

## INTRODUCING THE ESP32-C3

**Espressifs first RISC-V chip**

## **About me**

- Jeroen Domburg
- Senior Software / Technical Marketing Manager
- HW - me - SW

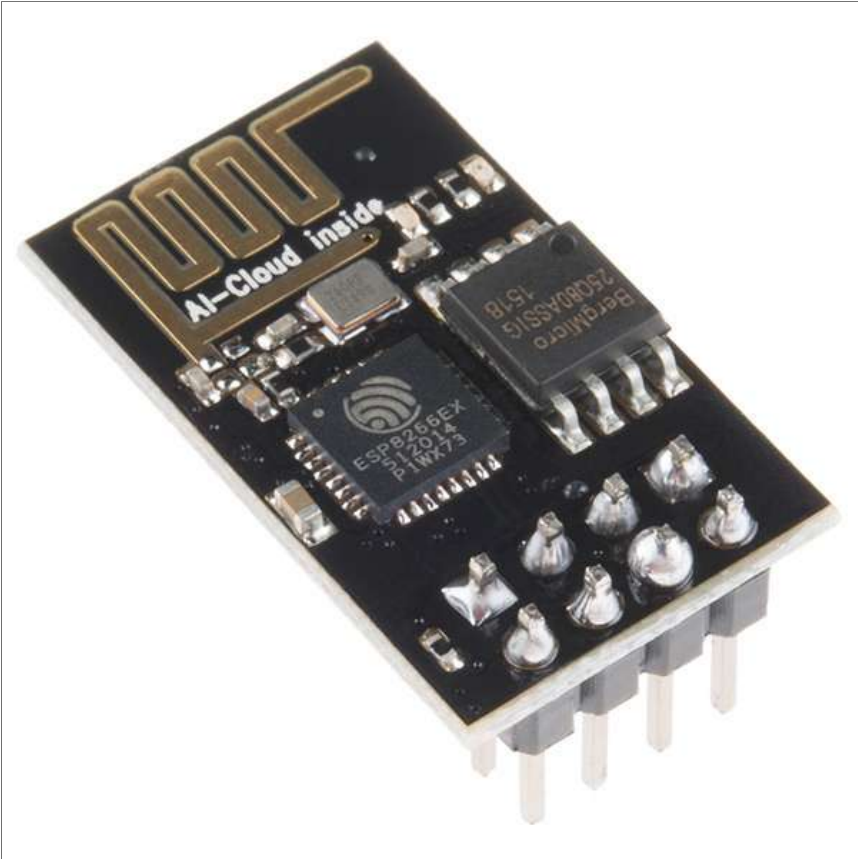
## **About Espressif**

- Fabless chip company
- IoT silicon
- HQ in Shanghai
- Offices in China, India, Czech, Singapore

