

IOT BOARDS

UNIT - 3



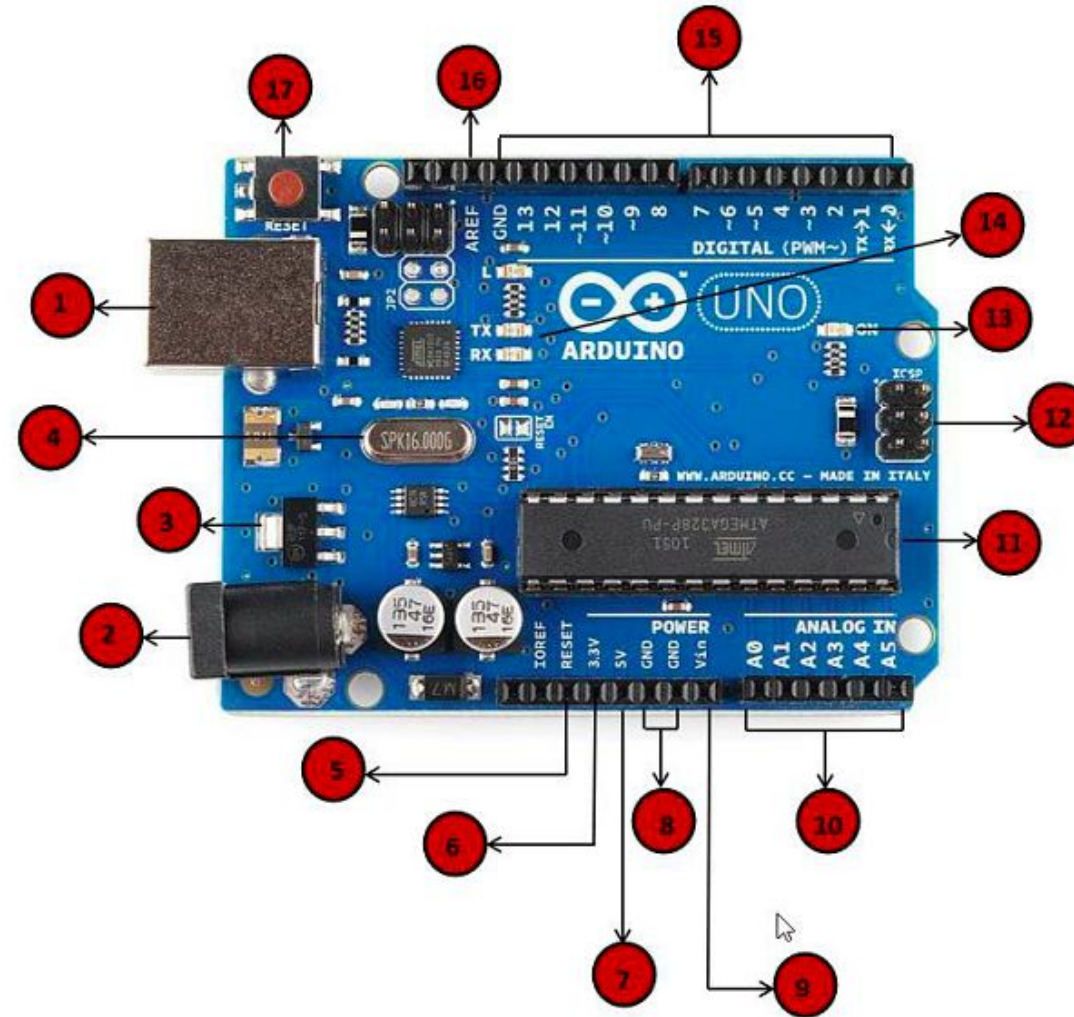
Introduction

- Arduino is an open-source prototyping platform in electronics based on easy-to-use hardware and software.
- Arduino is a microcontroller based prototyping board which can be used in developing digital devices that can read inputs like finger on a button, touch on a screen, light on a sensor etc.
- And turning it in to output like switching on an LED, rotating a motor, playing songs through a speaker etc.

- The Arduino board can be programmed to do anything by simply programming the microcontroller on board using a set of instructions for which, the Arduino board consists of a USB plug to communicate with your computer and a bunch of connection sockets that can be wired to external devices like motors, LEDs etc.
- The aim of Arduino is to introduce the world of electronics to people who have small to no experience in electronics like hobbyists, designers, artists etc.
- Arduino is based on open source [electronics project](#) i.e. all the design specifications, schematics, software are available openly to all the users.

- Arduino boards are generally based on microcontrollers from Atmel Corporation like 8, 16 or 32 bit AVR architecture based microcontrollers.
- The important feature of the Arduino boards is the standard connectors.
- Using these connectors, we can connect the Arduino board to other devices like LEDs or add-on modules called Shields.
- The Arduino boards also consists of on board voltage regulator and crystal oscillator.
- They also consist of USB to serial adapter using which the Arduino board can be programmed using USB connection.
- In order to program the Arduino board, we need to use IDE provided by Arduino.
- The Arduino IDE is based on Processing programming language and supports C and C++.

