Qualcomm
thinkabit lab

Getting Started Guide

A microcontroller is a fun and a stress-free introduction into the world of coding and engineering that allows you to use code to control devices, such as LEDs and Servos. We recommend you read through this document for an introduction to an Arduino microcontroller and using a breadboard. As other devices are introduced in each activity, they will be explained. Below is a recommended order of steps to prepare for the Arduino Software activities and the subsequent pages will provide detailed instructions for each step. Whether completing the coding activities on your own or leading a group of people through these activities, we recommend that you start here. The steps for getting started are outlined below.

Step 1: Downloading the Arduino Software

Make sure to download the Arduino software to a computer, not a tablet. The connection between the Arduino program and the Arduino board is through a USB port, therefore ensure computers have a usable USB port before starting.

Step 2: Purchasing Supplies

Order a complete kit, or purchase items individually and make the kit yourself. This section helps you decide which is the best option.

Step 3: Learn About the Arduino Uno

The Arduino Uno is a simple device, but can look complicated, and doesn't typically come with instructions. This section will guide you through learning the important parts of the Arduino Uno.

Step 4: Learn About Breadboards

While breadboards are useful and commonly used tools, students often do not understand what breadboards are or how they work. This section explains the breadboards and identifies the differences between standard and mini breadboards.

Once you have completed the 4 steps above, use the coding activities to learn and teach the Qualcomm® Thinkabit Lab™ Learning Center Activities. The activities are divided into different content areas (LEDs and Servos), but often rely on previous activities. We recommend that you read steps explaining what code to write, and wires to connect in addition to the extra explanations that go along with each step. This valuable information provides a better understanding of programming and circuitry and empowers you to do more activities individually.

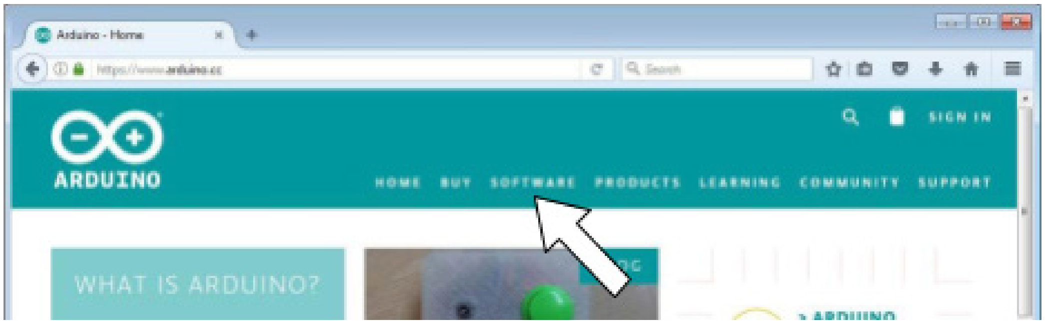
These activities are to be implemented with the support of an adult who has a basic understanding of safety considerations (both in general as well as of the specific safety considerations identified herein). Hands on activities can potentially cause harm to students/participants if not implemented properly. Adults should follow all general safety precautions, as well as the ones listed for these activities.

Never allow the red and black wires to touch together while they are connected to a powered Arduino board, as that creates a short circuit. A short circuit can potentially cause the wires and/or the Arduino board to get hot enough to burn the skin. In addition, in the event of a short circuit, the Arduino board can potentially catch on fire. One way to avoid this is to have students unplug the Aruduino from the power source before adjusting wires.

