
Creating Responsive Cloth:
An Introduction to Electronics
for Dynamic Textile Objects
and Wearables
Presented by Barbara Layne
and Rytha Kesselring
November 10-11, 2018
Canada Council
for the Arts
Conseil des Arts
du Canada
centre[3]

Workshop with Barbara Layne & RythÂ Kesselring

- Introduction to Basic electronics
- Learning how to use LEDs, sensor sand switches
- Developing circuits with a microcontroller,

  Adafruit FLORA
- Programming with Arduino software
- Sewing with conductive thread, creating a soft circuit
- Creating a small electronic textile project

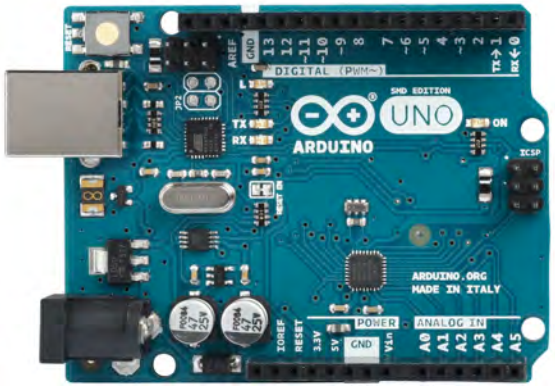
Microcontroller

A microcontroller is basically a tiny computer. It includes a processor, memory as well as Inputs and outputs.

Input / Output: Receiving and sending information to and from a computer.

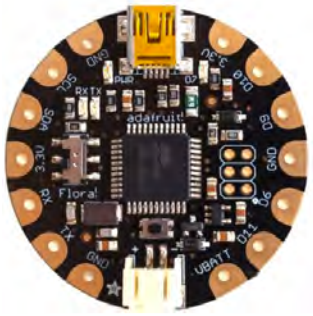
Arduino designs the most common microcontrollers. Arduino is an open source platform that provides free programming software witch we will be using during the workshop.

The microcontroller we will be working with is a sewable platform designed by Adafruit called FLORA. This microcontroller is Arduino compatible.



Arduino UNO

Arduino LilyPad

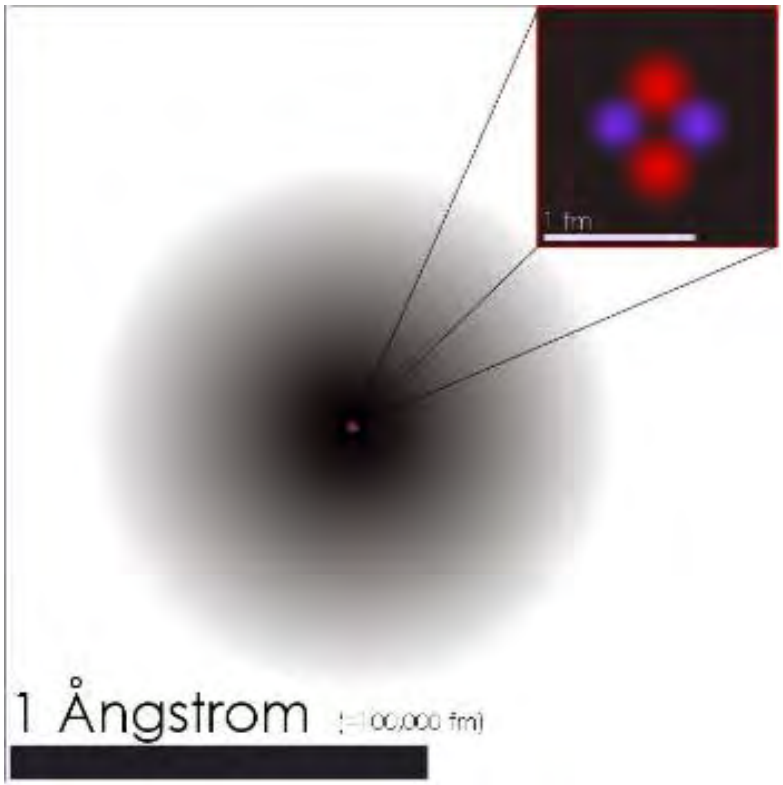


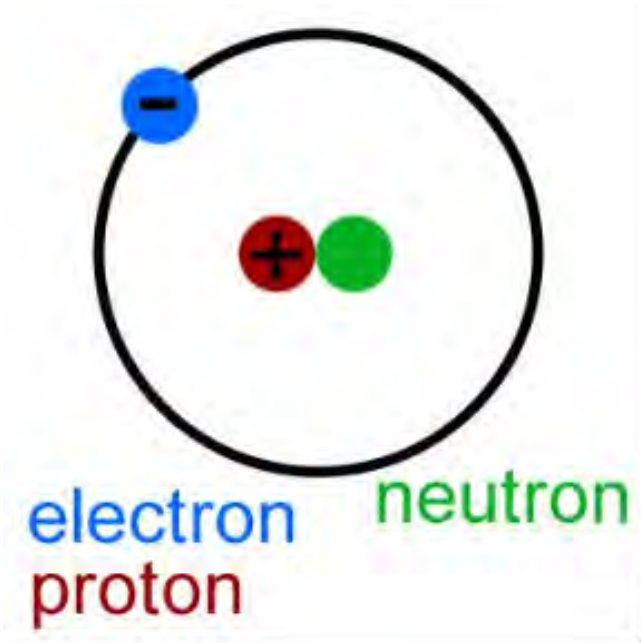
Adafruit FLORA

An Introduction to Basic Electronics

Basic definitions

- **Electric charge** is a characteristic of some subatomic particles. Electrons by convention have a charge of -1, while protons have the opposite charge of +1.





Basic definitions

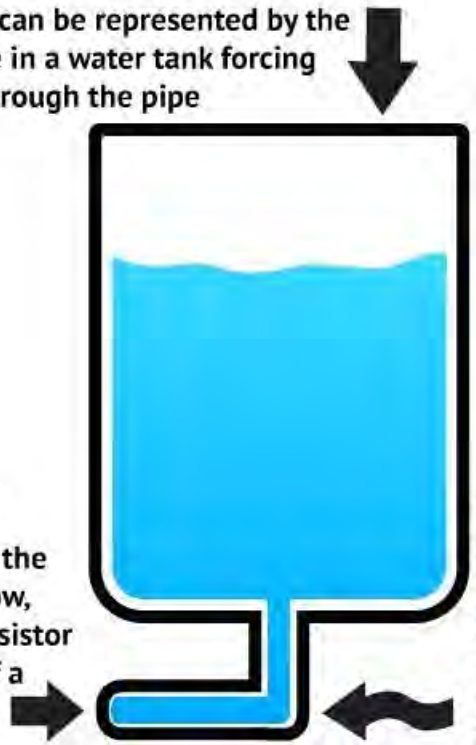
- **Electric Current (I)** is the flow of electric charge. The unit of electric current is the *ampere* (A), which is a measure of the flow of the electrons per time unit. (analogy: flow of water in a pipe)

- **Voltage (V)** is the difference of electrical potential between two points. The unit of voltage is the Volt (V). (analogy: the water level)

- **Resistance (R)**: measure of a material's ability to oppose the flow of electricity (analogy: a sponge in a pipe)

Voltage

Voltage can be represented by the pressure in a water tank forcing water through the pipe



