

Sensors, Displays & Actuators

Developing and Designing Interactive Devices
September 17, 2019

Lab debrief

Highlights? Questions?

Show examples
of cool labs



Pekopa

Input Output

Buttons

Displays (LEDs,
screens, sound)

Sensors

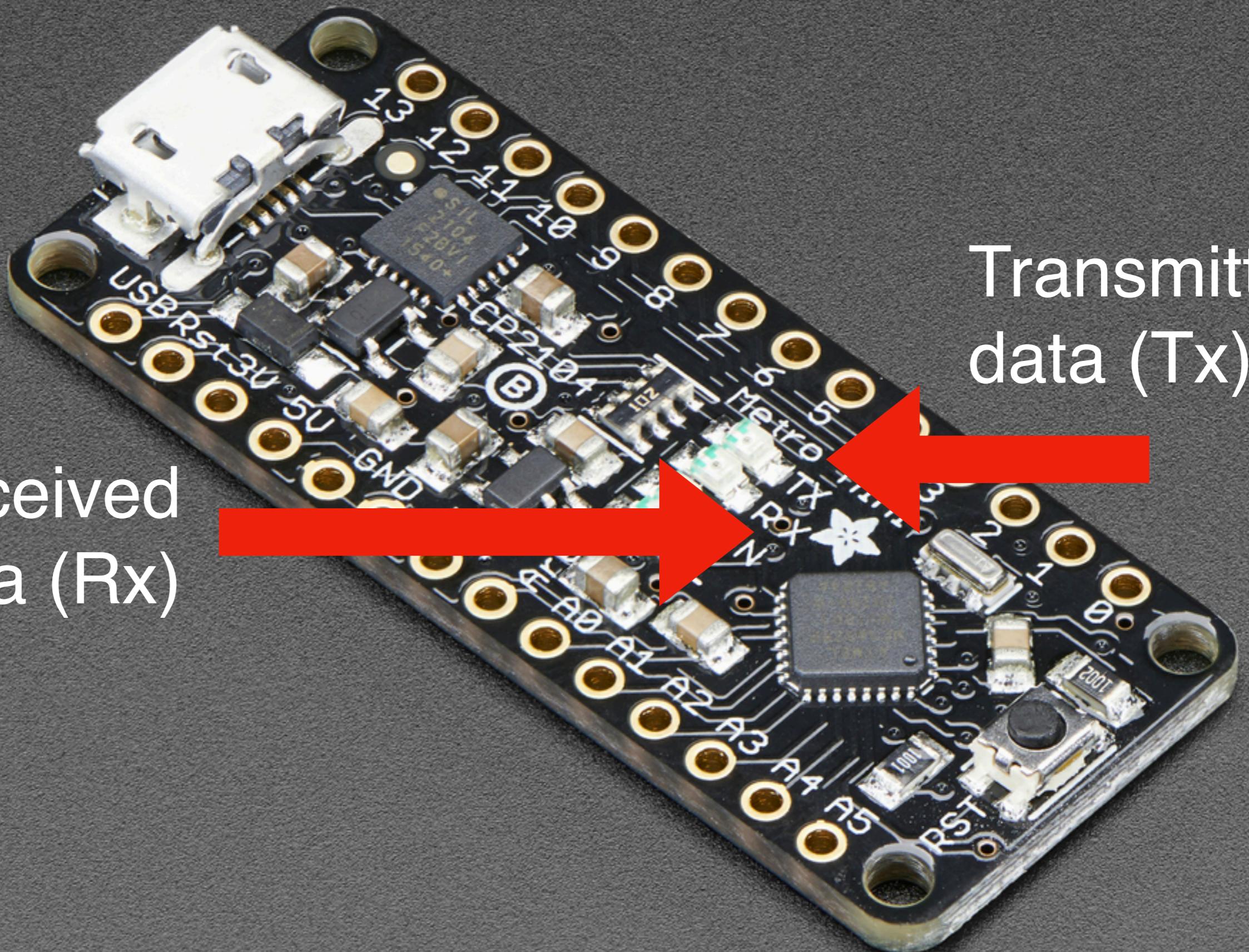
Actuators (motors,
valves, solenoids)

Received data (Rx)

Transmitted data (Tx)

Received
data (Rx)

Transmitted
data (Tx)

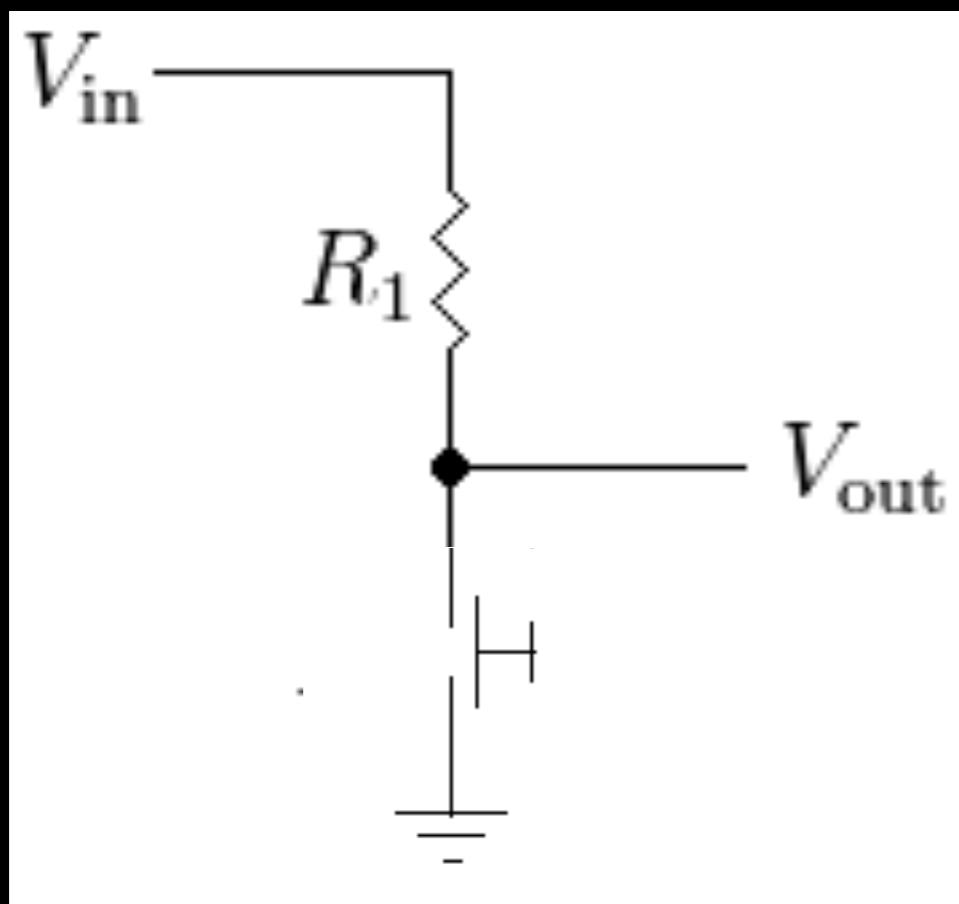


Sensors

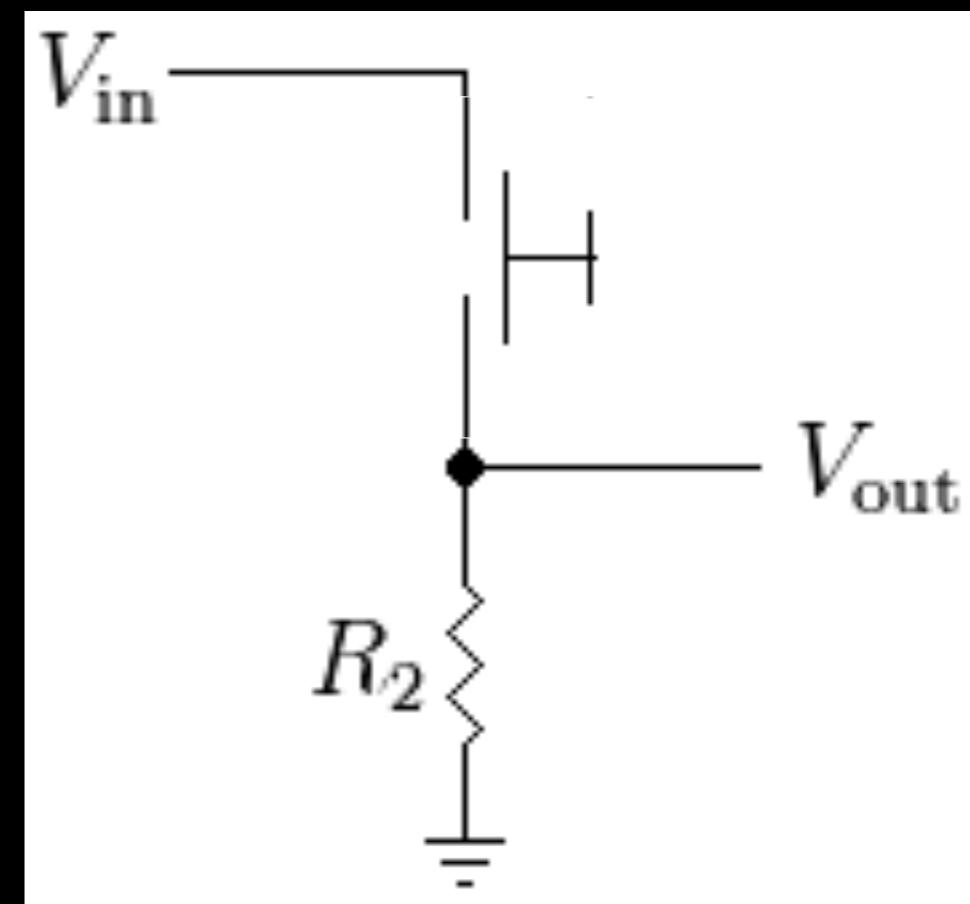
Sensors convert phenomenon in the world into signals that can be used in an electrical circuit

