Lab 01 : Working With Arduino Board

Part 1

Arduino

Arduino is an inexpensive, easy-to-use platform for small electronics projects. We'll be using an Arduino microcontroller board for the labs and you can chose it also for your project.

There are dozens of Arduino boards, of different sizes and capabilities. The UNO is the best board to get started with electronics and coding. The UNO is the most used and documented board of the whole Arduino family.

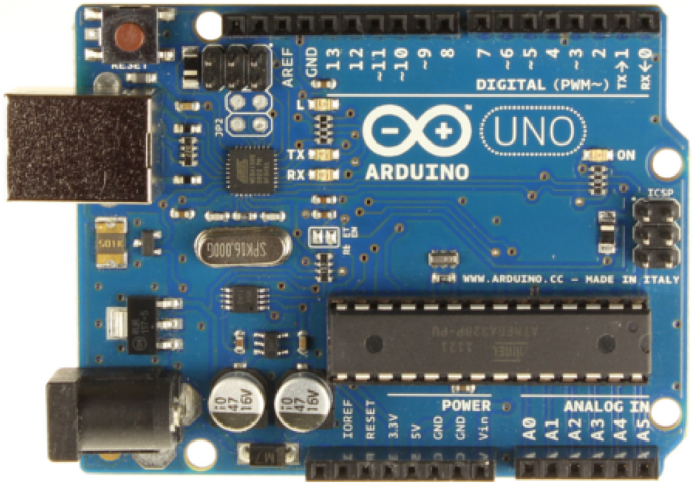


Figure 1 : Arduino UNO Board

It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started.

Installing the Arduino IDE

Download the Arduino IDE appropriate for your system from the Arduino website, and install it. For detailed instructions, see the Getting Started guides:

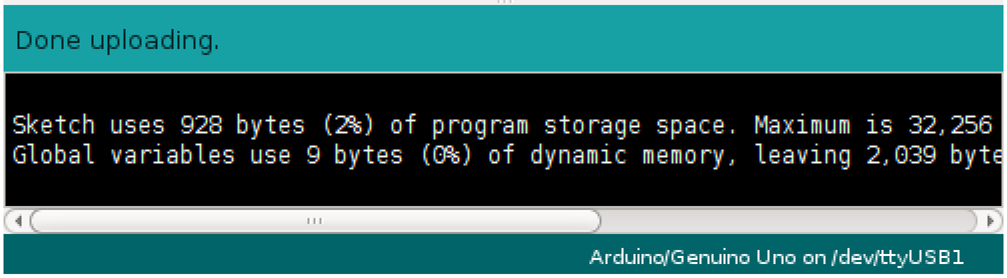
- Getting started on Arduino with **Windows**
- Getting started on Arduino with **Mac OS**

Mac users will additionally need to install the SiLabs drivers.

Testing your installation + your Arduino

To test things, we'll load a simple standard program "Blink" on to the Arduino, and confirm that it runs.

- Set the Arduino type being used: **Tools Menu > Board > Arduino Uno**. Select the board being used from Board Manager.
- Set the port. **For Windows users, this should be** COMx**, where** x **is some number.** For Mac users, this will be **_dev_ttyusbserial-xxxx**, where **xxxx** may be some number. **For Linux users, this will be** *dev*ttyUSB0 **or possibly** *dev*ttyACM0".
- Open the 'Blink' program: **File menu > Examples > 01. Basics > Blink**.
- In the new window that opens, click the 'upload' button: ➔
- The little TX and RX lights should flash on your Arduino, and after a few seconds you should see the message "Done uploading" on the IDE. You're now one step away from start writing your own code!



Done uploading.

```
Sketch uses 928 bytes (2%) of program storage space. Maximum is 32,256
Global variables use 9 bytes (0%) of dynamic memory, leaving 2,039 byte
```

Arduino/Genuino Uno on /dev/ttyUSB1

If it didn't work, have a look through our troubleshooting guide below. Once you have loaded Blink, that should be enough to get you going! But for those who want to dig a little deeper, there are full "getting started" instructions on the Arduino website.

Troubleshooting the connection

When I click upload, it tries for a while but says it has a "problem uploading to board."

- Check that you've set the board to Uno: **Tools > Board > Arduino Uno**.
- Check that you've set the port correctly: **Tools > Port**. This can be confusing; you might have to try a few different ports to see which one matches. One way to determine which port it is, is to unplug the Arduino and see which one disappears, and plug it back in and see which one re-appears.

Hardware: Putting your Arduino circuit together

Putting your circuit together

- When your USB cable is connected, the 5V pin provides a 5 V source that you can use to power the rest of your circuit. Don't forget to connect everything that needs to be connected to ground 'GND'. More details on this are provided in "Power pins" below.
- The inputs from and outputs to the rest of your circuit connect to the input/output pins, taking into account their capabilities as described in "Input/output (I/O) pins" below.

Which pins do what?

All of this information is taken from the Arduino Nano specifications page.

