Patrocinado por

MOUSER ELECTRONICS

Masterclass em ESP32

Um guia completo para desenvolver projetos atualmente

Fábio Souza
Diretor do Embarcados

WEBINAR
EMBARCADOS

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Agenda

- O que é ESP32?
- Panorama Atual do Ecossistema ESP32
  - Hardware
  - Software
- Escolher SoC ou Módulo
- Como começar um projeto de hardware?

O que é ESP32?

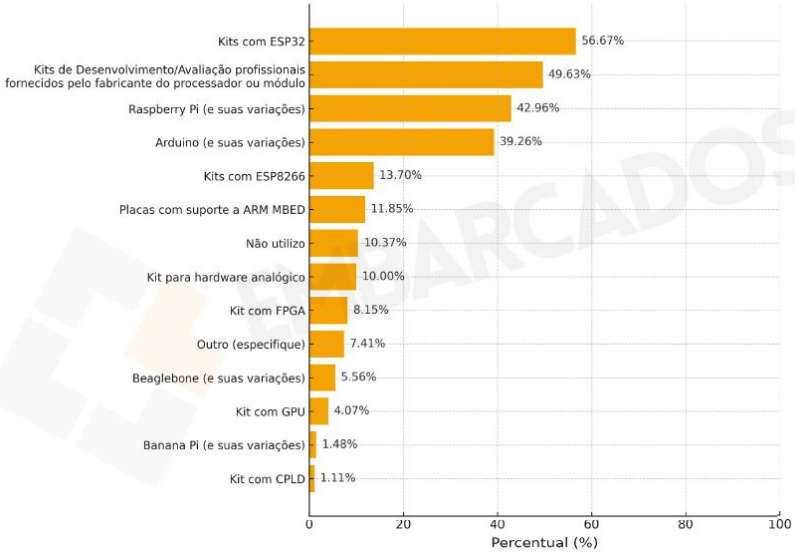
- Família de SoC (System-on-a-Chip) desenvolvida pela Espressif Systems
- Arquiteturas de 32-bit: Xtensa LX6, Xtensa 32-bit LX7 e RISC-V 32-bit
- Alto desempenho com foco em AIoT (Inteligência Artificial das Coisas)
- Conectividade: Wi-Fi, Bluetooth (LE) (Mesh), IEEE 802.15.4(Thread, Matter e Zigbee)
- Conjunto rico de periféricos:
  - GPIO, ADC, DAC, I2C, SPI, UART, PWM,MIPI-CSI, MIPI-DSI, USB 2.0 OTG, Ethernet, I3C, CAN etc.
- Suporta múltiplas configurações de memória
- Ideal tanto para automação residencial quanto para IoT industrial
- Pronto para sistemas inteligentes, conectados e eficientes

Importância do ESP32 atualmente

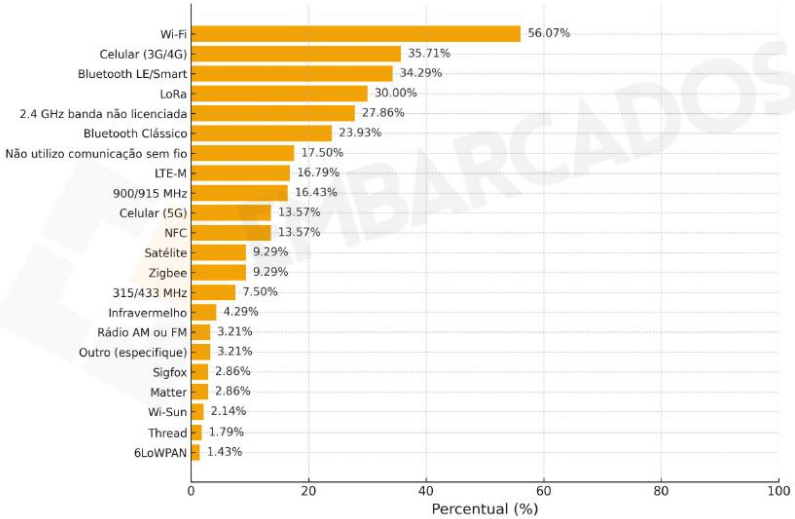
- O ESP32 se tornou um dos microcontroladores mais usado em projetos de IoT e sistemas embarcados de baixo custo. Muito usado em produtos comerciais, protótipos e pesquisa acadêmica.
- Evolução constante da família: É um ecossistema completo para AIoT
- Alinhado com as tendências do mercado:
  - Inteligência Artificial embarcada
  - Conectividade de última geração (Wi-Fi 6, Bluetooth 5, Thread, Zigbee, Matter)
  - Segurança: cada vez mais crítica em IoT (Secure Boot, Flash Encryption).
  - Eficiência energética: chips otimizados para aplicações alimentadas por Bateria.
- Ferramentas e ecossistema maduros

Pesquisa sobre o Mercado Brasileiro de Sistemas Embarcados e IoT 2025

Qual(is) ferramenta(s) de prototipagem rápida (ou kits de desenvolvimento) você utiliza para desenvolver seus produtos?



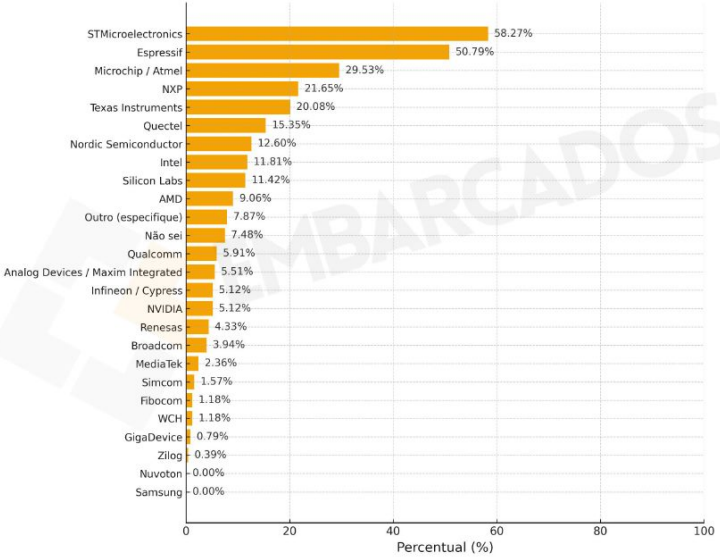
Caso Você tenha escolhido que utiliza o recurso "Comunicação sem fio", gostaríamos de saber quais interfaces sem fio que seu atual projeto de embarcados inclui:



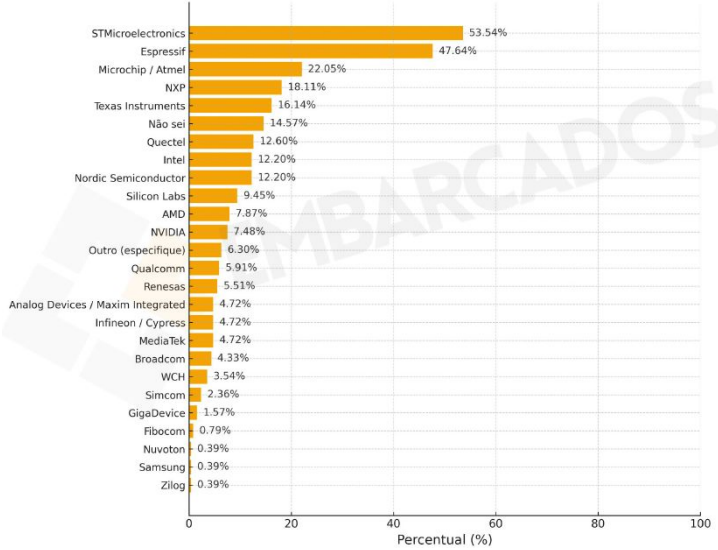
EMBARCADOS https://embarcados.com.br/relatorio-da-pesquisa-sobre-o-mercado-brasileiro-de-sistemas-embarcados-e-iot-2025/

Pesquisa sobre o Mercado Brasileiro de Sistemas Embarcados e IoT 2025

Agora nos diga qual ou quais fornecedores de microcontrolador/microprocessador estão sendo utilizados atualmente pela sua empresa em projetos de sistemas embarcados?



E qual ou quais fornecedores de microcontrolador/microprocessador você acredita que a sua empresa utilizará nos próximos projetos de sistemas embarcados?



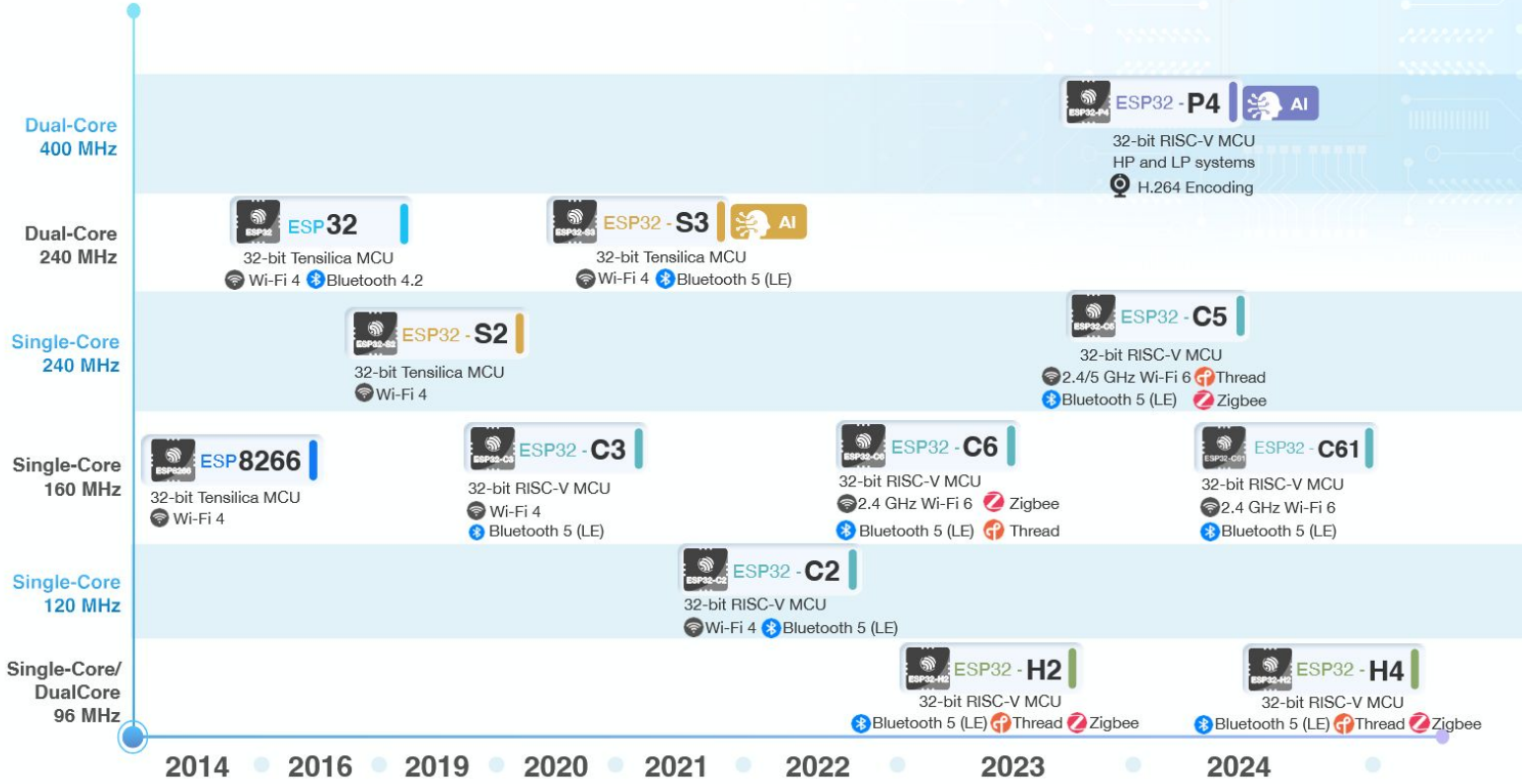
EMBARCADOS https://embarcados.com.br/relatorio-da-pesquisa-sobre-o-mercado-brasileiro-de-sistemas-embarcados-e-iot-2025/

Família de SoCs ESP32

- ESP32 Series
- ESP32-S Series
- ESP32-C Series
- ESP32-H Series
- ESP32-P Series

https://www.espressif.com/en/products/socs

Espressif's Series of SoCs



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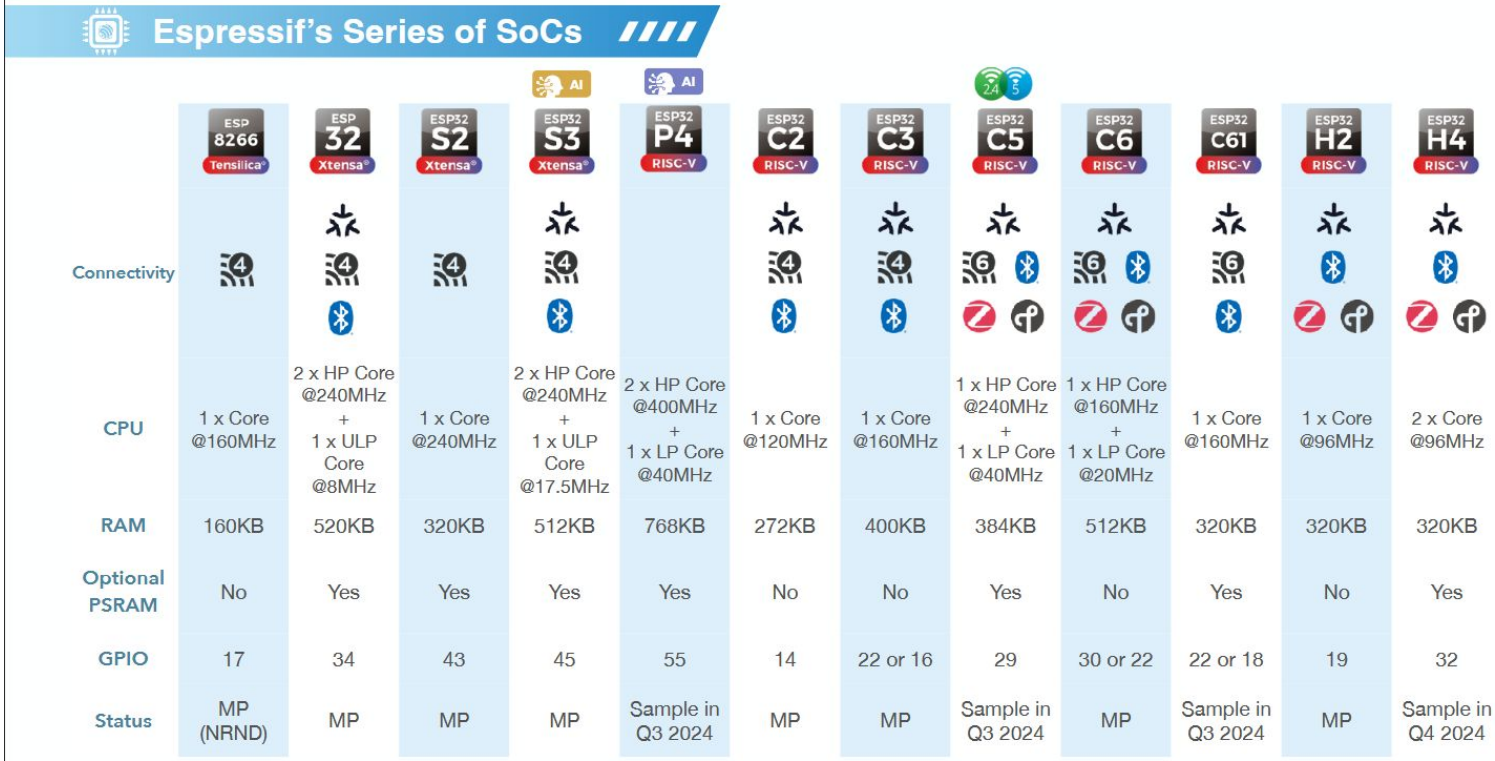