Resistor

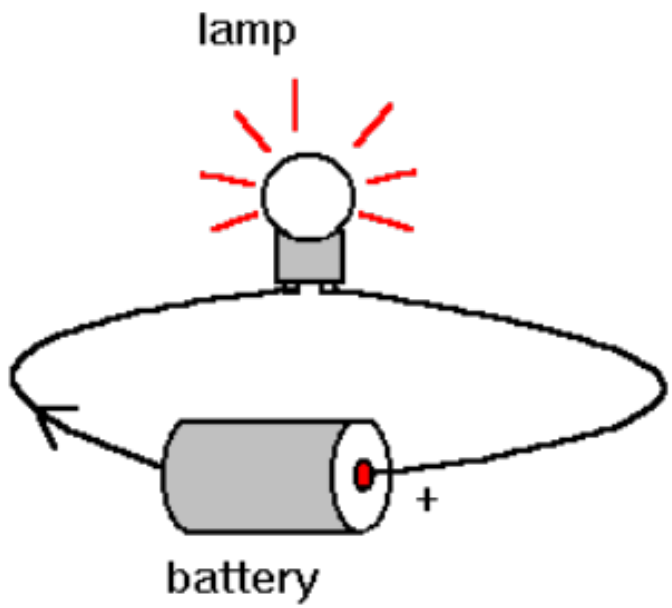
The small diameter of the pipe restricts water flow, similar to the way a resistor restricts the current of a circuit

Current

The water flowing through the pipe represents the electrical current, the more pressure there is the more current you get

Basic definitions

- **Electrical Network:** is a connection of two or more electrical components.
- **Circuit**: is a network that has a closed loop, giving a return path for the current.



Basic components

- Conductors
- Insulators
- Resistors
- Diodes
- Light-Emitting Diodes (LED's)
- Power source
- Switches

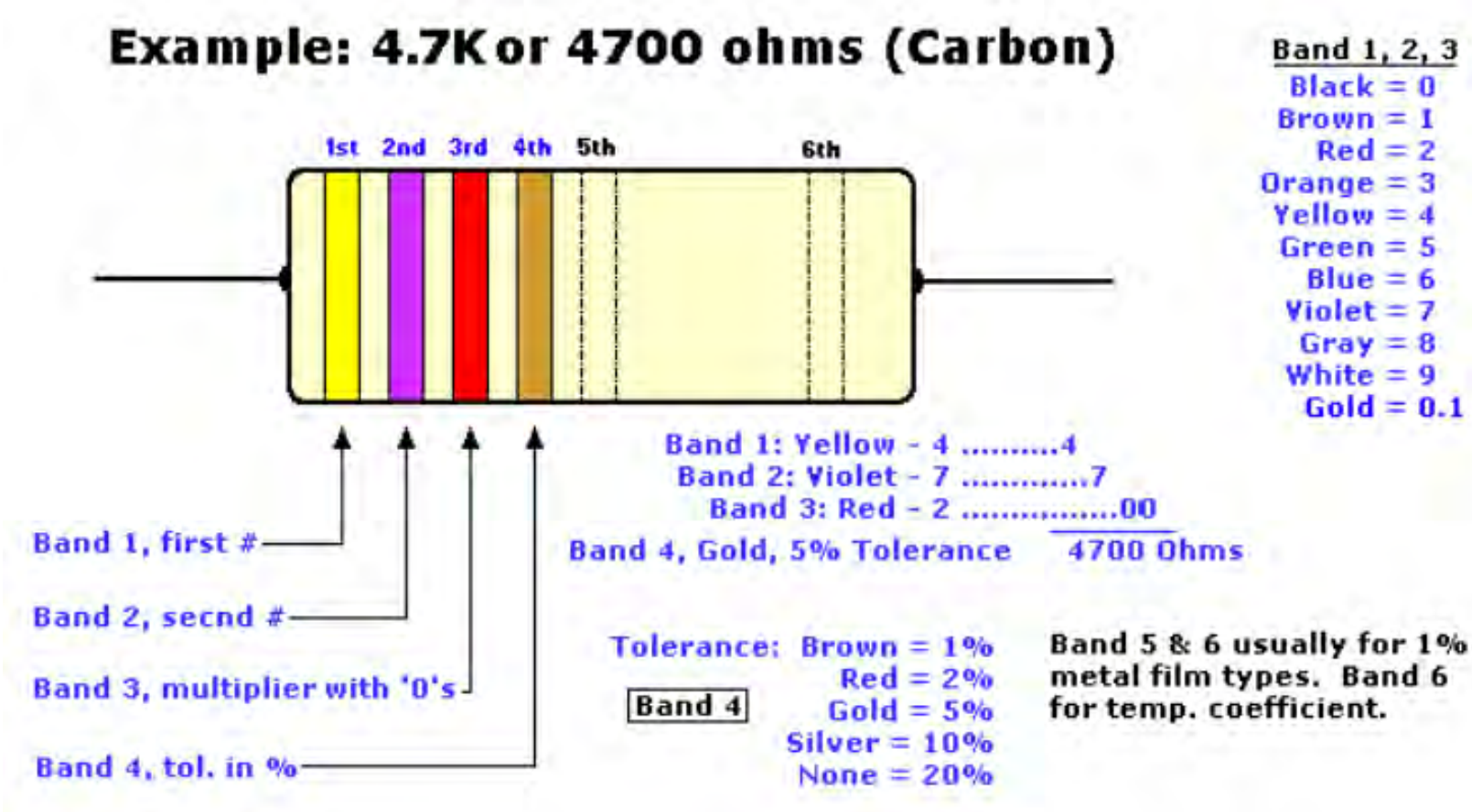
Classification of the materials

- In electrical engineering materials are classified according to their electrical resistance.
  - Conductors (very low resistance)
    - Copper, Gold, Silver
  - Insulators (very high resistance)
    - Plastic, Wood
  - Semi-conductors (the conductivity can be controlled)
    - Silicon (Diodes, Transistors)
  - Superconductors (no resistance)
    - Tin and Aluminium at extremely low temperatures

Resistors

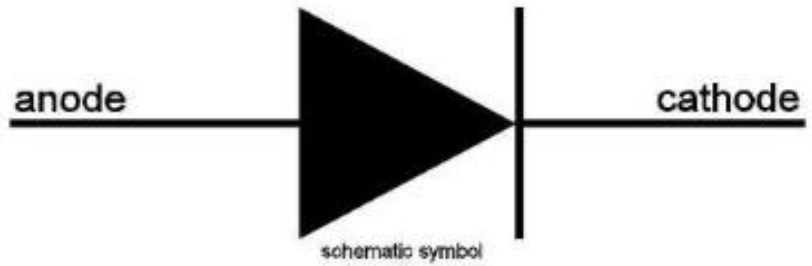
- Resistors resist, but do not totally block, the flow of electricity. They are used to control the flow of current.
- Value indicated through color code
- No polarity
- Expressed in Ohms