Power pins

There are three ways to power the Arduino board.

- When you plug in a **USB cable**, the Arduino will be powered from the USB cable. No other power source is required. In this case, V_{IN} should be left unused. The **5V pin will be powered by the USB cable**, and you can use this as a 5 V source for the rest of your circuit.
- You can supply a **constant 5 V** directly to the 5V pin yourself. In this case, V_{IN} should be left unused.
- You can supply a **voltage between 6 V and 20 V** to the VIN pin. *You probably won't be doing this.* There is a voltage regulator chip on the board that will use this to generate a 5 V supply. The 5V pin will be powered by this, and you can use it as a 5 V source for the rest of the circuit.

Using your AA battery pack

When using your AA battery pack, which gives about 4.5 V, to power your Arduino board, you should connect it to the 5V pin. Then, just be aware that your circuit will be powered by 4.5 V, not 5V. **Never do this at the same time as connecting a USB cable**, because that will try to push the USB's 5 V on to your non-rechargeable 4.5 V batteries.

The VIN circuit is only capable of stepping down, not up, so connecting 4.5 V to VIN won't work. Also, the 3V3 pin doesn't power the Arduino, it's actually just a 3.3 V output that is generated when the USB cable is plugged in.

Input/output (I/O) pins

- Pins **RX0, TX1, and D2 through D13** are **digital input/output** pins. We often refer to these as just “pin 0” through “pin 13”, respectively.
- Pins **A0 through A5** can be used either as **analog input** or **digital input/output** (but not at the same time).

What about **analog output**? There's no *true* analog output on the Arduino microcontroller, but there are pins that support *pulse-width modulation* (PWM), which is close enough for our purposes. In something of a misnomer, this is controlled using the analogWrite() function. The (digital) I/O pins capable of this are **3, 5, 6, 9, 10 and 11**.

Take note: All digital input/output pins can be configured as digital inputs or outputs. However, the *analog input* pins are **not** the same as the *analog output* pins!

Other pins

- RST is the reset pin. When it is driven low (by you, *e.g.* if you connect it to GND), it resets the Arduino. *You probably won't be using this.* Note that the button on the board connects RST to GND when pressed, *i.e.* it is a reset button.
- REF is an external reference for the analog input pins. *You probably won't be using this.* The “analog reference” is the voltage that configures the top of the analog input range, *i.e* what voltage would read 1023. By default, the reference is the 5 V supply, but if you want to use some other range, you can connect a voltage to this pin and configure the Arduino to use it with analogReference().

Software: Your own Arduino program

Often, it's most helpful to look at example programs to understand how they do things, and take snippets or modify them to do what you want to do. The examples (sometimes called “tutorials”) are in **File > Examples**, and there are helpful descriptions of them on in the Examples page on the Arduino website.

To get started, look at the ones in **Basics**, **Analog** and **Digital**. You can start to look at the others as you want to use more advanced functionality.

The basic structure of an Arduino program

Your basic Arduino template will look like this:

```
void setup() {
  // put your setup code here, to run once:

}

void loop() {
  // put your main code here, to run repeatedly:

}
```

The setup() function runs once when the Arduino is powered on. You should use this to configure pins (pinMode()) and, if you want to use the Serial Monitor, to run Serial.begin().

Serial is used for communication between the Arduino board and a computer or other devices. All Arduino boards have at least one serial port (also known as a UART or USART): Serial. It communicates on digital pins 0 (RX) and 1 (TX) as well as with the computer via USB. Thus, if you use these functions, you cannot also use pins 0 and 1 for digital input or output.

The loop() function runs repeatedly forever. You can think of it as being inside an infinite loop. In this loop, you read inputs and write to outputs, to achieve the effect you want on the rest of your circuit.

When you're programming a computer, infinite loops are a bad thing to be avoided. In electronics, infinite loops aren't only acceptable, but necessary: your program is always monitoring inputs and adjusting outputs, which can only do if it's in an infinite loop.

The Arduino reference

Once you're in the swing of programming, you might want to keep the **Arduino language reference** handy. It has a complete guide to much more than you need to know about the Arduino, so you certainly don't need to be familiar with it, but if you're wondering how a function works or whether there's a function to do what you want, it's a great guide.

References :

https://web.stanford.edu/class/engr40m/arduino.html

https://www.arduino.cc

Lab 01 : Working With Arduino Board

Part 2

In this part of the lab, students will learn basic electronics theory, how a breadboard works, joining components in series and parallel.

Task 1: Students will connect resistors, LEDs, switch using an Arduino and make an interactive circuit.

Follow the instructions at Project 01, Get to know your tools, given in the "Arduino Projects Book" available at the following link:

https://www.uio.no/studier/emner/matnat/ifi/IN1060/v21/arduino/arduino-projects-book.pdf

Task 2: If you are able to complete Task 1, it will be good to attempt some coding and do the project 02, "Spaceship Interface" of the same book.

Cheers,
Have a fun with Arduino ☺