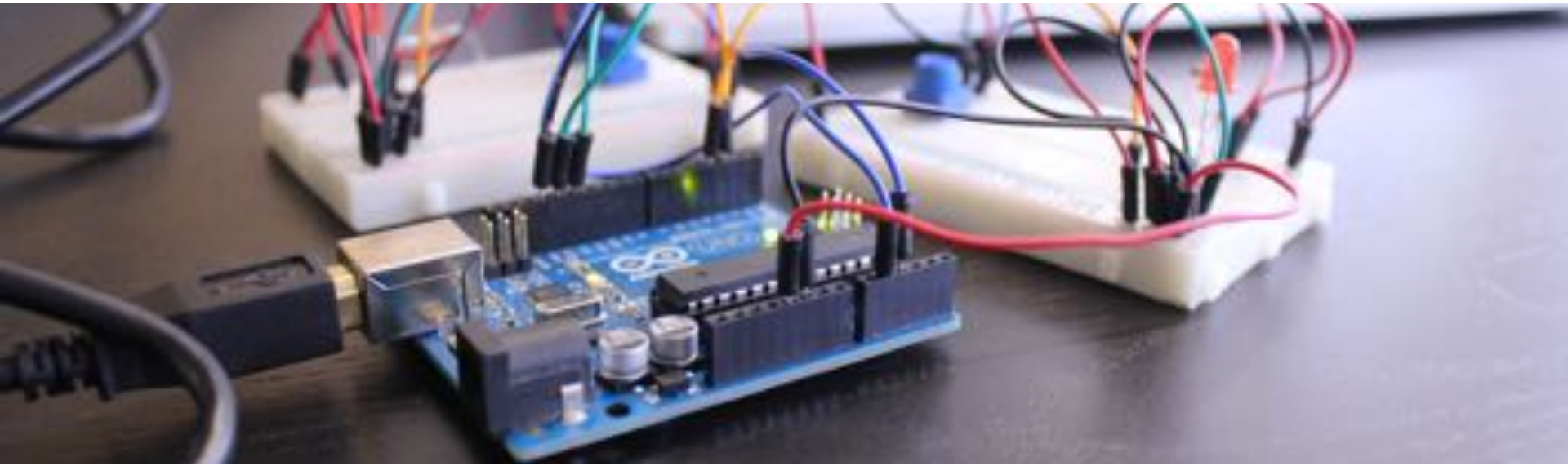
Electronic Prototyping

Introduction to electronic prototyping

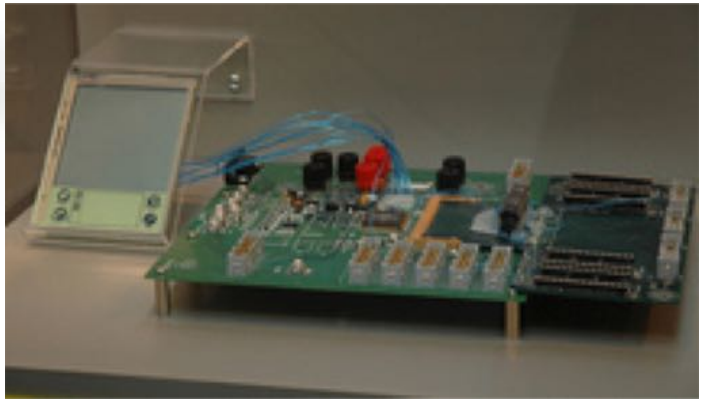
Lesson 1

Outline

- **Introduction to the Electronic Prototyping**
- **Components used for you prototype**
- **Breadboard and multimeter use**
- **Introduction to Arduino use**



Pretotype – Prototype – Product



Pretotyping

- **Formal Definition:**

–Pretotyping [pree-tow-tie-ping], verb: Testing the initial appeal and actual usage of a potential new product by simulating its core experience with the smallest possible investment of time and money.

- **Less formal definition:**

–Pretotyping is a way to test an idea quickly and inexpensively by creating extremely simplified, mocked or virtual versions of that product to help validate the premise that "If we build it, they will use it."

- **Very informal definition:**

–Pretotyping: Fake it and test it before you make it!

–Make sure – as quickly and as cheaply as you can – that you are building the right **it** before you build **it** right.

The Pretotyping Manifesto

*Make sure you are building the right **it***

*before you build **it** right*

innovators beat ideas

pretotypes beat productypes

building beats talking

simplicity beats features

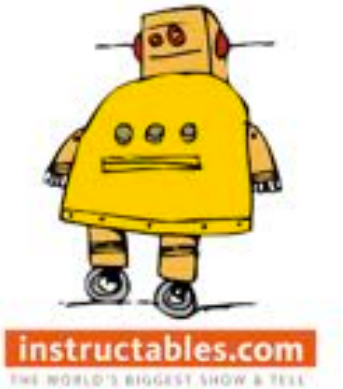
now beats later

commitment beats committees

data beats opinions

- www.pretotyping.org
- http://www.pretotyping.org/uploads/1/4/0/9/14099067/pretotype_it_2nd_pretotype_edition-2.pdf

Protoyping today



Making VS product prototyping

Making

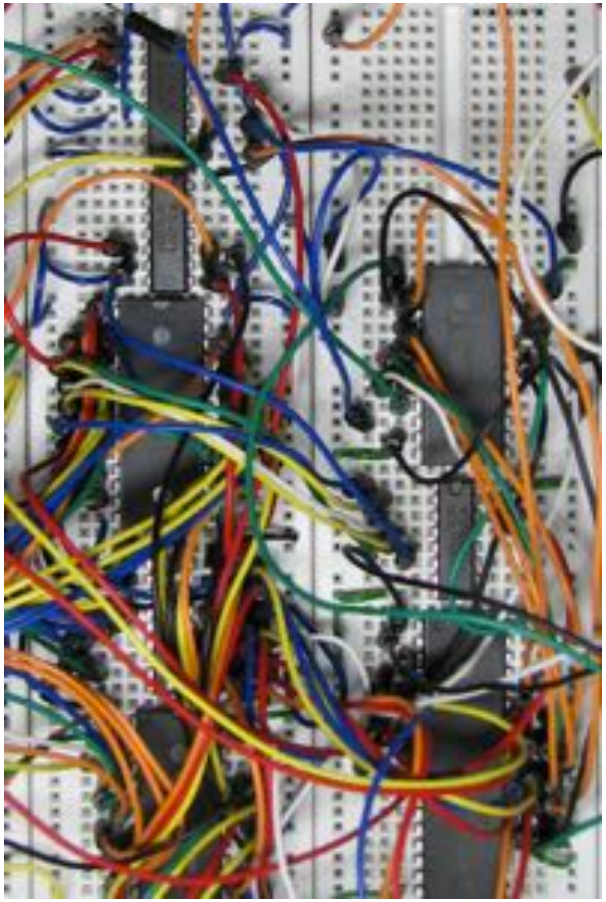
- For fun
- Needs to work once
- If it falls change product
- Needs beer