Resistor's color Code



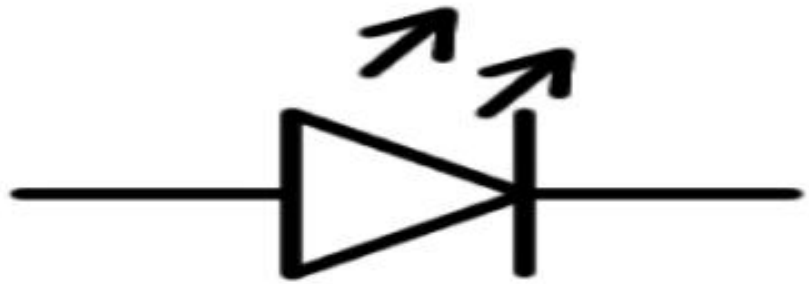
Diodes

- Diodes permit the flow of electricity in one direction, and block it in the other direction.
- Polarity
- Forward Voltage



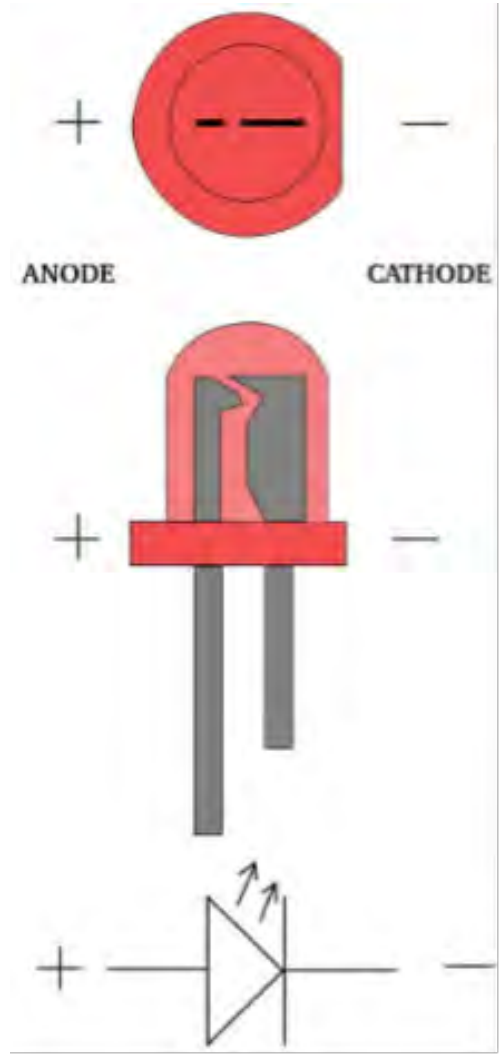
LED's

- LED's are special types of diodes which emit light when current flows through them.
- Polarity
- What is Forward Voltage (V_f) and Forward Current (I_f) of the LED you are using?



LED Polarity

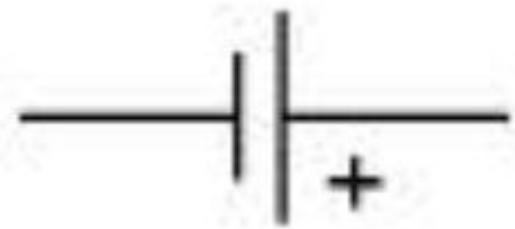
sign:	**+**	**–**
polarity:	positive	negative
terminal:	anode (A)	cathode (K)
leads:	long	short
exterior:	round	flat
interior:	small	large



Note: The only 100% accurate way to determine the polarity of an LED is to check its datasheet.

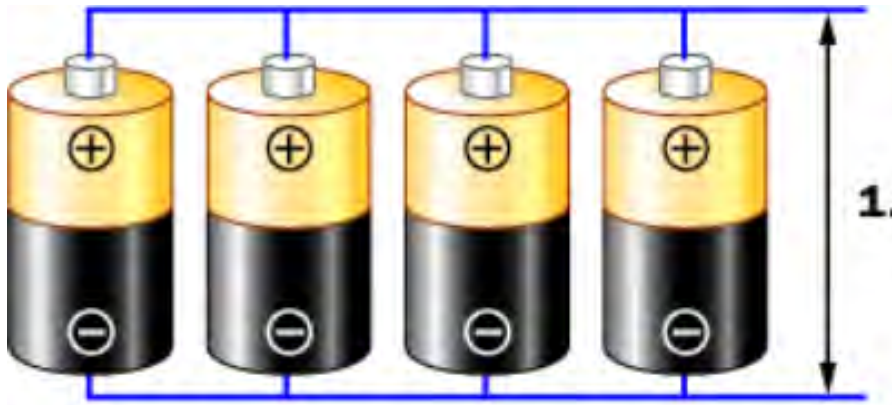
Power Source

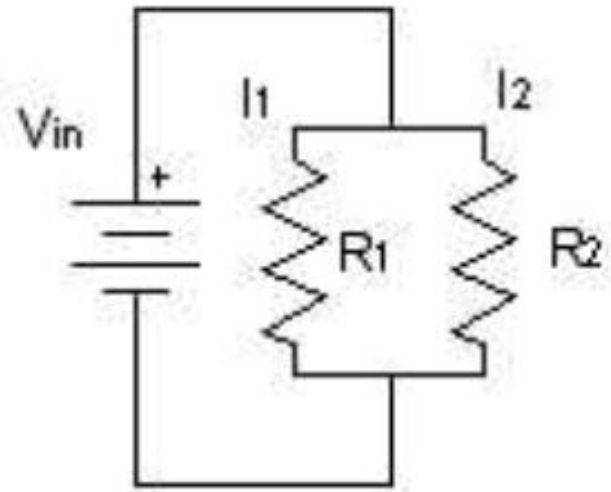
- DC (Direct Current)
- AC (alternating current)
- You might need a converter to go from AC to DC
- What are your power source voltage and current ratings?

