 without embedded flash supports up to 4 × 16 MiB of external QSPI flash and 8 MiB SRAM with hardware encryption based on AES to protect developer's programs and data.
ESP32 chips with embedded flash do not support the address mapping between external flash and peripherals.
- **Peripheral Input/Output:** Rich peripheral interface with DMA that includes capacitive touch, ADCs (analog-to-digital converter), DACs (digital-to-analog converter), I²C (Inter-Integrated Circuit), UART (universal asynchronous receiver/transmitter), CAN 2.0 (Controller Area Network), SPI (Serial Peripheral Interface), I²S (Integrated Inter-IC Sound), RMII (Reduced Media-Independent Interface), PWM (pulse width modulation), and more.
- **Security**
 - IEEE 802.11 standard security features all supported, including WFA, WPA/WPA2 and WAPI
 - Secure boot
 - Flash encryption

ESP32 FUNCTION BLOCK DIAGRAM



- 1024-bit OTP, up to 768-bit for customers
- Cryptographic hardware acceleration: AES, SHA-2, RSA, elliptic curve cryptography (ECC), random number generator (RNG)

Clarification note: In this context, "RTC" is a bit of an "Espressifism" because it's used as shorthand for the low-power and analog subsystem which is separate from the CPU and the main "digital" peripherals ("digital" is another Espressifism). There is some real time clock functionality as part of the RTC subsystem, but there's also a lot of other stuff.

COMMUNITY & DISCUSSION

Real-time chat via IRC is a great way to converse with others, learn new things, and sometimes get answers to questions on the spot. Having said that, the main drawback to online chat is that not everyone is active or looking at the channel (chat room) at the same moment — people work at different hours and live in different parts of the world — so timing can be hit-or-miss. So, if you ask a question in the channel, try to stick around for awhile, as it might take someone awhile to respond. For many questions, it's often better to **submit a post in the forums**, as that will typically have greater visibility to others, and is less dependent upon the immediate "here and now" and the ephemeral nature of online chat.

- **Forum:** [ESP32.com](https://www.espressif.com/en/forum) (Official Espressif ESP32 Forums)
- **Chat:** [#ESP32 on IRC.freenode.net](https://freenode.net)

In order to connect to the #ESP32 chat channel on the Freenode IRC network, you will need to use an IRC client program. For long term usage, it's recommended to download a full fledged IRC client. However, for temporary usage, you can [Freenode's webchat client](#).

- **Reddit:** [/r/esp32](https://www.reddit.com/r/esp32)
-

READINGS & VIDEOS

- **News**

- [@ESP32net on Twitter](#)
- [ESP32 tag on Hackaday.com](#)

- **Projects**

- [ESP32 tag on Hackaday.io](#)
- [ESP32 search on Hackster.io](#)
- [ESP32 search on Instructables](#)

- **Readings & Documentation**

- Getting Started
 - [ESP-IDF Programming Guide](#) ★
Generated from the [docs directory](#) in the ESP-IDF repository.
 - [Kolban's Book on ESP32 \(PDF\)](#) ★
 - [ESP-IDF Getting Started Guide \(PDF\)](#) ★
 - [Fast & Furious Guide to Programming the Nano32](#)
 - [ESP32-DevKitC Getting Started Guide](#)
 - [How to Get Started with the ESP32](#)
(Elliot Williams, Hackaday, 2016 Oct. 4)
 - [Get Started with ESP32](#)
(Rita Zhang, 2016 Sept. 29)
 - [Getting Started with ESP32 ESP-IDF](#)
- [Official Documentation on Espressif.com](#)
 - [ESP32 & ESP-WROOM-32 Documents](#)
 - [ESP32 Technical Reference Manual \(PDF\)](#) ★
 - [Silicon errata: ECO and Workarounds for Bugs in ESP32 \(PDF\)](#)
 - [ESP32 Hardware Design Guidelines \(PDF\)](#)
 - [ESP32 Bluetooth Networking User Guide \(PDF\)](#)
See also: [EspBlueFi Android App](#)
- [Documentation on ESP32.com Forums](#)
- [Ethernet on ESP32 using LAN8720](#)
- JTAG Debugging
 - [JTAG Debugging for ESP32 \(PDF\)](#)
Espressif's official guide to installing OpenOCD for ESP32 and debugging using `gdb` in a Linux virtual machine.
 - [GoJimmyPi's JTAG Debugging for ESP32, VSCode JTAG Debugging of ESP32 Part 1 & Part 2](#)
 - [How to debug ESP32 with JTAG / OpenOCD / GDB using FTDI C232HM DDHSL-0](#)
 - [Diagram \(Forum Post\)](#)
 - [Notes](#)
- Watson IoT Platform
 - [Connect an ESP32 to the Watson IoT Platform using the Arduino IDE](#)
 - [Experiments with Bluetooth and Watson](#)
Use an ESP32/Arduino to connect Bluetooth devices to the Watson IoT Platform.
Source code: [ESP32BleBeacon.ino](#), [ESP32BleGateway.ino](#)
- [Luca Dentella's ESP32 Tutorials](#)

1. Introduction
 2. Dev. environment: ESP-IDF
 3. Dev. environment: Eclipse
 4. Flash, bootloader, and FreeRTOS
 5. Wi-Fi scanner
 6. Connect to a Wi-Fi network
 7. Configuration menu
 8. TCP connection
 9. Basic I/O
 10. Random number generation
 11. LED candle
 12. I/O with interrupts
 13. Sending SMS with BulkSMS
 14. ESP-IDF v2; how to manage different versions
 15. Multicast DNS (mDNS)
 16. IFTTT
 17. Simple Network Time Protocol (SNTP)
 18. Access point
 19. Non-volatile storage
 20. Web server
 21. ESP32, WEMOS or not to WEMOS
- **ESP32 Tutorials from TechTutorialsX**
 Posts below are listed in chronological order.
 1. Hello, world
 2. Connecting to a Wi-Fi network
 3. Publishing messages to MQTT topic
 4. Subscribing to MQTT topic
 5. Parsing JSON
 6. Creating JSON messages
 7. Sending JSON messages over MQTT
 8. Arduino: using FreeRTOS functions
 9. Arduino: creating a FreeRTOS task
 10. Arduino: passing a variable as argument of a FreeRTOS task
 11. Arduino: getting FreeRTOS tasks priority
 12. Get task execution core
 13. Running code on a specific core
 14. Dual core execution speedup
 15. HTTP GET requests
 16. HTTP POST requests
 17. MicroPython support (setup & flashing)
 18. MicroPython: parsing JSON
 19. MicroPython: encoding JSON
 20. MicroPython: connecting to a Wi-Fi network
 21. MicroPython: running scripts from a computer
 22. MicroPython: writing a file
 23. MicroPython: reading a file
 24. MicroPython: uploading files to the file system
 25. MicroPython: running a script from the file system
 26. Uploading a program with Arduino IDE
 27. MicroPython: automatic connection to Wi-Fi
 28. Arduino: LED PWM fading
 29. MicroPython: HTTP POST requests
 30. MicroPython: using SHA-256
 31. Arduino: getting started with Wi-Fi
 32. Arduino: controlling a buzzer with PWM
 33. Arduino: HTTP POST requests to bottle application
 34. Bluetooth: using the BTstack library
 35. Bluetooth: finding the device with Python and BTstack
 36. Bluetooth: receiving data through RFComm
 37. Bluetooth: advertising an SPP service with SDP
 38. MicroPython: getting started with the uPyCraft IDE
 39. MicroPython: executing scripts with uPyCraft
 40. Arduino: setting a soft AP
 - **Random Nerd Tutorials**
 - Installing the ESP32 board in Arduino IDE for Windows and for Mac & Linux
 - Getting started with an ESP32 dev. module
 - Web server using Arduino IDE
 - ESP32 with DHT11/DHT22 temperature/humidity web server using Arduino IDE
 - **Notable Videos**
 - Engineers.SG
 - **Programming the ESP32** (William Hooi, 2016 Oct. 5, 16 min.)
 - **ESP32 Development Update** (Baoshi Zhu, 2017 May 3, 19.4 min.)
 - Linux.conf.au 2017 & Open Hardware Mini-Conference
 - **Microcontroller Hardware & Software** (Angus Gratton, 2017 Jan. 17, 23 min.)
 - **IoTuz Hardware Design, Manufacturing, Working with KiCad** (Bob Powers, 2017 Jan. 17, 40 min.)
 - **IoTuz Software Design Challenges and ESP-IDF** (Mark Wolfe, 2017 Jan. 17, 28 min.)
 - **MicroPython for ESP32** (Nick Moore, 2017 Jan. 17, 28 min.)
 - **Development Example Using IoTuz** (Andy Gelme, 2017 Jan. 17, 29 min.)
 - **Wi-Fi Range Testing with ESP32 & Webcam: 10 km Using Directional Antenna** (Florian Euchner, 2017 Apr. 8, 5¼ min.)
 - **Andreas Spiess's ESP32 Videos**
 - **#103 ESP32 Tutorial, Arduino IDE, Tests, and Comparison with ESP8266**
 - **#143 Huge Mailbag with ESP32 Boards, Capacitive LED Switches, Power Supplies, and More**
 - **#147 Introduction into ESP32 with First Tests: PWM, Servo, Web, Touch Sensors**
 Also titled "ESP32: It's Not as Difficult as You Think".
 - **#149 ESP32 Deep Sleep, RTC Memory, "Secret" LoLin Pins**
 - **Kolban's ESP32 Technical Tutorials (Repository)**
 Note: playlist is in reverse-chronological order, but most videos are self-contained and order-independent.