## **History of Espressif**

- ESP8266
- ESP32
- ESP32S2

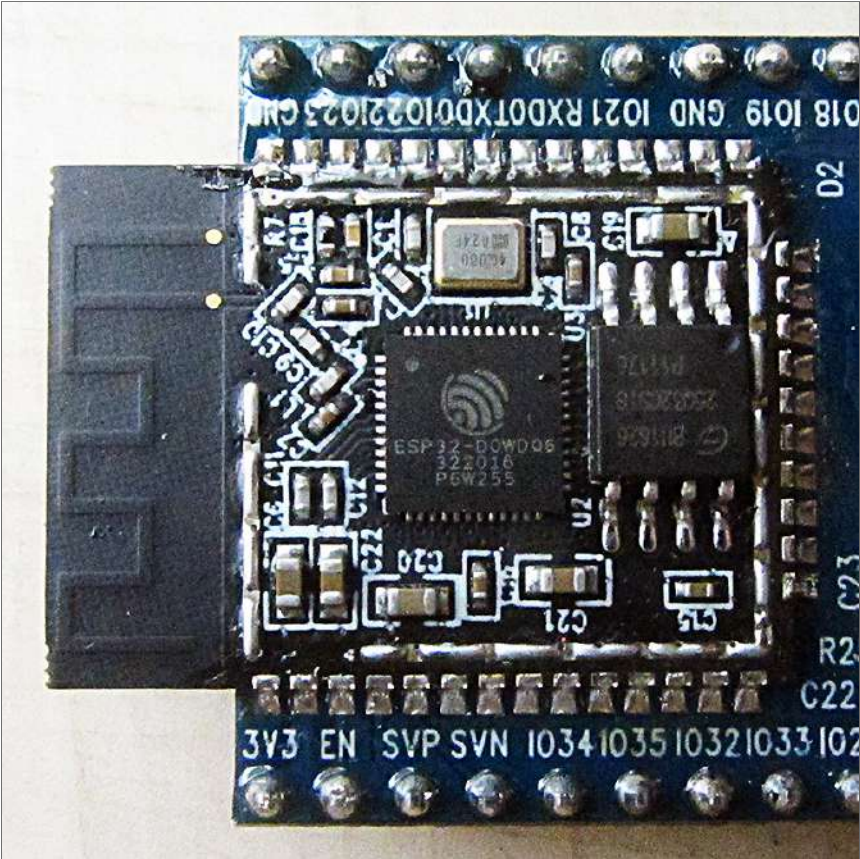
# History of Espressif: ESP8266



## **History of Espressif: ESP8266**

- 80/160MHz Xtensa
- WiFi
- 190'ish K of RAM
- External flash
- UART, SPI, GPIO, I2S, ADC
- 'WiFi coprocessor' / simple apps

# History of Espressif: ESP32



## **History of Espressif: ESP32**

- 80/160/240MHz Xtensa X 2
- WiFi, BT, BTle
- 520K of RAM
- External flash
- UART, SPI, GPIO, ADC, PCNT, MCPWM, LEDPWM, I2C, I2S, RMT, LCD, camera, timers...



## History of Espressif: ESP32S2

- 80/160/240MHz Xtensa X 1
- WiFi
- 320K of RAM
- External flash
- **USB**, UART, SPI, GPIO, ADC, PCNT, MCPWM, LEDPWM, I2C, I2S, RMT, LCD, camera, timers..
- RISC-V ULP

## **Software**

- ESP32 and up: ESP-IDF
- FreeRTOS, LWiP, Cmake (+ many libs)
- Others in the works: Zephyr, NuttX

## **Software: We're Open!**

- SDK: Fully open-source (Apache 2.0)
- TRM documents the hardware
- Exception: lower layers WiFi/BT

## **CPUs used**

- ESP8266: Xtensa LX106
- ESP32: Xtensa LX7 Dual-core (SMP)
- ESP32S2: Xtensa LX7 Single-core

## **Xtensa CPU?**

- Tensilica, now Cadence
- 32-bit RISC
- Some 'weirdness': windowed register file
- Extendable: custom CPU instructions
- Support tools from Cadence

## **Xtensa: Great!**

- CPU optimization: custom instructions by profiling
- IP well-used and low on bugs
- Support tools from Cadence
- Digital team understands Xtensa

## **Xtensa: Not so great...**

- We need general purpose computing
- ISA closed
- Documentation needs NDA
- Cadence tools closed source

## **New chip!**

- WiFi, BTLE
- Cheap & cheerful
- Single-core
- Some GPIO, some RAM...
- RISC-V?



## **Core**

- In-order 4-stage
- RISC-V 32bit IMC
- 160MHz
- We have RTL

## **Fix it!**

- Take existing design, tweak peripherals
- Take out Xtensa
- Put in RISC-V
- ...
- Profit!