Product Prototyping

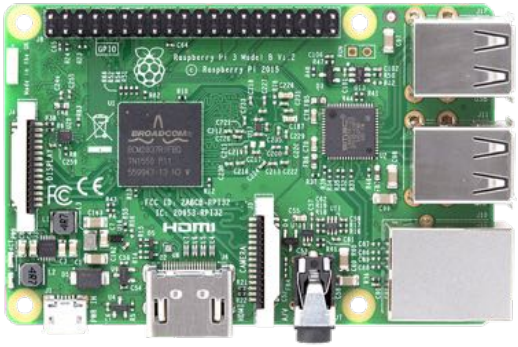
- To show your idea
- Needs to work at demo time
- If it falls needs to be fixed
- Needs skills and money

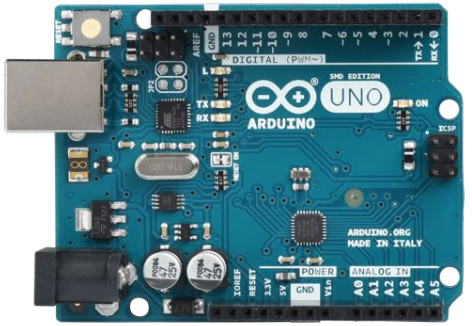
Prototype requirements

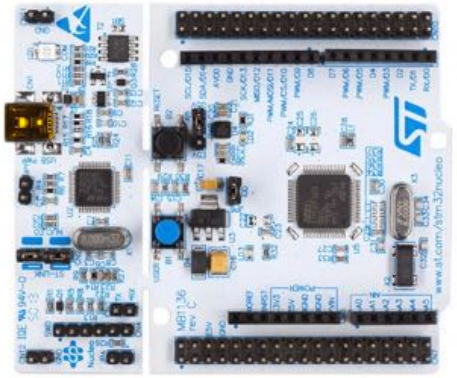
- **Demonstrate your product features**
- **Ready and functional as soon as possible**
- **Cheap**
- **Demonstrate your product features even during a demo**
  - Solid and reliable
  - Easy to transport
  - Easy to operate



