



# Sistemas con Microprocesadores

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## 2. Diseño de sistemas con microcontroladores

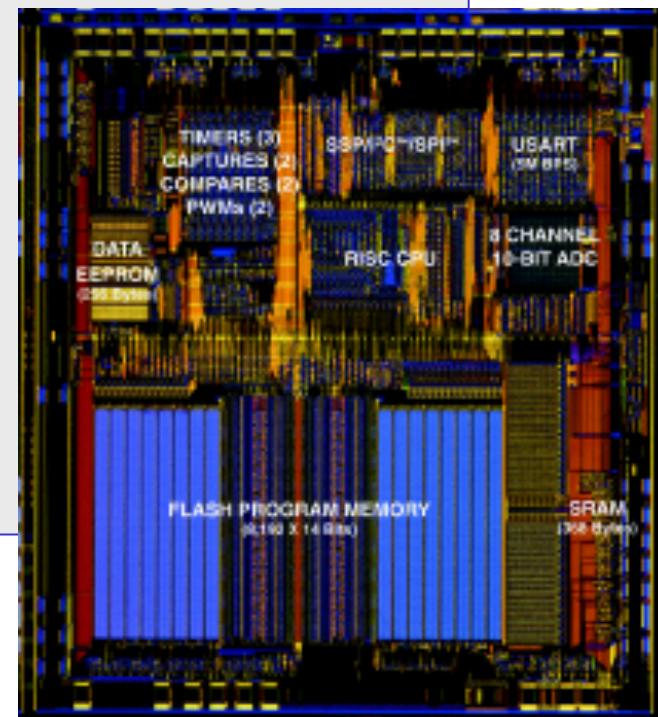
**2.1 Hardware y Software de desarrollo:  
Compiladores y ensambladores  
Tarjetas de programación/desarrollo**

**2.2 Arduino y otras plataformas**

# Microcontroladores

**Concepto de microcontrolador:** sistema microcomputador completo en un chip destinado a resolver una tarea específica.

- Núcleo microprocesador + memoria (instrucciones, datos) + elementos de entrada/salida. Estos recursos varían en función del fabricante y del modelo:
  - Memoria no volátil para programa
  - Memoria volátil para datos <y una parte no volátil>
  - Puertos paralelo y/o serie (I2C, RS232, USB, ..).
  - Convertidores A/D y D/A, comparadores analógicos, PWM,...
  - Temporizadores digitales, perro guardián, etc



# Fabricantes y modelos de microcontroladores

Muchos **fabricantes** de semiconductores tienen secciones específicas dedicadas a producción de microcontroladores: Motorola, ST microelectronics, Siemens (Infineon), National Semiconductors, Philips, Zilog, Microchip (Atmel), Hitachi, Toshiba, SGS, Parallax, etc.

Los **modelos** del microcontroladores de 8 bits más populares han sido los basados en el **8051** de Intel, adoptado como núcleo de microcontroladores de otros fabricantes, los **68xx** de Motorola, y los **PIC** de Microchip.

# Lenguajes y tecnologías de programación

## Lenguajes de programación:

- Tradicionalmente ensamblador.
- Cada vez es más extendido el uso de lenguajes de alto nivel (C, Basic, Javascript, Python) a medida que se van abordando aplicaciones más complejas y los tamaños de memoria de programa disponibles crecen.

## Tecnologías de grabación de la memoria de instrucciones:

**ROM** (el fabricante mediante máscara, series muy grandes)

**OTP** (One-Time-Programming, bajo coste, series grandes)

**EPROM** (borrado con UVA)

**EEPROM/FLASH** (útiles para depuración, actualización múltiple en el propio sistema, sistemas con reprogramación frecuente (por ej. microrobots), etc.)

Casi en desuso

# Herramientas de desarrollo

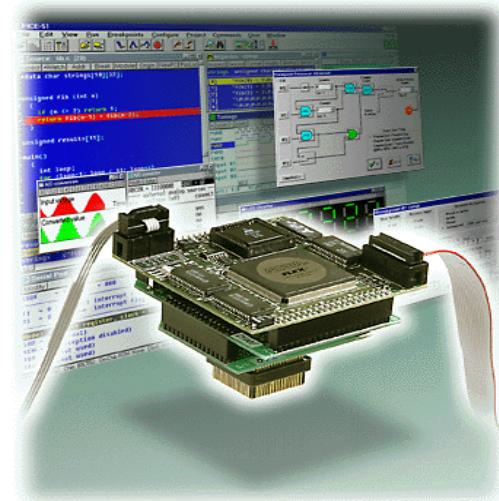
## Software:

Ensambladores, compiladores, simuladores (con facilidades de depuración de código). Normalmente incluidos en entornos de desarrollo integrados (IDE).

## Hardware:

- Dispositivos programadores y tarjetas de desarrollo básicas: soluciones de bajo coste para desarrollo de sistemas con microcontroladores.**
- Depuración de código en el propio circuito (ICE: In Circuit Emulator).**