Arduino Pin Out



1	Power USB Arduino board can be powered by using the USB cable from your computer. All you need to do is connect the USB cable to the USB connection (1).
2	Power (Barrel Jack) Arduino boards can be powered directly from the AC mains power supply by connecting it to the Barrel Jack (2).
3	Voltage Regulator The function of the voltage regulator is to control the voltage given to the Arduino board and stabilize the DC voltages used by the processor and other elements.
4	Crystal Oscillator The crystal oscillator helps Arduino in dealing with time issues. How does Arduino calculate time? The answer is, by using the crystal oscillator. The number printed on top of the Arduino crystal is 16.000H9H. It tells us that the frequency is 16,000,000 Hertz or 16 MHz.

5,17

Arduino Reset

You can reset your Arduino board, i.e., start your program from the beginning. You can reset the UNO board in two ways. First, by using the reset button (17) on the board. Second, you can connect an external reset button to the Arduino pin labelled RESET (5).

6,7
8,9

Pins (3.3, 5, GND, Vin)

- 3.3V (6) – Supply 3.3 output volt
- 5V (7) – Supply 5 output volt
- Most of the components used with Arduino board works fine with 3.3 volt and 5 volt.
- GND (8)(Ground) – There are several GND pins on the Arduino, any of which can be used to ground your circuit.
- Vin (9) – This pin also can be used to power the Arduino board from an external power source, like AC mains power supply.

10

Analog pins

The Arduino UNO board has six analog input pins A0 through A5. These pins can read the signal from an analog sensor like the humidity sensor or temperature sensor and convert it into a digital value that can be read by the microprocessor.

11





Main microcontroller

Each Arduino board has its own microcontroller (11). You can assume it as the brain of your board. The main IC (integrated circuit) on the Arduino is slightly different from board to board. The microcontrollers are usually of the ATMEL Company. You must know what IC your board has before loading up a new program from the Arduino IDE. This information is available on the top of the IC. For more details about the IC construction and functions, you can refer to the data sheet.

12

ICSP pin

Mostly, ICSP (12) is an AVR, a tiny programming header for the Arduino consisting of MOSI, MISO, SCK, RESET, VCC, and GND. It is often referred to as an SPI (Serial Peripheral Interface), which could be considered as an "expansion" of the output. Actually, you are slaving the output device to the master of the SPI bus.

	Power LED indicator This LED should light up when you plug your Arduino into a power source to indicate that your board is powered up correctly. If this light does not turn on, then there is something wrong with the connection.
	TX and RX LEDs On your board, you will find two labels: TX (transmit) and RX (receive). They appear in two places on the Arduino UNO board. First, at the digital pins 0 and 1, to indicate the pins responsible for serial communication. Second, the TX and RX led (13). The TX led flashes with different speed while sending the serial data. The speed of flashing depends on the baud rate used by the board. RX flashes during the receiving process.
	Digital I/O The Arduino UNO board has 14 digital I/O pins (15) (of which 6 provide PWM (Pulse Width Modulation) output. These pins can be configured to work as input digital pins to read logic values (0 or 1) or as digital output pins to drive different modules like LEDs, relays, etc. The pins labeled "~" can be used to generate PWM.
	AREF AREF stands for Analog Reference. It is sometimes, used to set an external reference voltage (between 0 and 5 Volts) as the upper limit for the analog input pins.

Arduino Types

- There are various types of Arduino boards present in the market that includes Arduino UNO, Red Board, LilyPad Arduino, Arduino Mega, Arduino Leonardo.
- All these Arduino boards are different in specifications, features and uses and are used in different type of electronics project.



Arduino Uno

- [Arduino UNO](#) is based on an ATmega328P microcontroller.
- It is easy to use compared to other boards, such as the Arduino Mega board, etc.
- The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header.
- It is the most used and of standard form from the list of all available Arduino Boards.
- It is also recommended for beginners as it is easy to use.