Electronic prototyping







Select the right Hardware

Generic application

- Arduino
  - Grove System
  - Lylipad/Flora
- ARM mbed
- ST Nucleo kits

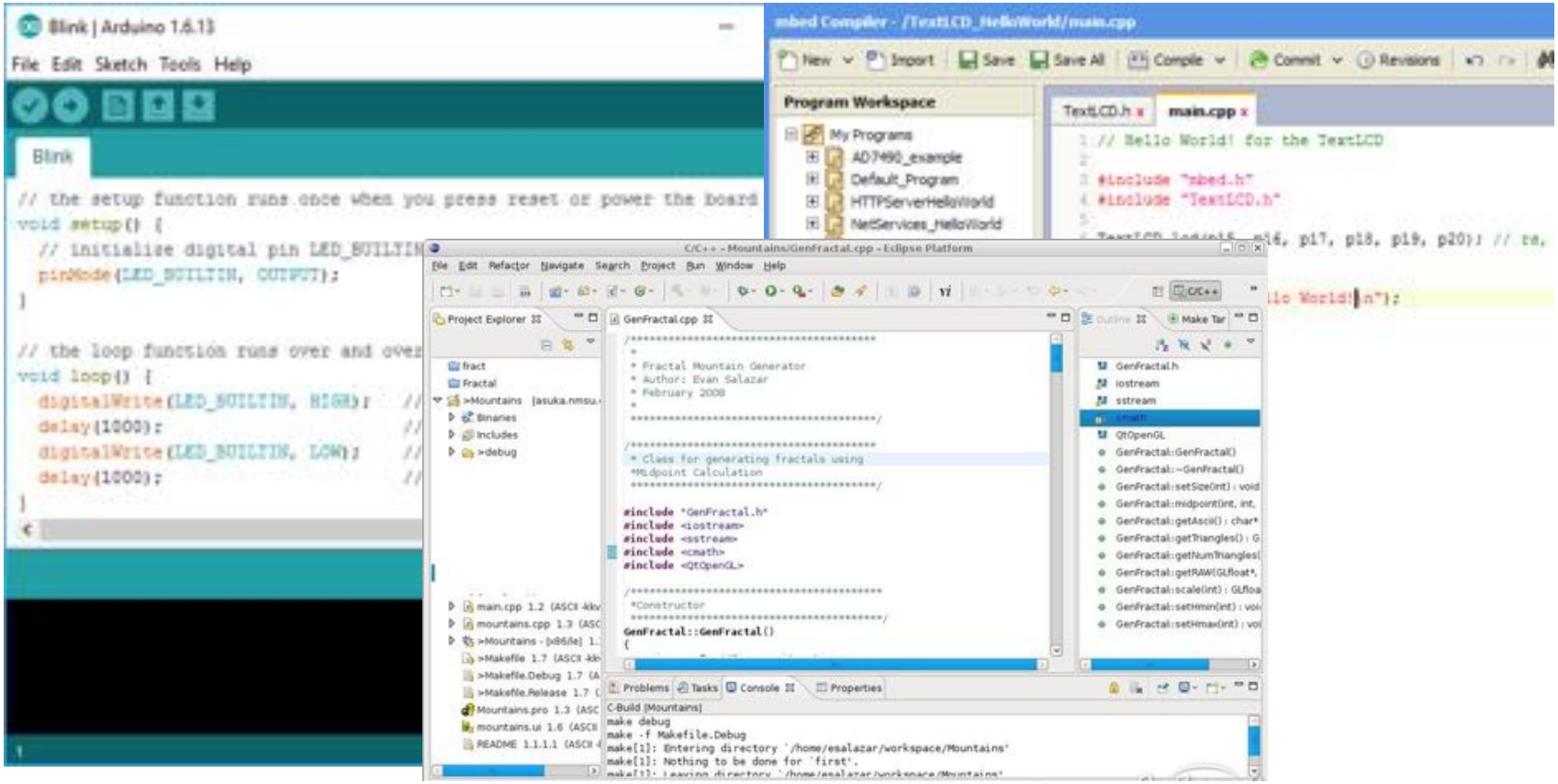
IoT application

- Particle
- Electric Imp
- Tessel
- OpenPicus

Android/Linux

- Raspberry Pi/Zero
- Intel Edison /Joule
- DragoBoard

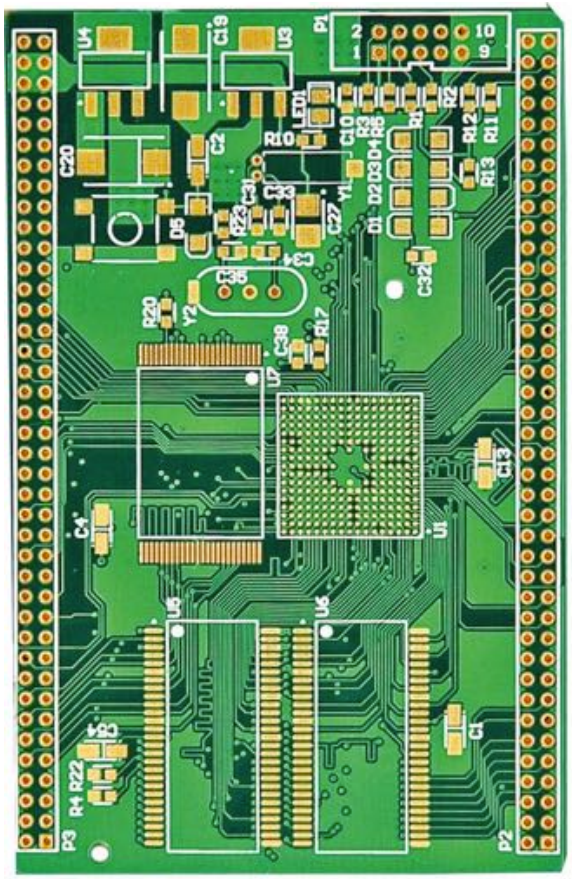
Development Environments



Start with existing Hardware

Design your own board

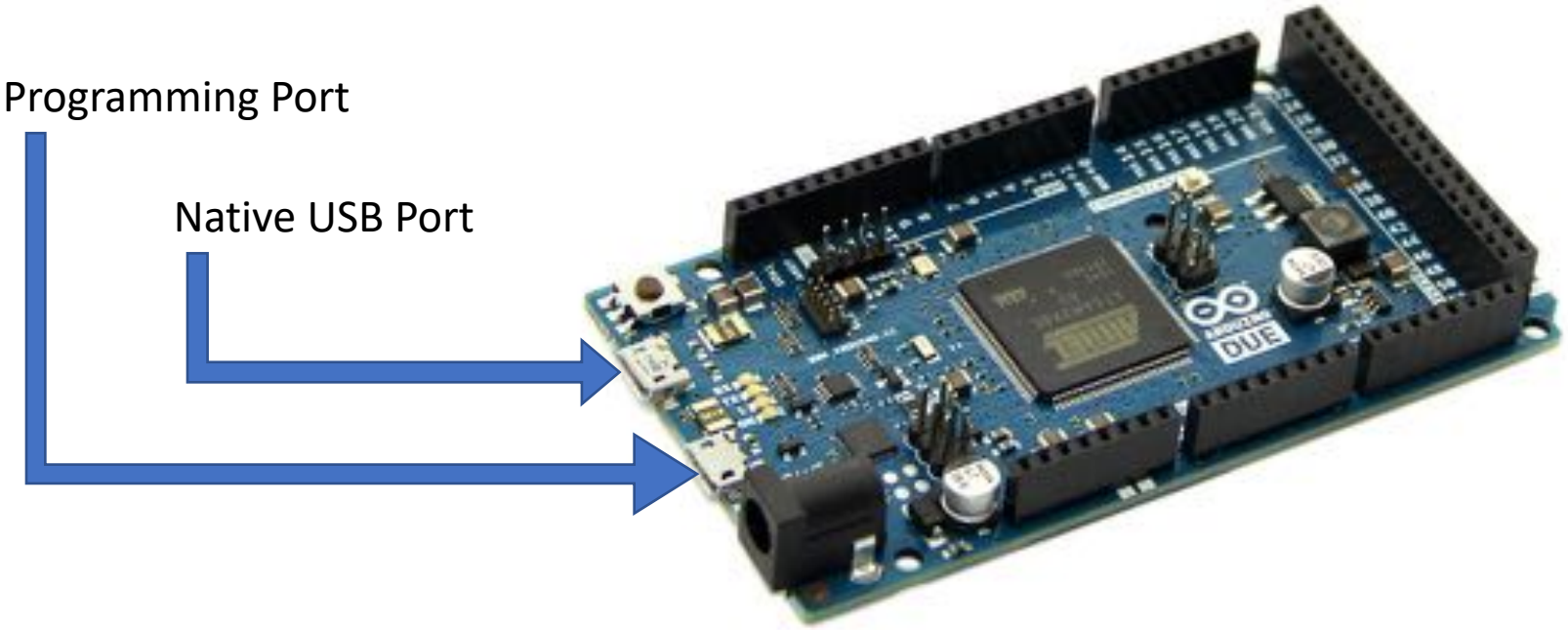
- **Hardware is hard**
  - Define specifications
  - Select components
  - Understand how they work
  - Connect everything
  - Route the PCB



Designing your electronic prototype

Components (1/22)

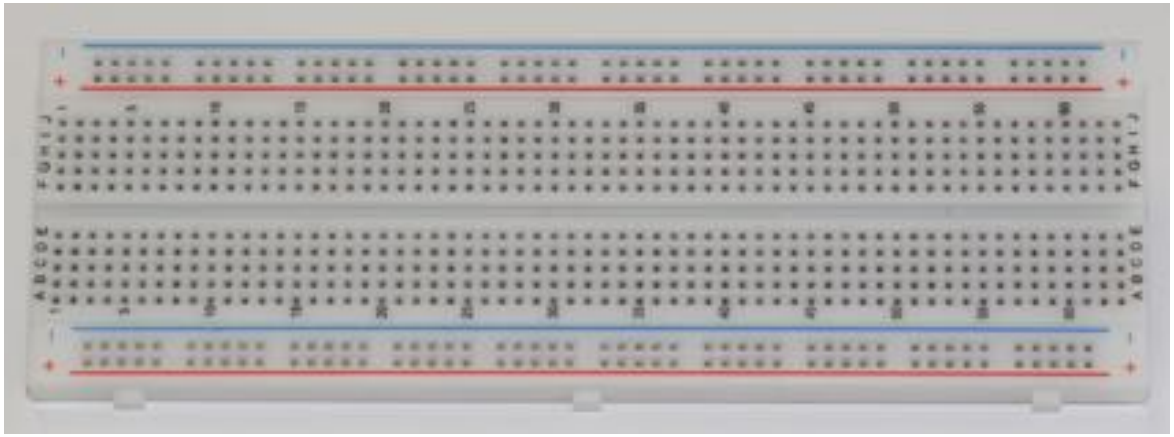
- **Arduino DUE**



Components (2/22)

- **Breadboard**

  A breadboard, sometimes called a proto-board, is a reusable platform for temporarily built electronic circuits.