Ejemplo: ICE multiplataforma basado en FPGA





# Sistemas con Microprocesadores

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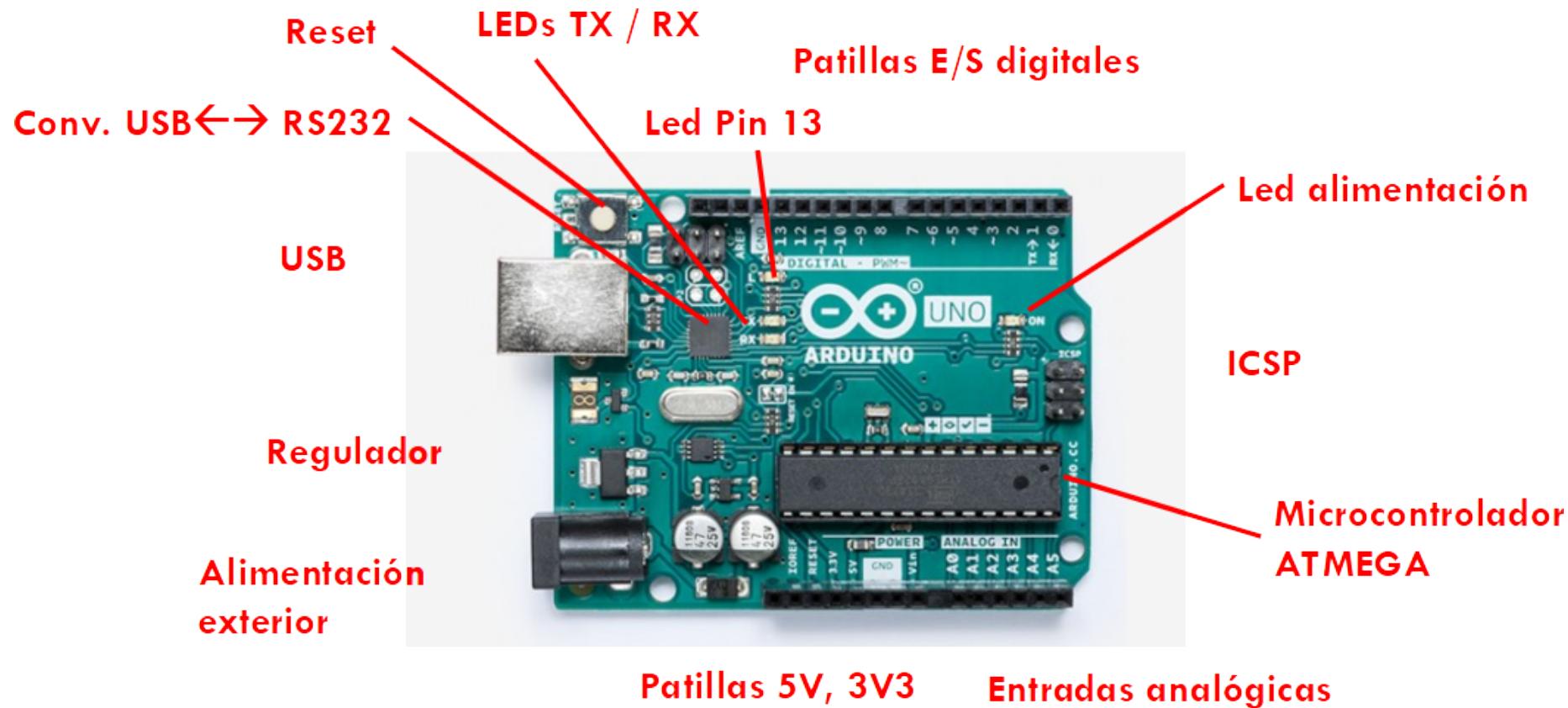
## 2. Diseño de sistemas con microcontroladores

**2.1 Hardware y Software de desarrollo:**  
**Compiladores y ensambladores**  
**Tarjetas de programación/desarrollo**

**2.2 Arduino y otras plataformas**

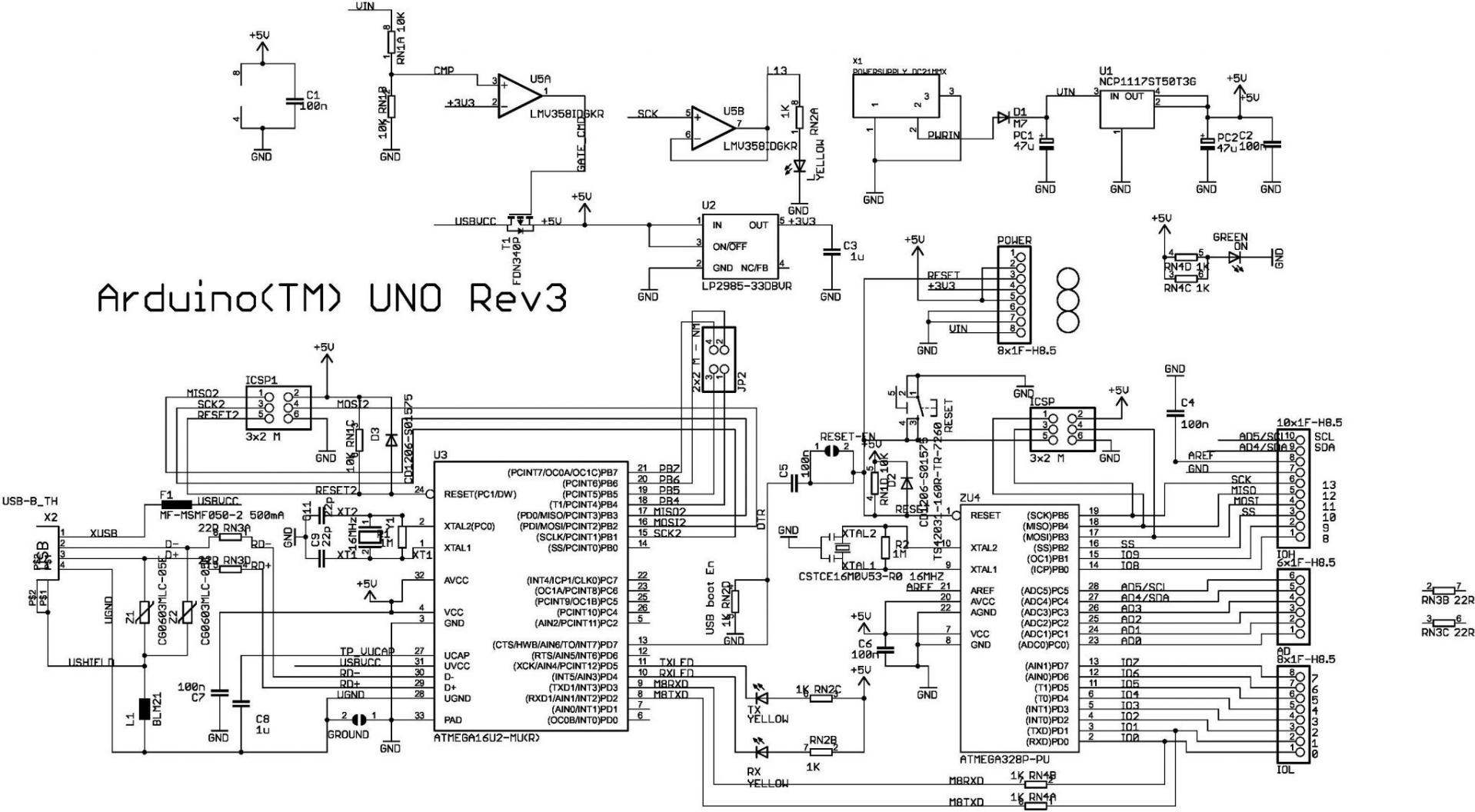
# Arduino UNO

- Micro. Microchip (Atmel) ATmega328P @ 16MHz
- [https://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-7810-Automotive-Microcontrollers-ATmega328P\\_Datasheet.pdf](https://ww1.microchip.com/downloads/en/DeviceDoc/Atmel-7810-Automotive-Microcontrollers-ATmega328P_Datasheet.pdf)