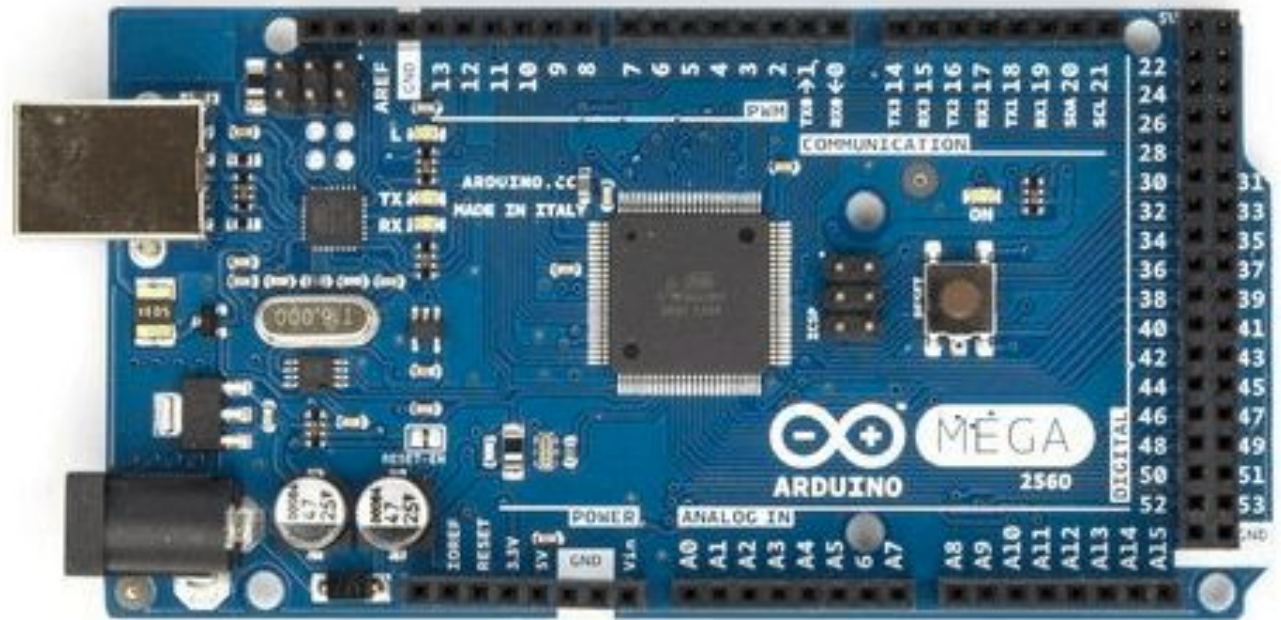
Arduino Nano

- The Arduino Nano is a small Arduino board based on ATmega328P or ATmega628 Microcontroller.
- The connectivity is the same as the Arduino UNO board.
- The Nano board is defined as a sustainable, small, consistent, and flexible microcontroller board.
- It is small in size compared to the UNO board. The devices required to start our projects using the Arduino Nano board are Arduino IDE and mini USB.
- The [Arduino Nano](#) includes an I/O pin set of 14 digital pins and 8 analog pins.
- It also includes 6 Power pins and 2 Reset pins.



Arduino Mega

- The Arduino Mega is based on ATmega2560 Microcontroller.
- The ATmega2560 is an 8-bit microcontroller.
- We need a simple USB cable to connect to the computer and the AC to DC adapter or battery to get started with it.
- It has the advantage of working with more memory space.
- The Arduino Mega includes 54 I/O digital pins and 16 Analog Input/Output (I/O), ICSP header, a reset button, 4 UART (Universal Asynchronous Receiver/Transmitter) ports, USB connection, and a power jack.



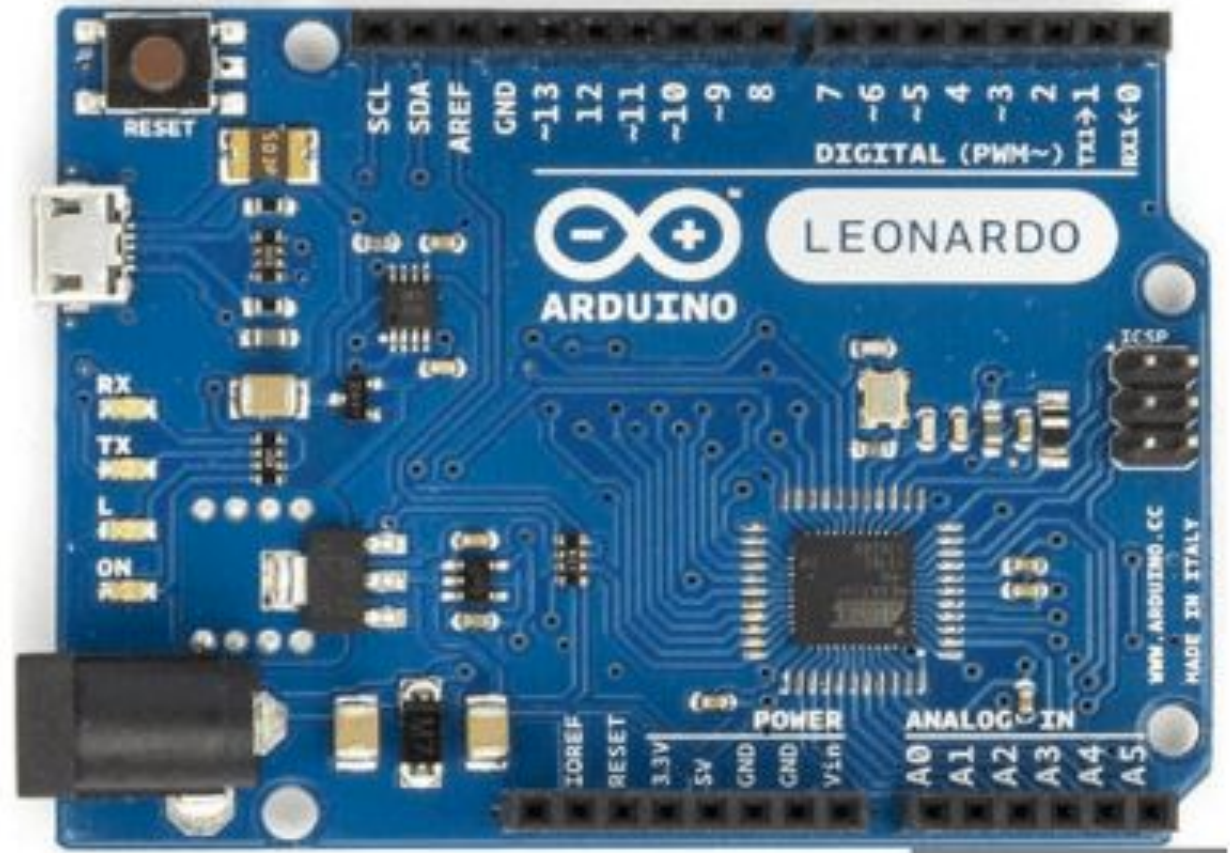
Arduino Micro

- The Arduino Micro is based on the ATmega32U4 Microcontroller.
- It consists of 20 sets of pins. The 7 pins from the set are PWM (Pulse Width Modulation) pins, while 12 pins are analog input pins.
- The other components on board are reset button, 16MHz crystal oscillator, ICSP header, and a micro USB connection.
- The USB is inbuilt in the [Arduino Micro](#) board