Components (3/22)

- **USB Cable**

Arduino UNO

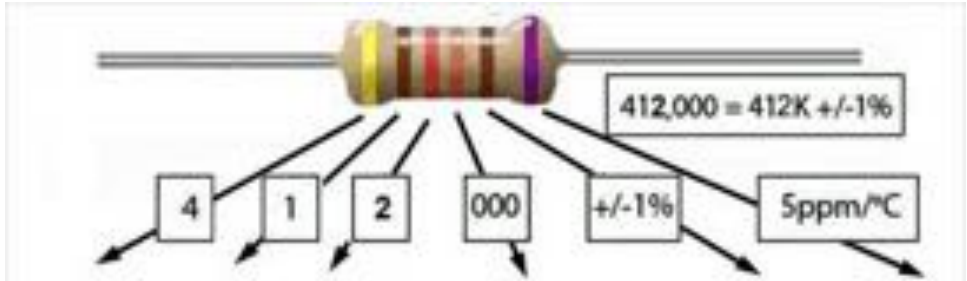
Arduino DUE

Components (4/22)

- **Resistor**
  - Resistors “resist” or **regulate the flow of electrons (current)**
  - Resistors can also be connected together in various **series and parallel combinations**
  - Resistors are what are called “**Passive Devices**”, that is they contain no source of power or amplification but only attenuate or reduce the voltage or current signal passing through them.

Components (5/22)

- **Resistor Code**



Band	1	2	3	4	5	6
Meaning	1st Digit	2nd Digit	3rd Digit	(No. of zeros)	Tolerance % (No band +/- 20%)	Temp. Coeff.
Silver				.00 (divide by 100)	+/-10%	
Gold				0 (divide by 10)	+/-5%	
Black	0	0	0	No Zeros		
Brown	1	1	1	0	+/-1%	100ppm/°C
Red	2	2	2	00	+/-2%	50ppm/°C
Orange	3	3	3	,000		15ppm/°C
Yellow	4	4	4	0,000		25ppm/°C
Green	5	5	5	00,000	+/-0.5%	
Blue	6	6	6	,000,000	+/-0.25%	10ppm/°C
Violet	7	7	7	0,000,000	+/-0.1%	5ppm/°C
Grey	8	8	8		+/-0.05%	
White	9	9	9			1ppm/°C

Components (6/22)

- **Capacitors**

  Basically a capacitor is formed *from two conducting plates separated by a thin insulating layer*. They are manufactured in many forms, styles, and from many materials. Capacitors are widely used in electrical and electronic circuits.

Components (7/22)

- **Electrolytic Capacitors:**

  Electrolytic capacitors are a type of capacitor that is *polarised*.
  They are able to offer *high capacitance values* - typically above 1µF, and are most widely used for low frequency applications (frequency limit if around 100 kHz) - power supplies, decoupling and audio coupling applications.

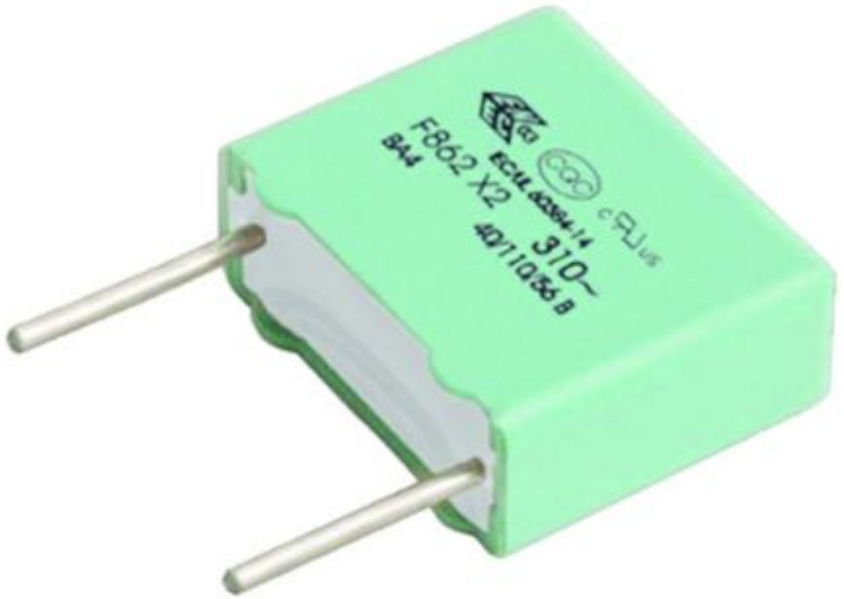
Components (8/22)

- **Ceramic Capacitors:**

  Values range from a few picofarads to around 0.1 microfarads. Ceramic capacitor types are by far the most commonly used type of capacitor being cheap and reliable and their loss factor is particularly low although this is dependent on the exact dielectric in use.

Components (9/22)

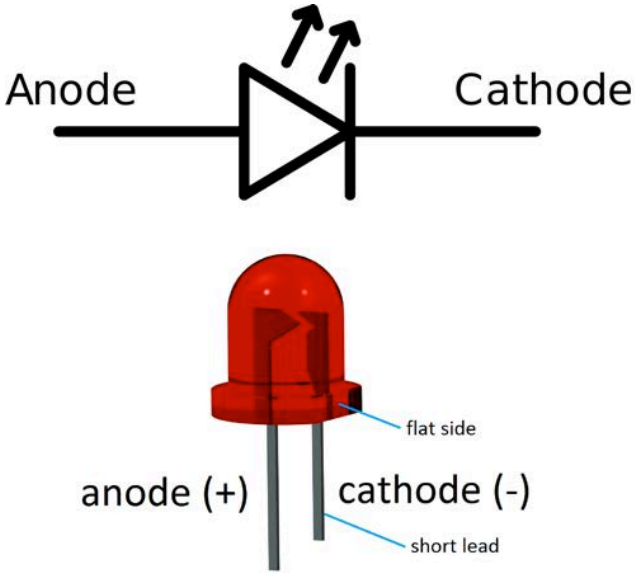
- **Polymer Capacitors**
  - Polystyrene, Polyester,
  - Metallised Polyester,
  - Polycarbonate,
  - Polypropylene.