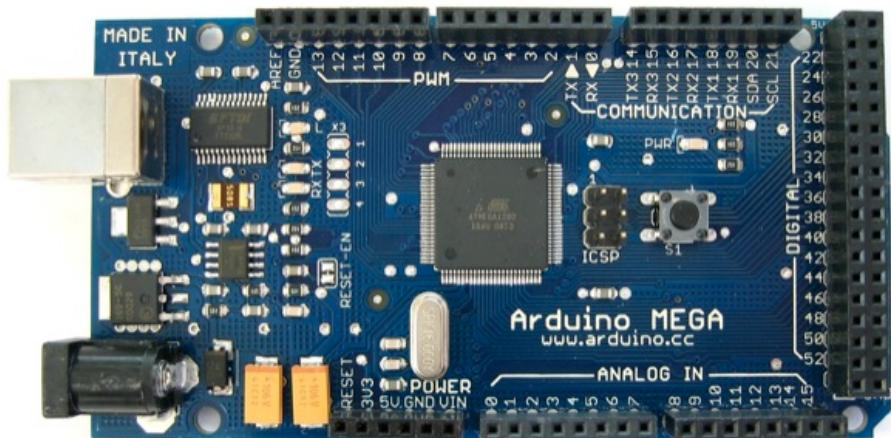
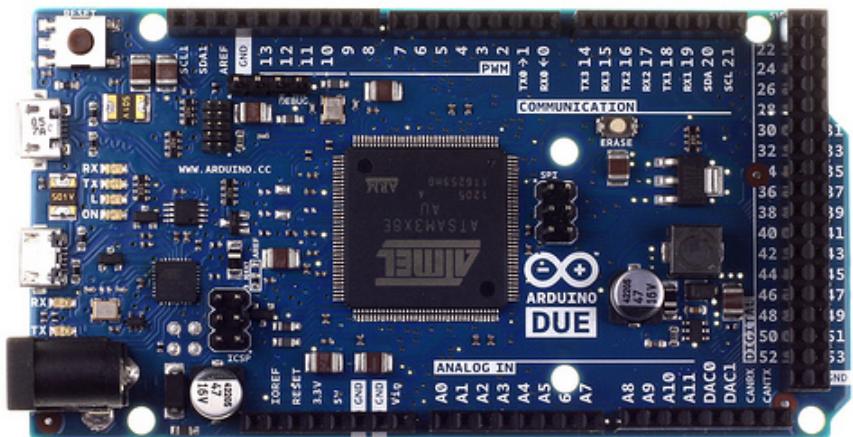
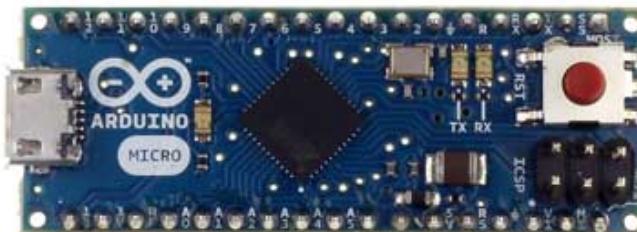
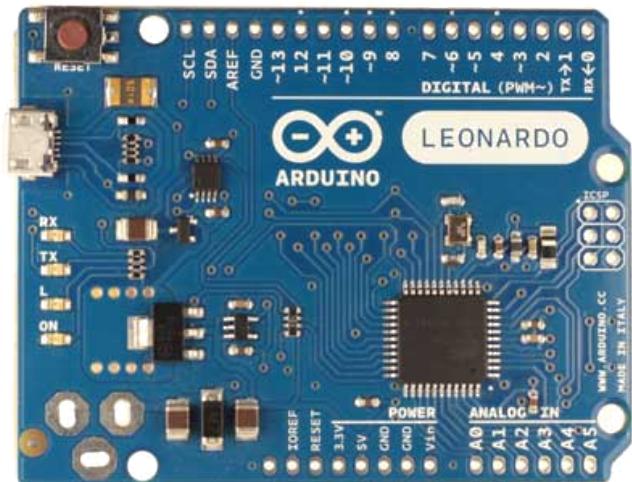
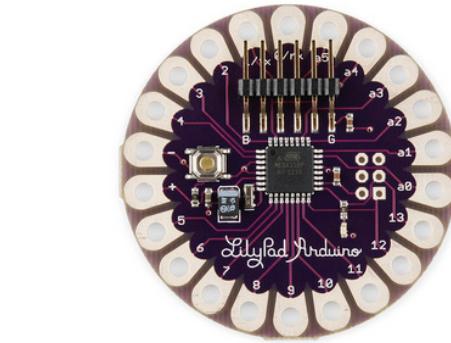
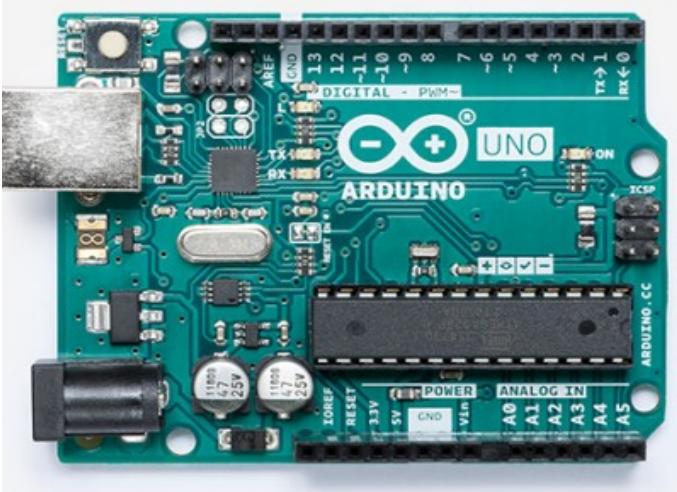