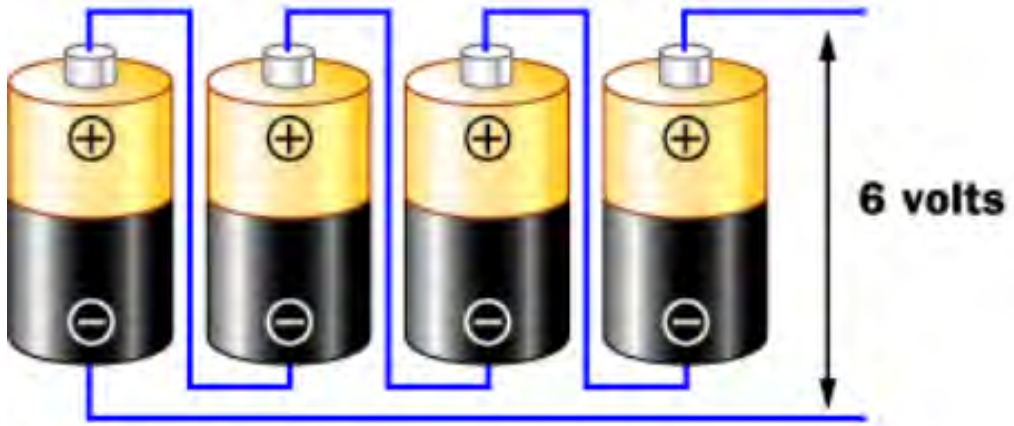


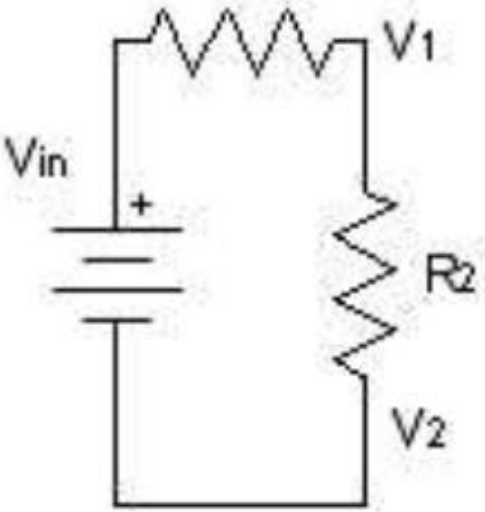
Series vs. Parallel

parallel





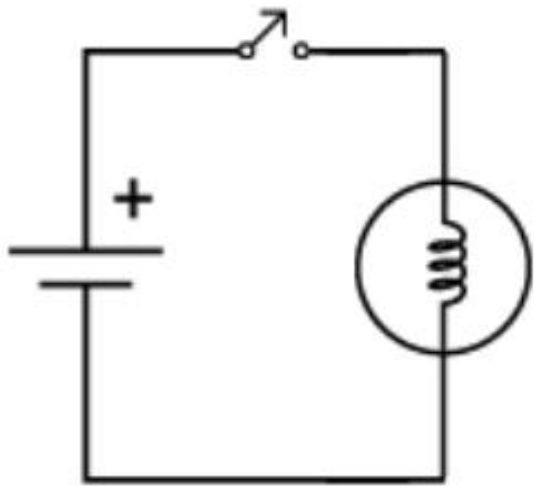


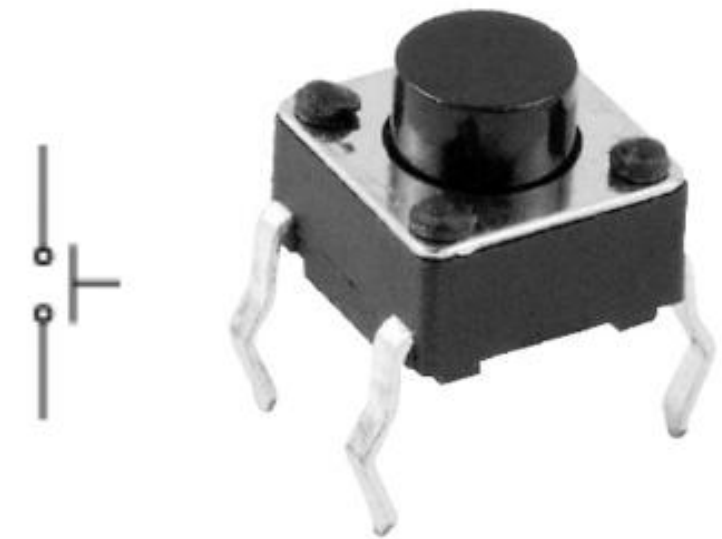


series

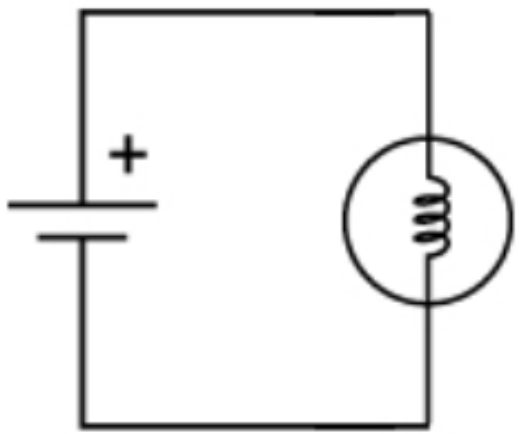
Switches

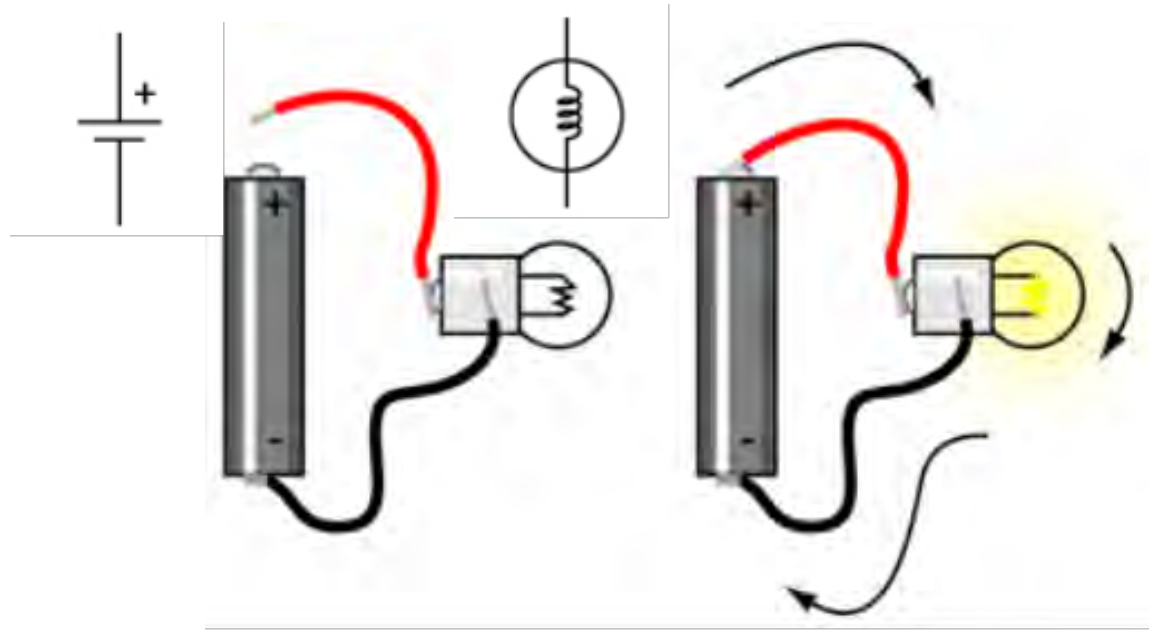
- Open and close a circuit





A Basic Circuit





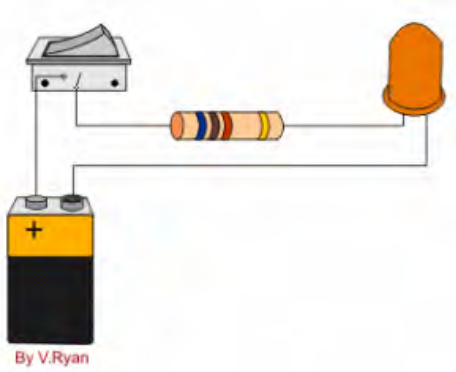
Built a simple circuit

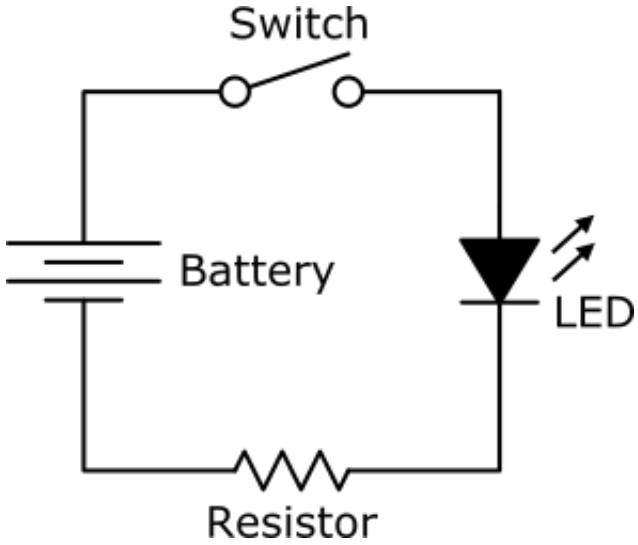
By now you should have a good understanding of LEDs and a limited knowledge of resistors.

