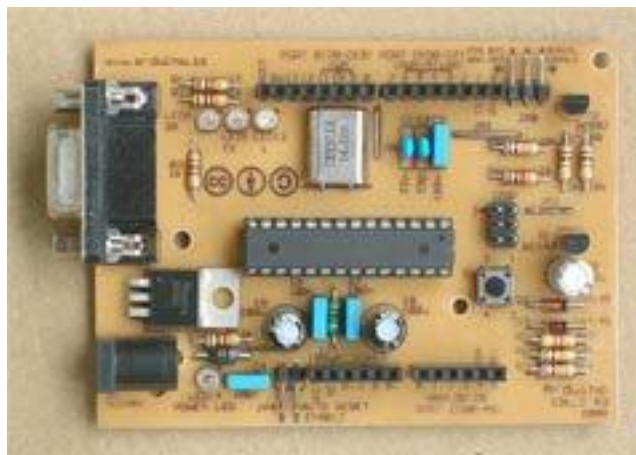# EM : Arduino

A team of developers consisting of Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, David Mellis, and Nicholas Zambetti envisioned a project named **Arduino**.

This project introduced a small programmable electronic board and cross-platform software, designed to be accessible to everyone, making it easy to create electronic systems. Since there may be beginners among us, let's start by exploring some common terminology related to electronics and computing.

An Electronic Board

An electronic board is a flat, flexible, or rigid base, typically made of epoxy or fiberglass. It features electrical traces arranged on one, two, or multiple layers (on the surface and/or internally), which enable electrical connections between electronic components. Each trace links specific components to one another to create a functional electronic system capable of performing the intended operations.

Exemple de carte électronique : Arduino Severino - (CC-BY-SA, arduino.cc)

What is Arduino?

Arduino is an open-source electronics platform designed to make it easier to create interactive projects by combining hardware and software. It is built around microcontroller boards that can read inputs—such as a light detected by a sensor or a finger pressing a button—and convert them into outputs, like turning on an LED or activating a motor. Arduino is widely used for prototyping, education, and developing real-world applications.

Source: [Arduino Official Website](#)

Use Cases of Arduino

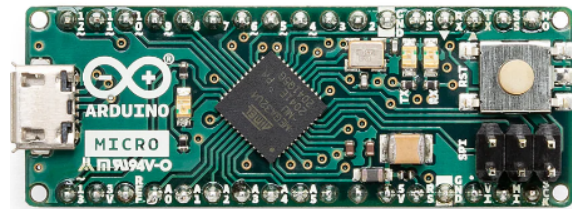Arduino's versatility makes it applicable in various fields:

1. **Home Automation**: Automate tasks like controlling lights, security systems, or appliances.

   ○ Example: A smart thermostat to regulate room temperature.

2. **Education**: Arduino is used in schools and universities to teach programming, electronics, and robotics.

   ○ Example: Building simple robots or creating simulations of physical systems.

3. **Agriculture**: Implement systems for soil moisture monitoring, irrigation control, or crop surveillance.

   ○ Example: Automated irrigation systems based on soil moisture levels.

4. **Healthcare**: Develop devices for patient monitoring, rehabilitation, or health diagnostics.

   ○ Example: Pulse oximeters and wearable health trackers.

5. **Creative Arts**: Use Arduino for interactive installations, musical instruments, and light displays.