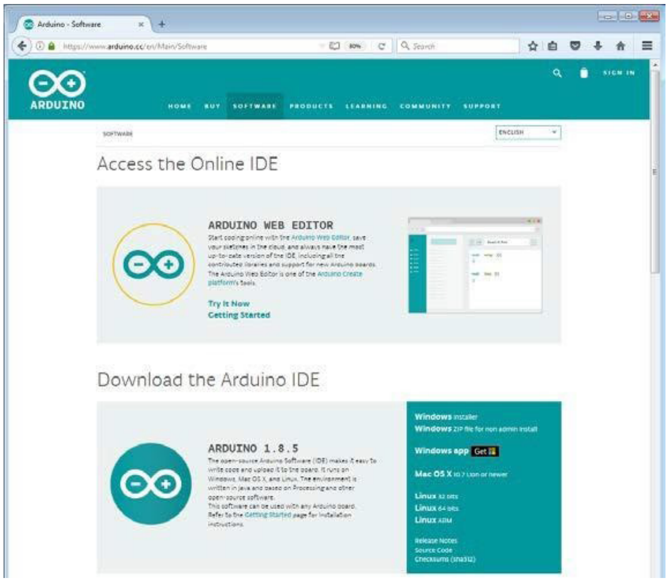
Step 1: Download the Software

This section explains how to download and install the Arduino software. The software is needed when using your computer to write programs for the Arduino board.

1. First, go to www.arduino.cc and click on the “SOFTWARE” tab.



2. Next, decide on the best IDE: (I) Access the Online IDE, i.e., Arduino Web Editor, or (II) Download the Arduino IDE. The Web Editor permits the user to create an online Arduino account and saves sketches in the cloud to access them anywhere (with internet connectivity). For the software downloaded to the desktop, no internet connectivity is needed. However, please note that there are different downloads for different operating systems, so be sure to select the link that matches the computer in use.



Access the Online IDE

ARDUINO WEB EDITOR

Start coding online with the Arduino Web Editor, save your sketches in the cloud, and always have the most up-to-date version of the IDE, including all the contributed libraries and support for new Arduino boards. The Arduino Web Editor is one of the Arduino Create platform's tools.

Try It Now
Getting Started

Download the Arduino IDE

ARDUINO 1.8.5

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.
This software can be used with any Arduino board. Refer to the Getting Started page for installation instructions.

Windows Installer
Windows ZIP file for non admin install
Windows app Get
Mac OS X 10.7 Lion or newer
Linux 32 bits
Linux 64 bits
Linux ARM
Release Notes
Source Code
Checksums (sha512)

3. Then, use the Arduino IDE to write code to send to Arduino. Once a code is sent to the Arduino, it lives on the Arduino Uno. Any future edits to that code on the computer will not be sent to the Arduino unless it is manually uploaded to the Arduino Uno. When using the Arduino software with a large class, we recommend testing the Arduino IDE by completing the LED Blink activity on each computer.

Learning Center Hardware Kit

This section outlines the materials needed for the Learning Center Hardware Kit. The kit contains all the components needed to build a few simple, but fun projects that will teach the basics of circuits and programming. These materials are all you need to comlete the activities on the learning center.

Materials

Item	Amount needed	Where to Buy	Approximate Price
Arduino	1 per kit	Arduino, Sparkfun, or Amazon	$25 - $50
Standard Breadboard	1 per kit	Amazon, Sparkfun	$5 - $10
Standard Servo (micro)	1 per kit	Sparkfun	$8 - $10
Continuous Servo (micro)	1 per kit	Sparkfun	$10 - $12
LEDs (Red, Green, Blue & Yellow)	4 per kit (1 each color)	Amazon	$3 for 80 pcs
Box (optional)	1 per kit	Amazon	$5 - $10
Resistors	4 per kit	Amazon	$5 - 10$
USB Cable	1 per kit	Amazon	$5 - $10
Red Wire*	4 per kit	Amazon	$10 - $15
Black Wire*	4 per kit	Amazon	$10 - $15
White Wire*	4 per kit	Amazon	$10 - $15
Wire Strippers**	1 per class	Amazon	$10 - $15

*It is recommended to purchase spools of wire. Wire should be 22-gauge solid (not stranded).