# Esquema Arduino UNO Rev3

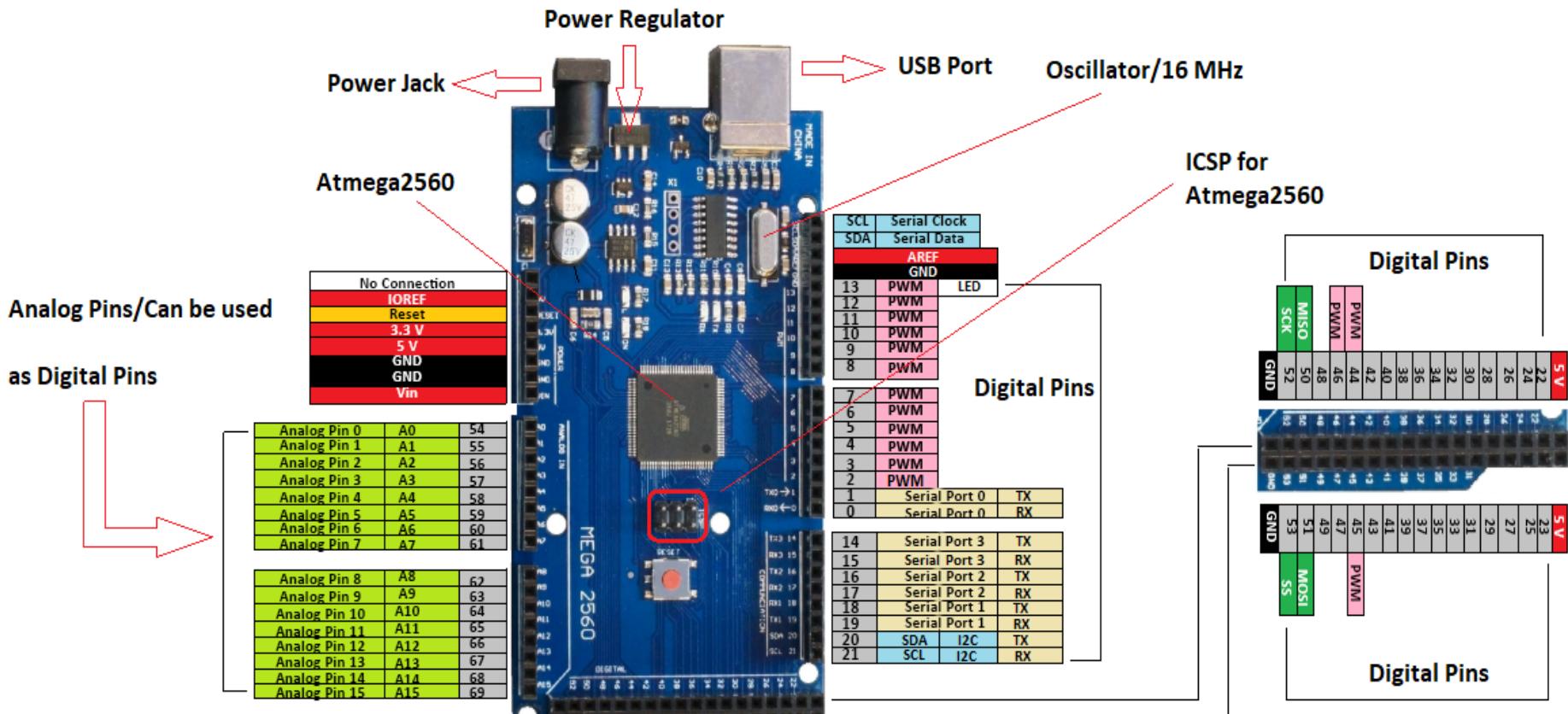
□ <https://electrosome.com/wp-content/uploads/2014/07/Arduino-Uno-R3-Schematic-Diagram.jpg>



# Placas Arduino



# Arduino MEGA



- Microcontrolador: ATmega2560
- Voltaje funcionamiento: 5V
- Voltaje Entrada: (recomendado) 7-12V
- Voltaje Entrada: (límites) 6-20V
- Patillas E/S digital 54 (14 con salida PWM)
- Patillas entrada analógica: 16

- Corriente DC por pin E/S: 40 mA
- Corriente DC para salida 3,3V: 50 mA
- Memoria Flash: 256 KB (8 KB bootloader)
- SRAM: 8 KB
- EEPROM: 4 KB
- Frecuencia de reloj: 16 MHz

# Placas Arduino

Placa	Micro	Flash (KB)	RAM (KB)	
Duecimille / Duemilanove	ATmega328 / 168	32/16	2/1	
<b>Uno</b>	<b>ATmega328</b>	<b>32</b>	<b>2</b>	
Leonardo	ATmega32u4	32	2,5	Trans. USB incluido
Micro	ATmega32u4	32	2,5	
Nano	ATmega328 / 168	32/16	2/1	
Due	AT91SAM3X8E	512	96	84 MHz
Mega	ATmega2560	256	8	

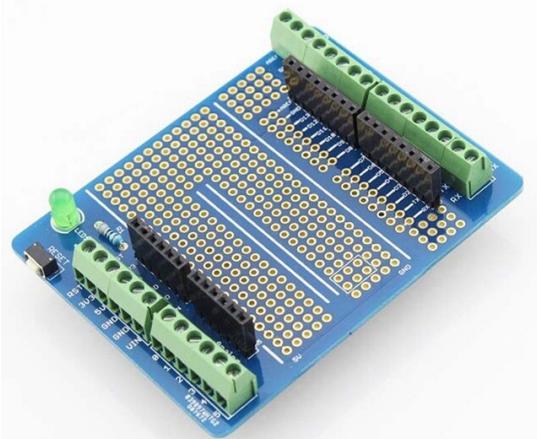
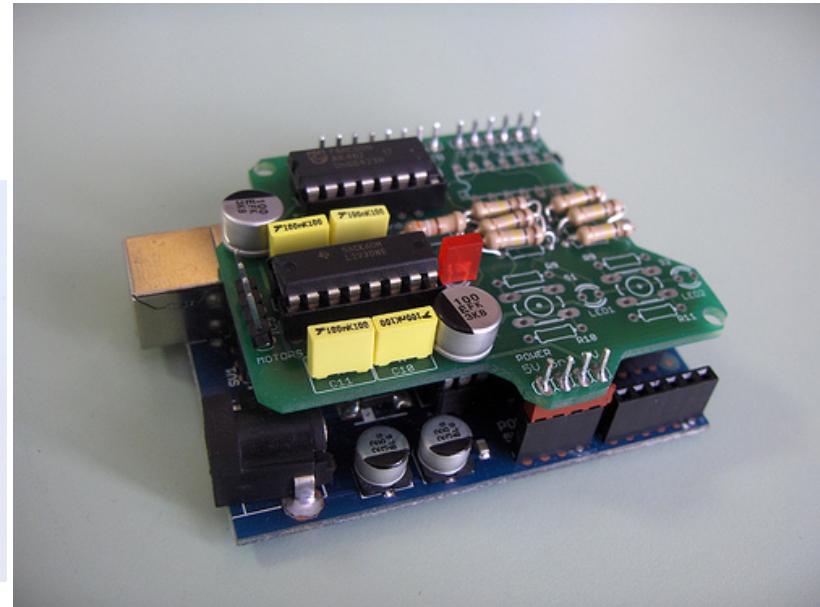
Otras placas: Yún, Galileo, Tre,...

