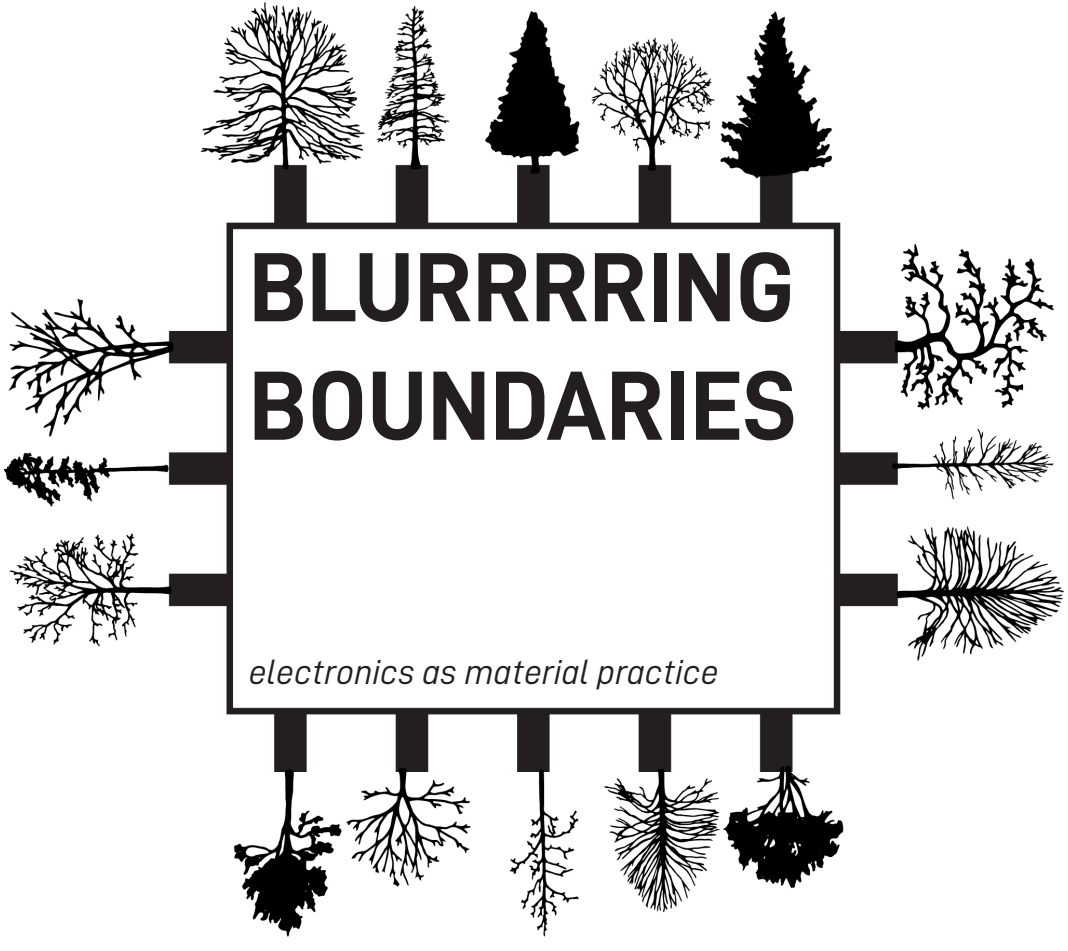
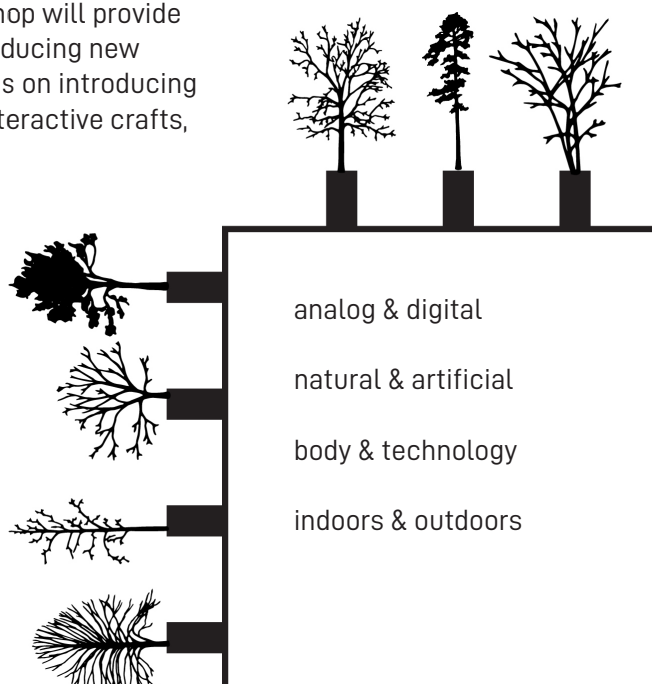

BLURRRRING
BOUNDARIES
electronics as material practice

Blurring Boundaries

Electronics as Material Practice

Electricity does not have to be cased up inside slick metal enclosures; we can also let it flow through painted pine-cones, carved traces, and the water in our bodies. The segregation of our abilities into discrete disciplines leaves gray areas to be explored and missing links to be made. This workshop will provide you with a time and place to disrupt your own practice by introducing new materials, tools, techniques, and places of making. With a focus on introducing electricity as a material property that can be used to create interactive crafts, this workshop will attempt to blur the boundaries between:



Shakerag
Session Two - June 9-15, 2019
shakerag.org

Hannah Perner-Wilson
James Goedert
Tess Cortes, Jackie Donovan, Geri Forkner,
Jeannine Gruska, Perry Johnson, Hallie Smith,
Fereshti Toosi, Maria Monterde, Lou Ann Smith

schedule

monday

intro to electricity
meet the materials
simple LED circuit

translating
world to computer
*resistance ---> volt
(voltage divider)
*analog ---> digital
(ADC)

--- lunch ---

translating
computer to world
*HIGH, LOW
*frequency
*PWM

soft-circuit techniques

make an ohmTool?

tuesday

hunt&gather materials

intro to textile sensors

textile sensors:
pressure/bend
squeez/stretch
tilt
pin

--- lunch ---

invent:
seasonal sensors

free working time

wednesday

electromagnetism

transistors, amplifiers

textile actuators:
fabric speaker
flap

gather more materials
(membrane, structure,
resonant body....)