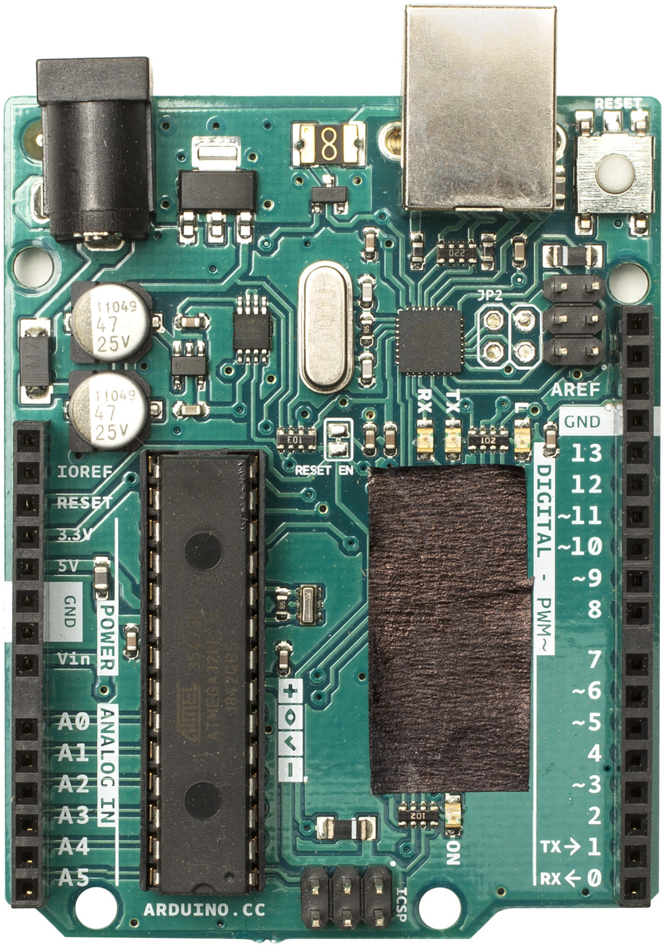
**Wire strippers are included so that wire can be cut into smaller pieces and stripped at both ends.

What is a Microcontroller and why use it?

This section provides an overview of the Arduino microcontroller and its different parts, in addition to the fundamental procedure of how to use it correctly.

The Arduino Uno is a microcontroller, or mini-computer, capable of controlling a variety of devices such as LEDs, buzzers, and motors. We use Arduino in the Qualcomm® Thinkabit Lab™ because it is easier to use than other microcontrollers, and it is extremely well documented on the internet. Having proper documentation makes the process of getting help simpler while learning how to use it. It can do something as simple as making an LED blink, and as sophisticated as operating a 3D printer. Furthermore, sensors or a Bluetooth module can also be attached to it, etc. ... the possibilities with this microcontroller are endless!

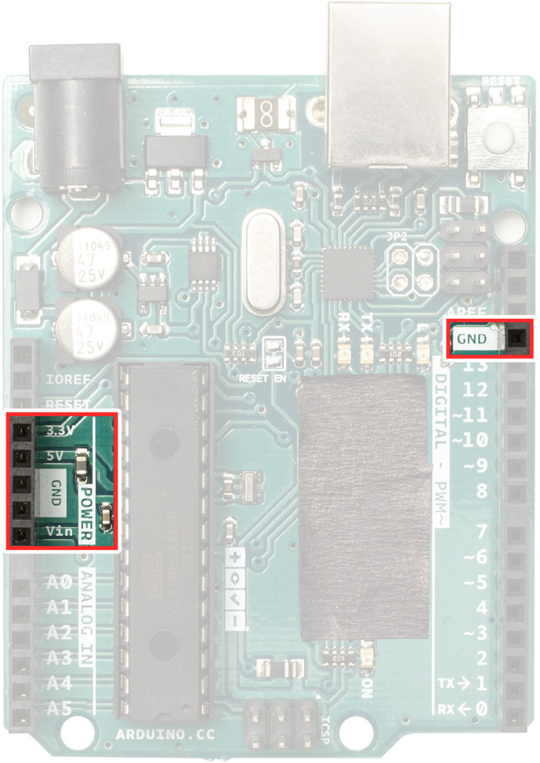
The important components of the microcontroller are: (1) The Power Rail, (2) Digital (PWM~), (3) Analog in, and (4) The power supply.



