



## Introduction to an Arduino Board

*Okolo C C<sup>1</sup>, Okafor O. O<sup>1</sup>, Omeje B. N<sup>1</sup>, Iwegbuna O N<sup>2</sup>, Ngene C C<sup>2</sup>*

<sup>1</sup>ELECTRONICS DEVELOPMENT INSTITUTE, FEDERAL MIN. OF SCIENCE AND TECHNOLOGY, AWKA CAPITAL TERRITORY, ANAMBRA STATE

<sup>2</sup>DEPARTMENT OF COMPUTER SCIENCE, NNAMDI AZIKIWE UNIVERSITY, AWKA, ANAMBRA STATE

### ABSTRACT

Arduino comprises of both a physical programmable circuit board (commonly known as a microcontroller) and a programming software, or IDE (Integrated Development Environment) that can be run on a PC, used to compose and transfer PC code to the circuit board. Arduino is a *microcontroller* which can do all the calculations very fastly and quickly with great accuracy. It can be done by using the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Unlike other programmable circuit boards, the Arduino does not require different equipment (called a software engineer) to upload code to the circuit board, one can essentially utilize a USB link. In a word, Arduino make the functions of the micro-controller into a more accessible package. The Uno is one of the more prevalent boards in the Arduino family and an extraordinary option for the beginners.

KEYWORDS: Arduino, microcontroller, input, output, circuit board.

### INTRODUCTION

Arduino is an open-source platform used for building electronics projects. It consists of both a physical programmable circuit board (often referred to as microcontroller) and a piece of software, or IDE (integrated development environment) that runs on computer, used to write and upload computer code to the physical board. Unlike most previous programmable circuit boards, it doesn't need a separate piece of hardware (called a programmer) in order to load new code onto the board, this can simply be done using a USB cable. The IDE makes use of a simplified programming language (c++ and c).

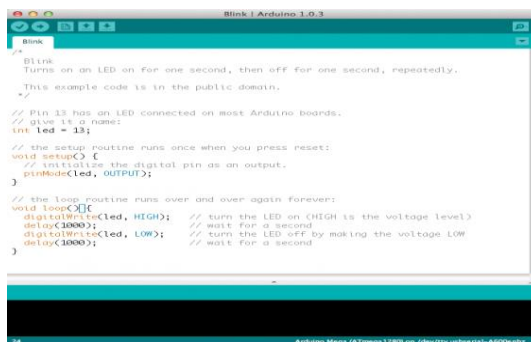


Fig 1. Arduino integrated development board and Arduino board

### AUDRINO CODE DEFINITIONS

- `setup()`: A function present in every Arduino sketch. Run once before the `loop()` function. Often used to set pinmode to input or output. The `setup()` function looks like: `void setup(){ //code goes here }`
- `loop()`: A function present in every single Arduino sketch. This code happens over and over again. The `loop()` is where (almost) everything happens. The one exception to this is `setup()` and variable declaration. ModKit uses another type of loop called “`forever()`” which executes over Serial. The `loop()` function looks like: `void loop() { //code goes here }`
- `input`: A pin mode that intakes information.
- `output`: A pin mode that sends information.
- `HIGH`: Electrical signal present (5V for Uno). Also ON or True in boolean logic.
- `LOW`: No electrical signal present (0V). Also OFF or False in boolean logic.
- `digitalRead`: Get a HIGH or LOW reading from a pin already declared as an input.

- digitalWrite: Assign a HIGH or LOW value to a pin already declared as an output.
- analogRead: Get a value between or including 0 (LOW) and 1023 (HIGH). This allows you to get readings from analog sensors or interfaces that have more than two states.
- analogWrite: Assign a value between or including 0 (LOW) and 255 (HIGH). This allows you to set output to a PWM value instead of just HIGH or LOW.
- PWM: Stands for Pulse-Width Modulation, a method of emulating an analog signal through a digital pin. A value between or including 0 and 255. Used with analogWrite

---

## COMMON COMPONENTS OF ARDUINO BOARDS

There are different types of Arduino boards for different purposes. But all the boards have the majority of following components in common.