<http://arduino.cc/en/Main/Products>

# Shields

- Permiten conectar fácilmente periféricos
- <http://shieldlist.org>

- Control de motores
- Ethernet
- Relés
- Prototipado
- ...

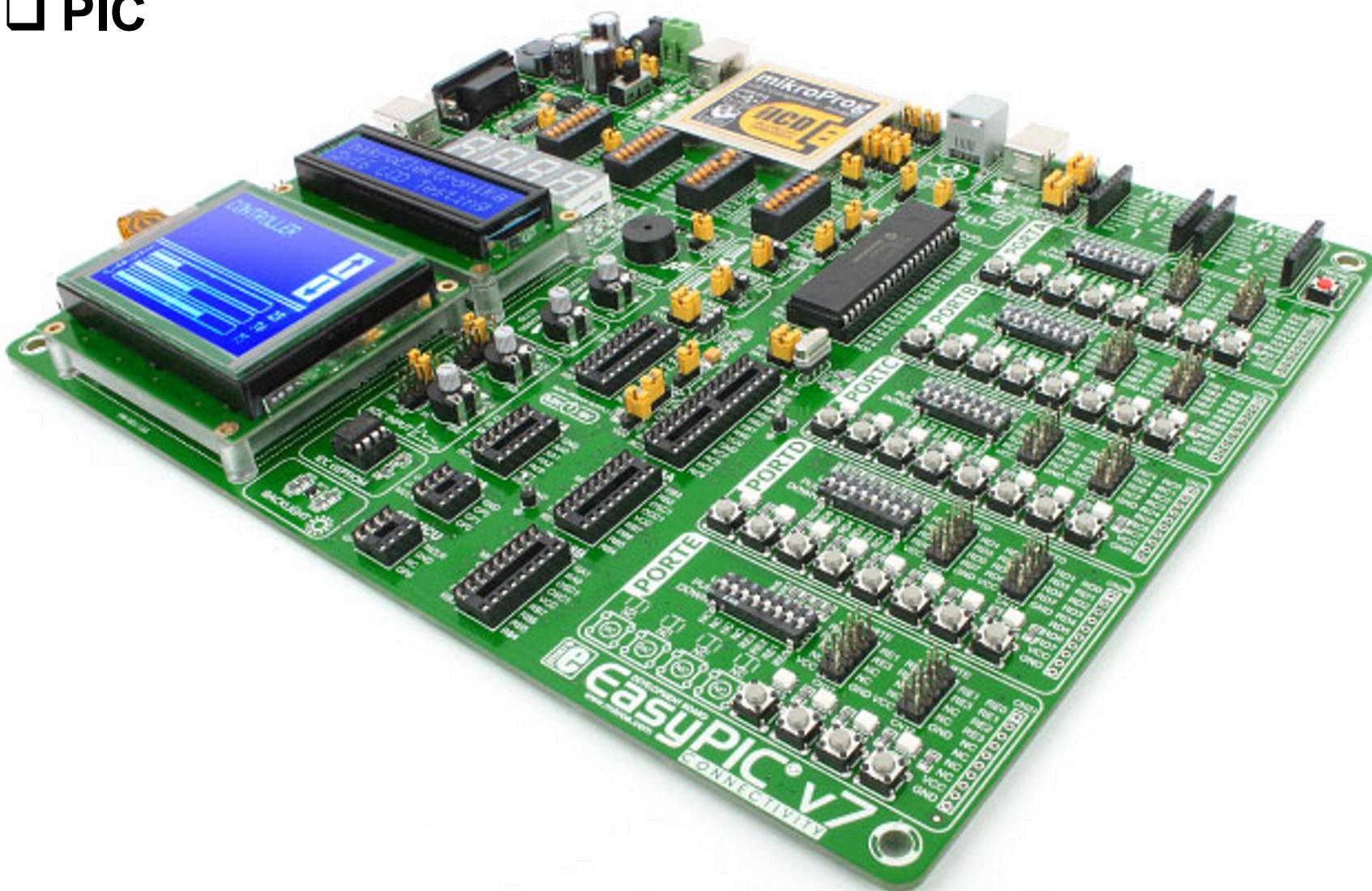


# ¿Qué se puede conectar a un Arduino?

- Buses incorporados como I2C y SPI permiten gran cantidad de periféricos
- Entradas digitales y analógicas, teclados, botones
- Pantallas LCD, *displays* 7 seg., pantalla de matriz de puntos
- Sensores: temperatura, humedad, presión, giróscopos, acelerómetros, ...
- Motores: Continua, paso a paso
- Comunicaciones:
  - USB, Bluetooth (+BLE), Zigbee, Ethernet, WiFi, RF, RFID, LoRa, NRF24L01 ...