1. Dev. environment on Raspberry Pi (forum post)
 2. Integration with Eclipse
 3. Attaching GDB for debugging
 4. ESP32-Duktape installation
 5. ESP32-Duktape web server
 6. Analog to digital conversion
 7. Tasks and concurrent sockets
 8. Pulse width modulation
 9. BMP180 I²C temperature & pressure sensor
 10. Using a logic analyzer
 11. Using the core dump
 12. Light dependent resistor
 13. Working with time
 14. DS1307 real time clock via I²C
 15. Displays and the U8g2 library
 16. HMC5883L compass
 17. Ambient light levels
 18. MPU6050 accelerometer
 19. FreeRTOS stack space
 20. Charting sensor data
 21. PCF8574 GPIO extender
 22. Driving the MAX7219
For eight-digit 7-segment (plus decimal points) display or an 8×8 LED matrix.
 23. Building a C++ application
 24. Community & chat: ESP32 IRC channel
 25. Integrating with LibCURL
 26. BLE and C++
 27. BLE, C++ and notifications
 28. RC522 RFID
 29. BLE notifications
 30. BLE client
- **PCBReflux's ESP32 Videos (Repository)**
 1. ESP32 Arduino and ESP-IDF installation
 2. Worst solder adapter ever (but great music)
 3. Arduino tutorial: getting to blinky
 4. ESP-IDF: playing with BLE/Bluetooth
 5. BLE/Bluetooth Eddystone implementation
 6. BLE/Bluetooth iBeacon implementation
 7. Arduino ucglib port with ILI9341 TFT LCD
 8. APA102 RGB LED strip controlled by Arduino sketch
 9. MAX6675 IoT Wi-Fi temp. sensor & ThingSpeak
 10. DIY Wi-Fi emergency button with SSL Gmail
 11. Weather station with Si7021 and OLED
 12. DIY Wi-Fi connected radar intrusion detector
 13. Bluetooth client reading from nRF51822 server
 14. HTTPS secure web server & Wi-Fi GPIO remote control
 15. Adapter, breadboard, UART, USB and more
 16. Wi-Fi enabled beacon tracker (a.k.a. the sheep counter)
 17. MQTT secure HTTPS TLS/SSL WebSocket ThingSpeak publish
 18. Deep sleep API and wake up
 19. MQTT secure HTTPS TLS/SSL WebSocket CloudMQTT subscribe
 20. FreeRTOS inter-task communication: queues
 21. ESP32-AT: playing with ESP32 AT commands
 22. ESP32-AT: Arduino Nano connected ESP32
 23. Current consumption
 24. IoT BLE MQTT gateway
 25. FreeRTOS inter-task communication: event groups
 26. "Atomic clock" using U-Blox GPS module
 27. External Hall effect switch and GPIO interrupts
 28. Internal Hall effect sensor
 29. Portable luxmeter with BH1750FVI
 30. Switching heavy loads with solid state relays (SSR)
 31. Playing sound / MQTT sound
 32. Smart LED prototype using AC solid state relays (SSR)
 33. RFID read & write with MFRC522 module
 34. Mosquitto + SSL/TLS, openHAB2, MQTT Dash
 35. Smart LED prototype 2, openHAB2, MQTT Dash
 36. Play MP3 with DFPlayer Mini
 37. Arduino/Eclipse crossover
 38. NeoPixel (WS2812B) library contest
 39. Bluetooth server tutorial & code walk
 40. IR remote (AX-1838HS)
 41. Touch sensor (300 LED NeoPixel skin detector)
 42. Arduino multitasking (WS2812 octo-tasking)
 43. Arduino multitasking (DRV8825 stepstick stepper motor driver)
 44. Arduino AP + web server + file upload
 45. 100 ways to buy an ESP32 board
 46. Eclipse Oxygen installation & configuration
 47. Temperature measurement
 48. Bluetooth logging multimeter with INA219 & SSD1306
 - **Mongoose OS Video Tutorials**
 - Mongoose OS installation
 - Working with files
 - Configuring Wi-Fi
 - Customize built-in web server
 - Mongoose OS & AWS IoT
 - Internet button & Amazon AWS IoT
Uses ESP8266, but applies to ESP32 too.
 - Control via AWS IoT MQTT
Uses ESP8266, but applies to ESP32 too.
 - AWS device shadows
 - ESP32 flash encryption
 - **Simba Embedded Programming Platform**
Brief demo videos; see YouTube description for links to source code and documentation.
 - Pumbaa: blink on Nano32
 - Pumbaa: Queue class unit testing on Nano32
 - Simba: hello world on Nano32
 - Pumbaa: dual board CAN blink on Nano32 and Arduino Due
 - Simba: CAN client-server test suite on Nano32 and Arduino Due
 - Pumbaa: writing Python with Emacs for Nano32
 - **First Impressions with ESP32 Units**
 - Ask An Engineer: ESP-WROOM-32 in the Store; Adafruit Feather ESP32 Revised to use ESP-WROOM-32 (Adafruit, 2016 Nov. 2)
 - Ask An Engineer: ESP32-DevKitC & Future Adafruit ESP32 Boards (Adafruit, 2016 Sept. 21) 55 minutes into the show, Limor Fried briefly discussed their sold-out Espressif ESP32-DevKitC boards and gave a sneak-peek at the future Adafruit Feather HUZZAH ESP32 & HUZZAH ESP32 boards.
 - Saturday chatten' ESP32 is here... (Adafruit, 2015 Sept. 17, 16.5 min.)
 - ESP32 Hands-On: Awesome Promise (Hackaday, 2015 Sept. 15)
 - **Miscellaneous Discussions**
 - ESP32 pSRAM Support
 - Assembler Language Reference Manual

- [esptool: ESP32 Reset To Bootloader Issues on Windows](#)

DEVELOPMENT

Development software, tools, environments, languages, platforms, frameworks, libraries, code, and other resources:

- **ESP-IDF (Espressif IoT Development Framework)**
 - [Repository](#)
Official development framework for ESP32.
 - [ESP-IDF Releases](#)
 - [Toolchain Setup: Windows, Linux, macOS](#)
 - [Examples](#)
 - [Components](#)
 - [ESP-IDF Program Template](#)
 - [AT Application for ESP32 ESP-IDF](#)
- **Other Espressif Projects**
 - [OpenOCD \(On-Chip Debugger\) Branch with ESP32 JTAG Support](#)
 - [BinUtils Fork with Support for the ESP32 ULP Co-processor](#)
 - [ESP32 Bluetooth/BLE Stack Precompiled Binary Library](#)
(Included in ESP-IDF.)
 - [ESP32 Wi-Fi Stack Precompiled Binary Libraries](#)
(Included in ESP-IDF.)
- **Arduino (C++)**
 - [Arduino Core for the ESP32](#)
- **Simba Embedded Programming Platform**
See also: [Pumbaa \(MicroPython on Simba\)](#)
 - [Repository](#)
 - [Latest Release](#)
 - [Official board support: Nano32, ESP32-DevKitC, Maple ESP32](#)
- **Zephyr Project**
A scalable real-time operating system (RTOS) supporting multiple hardware architectures, optimized for resource constrained devices, and built with security in mind.
 - [Preliminary ESP32 port](#)
 - [Supported Xtensa boards](#)
- **Mongoose OS**
 - [Benefits & Security](#)
 - [Quick Start Guide](#)
 - [Examples](#)
 - [Amazon AWS IoT](#)
 - [Internet Button & Amazon AWS IoT](#)
 - [Secure Remote Device Management](#)
- **NuttX RTOS**
 - [ESP32 Support](#)
- **MicroPython**
 - [Official MicroPython for ESP32](#)
In the *micropython-esp32* repository, the *esp32* branch is the default branch (and more active) rather than the *master* branch.
 - [MicroPython for ESP32-WROVER with 4 MiB of pSRAM](#)
 - [Pumbaa — MicroPython on Simba](#)
[Pumbaa Documentation](#)
 - [Pycom's MicroPython Port](#)
Note: *Pycom and Damien George join forces for the ESP32*
- **Lua**
 - [LuaNode](#)
 - [Lua RTOS](#)
Programming with the Lua programming language directly or using a block-based programming language that translates blocks to Lua.
 - [Boris Lovosevic's Lua RTOS Fork](#)
Modules added for LED (WS2812) & TFT (ILI9341 & ST7735), and other modules modified.
 - [Whitecat Ecosystem Blockly Based Web IDE](#)
Whitecat uses Lua RTOS at its core.
 - [NodeMCU Firmware \(ESP32 Development Branch\)](#)
 - [NodeMCU ESP32/ESP-IDF Project \(Progress Tracking\)](#)
 - [RTOS-SDK, ESP32 and the Way Forward \(Discussion\)](#)
Historical: [ESP31 RTOS Migration Status](#)
- **JavaScript**
 - [Duktape](#)
 - [Repository](#)
 - [Documentation](#)
 - [Binary Download & Installation \(esp32-duktape-2017-01-20.tar.gz\)](#)
 - [Espruino JavaScript](#)
 - [Repository](#)
 - [Documentation](#)
 - [Builds](#)
 - [Chat \(Gitter\)](#)
 - [Mongoose JS \(mJS\)](#)

- [Repository](#)
 - [Documentation](#)
 - [Introduction: *mJS — a new approach to embedded scripting*](#)
- **mruby** (Carson McDonald & Yamamoto Masaya)
 - [mruby Application Template](#)
 - [mirb](#) (Embeddable Interactive Ruby Shell)
 - [I²C Library for ESP32 mruby](#)
 - [Notable project: RubyOnWheelchair](#)
Although an STM32 based board was ultimately used for the final form of the project for on-board Ethernet, an ESP32 board was used in the prototyping process.
- **Forth**
 - [CForth](#)
 - [Discussion on ForthHub](#)
- **BASIC**
 - [TinyBasic](#) (See also: [BASIC in ESP32 textcast demonstration.](#))
- **Other Code & Libraries**
 - [ESP32-OTA-HTTPS: Secure Over-The-Air Updates](#) (Article)
 - [Lightweight HTTP client for ESP32.](#)
 - [Example of using libcurl with ESP32](#) (Forum Post)
 - [MQTT](#)
 - [ESP32 MQTT Library & Sample Project](#) (Tuan PM)
Component based on ESP-IDF for ESP32.
 - [MQTT Component for ESP-IDF Projects](#) (Joël Gähwiler)
Based on the `lwmmqtt` library.
 - [ESP32 \(ESP-IDF\) Wi-Fi connect and resolve DNS](#)
 - [Template for Connecting to the AWS IoT Platform](#)
 - [Rudi's Standalone HTTP Server](#)
(Forum Post 1, 2; Video 1, 2)
 - [Pre-built ESP8266 & ESP32 Toolchains for NodeMCU Development & CI Use](#)
 - [Neil Kolban's ESP32 Code Snippets](#)
 - [FreeLinux's ESP32 Repository](#)
 - [Controlling GPIO Over HTTP Server](#)
Uses lwIP `http_server_netconn` example.
 - [ThingSpeak Example](#)
 - [Ring Log](#) (Edmund Huber)
An on-disk [ring buffer](#) for persistent, fixed-sized logs.
 - [ESP-IDF Example Project](#)
 - [Library](#)
 - [Forum Post](#)
 - [Sensors](#)
 - [Single DS18B20 on ESP-IDF](#)
DS18B20 is a 1-Wire digital thermometer.
 - [Simple DHT11 Library](#)
DHT11 is a simple temperature & humidity sensor.
 - [Camera Demo with OV7725](#)
 - [LEDs](#)
 - [Digital RGB LED \(WS2812/SK6812/NeoPixel/APA102/DotStar\) Drivers](#)
 - [AniCharlieplex](#)
Animation using the IS31FL3731 breakout and a Charlieplex 9x16 LED matrix.
 - [Firmware & app for WS2812 LED strip control via Bluetooth](#)
 - [Robotics](#)
 - [Mini Wi-Fi/BLE 4WD robot platform](#) (Code, Summary Info)
 - [Gaming](#)
 - [ESP32-DOOM](#) (Forum Post, Video)
 - [15 Puzzle](#)
15 puzzle sliding tile puzzle for use with a ILI9328 display.
 - [Nintendo Game System Emulation](#)
 - [ESP32-NESEMU](#) (Video, Hackaday Summary)
A Nintendo Entertainment System emulator for the ESP32.
 - [Tiniest Game Boy Hides in Your Pocket](#) (Video)
 - [WiFiBoy32](#)
 - [Wi-Fi](#)
 - [ESP32 802.11 Freedom Output](#)
Send arbitrary IEEE 802.11 frames. See also: [ESP32 Wi-Fi Range Testing: 10 km Using Directional Antenna.](#)
 - [Sniffing](#)
 - [Wi-Fi Sniffer](#) (Łukasz Podkalicki)
 - [ArduinoPcap](#) (Stefan Kremser)
A library for creating and sending .pcap files for Wireshark and other programs. (Video)
 - [BluFi](#)
Although this is Bluetooth, BluFi provides onboarding for Wi-Fi setup. See also: [EspBluFi Android App](#) and [ESP32 Bluetooth Networking User Guide.](#)
 - [ESP-IDF BluFi Demo](#)
 - [ESP32-BluFi Component & ESP-IDF Demo](#) (Mark Wolfe)
 - [Bluetooth](#)
 - [BTstack Port for the Espressif ESP32 Platform](#)
 - [Audio](#)
 - [MP3 & AAC Decoder](#) (Forum Post, Demo Video)
Michael "MrBuddyCasino" Böckling's port of Jeroen "Spritetrn" Domburg's ESP8266 MP3 decoder to the ESP32.
 - [MP3 Decoder with OLED Display Support](#) (Demo Video)

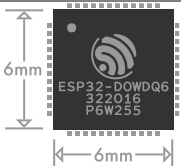
Microwavemont (kodera2t)'s fork of MrBuddyCasino's port with OLED display support. See also: [n24bass's fork](#)




- **CAN Driver (Thomas Barth)**
See also: [A CAN driver for the ESP32](#), [Hackaday.io project](#), and [forum thread](#).
- **TFT Library for ILI9341 & ILI9488 (Forum Post)**
- **Third-Party Tools & IDEs**
 - **PlatformIO**
PlatformIO "Espressif 32" platform package, documentation, and repository.
 - **Pymakr**
Pycom IDE for MicroPython on Pycom boards.
 - **Neil Kolban's Development Tools for ESP32 on Raspberry Pi**
([Forum Post](#), [Video](#))
 - **DevC++ IDE with ESP32 ESP-IDF Support**
([Setup Notes](#))
 - **QEMU ESP32**
 - **Whitecat Ecosystem Blockly Based Web IDE**
 - **Visuino Graphical Development for Arduino**
Commercial IDE with [various pricing options](#).
- **PCB Design Resources**
 - KiCad
 - **ESP32 KiCad Footprints** (Adam Vadala-Roth)
 - **KiCad Libraries** (Baoshi Zhu)
 - **KiCad ESP32 Schematic Symbol** (Nava Whiteford)
 - **WEMOS LoLin32 KiCad Library/Footprint** (Eric Renfro)
 - EAGLE
 - **EAGLE Library** (Macro Yau)
 - Altium Designer
 - **Library for ESP-32S & ESP-WROOM-32** (Evert Dekker)
 - Hardware Reference Design
 - **ESP32 Hardware Design Guidelines** (PDF)
 - **ESP32 Module Reference Design** (ZIP)
ESP32 module reference design resources, including schematics, PCB layout, Gerber files, and BOM list.
 - **ESP-WROOM-32 Reference Design** (ZIP)
ESP-WROOM-32 module reference design resources, including schematics, PCB layout, Gerber files, and BOM list. Intended for developers who purchase Espressif's official mass-produced ESP-WROOM-32 modules.