ESPRESSIF

Espressif SoC Product Portfolio

Comprehensive Connectivity, AI and HMI SoCs

Product Selector

	Feature	P-Series	S-Series		C-Series					H-Series		32-Series
		ESP32-P4	ESP32-S3	ESP32-S2	ESP32-C5	ESP32-C6	ESP32-C61	ESP32-C3	ESP32-C2	ESP32-H4	ESP32-H2	ESP32
Connectivity	Wi-Fi Generation		11b/g/n	11b/g/n	11a/b/g/n/ac/ax	11b/g/n/ax	11b/g/n/ax	11b/g/n	11b/g/n			11b/g/n
Wi-Fi	Data Rate		150 Mbps	150 Mbps	150 Mbps	150 Mbps	150 Mbps	150 Mbps	72.2 Mbps			150 Mbps
Wi-Fi	Dual Band				✓							
Wi-Fi	Wi-Fi 6				✓	✓	✓					
Wi-Fi	SoftAP		✓	✓	✓	✓	✓	✓	✓			✓
Wi-Fi	Sniffing		✓	✓	✓	✓	✓	✓	✓			✓
Wi-Fi	WPA Support		WPA3	WPA3	WPA3	WPA3	WPA3	WPA3	WPA3			
Wi-Fi	Wi-Fi CSI		✓	✓	✓	✓	✓	✓	✓			✓
Bluetooth	Bluetooth Low Energy		5.0		5.3	5.3	5.0	5.0	5.0	5.4	5.0	BT Classic/ 4.2
Bluetooth	LE-Audio									✓		
Bluetooth	Direction Finding									✓		
Bluetooth	Long Range		✓		✓	✓	✓	✓	✓	✓	✓	
Bluetooth	2Mbps Data Rate		✓		✓	✓	✓	✓	✓	✓	✓	
Bluetooth	Extended Advertising		✓		✓	✓	✓	✓	✓	✓	✓	
Bluetooth	BLE-Mesh		✓		✓	✓	✓	✓		✓	✓	
	Thread				✓	✓				✓	✓	
	Zigbee				✓	✓				✓	✓	
	Matter		Wi-Fi		Wi-Fi, Thread	Wi-Fi, Thread	Wi-Fi	Wi-Fi	Wi-Fi	Thread	Thread	Wi-Fi
	Ethernet	✓										✓
Type	SoC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Type	Module		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
io	Frequency		2.4 GHz	2.4 GHz	2.4 GHz 5 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz	2.4 GHz
io	Tx-Power		0 to 20 dBm	0 to 20 dBm	0 to 20 dBm	0 to 20 dBm	0 to 20 dBm	0 to 20 dBm	0 to 20 dBm	-15 to 9 dBm	-15 to 20 dBm	0 to 20 dBm

https://products.espressif.com/static/Espressif%20SoC%20Product%20Portfolio.pdf

A Nova Geração de Hardware

ESP32-P4: Disponível no mercado. Muitos projetos surgindo com ele.

ESP32-C5: Wi-Fi 6 dual-band, já está em produção em massa.

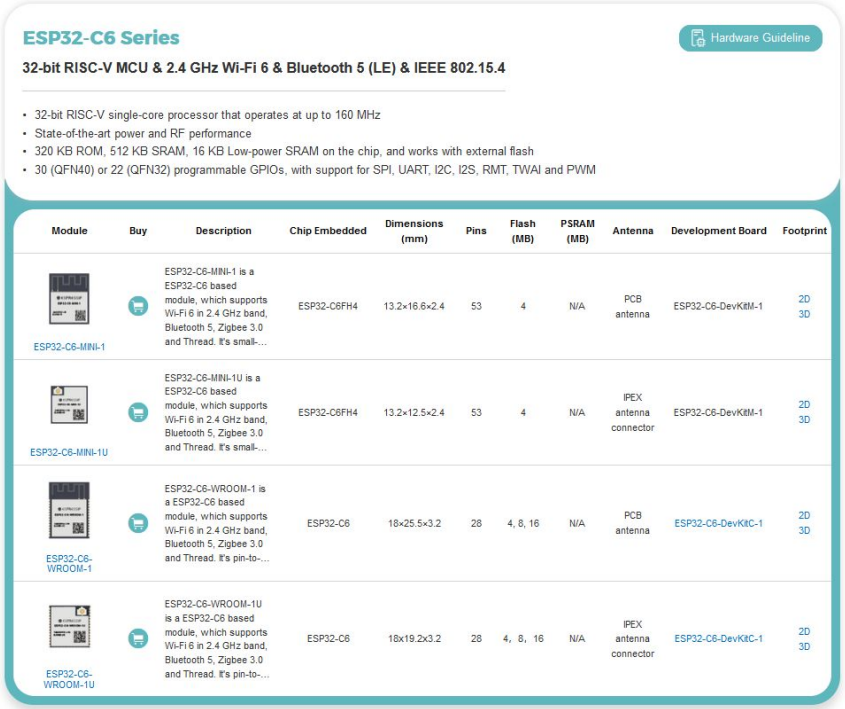
ESP32-C61: O ESP32-C61 foi projetado para atender à crescente demanda por tecnologia Wi-Fi 6, oferecendo periféricos otimizados, conectividade aprimorada e opções expandidas de memória.

ESP32-H4: Ainda não chegou no mercado

Família de Módulos ESP32

https://www.espressif.com/en/products/modules

Exemplos de Módulos ESP32



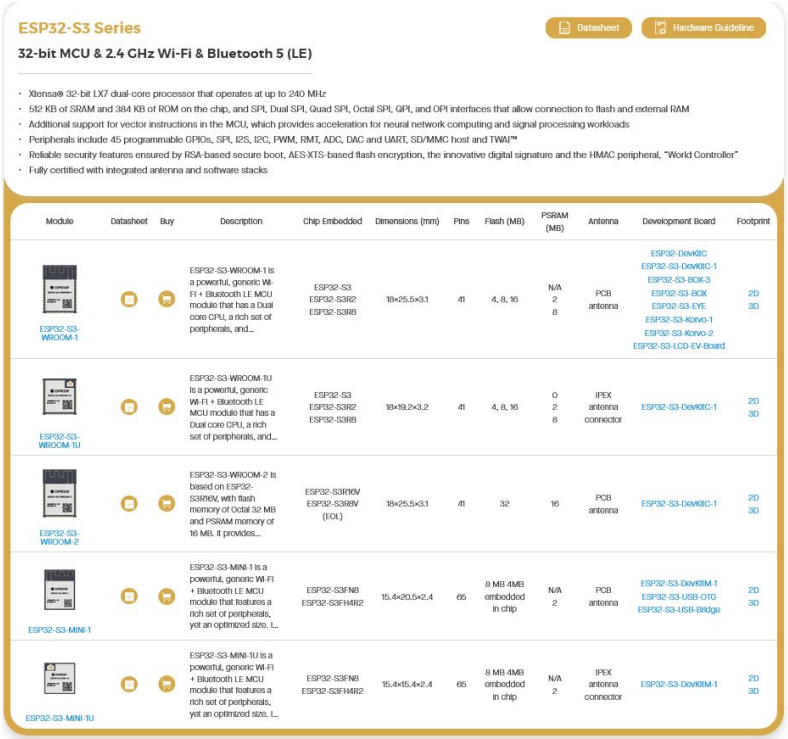
ESP32-C6 Series

Hardware Guideline

32-bit RISC-V MCU & 2.4 GHz Wi-Fi 6 & Bluetooth 5 (LE) & IEEE 802.15.4

- 32-bit RISC-V single-core processor that operates at up to 160 MHz
- State-of-the-art power and RF performance
- 320 KB ROM, 512 KB SRAM, 16 KB Low-power SRAM on the chip, and works with external flash
- 30 (QFN40) or 22 (QFN32) programmable GPIOs, with support for SPI, UART, I2C, I2S, RMT, TWAI and PWM

Module	Buy	Description	Chip Embedded	Dimensions (mm)	Pins	Flash (MB)	PSRAM (MB)	Antenna	Development Board	Footprint
ESP32-C6-MINI-1		ESP32-C6-MINI-1 is a ESP32-C6 based module, which supports Wi-Fi 6 in 2.4 GHz band, Bluetooth 5, Zigbee 3.0 and Thread. It's small-...	ESP32-C6FH4	13.2×16.6×2.4	53	4	N/A	PCB antenna	ESP32-C6-DevKitM-1	2D 3D
ESP32-C6-MINI-1U		ESP32-C6-MINI-1U is a ESP32-C6 based module, which supports Wi-Fi 6 in 2.4 GHz band, Bluetooth 5, Zigbee 3.0 and Thread. It's small-...	ESP32-C6FH4	13.2×12.5×2.4	53	4	N/A	IPEX antenna connector	ESP32-C6-DevKitM-1	2D 3D
ESP32-C6-WROOM-1		ESP32-C6-WROOM-1 is a ESP32-C6 based module, which supports Wi-Fi 6 in 2.4 GHz band, Bluetooth 5, Zigbee 3.0 and Thread. It's pin-to-...	ESP32-C6	18×25.5×3.2	28	4, 8, 16	N/A	PCB antenna	ESP32-C6-DevKitC-1	2D 3D
ESP32-C6-WROOM-1U		ESP32-C6-WROOM-1U is a ESP32-C6 based module, which supports Wi-Fi 6 in 2.4 GHz band, Bluetooth 5, Zigbee 3.0 and Thread. It's pin-to-...	ESP32-C6	18×19.2×3.2	28	4, 8, 16	N/A	IPEX antenna connector	ESP32-C6-DevKitC-1	2D 3D



ESP32-S3 Series

Datasheet | Hardware Guideline

32-bit MCU & 2.4 GHz Wi-Fi & Bluetooth 5 (LE)

- Xtensa® 32-bit LX7 dual-core processor that operates at up to 240 MHz
- 512 KB of SRAM and 384 KB of ROM on the chip, and SPI, Dual SPI, Quad SPI, Octal SPI, QPI, and OPI interfaces that allow connection to flash and external RAM
- Additional support for vector instructions in the MCU, which provides acceleration for neural network computing and signal processing workloads
- Peripherals include 45 programmable GPIOs, SPI, I2S, I2C, PWM, RMT, ADC, DAC and UART, SD/MMC host and TWAI™
- Reliable security features ensured by RSA-based secure boot, AES-XTS-based flash encryption, the innovative digital signature and the HMAC peripheral, "World Controller"
- Fully certified with integrated antenna and software stacks

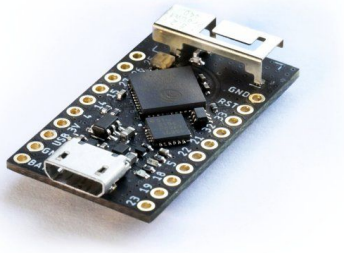
Module	Datasheet	Buy	Description	Chip Embedded	Dimensions (mm)	Pins	Flash (MB)	PSRAM (MB)	Antenna	Development Board	Footprint
ESP32-S3-WROOM-1			ESP32-S3-WROOM-1 is a powerful, generic Wi-Fi + Bluetooth LE MCU module that has a Dual core CPU, a rich set of peripherals, and...	ESP32-S3 ESP32-S3R2 ESP32-S3R8	18×25.5×3.1	41	4, 8, 16	N/A 2 8	PCB antenna	ESP32-DevKitC ESP32-S3-DevKitC-1 ESP32-S3-BOX-3 ESP32-S3-BOX ESP32-S3-EYE ESP32-S3-Korvo-1 ESP32-S3-Korvo-2 ESP32-S3-LCD-EV-Board	2D 3D
ESP32-S3-WROOM-1U			ESP32-S3-WROOM-1U is a powerful, generic Wi-Fi + Bluetooth LE MCU module that has a Dual core CPU, a rich set of peripherals, and...	ESP32-S3 ESP32-S3R2 ESP32-S3R8	18×19.2×3.2	41	4, 8, 16	0 2 8	IPEX antenna connector	ESP32-S3-DevKitC-1	2D 3D
ESP32-S3-WROOM-2			ESP32-S3-WROOM-2 is based on ESP32-S3R16V, with flash memory of Octal 32 MB and PSRAM memory of 16 MB. It provides...	ESP32-S3R16V ESP32-S3R8V (EOL)	18×25.5×3.1	41	32	16	PCB antenna	ESP32-S3-DevKitC-1	2D 3D
ESP32-S3-MINI-1			ESP32-S3-MINI-1 is a powerful, generic Wi-Fi + Bluetooth LE MCU module that features a rich set of peripherals, yet an optimized size. I...	ESP32-S3FN8 ESP32-S3FH4R2	15.4×20.5×2.4	65	8 MB 4MB embedded in chip	N/A 2	PCB antenna	ESP32-S3-DevKitM-1 ESP32-S3-USB-OTG ESP32-S3-USB-Bridge	2D 3D
ESP32-S3-MINI-1U			ESP32-S3-MINI-1U is a powerful, generic Wi-Fi + Bluetooth LE MCU module that features a rich set of peripherals, yet an optimized size. I...	ESP32-S3FN8 ESP32-S3FH4R2	15.4×15.4×2.4	65	8 MB 4MB embedded in chip	N/A 2	IPEX antenna connector	ESP32-S3-DevKitM-1	2D 3D

https://www.espressif.com/en/products/modules

SoC ou Módulo?

SoC

é o chip em si — oferece controle total sobre o design da sua placa de circuito impresso (PCB), mas exige conhecimento profundo em layout de RF, gerenciamento de energia, ajuste de antena e testes de conformidade. É ideal para PCBs customizadas em produção em massa.



Modulo

Os módulos simplificam esse processo. Eles já vêm com certificação de RF, memória flash e antenas integradas. A Espressif possui diversos módulos prontos para uso e com certificações.

Escolha de SoC ou Módulo

Vantagens:

- Custo mais baixo em grandes volumes.
- Flexibilidade total de design (antena, memória externa, reguladores).

Desafios:

- Exige experiência em **design de RF** e layout de alta frequência.
- Certificações de rádio ficam por conta do fabricante do produto.
- Maior risco e tempo de desenvolvimento.

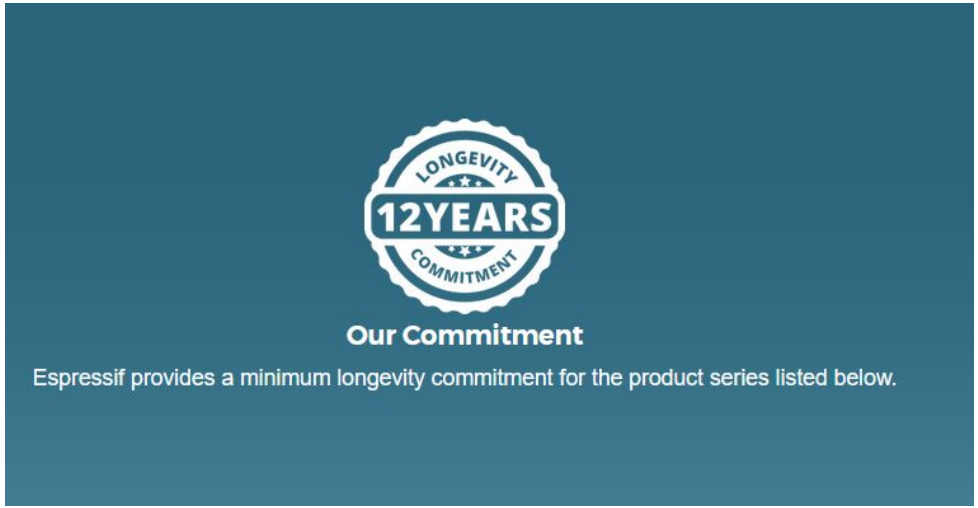
Indicado para:

- Produtos em **grande escala**.
- Empresas com equipe de hardware consolidada.