--- lunch ---

invent:
seasonal actuators

free working time

thursday

free working time

optional topics:

e-textile tailoring

ATtiny programming

reading datasheets

gemma M0 features:
*audio playback
*HID device (mouse,
keyboard, game con-
troller....)
*capacitive touch
sensing

friday

free working time

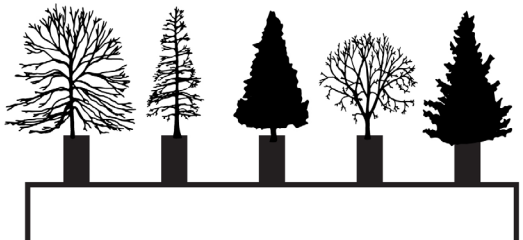
take time to document
and finalize
swatchbooks

--- lunch ---

process journey maps

clean-up

presentations



overview

what will we cover in the workshop?

INPUTS - sensors:

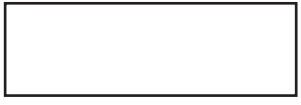
Analog:
pressure
bend
squeeze
slider

Digital:
tilt
stroke
contact

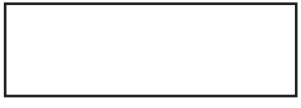
OUTPUTS - actuators:
LED
Vibration motor
Neopixel addressable RGB LED (needs data)
Speaker (needs frequency)

meet the materials

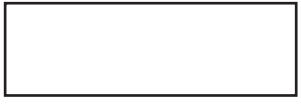
conductive materirals



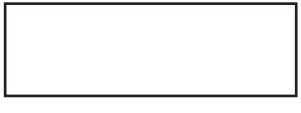
Copper plated ripstop fabric
(by Statex)



Silver plated lycra fabric
(by Statex)



Silver plated nylon conductive thread
(by Statex)

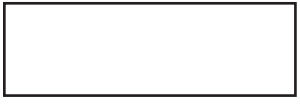


Copper conductive thread
(by Karl-Grimm)

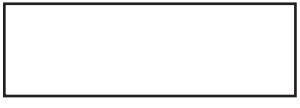
Stainless steel thread
(by Bekaert)

Copper tape

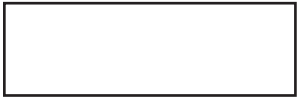
resistive materials



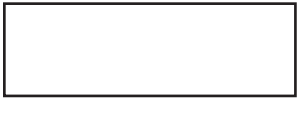
Non-woven piezoresistive fabric
(by Eeonyx)



Stretch piezoresistive fabric
(by Eeonyx)



Velostat
carbon impregnated plastic sheet (by 3M)



Carbon conductive paint
(by Bare Conductive)

Stainless steel and wool thread
(by Bekaert)

Stainless steel and wool fiber
(by Bekaert)

terminology

+ plus, positive, VCC

- minus, negative, ground (GND), 0V

1, HIGH = +5V, VCC

0, LOW = 0V, GND

analog

digital

input - sensor - “read"

output - actuaor - “write"

ADC (analog digital converter)

PWM (pulse width modulation)

IC (integrated circuit)

LED (light emitting diode)

RGB (red, green, blue)

AC/DC (alternating current, direct current)

PCB (printed circuitboard)

binary

10bit: 1024 values [0-1023]

8bit: 256 values [0-255]

Arduino, Lilypad, Flora, Gemma

microcontroller

resistor

variable resistor, resistive sensor

capacitor

diode

Neopixel - addressable LEDs

servo motor

breadboard

protoboard

jumper wires

aligator or crocodile clips

conductivity

resistance

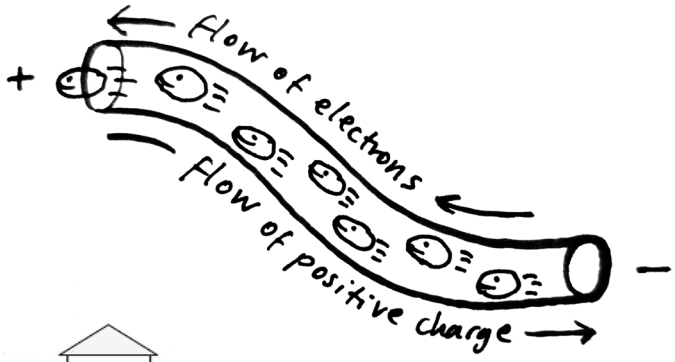
piezoresistance: “Piezo", derived from the Greek piezein,

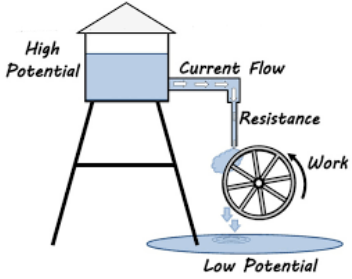
which means to squeeze or press

schematic diagram/schematic symbol

descrete “components", electronic “parts"

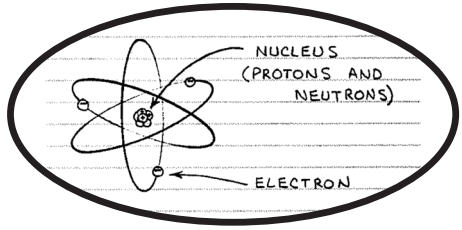
intro to electricity





Water Analogy

If we compare electricity to water flowing through a pipe, then:
Voltage is the water pressure,
Current is the stream of flow of water,
Resistance is the valve.