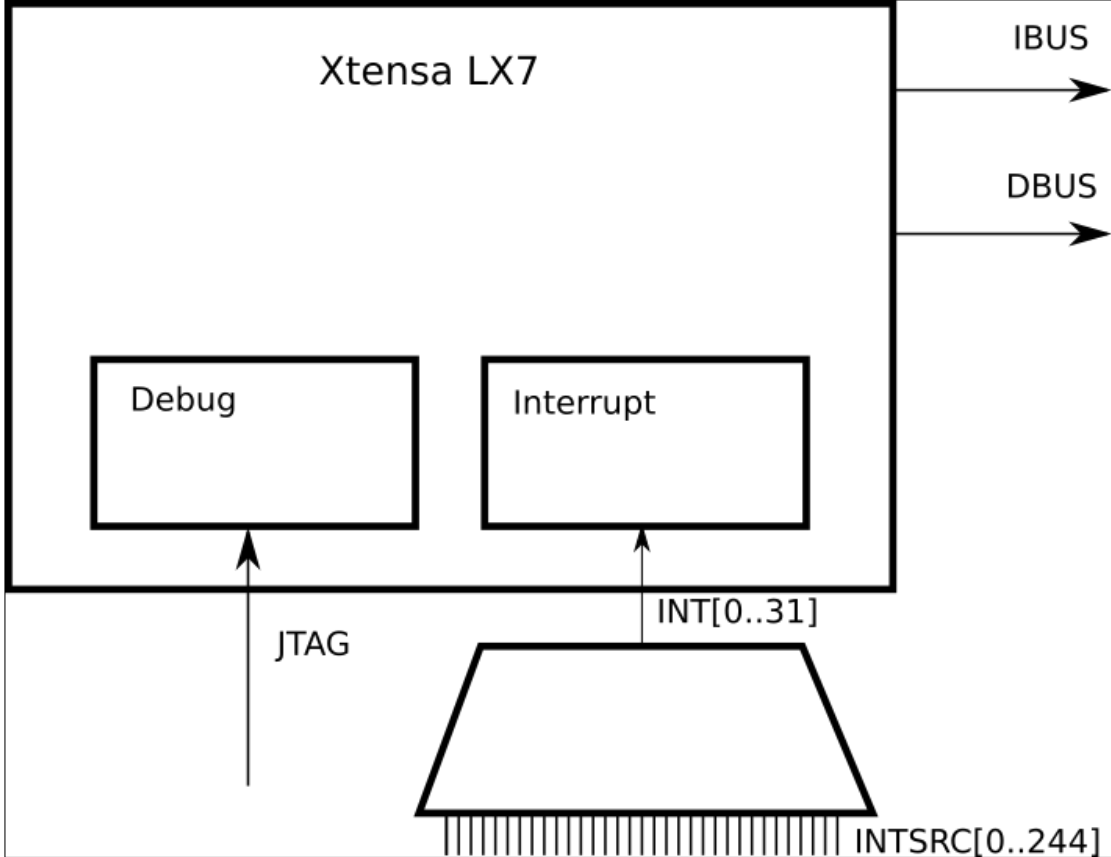
**The End**

---

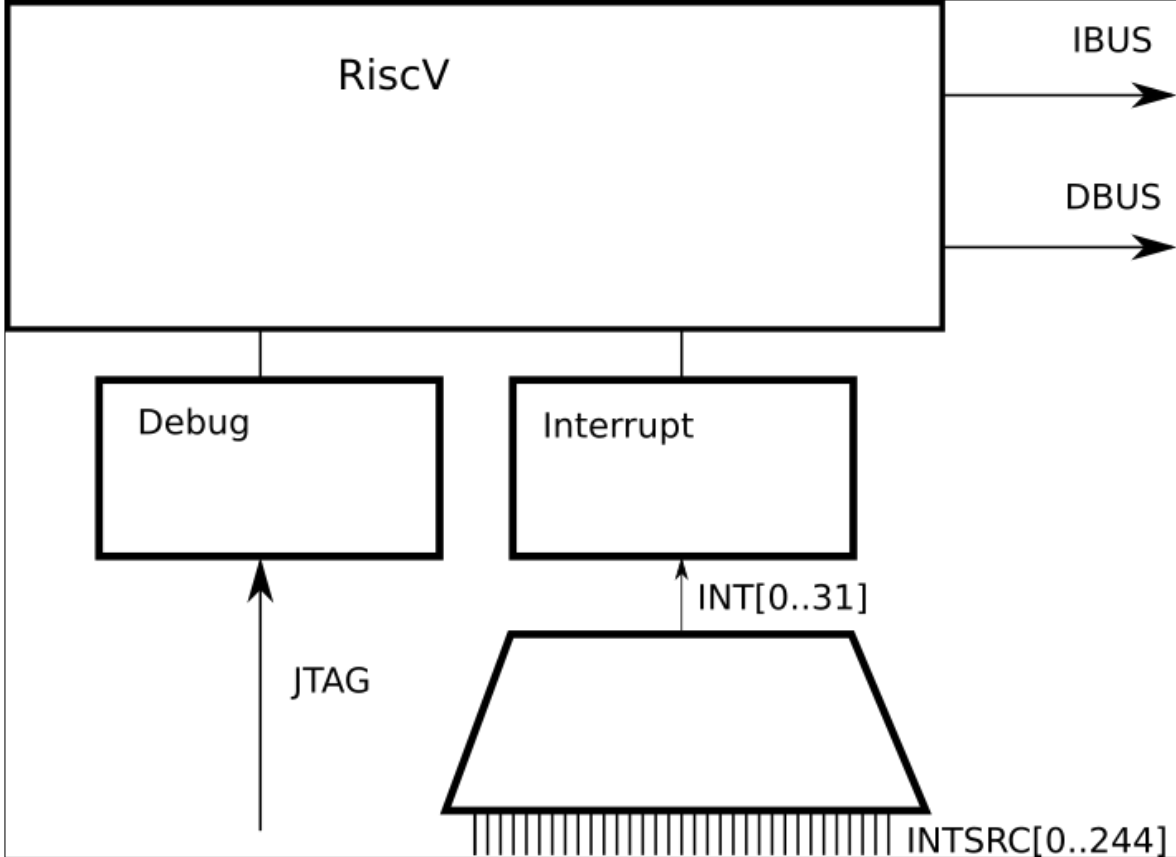
**Thanks for listening!**

**Questions?**

# Issues



# Issues