- Analog Reference pin (orange)
- Digital Ground (light green)
- Digital Pins 2-13 (green)
- Digital Pins 0-1/Serial In/Out - TX/RX (dark green) - These pins cannot be used for digital i/o (digitalRead and digitalWrite) if serial communication is also being used (e.g. Serial.begin). 4 • Reset Button - S1 (dark blue)
- In-circuit Serial Programmer (blue-green)
- Analog In Pins 0-5 (light blue)
- Power and Ground Pins (power: orange, grounds: light orange)
- External Power Supply In (9-12VDC) - X1 (pink)
- Toggles External Power and USB Power (place jumper on two pins closest to desired supply) - SV1 (purple)
- USB (used for uploading sketches to the board and for serial communication between the board and the computer; can be used to power the board) (yellow)

---

## COMPONENTS DESCRIPTION

- Arduino UNO The Uno is one of the most popular Arduino boards. It consists of 14-digital I/O pins, where 6-pins can be used as PWM(pulse width modulation outputs), 6-analog inputs, a reset button, a power jack, a USB connection and more. It includes everything required to hold up the microcontroller; simply attach it to a PC with the help of a USB cable and give the supply to get started with a AC-to-DC adapter or battery.
- Breadboard A breadboard is a construction base for prototyping of electronics. In the 1970s the solderless breadboard (a.k.a. plugboard, a terminal array board) became available and nowadays the term "bread\_board" is commonly used to refer to these. Because the solderless breadboard does not require soldering, it is reusable. This makes it easy to use for creating temporary prototypes and experimenting with circuit design. For this reason, solderless breadboards are also popular with students and in technological education. A variety of electronic systems may be prototyped by using breadboards, from small analog and digital circuits to complete central processing units (CPUs).
- DC Motor DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances.
- Servo Motor A servomotor is a rotary actuator or linear actuator. It can precisely control angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.
- Transistor A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.
- H-bridge An H-bridge is an integrated circuit (IC) that switches the polarity of a voltage applied to a load. These circuits are often used in robotics and other applications to allow DC motors to run forwards or backwards. Most DC-to-AC converters (power inverters), most AC/AC converters,

the DC-to-DC push-pull converter, most motor controllers, and many other kinds of power electronics use H bridges. In particular, a bipolar stepper motor is almost invariably driven by a motor controller containing two H bridges.

- Potentiometer A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. The measuring instrument called a potentiometer is essentially a voltage divider used for measuring electric potential (voltage); the component is an implementation of the same principle, hence its name.
- External Power Source For stand-alone operation, the board is powered by a battery rather than through the USB connection to the computer. While the external power can be anywhere in the range of 6 to 24 V (for example, you could use a car battery), a standard 9 V battery is convenient. While you could jam the leads of a battery snap into the Vin and Gnd connections on the board, it is better to connect the battery snap leads to a DC power plug and connect to the power jack on the board.
- Arduino Software The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board

## TYPES OF ARDUINO BOARD

Over the years, after the emergence of the first board there has been alterations to this board in order to adapt to new requirements and challenges that includes IOT (internet of things) app, 3D printing, wearable, and embedded surrounding. They include;

- (I) Arduino Uno
- (ii) Lily Pad Arduino
- (iii) Red Board
- (iv) Arduino Mega
- (v) Arduino Leonardo

### Arduino Uno

This is the most used and documented board of the whole Arduino family. It is this board that I used for my projects during my IT training at ELDI. It is based on AT mega 328p microcontroller. It has 14 digital input or output pins, out of which 6 can be used as PWM outputs, 6 analog inputs, a 16MHZ quartz crystal, a USB connection port, a power jack, an ICSP header and a reset button.