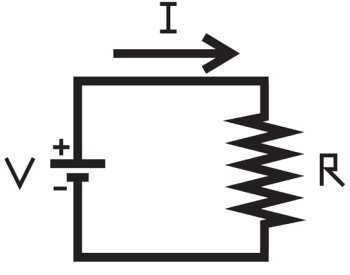
Voltage (V) - is electrical pressure or force. Sometimes referred to as potential. Voltage drop is the difference in voltage between the two ends of a conductor through which current is flowing.

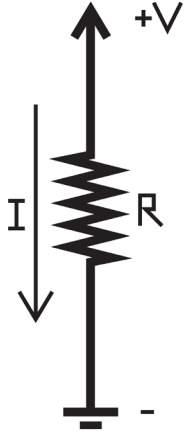
Current (I) - is the quantity of electronics passing a given point.
The unit of current is Ampere.
1 Amp = 6,280,000,000,000,000,000 electronics passing a point in one second.

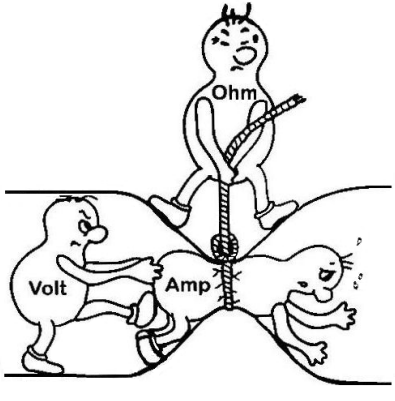
Resistance (R) - conductors are not perfect, they resist the flow of current to some degree. the unit of resistance is the Ohm (Ω).

book tip: Forrest M. Mims "Getting Started in Electronics"

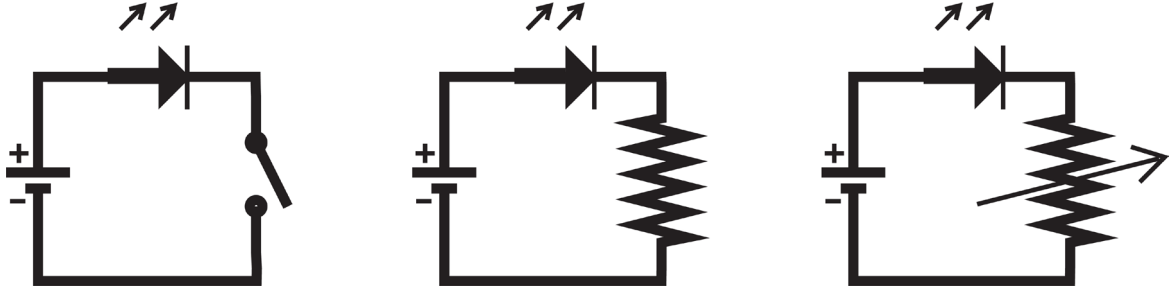
Ohm's Law: $V = I \times R$







simple LED circuit



schematic symbols:

power supply

resistor

variable resistor

LED

switch

multimeter

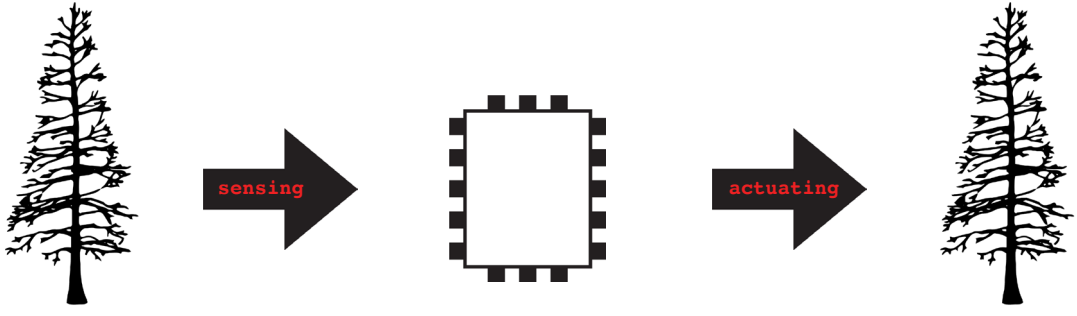
auto-ranging

in this mode it will beep when there is a direct connection (<100 ohm)

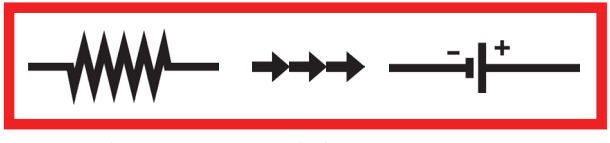
manual-range

*the numbers on the dial are **not** multipliers, but indicate the maximaum reading range. for example: if the dial is on 20K and the display says "12.4" then you are reading 12.4K ohm or 12,400 ohm*