Button is a sensor

Pull up



Pull down

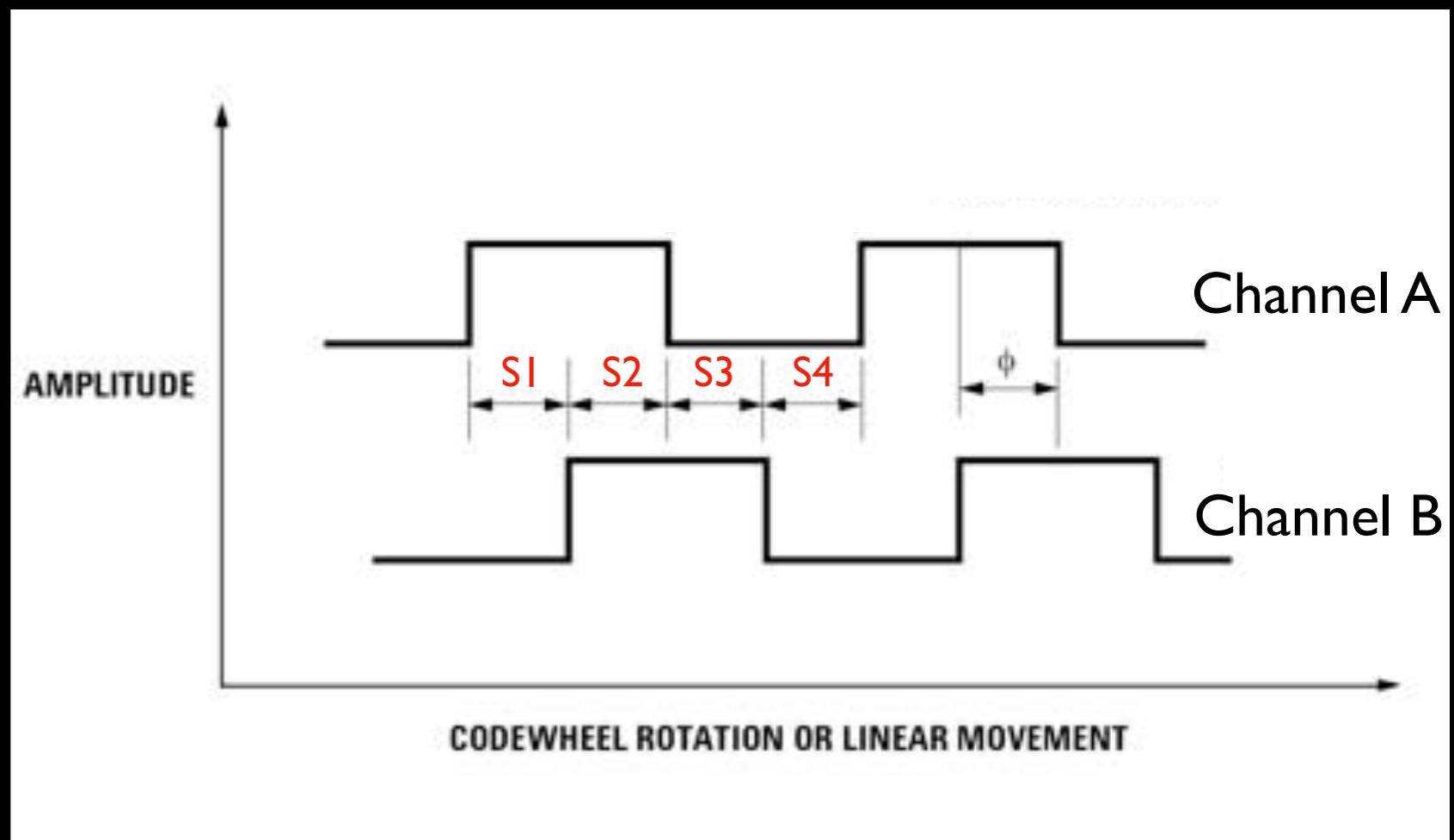


Rotary Encoder

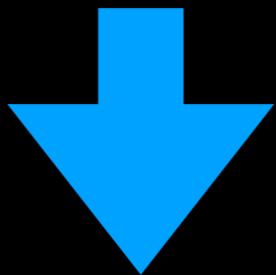


Sensors

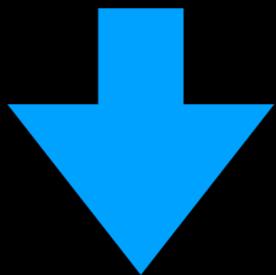
Time/Count varying sensors



Order of channel states

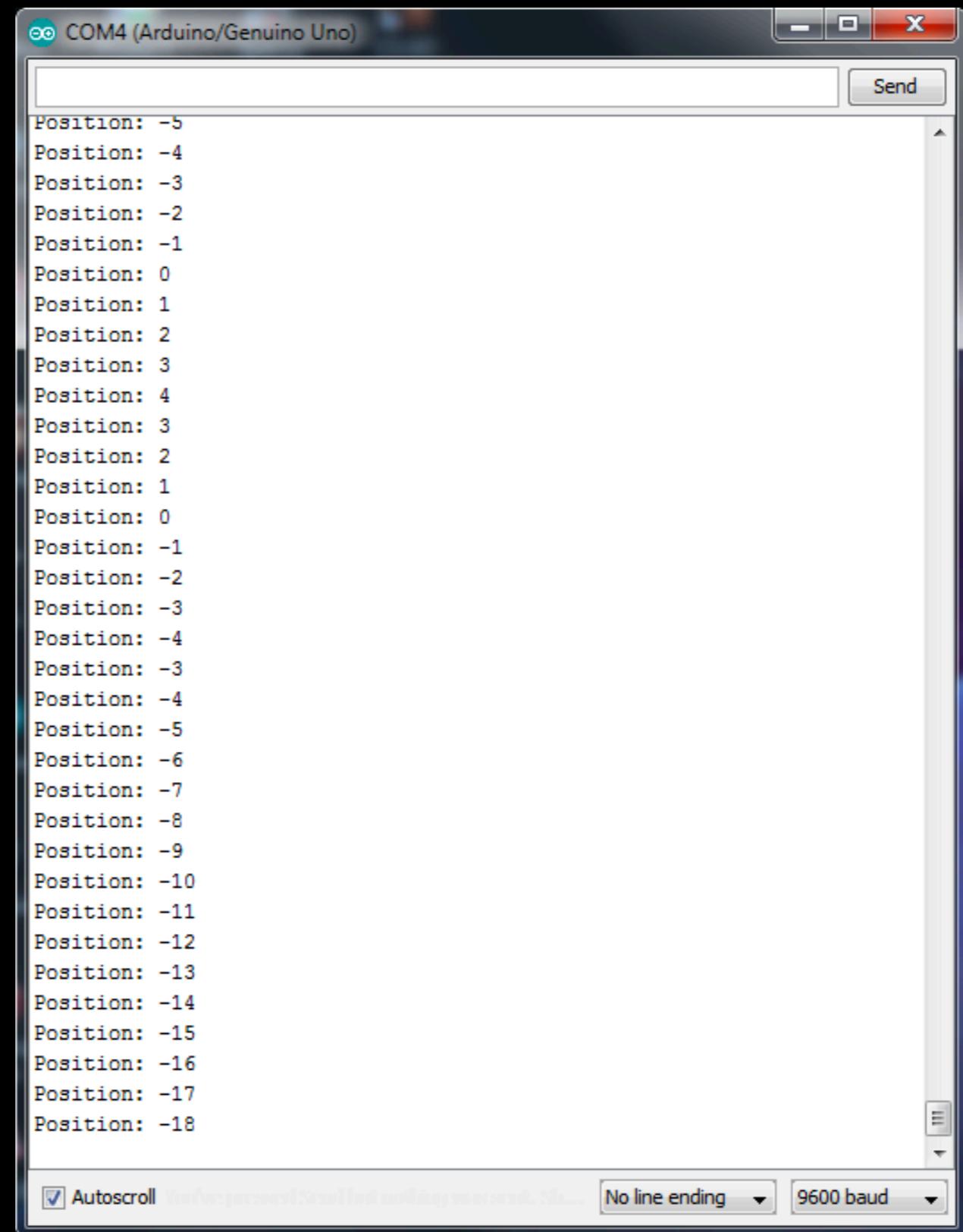


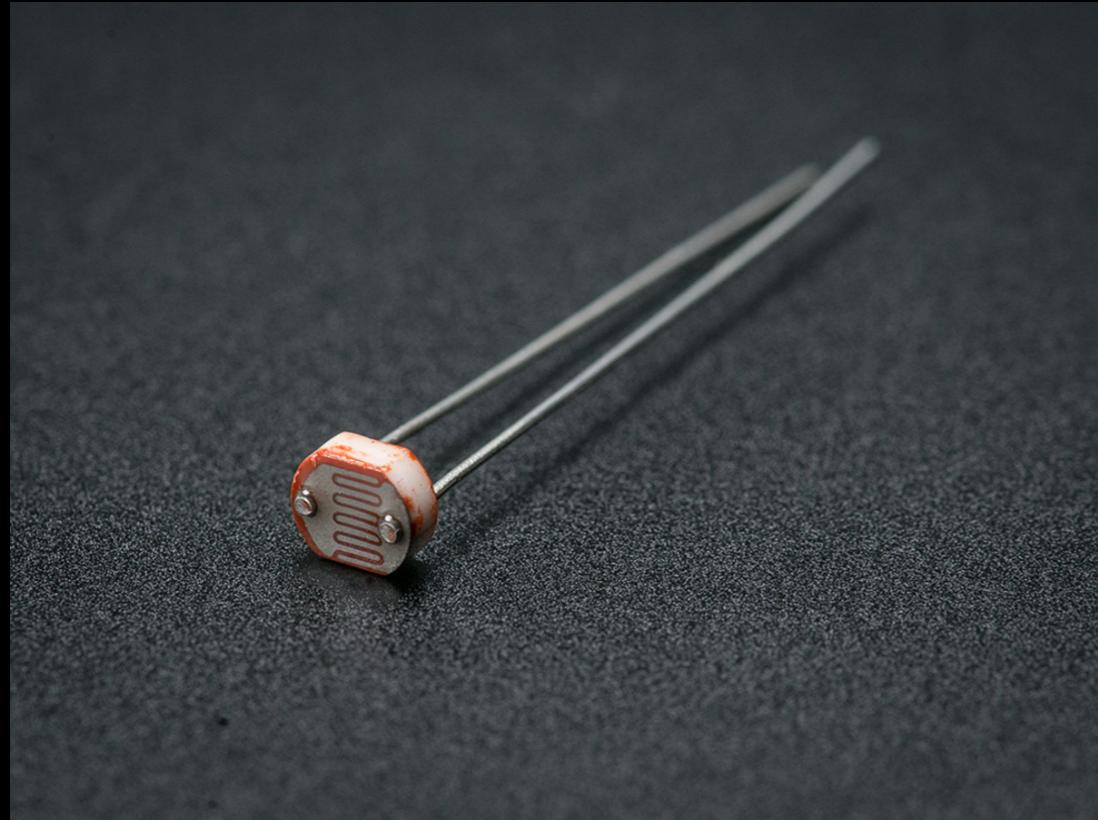
Tells the computer clockwise vs. counter-clockwise