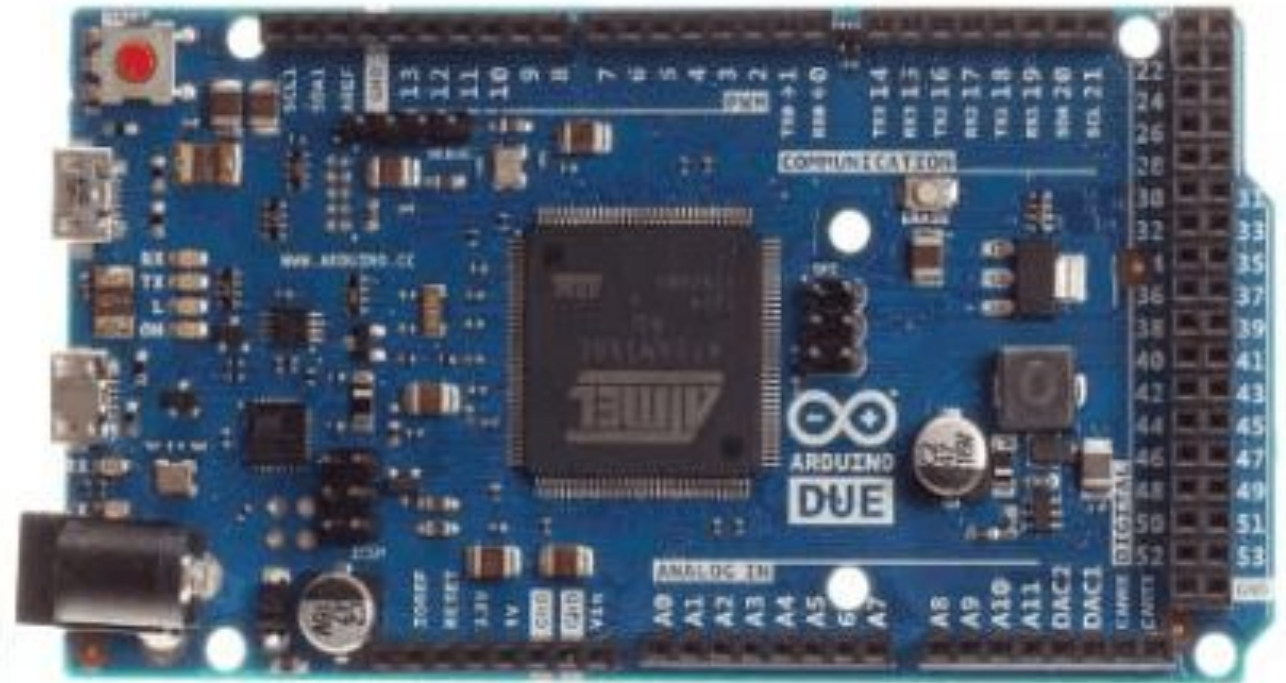
Arduino Leonardo

- The basic specification of the Arduino Leonardo is the same as the Arduino Micro.
- It is also based on ATmega32U4 Microcontroller.
- The components present on the board are 20 analog and digital pins, reset button, 16MHz crystal oscillator, ICSP header, and a micro USB connection.