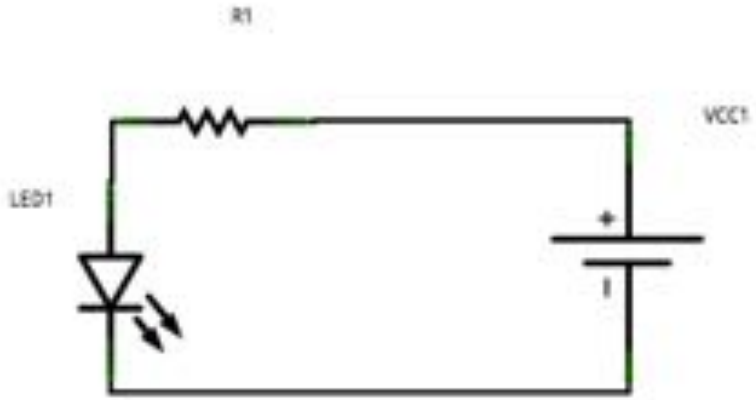


Components (10/22)

- **Light Emitting Diodes (LED)**

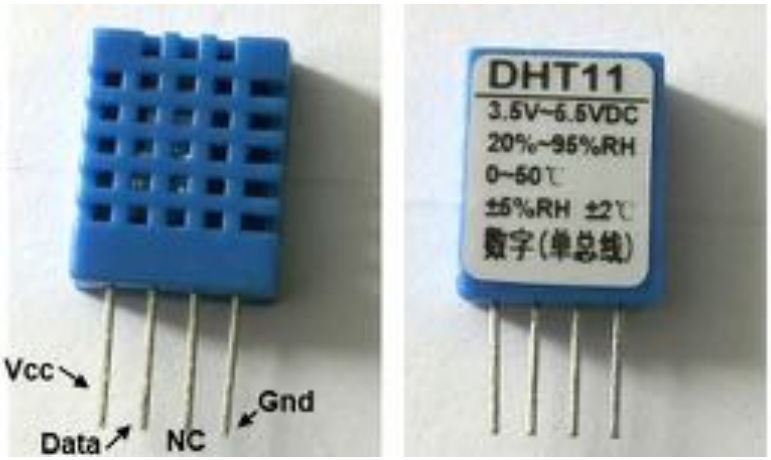
Diode Symbol + Arrows for light





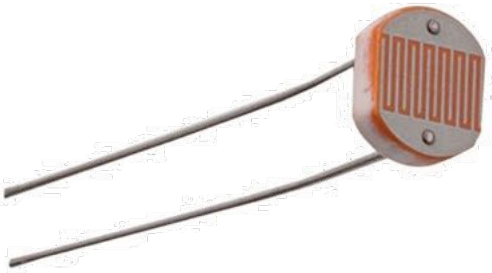
Components (11/22)

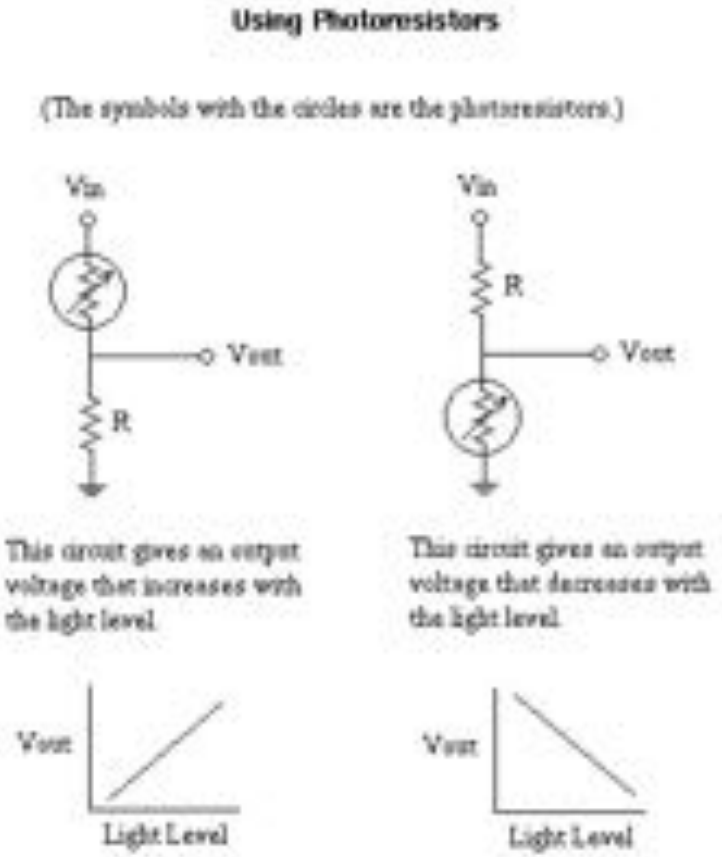
- **Basic temperature and/or humidity sensor**
  - DHT11 or DHT22 is a good entry-level choice
  - Library can be downloaded and incorporated to give easy access to features of the sensor



Components (12/22)

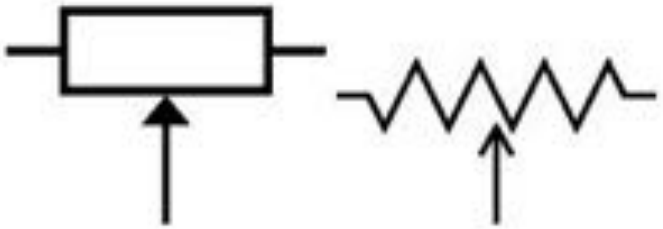
- **Photoresistor**
  - A photoresistor is a two-terminal semiconductor device that has an electrical resistance that depends on the light incident on the exposed semiconductor surface. The resistance decreases with increases in incident.





Components (13/22)

- **Potentiometer**
  - A potentiometer is a simple knob that provides a variable resistance, which we can read into the Arduino board as an analog value.