We can see direction of counting in serial monitor

Serial Monitor





Sensors

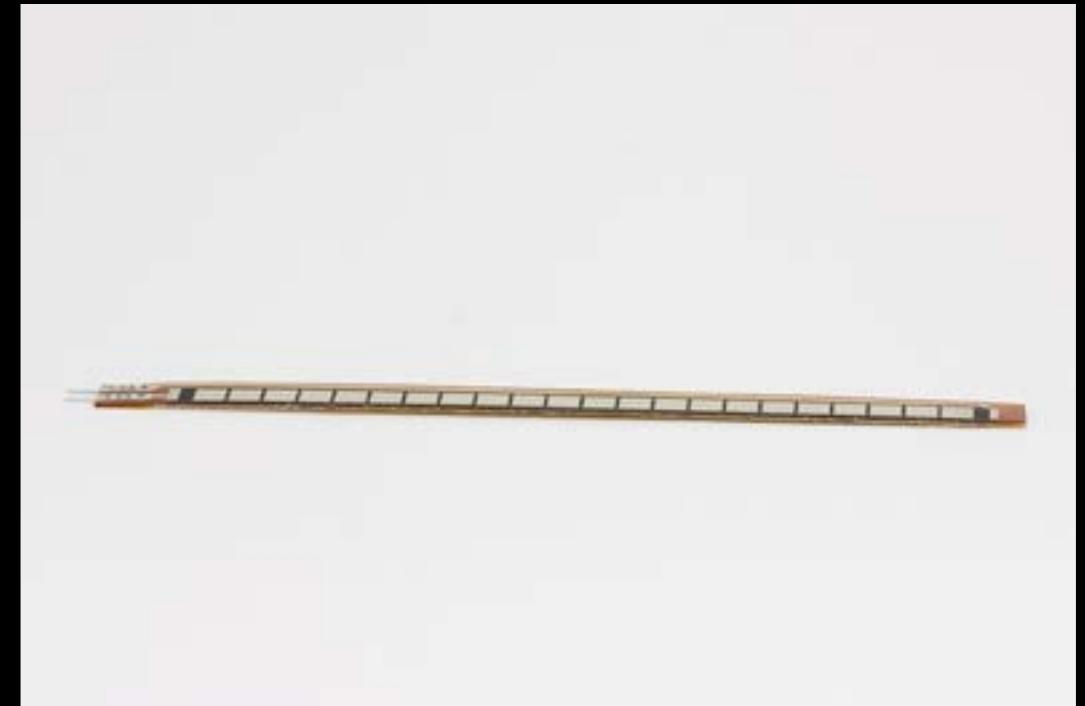
Resistance varying sensors

Photosensitive resistor



Force-Sensitive Resistor

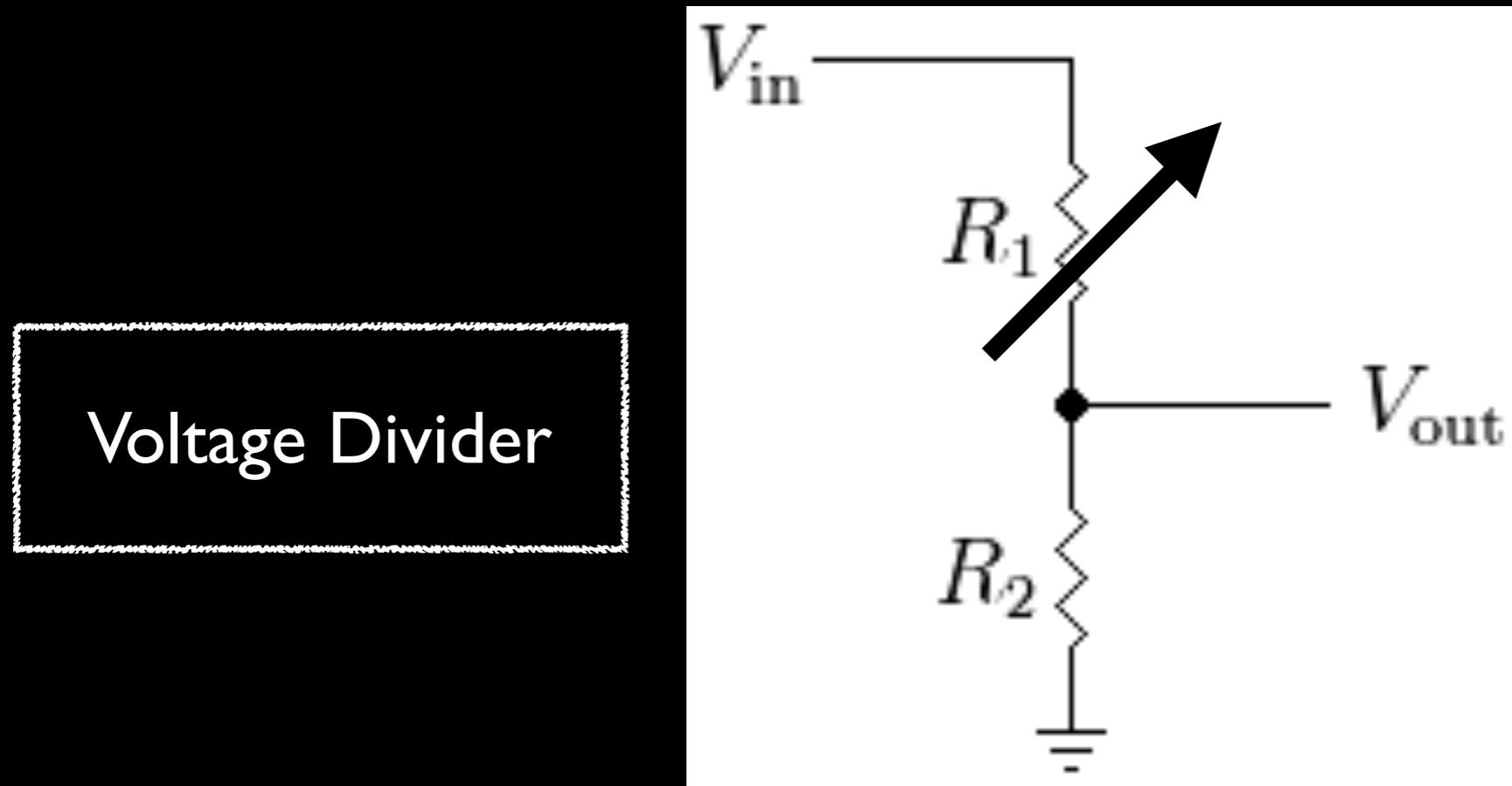
Image from Adafruit



Flex Sensors

Sensors

Resistance varying sensors

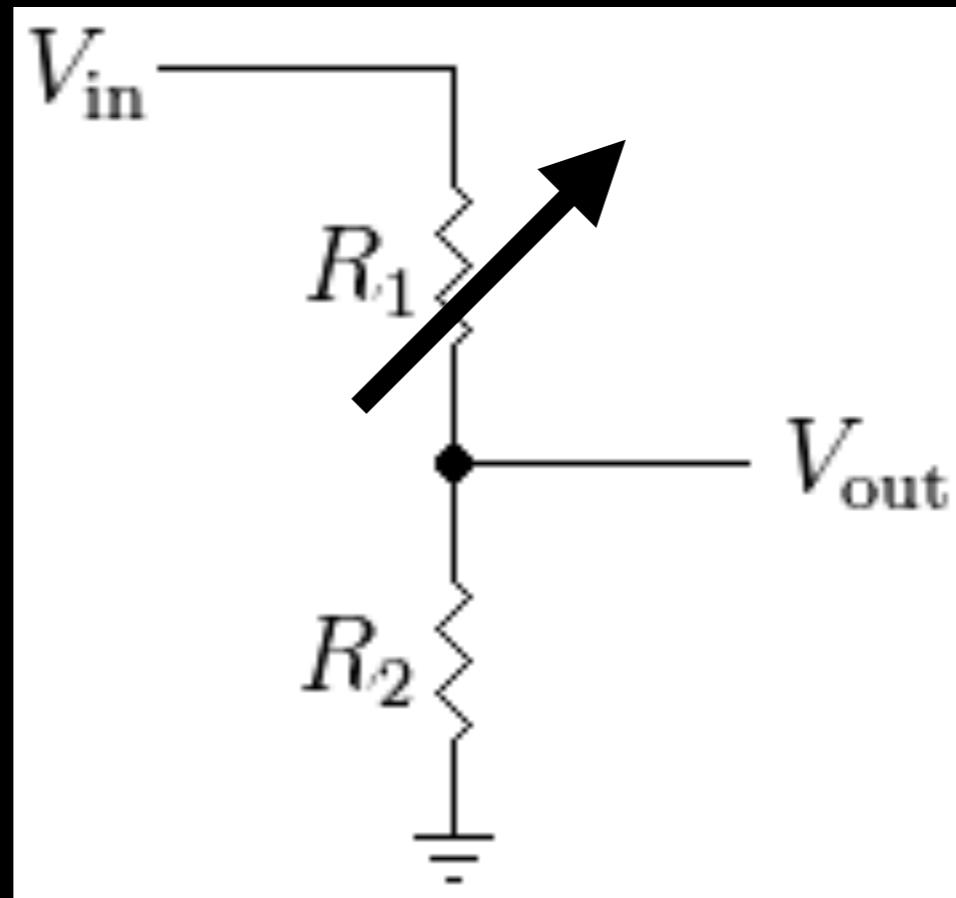


Voltage Divider

= Variable

Sensors

Resistance varying sensors



Voltage dividers:
helps us to reliably
measure the resistance

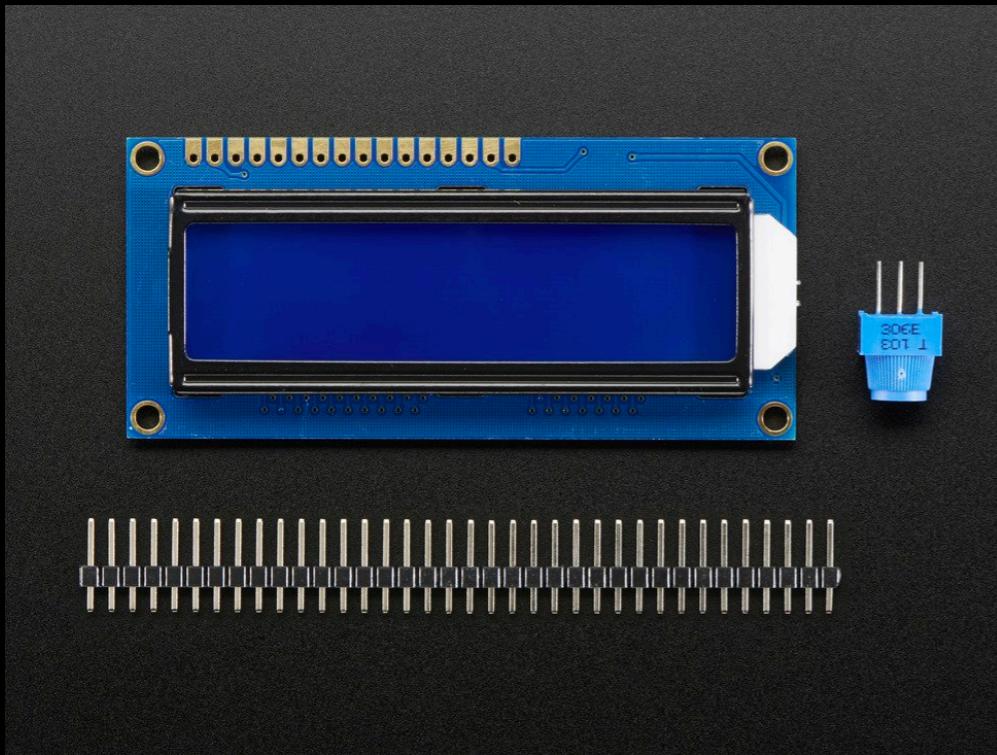
$$V_{out} = V_{in} \cdot \frac{R_2}{R_1 + R_2}$$

Where do we get cool
sensors, displays and
actuators?

Tinkersphere (152 Allen St.)

Adafruit
Sparkfun
Jameco
Mouser
Digikey

Displays Variations

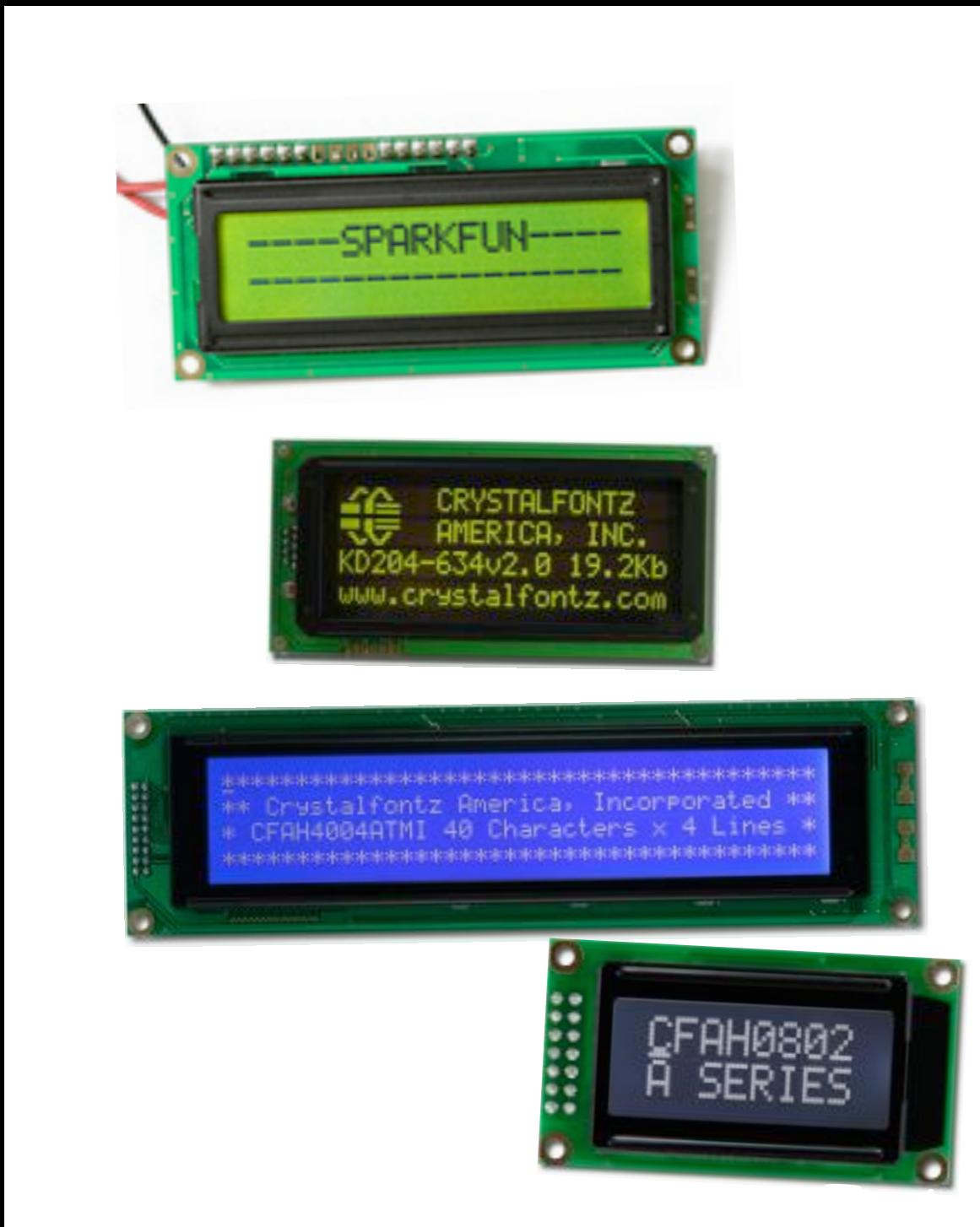


LCD

Speaker

Displays

Character displays



Variations:

- dimensions
- # columns and rows
- Colors
- Voltages
- Backlight
- HD44780 compatibility
- Control interfaces
(parallel v. serial)

Image from Sparkfun

Displays

Graphical displays

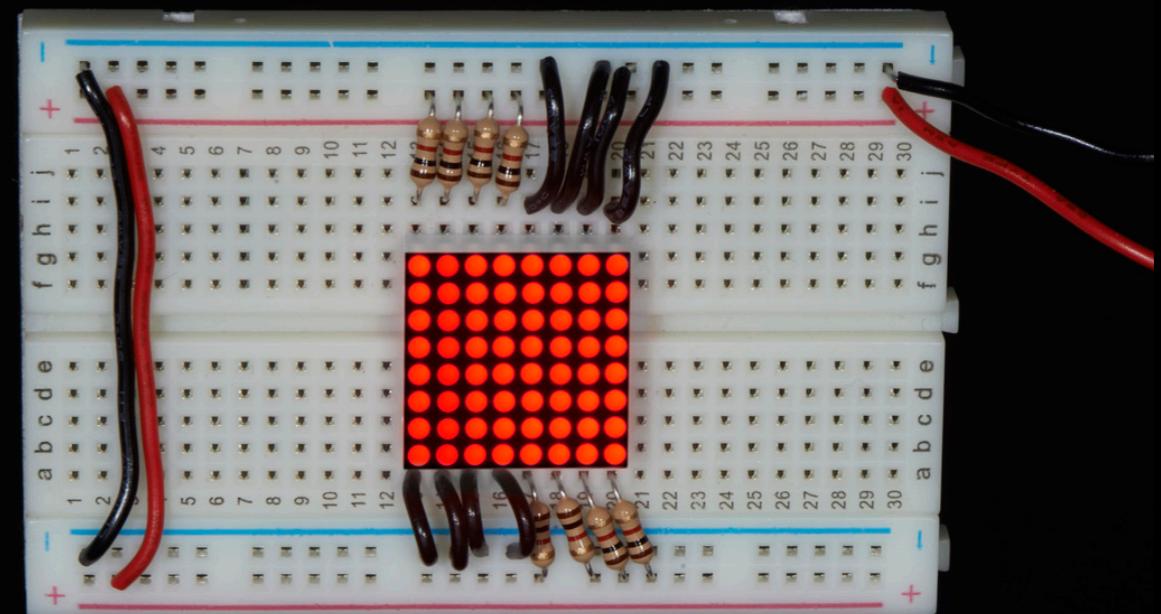
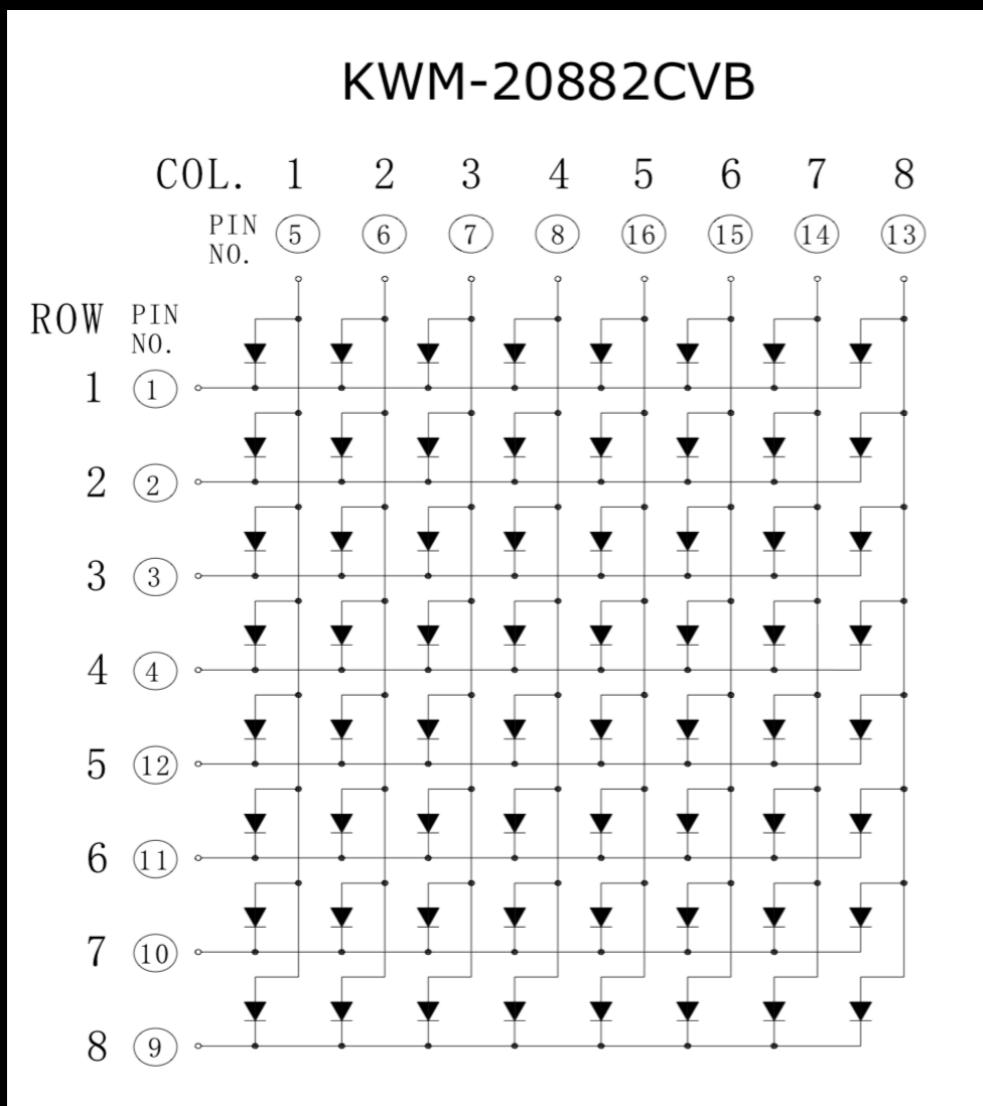
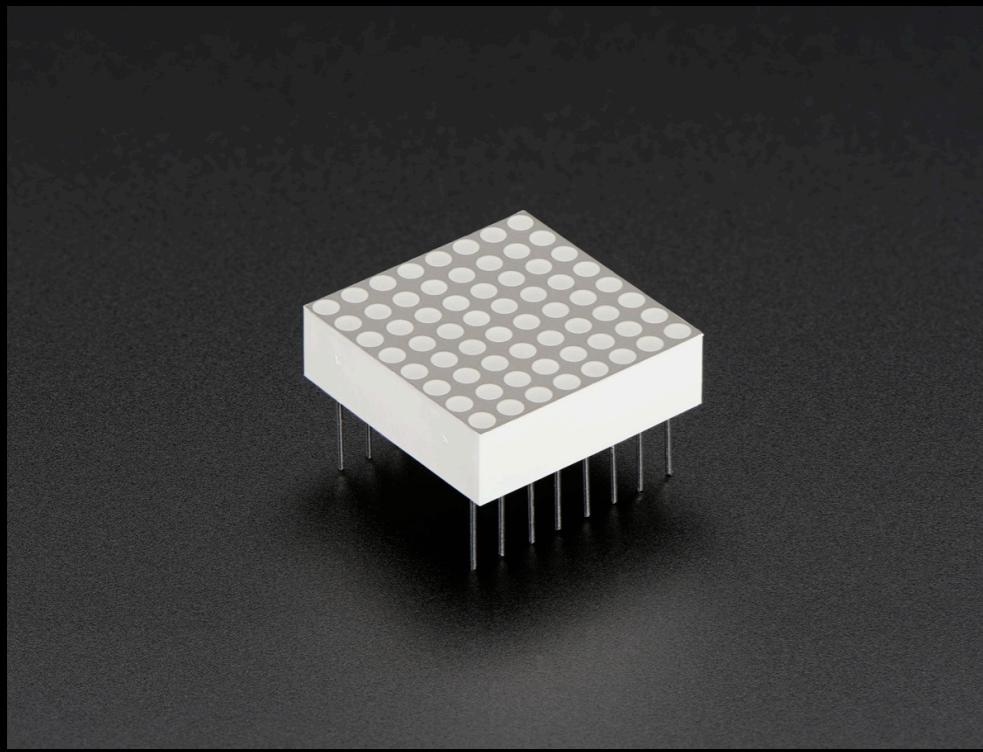


- Variations:
 - dimensions
 - pixel width & height
 - LCD v. OLED
- Voltages
- Backlight
- Color
- Control interfaces