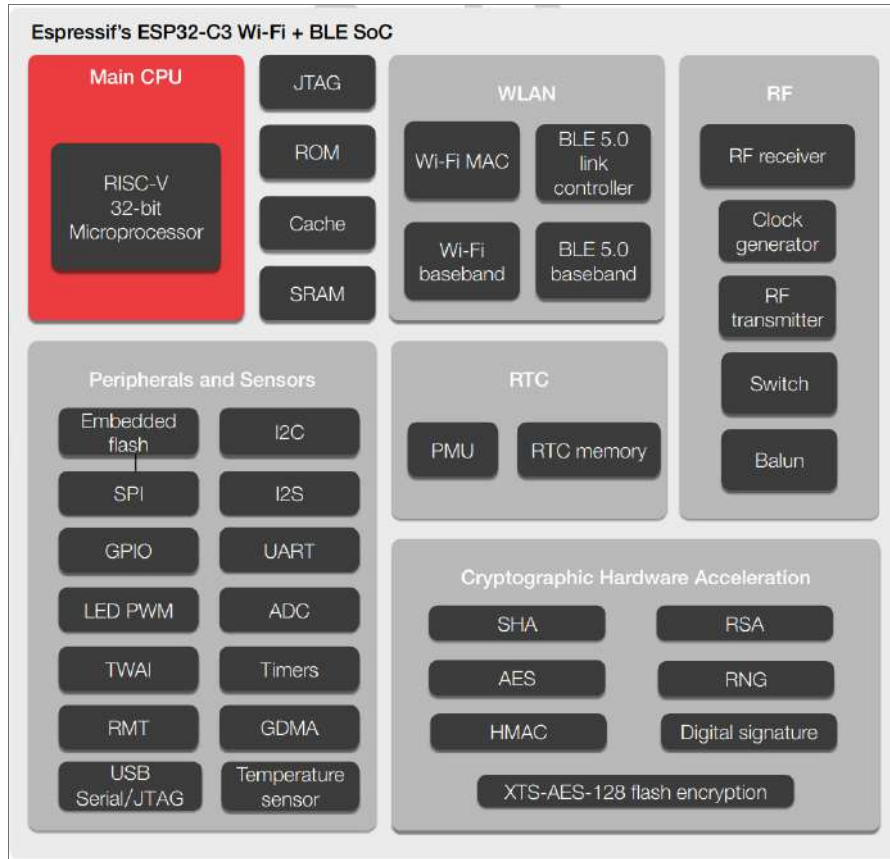
## **Interrupt controller**

- Adapter to interrupt source mux
- Priorities, level/edge, ...
- Not PLIC/CLIC compatible