- **Vantagens**:
  - Projeto mais rápido → só integrar o módulo na placa.
  - Certificações de rádio (ANATEL, FCC, CE) já incluídas.
  - Antena otimizada e validada pelo fabricante.
- **Desafios**:
  - Custo unitário maior.
  - Menor flexibilidade para customizações avançadas.
- **Indicado para**:
  - Protótipos, **produção em pequena/média escala**.
  - Times focados em firmware/produto final, sem expertise avançada em RF.

Mas como tudo na engenharia, depende…. Por exemplo:
Se o objetivo é validar rápido ou produzir em volumes menores → escolha **módulos prontos**.
Se a meta é alta escala e custo mínimo por unidade → vale investir no design com **SoC direto**.

Compromisso de Longevidade



ESP 32-S Series

ESP 32-S2	12 YEARS from Jan 1, 2020
ESP 32-S3	12 YEARS from Jan 1, 2021

ESP 32-C Series

ESP 32-C2	12 YEARS from Jan 1, 2022
ESP 32-C3	12 YEARS from Jan 1, 2021
ESP 32-C5	12 YEARS from Jan 1, 2025
ESP 32-C6	12 YEARS from Jan 1, 2023

ESP 32-H Series

ESP 32-H2	12 YEARS from Jan 1, 2023

ESP 32 Series	15 YEARS from Jan 1, 2016
ESP 8266 Series / ESP 8285	15 YEARS from Jan 1, 2014
ESP 8089 Series	12 YEARS from Jan 1, 2014

https://www.espressif.com/en/products/longevity-commitment

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Como escolher a melhor opção para meu projeto?

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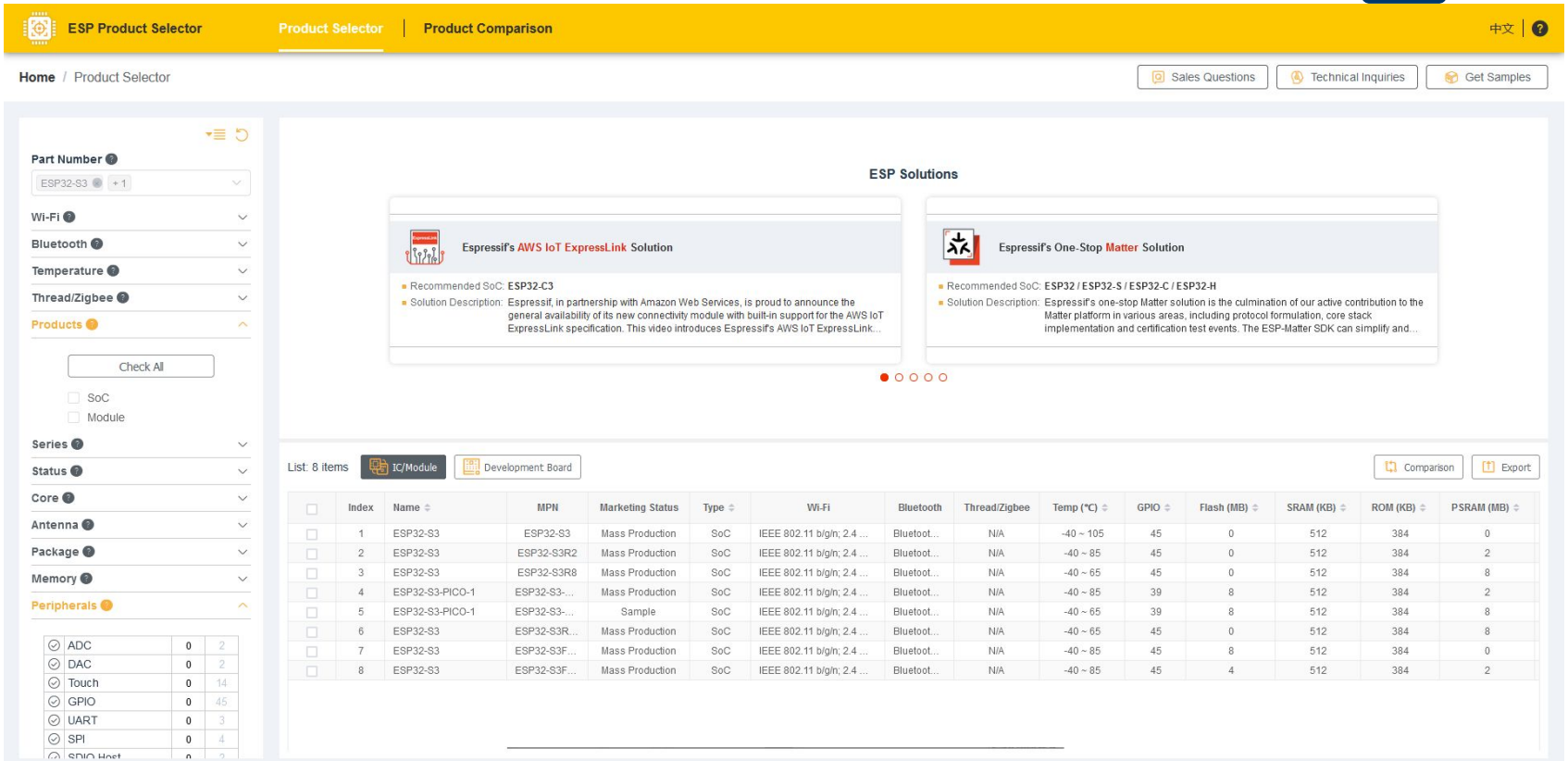
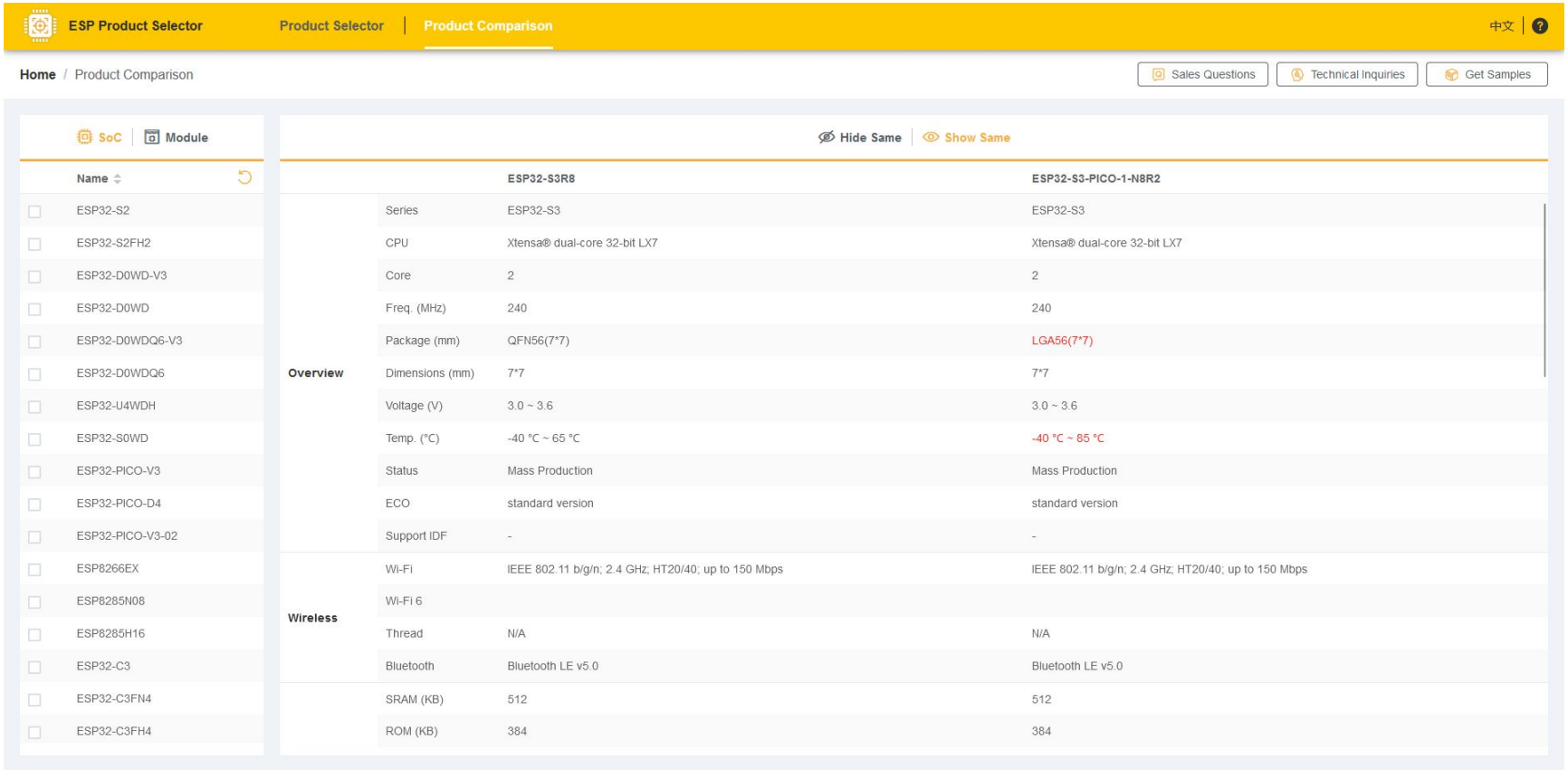
ESP Product Selector


ESP Product Selector
Product Selector
Product Comparison
中文
Home / Product Selector
Sales Questions
Technical Inquiries
Get Samples
Part Number
ESP32-S3
+ 1
Wi-Fi
Bluetooth
Temperature
Thread/Zigbee
Products
Check All
SoC
Module
Series
Status
Core
Antenna
Package
Memory
Peripherals
ADC 0 2
DAC 0 2
Touch 0 14
GPIO 0 45
UART 0 3
SPI 0 4
ESP Solutions
Espressif's AWS IoT ExpressLink Solution
Recommended SoC: ESP32-C3
Solution Description: Espressif, in partnership with Amazon Web Services, is proud to announce the general availability of its new connectivity module with built-in support for the AWS IoT ExpressLink specification. This video introduces Espressif's AWS IoT ExpressLink...
Espressif's One-Stop Matter Solution
Recommended SoC: ESP32 / ESP32-S / ESP32-C / ESP32-H
Solution Description: Espressif's one-stop Matter solution is the culmination of our active contribution to the Matter platform in various areas, including protocol formulation, core stack implementation and certification test events. The ESP-Matter SDK can simplify and...
List: 8 items
IC/Module
Development Board
Comparison
Export
Index Name MPN Marketing Status Type Wi-Fi Bluetooth Thread/Zigbee Temp (°C) GPIO Flash (MB) SRAM (KB) ROM (KB) PSRAM (MB)
1 ESP32-S3 ESP32-S3 Mass Production SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 105 45 0 512 384 0
2 ESP32-S3 ESP32-S3R2 Mass Production SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 45 0 512 384 2
3 ESP32-S3 ESP32-S3R8 Mass Production SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 65 45 0 512 384 8
4 ESP32-S3-PICO-1 ESP32-S3-... Mass Production SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 39 8 512 384 2
5 ESP32-S3-PICO-1 ESP32-S3-... Sample SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 65 39 8 512 384 8
6 ESP32-S3 ESP32-S3R... Mass Production SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 65 45 0 512 384 8
7 ESP32-S3 ESP32-S3F... Mass Production SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 45 8 512 384 0
8 ESP32-S3 ESP32-S3F... Mass Production SoC IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 45 4 512 384 2


ESP Product Selector
Product Selector
Product Comparison
中文
Home / Product Comparison
Sales Questions
Technical Inquiries
Get Samples
SoC
Module
Hide Same
Show Same
Name
ESP32-S2
ESP32-S2FH2
ESP32-D0WD-V3
ESP32-D0WD
ESP32-D0WDQ6-V3
ESP32-D0WDQ6
ESP32-U4WDH
ESP32-S0WD
ESP32-PICO-V3
ESP32-PICO-D4
ESP32-PICO-V3-02
ESP8266EX
ESP8285N08
ESP8285H16
ESP32-C3
ESP32-C3FN4
ESP32-C3FH4
ESP32-S3R8
ESP32-S3-PICO-1-N8R2
Overview
Series ESP32-S3 ESP32-S3
CPU Xtensa® dual-core 32-bit LX7 Xtensa® dual-core 32-bit LX7
Core 2 2
Freq. (MHz) 240 240
Package (mm) QFN56(7*7) LGA56(7*7)
Dimensions (mm) 7*7 7*7
Voltage (V) 3.0 ~ 3.6 3.0 ~ 3.6
Temp. (°C) -40 °C ~ 65 °C -40 °C ~ 85 °C
Status Mass Production Mass Production
ECO standard version standard version
Support IDF - -
Wireless
Wi-Fi IEEE 802.11 b/g/n; 2.4 GHz; HT20/40; up to 150 Mbps IEEE 802.11 b/g/n; 2.4 GHz; HT20/40; up to 150 Mbps
Wi-Fi 6
Thread N/A N/A
Bluetooth Bluetooth LE v5.0 Bluetooth LE v5.0
SRAM (KB) 512 512
ROM (KB) 384 384

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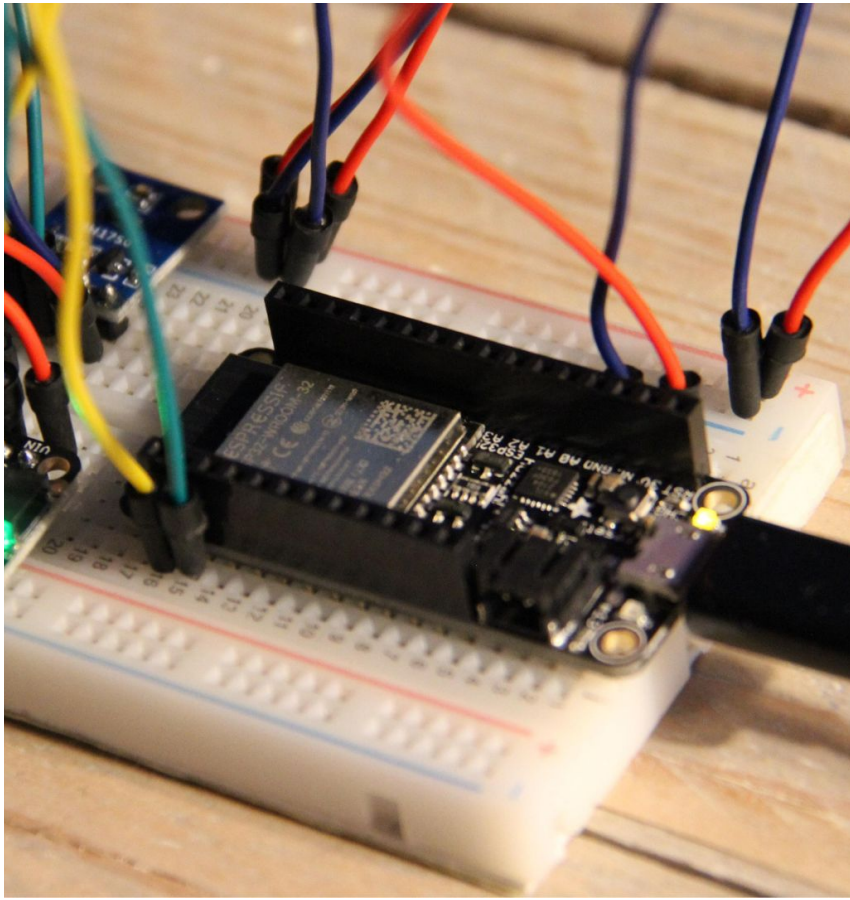
Placas de Desenvolvimento