Simbolo del Potenziometro

Components (14/22)

- **Infrared based detectors**
  - IR Flame sensor

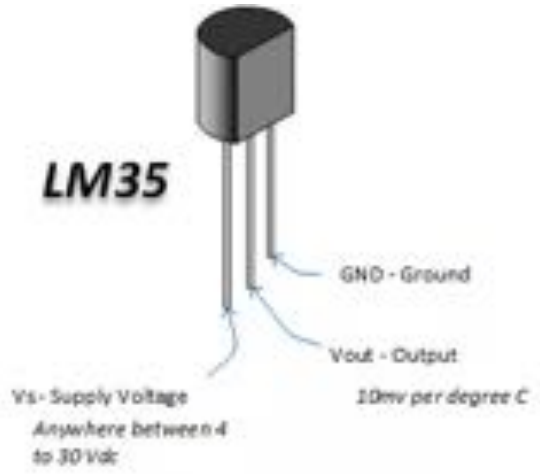
    When fire burns it emits a small amount of Infra-red light, this light will be received by the Photodiode (IR receiver) on the sensor module

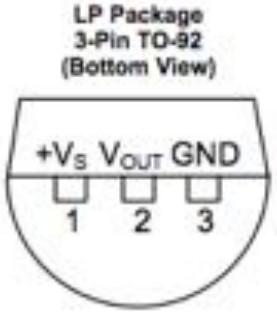
  - IR receiver and remote control

    Pressing a button on the remote control, a unique hexadecimal code is generated. This information is modulated and sent over IR to the receiver.

Components (15/22)

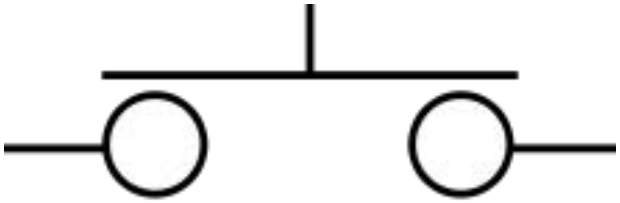
- **Temperature sensor (LM35)**
  - The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly proportional to the Centigrade temperature.





Components (16/22)

- **Push button**
  - A push button is an on-off switch. Press to turn on. Release to turn off. (There are some push buttons that work the opposite, i.e. press to turn off and release to turn on)



Components (17/22)

- **Small servos**
  - Arduino can be used to position servo at a given angle for use in projects.
  - Other sensors can be attached to the servo to add a layer of complexity
  - Servo motor can only turn half cycle
  - Servo library included in Arduino IDE

Components (18/22)

- **Stepper motor**
  - Unipolar stepper motor turns only one step a time in either direction depending on the control
  - Need a driver chip to work

Components (19/22)

- **DC Motor**
  - DC motor turns continuously in either direction depending on the polarity of the wires
  - Need a L293D H-Bridge driver chip to control the direction and speed of the turning

Components (20/22)

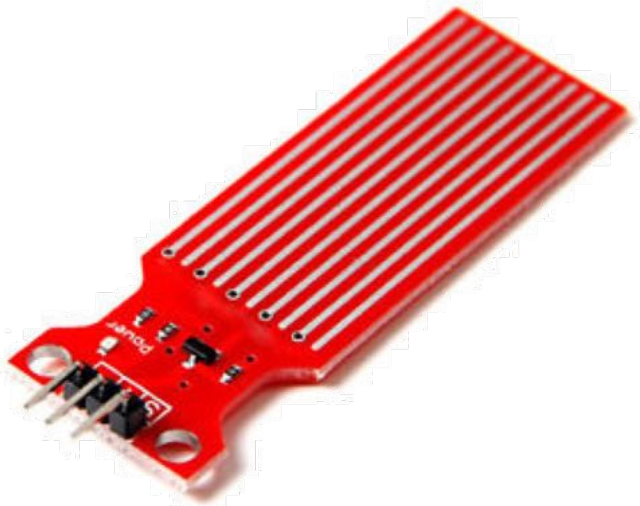
- **Liquid Crystal Display (LCD)**
  - LCD Screen with backlight
    - (16x2 is common and teaches the complications of textual display)
  - The parallel version uses 4 digital pins for display (PCF8574)
  - It is possible to download PCF8574 library directly from Arduino

Components (21/22)

- **Joystick module**
  - The thumbstick is analog and provides accurate directional readings. Additionally, you can press the joystick down to activate a ‘press to select’ push-button.

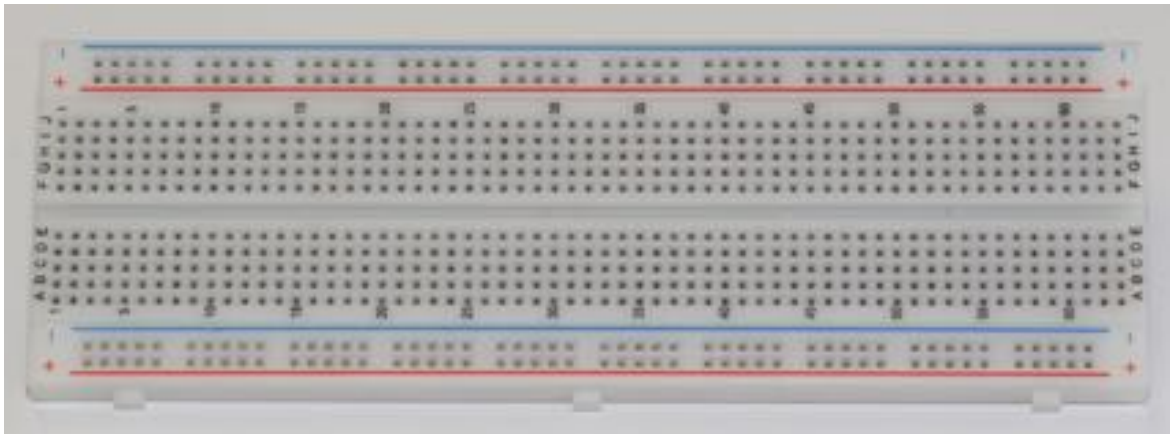
Components (22/22)

- **Water level sensor**
  - This module provides a low-cost and easy-to-use water level detection, measuring water level up to 40mm.