HARDWARE

Chips

ESP32 chips presently come in Quad-Flat No-leads (QFN) packages with 48+1 pads. See chapter 6 *Package Information* in the [ESP32 Datasheet](#) for physical footprint/dimensions.



IDENTIFIER	PROCESSOR CORES	EMBEDDED FLASH MEM.	PACKAGE SIZE	SILICON REVISION	NOTES																		
ESP32-D0WDQ6	2	0 MiB	6×6 mm²	0	<div><ul style="list-style-type: none">• Initial production release (non-beta) chip of the ESP32 series.• Manufacture process: TSMC ultra-low power 40 nm• Datasheet• Chip pinout poster• Die photos• Launch/release date: 2016 Sept. 6• Known manufacture dates:<table><thead><tr><th>WAFER LOT NUMBER</th><th>YEAR</th><th>WEEK</th></tr></thead><tbody><tr><td>P6W255</td><td>2016</td><td>32nd</td></tr><tr><td></td><td></td><td>35th</td></tr><tr><td></td><td></td><td>39th</td></tr><tr><td></td><td></td><td>50th</td></tr><tr><td>PC3W29</td><td>2017</td><td>1st</td></tr></tbody></table></div> <div></div> <div>Note: PC3W29 is still revision 0; revision 1 not released yet.</div>	WAFER LOT NUMBER	YEAR	WEEK	P6W255	2016	32nd			35th			39th			50th	PC3W29	2017	1st
WAFER LOT NUMBER	YEAR	WEEK																					
P6W255	2016	32nd																					
		35th																					
		39th																					
		50th																					
PC3W29	2017	1st																					
1					<div><ul style="list-style-type: none">• Known manufacture dates:<table><thead><tr><th>WAFER LOT NUMBER</th><th>YEAR</th><th>WEEK</th></tr></thead><tbody><tr><td>PCKA36</td><td>2017</td><td>6th</td></tr><tr><td></td><td></td><td>11th</td></tr><tr><td></td><td></td><td>12th</td></tr></tbody></table></div>	WAFER LOT NUMBER	YEAR	WEEK	PCKA36	2017	6th			11th			12th						
WAFER LOT NUMBER	YEAR	WEEK																					
PCKA36	2017	6th																					
		11th																					
		12th																					

ESP32-D0WD	2	0 MiB	5×5 mm ²	?	<ul style="list-style-type: none">Smaller physical package, but otherwise functionally the same as ESP32-D0WDQ6.Known manufacture dates:<table><tr><th>WAFER LOT NUMBER</th><th>YEAR</th><th>WEEK</th></tr><tr><td>PC3W29</td><td>2017</td><td>10th</td></tr></table>	WAFER LOT NUMBER	YEAR	WEEK	PC3W29	2017	10th	
WAFER LOT NUMBER	YEAR	WEEK										
PC3W29	2017	10th										
ESP32-D2WD	2	2 MiB	5×5 mm ²	?	<ul style="list-style-type: none">Variation with 2 MiB (16 Mibit) of embedded flash.GPIO16, GPIO17, SD_CMD, SD_CLK, SD_DATA_0 and SD_DATA_1 are used for internally connecting the embedded flash, and are not recommended for other uses. ⚠Known manufacture dates:<table><tr><th>WAFER LOT NUMBER</th><th>YEAR</th><th>WEEK</th></tr><tr><td>PP3376</td><td>2017</td><td>13th</td></tr></table>	WAFER LOT NUMBER	YEAR	WEEK	PP3376	2017	13th	
WAFER LOT NUMBER	YEAR	WEEK										
PP3376	2017	13th										
ESP32-S0WD	1	0 MiB	5×5 mm ²	?	<ul style="list-style-type: none">Variation with single-core (instead of dual-core) processor.							

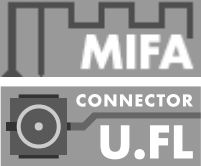
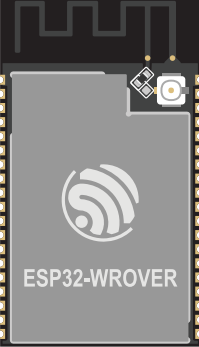




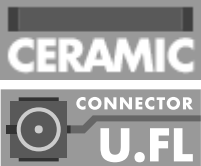


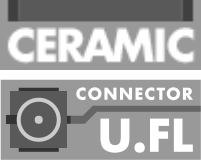
The "Processor Cores" column above lists number of cores for the main processor; this number excludes the ULP co-processor. See *ECO (Engineering Change Order) and Workarounds for Bugs in ESP32* for differences between revision 0 and revision 1. For information on the ESP31B prototype/beta chip, [visit the Historical page](#).









Compact SMT Modules

The ESP32-based Wi-Fi/Bluetooth communication modules in the table below are surface-mount devices (SMD). Each module is a small printed circuit board upon which chips and other components are soldered and treated as an inseparable assembly to be integrated onto another PCB. All the modules listed below contain an ESP32 chip, a 40 MHz crystal (clock), and a flash memory chip, but vary in features such as antenna configuration, capacity of the flash memory chip, and EMI shielding. Because these wireless communication module boards are designed for incorporation into final products (unlike development boards), they lack development components which are unnecessary or undesirable in final products — e.g., typically no USB-to-UART nor programming/reset buttons — minimizing both cost and physical size.

MAKER	MODEL	FLASH MEMORY	ANTENNA	EMI SHIELD	NOTES
Espressif 	ESP-WROOM-32	4 MiB GD25Q32CSIG		Yes	<ul style="list-style-type: none"> Initial production release (non-beta) module board created by Espressif. Size: 18 mm × 25.5 mm Datasheet Schematic Pinout poster Regulatory <ul style="list-style-type: none"> FCC ID: 2AC7Z-ESPWROOM32 MIC/TELEC certificate number: 211-161007 CE notified body: Bay Area Compliance Laboratories Corp. (1313) Hardware reference design (ZIP) A special variation of the ESP-WROOM-32 module with 16 MiB flash is used with the SHA2017 Badge. Availability: Released & purchasable






	ESP32-WROVER	4 MiB IS25WP032		Yes	<ul style="list-style-type: none"> "Two column" footprint differs from ESP-WROOM-32 footprint; notably, placement of pads 15–24. Espressif ESP-WROVER-KIT, Espressif ESP32-Lyra, and Baoshì's JESP32 Nano boards have solder pads that accept the ESP32-WROVER footprint. pSRAM: 4 MiB (ESP-PSRAM32) User guide Pinout Regulatory <ul style="list-style-type: none"> FCC ID: 2AC7Z-ESP32WROVER CE notified body: Bay Area Compliance Laboratories Corp. (1313) SRRC CMIIT ID: 2017DP3657 EMI shield: Pre-release, early versions of this module (intended for testing) lacked an EMI shield, however, the production release of this module includes a shield. Availability: Presently included with latest models of the ESP-WROVER-KIT, but not yet sold separately. 	
Ai-Thinker	ESP-32S	4 MiB W25Q32FVSI		Yes	<ul style="list-style-type: none"> Remake/clone of the ESP-WROOM-32. FCC ID: 2AHMR-ESP32S Ai-Thinker wiki ESP32 article Availability: Released & purchasable 	
AnalogLamb	ESP-32S-ALB	4 MiB		No	<ul style="list-style-type: none"> Clone of the ESP-32S module. Footprint: Compatible with ESP-WROOM-32 & ESP-32S. Module PCB has green color solder mask coating. Lacks EMI shield and is not FCC certified. Availability: Released and in stock. 	
	ALB32-WROVER	8 MiB		Yes	<ul style="list-style-type: none"> Footprint same as ESP-WROOM-32. pSRAM: 4 MiB Size: 18 mm × 25 mm × 3 mm Note: Not FCC tested. Announcement Availability: To be released 2017 August 8. 	
DFRobot	ESP-WROOM-32	4 MiB		Yes	<ul style="list-style-type: none"> Clone/remake of Espressif ESP-WROOM-32 module. Wiki article Photo by Hugatry Note: Unlike the official Espressif ESP-WROOM-32, this clone by DFRobot is not presently FCC certified. 	
eBox & Widora	ESP32-Bit	4 MiB		Yes	<ul style="list-style-type: none"> Antenna: on-board ceramic antenna and connector for an external antenna. Footprint: Unique and differs from all other manufactured modules. Pinout Seller: DIYmall on Amazon Availability: Released & purchasable (Although rather pricy.) 	
Freematics	ESP32 Module	4 MiB (also 16 MiB in future variation)		Yes	<ul style="list-style-type: none"> Clone/remake of Espressif ESP-WROOM-32 module. Seen on Freematics ESPRIT development board. Does not appear to be sold separately. 	
IntoRobot	W32	4 MiB		Yes	<ul style="list-style-type: none"> Custom ESP32 based module. Footprint: Custom footprint differs from ESP-WROOM-32. Datasheet (PDF) Documentation Seller: IntoRobot on Taobao 	
	W33	4 MiB		Yes	<ul style="list-style-type: none"> ESP32 based module with on-board ceramic antenna and U.FL connector for external antenna. Footprint: Custom footprint differs from ESP-WROOM-32. Datasheet (PDF) Documentation Seller: IntoRobot on Taobao 	

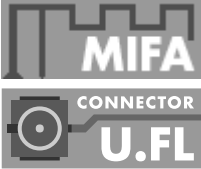


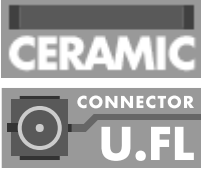
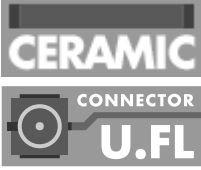
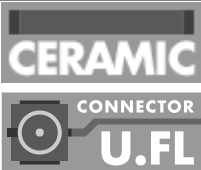
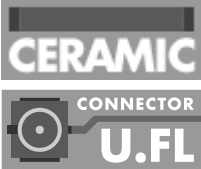
ITEAD	PSH-C32 IM160913001	1 MiB PN25F08		No	<ul style="list-style-type: none"> • Wiki article • Schematic • Compared to other modules, 1 MiB is an unusually small flash memory capacity. △ • Footprint: Unique and differs from all other manufactured modules. • EMI shield: None. (But has solder pads for a shield.) • History: <ul style="list-style-type: none"> • 2017 Feb. 15: Initial wiki page • 2017 Feb. 22: Twitter announcement • Availability: Released & purchasable
Pycom	W01	8 MiB		Yes	<ul style="list-style-type: none"> • OEM module version of the WiPy 2.0. Supports Wi-Fi and Bluetooth. • Pinout & dimensions/footprint • See also: OEM Reference Board for Pycom modules.
	L01	8 MiB		Yes	<ul style="list-style-type: none"> • OEM module version of the LoPy. Supports Wi-Fi, Bluetooth, and LoRa. • See also: OEM Reference Board for Pycom modules.
	S01	8 MiB		Yes	<ul style="list-style-type: none"> • OEM module version of the SiPy. Supports Wi-Fi, Bluetooth, and Sigfox. • Sigfox maximum Tx power variations: 14 dB_{mW} (Europe), 22 dB_{mW} (America/Australia/New Zealand) • See also: OEM Reference Board for Pycom modules.
	G01	8 MiB		Yes	<ul style="list-style-type: none"> • OEM module version of the GPy. Supports Cellular LTE-CAT M1/NB1, Wi-Fi and Bluetooth. • See also: OEM Reference Board for Pycom modules.
U-Blox	NINA-W131	2 MiB		Yes	<ul style="list-style-type: none"> • Part of the U-Blox NINA-W1 series of Wi-Fi modules. • NINA-W131 has connection pad for an external antenna.
	NINA-W132	2 MiB		Yes	<ul style="list-style-type: none"> • Part of the U-Blox NINA-W1 series of Wi-Fi modules. • NINA-W132 has an on-board planar inverted-F antenna — shaped (cut & bent) metal.
United Technologies	WB_MODE_V1	4 MiB 25Q32A		No	<ul style="list-style-type: none"> • Appears to be a clone of the ESP-32S module. • Seen soldered onto GHX_BOARD_V1 development board. • Does not appear to be sold separately. • EMI shield: None. (But has solder pads for a shield.)

