TERRAPIN WORKS

Intro to Sensor Interfacing

Students please sign in for the TW Workshop!

https://go.umd.edu/TWSP25

Interfacing with Sensors

Please sign in!

^ENES100 Sign-in Only!

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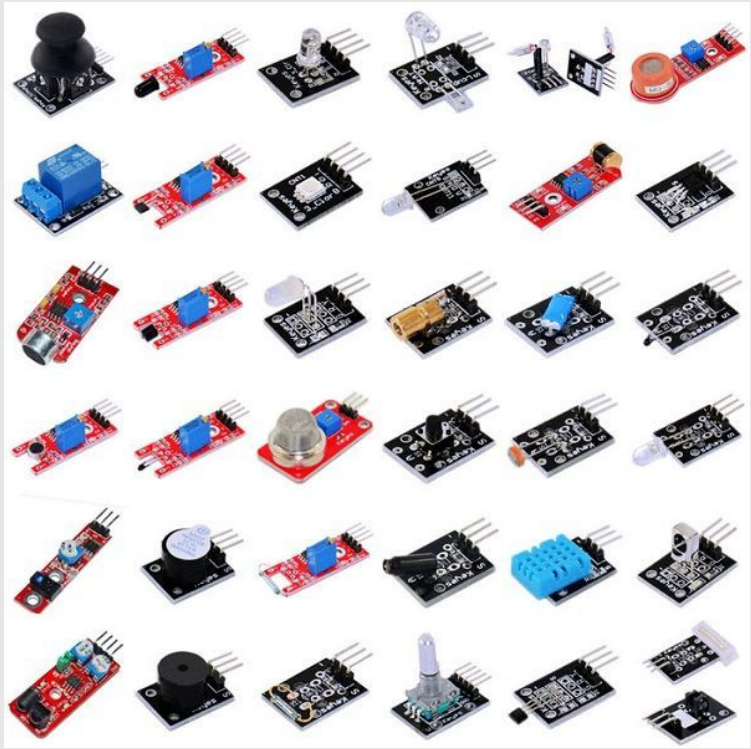
What do sensors do?

Convert **physical attributes** into **electrical signals.**

Can convert

- Distance
- Temperature
- Humidity
- And much more



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What ARE they?

Often use materials whose electrical properties **change a lot under different physical conditions**.

Piezoelectric Ceramic	Voltage changes under **physical strain** (eg. sound waves!)
Photoresistive PbS	Resistance changes with **light** exposure

Breakout Boards

- Sensors are small and delicate
- Often require **supporting components**
- Breakout boards helps solve these issues

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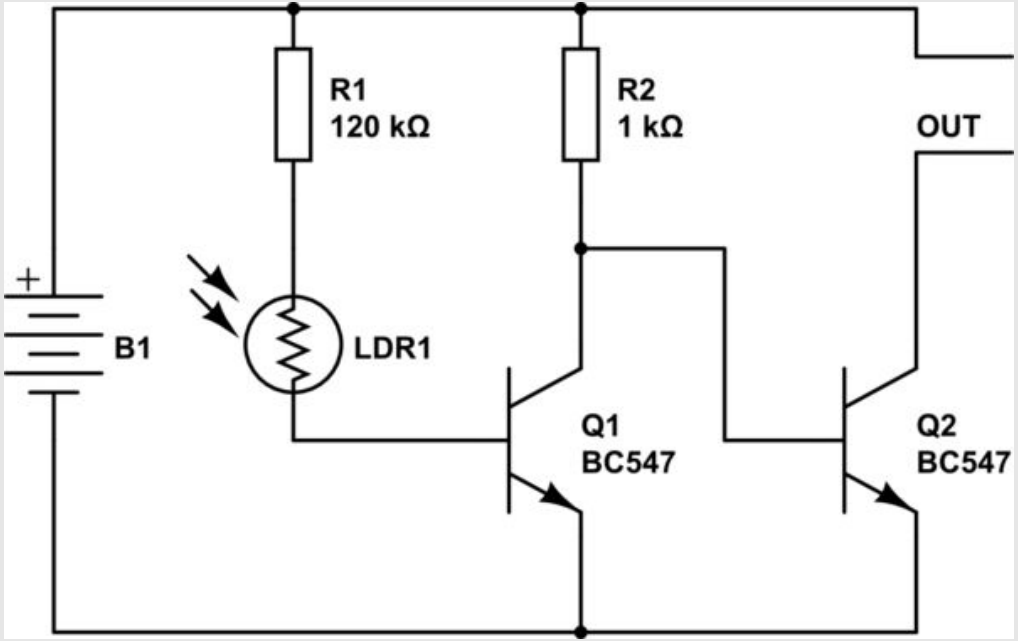
Breakout Boards