Image from Sparkfun, Crystalfontz

Displays

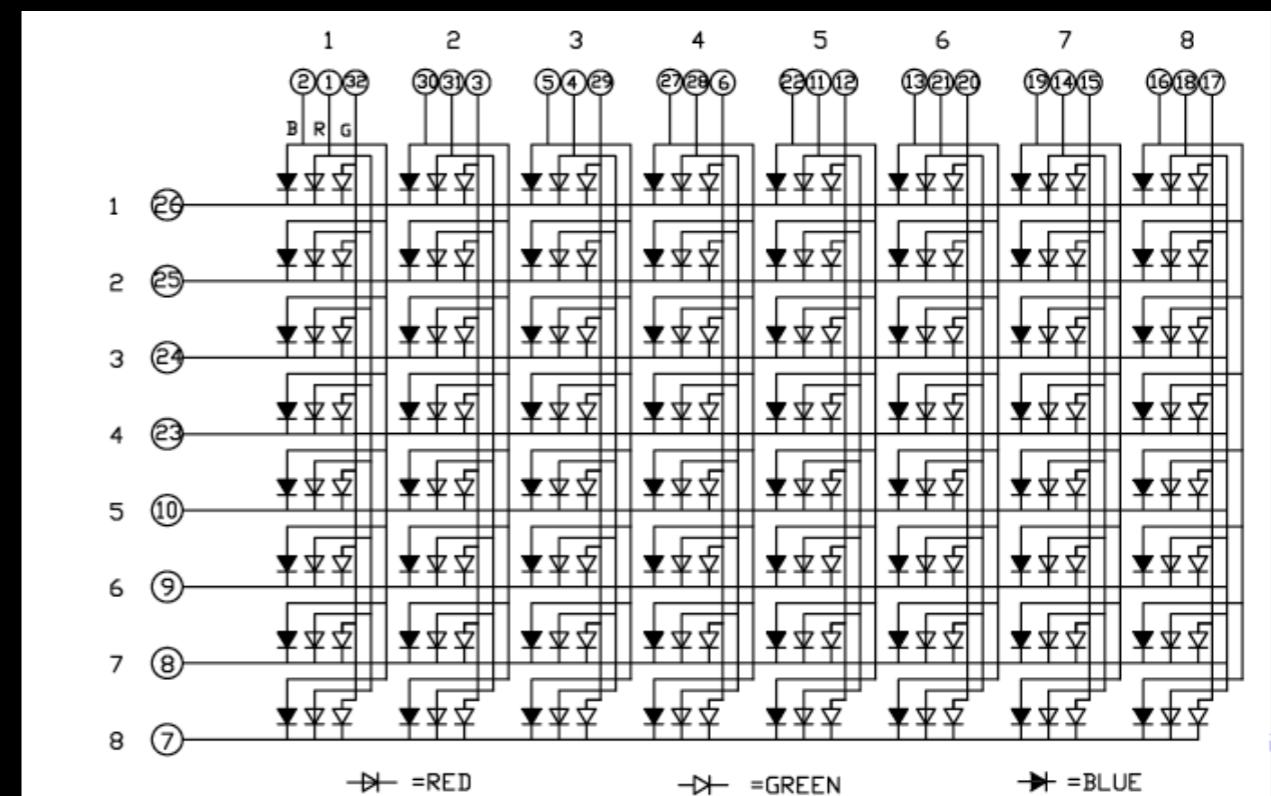
Variations on LEDs



Images from Adafruit

Displays

Variations on LEDs (RGB LEDs)

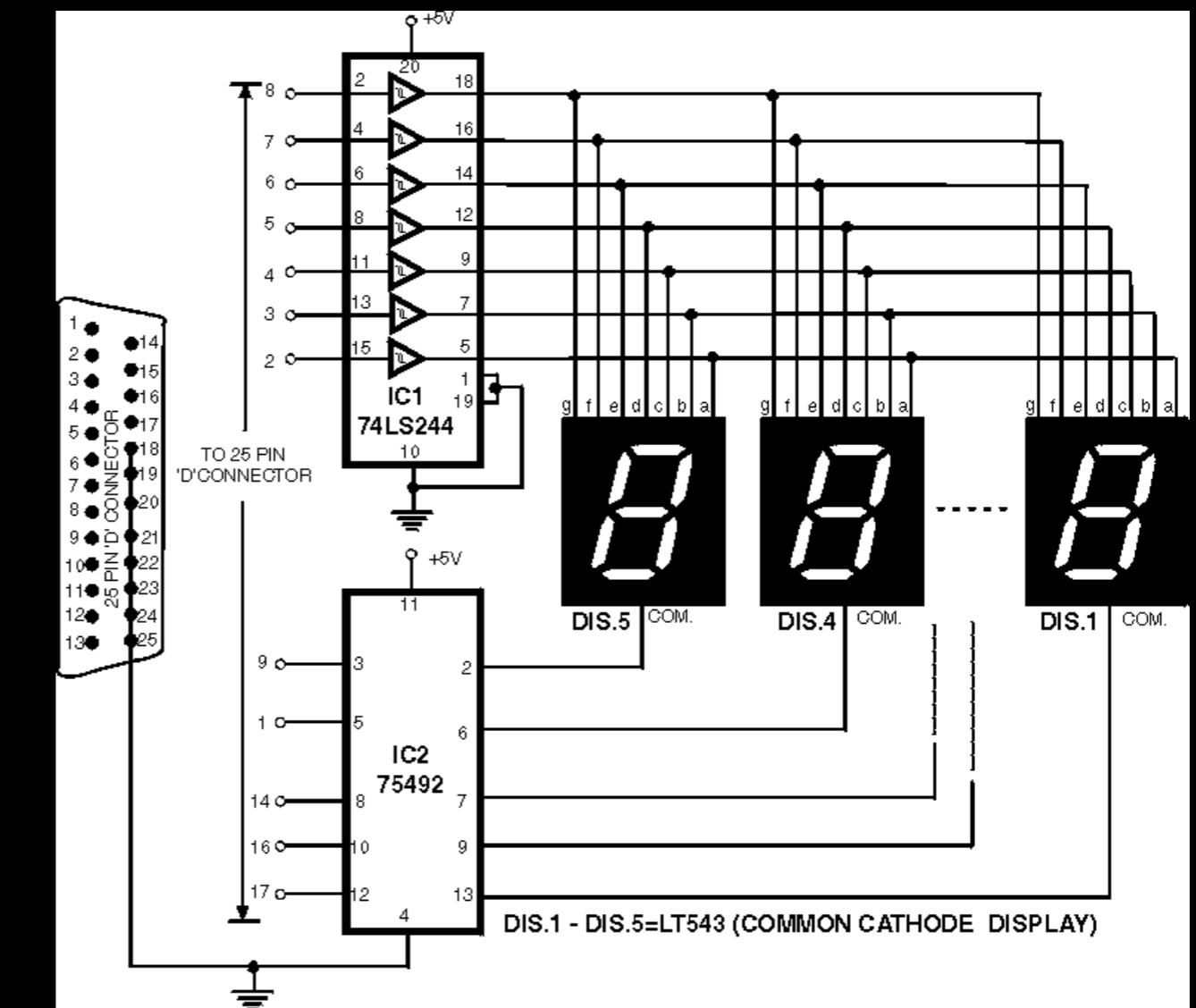
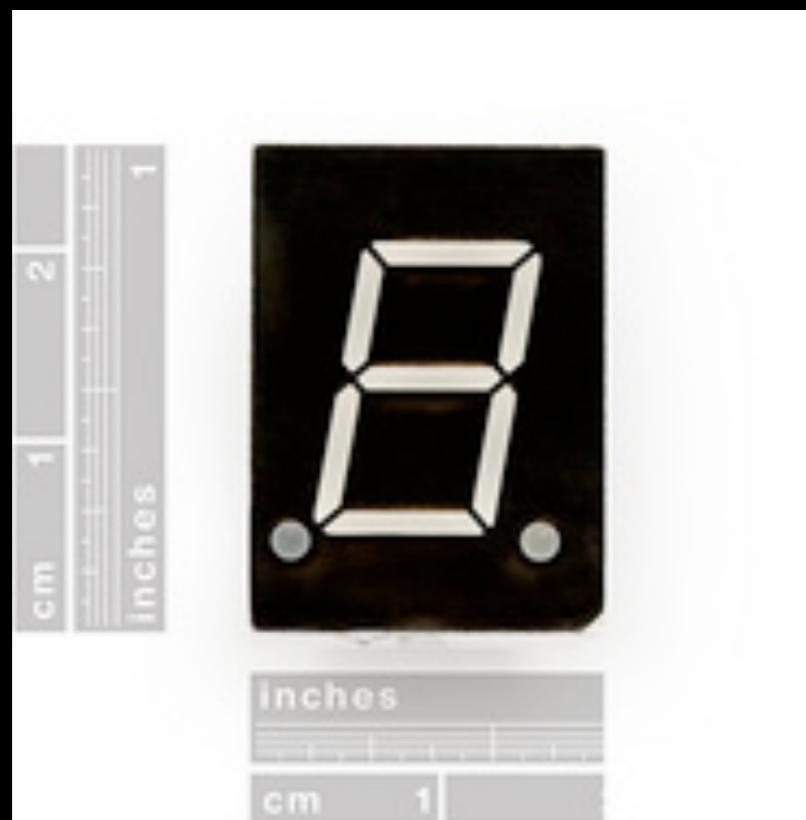


Images from Adafruit

Displays

Variations on LEDs

Segment LEDs



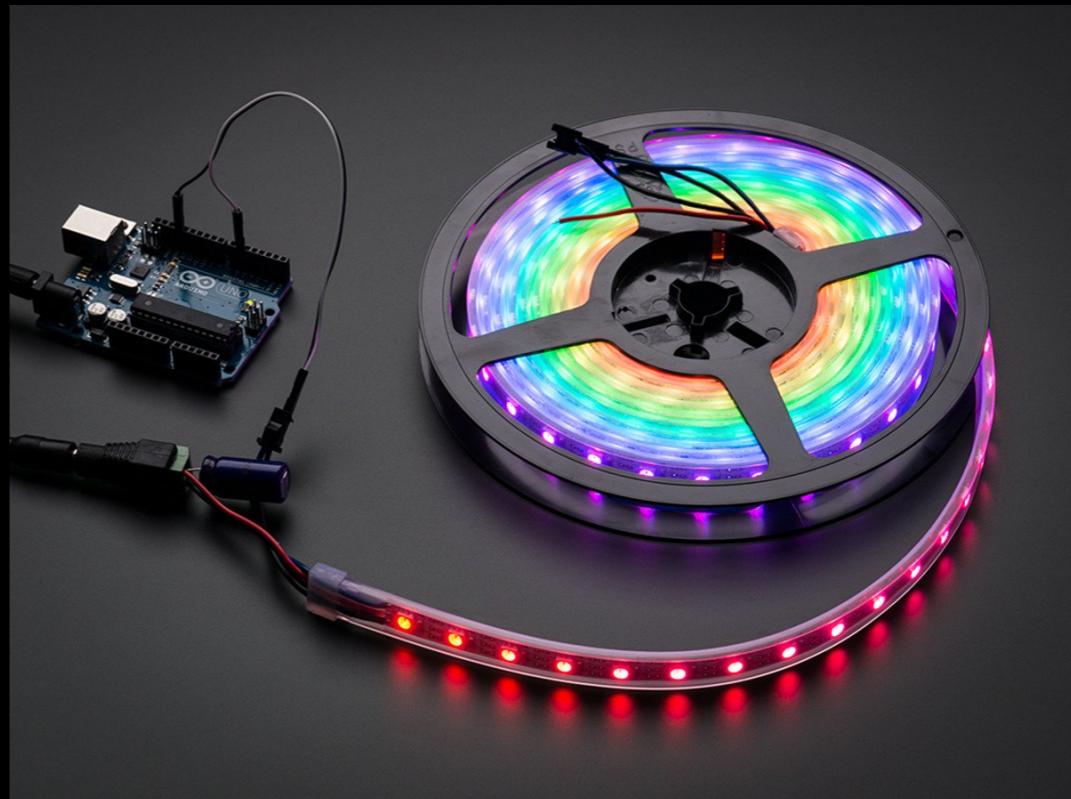
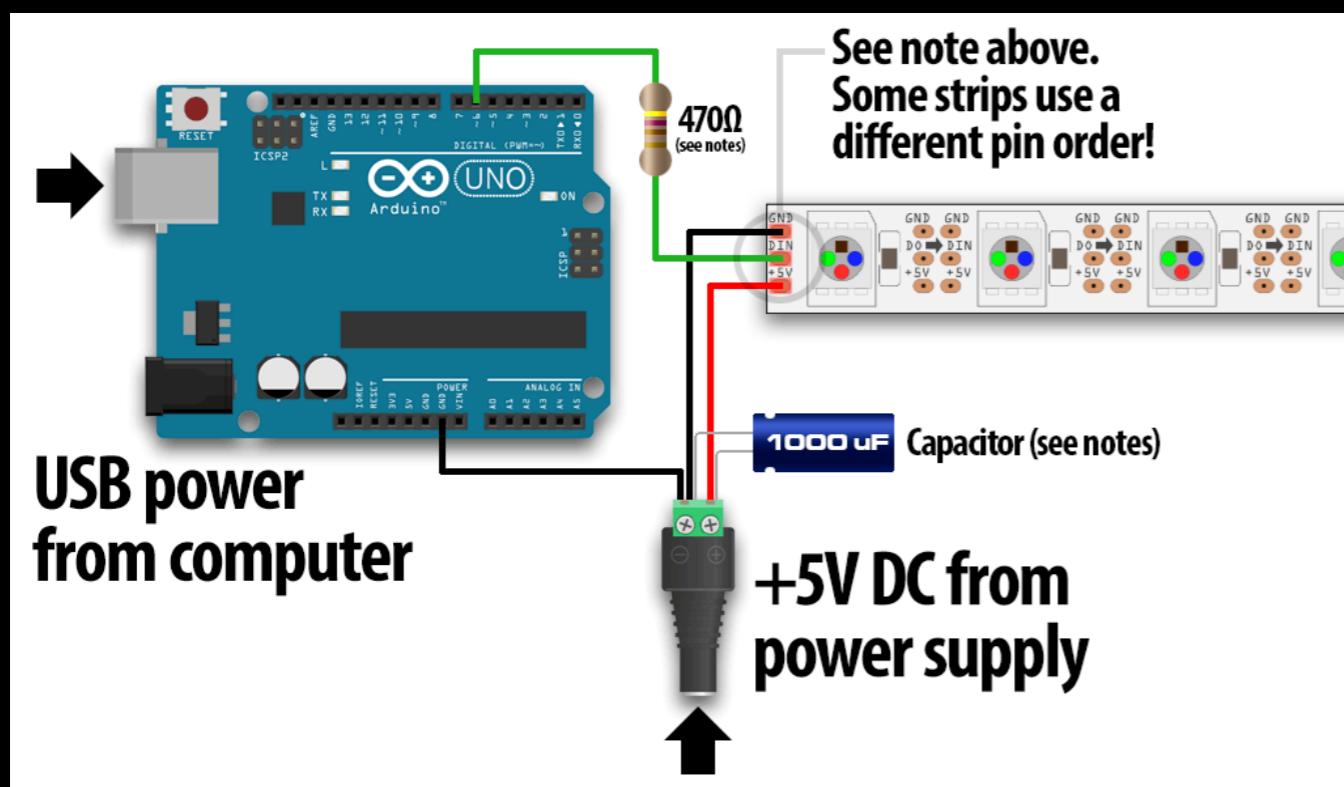
Images from Adafruit