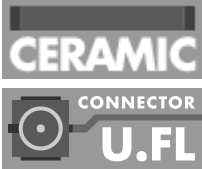

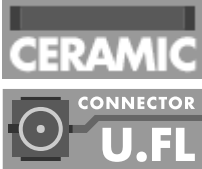
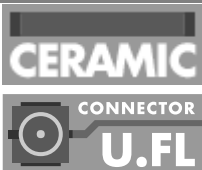

For information on Espressif's ESP-WROOM-03 beta module and Ai-Thinker's ESP3201, ESP3207 and ESP3212 modules, [visit the Historical page](#).

Small & Medium Development Boards/Modules (Not SMT Module-Based)

These small and medium sized development boards have USB-to-UART interfaces, but the ESP32 chip is directly incorporated into the board (instead of using a ESP32-based SMT module).

MAKER	MODEL	FLASH MEMORY	ANTENNA	EMI SHIELD	USB↔UART	NOTES
Electronic Sweet Peas	ESP320	16 MiB (tentative)		No	SiLabs CP2104	<ul style="list-style-type: none"> • Very small development board. Similar to the Electronic Sweet Peas ESP210 board. • Part of the Node.IT family concept. • Availability: Unreleased; under development
Gravitech & MakerAsia	Nano32	4 MiB or 8 MiB		No	FTDI FT231XQ	<ul style="list-style-type: none"> • Released; available for order from Gravitech US and Gravitech Thai. • Programming guide • From Gravitech (creator of Arduino Nano) and MakerAsia (creator of ESPresso Lite).
Heltec Automation	WIFI Kit 32	?		No	SiLabs CP2102	<ul style="list-style-type: none"> • ESP32 development board with OLED display and battery connector. • Pinout


	WIFI LoRa 32	?		No	SiLabs CP2102	<ul style="list-style-type: none"> ESP32 development board with 0.96 inch OLED display, battery connector, and LoRa (SX1278). Antennas: ESP32 Wi-Fi & Bluetooth uses the MIFA PCB trace and SX1278 LoRa uses an external antenna via the U.FL connector. Pinout
Makestro/DycodeX	ESpectro32	?		No	FTDI FT231XS	<ul style="list-style-type: none"> Development board with USB connector, battery connector, on/off switch, RGB LED (on GPIO21), button (GPIO5), ceramic antenna, Grove connector, headers for I²C and more. Video: Early hardware blink test Availability: Unreleased; under development
Pesky Products Kris "onehorse" Winer	ESP32 Development Board	4 MiB N25Q032A		No	FTDI FT230XQ	<ul style="list-style-type: none"> Other notable components: MAX1555 LiPo battery charger, 3.3 V MIC5528 LDO supplying 500 mA Gerber files available on OSH Park Antenna connection: Plated through-hole at end of antenna trace for soldering on an antenna. (1.25" copper wire can be used for the antenna.)
Pycom	WiPi 2.0	4 MiB		Yes	(None)	<ul style="list-style-type: none"> MicroPython programmable Wi-Fi & Bluetooth IoT development platform with a 1 km Wi-Fi range. FCC ID: 2AJMTWIPY2R Documentation <ul style="list-style-type: none"> Datasheet Pinout Deep sleep issue and fix for affected boards (deep sleep shield schematic) See also: Pycom expansion boards & shields
	LoPy	4 MiB		Yes	(None)	<ul style="list-style-type: none"> Triple network board with Wi-Fi, BLE, and LoRa. FCC ID: 2AJMTLOPY1R Documentation <ul style="list-style-type: none"> Datasheet Pinout Do <i>not</i> connect anything to pins P5, P6 and P7, since these pins are used by the SPI bus that controls the LoRa radio. These pins should be treated as NC (No Connection). Wiring connections to these pins will cause incorrect behavior of the LoRa radio. See also: Pycom expansion boards & shields
	SiPy	4 MiB		Yes	(None)	<ul style="list-style-type: none"> Triple network board with Wi-Fi, BLE, and Sigfox. FCC ID: 2AJMTSIPY1 Documentation <ul style="list-style-type: none"> Datasheet Pinout Do <i>not</i> connect anything to pins P5, P6 and P7, since these pins are used by the SPI bus that controls the Sigfox radio. These pins should be treated as NC. Wiring connections to these pins will cause incorrect behavior of the Sigfox radio. See also: Pycom expansion boards & shields
	GPY	4 MiB		Yes	(None)	<ul style="list-style-type: none"> Triple network board with Wi-Fi, BLE and cellular LTE CAT M1/NB1. Documentation <ul style="list-style-type: none"> Datasheet See also: Pycom expansion boards & shields

FiPy	4 MiB		Yes	(None)	<ul style="list-style-type: none"> Quintuple network board with Wi-Fi, BLE, LoRa, Sigfox and dual LTE-M (CAT M1 and NB-IoT). Documentation <ul style="list-style-type: none"> Datasheet See also: Pycom expansion boards & shields
SparkFun	ESP32 Thing 4 MiB W25Q32FVSI		No	FTDI FT231XS	<ul style="list-style-type: none"> Small development board with RST/IOO buttons and LiPo battery charger. Antenna: Inverted-F antenna (PCB trace) Hookup guide Pinout Repository Accessories: <ul style="list-style-type: none"> Power control shield Hookup guide, schematic, Eagle files (ZIP), MC33926 datasheet, repository Environment sensor shield Includes sensors for pressure/humidity/temperature (BME280), air quality (CCS811), and ambient light (APDS-9301). Qwiic shield Schematic, Eagle files (ZIP), repository
Whitecat	ESP32 N1 4 MiB		No	(None)	<ul style="list-style-type: none"> Whitecat N1 board <i>without</i> LoRa transceiver. Second voltage regulator for power on / power off sensors through a dedicated GPIO. Size: 78 mm × 26 mm Seller: Whitecat (€30)
	ESP32 N1 LORA 4 MiB		No	(None)	<ul style="list-style-type: none"> Whitecat N1 board <i>with</i> LoRa transceiver. Second voltage regulator for power on / power off sensors through a dedicated GPIO. Size: 78 mm × 26 mm Seller: Whitecat (€40)
Widora	Air 16 MiB		No	SiLabs CP2104	<ul style="list-style-type: none"> A development board with a slim form-factor that makes it great for use on a breadboard. History: <ul style="list-style-type: none"> 2016 Sept. 21: Vers. 1.0 up and running. 2016 Oct. 18: Vers. 3.0 photo; development and testing finalized. Mass production run soon. 2017 Feb. 22: Vers. 4.0 boards assembled. 2017 Mar. 5: Vers. 4.0 photo on a breadboard.

Small & Medium Development Boards/Modules (SMT Module-Based)

Development boards are designed to be easily worked with for the purpose prototyping and development. Typically this means connections are broken out with 0.1" spaced headers (in contrast to the more tightly spaced connections seen on the compact SMT module boards). Furthermore, development boards often contain on-board components to aid in easy prototyping & programming — e.g., power-supply/regulation, USB-to-UART, and buttons for flashing & resetting.

MAKER	MODEL	SMT MODULE	USB⇄UART NOTES
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Espressif 	ESP32-DevKitC Core Board	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Other notable components: Micro-B USB connector, AMS1117 LDO Documentation: <ul style="list-style-type: none"> Getting started guides: official PDF guide & HTML guide in ESP-IDF docs Schematic (V2) Development board reference design (ZIP) Includes PCB layout, Gerber files, BOM list, and schematic. Versions: <ul style="list-style-type: none"> V1 (blue solder mask) had an auto-reset issue. Related discussion: Exposing the EN and Boot buttons off DevKitC V2 (black solder mask) fixed the auto-reset issue.
Adafruit	HUZZAH32 ESP32 Feather Board	ESP-WROOM-32	SiLabs CP2104	<ul style="list-style-type: none"> Availability: Temporarily out of stock. (In production; was available, but presently sold out.) History: <ul style="list-style-type: none"> 2016 Sep. 21: Teaser tweet & first sneak peek (video) (Starts at time index 0:58:25.) 2016 Nov. 2: Second sneak peek (Starts at time index 1:02:34.) 2017 May 5: Assembly teaser video 2017 May 7: ESP32 Feather is (almost) here 2017 May 8: Short manufacturing montage 2017 May 10: Product posted to store 2017 May 11: Product announcement blog post
Ai-Thinker	NodeMCU-32S	ESP-32S	SiLabs CP2102	<ul style="list-style-type: none"> A development board with USB-to-UART and EN/IOO buttons. Ai-Thinker wiki NodeMCU-32S article Pinout Schematic LDO: AMS1117
AnalogLamb	ESP32 Development Board	ESP-32S-ALB ESP-32S, or ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Development board appears similar to ESP32-DevKitC. Schematic Hackaday.io project
AprilBrother	ESPea32	ESP-32S	SiLabs CP2104	<ul style="list-style-type: none"> Compact development board with small perfboard area that can be cut down to a smaller size if desired. Note: Module soldered onto underside of board. Repository
Ayarafun/LamLoei	Node32S	ESP-WROOM-32	FTDI FT231XS	<ul style="list-style-type: none"> Development board with USB-to-UART, EN & BOOT buttons, LED (GPIO2), battery connector & charging circuit, and on the "Plus" edition, a humidity/temperature sensor. Board underside has an artistic elephant silkscreened onto it. Pinout Photos Node32S Arduino IDE Guide (Thai) Node32S Book (Thai) LamLoei Facebook Componentless bare PCB also available.
Baoshi	JESP32	ESP-WROOM-32 or ESP32-WROVER	FTDI FT2232HL	<ul style="list-style-type: none"> JESP32 is really a combination of two separate boards: JESP32 Nano and JESP32 JTAG. JESP32 Nano is the ESP32 development board, and JESP32 JTAG is a JTAG shield for the JESP32 Nano. JESP32 is designed to be breadboard friendly. History: <ul style="list-style-type: none"> 2016 Nov. 2: Prototype board 2017 Feb. 6: Rendered board pair 2017 Apr. 6: Assembled board pair 2017 Apr. 11: Assembled boards being washed
DFRobot	FireBeetle ESP32 DFR0478	DFRobot ESP-WROOM-32 (clone module)	?	<ul style="list-style-type: none"> Product information (wiki article) Video: LED blink demo Other articles: "DFRobot's FireBeetle ESP32 board" & "Arduino: Hello World" Seller: DFRobot
DOIT/SmartArduino	ESP32 DevKit	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Information & usage guide Schematic Versions: V1 DOIT ESP32 DevKit V1 boards have been sold as "Geekcreit" sometimes in product listings.