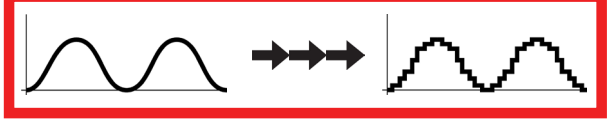
translating between world and computer



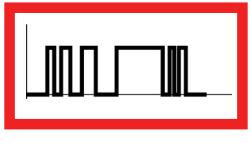
translating resistance to voltage



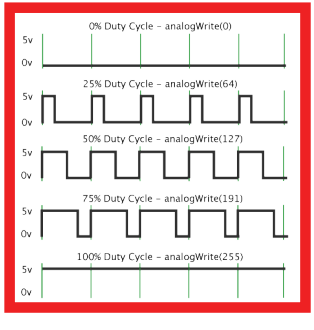
translating analog to digital



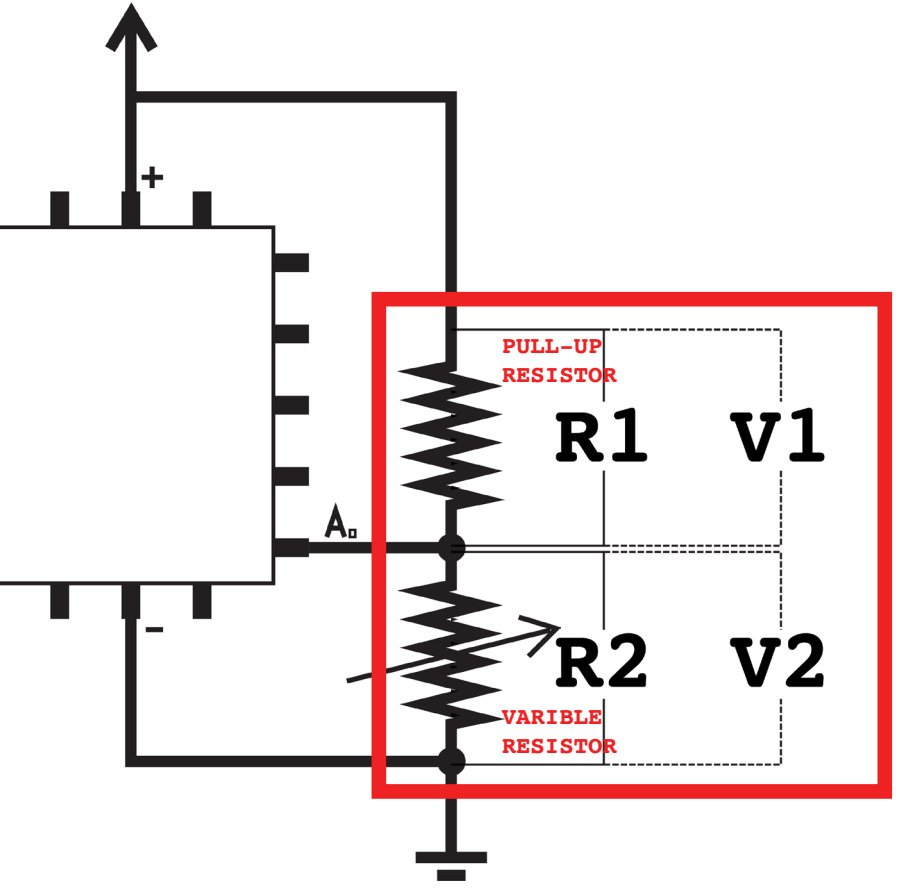
HIGH, LOW



PWM



resistance *voltage divider* -------> voltage

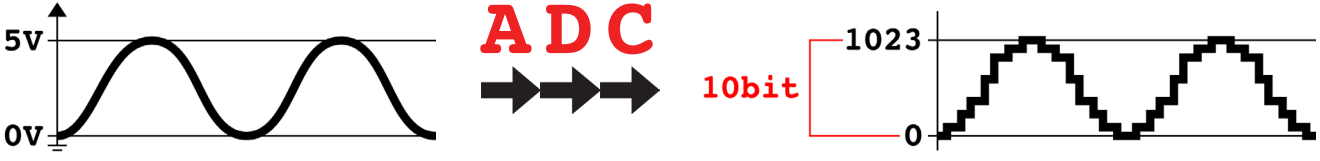


$$\frac{R1}{R2} = \frac{V1}{V2}$$

VOLTAGE DIVIDER

analog ----------> digital

analog to digital converter (ADC)



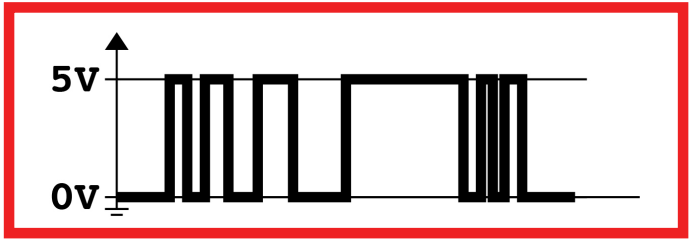

```
void setup() {
  Serial.begin(9600);
}

void loop() {
  Serial.println(analogRead(A0));
  delay(2);
}
```

ANALOG DIGITAL CONVERTER

digital ----------> HIGH / LOW

```
digitalWrite(PIN#, HIGH);
```



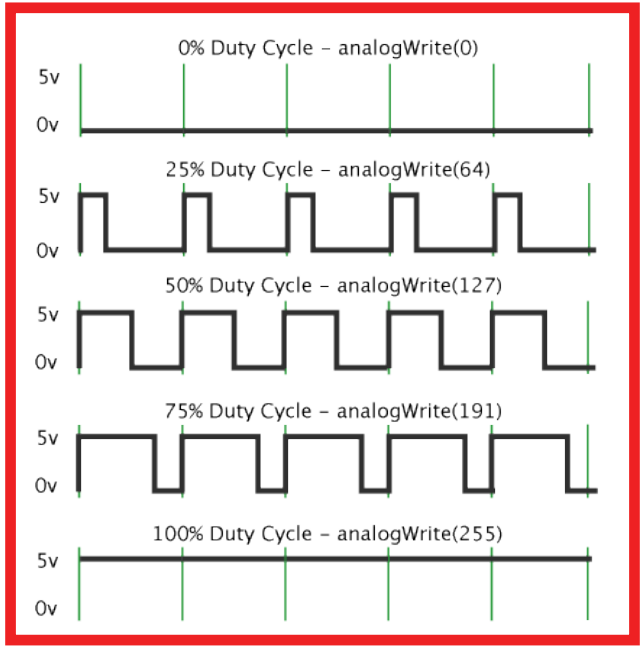
HIGH - 1 - VCC - on

LOW - 0 - GND - off

```
digitalWrite(PIN#, LOW);
```

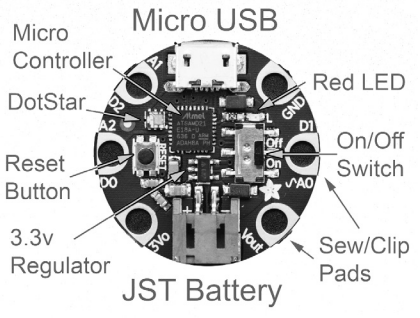
digital ---------> PWM *"fake analog"*

```
analogWrite(PIN#, [0-255]);
```