Build the circuit seen below using these components:

- Led
- 220 resistor
- Slide switch

When the switch is open the LED lights.





FLORA

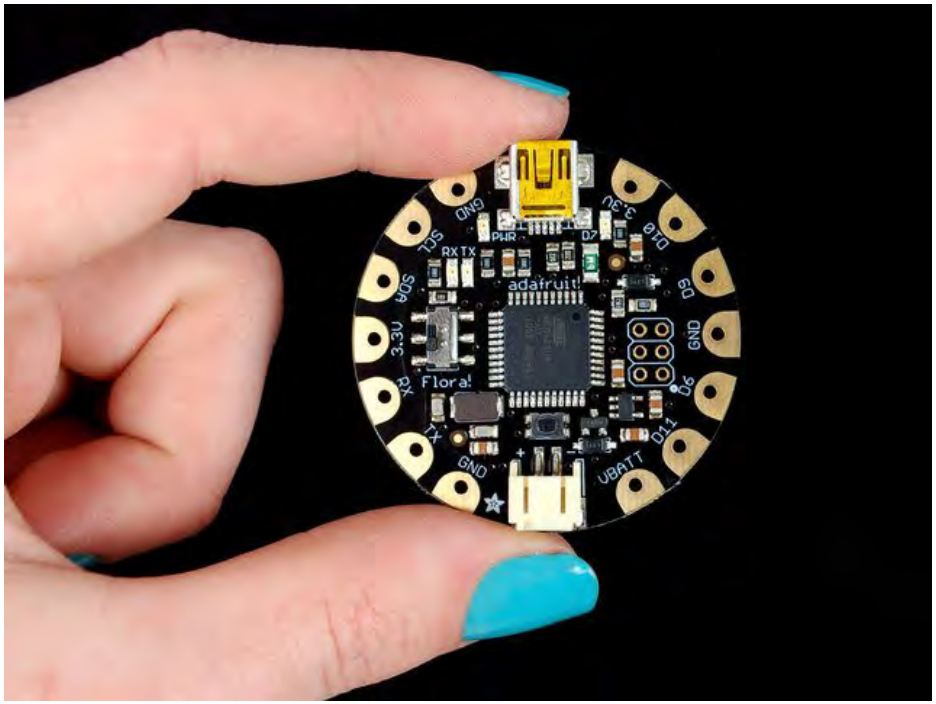
FLORA is Adafruit's wearable electronics platform.

It's built around the Atmega32u4 chip, which has built-in USB support.

No pesky special cables or extra parts for programming just plug it in and get started making the wearables project of your dreams!

Works on Windows and Mac and is Arduino compatible.

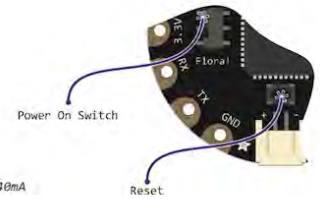
Outputs of 3.3V



Important: You shouldn't use **VBATT** as an input as you might damage your battery if you also plug in the USB connector to a computer! The ideal use of **VBATT** is when you want to power something like NeoPixels or a servo, something that requires more than the 150mA available from the onboard regulator.

adafruit FLORA

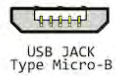
PINOUT DIAGRAM

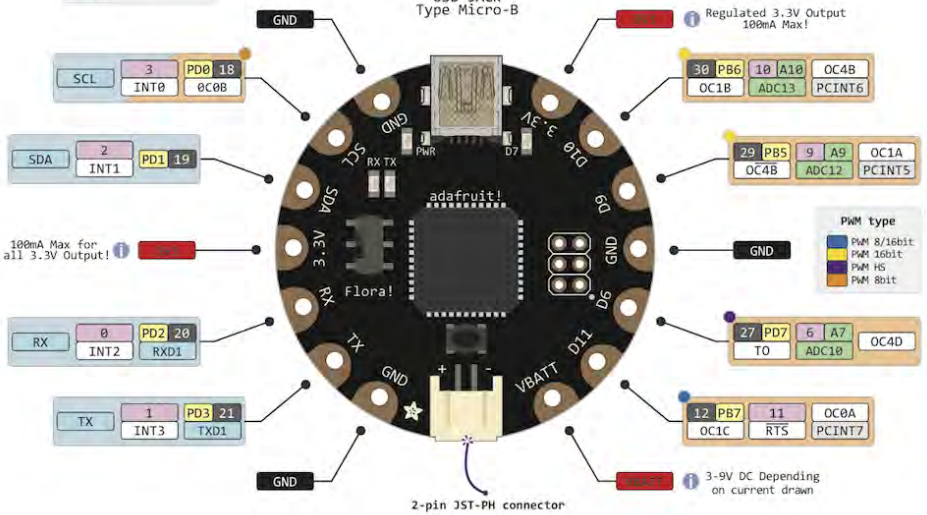


GND
Power
Control
Physical Pin
Port Pin
Pin Function
Digital Pin
Analog Related Pin
PWM Pin
Serial Pin
IDE

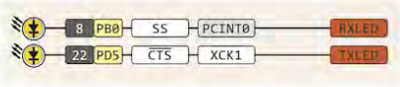
⚠ ***Absolute** max per pin 40mA*
reccomended 20mA

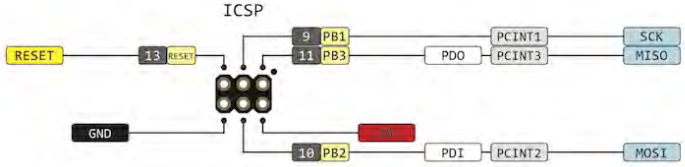
PWM ***Absolute max 200mA***
for entire package





http://www.adafruit.com/products/659





Power the microcontroller

First verify what is the ideal power for your microcontroller.
LOOK UP THE DATA SHEET IF YOU DON'T KNOW