(1) THE POWER RAIL

The power rail is how to get power from the microcontroller to the rest of the devices.

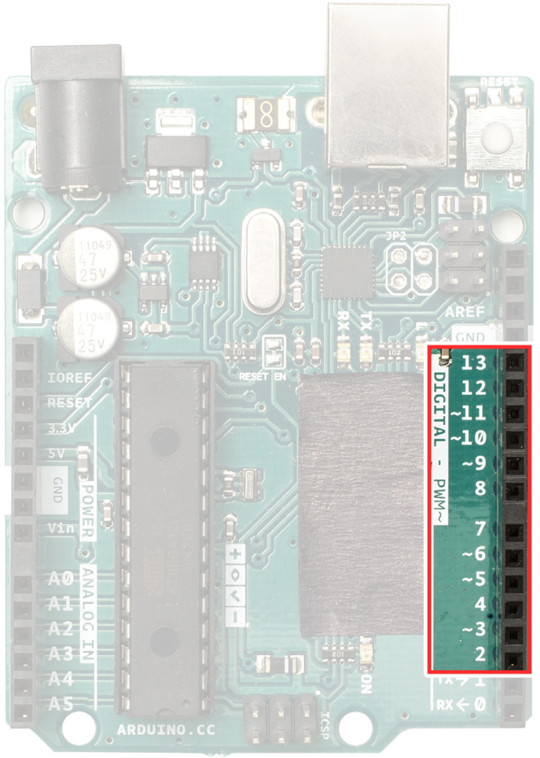
- 3.3V – This pin provides 3.3 volts, and this is the “positive side” of power.
- 5V – This pin provides 5 volts. This is also the “positive side” of power.
- GND – Ground is the“negative side” of power. (Note there are 3 GND pins on the board, and it makes no difference which one to use, they’re all connected).
- Vin – This pin provides the voltage supplied to the microcontroller. So, if a 9-volt battery is connected, it will provide 9 volts. This is also the “positive side” of power.
- Be careful not to give the attached devices, such as LEDs or Servos, too much power, especially when using the Vin pin.
- Remember, if a wire attached to a positive pin touches a wire attached to a negative pin, it will create a “short circuit” that will burn out the Arduino.



(2) DIGITAL (PWM~)

The microcontroller has “digital” and “analog” pins to input and output electrical signals. Digital signals are either “On” or “Off” (high voltage or low voltage), while analog signals can vary between 0% - 100%. All digital pins can input and output a digital signal, while some can output an analog signal.

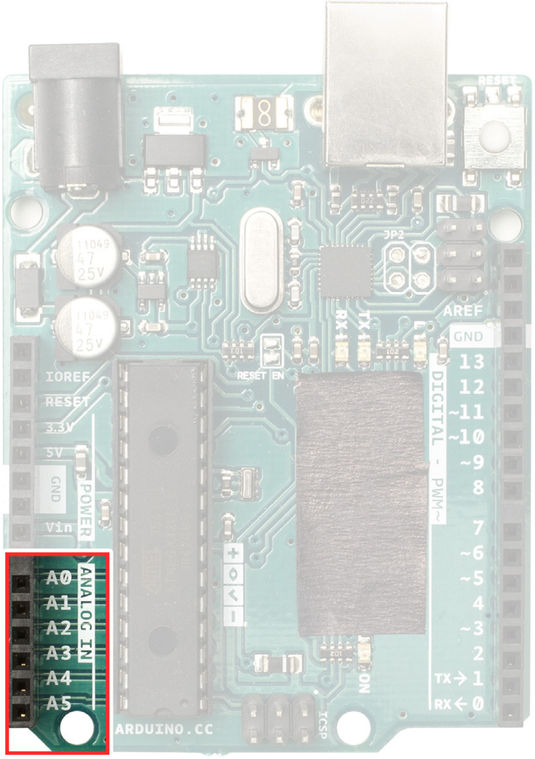
- A pin’s mode set to INPUT will sense electrical signals (this is also called “reading”). For example, these digital pins could read the electrical signal generated by pushing a button.
- A pin’s mode set to OUTPUT will send out electrical signals (this is also called “writing”). For example, digital pins can be used to send electricity to make an LED turn on.
- Pins with a ~ next to their number can OUTPUT a Pulse Width Modulation (PWM) signal. By turning on and off quickly, they can produce what looks like an analog OUTPUT signal. These are the pins we use to control Servos.
- Notice 0 and 1 are left out. These pins are used for TX (transferring data) and RX (receiving data). We typically don’t use these pins because they are commonly used to troubleshoot the code using the serial monitor.