PULSE WIDTH MODULATION

Arduino & Gemma



STRUCTURE

void setup() { . . . }
The setup function is called when a sketch starts.
It will only run once after each powerup or reset of the Arduino board.

void loop() { . . . }
loops consecutively, allowing your program to change and respond.

I/O	DIGITAL	ANALOG
READ	**digitalRead(pin);** *returns: HIGH or LOW*	**analogRead(pin);** *returns: 10bit analog reading between 0 - 1023 (ADC resolution)*
WRITE	**digitalWrite(pin, HIGH or LOW);** *writes: HIGH (3V, 5V) or LOW (0V or GND)*	**analogWrite(pin, [0-255]);** *writes: 8bit PWM duty cycle between 0(always off) - 255(always on)*

SERIAL COMMUNICATION

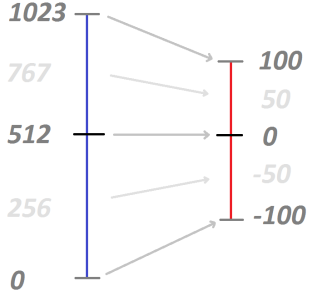
Serial.begin(speed);
Sets the data rate for serial data transmission.
speed: in bits per second (baud)

Serial.print(val);
Prints data to the serial port as human-readable ASCII text.
val: the value to print - any data type

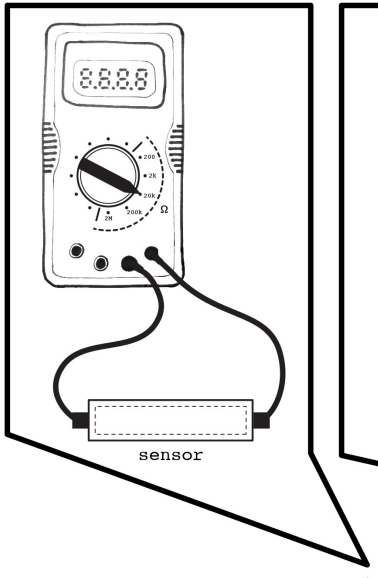
MATH

constrain(x, a, b);
Constrains a number to be within a range.
x: the number to constrain / a: the lower end of the range / b: the upper end of the range
returns: the constrained value

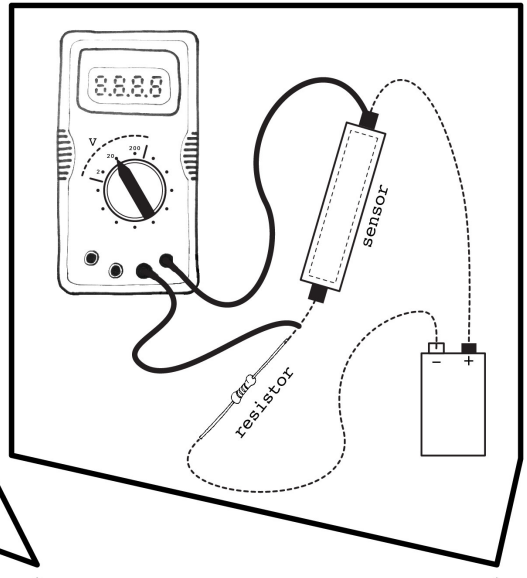
map(value, fromLow, fromHigh, toLow, toHigh);
Re-maps a number from one range to another.
value: the number to map
fromLow, fromHigh: the lower and upper bounds of the value's current range
toLow, toHIGH: the lower and upper bounds of the value's target range
returns: the mapped value