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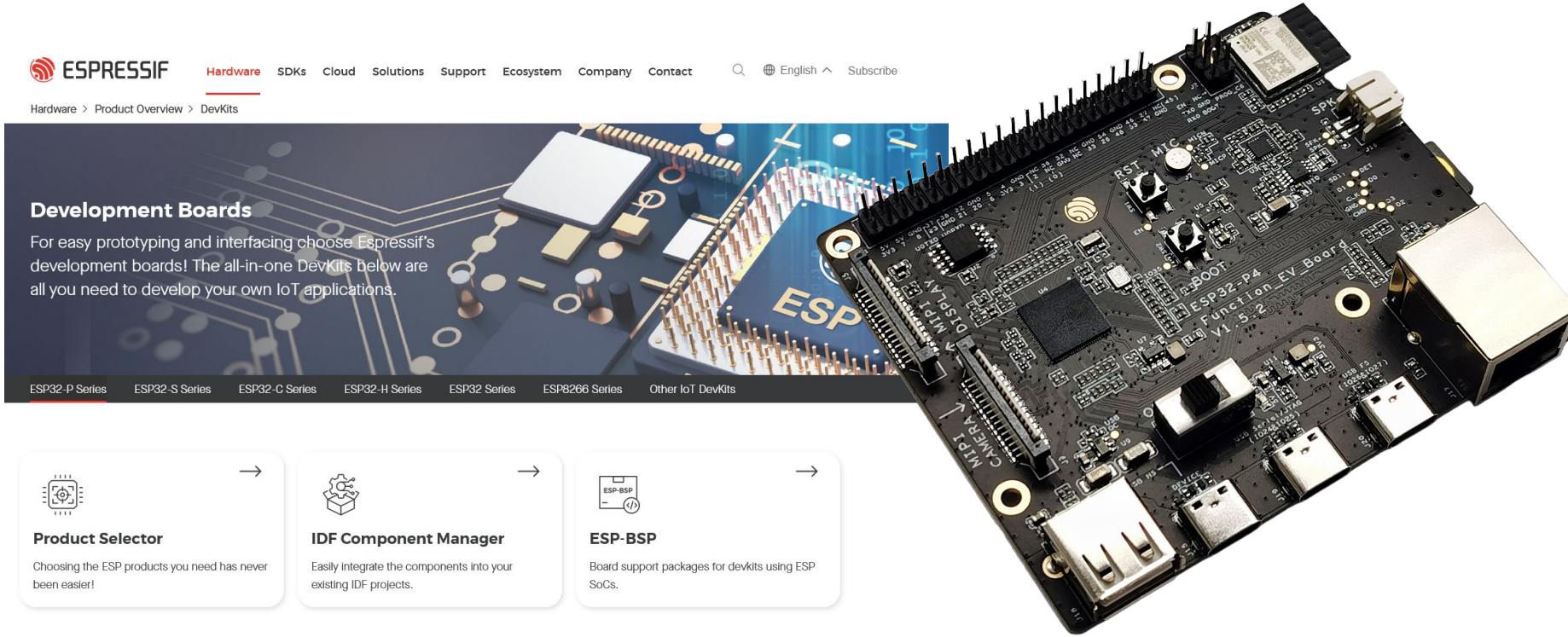
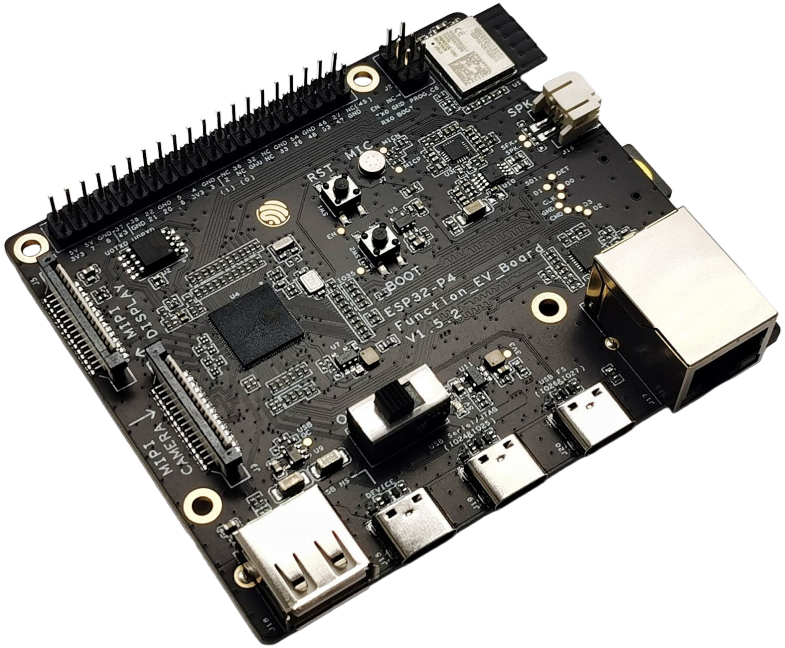
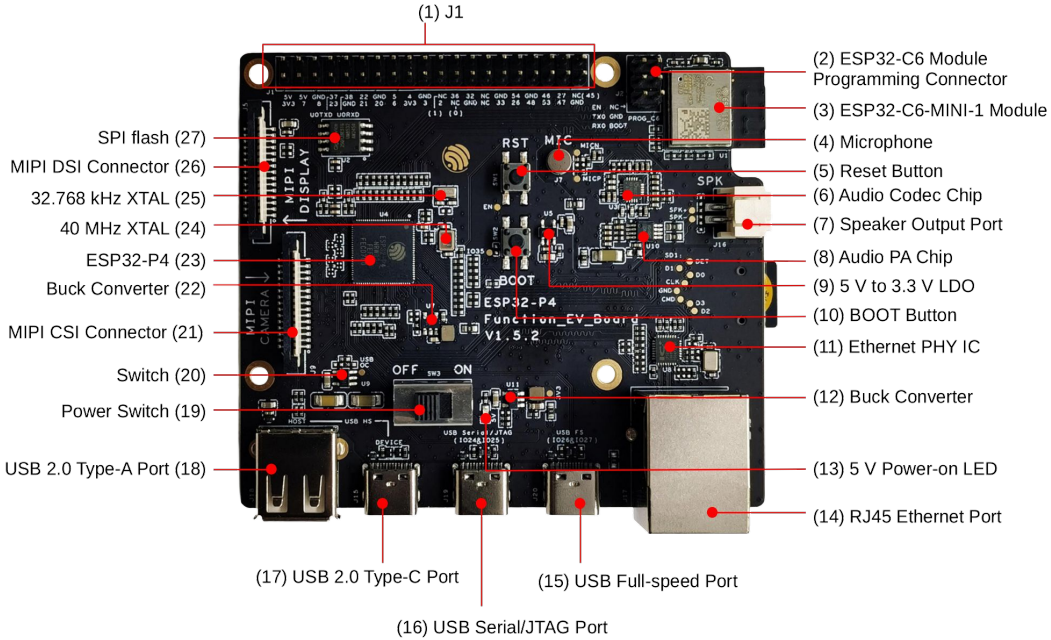
Placas de Desenvolvimento



https://www.espressif.com/en/products/devkits

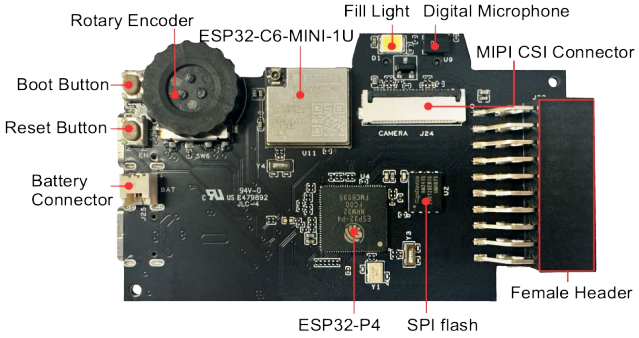
ESP32-P4-Function-EV-Board

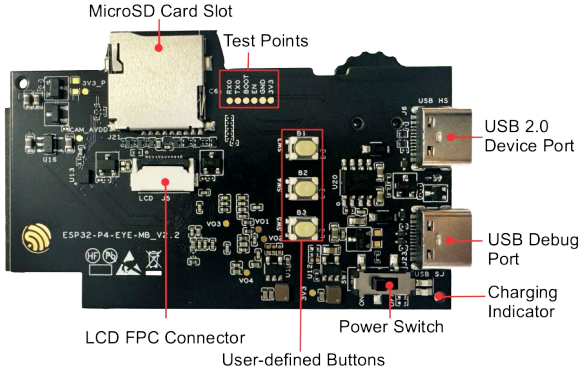




https://br.mouser.com/ProductDetail/Espressif-Systems/ESP32-P4-Function-EV-Board?qs=2FehpBK1j97APemKvWKSNQ%3D%3D

ESP32-P4-EYE





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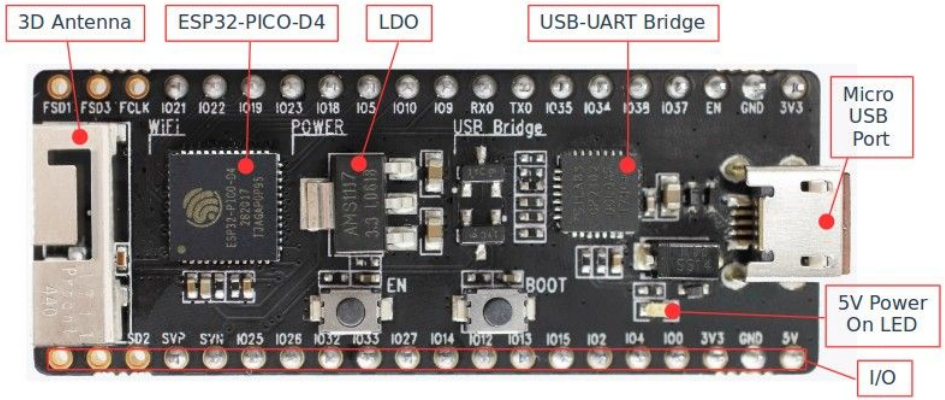

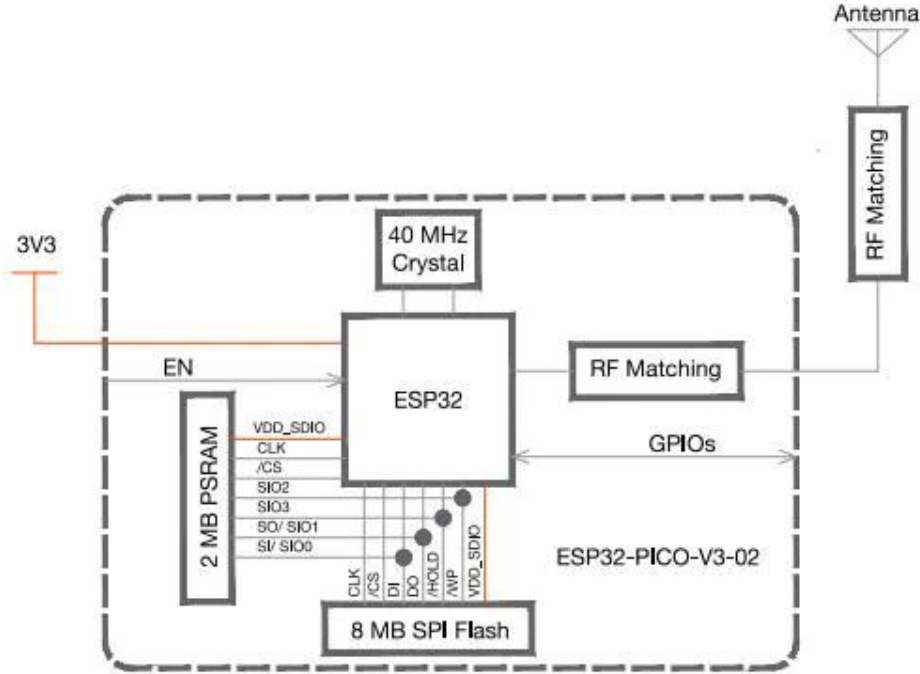

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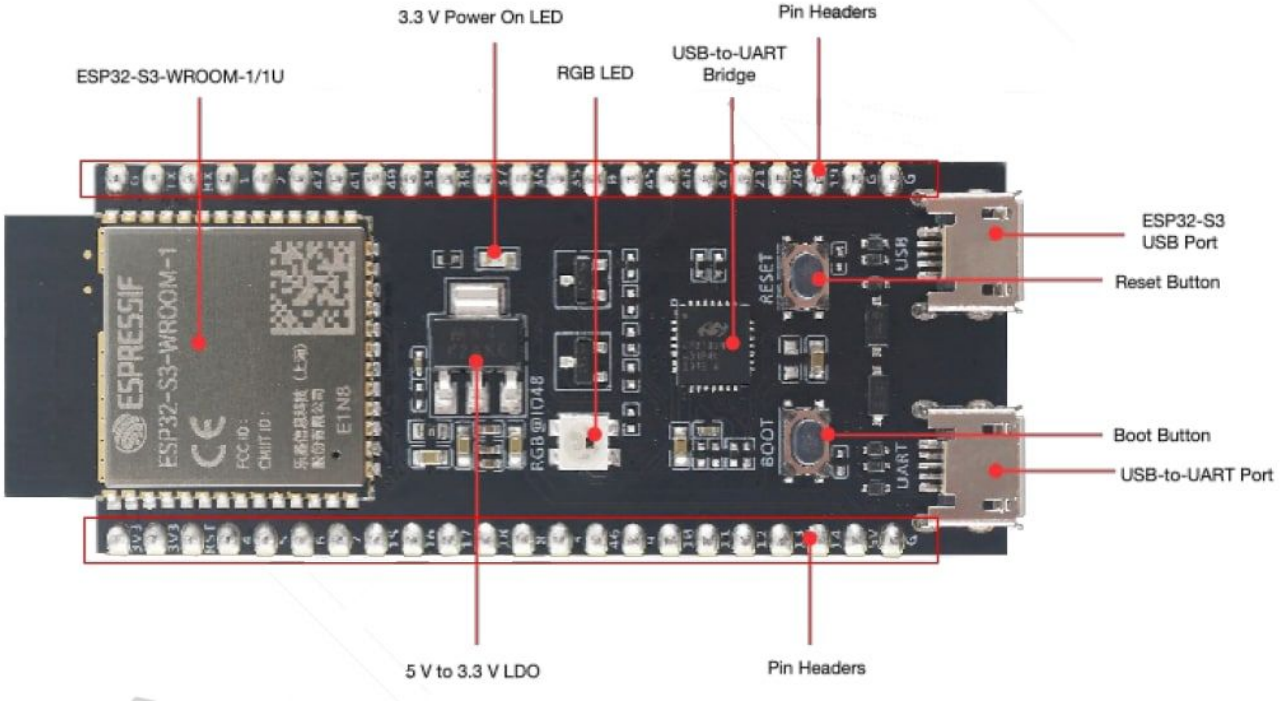
ESP32-S3-DevKitC-1



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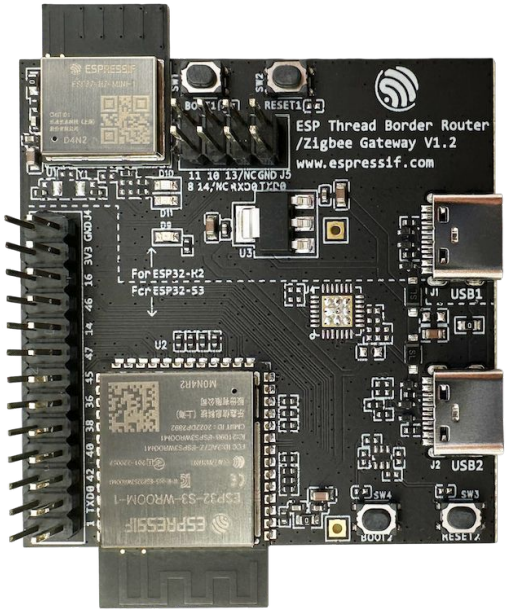
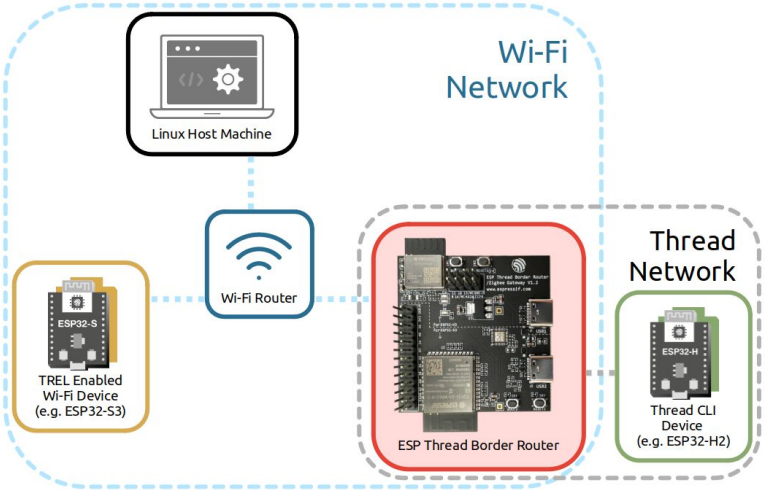
ESP Thread Border Router/Zigbee Gateway