Dongsen Technology Travis Lin	D-duino-32	ESP-32S or ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Development board with ESP-32S module, 0.96" OLED, and programming buttons. LDO: AMS1117 Versions: <ul style="list-style-type: none"> V1: 6.5 cm long. V2: 5.75 cm long, more stable Micro USB connector.
	Pocket 32	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Development board with ESP-WROOM-32 module, USB-to-UART, programming buttons, on/off switch, 18650 battery socket, charging circuit & indicator LED, and user programmable LED (on GPIO16). LDO: AMS1117 History: <ul style="list-style-type: none"> 2017 Apr. 13: Testing; side-by-side comparison with Pocket WiFi (ESP8266) 2017 Apr. 24: Product listed on Tindie
	X-32	ESP-32S or ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Compact, small development board/module with USB-to-UART, LDO regulator, and EN & Boot buttons. Designed for the <i>X-project</i> family of stackable modules.
dotstudio	Nefry BT	ESP-WROOM-32	FTDI FT232RQ	<ul style="list-style-type: none"> Nefry BT is an ESP-WROOM-32 based IoT device with four Grove connectors and an RGB LED. Nefry BT follows in the footsteps of the ESP-WROOM-02 (ESP8266) based Nefry v2.0. Designed to fit inside a repurposed Frisk mints container. Nefry is pronounced as <i>ne-fu-rii</i>. Kibidango crowd-funding page
eBox	ESP32-T	ESP32-Bit, ESP-WROOM-32 or ESP-32S (not included)	SiLabs CP2102	<ul style="list-style-type: none"> Development board primarily for the eBox/Widora ESP32-Bit module, which is <i>not</i> included with this board as currently sold. (Module must be purchased separately and then soldered on.) Module: Not included Has pads for eBox/Widora ESP32-Bit module (and ver. 2 has additional pads for the ESP-WROOM-32/ESP-32S module). Versions: <ul style="list-style-type: none"> V1 has underside connection pads for the never released ESP3212 module. V2 has underside connection pads for the ESP-WROOM-32/ESP-32S module. Also, V2 development board pinout differs from V1. Sellers: DIYmall on Amazon & eBox on Taobao
	ESP32-ST	ESP-32S or ESP-WROOM-32 (not included)	SiLabs CP2102	<ul style="list-style-type: none"> Although similar in design to the ESP32-T, the ESP32-ST development board only has solder pads for the ESP-WROOM-32/ESP-32S module footprint. (No solder pads for the eBox/Widora ESP32-Bit module.) Pinout Module: Not included Has pads for ESP-WROOM-32/ESP-32S module footprint.
EzSBC	ESP32-01 Breakout & Dev. Board IoT Controller	ESP-WROOM-32 or ESP-32S	FTDI FT231XS	<ul style="list-style-type: none"> Development board with USB-to-UART, two tri-color LEDs, and EN/IOO buttons. Schematic History: 2017 Jan. 7 product announcement Seller: EzSBC, EzSBC on Tindie
Elecrow	ESP32 WIFI/BLE Board ARS01119B	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Development board with USB-to-UART bridge, Micro USB connector, battery connector and integrated battery charger. Wiki article EAGLE files (schematic and PCB layout)
Explore Embedded	Hornbill ESP32 Dev	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Repository Crowd Supply Hackaday.io project Projects: <ul style="list-style-type: none"> Air quality monitoring (repository) Open universal remote (BLE/IR bridge) Hornbill industrial data logger (repository) Hornbill lights (repository) Controlling WS2812 LED strips via Bluetooth. Additionally, the Hornbill ESP32 Proto is a supplementary protoboard/perfboard with microSD slot intended to be used with the Hornbill ESP32 Dev board in project development.

	Hornbill ESP32 Minima	ESP-WROOM-32	(None)	<ul style="list-style-type: none"> Circular development board with large contacts for easy prototyping with alligator clips. LIPO battery connector for building wearables. Schematic Repository Project: Frivolous Internet Connected Display
Geekworm	Easy Kit ESP32-B1	ESP-WROOM-32	WCH CH340C	<ul style="list-style-type: none"> Development board with red solder mask. LDO: AMS1117 Availability: Released and purchasable.
GNDTechnik	ESP32 Breakout Kit	ESP-WROOM-32	SiLabs CP2104	<ul style="list-style-type: none"> Development board/module with ESP-WROOM-32 module, USB-to-UART, Reset & Boot (IO0) buttons, Li-ion battery connector & charger, two Grove connectors, LED on IO2, and three indicator LEDs. Headers are 0.1" spaced for breadboard compatibility. Photos: <ul style="list-style-type: none"> 2017 Apr. 30: Assembled board 2017 Jun. 30: Operational with peripherals Availability: Unavailable, but should be available soon.
Gouuuu Tech Guoyun Technology 果云科技	Gouuuu-ESP32	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Vaguely, the board visually looks like a cross between the DOIT ESP32 DevKit and the XiaoJ ESP32-Mini-Board designs. Silkscreen on the underside reads "GOOUUU-ESP32". Seen sold in various Asian electronics reseller online market venues. Sometimes erroneously listed as a DOIT board.
IntoRobot	Fig	W32 or W33	SiLabs CP2104	<ul style="list-style-type: none"> Development board with USB-to-UART, light sensor, battery interface, and more. Module options: This board is sold with either the IntoRobot W32 or W33 module. Notably, W33 has a ceramic antenna and U.FL connector. Size: 48.01 mm × 26.42 mm Datasheet (PDF) Documentation Seller: IntoRobot on Taobao
iohippo M. Hamit Yanik	ESP32 Dev. Board	ESP-WROOM-32	SiLabs CP2102N	<ul style="list-style-type: none"> ESP32 development board with Li-Po connector & charger, USB connector, USB⇌UART, and boot/reset buttons. History: <ul style="list-style-type: none"> 2017 Mar. 13: Renderings, photo, and video Availability: Unreleased; under development
Kilobyte Benjamin Marty, a.k.a. Berkutta	ESP32 Breakout	ESP-WROOM-32	SiLabs CP2102N	<ul style="list-style-type: none"> A custom development board with IO0/Boot & EN/Reset buttons, USB-to-UART, LDO, and a tri-color LED. The area underneath the module antenna is cutout. History: <ul style="list-style-type: none"> 2017 Feb. 23: Early board design 2017 Mar. 4: Board ordered from OSH Park 2017 Mar. 23: Assembled boards (OSH Park PCB) 2017 Apr. 17: Assembled board (Elecrow PCB) Seller: Kilobyte on Tindie
	Tiny ESP32 Board "ESP32 tiny module"	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Tiny ESP32 board with optional battery header and BME280. Size: 1.15 × 1.05 in² (29.21 × 26.72 mm²) Schematic
	RAK831 ESP32	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> LoRaWAN enabled ESP32 board.
The Magic Cauldron BambooHill	ESP-WROOM-32 Breakout	ESP-WROOM-32	FTDI FT231XS	<ul style="list-style-type: none"> Development board with microSD card slot underneath. Pinout Schematic Bill of materials Versions: 1.0 (v1 r3), 2.0a (v2 r6), 2.0b Seller: Switch Science (¥3980)
MH-ET LIVE	ESP32 DevKit	ESP-WROOM-32	SiLabs CP2104	<ul style="list-style-type: none"> Development board with USB connector, USB-to-UART chip, LDO, and EN/BOOT buttons. User guide Code: MHETLIVE32dev variant files for ESP32 Arduino Core Seller: WAVGAT on AliExpress

	ESP32 MiniKit	ESP-WROOM-32	SiLabs CP2104	<ul style="list-style-type: none"> Small development board designed for compatibility with shields designed for the ESP8266 based WeMos D1 Mini. Some sellers are calling it the "MH-ET LIVE D1 mini", but MH-ET LIVE calls it the "ESP32 MiniKit". Early boards have a typographical error in the silkscreen, labeling the board as "ESP32 MminiKIT". User guide Repository & shield libraries Seller: WAVGAT on AliExpress
PatternAgents	thingSoC ESP32S	ESP-32S or ESP-WROOM-32	(None)	<ul style="list-style-type: none"> ESP32-based breakout board/module for the thingSoC open source sockets family. Repository Pinout Getting started guide Hackster.io project
SunDUINO	ESP32 MiniBoard	ESP-WROOM-32	(None)	<ul style="list-style-type: none"> Development breakout board for ESP-WROOM-32/ESP-32S module. Lacks USB-to-UART; only a direct UART connection is provided. LDO: TS1117CW-3.3V
Switch Science	ESPr Developer 32	ESP-WROOM-32	FTDI FT231XS	<ul style="list-style-type: none"> Development board designed with compatibility for ESPr shields. Size: 18 mm × 25.5 mm × 2.8 mm Schematic
thingTronics	WiTooth	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Development board with USB-A plug for easily plugging the board into a computer for programming or directly into a typical USB power adapter — no cable required. Repository Pictures: <ul style="list-style-type: none"> 2017 Feb. 17: Rendering 2017 Mar. 8: Bare board 2017 Mar. 15: Finished board Versions: 1.0, 1.1 Availability: Unreleased; under development
Watterott	ESP-WROOM-32-Breakout	ESP-WROOM-32	SiLabs CP2102N	<ul style="list-style-type: none"> Development board similar to ESP32-DevKitC. Versions: <ul style="list-style-type: none"> 1.0: Schematic 1.1: Schematic Repository
WEMOS	LoLin32	ESP-WROOM-32	SiLabs CP2104	<ul style="list-style-type: none"> Development board with reset button, USB-to-UART, and battery interface. Wiki article Forum Commit to Arduino core for ESP32 KiCad Library & Footprint Seller: WEMOS CC Store on AliExpress
"WeMos" (not actually WeMos)	LoLin OLED or D-duino	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Development board/module with on-board OLED. Even though the "LoLin OLED" board has "WeMos" branding silkscreened onto it, the official WeMos forum administrator posted a reply stating that "it's not [a] product from WEMOS". This board is a copy/clone of Travis Lin's D-duino-32. Sellers: Banggood and various vendors on AliExpress
	WiFi&Bluetooth Battery	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> This board is a copy/clone of Travis Lin's Pocket 32. Has "WeMos" branding silkscreened onto it, but not actually from WeMos. Sellers: various vendors on AliExpress
	X-32	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> This board is a copy/clone of Travis Lin's X-32. Has "WeMos" branding silkscreened onto it, but not actually from WeMos. Seen listed under ambiguous names such as "LoLin ESP32 WeMos". Sellers: various vendors on AliExpress
XiaoJ	ESP32-Mini-Board	ESP-WROOM-32	SiLabs CP2102	<ul style="list-style-type: none"> Sold by: XiaoJ的杂货铺 LDO: AMS1117 History: <ul style="list-style-type: none"> 2016 Aug. 28: Prototype first seen

Large Development, Specialty & Project Boards

MAKER	MODEL	SMT MODULE	FLASH MEMORY	USB⇌UART	NOTES
Espressif 	ESP-WROVER-KIT (previously ESP32-DevKitJ)	ESP-WROOM-32 or ESP32-WROVER	4 MiB (from SMT module)	FTDI FT2232HL	<ul style="list-style-type: none"> Other notable components: <ul style="list-style-type: none"> Display: 3.2" SPI LCD USB⇌JTAG: provided by FTDI FT2232HL Other data interfaces: microSD card, VGA camera Power: <ul style="list-style-type: none"> Interfaces: 5 V_{DC} barrel jack & Micro-B USB LDO: NCP1117 (1 A); can be replaced with LM317DCY (1.5 A) Versions & schematics: <ul style="list-style-type: none"> V1 (red solder mask): Schematic V2 (black solder mask): Schematic V3 (black solder mask with female header camera connector): Schematic Discussion of V1/V2 differences Getting started guide Demos & code: Nofrendo NES-Emulator (video), camera demo, LCD driver & sample code (forked from ESP32_Adafruit_ILI9341). Sellers: Adafruit, Grid Connect, and Olimex
	ESP32-Lyra	ESP-WROOM-32 or ESP32-WROVER	4 MiB (from SMT module)	?	<ul style="list-style-type: none"> A large development board for audio playback & recording. Wi-Fi Certified interoperability certificate ID: WFA69503 Further details available toward the end of Espressif's 2016 Sept. 7 press release.
	ESP32 Demo Board V2	ESP-WROOM-32	4 MiB (from SMT module)	FTDI FT232RL	<ul style="list-style-type: none"> A large development & demo board with large, circular touch pads. Schematic
AnalogLamb	Maple ESP32	ESP-32S-ALB, ESP-32S, or ESP-WROOM-32	4 MiB (from SMT module)	SiLabs CP2104	<ul style="list-style-type: none"> Notable features: microSD card interface & battery interface. Versions: R1 (currently sold), R2 (coming soon) Diagrams: <ul style="list-style-type: none"> Assembly drawing Schematic Hackaday.io project
Asukiaaaa	ESP32BB	ESP-WROOM-32	4 MiB (from SMT module)	SiLabs CP2102 (rev 1.0–1.4 used FT232RQ)	<ul style="list-style-type: none"> Development board for ESP-WROOM-32 (or ESP-32S) with USB connector, USB⇌UART, buttons, and breadboard. Repository (KiCad project) Versions/revisions: 1.0 (photos), 1.1 (photos), 1.2 (photos), 1.3 (photos), 1.4 (photos), 2.0 (photos), 2.1, 2.2 Starting with revision 2.0, SiLabs CP2102 is used instead of FTDI FT232RQ for the USB-to-UART chip.
	ESP32Stack	ESP-WROOM-32	4 MiB (from SMT module)	SiLabs CP2102	<ul style="list-style-type: none"> A stacking board with ESP-WROOM-32, Micro-B USB, CP2102 USB-to-UART, and more. Repository Photos See also: EmptyStack
ESP32.vn	ESP-IoT-Uno	ESP-WROOM-32	4 MiB (from SMT module)	SiLabs CP2102	<ul style="list-style-type: none"> Open source hardware ESP32-based Arduino Uno style development board.
Freematics	ESPRIT	Custom ESP-WROOM-32 Clone	4 MiB (from SMT module)	SiLabs CP2102	<ul style="list-style-type: none"> Freematics ESPRIT is an Arduino compatible development board based on Espressif ESP32 with additional features for telematics projects. Features an xBee socket with switchable VCC voltage (3.3 V or 5 V), so 2G (SIM800) and 3G (SIM5360) xBee modules will work on it to provide cellular network access. The second and third serial UARTs can be accessed from two onboard 4-pin connectors, which the Freematics OBD-II adapter and GPS receiver can be hooked on. Freematics repository Contains files for Freematics ESPRIT and other Freematics hardware. Seller: Freematics