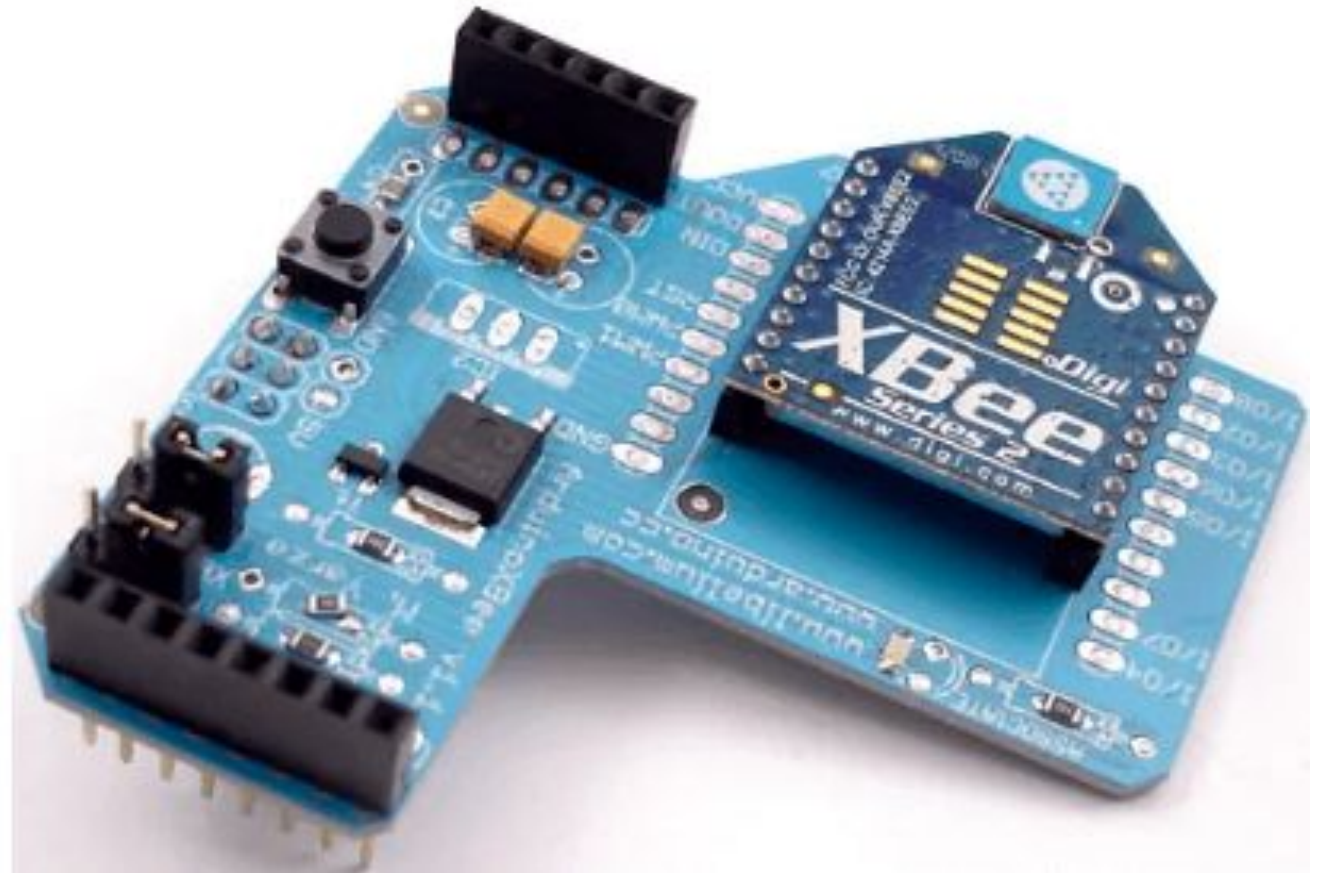
Arduino Due

- The Arduino Due is based on the 32-bit ARM core.
- It is the first Arduino board that has developed based on the ARM Microcontroller.
- It consists of 54 Digital Input/Output pins and 12 Analog pins.
- The Microcontroller present on the board is the Atmel SAM3X8E ARM Cortex-M3 CPU.
- It has two ports, namely, native USB port and Programming port.
- The micro side of the USB cable should be attached to the programming port.



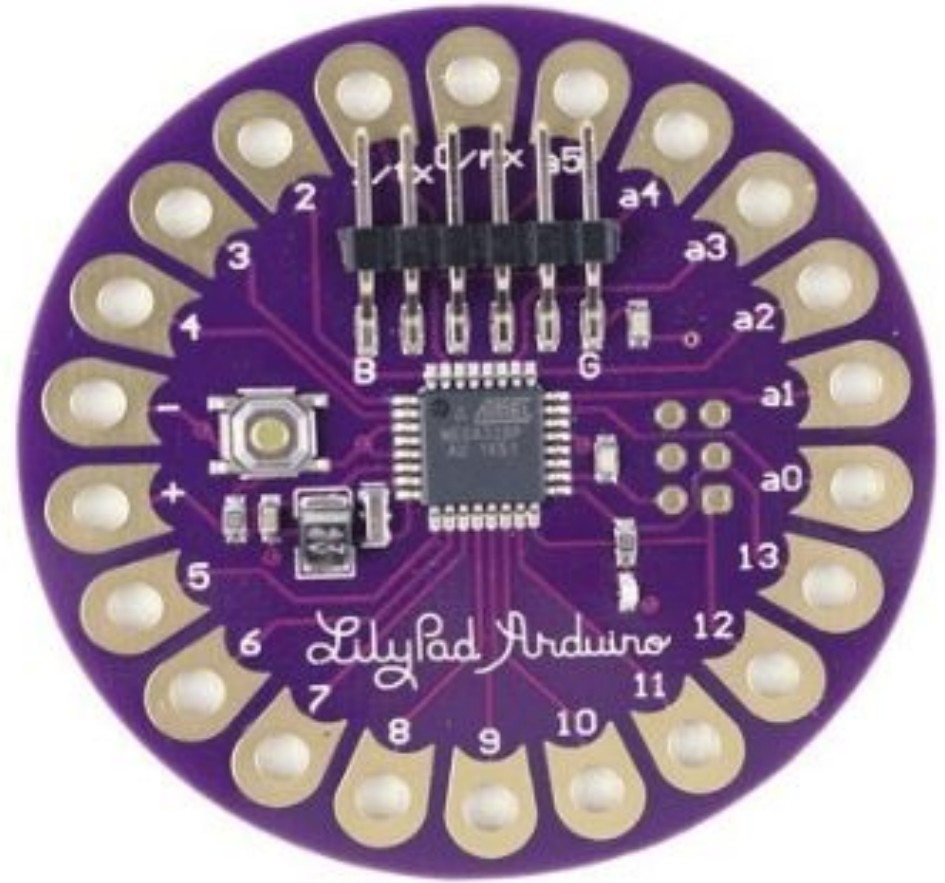
Arduino Shield

- The Arduino shields are the boards, which can be plugged on the top of the PCB.
- The shields further extend the potential of the PCB's.
- The production of shields is cheap. It is also easy to use.
- There are various types of Arduino shields that can be used for different purposes.
- For example, the Xbee shield.
- The Xbee shield can be used for wireless communication between multiple Arduino boards over distances upto 300 feet using the Zigbee Module.