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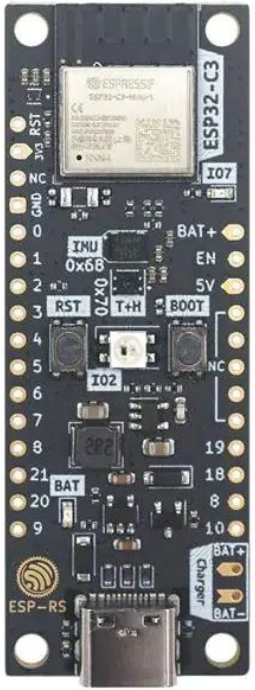
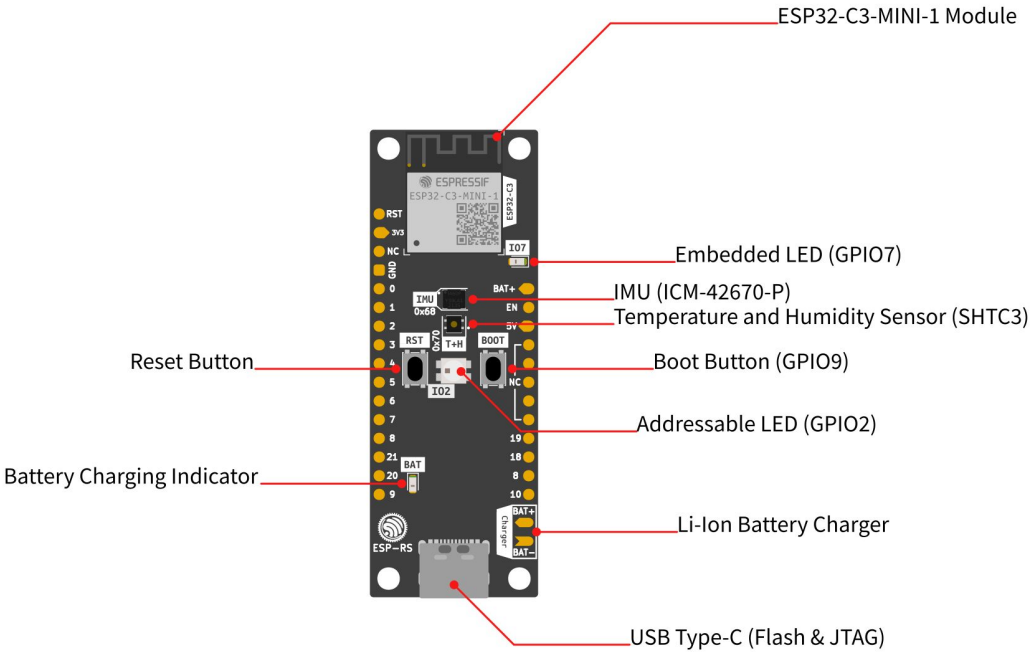
ESP32-C3-DevKit-RUST-1





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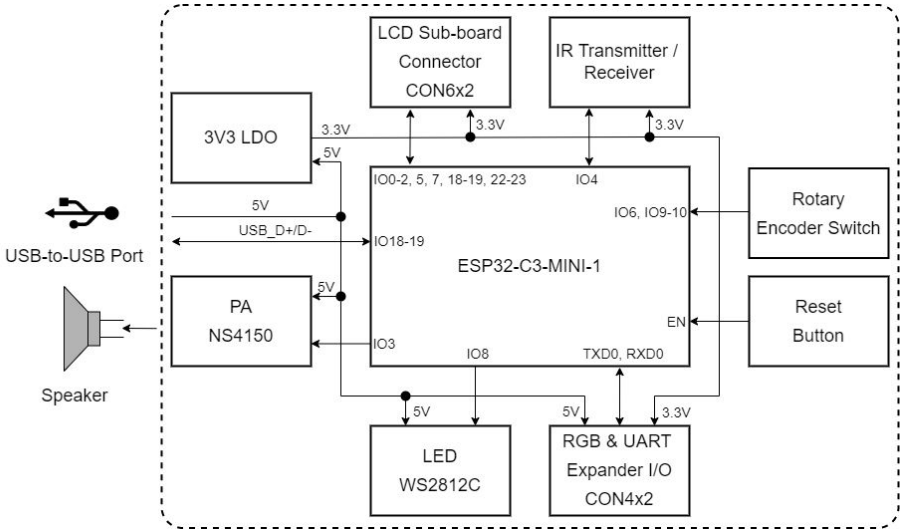
ESP32-S3-BOX-3

Microcontroller			
Type:	ESP32-S3	CPU:	Dual-Core Xtensa® 32bit LX7 up to 240 MHz
Memory			
SRAM:	512 KB	ROM:	384 KB
PSRAM:	Octal SPI, 16 MB	PSRAM Speed:	120 MHz (Experimental Feature)
External Flash:	Quad SPI, 16 MB		
AI Feature			
AI Algorithm	Neural Network, Acoustic algorithm, etc.	Computing Acceleration	Vector, Complex number, FFT, etc.
Wireless			
Wi-Fi:	2.4 GHz, IEEE 802.11b/g/n	Bluetooth® LE:	Bluetooth® 5 LE and Bluetooth® mesh
Display			
Display Type:	2.4-inch LCD	Display Resolution:	240 x 320 pixels
Display Interface:	SPI	Interface Speed:	40 MHz
Touch Type:	Capacitive	Touch Points:	10
Driver IC	ILI9342C		
Audio Input			
Microphone Type:	Dual Mic	ADC Model:	ES7210
Mute:	Supported		
Audio Output			
Speaker Model:	8 Ohm 1 W	PA Model:	NS4150
Codec Model:	ES8311		
Sensor			
Sensor Type:	3-axis Gyroscope, 3-axis Accelerometer	Sensor Model:	ICM-42607-P
Interface			
Type:	USB Type-C	Usage:	Power, USB download/JTAG debug, general USB device functions
Type:	Goldfinger	Usage:	I/O Expansion
User Interface			
Onboard Buttons	Reset, Boot, Mute	Onboard LEDs	Power LED, Mute LED
OS / SDK			
Original OS:	FreeRTOS	SDK:	ESP-IDF
Outline			
Dimensions:	61 x 66 x 16.6 mm	Weight:	292 g
Power			
USB-C Power:	5 V - 2.0 A Input	Battery:	N/A

https://br.mouser.com/ProductDetail/Espressif-Systems/ESP32-S3-BOX-3?qs=sGAEpiMZZMuqBwn8WqcFUipNqoezRlc4u4gjCc9cblNcfZiByE2ecw%3D%3D

ESP32-C3-LCDkit



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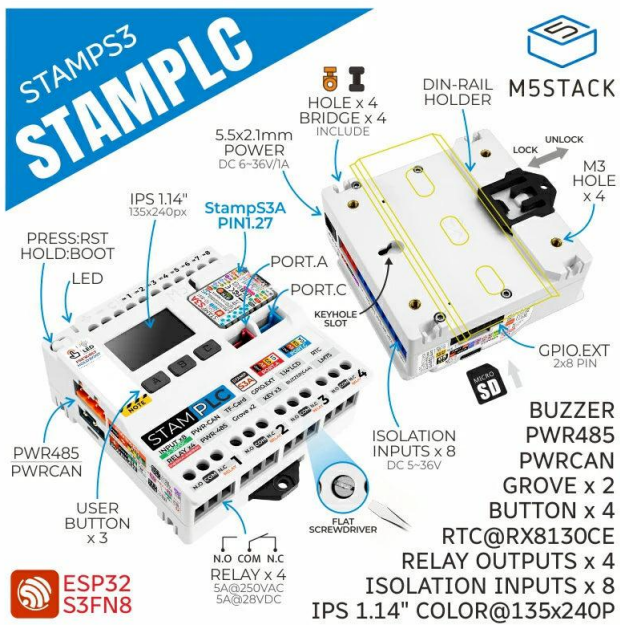

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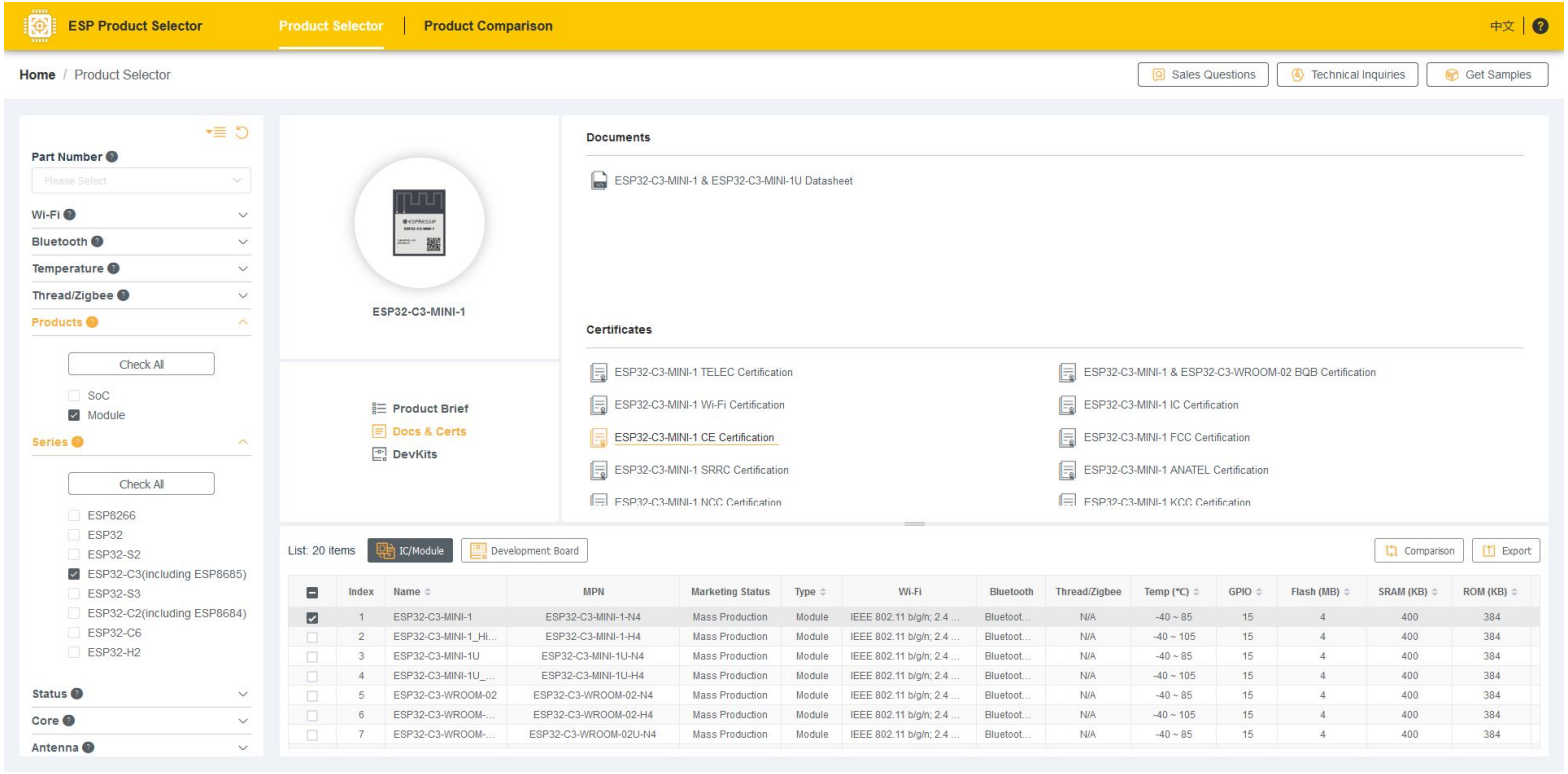
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Product Selector
Product Comparison
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Technical Inquiries
Get Samples
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Wi-Fi
Bluetooth
Temperature
Thread/Zigbee
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Series
Check All
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ESP32
ESP32-S2
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ESP32-S3
ESP32-C2(including ESP8684)
ESP32-C6
ESP32-H2
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ESP32-C3-MINI-1
Product Brief
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DevKits
Documents
ESP32-C3-MINI-1 & ESP32-C3-MINI-1U Datasheet
Certificates
ESP32-C3-MINI-1 TELEC Certification
ESP32-C3-MINI-1 & ESP32-C3-WROOM-02 BQB Certification
ESP32-C3-MINI-1 Wi-Fi Certification
ESP32-C3-MINI-1 IC Certification
ESP32-C3-MINI-1 CE Certification
ESP32-C3-MINI-1 FCC Certification
ESP32-C3-MINI-1 SRRC Certification
ESP32-C3-MINI-1 ANATEL Certification
ESP32-C3-MINI-1 NCC Certification
ESP32-C3-MINI-1 KCC Certification
List: 20 items
IC/Module
Development Board
Comparison
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Index
Name
MPN
Marketing Status
Type
Wi-Fi
Bluetooth
Thread/Zigbee
Temp (°C)
GPIO
Flash (MB)
SRAM (KB)
ROM (KB)
1 ESP32-C3-MINI-1 ESP32-C3-MINI-1-N4 Mass Production Module IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 15 4 400 384
2 ESP32-C3-MINI-1_Hi... ESP32-C3-MINI-1-H4 Mass Production Module IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 105 15 4 400 384
3 ESP32-C3-MINI-1U ESP32-C3-MINI-1U-N4 Mass Production Module IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 15 4 400 384
4 ESP32-C3-MINI-1U_... ESP32-C3-MINI-1U-H4 Mass Production Module IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 105 15 4 400 384
5 ESP32-C3-WROOM-02 ESP32-C3-WROOM-02-N4 Mass Production Module IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 15 4 400 384
6 ESP32-C3-WROOM-... ESP32-C3-WROOM-02-H4 Mass Production Module IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 105 15 4 400 384
7 ESP32-C3-WROOM-... ESP32-C3-WROOM-02U-N4 Mass Production Module IEEE 802.11 b/g/n; 2.4 ... Bluetoot... N/A -40 ~ 85 15 4 400 384

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Mfr. #:	ESP32-C3-MINI-1-N4
Mfr.:	Espressif Systems
Customer #:	Customer #
Description:	Multiprotocol Modules SMD module, ESP32-C3FN4, PCB antenna, -40 C +85 C
Datasheet:	ESP32-C3-MINI-1-N4 Datasheet (PDF)
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ESP32-C3-MINI-1U
Datasheet

Small-sized 2.4 GHz Wi-Fi (802.11 b/g/n) and Bluetooth® 5 module
Built around ESP32-C3 series of SoCs, RISC-V single-core microprocessor
4 MB flash in chip package
15 GPIOs
On-board PCB antenna or external antenna connector

ESP32-C3-MINI-1

ESP32-C3-MINI-1U

Version 1.3
Espressif Systems

ESP32-C3 Series
Datasheet

Ultra-Low-Power SoC with RISC-V Single-Core CPU
2.4 GHz Wi-Fi (802.11 b/g/n) and Bluetooth® 5 (LE)
Optional 4 MB flash in the chip's package
QFN32 (5×5 mm) Package

Including:

ESP32-C3
ESP32-C3FN4 – Not Recommended for New Designs (NRND)
ESP32-C3FH4
ESP32-C3FH4AZ

ESP32-C3
Technical Reference Manual

ESP32-C3 Family
Hardware Design Guidelines

Version 1.0
Espressif Systems

9 Related Documentation and Resources

Related Documentation

- ESP32-C3 Series Datasheet – Specifications of the ESP32-C3 hardware.
- ESP32-C3 Technical Reference Manual – Detailed information on how to use the ESP32-C3 memory and peripherals.
- ESP32-C3 Hardware Design Guidelines – Guidelines on how to integrate the ESP32-C3 into your hardware product.
- *Certificates*
  https://espressif.com/en/support/documents/certificates
- *ESP32-C3 Product/Process Change Notifications (PCN)*
  https://espressif.com/en/support/documents/pcns?keys=ESP32-C3
- *ESP32-C3 Advisories* – Information on security, bugs, compatibility, component reliability.
  https://espressif.com/en/support/documents/advisories?keys=ESP32-C3
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  https://espressif.com/en/support/download/documents

Developer Zone

- ESP-IDF Programming Guide for ESP32-C3 – Extensive documentation for the ESP-IDF development framework.
- *ESP-IDF* and other development frameworks on GitHub.
  https://github.com/espressif
- *ESP32 BBS Forum* – Engineer-to-Engineer (E2E) Community for Espressif products where you can post questions, share knowledge, explore ideas, and help solve problems with fellow engineers.
  https://esp32.com/
- *The ESP Journal* – Best Practices, Articles, and Notes from Espressif folks.
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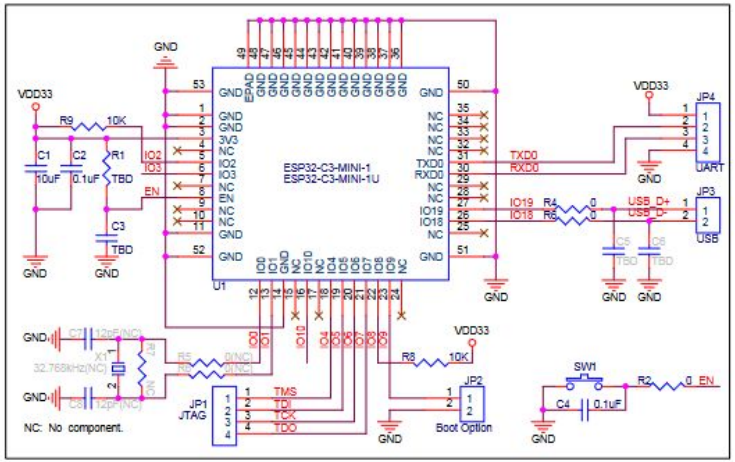
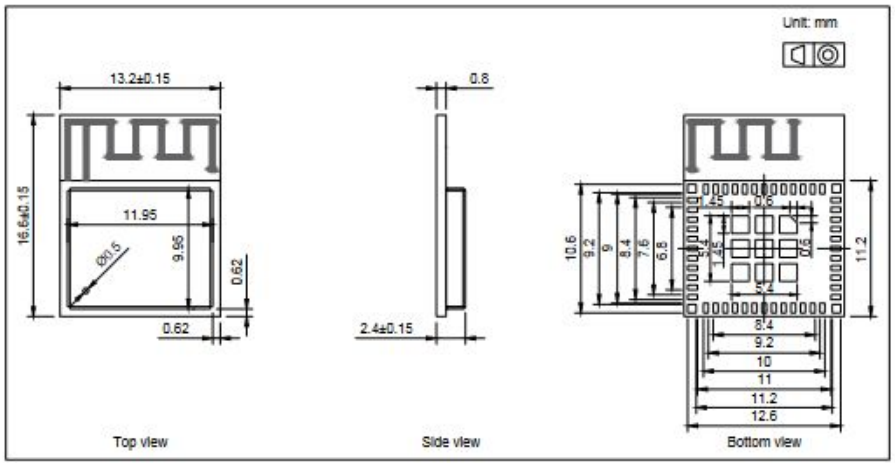

ESP32-C3-MINI-1
ESP32-C3-MINI-1U
U1
VDD33
GND
EN
TXD0
RXD0
IO19
IO18
USB_D+
USB_D-
TMS
TDI
TCK
TDO
JP1
JTAG
JP2
Boot Option
JP3
USB
JP4
UART
SW1
R9 10K
R8 10K
C1 10uF
C2 0.1uF
C3 TBD
C4 0.1uF
C5 TBD
C6 TBD
R1 TBD
R2 0_EN
R4 0
R5 0
R6 0
R7 0(NC)
R10 0(NC)
C7 12pF(NC)
C8 12pF(NC)
X1 32.768KHz(NC)
NC: No component.


Unit: mm
13.2±0.15
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9.95
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0.62
0.62
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11
11.2
12.6
Top view
Side view
Bottom view

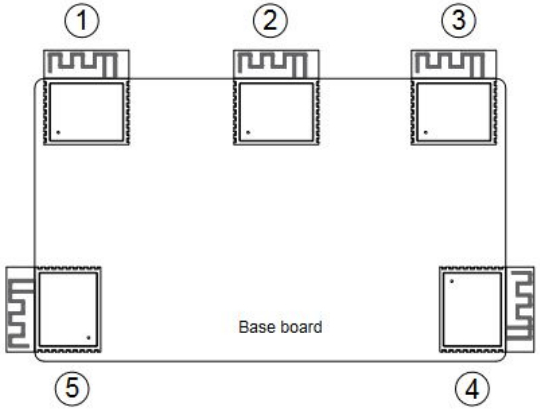


Figure 12: Placement of ESP32-C3 Modules on Base Board. Antenna Feed Point on the Right

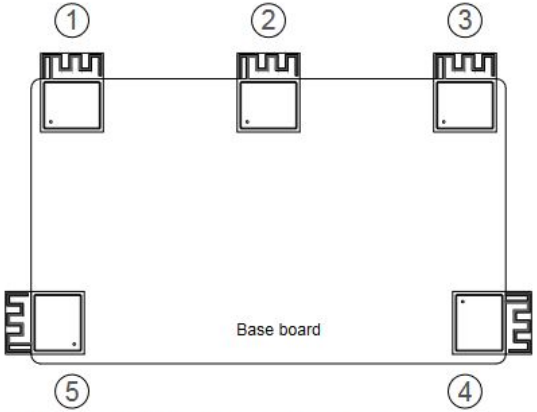


Figure 13: Placement of ESP32-C3 Modules on Base Board. Antenna Feed Point on the Left

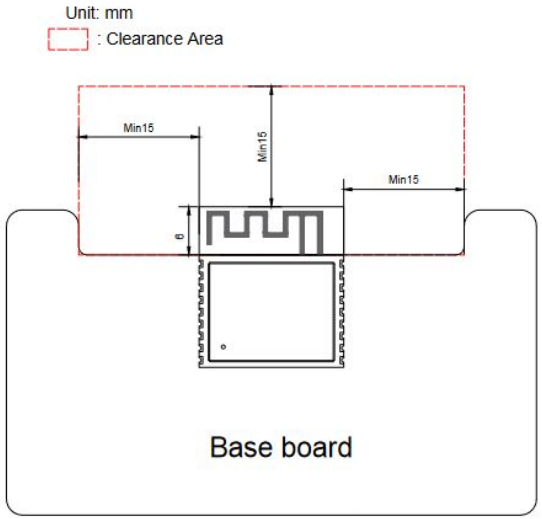
Note:

In Figure 12, the recommended position of ESP32-C3 modules (feed point on the right) on the base board should be:

- Position 3, 4: Highly recommended;
- Position 1, 2, 5: Not recommended.

In Figure 13, the recommended position of ESP32-C3 modules (feed point on the left) on the base board should be:

- Position 1, 5: Highly recommended;
- Position 2, 3, 4: Not recommended.



3.8 Typical Layout Problems and Solutions

3.8.1 Ripple in the power supply is not large, but the RF transmit (TX) performance is rather poor.

Analysis:

Ripple in the power supply can significantly affect the RF TX performance. Please note that ripple in the power supply must be measured when ESP32-C3 family works in TX mode. Ripple in the power supply changes along with power. The higher the power, the larger the ripple.

Generally, the peak value of the ripple should be < 80 mV when ESP32-C3 family transmits MCS7@11n packets, and < 120 mV when ESP32-C3 family transmits 11m@11b packets.

Solution:

Add a 10 μF filter capacitor to the branch of the power trace (the branch routed from the analog power supply pin of ESP32-C3 family). The 10 μF capacitor should be as close to the analog power supply pin as possible. The closer the capacitor, the smaller the ripple.

3.8.2 Ripple in power supply is small during packet transmission, but RF TX performance is still poor.

Analysis:

Besides ripple in the power supply, RF TX performance can also be affected by the crystal itself. The following factors will result in poor RF performance:

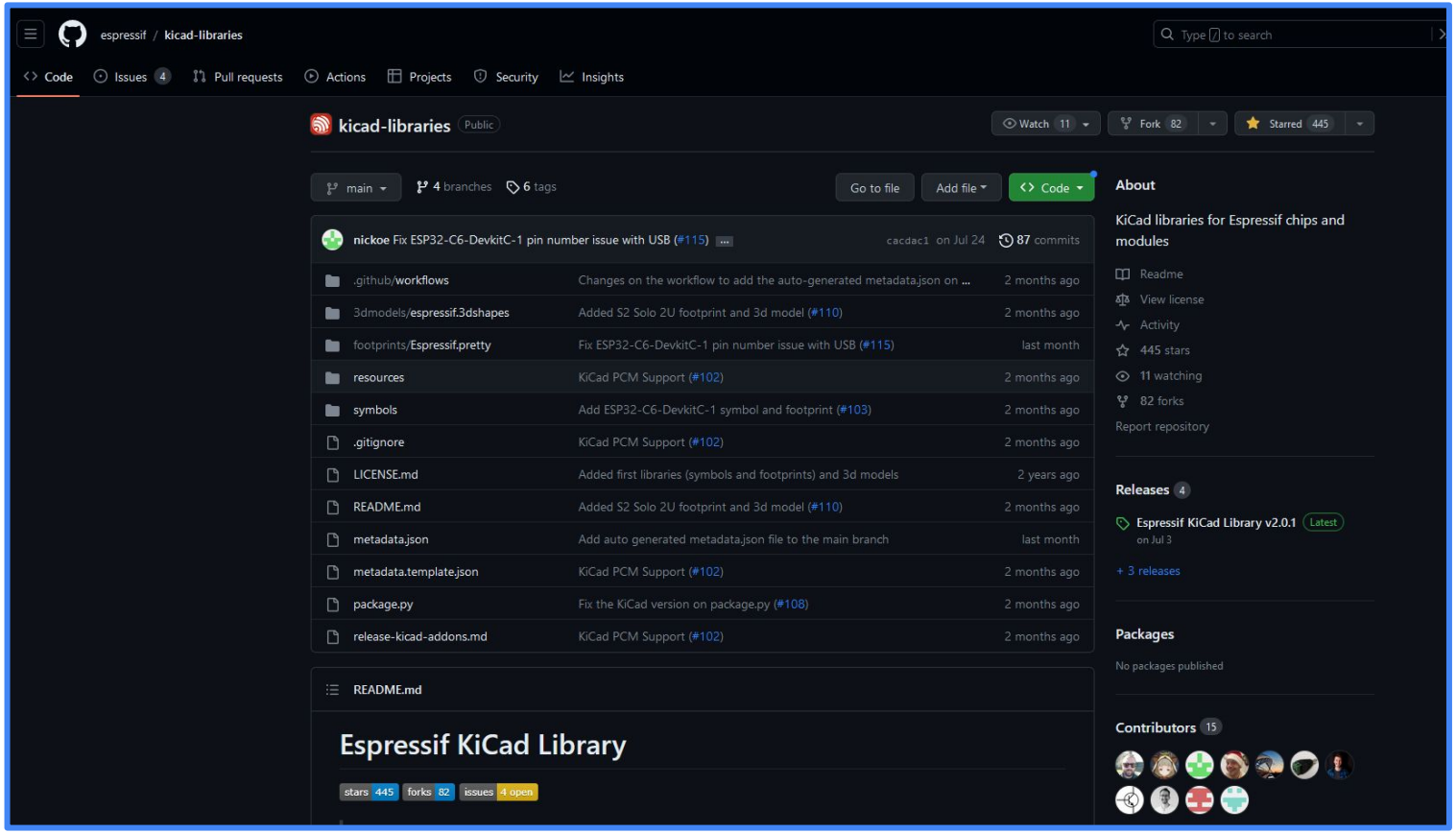
- Large frequency deviation and other quality issues of the crystal
- Interference from high-frequency signals, e.g. signal coupling resulted from a cross-layer design
- High-frequency signal traces under the crystal, such as UART trace
- Inductive or radiation components around the crystal, such as inductors and entennas

Solution:

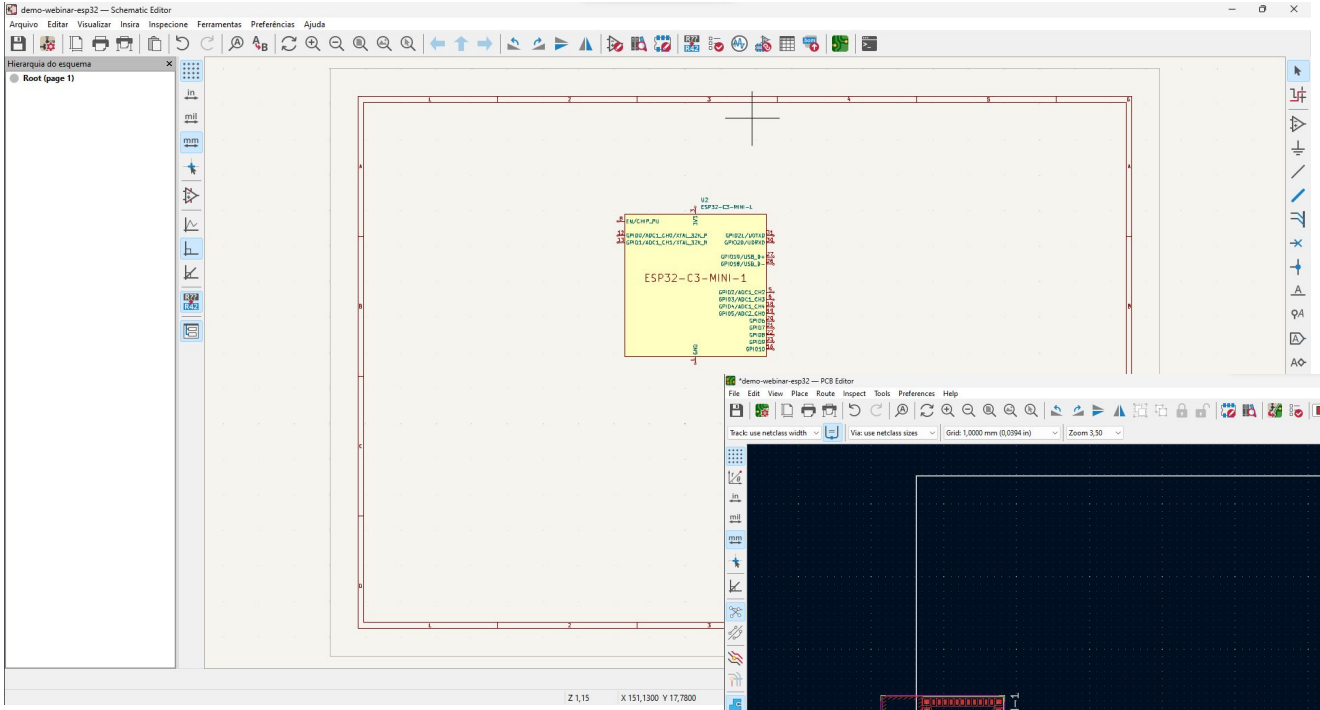
This problem is caused by improper PCB layout and can be solved by optimizing the layout. For layout principles, please see Section 3.