(3) ANALOG IN

The analog pins on the microcontroller can only INPUT electrical signals. They can read digital or analog signals.

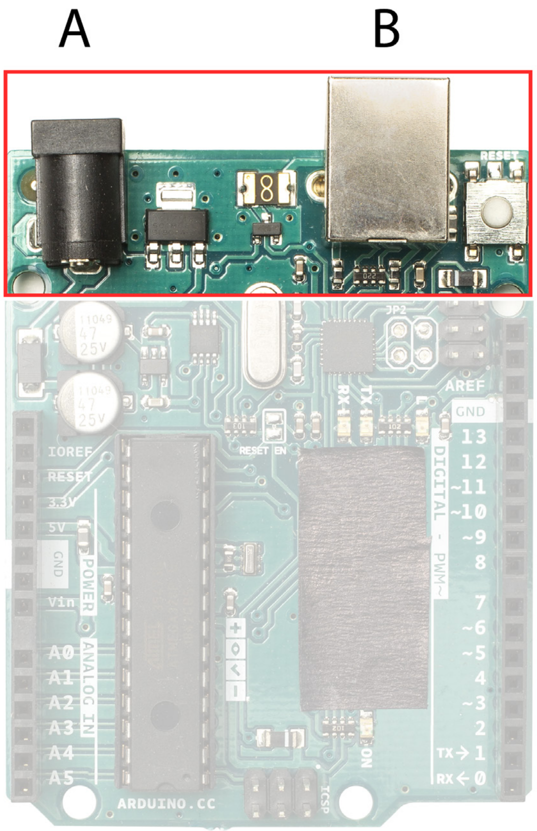
- An Analog Signal, unlike a digital signal, can take on more values than mere **on** or **off**, so we can read values that vary between all the way off and all the way on.
- These pins are useful for sensors that can measure many benefits, such as a light sensor, a distance sensor or a potentiometer (or knob).
- Note that these pins are only used for INPUT (reading information) and not for OUTPUT (writing information).



(4) The POWER SUPPLY

The power supply is where we can connect a battery pack, power cable or USB Cable to provide power to the Arduino.

- Port A is where to connect a battery pack. The Arduino has a built-in regulator that runs on 7V - 12V.
- The Vin pin matches the voltage supplied to the board.
- Be careful not to give too much power to connected devices to Vin because you may burn the devices.
- Port B is the connection for the USB cable. Not only can the USB cable supply power to the Arduino, but it is also how we send the code from the computer to the Arduino.



What is a breadboard and why do we use them?