John Spencer & Angus Gratton	ESPlant V2.0	ESP-WROOM-32 or ESP-32S	4 MiB (from SMT module)	SiLabs CP2102	<ul style="list-style-type: none"> Environmental Sensor Plant — solar Wi-Fi gardening/meteorological sensor. ESPlant V2.0 is the ESP32-based version of the original ESPlant ESP8266-based board. John Spencer's V2.0 branch (originally forked from CCHS Melbourne repository) Schematic Photos: Bare board & assembled board
Keri's Lab (Ryotaro Onuki)	KERISP32	ESP-WROOM-32 (or compatible)	4 MiB (from SMT module)	FTDI FT232RL	<ul style="list-style-type: none"> LDO: NJM2884 Features: microSD slot, Micro-B USB connector Repository Early designs used FT234XD, but FT232RL is currently used. Availability: Unreleased; under development
Microwavemont	ESP32 Super Board	ESP-WROOM-32	4 MiB (from SMT module)	FTDI FT231X	<ul style="list-style-type: none"> ESP32 development board with an OLED (connected via I²C) and LiPo battery charger. Hackaday.io project Editions: <ul style="list-style-type: none"> 1.3" Monochrome OLED (\$25) Code: SH1106 sample code and modified support library. Video: Monochrome OLED Demo 0.95" Color OLED (\$33) Code: SSD1331 sample code and support library. Video: Color OLED Demo
	ESP32 Monster Board	ESP-WROOM-32	4 MiB (from SMT module)	FTDI FT231X (unconfirmed)	<ul style="list-style-type: none"> Board with 1.3" OLED, CAN interface, FTDI USB-to-UART, LiPo charger, and 100BASE-TX Ethernet. Hackaday.io project Pinout & schematic History: <ul style="list-style-type: none"> 2017 Apr. 6: Top/bottom photo, OLED operational photo 2017 Apr. 12: Ethernet operational (demo video) 2017 May 3: Ethernet status on OLED (demo video) Code: ESP32 OLED LAN8720 Sample Note: Referring to this as the "Monster Board" even though silkscreen says "Super Board" to differentiate between the two.
	ESP32 CAN CAN Board	ESP-WROOM-32	4 MiB (from SMT module)	FTDI FT231XS	<ul style="list-style-type: none"> ESP32 development board with 1.3" OLED (via I²C), LiPo charging circuit, FTDI FT231XS USB-to-UART interface, MCP2551 CAN-bus transceiver, and regulated 5 V generator for CAN-bus interface (boost-up from LiPo 3.7&V). History: <ul style="list-style-type: none"> 2017 Apr. 13: Video preview 2017 Apr. 16: Awaiting Tindie approval; pinout posted 2017 Apr. 17: Product listed on Tindie Seller: Microwavemont on Tindie (\$30)
	ESP32-ADB Audio Developing Board	ESP-WROOM-32	4 MiB (from SMT module)	SiLabs CP2102 (rev. 1 used FT231XS)	<ul style="list-style-type: none"> ESP32 audio development board with PCM5102A I²S DAC, USB-to-UART, LiPo charger, and 1.3" OLED display (SH1106 via I²C). Versions/revisions: <ul style="list-style-type: none"> Rev. 1: Used FT231XS USB⇌UART. Rev. 2: Uses CP2102 USB⇌UART; has enable/disable jumper for LiPo charger. Code: ESP32 OLED WebRadio Seller: Microwavemont on Tindie (\$26)
	ESP32-ADB Type R	ESP-WROOM-32	4 MiB (from SMT module)	FTDI FT231XS	<ul style="list-style-type: none"> ESP32 audio development board with high-resolution DAC (TI PCM5102A), two MEMS I²S microphones (Knowles SPH0645LM4H-B) for recording audio, on-board LiPo battery charger, and 132×64 pixel display (SH1106 OLED). Hackaday.io project Video: ESP32-ADB Type R "Megaphone"

	ESP32 Web Radio & BT Receiver with Class-D Amp	ESP-WROOM-32	4 MiB (from SMT module)	FTDI FT231XS	<ul style="list-style-type: none"> ESP32 web radio and Bluetooth audio development board with I²S DAC (TI PCM5102A) and class-D amplifier (TI TPA3110). Kit includes fully-tested (completed) main board and 100–240 AC/DC 9 V adapter. Code: ESP32 OLED WebRadio Seller: Microwavemont on Tindie (\$50)
Noduino	Quantum	(SoC directly incorporated.)	16 MiB W25Q128FV or MXIC 25L128	SiLabs CP2102	<ul style="list-style-type: none"> An "Arduino-style" development board. Antenna: <ul style="list-style-type: none"> MIFA (PCB trace) U.FL connector (for external antenna) Product page on Taobao.
Olimex	ESP32-EVB	ESP-WROOM-32	4 MiB (from SMT module)	WCH CH340T (rev. B only)	<ul style="list-style-type: none"> Features: Two relays (250 V_{AC} / 10 A), Ethernet (100BASE-T), microSD card connector, infrared transmitter/receiver (Rev. B only), reset & user buttons, UEXT connector to attach different sensors & modules, 40 pin GPIO 0.1" step connector, LiPo charger & step up converter allowing ESP32-EVB to run from LiPo battery, 5 V power barrel jack, CH340T USB-to-UART (Rev. B only), and three mount holes. Repository Versions/revisions: <ul style="list-style-type: none"> Rev. A: Schematic Rev. B: Schematic
	ESP32-Gateway	ESP-WROOM-32	4 MiB (from SMT module)	WCH CH340T	<ul style="list-style-type: none"> A stripped down version of ESP32-EVB that keeps the connectivity: Wi-Fi, BLE, Ethernet, USB for programming, and microSD card slot.
	ESP32-PRO	(SoC directly incorporated.)	4 MiB	?	<ul style="list-style-type: none"> Board with 4 MiB pSRAM, 4 MiB flash, external crypto engine (ATECC508A), LiPo charger, SD/MMC card slot, and USB On-The-Go (USB-OTG). Announcement & general info Repository & schematic Availability: Unreleased; under development
ProtoCentral	Kalam32-Dev	(SoC directly incorporated.)	4 MiB W25Q32	FTDI FT231X	<ul style="list-style-type: none"> Development board with "Arduino Uno style" form factor, two capacitive touch switches, three WS2812B addressable RGB LEDs, and battery connector. Antenna: IFA (PCB trace) Schematics & other documents
Robotika Brno	RB3200-ESP32universal	ESP-WROOM-32	4 MiB (from SMT module)	SiLabs CP2102	<ul style="list-style-type: none"> Features four pin headers for each of the ESP-WROOM-32 module's pins, Arduino Uno compatible header, USB-to-UART, support for an external power supply with high-current voltage regulator, and diagnostic LEDs. Repository
SunDUINO	ESP32 SunDUINO	ESP-WROOM-32	4 MiB (from SMT module)	(None)	<ul style="list-style-type: none"> Arduino-style development board. Power connectors: 5 V DC barrel & Micro-B USB (for power only) LDO: AMS1117 USB⇌UART: None on-board
United Technologies	GHX_BOARD_V1	WB_MODE_V1	4 MiB (from SMT module)	?	<ul style="list-style-type: none"> Sold by: 联美科技 ("United Technologies") Price: \$18 USD (approx.) Module: Clone of ESP-32S labeled "WB_MODE_V1".
"WeMos" (not actually WeMos)	D1 R32	ESP-WROOM-32	4 MiB (from SMT module)	WCH CH340	<ul style="list-style-type: none"> Arduino-style development board. Has "WeMos" branding silkscreened onto it, but not actually from WeMos. Sellers: vendors on AliExpress

Other Development Boards & Specialty Projects

MAKER	MODEL	NOTES
David Freitag	CANBus Triple Clone	<ul style="list-style-type: none"> A CANBus Triple clone based on the Espressif ESP32 SoC
Espressif	ESP_Test Board_V3	<ul style="list-style-type: none"> A test board used internally by Espressif with SMA connector, 8-digit toggle switch, 5 V power jack, and various headers.

HackerBoxes	Conference Badge PCB	<ul style="list-style-type: none"> The HackerBoxes Conference Badge PCB is part of the <i>HackerBox #0020 Summer Camp</i> kit. This board features solder points for combining together an ESP32-DevKitC, 2.2 inch TFT display, battery manager module, and other components.
Hardwire	Trigger	<ul style="list-style-type: none"> Data logger hardware for the Hardwire platform. Photo Availability: Unreleased; under development
HydraBus	HydraESP32	<ul style="list-style-type: none"> HydraESP32 V1.1 Rev1.0 shield/breakout board for ESP-WROOM-32. This shield can be used with or without a HydraBus board. LDO: TPS73633DBVR (SOT23-5)
Joshua Valdés	ESP-WROOM-32-Board	<ul style="list-style-type: none"> Repository Note: This repository contains designs for both an ESP-WROOM-32 based board and designs for a board based around the scrapped/defunct ESP3212 module.
lipoyang	GPduino-T	<ul style="list-style-type: none"> Wi-Fi remote control model car/tank control board. History: <ul style="list-style-type: none"> 2017 May 27: PCB layers (rendering) 2017 Jun. 7: Photo of bare boards Related: ESP8266-based GPduino-R, GPduino series page
Morecat Lab	WiFi-BareBoard32 WiFi-BB32	<ul style="list-style-type: none"> Repository Photos: <ul style="list-style-type: none"> 2017 Jul. 31: Bare board 2017 Aug. 1: Assembled & comparison photo
Morgan Allen	LoRaNet32	<ul style="list-style-type: none"> A Wi-Fi/BLE-to-LoRa bridge with ESP32, RN2483, LiPo charge controller, and SiLabs CP2102N USB-to-UART. Hackaday.io project Repository
OHC2017	IoTuz	<ul style="list-style-type: none"> Project board created for the 2017 Open Hardware Conference, a mini-conference during Linux.conf.au 2017. Info: <ul style="list-style-type: none"> Documentation OCH2017 wiki article Blog post "IoTuz Driver for our ESP32 board built at Open Hardware Miniconf at Linux.Conf.au 2017" Forum post "ESP32 IoTuz Demo for IoTuz board and WROVER" Videos: <ul style="list-style-type: none"> Presentations: Hardware kit preparation, IoTuz hardware design, manufacturing, working with KiCad, IoTuz software design challenges and ESP-IDF, ESP32 development example using IoTuz Brief demos: Touchscreen demo, short overview, full demo, hardware intro, controls, infrared demos, BreakOut Tetris, IoTuz on ESP-WROVER-KIT Repositories: Hardware, Firmware, Drivers
ProtoCentral	HeartyPatch	<ul style="list-style-type: none"> A single-lead ECG-HR patch based on ESP32 and MAX30003. Hackaday.io project Related: Single-lead ECG & heart rate variability using MAX30003
SHA2017 Badge Team MarkusBec, et al.	SHA2017 Badge	<ul style="list-style-type: none"> An electronic badge for the SHA2017 hacker camp/conference. Uses special version of the ESP-WROOM-32 module with 16 MiB flash. General info wiki article Development project wiki article Repositories History: <ul style="list-style-type: none"> 2016 Nov. 10: Rev0.0.1 Dev. prototype with components; more and more boards 2016 Nov. 28: Rev0.0.1 Dev. finished, packaged prototype boards; first prototype with display 2017 Jan. 21: Rev0.0.1 Dev. e-Ink display 2017 Jan. 22: Rev0.1.0 board layout progress 2017 Jan. 25: Rev0.1.0 board layout 2017 Feb. 17: Rev0.1.0 photo 2017 Apr. 1: Rev0.1.0 webcam April Fool's joke 2017 Apr. 4: Rev0.1.0 photo 2017 May 31: SHA2017 badge stretch goals 2017 Jun. 2: "Espressif Sponsors the SHA2017 Badge Project"
Kevin Webster	BlazeTrak	<ul style="list-style-type: none"> BlazeTrak IoT tracker and logger with ESP32 (Wi-Fi & BLE), GPS, IMU, altimeter, microSD, and USB interface. Repository History: <ul style="list-style-type: none"> 2017 Mar. 3: Prototype PCB photo 2017 Mar. 5: Prototype PCB photos & alpha tester sign-up (\$37), board rendering; forum announcement/discussion 2017 Apr. 2: Hardware testing, tracking GPS satellites Availability: Unreleased; under development