Displays

Addressable smart LEDs



RGB LEDs with driver chip (WS2812), on a bus, controlled with 1 I/O wire. Neopixel is Adafruit's brandname for theirs.



Images from Sparkfun, Adafruit

Actuators

Variations

An actuator is a mechanical device for moving or controlling a mechanism or system.

Motors (i.e. servo)

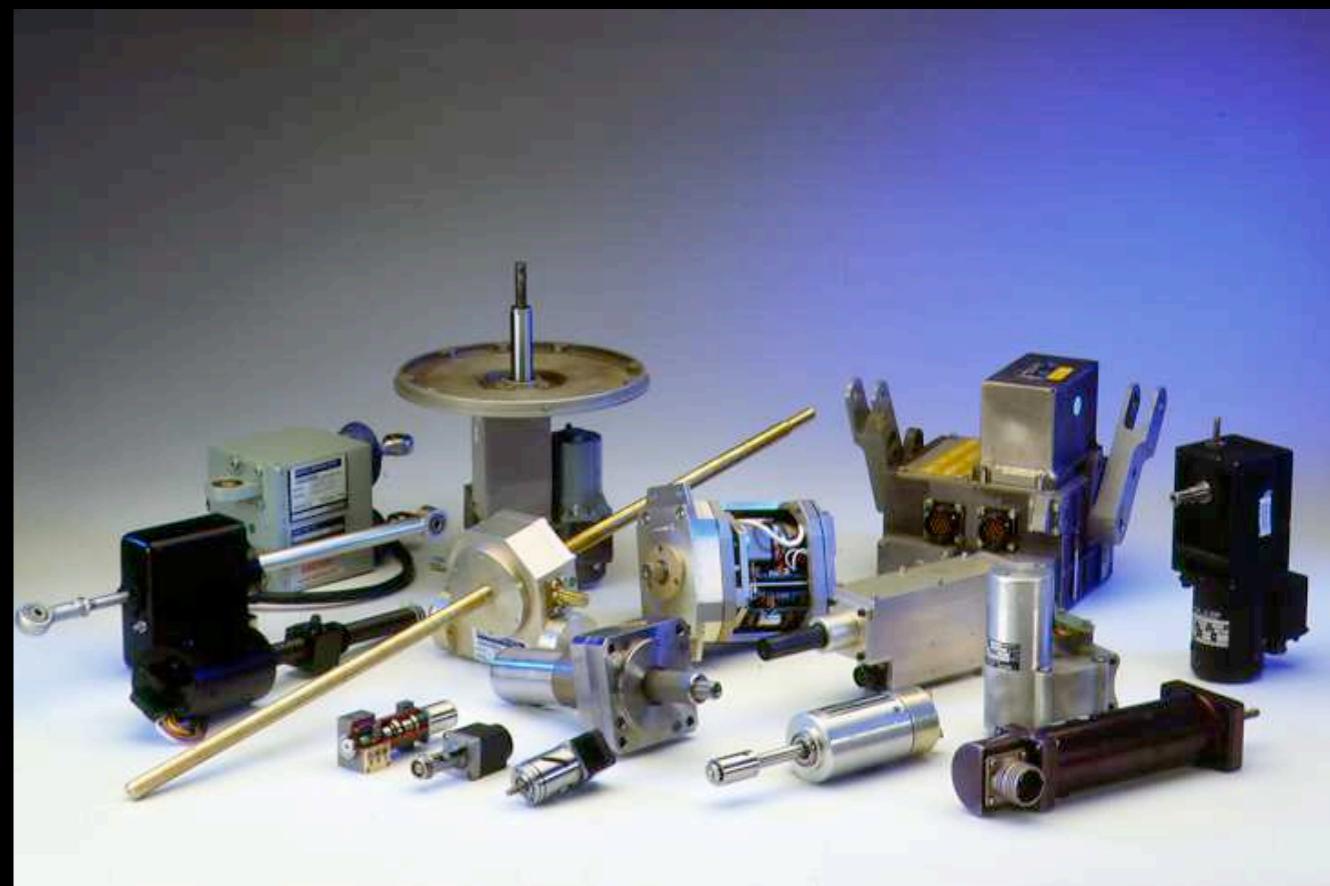
Solenoids (i.e. electric door)

Clutches (i.e. chainsaw)

Pneumatics (i.e. leaf blower)

Hydraulics (i.e. crane)

Piezoelectrics (i.e. speakers)



Actuators

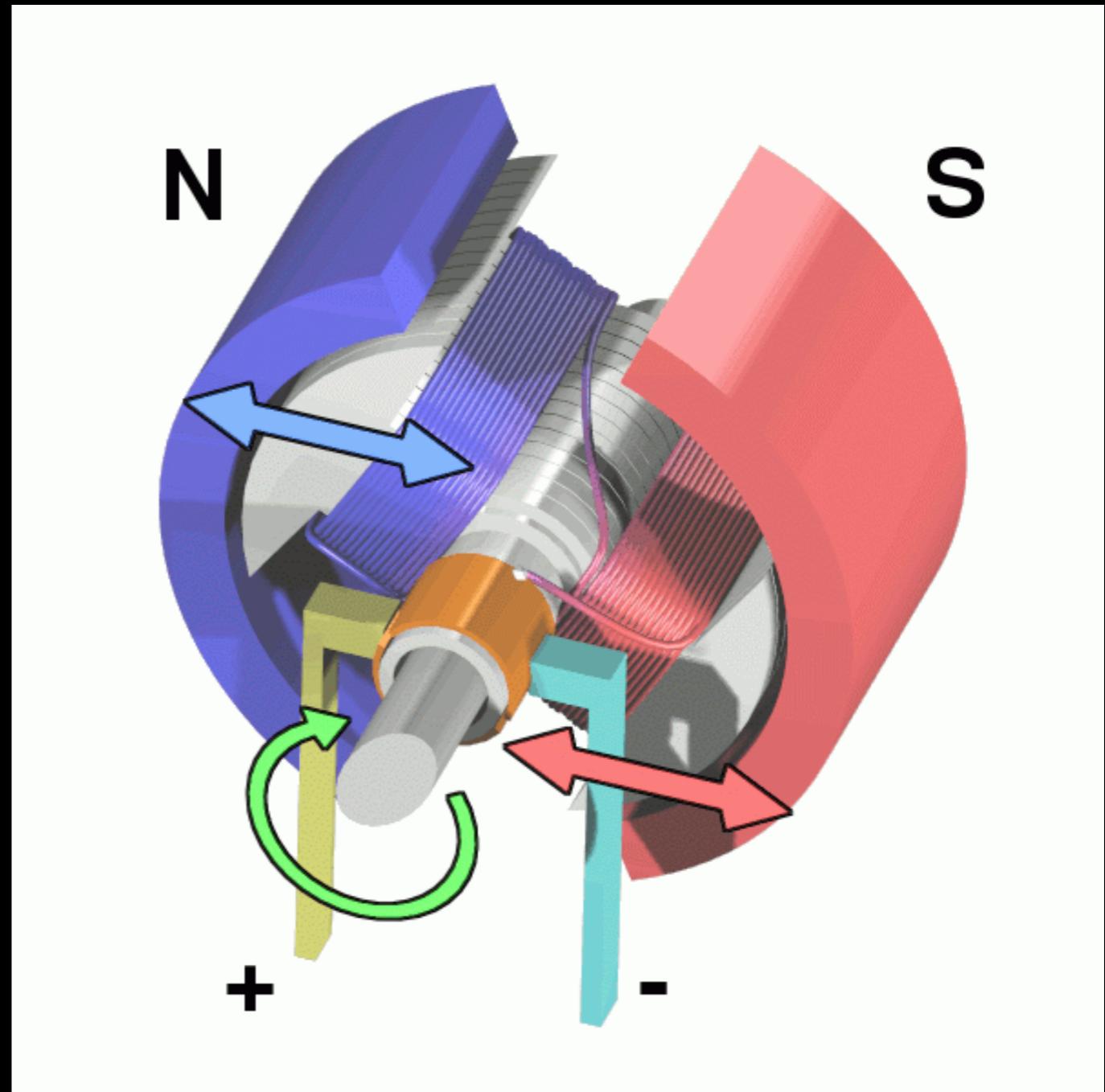
You've used one!

A speaker is an actuator that converts electrical frequencies into sound.