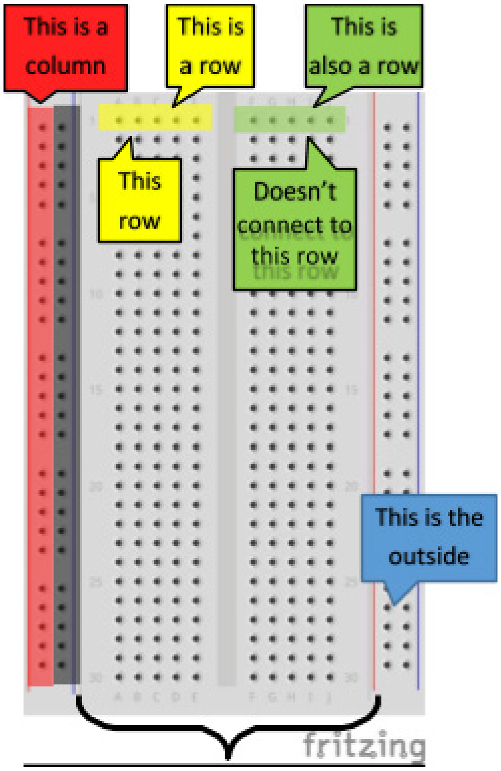
This section explains the breadboard. Most Arduino activities use a breadboard. Breadboards give a smooth connection between plugging wires and electronic parts. The link is not as sturdy as a permanent connection, such as soldering, but it makes it easy to move pieces around when something is not working. For instance, when building a project for the first time, no permanent connection is needed until knowing that the circuit works.

Breadboards also make it easier to connect multiple wires, which is especially helpful when using multiple devices that need power. All breadboards do this by plugging wires into small holes attached to a metal strip inside the breadboard. The strip connects either rows or columns on the breadboard, and any parts plugged into holes that touch the same metal strip will be electronically connected. (To see how the breadboard makes connections between the holes, take off the back of a breadboard and look inside).

There are two different types of breadboards: (1) Standard breadboard and (2) mini breadboards. Our Adruino activities use standard breadboards but could also be completed using and/or mini breadboard.

(1) Standard Breadboards

A standard breadboard is one that has both rows and columns of connections. The "inside" of the board connects the rows and the "outside" of the board connects the columns. A single row is defined as 5 holes adjacent to each other and **NOT** across the gap in the middle.

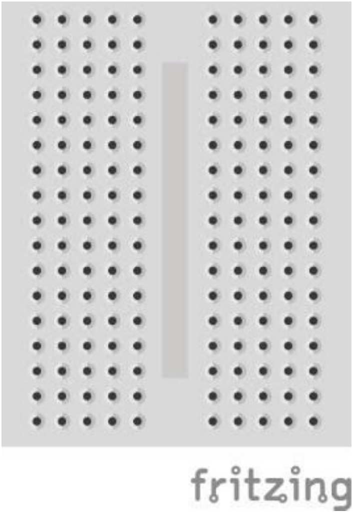


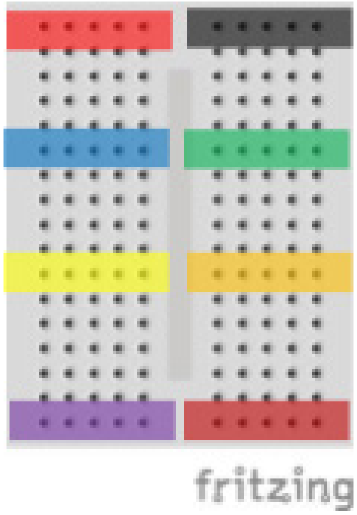
A standard breadboard usually comes with letters and numbers along the top and sides to help with wire placement. Each number connects to itself but does not join across the middle aisle. So, 1a connects to 1b, 1c, 1d, and 1e (the yellow highlighted row in the image), but does not relate to 1f, 1g, 1h, 1i, or 1j (the green highlighted row in the image). Likewise, 1a does not connect to 2a or 3a or any other a.

Breadboards also come with a column (or rail) on each side, with a long strip of positive (highlighted in red in the image) and negative (highlighted in black) holes. Although there are gaps along the line, the entire column is connected. That way, both positive and negative rails can be used to connect many devices that need power.

(2) Mini Breadboards

Since many of the activities use minimal components, it is possible to complete them using a mini breadboard. Notice that a mini breadboard is a subset of the standard-size breadboard. They do not include the outside rails and have about half as many rows. When using a mini breadboard, it may be easier to color a few rows in different colors (as shown here) to assist with proper connections.





All circuit images created with Fritzing