Koenraad Verheyden	Cube	<ul style="list-style-type: none"> A "3D" PCB with NeoPixel LEDs, 9-axis IMU (accelerometer & gyro), and battery power connector. Version: 0.1 (Prototype) History: <ul style="list-style-type: none"> 2017 Mar. 22: Bare PCB parts & assembly 2017 Mar. 23: Assembly almost complete Availability: Unreleased; under development
M5Stack	Core	<ul style="list-style-type: none"> History: <ul style="list-style-type: none"> 2017 Mar. 28: "M5Stack to be relaunched with ESP32" 2017 May 11: M5Stack IoT Kit added to Microsoft Azure IoT device catalog 2017 May 17: Pre-release device seen 2017 June 5: "M5Stack Core - ESP32" (Time4EE) 2017 July 30: Teaser posts on /r/arduino and /r/esp32 Repositories: <ul style="list-style-type: none"> M5stack Board Support M5Stack Arduino Library Arduino Azure IoT Library for ESP32 Pricing (tentative): \$9.90 for a Core module; \$14.90 for the basic kit Availability: Under development
MATRIX Labs	MATRIX Voice	<ul style="list-style-type: none"> An open-source voice recognition platform consisting of a 3.14 inches in diameter development board, with a radial array of 7 MEMS microphones connected to a Xilinx Spartan6 FPGA & 8 MiB SDRAM with 18 RGBW LEDs & 64 GPIO pins. ESP-WROOM-32 module used in the stand-alone "MATRIX Voice Wi-Fi/BT/MC" edition. (In contrast to the MATRIX Voice base-model, which is intended to be coupled with a Raspberry Pi.)
Renesas	GR-LYCHEE	<ul style="list-style-type: none"> Variation of the GR-LYCHEE board using the ESP32-based ESP-WROOM-32 module instead of ESP8266-based ESP-WROOM-02. 2017 Jun. 2: "New ESP32-Based Development Board by Renesas" Teaser video & photo
RETO ROBOT Salvador Hurtado Alia	Emme	<ul style="list-style-type: none"> An amphibious robot. 2017 Jun. 2: "Emme: A New Robot Based on ESP-WROOM-32" Kickstarter
Stephen Heppell	Learnometer	<ul style="list-style-type: none"> Project purpose: Monitor your classroom environment for factors that hinder learning. Photo of bare board
tinyFab	TF01EINKV1	<ul style="list-style-type: none"> Circuit board under development that employs ESP32 for smart home use.

For information about development boards that never were or obsolete otherwise, visit the [Historical](#) page.

Flashing/Testing Fixture Boards

Fixture for temporarily connecting to a module for the purpose of programming/flashing and testing. (No soldering.)

MAKER	MODEL	NOTES
XiaoJ	ESP-WROOM-32 Flashing/Testing Fixture	<ul style="list-style-type: none"> Compatible with ESP-WROOM-32 and ESP-32S module castellated edge footprints. USB⇌UART: SiLabs CP2102 Sellers: XiaoJ on Taobao, Kmust Store on AliExpress, and AnalogLamb

Buttoned Breakout Boards

Breakout boards (for modules) that include programming buttons, and perhaps with a few supplemental components, but lacking components otherwise included on typical development boards.

MAKER	MODEL	NOTES
Aitendo	P-ESP32D	<ul style="list-style-type: none"> Buttoned breakout board compatible with ESP-WROOM-32 and ESP-32S footprints. Not to be confused with the previously released P-ESP32, P-ESP32B, and P-ESP32C boards, which are merely basic breakout boards without buttons nor other components.
Ai-Thinker	ESP-32S Breakout Board	<ul style="list-style-type: none"> Simple breakout board with "Reset" and "IO0" buttons. Has dual-row connections along the longest sides, making this board incompatible for breadboard use. Version 1.1 (2016 October 15)
Black Electronics	ESP32 Module Breakout Board	<ul style="list-style-type: none"> Simple breakout board with reset and GPIO O switches. Compatible with ESP-WROOM-32 and ESP-32S module footprints. Repository
eBox	ESP-32S/ESP-WROOM-32 Breakout Board	<ul style="list-style-type: none"> Simple breakout board with "Reset" and "IO0" buttons; nearly identical to Ai-Thinker's "ESP-32S Breakout Board" Has dual-row connections along the longest sides, making this board incompatible for breadboard use.

Indoor Corgi Elec.	E32-BreadPlus	<ul style="list-style-type: none"> A neat breakout board for ESP-WROOM-32/ESP-32S module breadboarding. An especially nice "skinny long neck" form factor for breadboard use! ✱ Schematic Seller: Switch Science (¥680)
KUC Architect make-KUC	ESP-WROOM-32 Breakout A-Type MK-PKBN-047	<ul style="list-style-type: none"> Compact breakout board for ESP-WROOM-32 module footprint. Copper etched label underneath solder mask reads "esp32 BB v1". Schematic & bill of materials Flashing instructions History: <ul style="list-style-type: none"> 2017 Apr. 10: Photo & pinout 2017 Apr. 11: Product info posted & tweeted Seller: Make-KUC (¥990)
	ESP-WROOM-32 Breakout B-Type MK-PKBN-048	<ul style="list-style-type: none"> Schematic & bill of materials Flashing instructions Seller: Make-KUC (¥1190)
	ESP-WROOM-32 Breakout C-Type MK-PKBN-049	<ul style="list-style-type: none"> Copper etched label underneath solder mask reads "BB-v1". Schematic & bill of materials Flashing instructions History: <ul style="list-style-type: none"> 2017 Apr. 12: First seen 2017 Apr. 16: GATT server setup Seller: Make-KUC (¥990)
Kyoritsu Electronics Industry	KP-ESP32C	<ul style="list-style-type: none"> Buttoned breakout board for ESP-WROOM-32 footprint. Size: 38 mm × 40.6 mm (Excluding the protruding antenna of the module.) Documentation: Manual (PDF) Seller: Eleshop.jp (Kyoritsu)
Makestro/DycodeX	ESP-WROOM-32 Breakout	<ul style="list-style-type: none"> Simple breakout board with "Reset" and "Flash" switches. Compatible with ESP-WROOM-32 and ESP-32S module footprints.

Basic Breakout Boards

Basic breakout boards (for modules) without any programming buttons and often without any other components (but some have capacitors); breaking out the tightly-spaced SMT module castellated edge contacts into wider-spaced contacts for headers.

MAKER	MODEL	NOTES
Aitendo	P-ESP32B & P-ESP32C	<ul style="list-style-type: none"> Simple breakout board compatible with ESP-WROOM-32/ESP-32S footprint. Two slightly different P-ESP32B boards have been seen in the wild: one with a green solder mask and thin 3.3 V trace, and another with yellow solder mask and thicker 3.3 V trace. The product listing for P-ESP32C currently uses photos of the P-ESP32B board with a green solder mask. Previously released as simply "P-ESP32". Not to be confused with P-ESP32D, which has buttons and a few other components. Pins: 38
Akizuki Electric	AE-ESP-WROOM-32	<ul style="list-style-type: none"> Breakout board for ESP-WROOM-32 module with "skinny long neck" form factor for easy breadboard use. Capacitors: 100 µF (GRM31CB30J476M) & 1 µF (GRM188R71E104K) between 3.3 V line and ground. Schematic
Espressif	ESP_Module_Testboard	<ul style="list-style-type: none"> Simple breakout board which was included with ESP-WROOM-03 beta modules. Pins: 38
Kyoritsu Electronics Industry	KP-ESP32X	<ul style="list-style-type: none"> Breakout board for ESP-WROOM-32 module with "skinny long neck" form factor for easy breadboard use. Size: 76.2 mm × 25.4 mm (Excluding the protruding antenna of the module.) Pins: 38 Capacitors: C1: 10 µF, C2: 0.1 µF, C3: 0.1 µF Documentation: Manual (PDF) Seller: Eleshop.jp (Kyoritsu)
NOA Labs	ESP-32S Module Adapter Breakout Board	<ul style="list-style-type: none"> Simple breakout board compatible with ESP-WROOM-32 and ESP-32S footprints.
Seeed Studio	ESP-32S Extension Board	<ul style="list-style-type: none"> Breakout board for Ai-Thinker ESP-32S module. Included for free with the initial ESP-32S orders from Seeed Studio. Has column-similar/redundant dual-row connections along the longest sides for easier stand-alone use without a breadboard (but still could be used with a breadboard). Has connections available to solder on two Grove connectors.

Switch Science **ESP-WROOM-32 2-Line Breakout** • Breakout board for ESP-WROOM-32 module.

For information on breakout boards for the scrapped ESP3212 module, visit the *Historical page*.

Boards Using ESP32 for Supplementary Purposes

Boards where ESP32 is not the primary component; used as a supplementary component, providing Wi-Fi/Bluetooth connectivity.

MAKER	MODEL	NOTES
Adam Vadala-Roth	Vento	<ul style="list-style-type: none"> A solar powered Wi-Fi development platform; descendant of the tech behind SunLeaf. Vento has an ARM Cortex M4F and uses an ESP32 SoC with PCB trace inverted-F antenna for Wi-Fi/Bluetooth. Repository
Arduino/SiFive	Arduino Cinque	<ul style="list-style-type: none"> Arduino Cinque is based on SiFive's Freedom E310 — the industry's first commercially available RISC-V core — running at 320 MHz. An on-board ESP32 chip provides support for 2.4 GHz Wi-Fi and Bluetooth.
Fluo Technology	FluoWiFi	<ul style="list-style-type: none"> Arduino-style development board with Atmel ATmega644P 8-bit AVR micro-controller running at 16 MHz at its core. ESP-WROOM-32 module used for Wi-Fi/Bluetooth connectivity. (In the relative scheme of things, if this seems like driving a Ferrari with a tow truck, you're not alone.) Pinout poster
Husarion	CORE2	<ul style="list-style-type: none"> Robotics prototyping/development platform with an ARM processor at its core. The CORE2 model incorporates an ESP32-based module for Wi-Fi and Bluetooth connectivity.

Commercial/Consumer Devices

MAKER	MODEL	NOTES
DingTalk Alibaba	M1	<ul style="list-style-type: none"> M1 is a biometric attendance-tracking system. 2017 Jun. 2: "DingTalk's New Biometric Attendance Monitor Based on ESP32"
Pium	Pium	<ul style="list-style-type: none"> Pium is a smart home fragrance device that uses EPS32 inside.

PURCHASING

Disclaimer: Vendors are listed here for informational purposes only. Buyers should use prudence and careful judgement when ordering. Before ordering, read all product descriptions and check vendor ratings when possible. Prices listed below are approximate and do not include shipping costs. Furthermore, prices listed below may be outdated, so be diligent and check for yourself.

Note to the beginner: If you are just getting started and don't know what to purchase, it would probably be best for you to purchase a *development board* (instead of a *compact SMT module*) for easier hardware setup and an better first time experience. Espressif's official, publicly sold development boards are ESP32-DevKitC and ESP-WROVER-KIT.

Note about Taobao: Those unfamiliar with Taobao should read Naomi Wu's article, ["Source Parts on Taobao: an Insider's Guide"](#) before attempting to make a purchase through the venue.