3.8.3 When ESP32-C3 family transmits data packets, the measured power is much higher or lower than the target power, and the EVM is relatively poor.

Analysis:



https://github.com/espressif/kicad-libraries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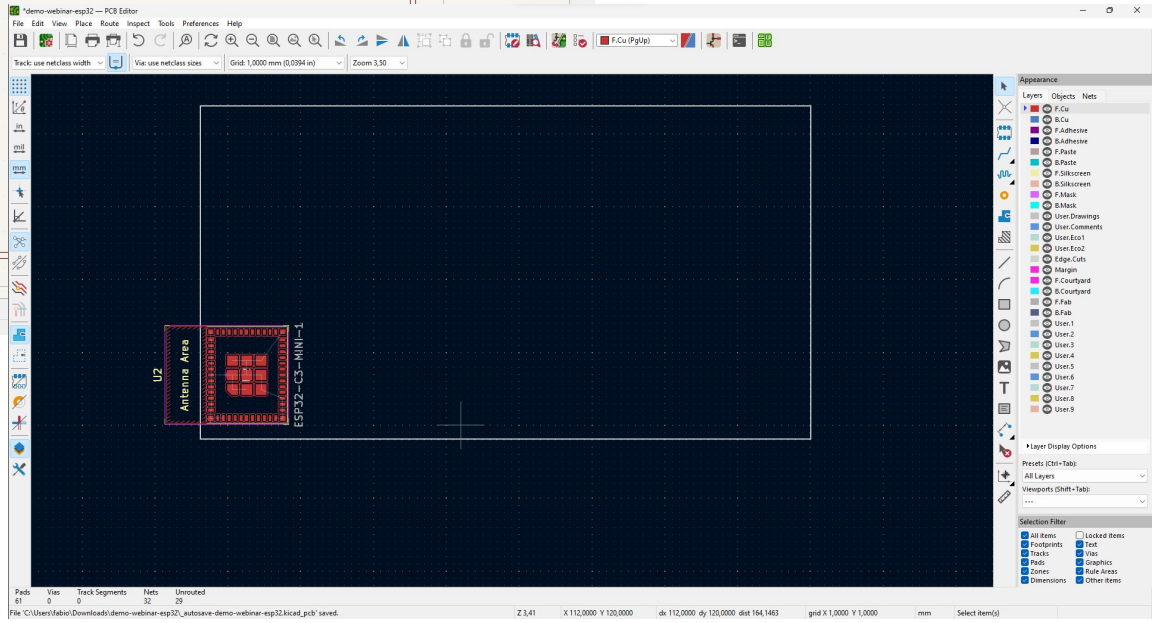
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U2
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ESP32-C3-MINI-1
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Pads Vias Track Segments Nets Unrouted
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Z 3,41
X 112,0000 Y 120,0000
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grid X 1,0000 Y 1,0000
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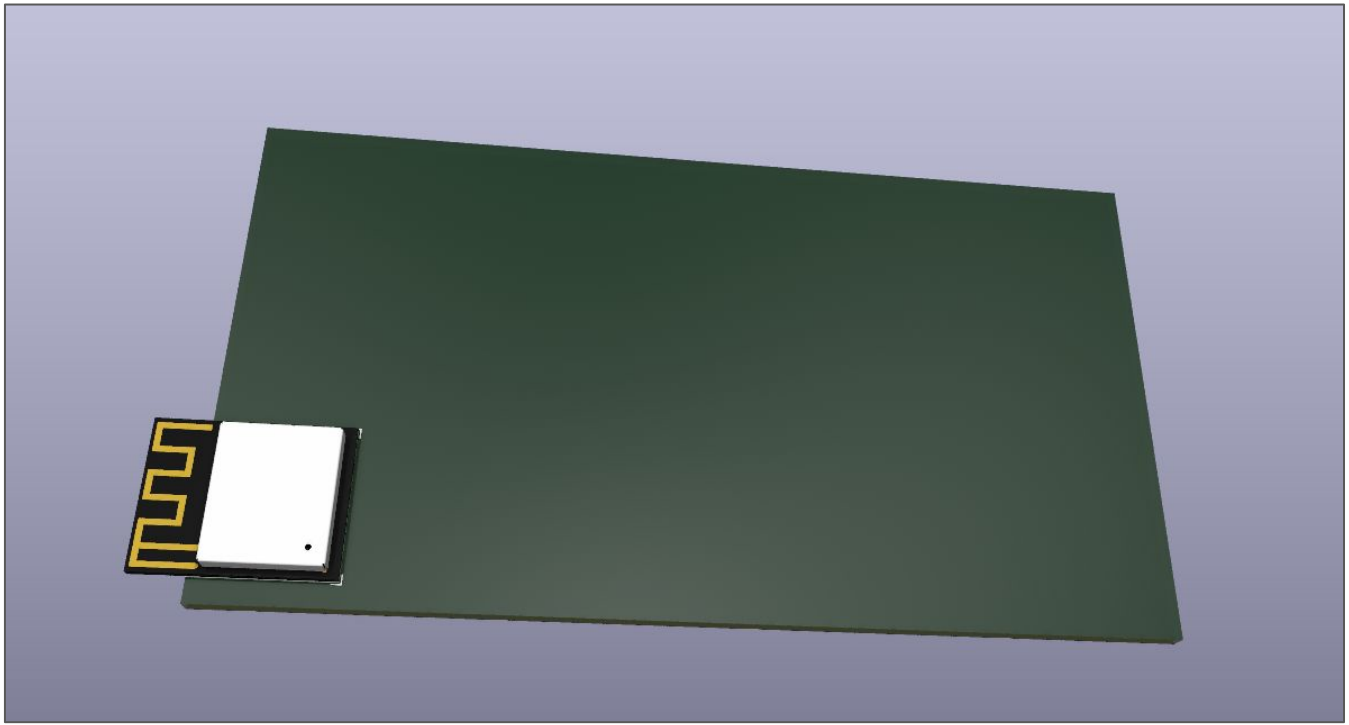
Select item(s)



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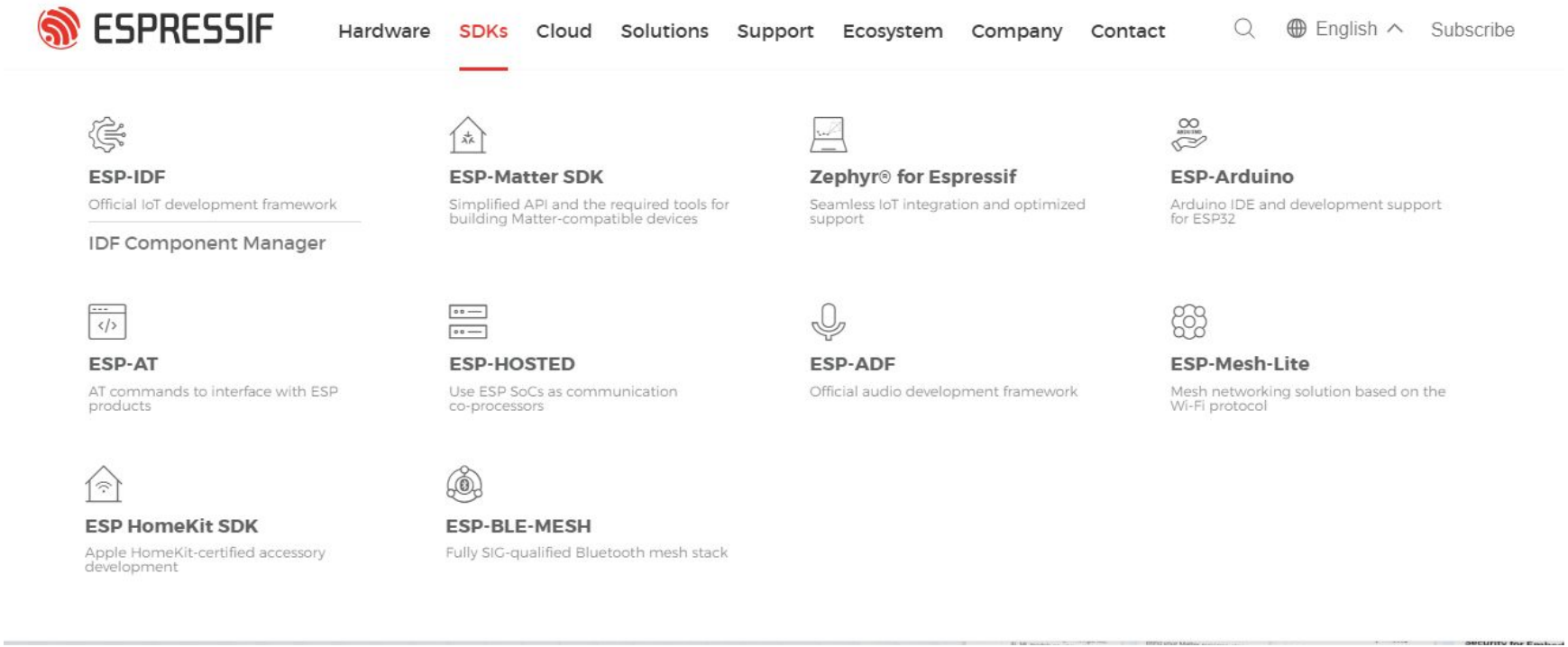
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ESP-HOSTED
Use ESP SoCs as communication co-processors
ESP-ADF
Official audio development framework
ESP-Mesh-Lite
Mesh networking solution based on the Wi-Fi protocol
ESP HomeKit SDK
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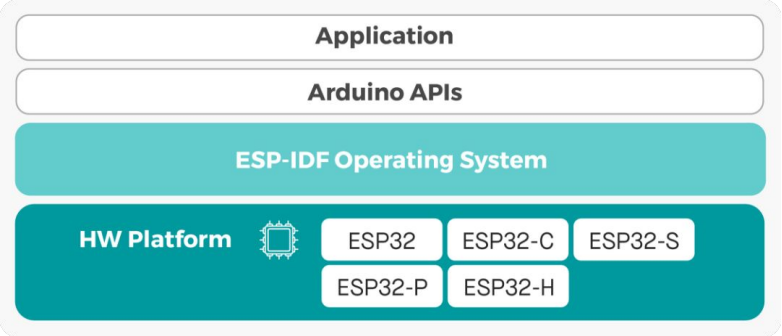
Arduino core for ESP32

- Arduino Core para ESP32 Desenvolvido pela Espressif desde 2016
- Transição suave: prototipagem → produção
- Compatível com ESP RainMaker®
- Segundo apresentado pela Espressif no Summit Brasil 2025:
  - Visão do Produto: “Se tornar a solução de entrada preferida ao lidar com incertezas.”
- Novidade: Suporte a Zigbee



Arduino Core for ESP32

Arduino Component for ESP-IDF

Arduino APIs

RainMaker®

https://www.espressif.com/en/sdks/esp-arduino

Zephyr para o ESP32

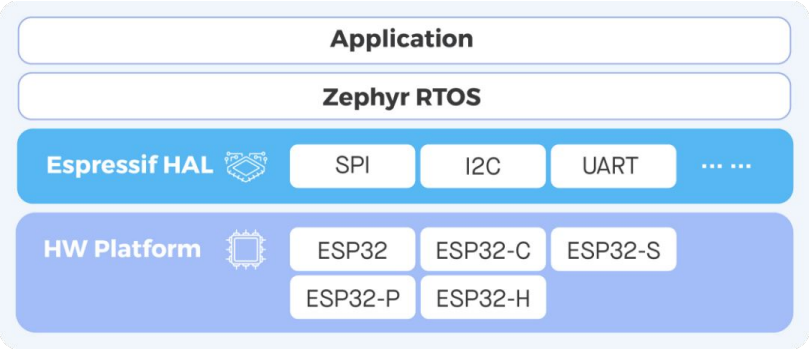
RTOS Open Source → gerenciado pela Linux Foundation, comunidade ativa.

Otimizado para IoT/AIoT → modular, seguro e escalável.

Suporte Espressif → integração nativa com Wi-Fi/BLE, HAL dedicado.

Produção real → já usado em produtos comerciais.

Colaboração contínua → Espressif contribui direto no upstream.



Zephyr RTOS

Espressif HAL

MCUboot

AMP

NuttX

- Open Source e POSIX-like
  - RTOS compatível com APIs POSIX e ANSI C.
  - Ideal para quem busca portabilidade e padronização.
- Recursos Avançados
  - Suporte a multitarefa, threads, drivers de periféricos, rede e sistemas de arquivos.
  - Modular, escalável e próximo de um “Linux embarcado”.
- Espressif + NuttX
  - Suporte oficial para ESP32, ESP32-S e ESP32-C.
  - Ativo na comunidade e upstream, garantindo evolução constante.

Visão da Espressif para o NuttX: Desenvolver o suporte da Espressif para NuttX, tornando-o nossa solução de plataforma de computação que realiza uma transição perfeita de desenvolvedores de ambientes Linux para o desenvolvimento de RTOS baseado em microcontroladores.

RUST

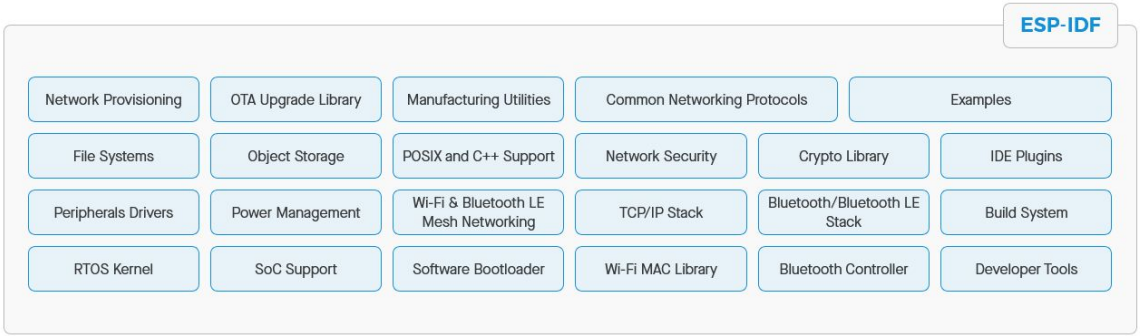
- Nova linguagem → segura, moderna e orientada a desempenho.
- Novo paradigma → foco em segurança de memória e concorrência sem data races.
- Rust on Embedded → habilitando o uso em microcontroladores (HAL, drivers, crates).
- Status atual → em fase beta/pré-release (ESP-HAL 1.0 RC1).
-
- Visão da Espressif:
  - Desenvolver e melhorar o ecossistema Rust para ESP32.
  - Tornar Rust uma opção real para a comunidade embarcada.
  - Expandir a base de usuários, atraindo devs vindos do mundo de sistemas modernos.