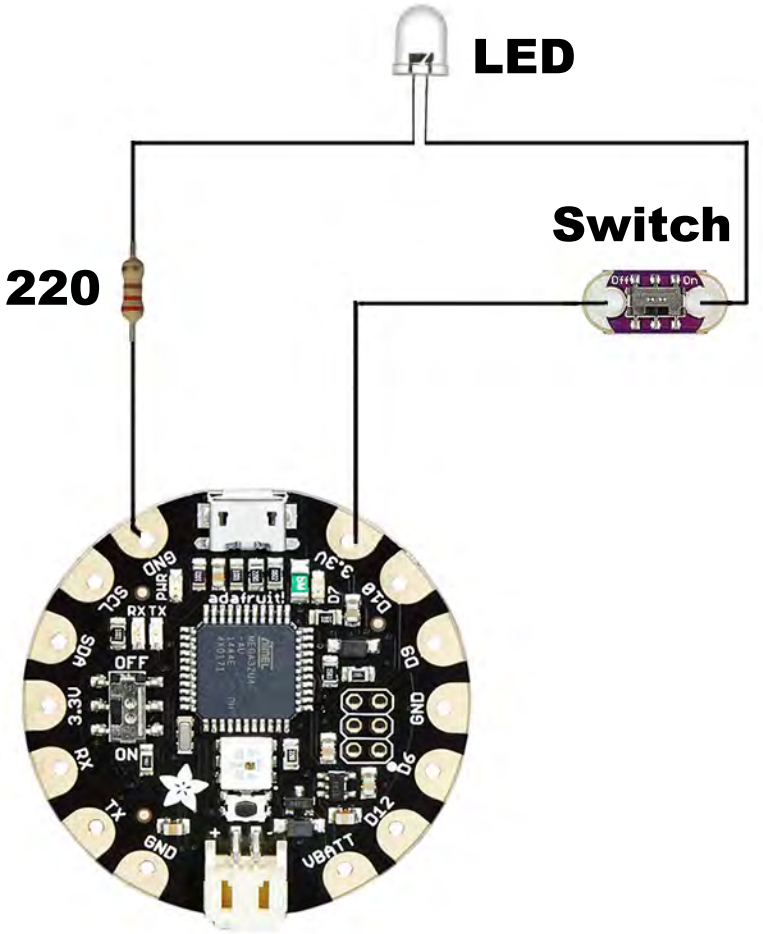
You can power the microcontroller by:

- Connecting the microcontroller to the computer with a USB cable, **Micro B USB** for FLORA
- Connecting batteries
- External power supply; some boards have an on board power adapter.

NEVER CONNECT THE MICROCONTROLLER TO MORE THAN ONE POWER SUPPLY!!!

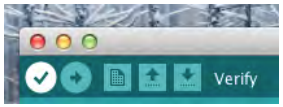
Build your circuit before adding power.
If you need to modify the circuit, make sure to turn the power off, that way you have less risks to short circuit something

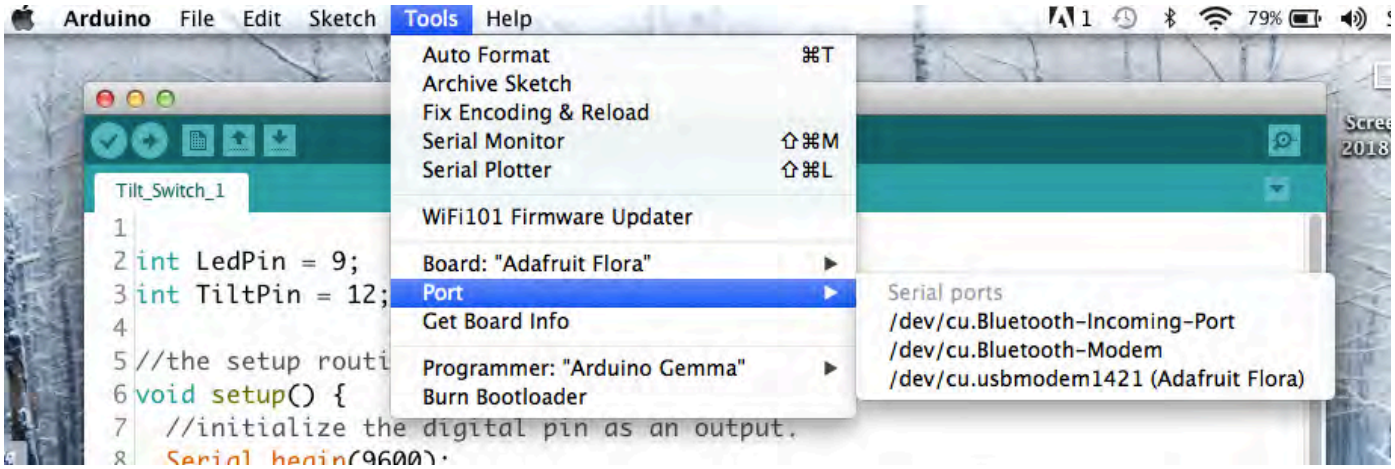
FLORA, simple Switch circuit



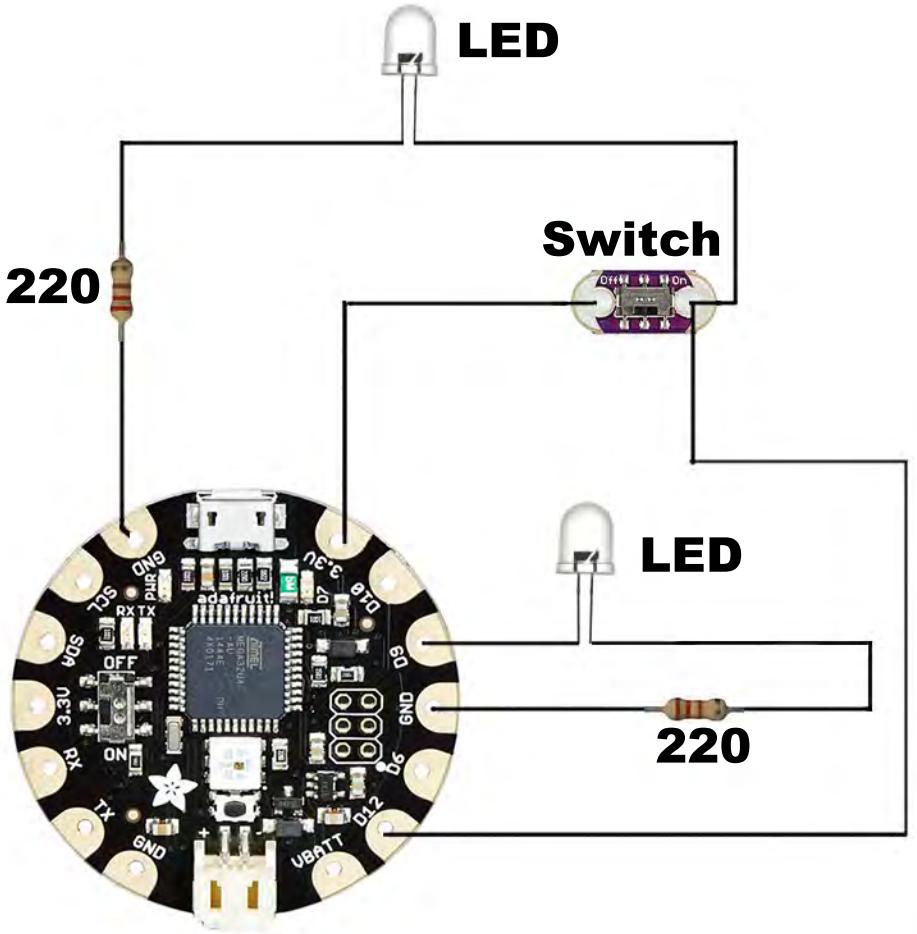
Uploading a program to your Microcontroller

- Move the codes you downloaded to the Arduino document. There should be a new file in your documents called Arduino, drag the codes directly into that file.
- Open the Arduino software
- You will find the example sketches (programs) under «File», «Sketchbook».
- Open double click on the sketch you want to use.
- Click on the «check mark» to verify if the code is working fine.
- If there is a problem with the code it will be written at the bottom of the Arduino window.
- Connect your FLORA to the computer using the Micro B USB cable.
- Before uploading the code you need to identify the board you are using. To do so, go to «Tools» and choose the «Board» you are using: **Adafruit FLORA**.
- You also need to identify witch port you are using to transfer the code to the microcontroller. The port is the connection point between the computer and the microcontroller. Usually it is a USB port (COM for PCs). You can identify the port under the «Tools» tab, then choose «port» and look for usb or com option.
- Click on Upload (the arrow).