Arduino LilyPad

- The Arduino LilyPad was initially created for wearable projects and e-textiles.
- It is based on the ATmega168 Microcontroller.
- The functionality of Lilypad is the same as other Arduino Boards.
- It is a round, light-weight board with a minimal number of components to keep the size of board small.
- The Arduino Lilypad board was designed by Sparkfun and Leah.
- It was developed by Leah Buechley. It has 9 digital I/O pins.





Programming in Arduino Using Online IDE

Arduino Web Editor

- The Arduino Web Editor is the up-to-date online version of the IDE.
- We can create our Arduino sketches online without installing the software.
- It includes all the latest Arduino boards and contributed libraries.
- The libraries that are not provided in the Arduino IDE can be manually added to the Web Editor, and these are called as **contributed libraries**.
- We can work on our projects with Arduino Web Editor as long as we have an internet connection.
- To work offline, we need to download the latest [Arduino IDE](#) according to the system requirements.

Features of Arduino Web Editor

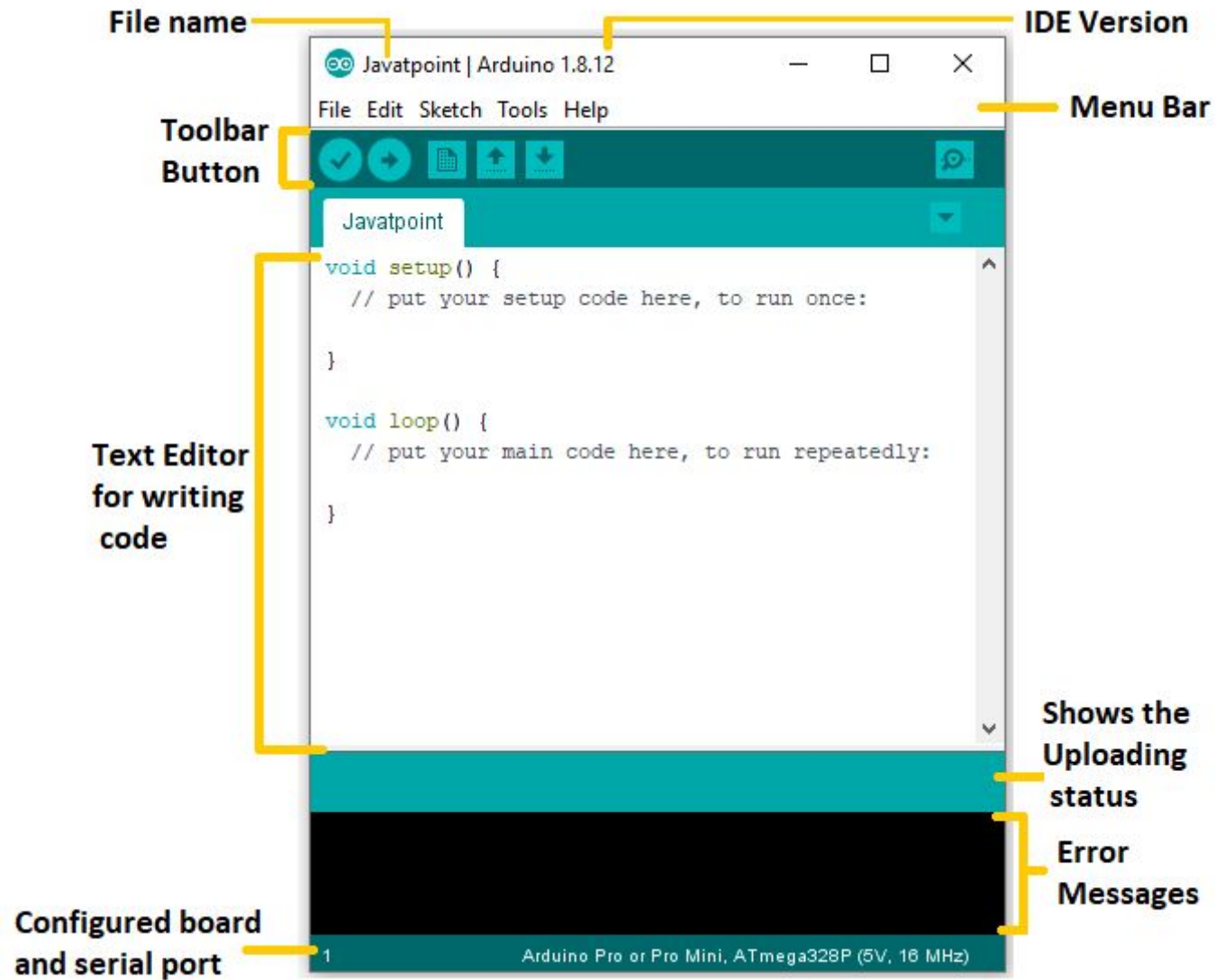
- We can work anywhere with a reliable internet connection.
- It allows easy sharing of our projects and sketches.
- It has compatibility only with the official boards of Arduino.
- It has various built-in libraries.
- We can automatically indent our code so that the code is more convenient to read.
- We can maximize and minimize the coding screen accordingly.