Fig 2 Arduino Uno board

### Lily Pad Arduino

This is a wearable e-textile technology. Each board was designed with huge connecting pads and a smooth back to let them be sewn into clothing using conductive thread. It comprises of input or output pins, power and sensor boards. It is based on ATmega168v (the low-power version of AT mega 168) or AT mega 328p.



Fig 3 Lily Pad Arduino board

### Red Board Arduino

This board is similar to the Arduino Uno board we saw earlier, but differs in some areas. Arduino Uno uses the larger square-ish type B connector, often found on USB printers. Whereas the Red Board uses a mini-B connector, which is a lower profile USB connector that can be found on mp3 player. Furthermore, it has a red color, hence the name Red Board.

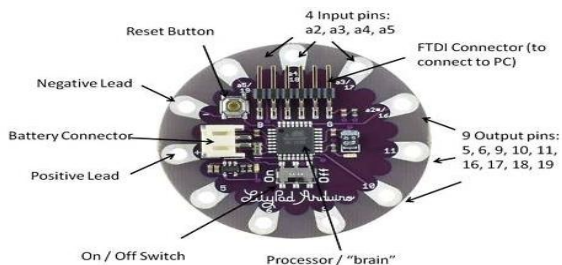


Fig.4 Red Board Arduino board

**Arduino Mega (R3)**

This board is designed for more complex projects. It has 54 digital input or output pins, 16 analog inputs, reset button, power jack and USB connection port. The huge number of pins makes it very helpful for designing projects that need a bunch of digital input or output pins. It is recommended board for 3D printer and robotics projects.

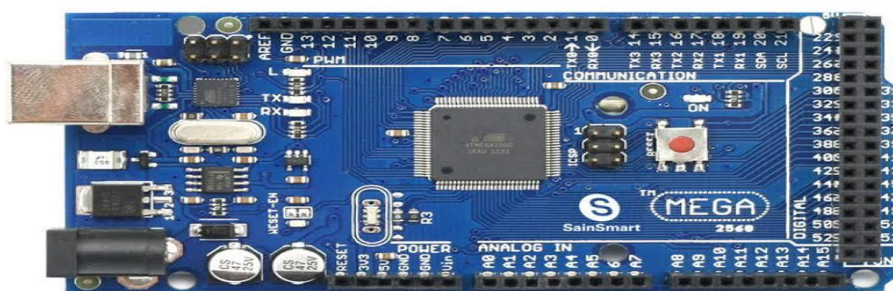
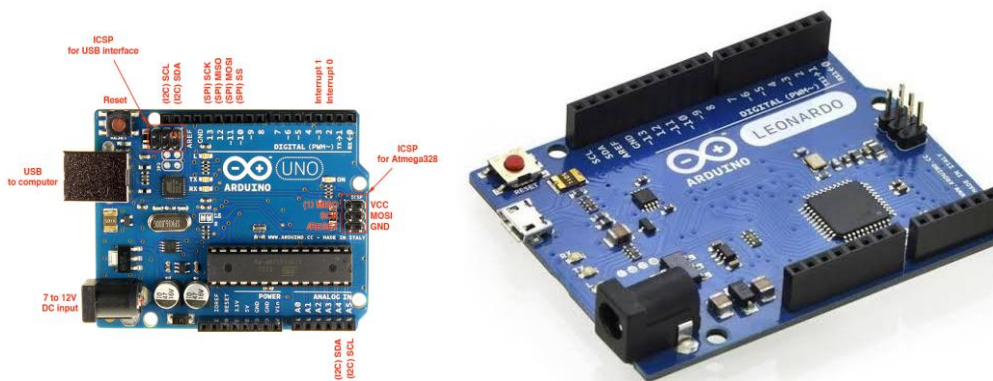


Fig. 5 Arduino Mega (R3) board

**Arduino Leonardo**

This is the first development board of an Arduino. It is based on AT mega 32u4. It has 20 digital input or output pins out of which 7 can be used as PWM output pins and also it has 12 analog input pins.