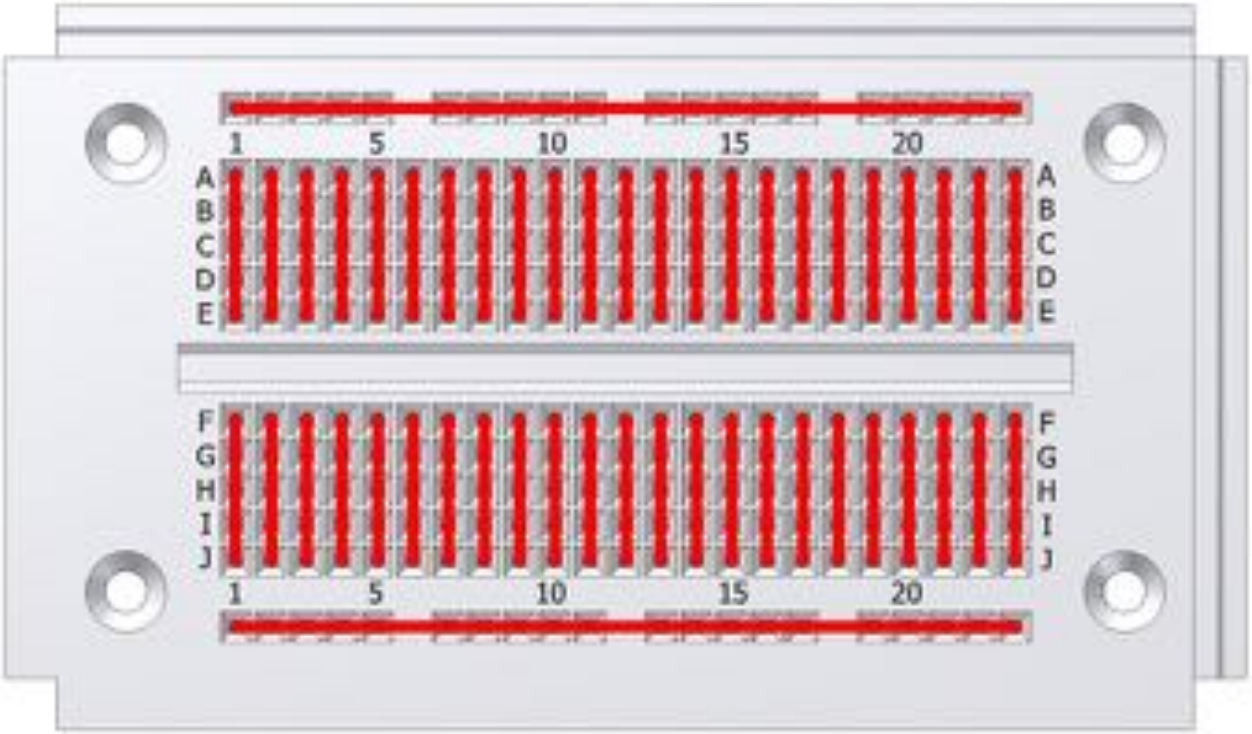


Breadboard use (1/5)

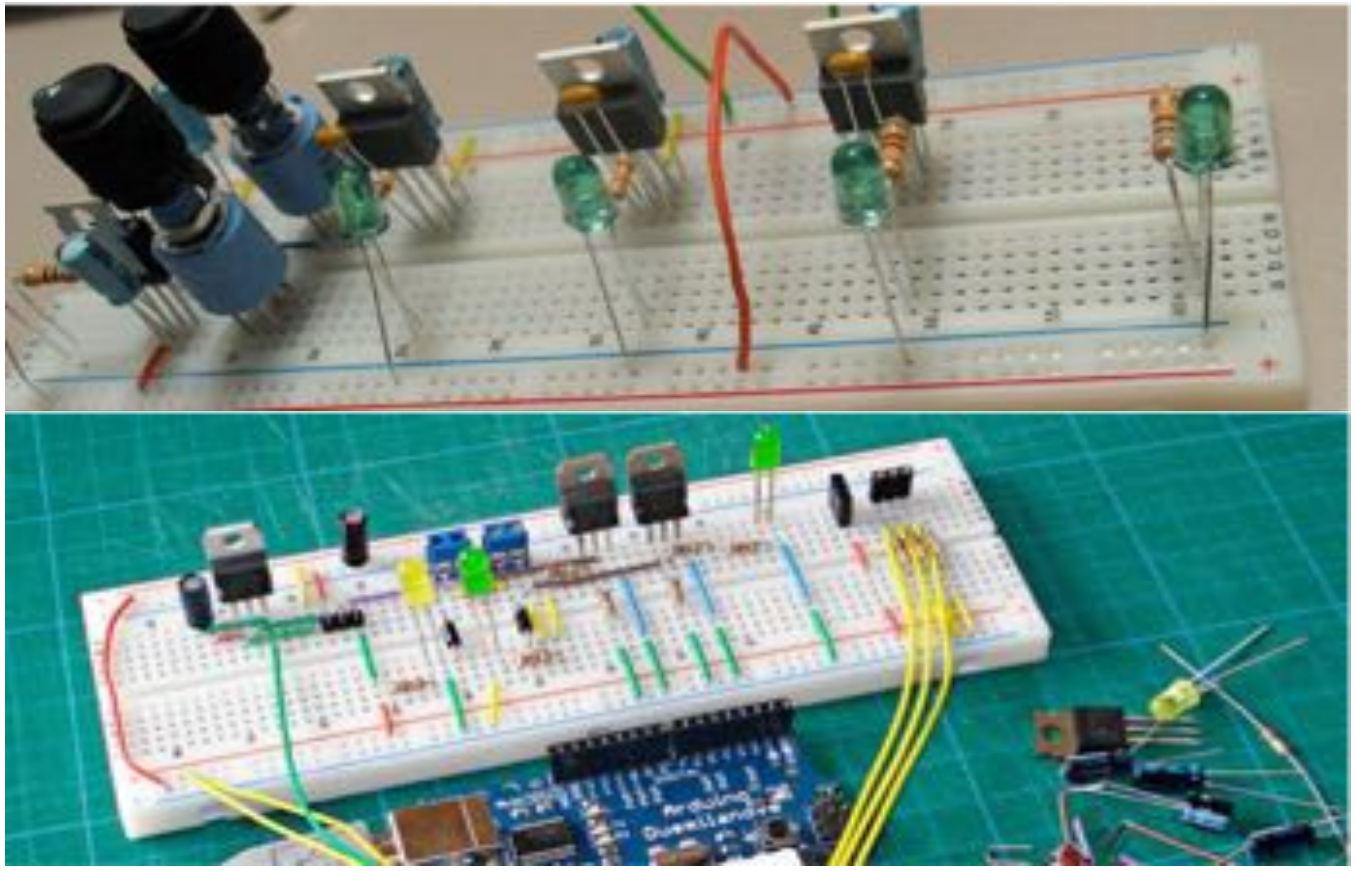
- **Electric component leads and the wire used to connect them are inserted into holes that are arranged in a grid pattern on the surface of the breadboard.**
- **A series of internal metal strips serve as jumper wires. They connect specific rows of holes.**