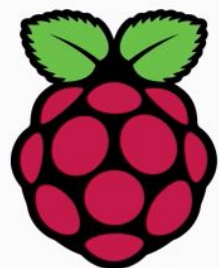


Programming in Arduino Using Offline IDE

Arduino IDE

- The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards.
- The IDE application is suitable for different operating systems such as **Windows, Mac OS X, and Linux**. It supports the programming languages C and C++.
- The program or code written in the Arduino IDE is often called as sketching.
- We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software.
- The sketch is saved with the extension '.ino.'



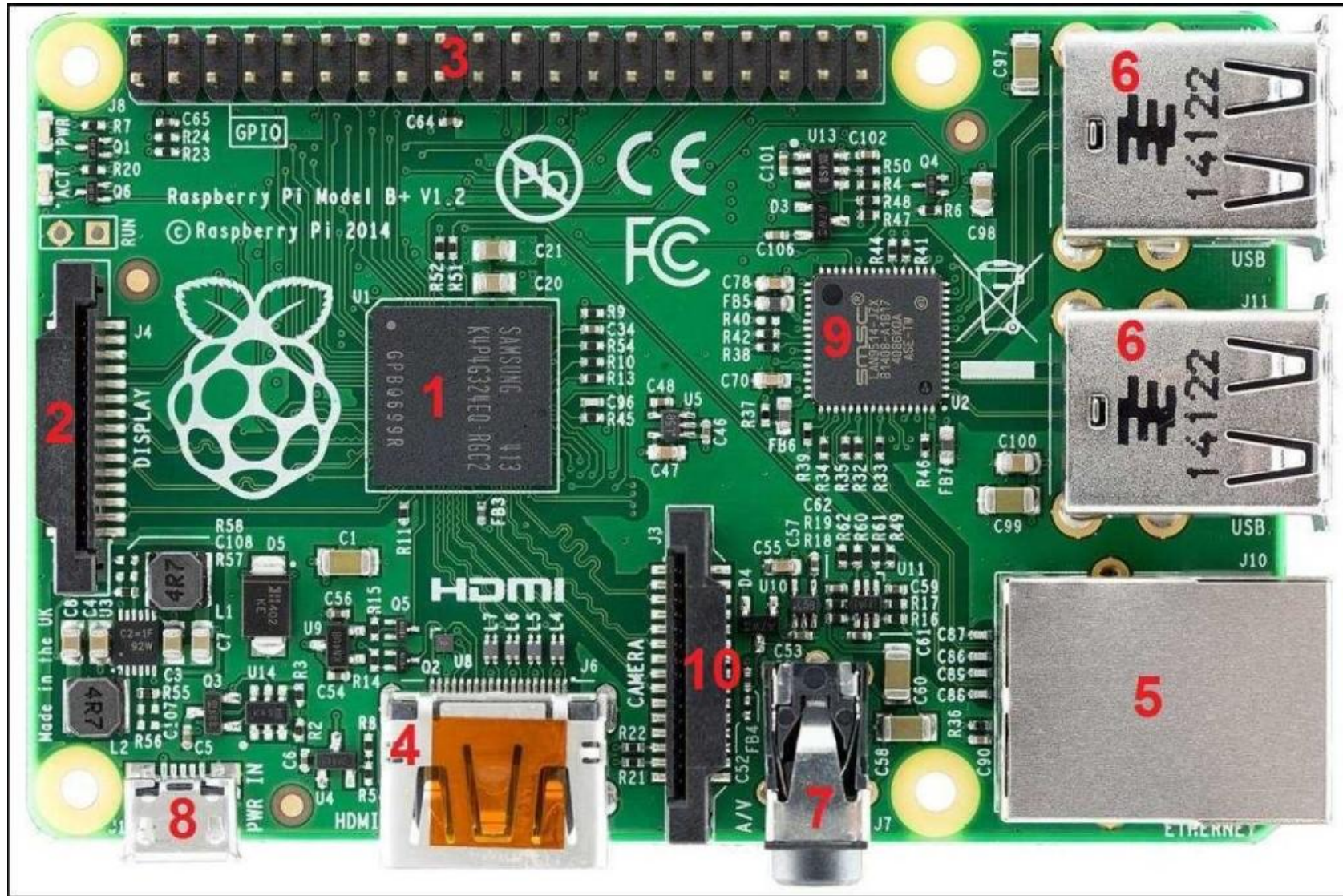


Raspberry Pi OS

Introduction

- The Raspberry Pi is a low cost, **credit-card sized computer** that plugs into a computer monitor or TV, and uses a standard keyboard and mouse.
- It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python.
- It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.
- Raspberry Pi has the ability to interact with the outside world, and has been used in a wide array of digital maker projects, from music machines and parent detectors to weather stations and tweeting birdhouses with infra-red cameras.
- We want to see the Raspberry Pi being used by kids all over the world to learn to program and understand how computers work.

Raspberry Pi Pin Out



- **1 – a system on a chip (SoC)** – an integrated circuit that incorporates many computer components on a single chip – the CPU, memory, and RAM.
- The **Raspberry Pi B+** model uses the **ARM1176 700 Mhz** processor, the powerful **GPU (Graphical Processing Unit)** capable of playing HD videos, and **512 MB** of RAM.
- **2 – DSI display connector** – used to attach an LCD panel.
- On the other side of the board is a **microSD** card slot that holds the operating system.
- **3 – GPIO (General-Purpose Input/Output) pins** – pins used to connect electronics devices.
- The Raspberry Pi Model B has **26** pins, while B+ has **40**.

