# Microcontrollers & Applications

Lecture 1.1: Comparing Microcontroller Boards

#### Microcontroller Board

A single-board microcontroller is a microcontroller built onto a single printed circuit board (PCB). This board provides all of the circuitry necessary for a useful control task: a microprocessor, input/output (I/O) circuits, a clock generator, random-access memory (RAM), stored program memory (i.e. Read-only memory, ROM) and any necessary support integrated circuits (ICs) including analog to digital converter (ADC), digital to analog converter (DAC), pulse-width modulation (PWM), etc. The intention is that the board is immediately useful to an application developer, without requiring them to spend time and effort to develop controller hardware.

https://en.wikipedia.org/wiki/Single-board\_microcontroller

### Today's Famous Low-cost Boards



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# Comparison (1)

Features (CPU)	Raspberry Pi Pico	Arduino Uno	ESP8266	ESP32
Microcontroller	RP2040	ATMega328P	ESP8266	ESP32
Core	Dual	Single	Single	Dual
Architecture	32-bit ARM M0+	8-bit RISC	32-bit LX106	32-bit LX6 (600 DMIPS)
Clock speed	Up to 133 MHz	I6 MHz	Up to 160 MHz	Up to 240 MHz
Operating voltage	3.3V	5.0V	3.3V	3.3V
GPIO voltage	3.3V	5.0V	3.3V	3.3V

# Comparison (2)

Features (Extra)	Raspberry Pi Pico	Arduino Uno	ESP8266	ESP32
Digital pins	26	14	16	36
PWM pins	16	6	16	32
Analog pins	3	6	I	15
SPI / I2C / UART / I2s	2/2/2/-	/ /-	2/1/2/2	4 / 2 / 2 / 2
Wi-Fi	-	-	+	+
Bluetooth	-	-	-	+
Built-in sensor	Temperature	-	-	Temperature, Touch, Hall effect
On-board LED	GP25	D13	D0	D2

# Comparison (3)

Features (Programming)	Raspberry Pi Pico	Arduino Uno	ESP8266	ESP32
Flash memory	2 MB	32 KB	4 MB	4 MB
RAM	264 KB	264 KB	128 KB	520 KB
EEPROM	-	І КВ	520 b	-
Advantages	Machine learning	Beginners + Pro (with modules)	loT	loT
Programming language	C C++ Micro python	Arduino IDE C C++	Arduino IDE C C++ Micro python Javascript	Arduino IDE C C++ Micro python

#### Arduino Models

- Arduino UNO Rev3
- Arduino Due
- Arduino Mega
- Arduino Micro
- Arduino Nano
- Arduino Leonardo
- Arduino Lilypad













# Arduino Model Comparison

Feature	Uno	Due	Mega	Micro	Nano	Leonardo	Lilypad
Microcontroller	Atmega 328	AT91SAM3X8E	Atmega 2560	Atmega 32U4	Atmega 328	Atmega 32U4	Atmega 168
Clock	16 MHz	84 MHz	16 MHz	16 MHz	16 MHz	16 MHz	8 MHz
Digital I/O	14	54	54	20	14	20	14
PWM	6 of digital	12 of digital	15 of digital	7 of digital	6 of digital	7 of digital	6 of digital
Analog input	6	12	16	16	8	12	6
Flash	32 KB	512 KB	256 KB	32 KB	32 KB	32 KB	16 KB
RAM	2 KB	96 KB	8 KB	2.5 KB	2 KB	2.5 KB	I KB
EEPROM	І КВ	-	4 KB	І КВ	І КВ	І КВ	512 B
Serial ports	I	4	4	1	1	1	T
Dimension (mm)	68.6 × 53.3	101.6 x 53.3	101.6 x 53.3	33.0 x 17.8	43.18 x 18.54	68.6 × 53.3	R 51
+ extras	-	2 analog outputs Keyboard	-	Keyboard	-	Keyboard	-

#### **Other Boards**



**ESP32: Board** 



- ESP8266 NodeMCU
- ESP8266 Module
- Raspberry Pi
- Raspberry Pi Pico



**Rasberry Pi Pico** 



ESP8266: NodeMCU

**Rasberry Pi 4** 

ESP8266: Wifi Serial Transceiver Module



#### Raspberry Pi Alternatives & Operating Systems

- Orange Pi
- NanoPi
- Banana Pi
- Odroid
- Onion Omega
- RockPi
- Udoo Bolt
- Asus Tinker Board
- NVIDIA Jetson
- Libre Computer

- Raspberry Pi is defined as a minicomputer the size of a credit card that is interoperable with any input and output hardware device like a monitor, a television, a mouse, or a keyboard effectively converting the set-up into a full-fledged PC at a low cost.
- The SD card should have the operating system installed and is required for the computer to boot.
- Raspberry computers are compatible with Linux OS. This reduces the amount of memory needed and creates an environment for diversity. Alternative OSs are Windows 10 IoT, Raspbian (Raspberry Pi OS), Ubuntu MATE, LibreELEC, OSMC (open source media center), Home Assistant OS, OpenHABian, RISC OS, RetroPie, OctoPi, DietPi, OpenMediaVault, ...



# Thanks for listening ③

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