FLORA, simple Switch circuit with 2 LEDs

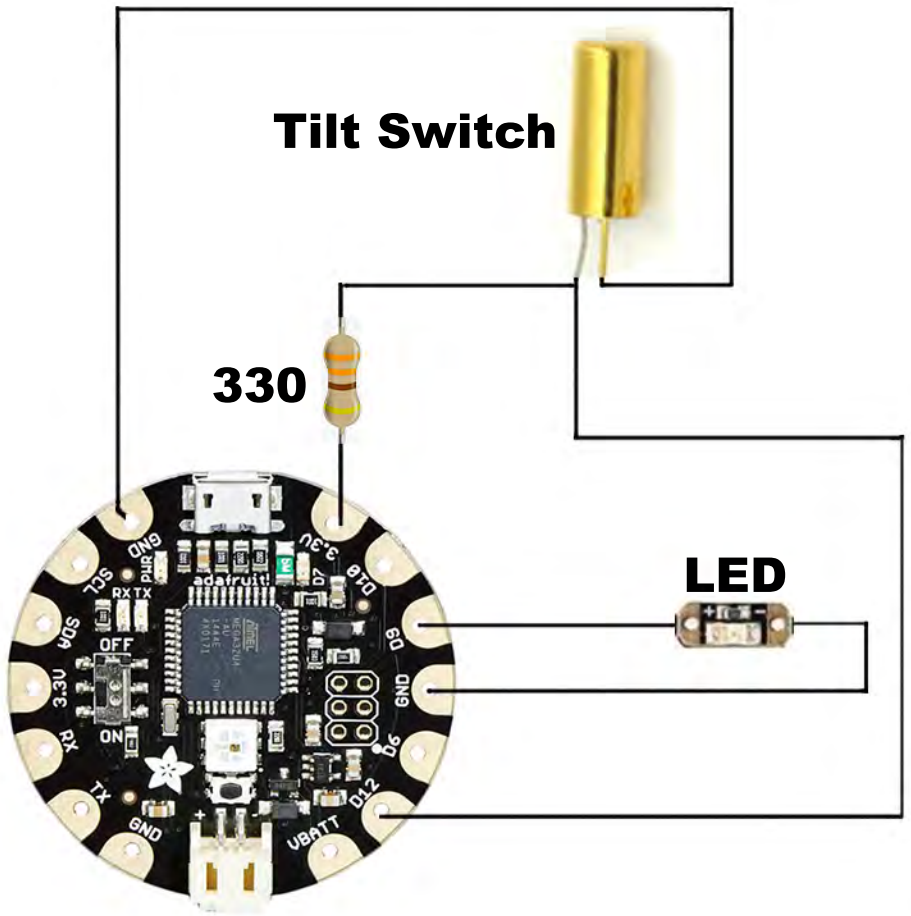


Tilt Sensor

Tilt sensors allow you to detect orientation or inclination. If used properly, they will not wear out. Their simplicity makes them popular for toys, gadgets and appliances. Sometimes they are referred to as "mercury switches", "tilt switches" or "rolling ball sensors" for obvious reasons.

They are usually made by a cavity of some sort (cylindrical is popular, although not always) and a conductive free mass inside, such as a blob of mercury or rolling ball. One end of the cavity has two conductive elements (poles). When the sensor is oriented so that that end is downwards, the mass rolls onto the poles and shorts them, acting as a switch throw.

FLORA: Tilt Switch and 1 LED

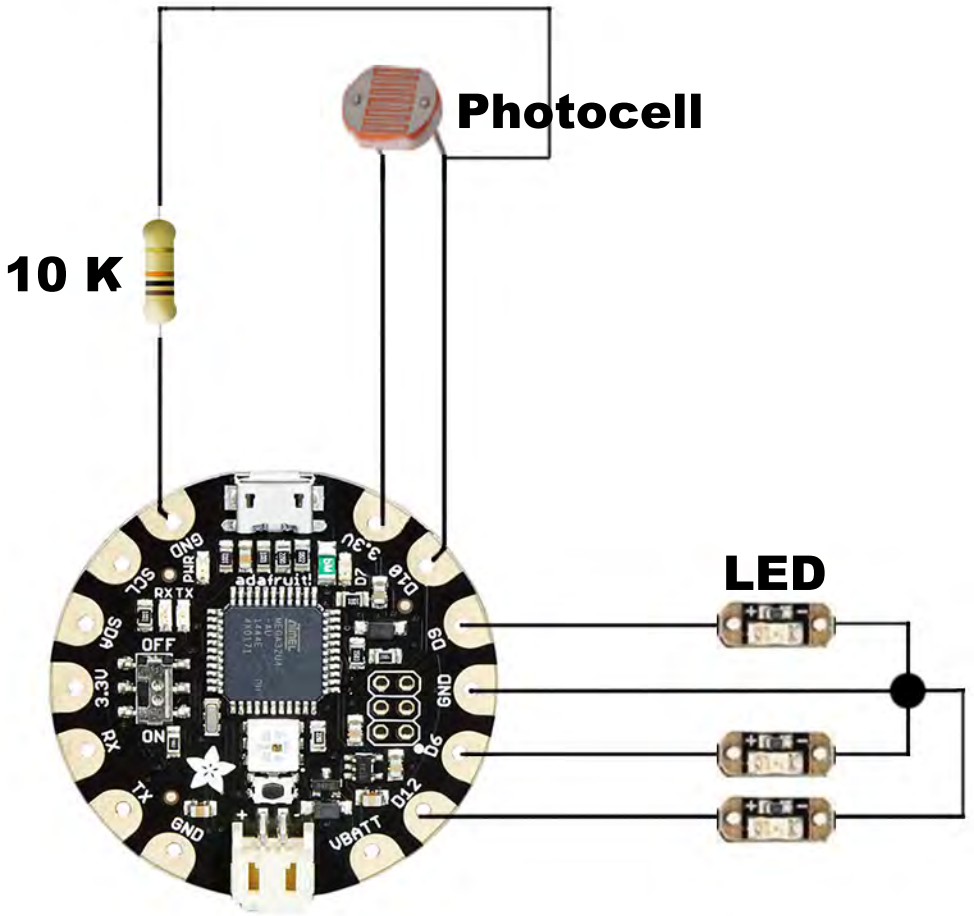


Photocell

Photocells are sensors that allow you to detect light. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason they often appear in toys, gadgets and appliances. They are often referred to as CdS cells (they are made of Cadmium-Sulfide), light-dependent resistors (LDR), and photoresistors.

Photocells are basically a resistor that changes its resistive value (in ohms Ω) depending on how much light is shining onto the squiggly face. They are very low cost, easy to get in many sizes and specifications, but are very innacurate. Each photocell sensor will act a little differently than the other, even if they are from the same batch. The variations can be really large, 50% or higher! For this reason, they shouldn't be used to try to determine precise light levels in lux or millicandela. Instead, you can expect to only be able to determine basic light changes.