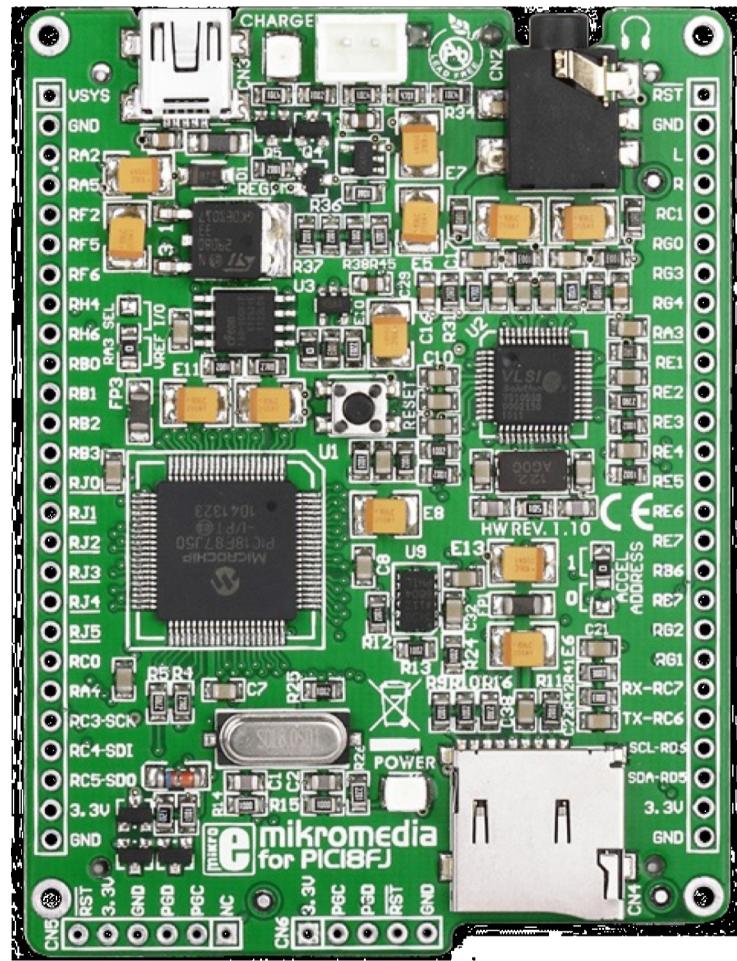
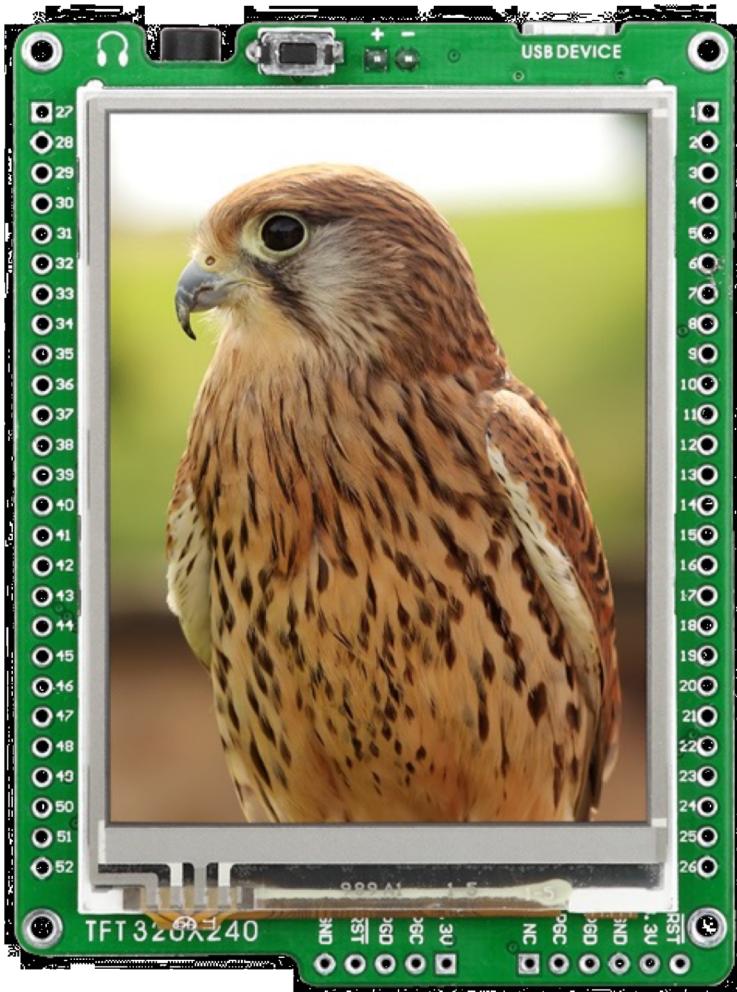
# Otras plataformas

## □ PIC



# Otras plataformas

PIC

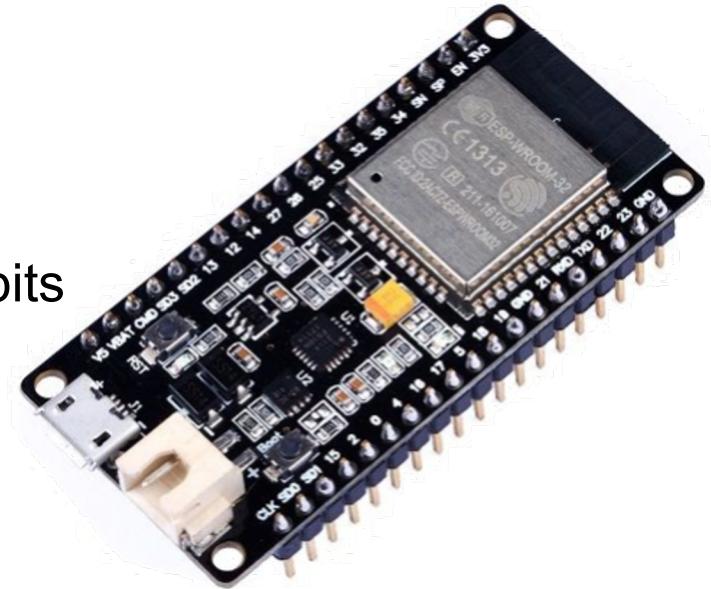


# Otras plataformas

## □ ESP32 de Espressif

### – Especificaciones generales:

- Procesador dual core Xtensa® LX6 de 32 bits
- Reloj : 160 Mhz y 240 Mhz
- 520 Kb de RAM
- Wifi integrado: Acces point & Station
- Bluetooth 4,2 2,4 Ghz; BT 2.0 y 4.0 BLE
- 36 E/S de propósito general.
- 16 x Analog-to-Digital Converter (ADC) de 12 bits.
- 2 x Digital to Analog converter DAC de 8 bits.
- Pueden definirse hasta 16 canales de PWM.
- 2 x UART
- 2 x I2C
- 4 x SPI channels.