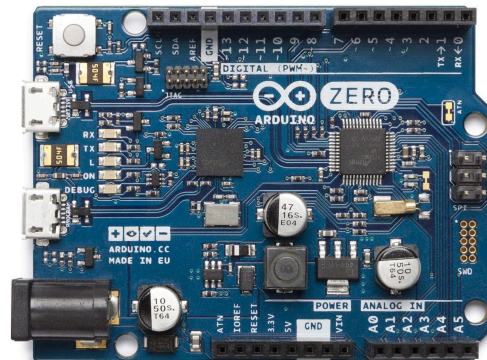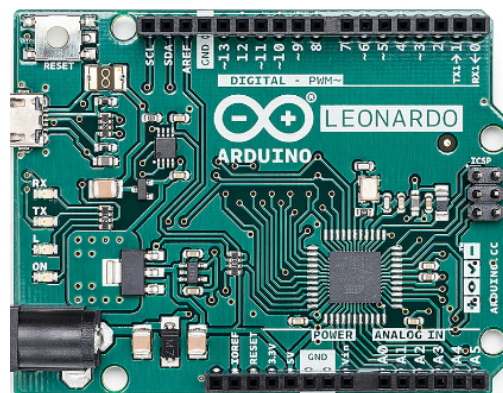   ○ Example: LED-based art installations.

Arduino models
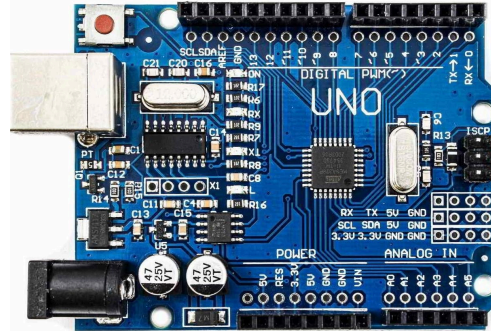
Arduino UNO	
Arduino Micro	
Arduino Zero	
Arduino Leonardo	

Detailed Description of the Arduino Uno

The Arduino Uno is one of the most popular microcontroller boards in the Arduino ecosystem. It is designed to be user-friendly and versatile, making it an excellent choice for beginners and experienced developers alike.

Physical Overview

1. **Dimensions**: The Arduino Uno board measures approximately 68.6 mm x 53.4 mm (2.7 x 2.1 inches), making it compact and easy to integrate into projects.
2. **Build Material**: The board is made of durable printed circuit board (PCB) material with electronic components soldered onto it.
3. **Connectivity**: Features a USB Type-B connector and a DC power jack for power input.

Components and Features

1. **Microcontroller**:
   - The Arduino Uno is powered by the ATmega328P microcontroller.
   - It operates at a clock speed of 16 MHz and features:
     - 32 KB of flash memory (program storage).
     - 2 KB of SRAM (runtime data storage).
     - 1 KB of EEPROM (non-volatile memory).
   - It processes inputs and generates outputs based on programmed instructions.
2. **Digital I/O Pins**:
   - The board has 14 digital input/output pins, numbered 0 to 13.
   - Six of these pins (3, 5, 6, 9, 10, 11) support PWM (Pulse Width Modulation) output, useful for controlling motors and LEDs.
3. **Analog Input Pins**:
   - Six analog pins (A0 to A5) allow the board to read varying voltage levels from sensors.
   - The analog-to-digital converter (ADC) converts these inputs into 10-bit digital values (0 to 1023).
4. **USB Connector**:
   - A standard USB Type-B port connects the Arduino Uno to a power source or a computer for power and serial communication.
5. **Power Jack**:
   - The barrel jack allows for an external power supply, with recommended voltage between 7-12V.
   - Includes an onboard voltage regulator to ensure stable 5V and 3.3V outputs.
6. **Reset Button**:
   - A small push button resets the microcontroller, restarting the program execution from the beginning.
7. **Oscillator**:
   - A 16 MHz crystal oscillator ensures precise timing for operations.
8. **LED Indicators**:
   - A "Power" LED indicates the board is receiving power.
   - Pin 13 has a built-in LED for basic testing and debugging.
   - RX and TX LEDs show data transmission and reception activity.
9. **ICSP Header**:
   - The In-Circuit Serial Programming (ICSP) header allows for low-level programming of the microcontroller.

10. **Voltage Regulators**:
    ○ Regulates input voltage to prevent damage to the components.
    ○ Provides stable 5V and 3.3V outputs for connected devices.