Breadboard use (2/5)



Breadboard use (3/5)

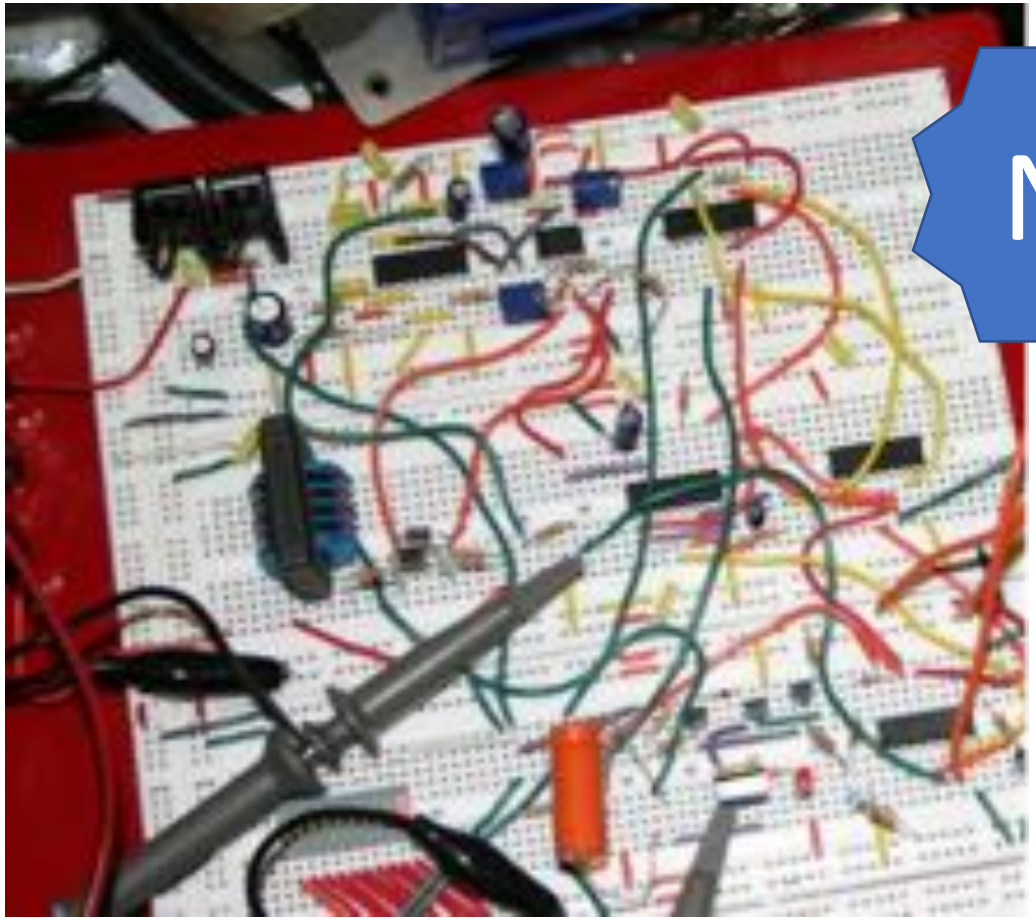


Breadboard use (4/5)

- **Correct use of the Breadboard**

  The components must be arranged according to an ordered pattern, so that they can be easily removed without unmake the circuit. The components must be inserted respecting the perpendiculars.

Breadboard use (5/5)



Electrical Power (1/2)

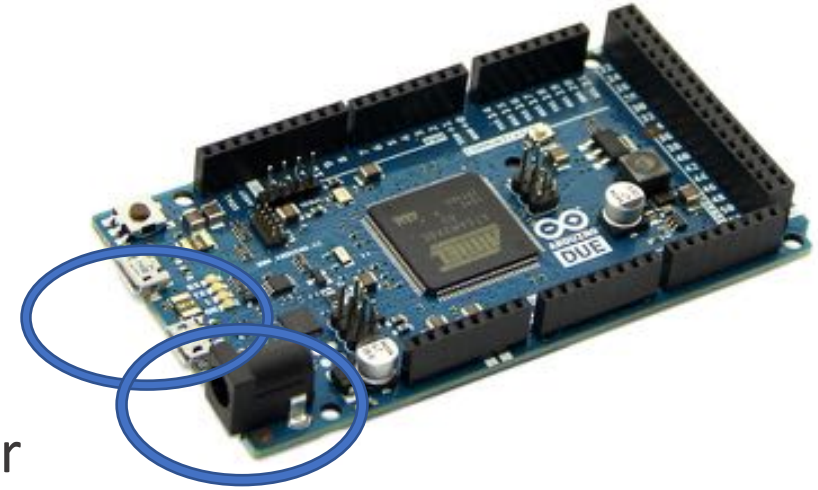
- **Power for electronic device**
  - To turn on any electronic device, you need to connect to both the + and the – ends of the power source
  - Use wires to connect between the power source and your device
  - One main cause of destroying your circuit is reversing the + and the – ends

Electrical Power (2/2)

- **Power TO Arduino**
  - You can either plug in a 9V adapter or a USB cable from a computer to the Arduino to provide power to the Arduino

USB

9V Adapter



Electrical Power

- **Power FROM Arduino**
  - Unlike most Arduino boards, the Arduino Due board runs at 3.3V. The maximum voltage that the I/O pins can tolerate is 3.3V. Applying voltages higher than 3.3V to any I/O pin could damage the board.

Multimeter use (1/3)

Multimeter use (2/3)

Front Panel Symbols

Symbol	Meaning
V ⎓	V DC
V ∿	V AC
mV	millivolts (.001V or 1/1,000V)
A	Amps
mA	milliamps (.001A or 1/1000A)
µA	microA (.000001A or 1/1,000,000A)
Ω	Resistance (Ohms)
kΩ , MΩ	kilo-Ohms, Megohms
))))	Continuity beeper

Multimeter use (3/3)

Front Panel Symbols

Symbol	Meaning
⊣⊢	Capacitance (uF: Microfarads) (nF: Nanofarads)
⊣▶⊢	Diode test
Hz	Hertz (cycles/sec)
REL Δ	Relative or offset reading
Range	Manual override of autorange
Hold H	Touch Hold-last stable reading
MIN MAX	Highest, lowest recorded readings
ϟ	Dangerous voltage levels
⚠	Caution: see manual