- Breakout boards host a circuit to support a sensor
- Gives sensor power
- Takes sensor output and turns it into a signal that's easy for an Arduino to read



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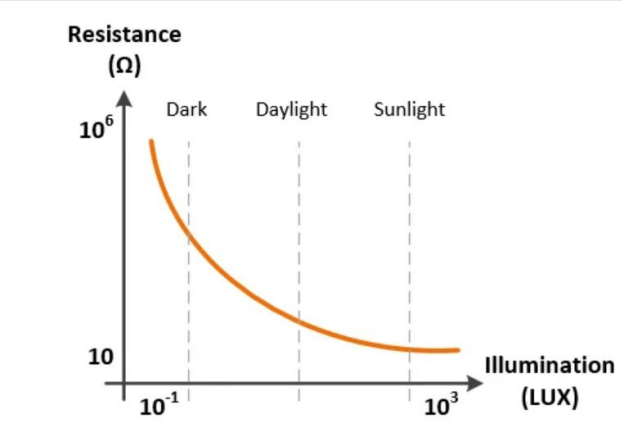
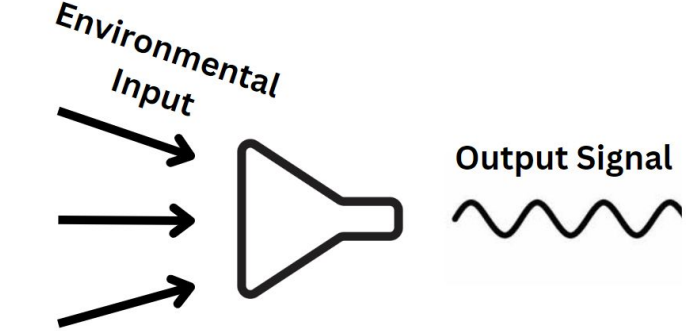
Analog Sensors

- Real values exist as a continuous range. Anything in this continuous range is analog.
- Analog sensor convert physical analog values into analog electrical values with an (ideally linear) transfer curve.

$$E = kS$$





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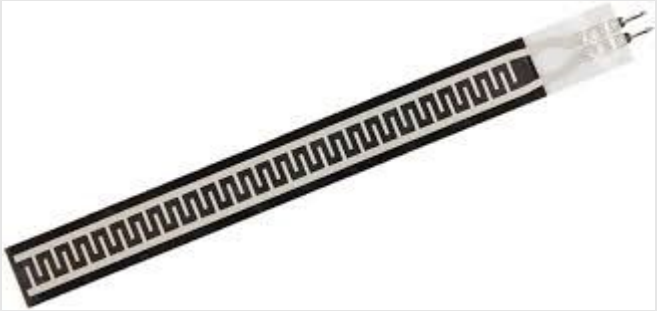
Analog Sensors

- Analog sensors are typically **2 pin**.
- “Sensed” parameter varies the **resistance** across the device’s pins.
- **Voltage dividers** are used to measure these changes in resistance!