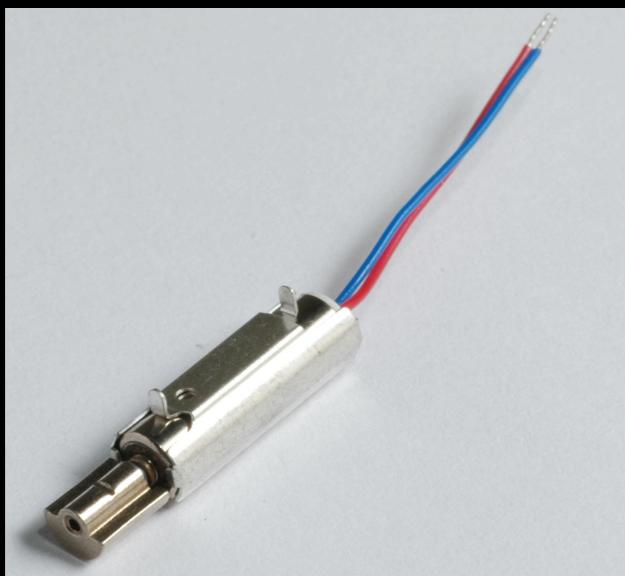
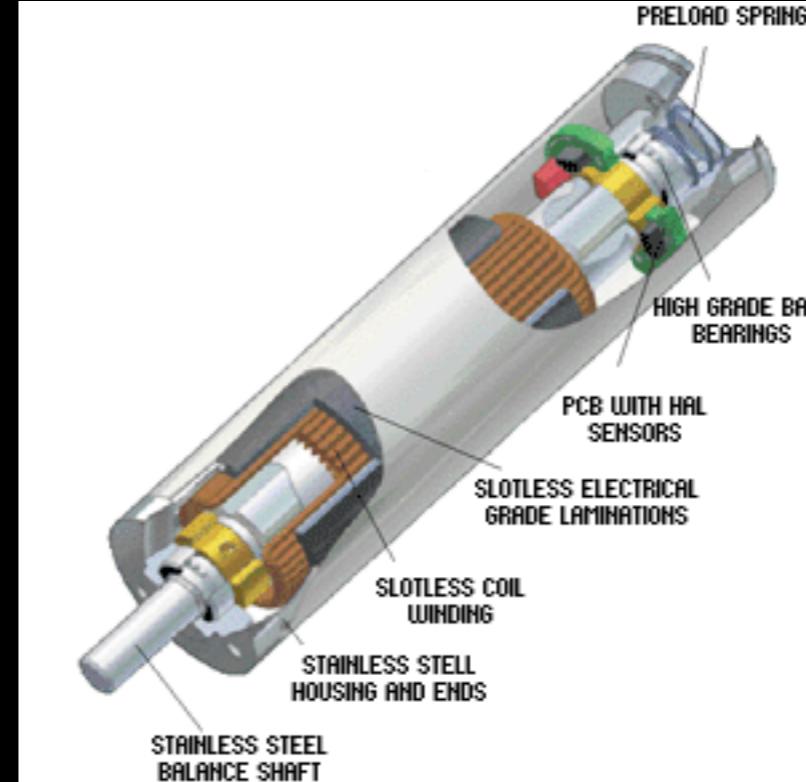
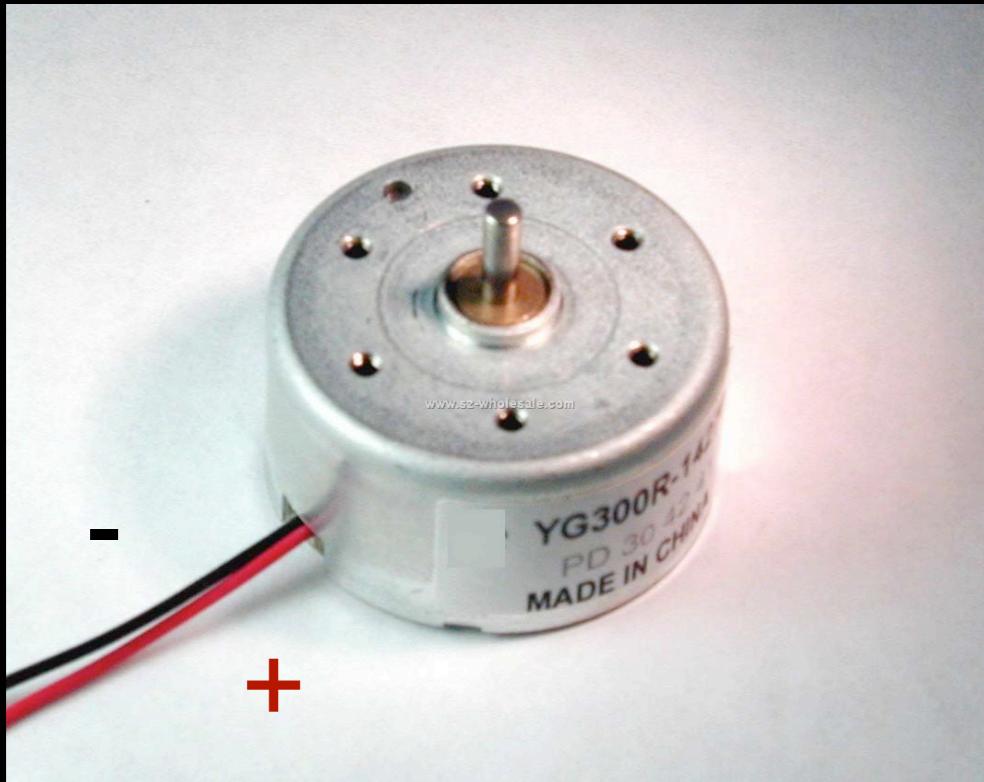


Motor

An electric motor is an electrical machine that converts electrical energy into mechanical energy.



Actuators DC Motors



Switch colors to spin other direction

Actuators

Coin Cell Vibration Motor

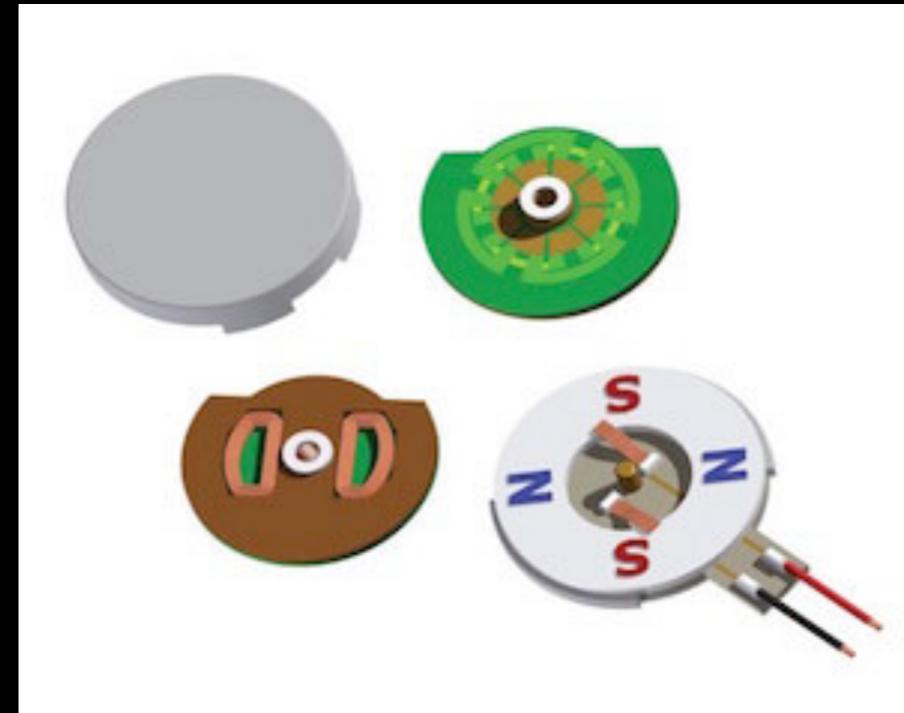
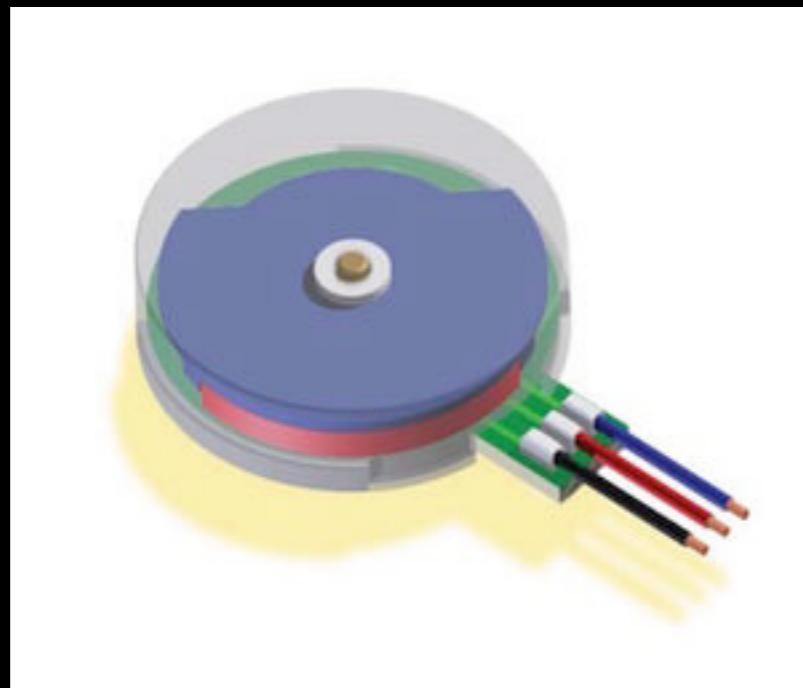
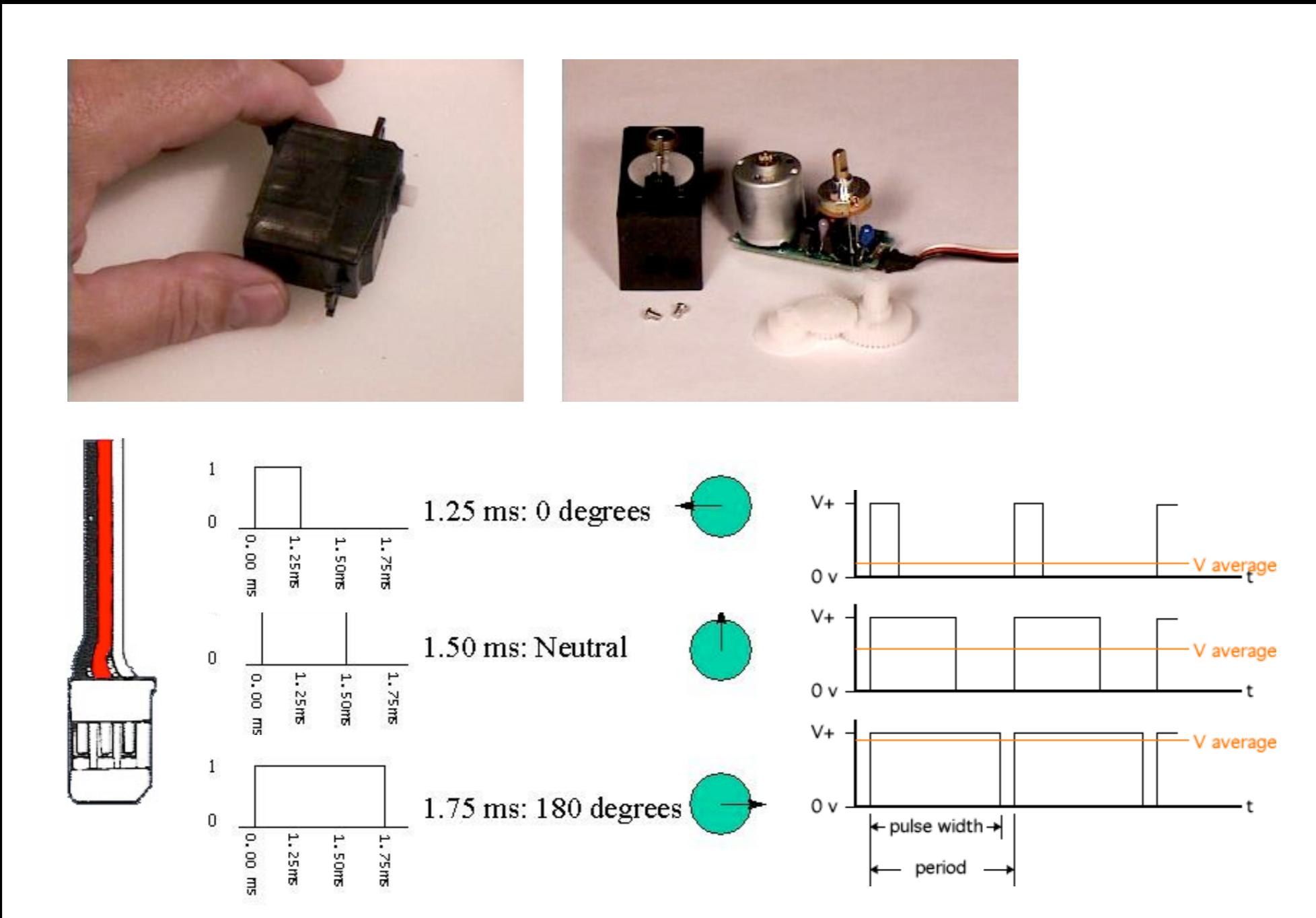