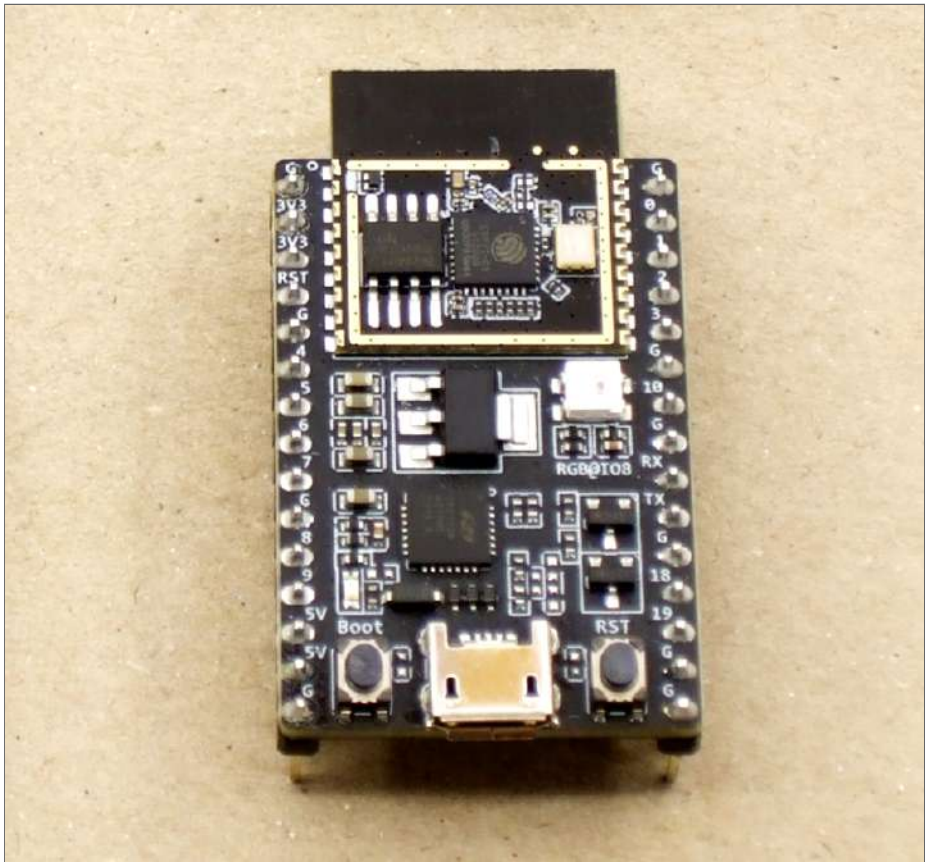
## **Debug subsystem**

- New design
- Access HARTS & system bus
- RiscV debug spec compatible

# The rest of the SoC





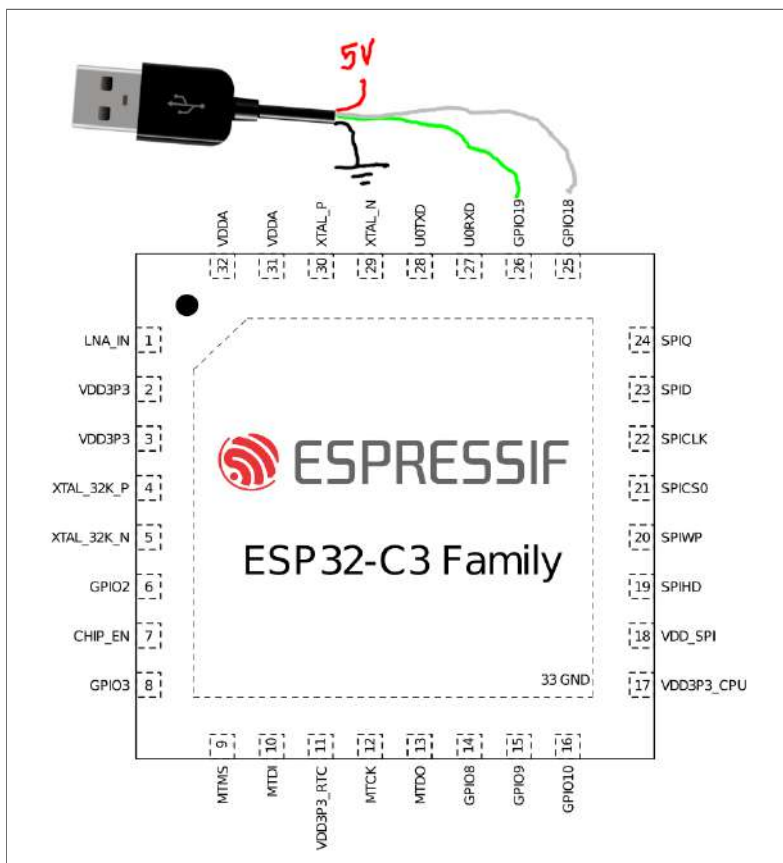


## **Software**

- ESP-IDF
- Arduino
- NuttX
- ...?