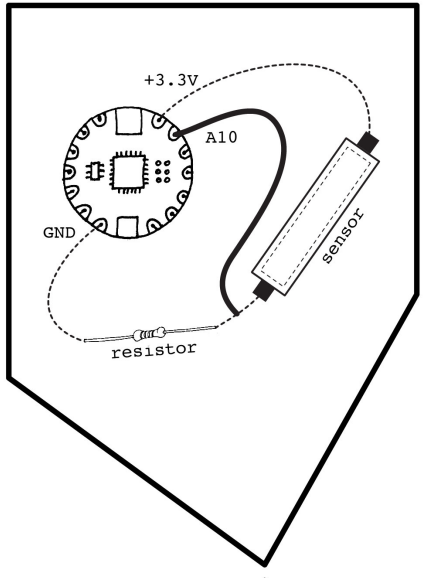
sensor's resistance range



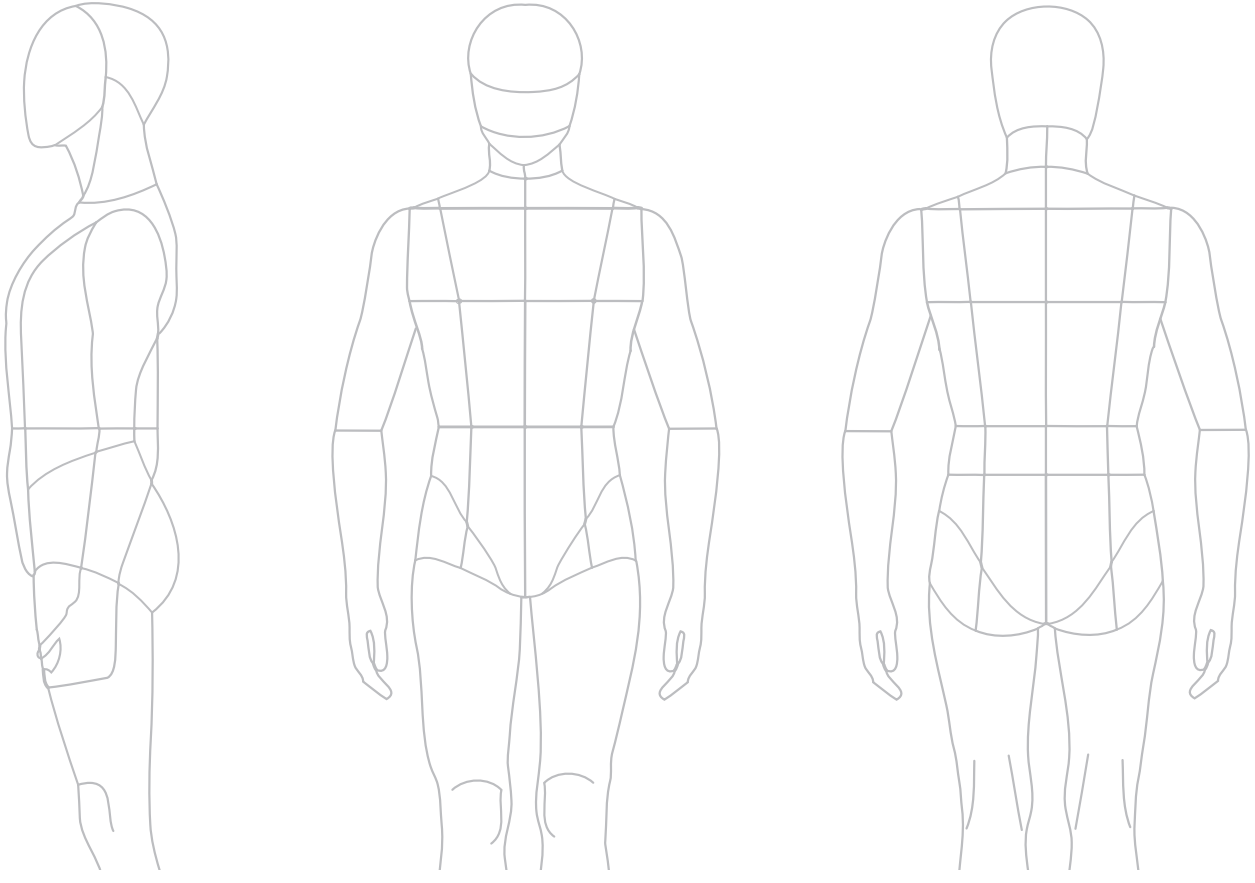
sensor's voltage range



sensor's 10bit ADC range



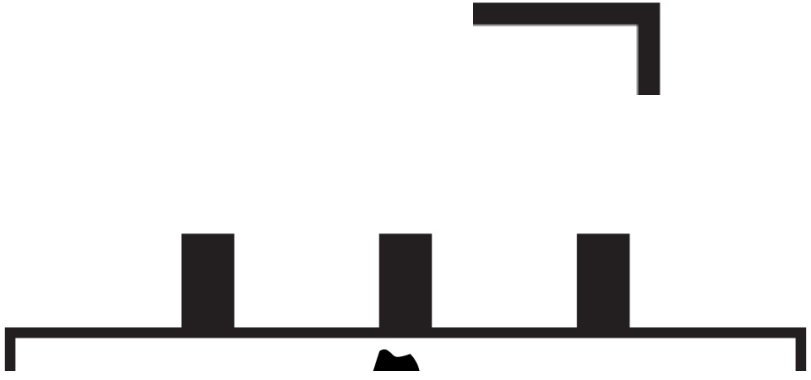
sensor	max Ω resting	min Ω activated	mean Ω resistor	max V resting	min V activated	max ADC resting	min ADC activated

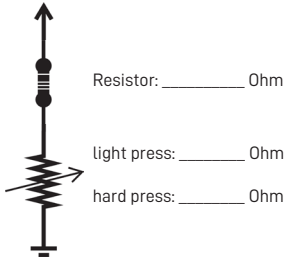


swatch: velostat pressure sensor

analog sensor

constructed from layering a piece of Velostat between two pieces of copper tape on paper and folded in half.

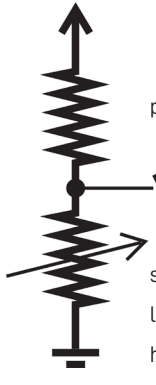




swatch: _____

analog sensor

description:



pullup resistor: _____ Ohm

sensor:

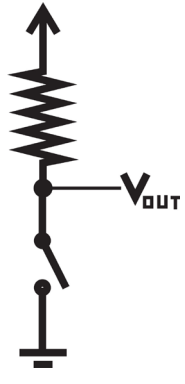
light press: _____ Ohm

hard press: _____ Ohm

swatch: _____

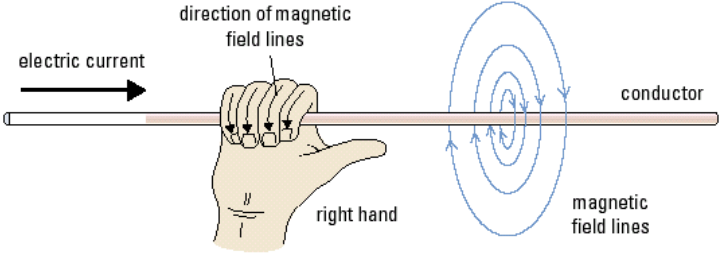
digital sensor/switch

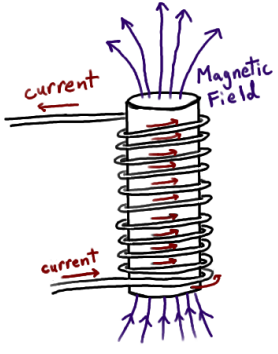
description:



electromagnetism

A current flowing through a wire creates a magnetic field around the wire. This is called electromagnetism. The magnetic field disappears when the current is turned off. You cannot see the field, but you can observe its effect.