**IOREF** - This pin is the input/output reference. It provides the voltage reference with which the microcontroller operates.

#### **ANALOG IN:**

**A0 - A5** - The Arduino Uno has 6 analog pins, which utilize ADC (Analog to Digital converter). These pins serve as analog inputs but can also function as digital inputs or digital outputs. ADC stands for Analog to Digital Converter. It is an electronic circuit used to convert analog signals into digital signals. This digital representation of analog signals allows the processor (which is a digital device) to measure the analog signal and use it through its operation. Arduino analog Pins (A0-A5) are capable of reading analog voltages. On Arduino the ADC has 10-bit resolution, meaning it can represent analog voltage by 1,024 digital levels. The ADC converts voltage into bits which the microprocessor can understand.

#### **DIGITAL PINS**

**Pins 0-13** - These pins serve as digital input/output pins. Pin 13 is connected to the built-in LED. Pins 3, 5, 6, 9, 10, 11 have PWM capability - Pulse Width Modulation (PWM) is a modulation technique used to encode a message into a pulsing signal. A PWM is comprised of two key components: frequency and duty cycle. The PWM frequency dictates how long it takes to complete a single cycle (period) and how quickly the signal fluctuates from high to low. The duty cycle determines how long a signal stays high out of the total period. Duty cycle is represented in percentage.

It's important to note that:

- (a) Each pin can provide/sink up to 40 mA max. But the recommended current is 20 mA.
- (b) The absolute max current provided (or sank) from all pins together is 200mA.

#### **COMMUNICATION PROTOCOLS**

**Serial (TTL)** - Digital pins 0 and 1 are the serial pins of the Arduino Uno. They are used by the onboard USB module. Serial communication is used to exchange data between the Arduino board and another serial device such as computers, displays, sensors etc. Each Arduino board has at least one serial port. Serial communication occurs on digital pins 0 (RX) and 1 (TX) as well as via USB. Arduino supports serial communication through digital pins with the Software Serial Library as well. This allows the user to connect multiple serial-enabled devices and leave the main serial port available for the USB.

**SPI - SS/SCK/MISO/MOSI** pins are the dedicated pins for SPI communication. They can be found on digital pins 10-13 of the Arduino Uno and on the ICSP headers. Serial Peripheral Interface (SPI) is a serial data protocol used by microcontrollers to communicate with one or more external devices in a bus like connection. The SPI can also be used to connect 2 microcontrollers.

**Aref** - Reference voltage for the analog inputs.

**Interrupt** - INT0 and INT1. Arduino Uno has two external interrupt pins.

---

## **CONCLUSION**

In this paper, we have successfully introduced the Arduino board. We succeeded in explaining the Arduino codes, its component and description. We also studied the types of Arduino and its communication protocols.

---

## **REFERENCES**

1. Introduction to the Arduino Board. Retrieved from <https://www.arduino.cc/en/Guide/Board?from=Tutorial.ArduinoBoard> [Accessed: 01 Nov, 2018]
2. Controlling a Stepper Motor With an Arduino. Retrieved from <https://www.instructables.com/id/Controlling-a-Stepper-Motor-with-an-Arduino/> [Accessed: 04 Nov, 2018]
3. Arduino, Arduino Projects Book. Torino, Italy, 2015
4. MCG 5184, Mechatronics Laboratory Manual, edited by Theja Ram Pingali, Ot\_tawa, 2017
5. C. McManis, "H-Bridge Theory and Practice — Cuck's Robotics Note\_book." Retrieved from <http://www.mcmanis.com/chuck/robotics/tutorial/h-bridge/> [Accessed: 07 Nov, 2018]
6. Ben, "What is an Arduino? - learn.sparkfun.com." Retrieved from <https://learn.sparkfun.com/tutorials/what-is-an-arduino> [Accessed: 01 Nov, 2018]
7. Components. Retrieved from <https://store.arduino.cc/usa/components> [Accessed: 05 Nov, 2018]