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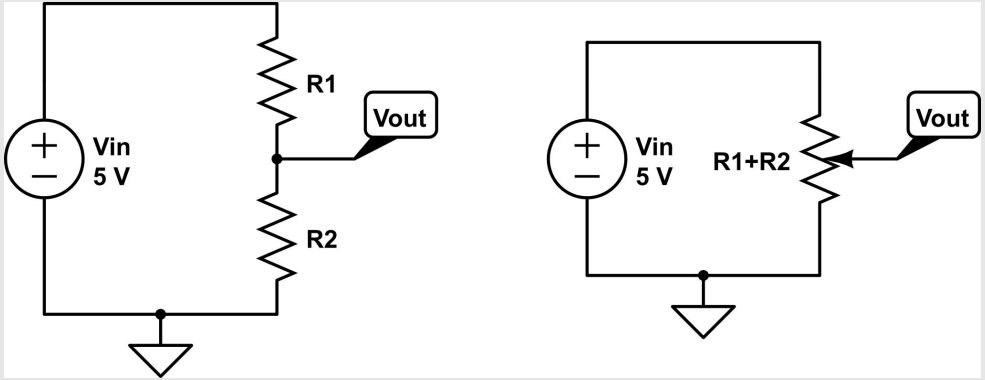
Dividing Voltages

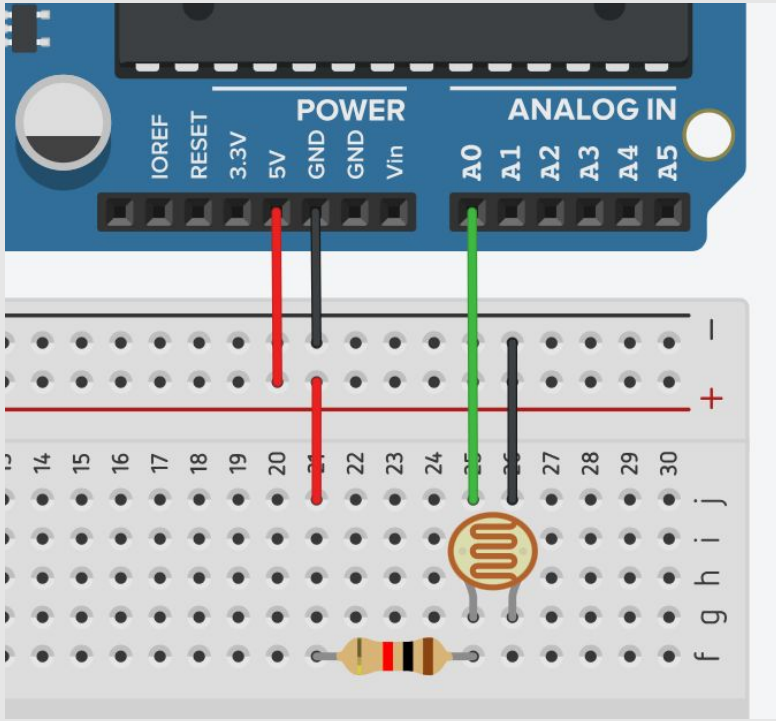
Many sensors use **voltage dividers** to generate signals. These use the **ratio** between two resistances to get a fraction of a supplied voltage.



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

Project 1 - Photoresistor

- Photoresistors change resistance under different light intensities
- Use photoresistor with a normal resistor in a **voltage divider**
- Analog pin on Arduino measures divider output



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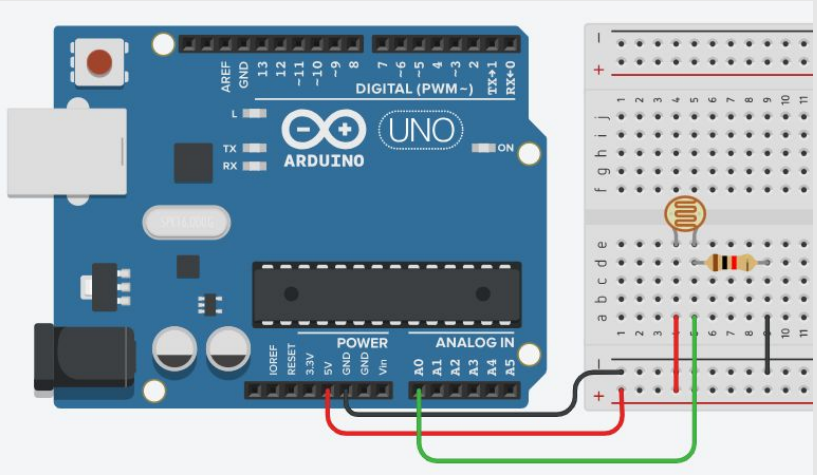
Project 1 - Photoresistor

```
#define CALIBRATION 0.66

int photo_pin = A0, adc_range;

void setup() {
  Serial.begin(9600);
  pinMode(photo_pin, INPUT);
  adc_range = round(1024*CALIBRATION);
}

void loop() {
  int raw_val = analogRead(photo_pin);
  int percent = map(raw_val, 0, adc_range, 0, 100);
  Serial.print(percent);
  Serial.println("% brightness");
  delay(10);
}
```