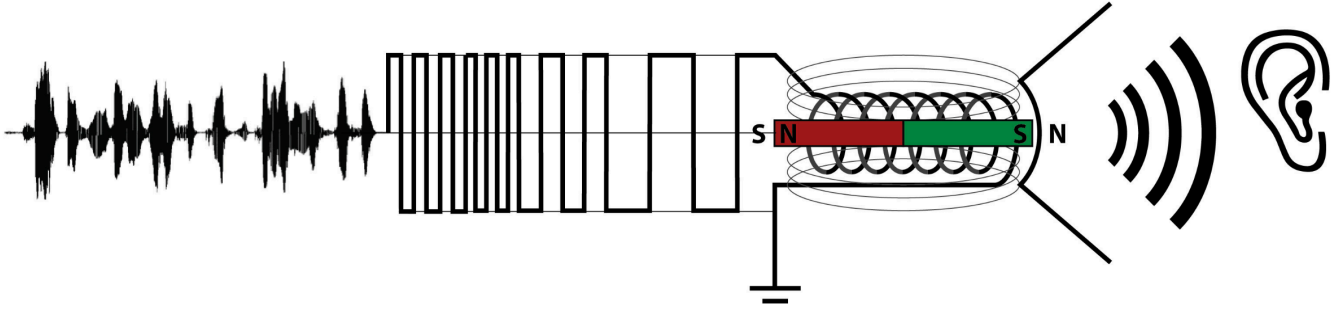




Electromagnets usually consist of insulated wire wound into a coil because this allows you to increase the strength of the magnetic field. The more turns in your coil, the stronger the electromagnetic field. The electromagnetic field is concentrated in the hole in the center of the coil.

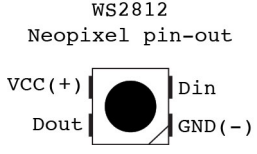
dynamic speaker

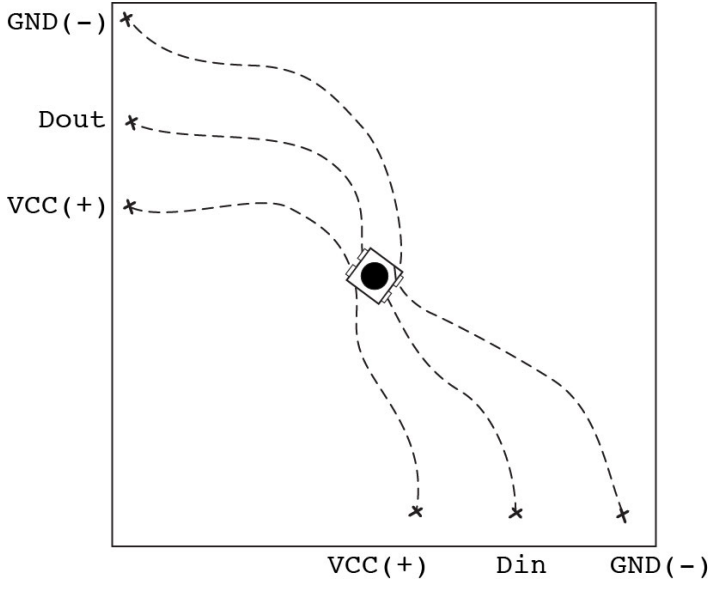
A coil of wire is attached to a membrane and wrapped around a per-manent magnet, with space for the coil to move in relation to the magnet.When pulses of electrical current (a sound signal) is fed into the coil it becomes an electromagnet and attracts or repells itself from the permanent magnet causing the membrane to move and move the air around it, sending soundwaves through the air which we will hear.



swatch: neopixel LED

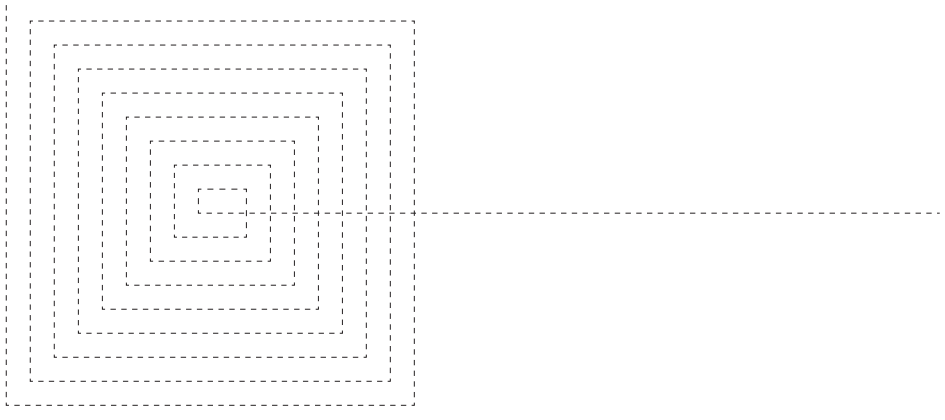
first solder the lines of karl-grimm copper thread to the leads of the Neopixel, then you can fasten the threads to the fabric using couching technique.