- **4 – HDMI port** – used for connecting to a monitor or TV. HDMI can carry both sound and picture.
- **5 – Ethernet port** – a standard **10/100 Mbit/s** Ethernet port used to connect your device with the rest of the network.
- **6 – USB ports** – standard **USB 2.0** ports used to connect peripherals such as a keyboard and mouse. The Raspberry Pi Model B has **2** USB ports, while the B+ Model has **4**.
- **7 – Audio port** – a **3.5mm** jack used to connect speakers.
- **8 – Micro-USB power connector** – used to power the Raspberry Pi.
- **9 – USB and Ethernet interface chip**
- **10 – Camera connector** – enables the capturing of photographs and videos.



Raspberry Pi Types

1 Model B

- Raspberry Pi 1 Model B also has a 10/100 Ethernet port so that you can suit web pages from right there on the Pi. The system volume lives on an SD card, so it's easy to debug, run and prepare several additional operating systems on the same hardware.
- Most Linux distributions for the Pi will cheerfully live on a 2GB SD card, but larger cards are supported.
- The Model B's two built-in USB ports provide enough connectivity for a keyboard and mouse, and you can use a USB hub by adding more.
- However, it is recommended that you use a powered hub to overtax the on board voltage regulator.
- Powering the Raspberry Pi is easy; plug any USB power supply into the micro-USB port.
- Unfortunately, there's no power button, so the Pi will begin to boot as soon as power is applied; Remove power, it will turn off.
- Low-level peripherals on the Pi make it excellent for hardware hacking, and the 0.1" spaced GPIO header on the Pi gives you access to UART, 8 GPIO, SPI, I2C, as well as 5 and 3.3V sources.

1 Model A+

- The Raspberry Pi Model A+ is a low-cost version of the Raspberry Pi and is smaller.
- It is established on the BCM2835 system-on-chip (SoC), including an ARM11 processor and a powerful GPU.
- The Raspberry Pi Model A+ is recommended for embedded and low-power projects that do not require Ethernet or multiple USB ports

1 Model B+

- Raspberry pi model B is replaced us raspberry pi model B+.
- Model B+ Raspberry pi is compared with model B it has.
 - **More USB:** Model B+ has 4 USB 2.0 ports, two on the Model B and overcurrent behaviour with a better hotplug.
 - **Micro SD:** The push-push micro SD version is replaced with the old friction-fit SD card socket.
 - **More GPIO:** Model A and B have the same pinout for the first 26 pins retained, with the GPIO model B+ having 40 pins.
 - **Better Audio:** The audio circuit has a reliable, low-noise power supply.
 - **Lower Power Consumption:** Here, the linear regulators are returned by switching one, and it will decrease the power consumption by between 1W and 0.5W.
 - **Neater Form Factor:** The USB connections are arranged with broad edges. There are four squarely-placed maintaining holes, and the video is moved composite with the 3.5mm jack.

Zero model

- Raspberry pi Zero model is half the size of the model A+ with twice a utility.
- Any project has the same specification like Micro-USB OTG port, 1GHz, 512MB RAM, Mini-HDMI port Micro-USB power, Single-core CPU, Composite video, HAT-compatible 40-pin header and resets headers and CSI camera connector.

2 model

- The raspberry pi 2 has an [ARM cortex-A7 quad-core processor](#) with 900MHz, and the SDRAM is about 1GB.
- It is completely consistent with the raspberry pi 1.

3 Model

- The Raspberry Pi 3 Model B is the third generation Raspberry Pi.
- This powerful credit-card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B.
- Whilst maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processor, 10x faster than the first generation Raspberry Pi.
- Additionally it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs.

4 Model

- Raspberry Pi 4 Model B is the latest product in the popular Raspberry Pi range of computers.
- It offers ground-breaking increases in processor speed, multimedia performance, memory, and connectivity compared to the prior-generation Raspberry Pi 3 Model B+, while retaining backwards compatibility and similar power consumption.
- For the end user, Raspberry Pi 4 Model B provides desktop performance comparable to entry-level x86 PC systems.
- This product's key features include a high-performance 64-bit quad-core processor, dual-display support at resolutions up to 4K via a pair of micro-HDMI ports, hardware video decode at up to 4Kp60, up to 4GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE capability (via a separate PoE HAT add-on).
- The dual-band wireless LAN and Bluetooth have modular compliance certification, allowing the board to be designed into end products with significantly reduced compliance testing, improving both cost and time to market.



Programming Raspberry Pi Using Python

Thonny

- It is considered a great IDE for Pi if you wish to use Python.
- It's simple to use and has built-in Python 3.7.
- If you are a beginner in Python, Thonny provides a clean, vanilla interface.
- This makes sure that as a beginner you are not overburdened with complex features often found in many IDEs so that you can work towards getting the code right.
- It comes equipped with a debugger to help you detect and correct errors.

Code::Blocks

- It is a widely used cross-platform IDE for Raspberry Pi.
- It offers support for C, C++, and Fortran programming languages and provides multiple compiler options such as GCC, Clang, and Visual C++.
- As it is a full-fledged IDE, it comes equipped with a built-in compiler as well as a debugger to help simplify your app development process.
- When you use Code::Blocks, you also get a robust code editor that is loaded with many features like syntax highlighting, code completion, and more.