Python

- MicroPython → prototipagem rápida e flexível
- CircuitPython → foco em educação e acessibilidade

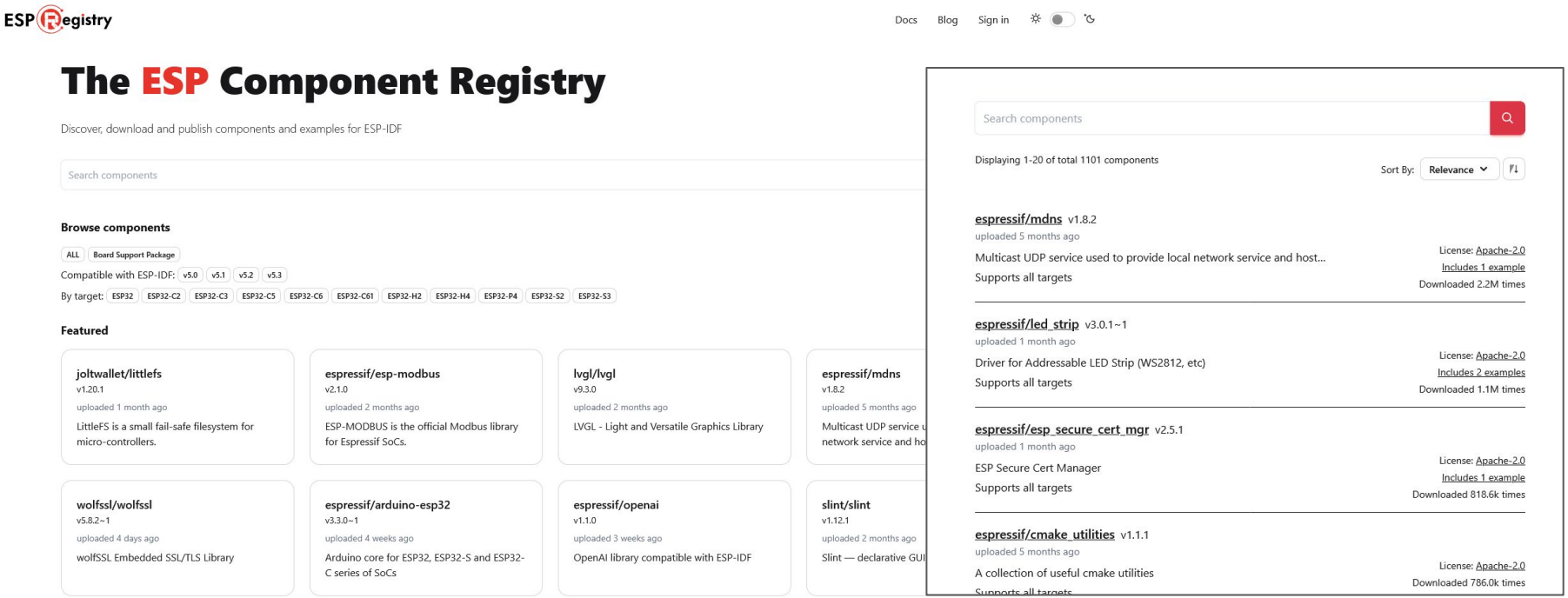
ESP-IDF

- Framework oficial da Espressif para toda a linha ESP32.
  - Atualmente pode ser considerado como um S.O para o ESP32
  - Código aberto (Apache 2.0) no GitHub.
- Pronto para Produção:
  - Usado em milhões de dispositivos no mercado.
  - Releases estáveis com suporte de longo prazo.
- Completo e Flexível:
  - Drivers de periféricos, Wi-Fi, Bluetooth, Mesh, ESP-NOW.
  - Suporte a FreeRTOS, POSIX, bibliotecas de rede e segurança.
  - +100 exemplos e documentação detalhada.



https://www.espressif.com/en/products/sdks/esp-idf

The ESP Component Registry



https://components.espressif.com/

Frameworks e bibliotecas

- SDK for Matter: O SDK da Espressif para **Matter** foi desenvolvido sobre o SDK open-source do Matter para fornecer uma API simplificada e as ferramentas necessárias para criar dispositivos compatíveis com Matter utilizando SoCs da Espressif.
- Espressif's Audio Front-End Algorithms: Algoritmos de áudio de alto desempenho para viabilizar interfaces de usuário por voz com SoCs da Espressif
- ESP-AT: Solução para interface com ESP32 através de comandos AT
- ESP-Hosted:solução open-source que permite que SoCs/módulos da Espressif (como o ESP32) atuem como coprocessadores de comunicação sem fio
- ESP-ADF: O ESP-ADF oferece suporte abrangente para o desenvolvimento de aplicações de áudio nos SoCs da Espressif Systems. Com o ESP-ADF, você pode facilmente adicionar funcionalidades e desenvolver aplicações de áudio e vídeo que vão desde as mais simples até as mais complexa
- ESP-Mesh-Lite: uma solução de rede Wi-Fi Mesh baseada no protocolo Wi-Fi. Ele oferece suporte a um grande número de dispositivos distribuídos em áreas internas e externas, conectando-os à mesma rede.
- ESP HomeKit SDK: foi desenvolvido internamente pela Espressif para permitir a criação de acessórios compatíveis com o Apple HomeKit
- ESP-BLE-MESH: uma pilha de protocolo open-source baseada em Bluetooth® Mesh. Ela é totalmente certificada pelo Bluetooth® Special Interest Group e oferece suporte a todas as funções e modelos de aplicação da Especificação Bluetooth® Mesh v1.0.1.
- ESP-NOW: um protocolo de comunicação sem fio definido pela Espressif, que permite o controle direto, rápido e de baixo consumo de energia de dispositivos inteligentes, sem a necessidade de um roteador.
  ESP-WHO: processamento de imagens
- ESP-SR Speech Recognition Framework: ajuda os usuários a criar soluções de fala com IA.

https://www.espressif.com/en/products/sdks/esp-idf

Cloud

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ESP RainMaker®

Private AIoT Cloud platform with minimal coding and high security

ESP Insights

A remote diagnostics solution to monitor the health of on-field devices

ESP RainMaker®

- Homepage
- Product Brief
- Tech Blogs
- Customer Stories

ESP Insights

- Homepage
- Tech Blogs
- Get Started
- Dashboard

Cloud Services

- Maintain & Iterate
- Tools Support
- Consult & Customize

Develop Resources

- Get Started
- GitHub Repository
- Client APPs
  - Nova Home (Source Code Available)
  - ESP RainMaker (Fully Open Source)
- Dashboard (Public)

Solution Integration

- Matter Fabric
  Quickly create your own Matter ecosystem
- ESP-Mesh-Lite
  Cloud-based mesh device group control
- AWS IoT ExpressLink
  Build Cloud-connected devices with AWS IoT

Soluções

ESPRESSIF

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ESP Matter Offerings

SoCs, SDKs, and services for easy Matter device building

Device Connectivity

- Remote Debugging Platform (ESP Insights)
- ACK Solution (Alexa Connect Kit)
- ACS Solution (Amazon Common Software)
- ESP AWS IoT ExpressLink Solution

Low-Power Solutions

- Wireless Communication Protocol (ESP-NOW)
- ESP Smart Switch Solution

HMI

- Smart Displays

Audio Solutions

- ESP Audio Front-End Algorithms

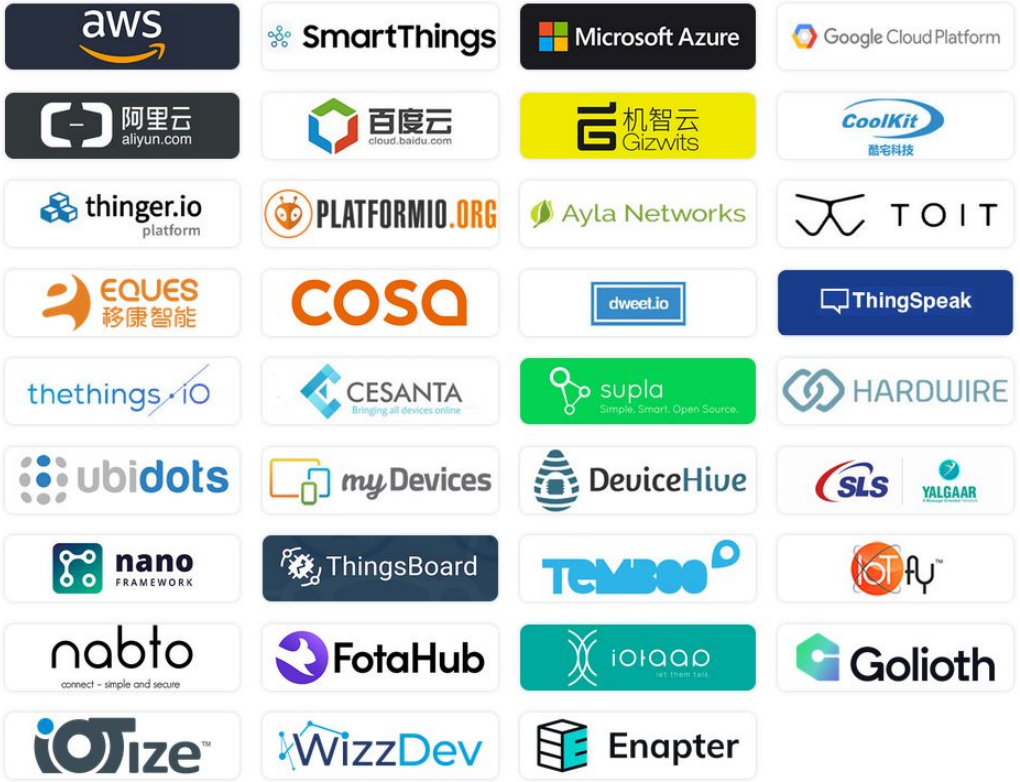
AI Solutions

- Face Detection (ESP-WHO)
- Voice Assistant (ESP-SR)

Peripherals

- Device Drivers
- USB Solutions

Plataformas de terceiros



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SDKs de terceiros

Title	Platform	Download
+ Enapter Developer Toolkit	Enapter	
+ TrillConnect SDK for ESP32-S3	Multiplatform	
+ .NET nanoFramework	Multiplatform	
+ Toit: Containers on the ESP32	Toit	

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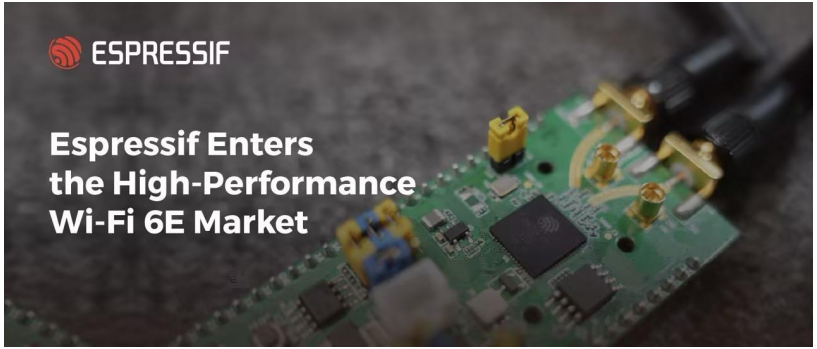
esource > Third-Party SDKs

+ SLS Yalgaar SDK for ESP8266 and ESP32	RTOS	
+ PlatformIO IDE for ESP8266 & ESP32	Multiplatform	
+ AliOS Things for ESP32 & ESP8266	Multiplatform	
+ DeviceHive ESP8266 Firmware	NONOS	
+ Zerynth Studio for ESP32 and ESP8266	Multiplatform	
+ Mongoose OS	RTOS	
+ Gizwits GAgent for ESP8266	RTOS	

Novidades

O ESP32-C6, primeiro RISC-V a obter PSA-L2, garante segurança reconhecida mundialmente, facilitando conformidade regulatória e abrindo portas para aplicações IoT críticas



Espressif entra no mercado de Wi-Fi 6E, levando conectividade tri-band (2.4/5/6 GHz) com alta performance, baixa latência e largura de banda ampliada para aplicações IoT e multimídia.

ESP-BIST - Espressif’s Built-In Self-Test

Um framework bare metal para desenvolver aplicações compatíveis com a norma IEC 60730 Classe B. Ele fornece código e ferramentas para testes essenciais de segurança, como verificação de memória, registradores e clock. Essa biblioteca inclui testes para:

- Registradores da CPU
- Registradores de configuração e status (CSRs)
- Memória volátil
- Memória não volátil
- Pilha da CPU
- Contador de programa (PC)
- Fontes de clock

Objetivo:

- Simplificar e acelerar o desenvolvimento de software para aplicações seguras utilizando os SoCs Espressif, em conformidade com as normas e requisitos de certificação.
- Proporcionar um framework para desenvolvimento de aplicações seguras.
- Fornecer uma biblioteca de testes de hardware e software.

https://github.com/espressif/esp-bist

Referências

https://www.espressif.com/en

https://documentation.espressif.com/en/home

https://developer.espressif.com/

ESP-IDF Programming Guide

https://github.com/espressif/esp-idf

Curso gratuito?

Masterclass ESP32: Introdução Completa

- Descubra o ecossistema ESP32 e dê seus primeiros passos práticos com o ESP-IDF, VS Code e Espressif IDE.

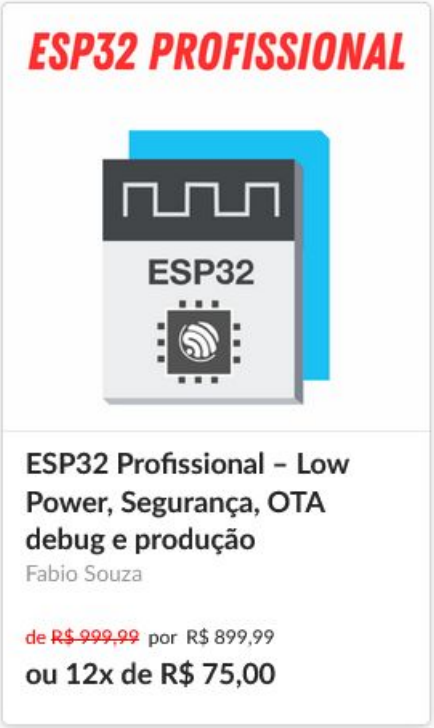
INSCREVA-SE AGORA

EMBARCADOS

Curso disponivel

https://cursos.embarcados.com.br/cursos/franzininho-wifi-arduino-ide/

Curso em Lançamento

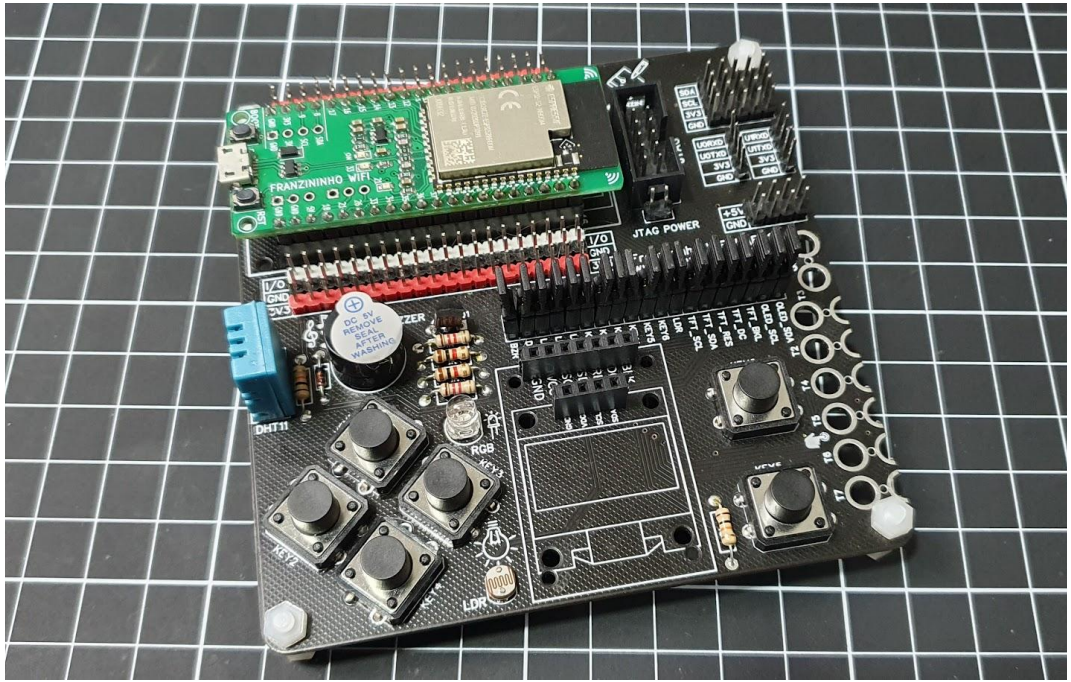


https://cursos.embarcados.com.br/cursos/

Academia ESP32 - TURMA 2

https://cursos.embarcados.com.br/cursos/academia-esp32-profissional-7rukh0/bundle/

Franzininho WiFi LAB01



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Ebook Gratuito

https://embarcados.com.br/e-books/e-book-explorando-o-potencial-do-esp32-guia-de-iniciacao-ao-esp-idf-5/

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