FLORA: Photocell and 3 LEDs

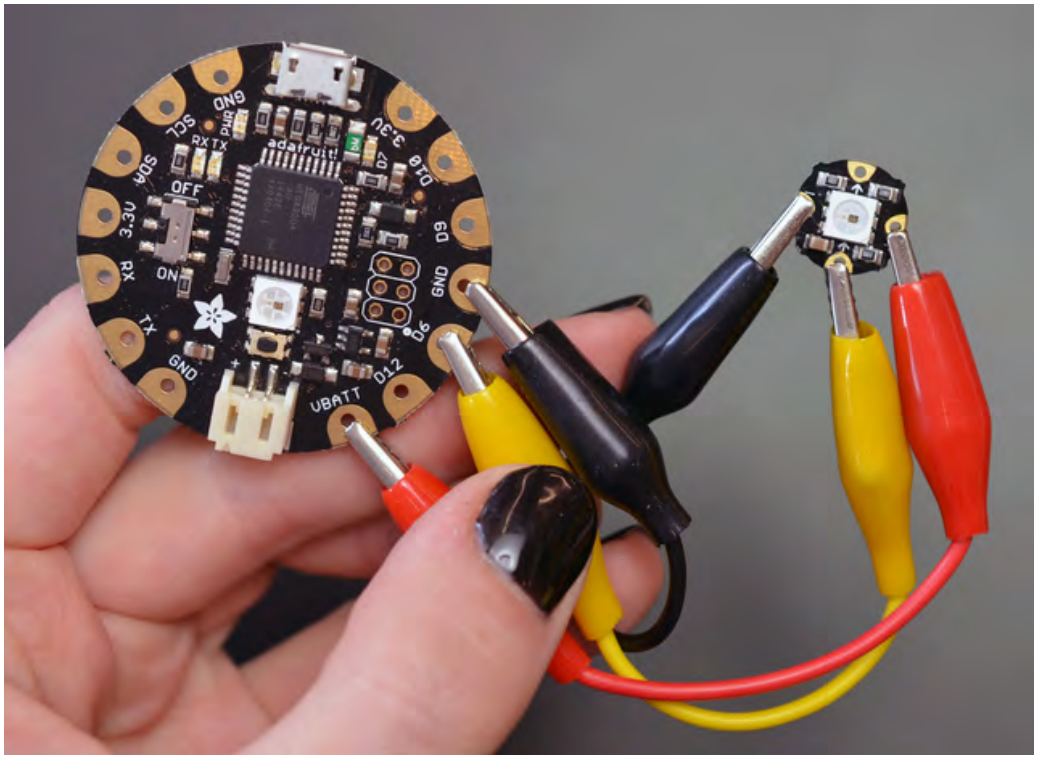


NeoPixel

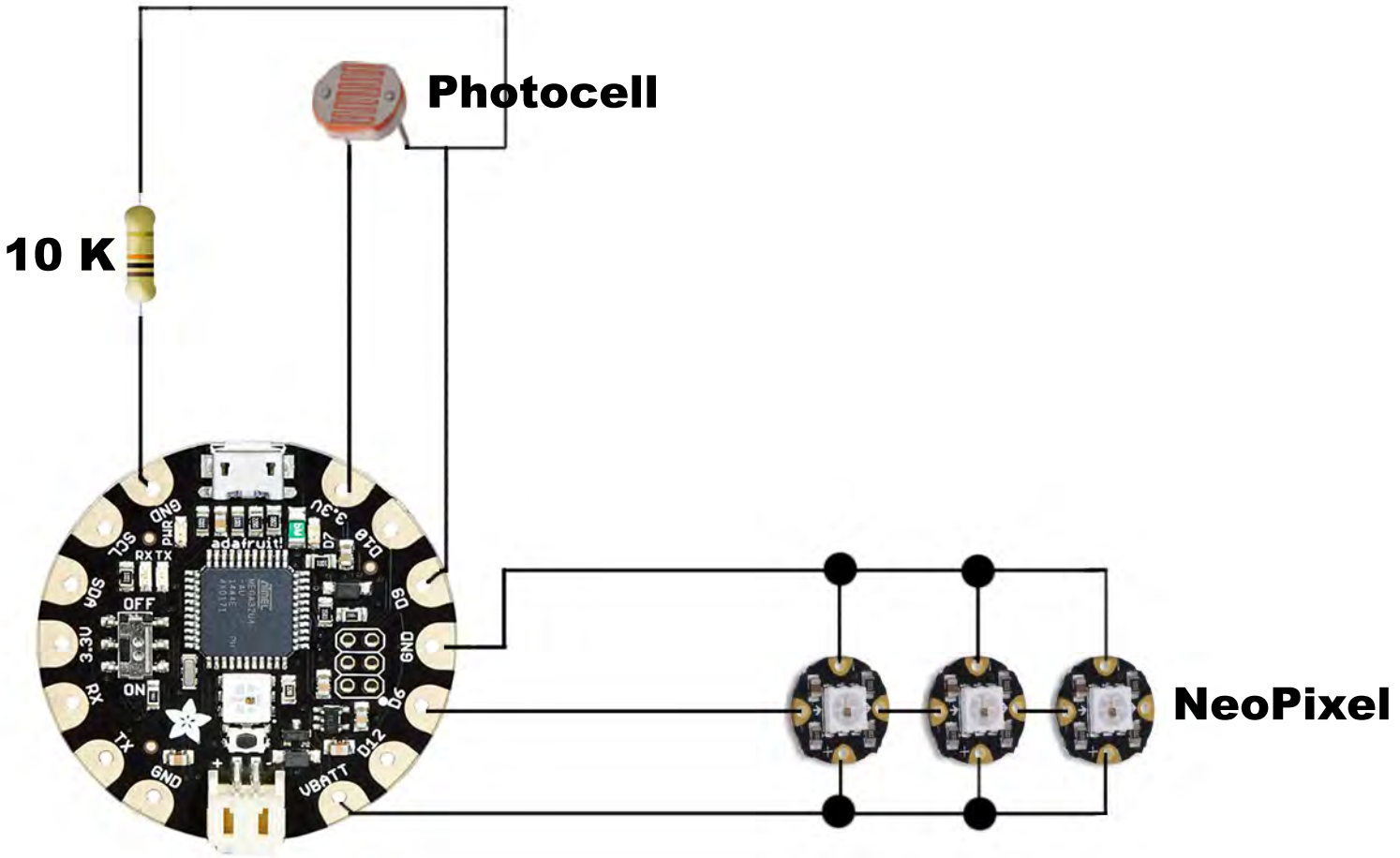
The **WS2812** Integrated Light Source — or ***NeoPixel*** in Adafruit parlance — is the latest advance in the quest for a simple, scalable and affordable full-color LED.

Red, green and blue LEDs are integrated alongside a driver chip into a tiny surface-mount package controlled through a single wire. They can be used individually, chained into longer strings or assembled into still more interesting form-factors.

Your Flora comes with an onboard NeoPixel!



FLORA: Photocell and NeoPixels



Resources

Adafruit industries: https://www.adafruit.com

Arduino : https://www.arduino.cc

https://www.clear.rice.edu/elec201/Book/basic_elec.html

Seattle robotics: http://www.seattlerobotics.org/guide/electronics.html

Wiki Books: https://en.wikibooks.org/wiki/Practical_Electronics

Make : books