swatch: copper tape speaker

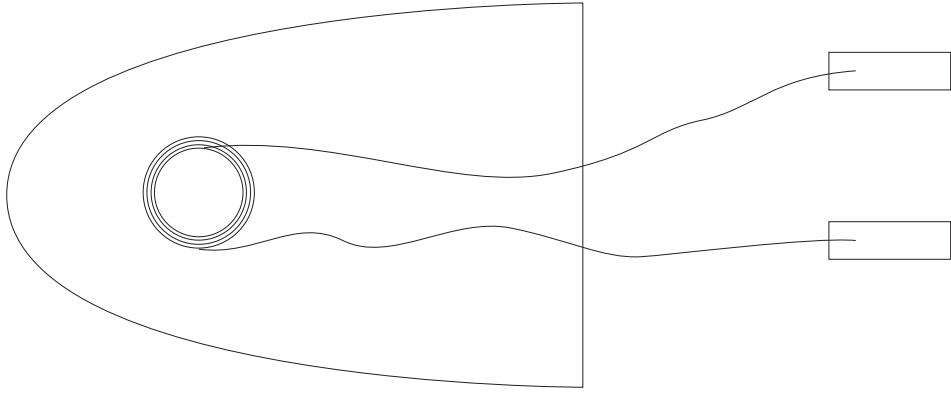
cut a strip of copper tape in half start at the edge of the page tape to the middle of the page then insulate your trace with some masking tape now continue to coil the tape around in a square until you have at least 5-6 turns measure how much resistance your coil has.



_____Ohm

swatch: magnet wire speaker

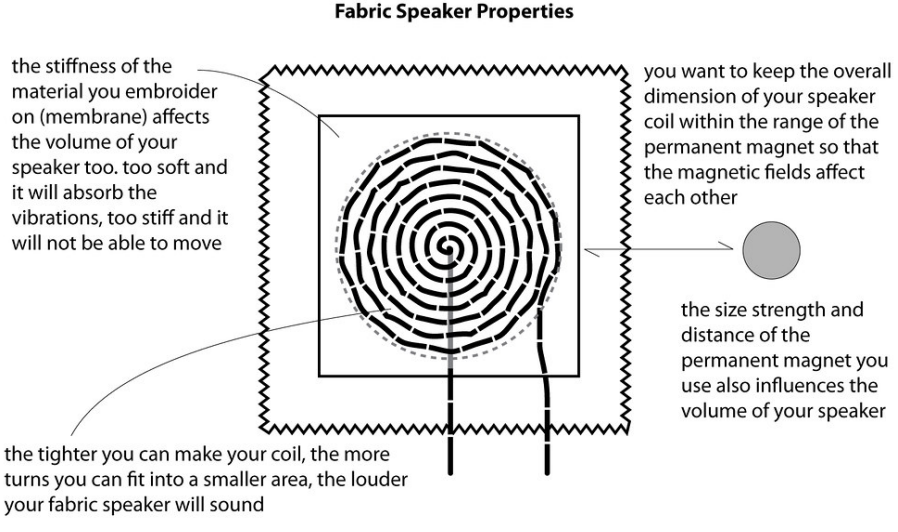
measure 2m of thin enameled wire wrap it around the tip of a 1.5cm diameter pen how many turns could you make? tape the coil to a flap of thin paper tape the flap to this page tape two pieces of copper tape to this page.



_____Ohm

swatch: fabric speaker

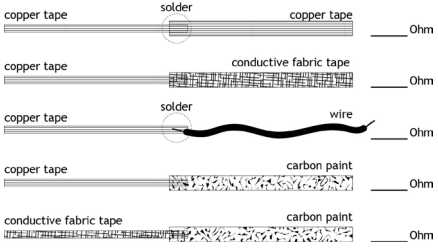
measure 1m of karl-grimm copper thread. tie a knot 10cm from one end. thread it through a needle and stitch it through the center of your fabric so that the 10cm remains on the back side of your fabric. remove needle from conductive thread. thread a needle with non-conductive thread and use it to courch the conductive thread a-round-and-a-round in a spiral. test at any point along the way.....

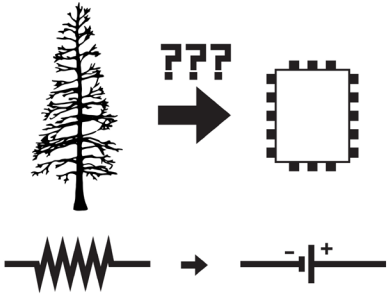


_____Ohm

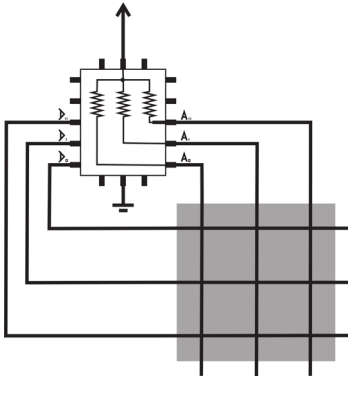
swatch: pressure sensor matrix

materials:





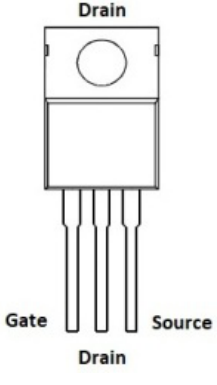
circuit schematic:

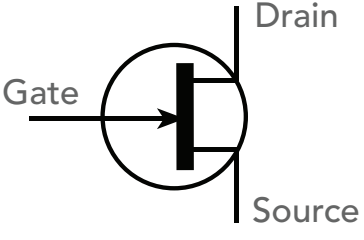


transistor switch

N-channel power MOSFET - 30V / 60A - TO-220 package

While a normal switch would require an actuator to be physically flipped, this switch is controlled by the voltage at the base pin. A microcontroller I/O pin, like those on an Arduino, can be programmed to go high or low to turn the LED on or off.

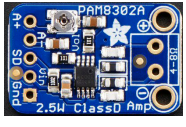




audio amp

Subtitle Text

text text text text



day0 - sunday

9 June 2019

day1 - monday

10 June 2019

day2 - tuesday

11 June 2019

day3 - wednesday

12 June 2019

day4 - thursday

13 June 2019

day5 - friday

14 June 2019