Serial Monitor

```
70% brightness
70% brightness
70% brightness
70% brightness
70% brightness
```



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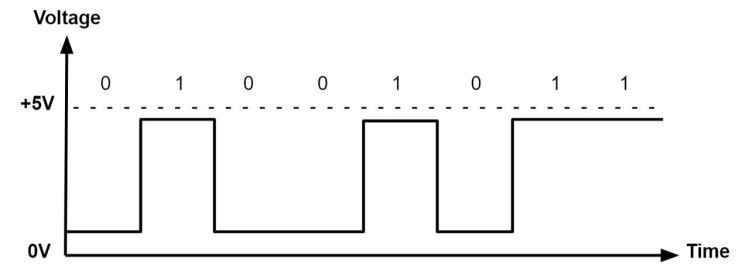
Digital Sensors

- Digital values are boolean/binary meaning they are either **true** or **false**, **1** or **0**, **on** or **off**.
- Computers/Controllers think in digital values by mapping binary strings to decimal numbers
- Many sensors convert from analog to digital on the breakout board to streamline communication



Decimal	Binary
0	0
1	1
2	10
3	11
4	100
5	101
6	110
7	111
8	1000
9	1001

Decimal	Binary
10	1010
11	1011
12	1100
13	1101
14	1110
15	1111
16	10000
17	10001
18	10010
19	10011

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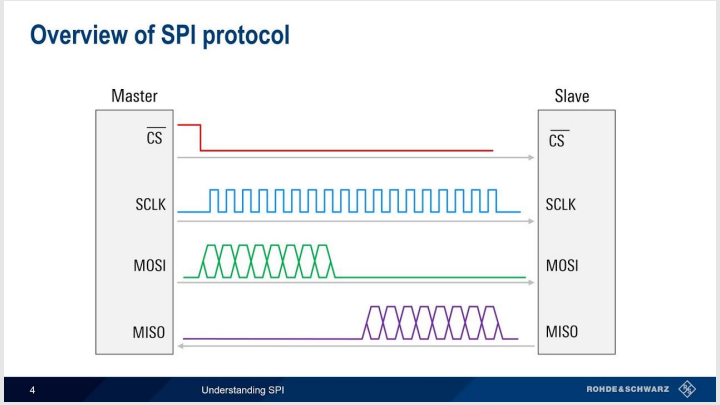
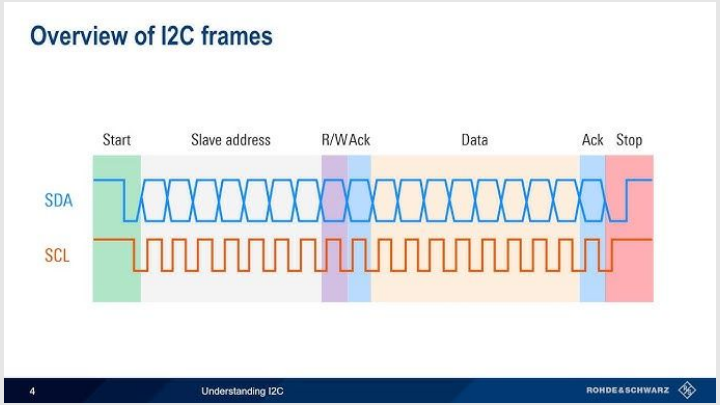
Digital Sensors

- Digital sensors use digital values to communicate their data.
- Sensors use predefined patterns to communicate specific information.
- More complicated sensors have predefined structures of digital values.
- These structures are called **communication protocols** and allow for more complicated data to be sent.