## **Tools**

- GCC
- LLVM
- TinyCC
- OpenOCD

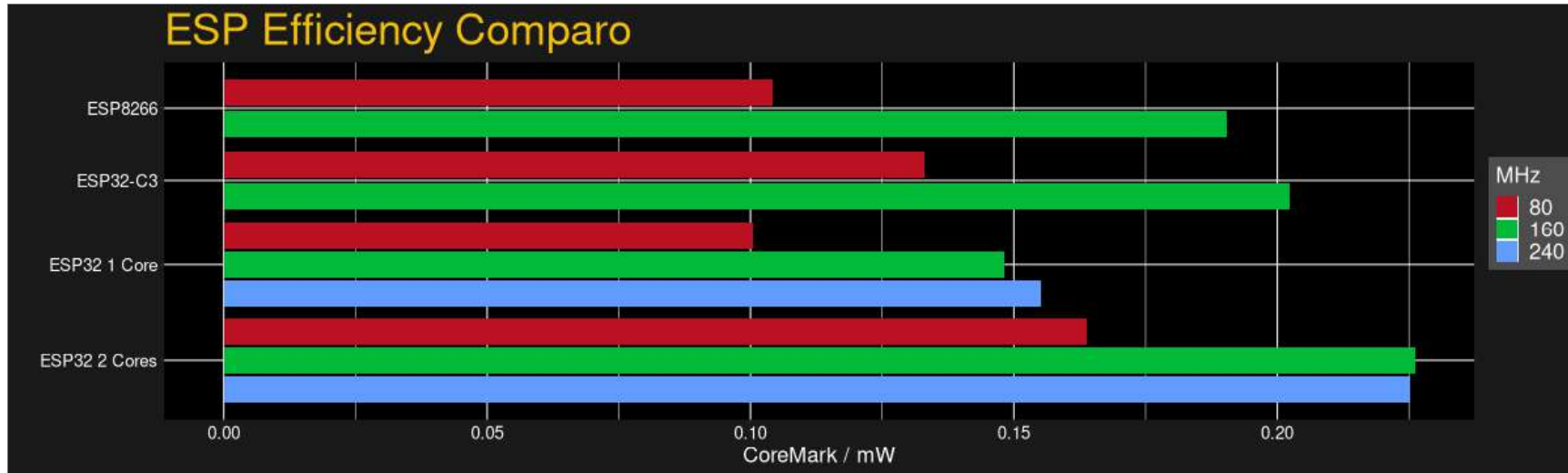


# Advantages of the RISC-V core



Source: Hackaday











# Advantages of the RISC-V core



Source: Hackaday

## **Future plans**

- More compliancy
- Faster core
- Instruction extensions
- Multicore

Select	Image	Part #	Mfr.	Description	Datasheet	Availability	Pricing (JPY)	Qty.	RoHS
<input type="checkbox"/>	 <a href="#">Enlarge</a>	<b>Mfr. Part #</b> ESP32-C3  <b>Mouser Part #</b> 356-ESP32-C3  	Espressif Systems	WiFi Modules (802.11) SMD IC ESP32-C3, single-core MCU, 2.4G Wi-Fi & BLE 5.0 combo, QFN 32-pin, 5*5 mm		Non-Stocked Lead-Time 6 Weeks	<input type="text" value="Price by Qty."/> <b>Cut Tape</b> 1: ¥118 <b>Reel</b> 5,000: ¥118	<input type="text"/> Min.: 1 Mult.: 1 <b>Reel: 5,000</b>	 <a href="#">Details</a>
<input type="checkbox"/>	 <a href="#">Enlarge</a>	<b>Mfr. Part #</b> ESP32-C3-DevKitM-1  <b>Mouser Part #</b> 356-ESP32-C3DEVKITM1  	Espressif Systems	WiFi Development Tools (802.11) ESP32-C3 general-purpose development board, embeds ESP32-C3-MINI-1, 4 MB flash, with pin header  <a href="#">Learn More</a>	<a href="#">Datasheet</a>	730 On Order  <a href="#">View Dates</a>	1: ¥944	<input type="text"/> Min.: 1 Mult.: 1	 <a href="#">Details</a>
<input type="checkbox"/>	 <a href="#">Enlarge</a>	<b>Mfr. Part #</b> ESP32-C3-DevKitC-02  <b>Mouser Part #</b> 356-ESP32C3DEVKITC02  	Espressif Systems	Development Boards & Kits - Wireless ESP32-C3 general-purpose development board, embeds ESP32-C3-WROOM-02-N4, 4 MB flash, with pin header  <a href="#">Learn More</a>	<a href="#">Datasheet</a>	340 On Order  <a href="#">View Dates</a>	1: ¥1,062	<input type="text"/> Min.: 1 Mult.: 1	 <a href="#">Details</a>
<input type="checkbox"/>		<b>Mfr. Part #</b>	Espressif	WiFi Modules (802.11)	<a href="#">Datasheet</a>	862	1: ¥224.2	<input type="text"/>	 <a href="#">Details</a>





**The End**

---

**Thanks for listening!**

**Questions?**

[www.espressif.com](http://www.espressif.com)

[jeroen@espressif.com](mailto:jeroen@espressif.com)

**Thanks!**