Chips

A few words of clarification because some people have erroneously confused *chips* with *SMT modules*: If you wish to purchase just the Espressif ESP32 chip itself, understand that this means you're only receiving the fabricated silicon contained within a tiny Quad-Flat No-leads package. For those seeking integration/inclusion of ESP32, using an SMT module board with ESP32 inside is often more desirable, since such modules combine an ESP32 chip, 40 MHz crystal (clock), flash memory chip, and appropriate "glue" components into a ready-to-use, compact assembly. Having said that, if you wish to purchase only the chip and not a module board, you can purchase the chip through vendors listed below. You can also find sellers in venues like [eBay](#) and [AliExpress](#) using search queries with "ESP32" and "QFN", "SMT", "SMD", "package", "bare" or "raw"; also using the full identifier (such as "ESP32-D0WDQ6" or "ESP32-D2WD") in search queries may prove fruitful.

In addition to the sellers listed below, you can **contact Espressif directly for chip purchase inquiries**.



IDENTIFIER	SELLER	PRICE PER CHIP	SELLER NOTES
ESP32-D0WDQ6	AnalogLamb	\$3.00	
	Charles Lohr on eBay	\$3.40	Sold as \$16.99 for quantity 5.
	Grid Connect	\$2.75	Minimum order quantity 10.
	Smart Prototyping	\$4.50	Out of stock. \$3.50 each for quantity 50 or more.
	Watterott	€2.50	Includes 19% VAT.
ESP32-D0WD	AnalogLamb	\$3.70	
	Grid Connect	\$2.75	Minimum order quantity 10.
	Watterott	€4.00	Includes 19% VAT. €3.00 each for quantity 500 or more.

ESP32-D2WD	AnalogLamb	\$3.70	
	Grid Connect	\$3.25	Minimum order quantity 10.
	Watterott	€4.24	Includes 19% VAT. €3.24 each for quantity 500 or more.
ESP32-S0WD	Grid Connect	\$2.35	Minimum order quantity 10.

Prices for chips listed in the table above last were updated on 2017 July 23.

Compact SMT Modules

Compact modules designed for surface-mount technology integration are listed below. Espressif ESP-WROOM-32 (FCC ID 2AC7Z-ESPWROOM32) and Ai-Thinker ESP-32S (FCC ID 2AHMR-ESP32S) SMT modules have received FCC IDs. ESP32-WROVER (FCC ID 2AC7Z-ESP32WROVER) has received an FCC ID, but is not sold a la carte yet. Pycom OEM modules appear to still be in the process of receiving FCC IDs, but, if interested, be sure contact Pycom for the current status with regard to this matter.

MAKER	MODEL	SELLER	PRICE PER MODULE	SELLER NOTES
Espressif 	ESP-WROOM-32 FCC ID 2AC7Z-ESPWROOM32.	Adafruit	\$8.95	
		AnalogLamb	\$3.99	
		Eckstein	€7.95	
		Elecrow	\$5.90	
		Electrodragon	\$3.50	
		Geekworm on DealExtreme	\$6.12	
		Geekworm on DealExtreme	\$5.03	Sold as \$25.15 for quantity 5.
		Grid Connect	\$3.95	
		Makestro	Rp 69000	
		Olimex	€6.00	€4.80 each for quantity 50 or more.
		Olimex on Amazon	\$7.50	Sold as \$14.99 for quantity 2.
		RobotShop	£8.33	Includes tax. £7.84 each for quantity 100 or more.
		Tronixlabs Australia	AU\$9.95	Includes GST.
		Watterott	€4.85	Includes 19% VAT.
		Contact Espressif sales directly.		
Ai-Thinker	ESP-32S FCC ID 2AHMR-ESP32S. Footprint compatible with Espressif ESP-WROOM-32 module.	Banggood	\$8.69	
		Elecrow	\$6.95	
		Electrodragon	\$4.80	
		Open-Smart on DealExtreme	\$8.61	
		Seeed Studio	\$7.95	
		ShenZhen2U	\$6.95	
		Smart Prototyping	\$7.90	\$5.50 each for quantity 50 or more.
		Watterott	€7.50	Includes 19% VAT. Out of stock.
		AliExpress	Prices vary	
AnalogLamb	ESP-32S-ALB Clone of the Ai-Thinker ESP-32S module.	AnalogLamb	\$3.40	
DFRobot	ESP-WROOM-32 Clone of Espressif's ESP-WROOM-32 module. Not FCC certified.	DFRobot	\$6.49	
		ABRA	\$8.49	
eBox/Widora	ESP32-Bit Module has a built-in ceramic antenna and U.FL connector. Footprint unique and differs from other modules.	Amazon	\$13.99	
		eBox on Taobao	¥63	
ITEAD	PSH-C32  On-board flash chip is unusually small (1 MiB), and this may be extremely limiting. Footprint unique and differs from other modules.	ITEAD	\$6.99	
Pycom	W01	Pycom	€8.95	Minimum order quantity 10. €7.95 each for quantity 100.
	L01	Pycom	€15.95	Minimum order quantity 10. €14.95 each for quantity 100.
	S01 (14 dBm)	Pycom	€16.95	Minimum order quantity 10. €15.95 each for quantity 100.


S01 (22 dBm)	Pycom	€21.95	Minimum order quantity 10. €20.95 each for quantity 100.
G01	Pycom	€24.95	Minimum order quantity 10. €23.95 each for quantity 100.

Prices for SMT modules listed in the table above were last updated on 2017 July 17.

Development Boards/Modules

In contrast to compact SMT modules, development boards break out connections to be larger and more "human scale" for easier prototyping and development and frequently include additional circuitry and interfaces for power supply and programming.

Pycom WiPy 2.0 (FCC ID 2AJMTWIPY2R), Pycom LoPy (FCC ID 2AJMTLOPY1R), and Pycom SiPy (FCC ID 2AJMTSIPY1) development boards/modules have received FCC IDs. Development boards that employ SMT modules with FCC IDs (such as the Espressif ESP-WROOM-32, Espressif ESP32-WROVER, or Ai-Thinker ESP-32S module) will have that SMT module component certified.

MAKER	MODEL	SELLER	PRICE
Espressif 	ESP32-DevKitC ("Core Board")	Adafruit	\$15.00
		Electrodragon	\$10.00
		Grid Connect	\$15.00
		Olimex	€17.00 €13.60 for quantity 50 or more.
		Olimex on Amazon	\$14.99
		Tronixlabs Australia	AU\$19.00 Includes GST.
		Watterott	€21.50 Includes 19% VAT. Out of stock.
	ESP-WROVER-KIT Check with seller to determine which module is included with the kit.	Adafruit	\$49.95
		AnalogLamb	\$47.00
		Grid Connect	\$39.95
		Olimex	€44.00
		Olimex on Amazon	\$49.00
		Tronixlabs Australia	AU\$109.00 Includes GST.
		Watterott	€52.36 Includes 19% VAT.
Adafruit	HUZZAH32 (ESP32 Feather)	Adafruit	\$19.95 Out of stock.
Ai-Thinker	NodeMCU-32S	DIYmall on Amazon	\$12.99
		HiLetgo on Amazon	\$12.99
		ShenZhen2U	\$14.90
		AliExpress	Prices vary
AnalogLamb	Maple ESP32	AnalogLamb	\$15.90
		Tindie	\$20.90
	ESP32 Development Board	AnalogLamb	\$12.50
AprilBrother	ESPea32	AprilBrother on Tindie	\$6.00
Ayarafun/LamLoei	Node32S Plus	Gravitech Thai	790฿
DFRobot	FireBeetle ESP32	DFRobot	\$19.00 Out of stock.
DOIT	ESP32 DevKit	SmartArduino	\$12.33
		ABRA	\$17.82
		Banggood	\$7.91
		DIYmore on Amazon	\$14.60
Explore Embedded	Hornbill ESP32 Dev	Explore Embedded	₹1,399.00
		Explore Embedded on Tindie	\$25.00
	Hornbill ESP32 Minima	Explore Embedded	₹1,099.00
		Explore Embedded on Tindie	\$16.00
EzSBC	ESP32-01 Breakout & Dev. Board	EzSBC	\$16.95
		EzSBC on Tindie	\$16.95
Geekworm	Easy Kit ESP32-B1	Geekworm on AliExpress	\$9.70
		Geekworm on Amazon	\$14.99
		Geekworm on DealExtreme	\$10.61
		Banggood	\$7.39
		MakerFocus on Amazon	\$14.99

Gravitech/MakerAsia	Nano32	Gravitech US	\$20.00	\$18.00 each for quantity 10.
		Gravitech Thai	690฿	4 MiB flash model.
		Gravitech Thai	890฿	8 MiB flash model.
Noduino	Quantum	Noduino on Taobao	¥99.00	
		AnalogLamb	\$25.90	
Pycom	WiPy FCC ID 2AJMTWIPY2R. Uses custom Pycom MicroPython firmware, but can be flashed with other firmware.	Pycom	€19.95	
		ABRA	\$24.96	
		Adafruit	\$26.50	
		Antratek	€24.14	Includes VAT.
		Chicago Electronic Distributors	\$29.95	
		National Control Devices (ControlEverything.com)	\$26.99	
		Seeed Studio	\$22.00	
		Pycom	€29.95	
		ABRA	\$35.67	
		Adafruit	\$39.95	
	LoPy FCC ID 2AJMTLOPY1R.	Antratek	€36.24	Includes VAT.
		Chicago Electronic Distributors	\$34.95	
		National Control Devices (ControlEverything.com)	\$39.99	
		Seeed Studio	\$32.00	
		Pycom	€29.95	Sigfox 14 dBm model.
			€34.95	Sigfox 22 dBm model.
		Antratek	€36.24	Includes VAT. Sigfox 14 dBm model.
		Chicago Electronic Distributors	\$44.99	Sigfox 22 dBm model.
		Watterott	€35.64	Includes 19% VAT.
		Pycom	€54.00	
	FiPy	Pycom	€44.00	
	GPy	Pycom	€44.00	
SparkFun	ESP32 Thing	SparkFun	\$19.95	
		SparkFun on Amazon	\$21.95	
		Antratek	€24.14	Includes VAT.
		Digi-Key	\$19.95	
		RobotShop	£19.85	Includes tax. £15.56 each for quantity 100.
Watterott	ESP-WROOM32-Breakout	Watterott	€17.95	Includes 19% VAT.
Widora	Air	Widora on Taobao	¥78.00	
		Smart Prototyping	\$25.90	\$15.90 each for 50 or more.
WEMOS	LoLin32	WEMOS CC Store on AliExpress	\$6.90	
		Tronixlabs Australia	AU\$19.00	Includes GST.

Prices for development boards/modules listed in the table above were last updated on 2017 July 17.

Tweets by @ESP32net

ESP32 Retweeted

**Andreas Spiess** @spiessa

New Video: More Serial Connections for the ESP32 in Arduino IDE

#ESP32 @i_grr

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20h

**ESP32** @ESP32net

Building a tank volume reader with #ESP32, @Ubidots, and an HC-SR04 ultrasonic sensor...

 dzone.com/articles/build...

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13h

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- SPI0 is permanently reserved for cache access to the flash chip. SPI1 is connected to the same pins via an arbiter and is used to write to flash. You can use SPI1 to also write to other peripherals connected in parallel with the flash (but with another /CS), however, this is tricky to implement because it means you can't simultaneously access flash anymore. That's why it's not in the driver yet.
- International System of Quantities (ISQ) notation is used to represent the measure of data described on this page. Notably, International Electrotechnical Commission (IEC) defined *binary prefixes* (based on powers of two) are used where appropriate; International System of Units (SI) defined *metric prefixes* (based on powers of ten) are used where appropriate. For the most part, this means you'll see binary prefixes — e.g., kibi (Ki) and mebi (Mi) — used for memory capacities and data sizes. However, low-level information transfer rates and networking data rates (notably Wi-Fi and Bluetooth data rates) typically focus on raw bits per second (without the notion of the byte) with multiples expressed in powers of ten; thus use metric prefixes. See *Binary prefix*, *Orders of magnitude (data)*, *Orders of magnitude (bit rate)*, and *Data rate units* on Wikipedia for more information.
- Unless stated otherwise, "ESP-WROOM-32" implies Espressif's ESP-WROOM-32 module and not ESP-WROOM-32 clones.
- ESP32.net is independently operated and not affiliated with Espressif Systems.