# Otras plataformas

## ESP32-WROOM-32



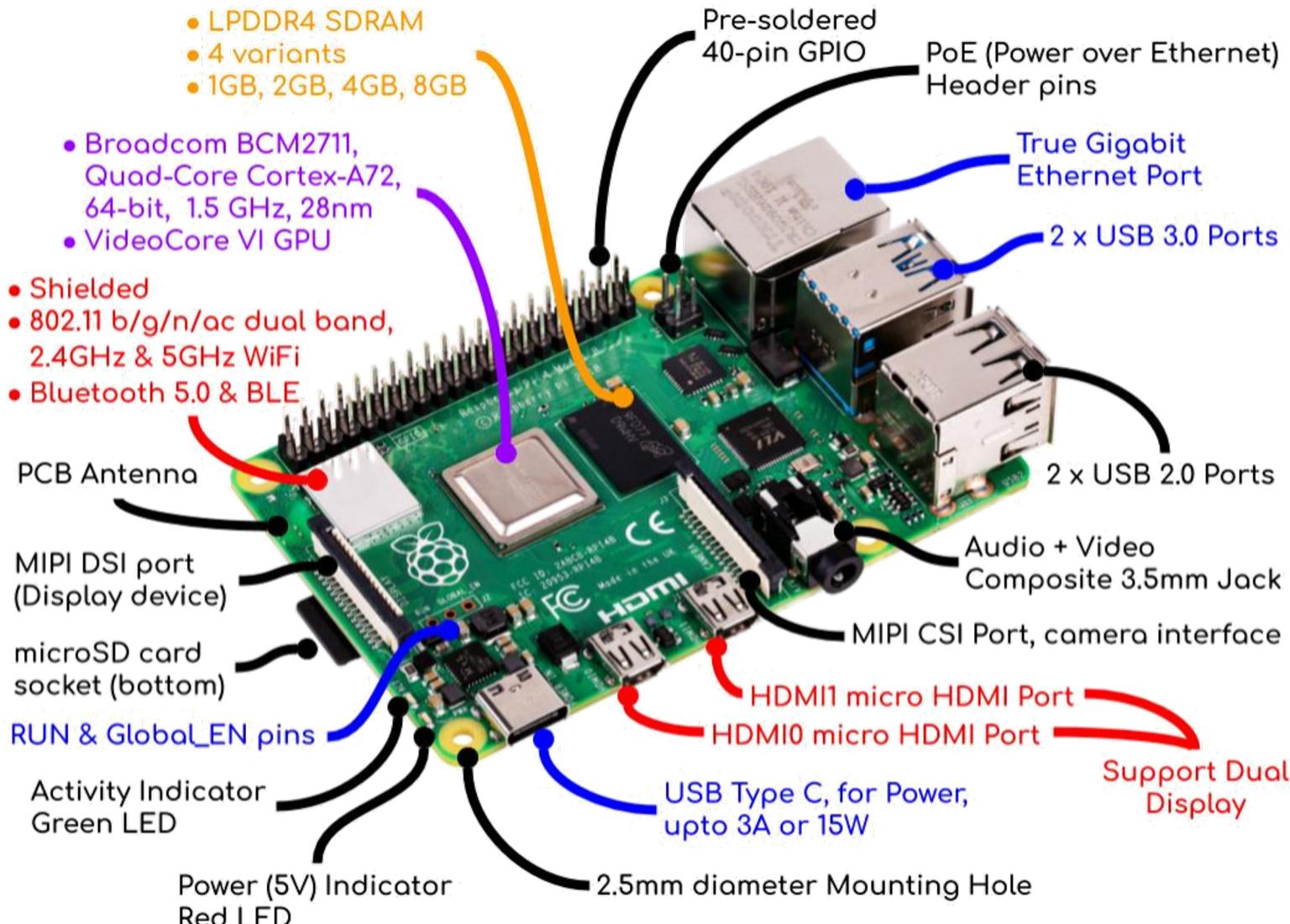
ESP32-WROOM-32 PINOUT  
(aka ESP32-DevKitC)

- Power
- GND
- Serial Pin
- Analog Pin
- Control
- Physical Pin
- Port Pin
- Touch Pin
- DAC Pin
- ~ PWM Pin

<b>JTAG RESET</b> <span style="color: red;">⚠</span>	
<span style="color: red;">3.3V</span>	<span style="color: red;">GND</span>
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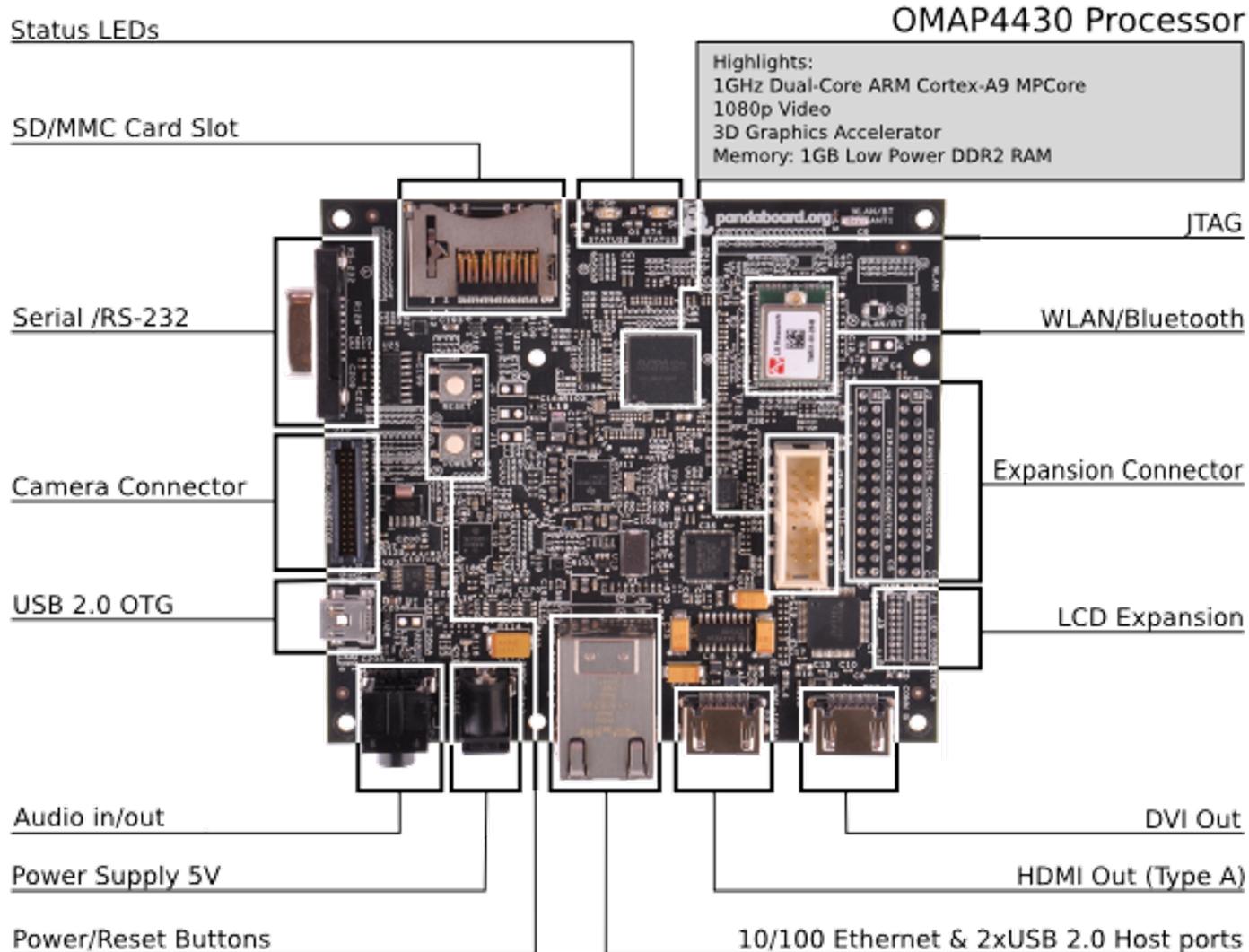
# Otras plataformas