Image from <http://www.nfpmotor.com/products-coin-vibration-motors.html>

Actuators

Servo Motors



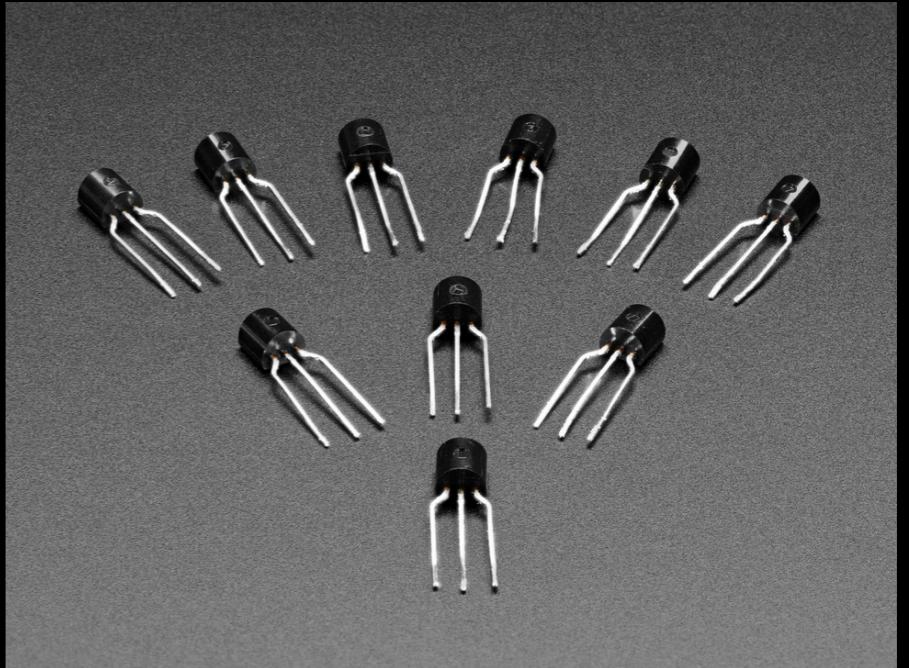
The motor angle is changed depending on width of the PWM

Transistors

What would I use a transistor for?

For amplifying current

For switching current



THE CLAPPER®

CLAP ON! CLAP OFF!

The Sound
Activated
On/Off
Switch

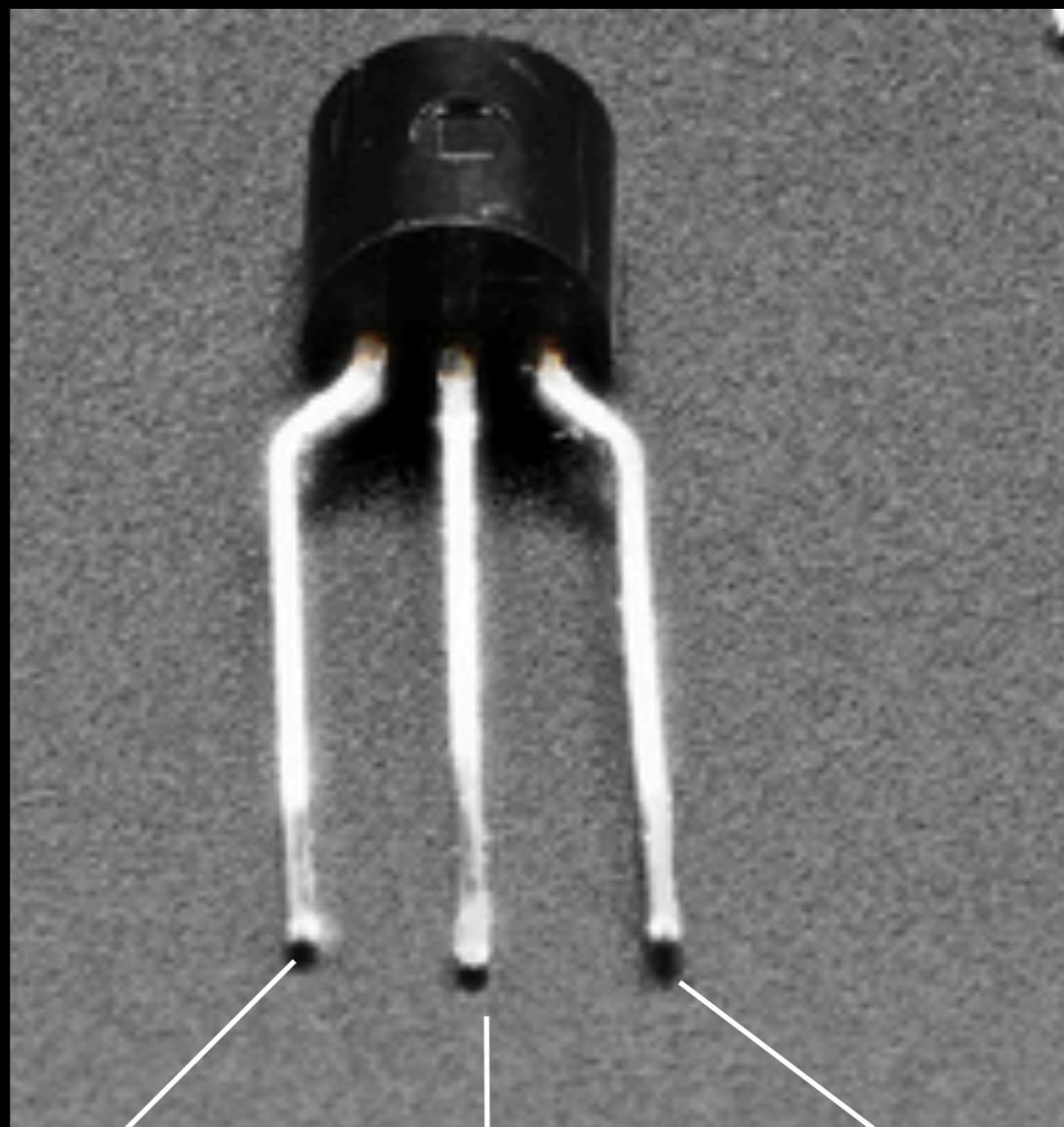


Control your lamps



Control your TV

Transistor



Emitter

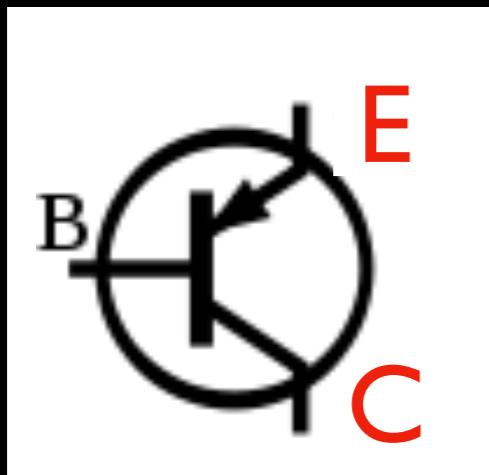
Base

Collector

Transistors

BJTs (Bi-Polar Junction): NPN or PNP?

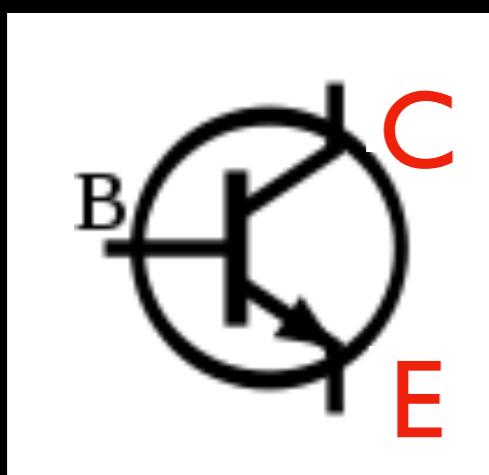
PNP: Pointing In Proudly



If base is at lower voltage than emitter, current flows from E to C

- Small amount of current also flows from E to B (sink current)

NPN: Not Pointing In



If base is at higher voltage than emitter, current flows from C to E

- Small amount of current also flows from B to E (source current)

Current is always flowing from high to low

Transistors

Darlington transistors

Allow higher gain

A little slow

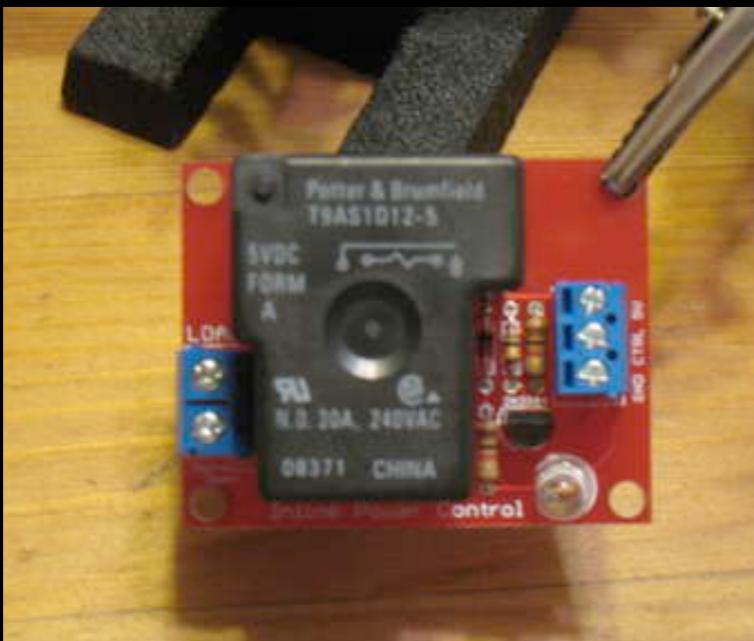
Common ones to use:

ULN2003 for LED arrays, relays, printer hammers

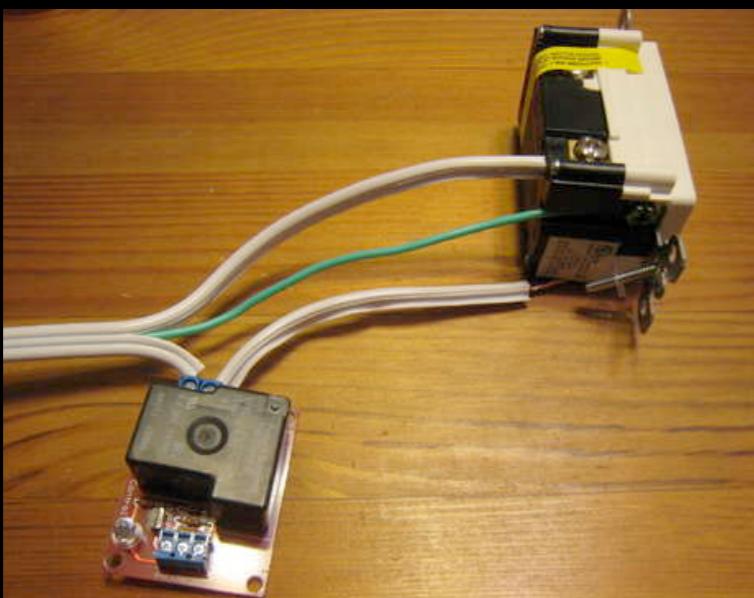
TIP120 for motors, incandescent lamps

Relays

Good if you're controlling an AC device!



Here, Sparkfun board for SPST relay capable of switching 220VAC@30A



In general, relays are like electronically controlled switches

This week's Lab

Looking ahead
Data Logger, and using cool sensors!