Electrical Characteristics

- **Operating Voltage**: 5V.
- **Input Voltage (Recommended)**: 7-12V.
- **Maximum Current (per I/O pin)**: 40 mA.

Advantages

1. **Simplicity**: The Arduino Uno's straightforward design makes it accessible to beginners.
2. **Expandability**: Compatible with shields (add-on boards) to enhance functionality.
3. **Reliability**: Built with robust components, ensuring durability for long-term use.

Components of an Arduino Board

An Arduino board consists of several components that work together to make it functional:

1. **Microcontroller**:

   ○ The "brain" of the board, responsible for executing the instructions written in code. Common microcontrollers include the ATmega328P (used in Arduino Uno) and ARM Cortex processors (in advanced boards).
   ○ Features: Built-in memory (flash, SRAM), processing speed (16 MHz for ATmega328P), and I/O pin management.
   ○ Function: Controls operations based on the uploaded program and manages input/output.
   ○ **Source:** [Microchip ATmega328P Datasheet](#)

2. **Digital I/O Pins**:

   ○ Typically 14 pins (on Arduino Uno), configurable as input or output.
   ○ Input Example: Detecting button presses or reading signals from a digital sensor.
   ○ Output Example: Driving LEDs or controlling a relay.
   ○ Special Pins: Some pins have PWM (Pulse Width Modulation) capability for simulating analog signals.
   ○ **Source:** [Arduino Uno Technical Specifications](#)

3. **Analog Input Pins**:

   ○ Typically 6 pins (on Arduino Uno) used for reading continuous signals, such as temperature or light intensity.
   ○ Function: Converts varying voltage levels into digital values using a 10-bit Analog-to-Digital Converter (ADC), offering 1024 distinct levels.
   ○ Use Case: Reading data from potentiometers or analog sensors.
   ○ **Source:** [Arduino Documentation](#)

4. **USB Port**:

   - Function: Enables communication between the Arduino and a computer for uploading programs and serial communication.
   - Power Supply: Provides power (5V) to the board during development.
   - Communication: Acts as a serial interface (via USB-to-UART bridge).
   - **Source:** [Arduino Guide](#)

5. **Power Jack**:

   - Function: Allows the Arduino to run independently of a computer by connecting to an external power source.
   - Voltage Range: Typically accepts 7-12V DC, regulated internally to 5V.
   - Use Case: Running long-term projects without a USB connection.
   - **Source:** [Arduino Uno Datasheet](#)

6. **Reset Button**:

   - Function: Resets the microcontroller, restarting the uploaded program from the beginning.
   - Use Case: Useful during debugging or to reinitialize a program.
   - **Source:** [Arduino Uno Manual](#)

7. **Voltage Regulators**:

   - Function: Stabilizes incoming power, ensuring the microcontroller and other components receive a steady 5V or 3.3V.
   - Features: Protects against voltage fluctuations from external power supplies.
   - Importance: Prevents damage to sensitive electronics.
   - **Source:** [Arduino Documentation](#)

8. **Crystal Oscillator**:

   - Function: Provides a stable clock signal for the microcontroller to operate accurately.
   - Frequency: Typically 16 MHz on Arduino Uno boards.
   - Use Case: Ensures precise timing for operations and synchronization.
   - **Source:** [Arduino Technical Details](#)

9. **LED Indicators**:

   - Types: Power LED (indicates the board is powered), TX/RX LEDs (show serial communication activity), and a built-in LED on pin 13 for testing.
   - Use Case: Helps monitor board status and debug simple programs.
   - **Source:** [Arduino Guide](#)

Key Features of Arduino

- **Open Source**: Arduino's hardware and software designs are freely available.
- **Cross-Platform**: Compatible with Windows, macOS, and Linux.
- **Extensive Library Support**: Numerous libraries simplify coding.
- **Community Support**: A large global community provides tutorials, troubleshooting, and project inspiration.