## ☐ Raspberry Pi 4 Model B



# Otras plataformas

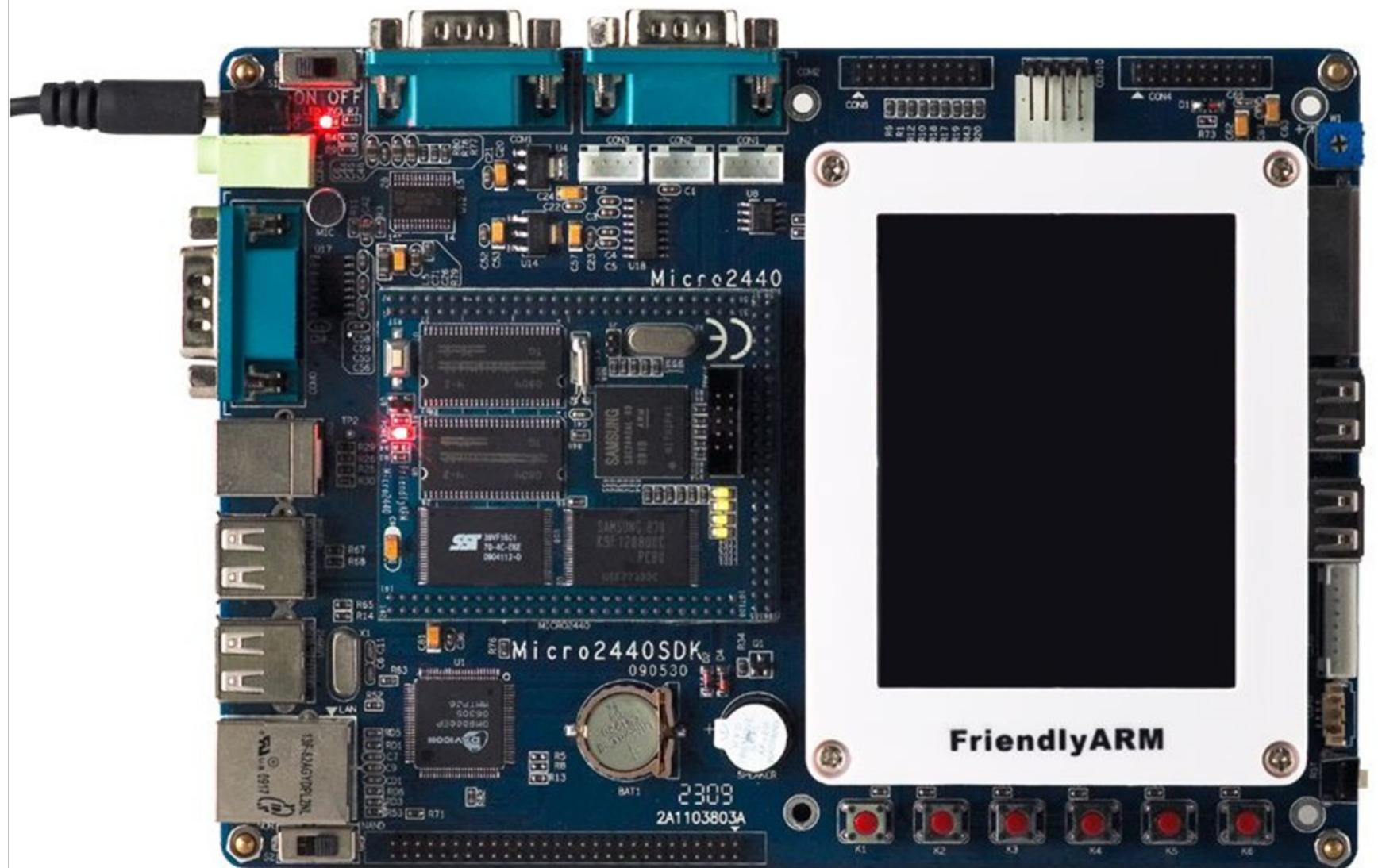
## □ PandaBoard



Board Dimensions: W:4.0" (101.6 mm) X H: 4.5" (114.3 mm)

# Otras plataformas

## □ FriendlyARM



# Proveedores

- Bricogeek, Electan, ...
- DX.com, Aliexpress, Ebay, ...
- Farnell
  - <http://es.farnell.com>
- RS Amidata
  - <http://es.rs-online.com>