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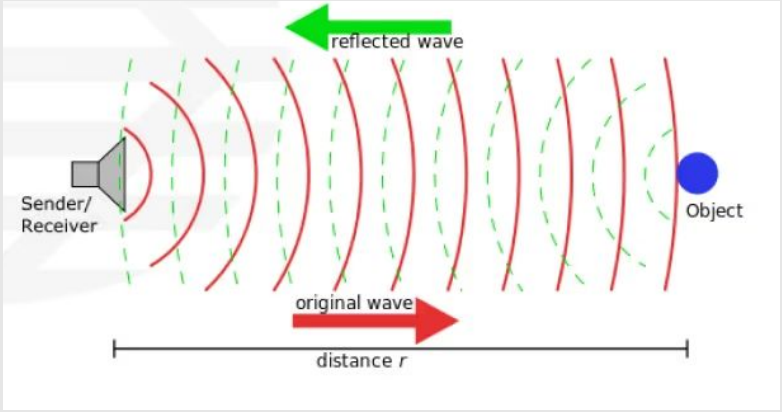
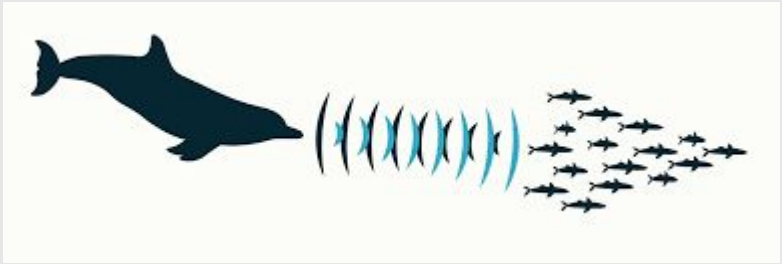
Project 2 - Ultrasonic Distance Sensor

- Ultrasonic sensors uses sound waves to **measure distance**
- Send a trigger pulse and then watching for a return
- Ultrasonic sensors have a conical **viewing angle** due to sound dispersing





Like echolocation!

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Project 2 - Ultrasonic Distance sensor

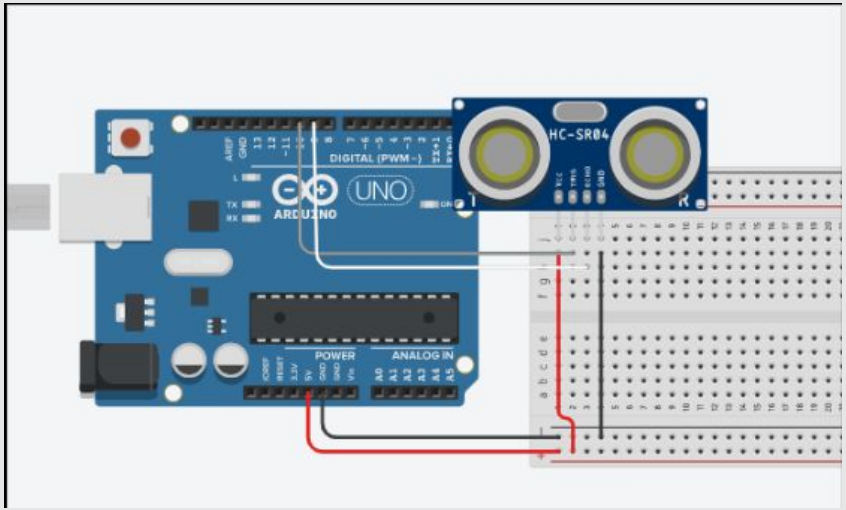
```
int triggerPin = 10;
int echoPin = 9;

void setup()
{
  Serial.begin(9600);
  pinMode(triggerPin, OUTPUT);
  pinMode(echoPin, INPUT);
}

void loop()
{
  delay(100);
  Serial.println(readDistance());
}

long readDistance()
{
  digitalWrite(triggerPin, LOW);
  delay(2);
  digitalWrite(triggerPin, HIGH);
  delay(10);
  digitalWrite(triggerPin, LOW);
  return 0.01723*pulseIn(echoPin, HIGH);
}

```



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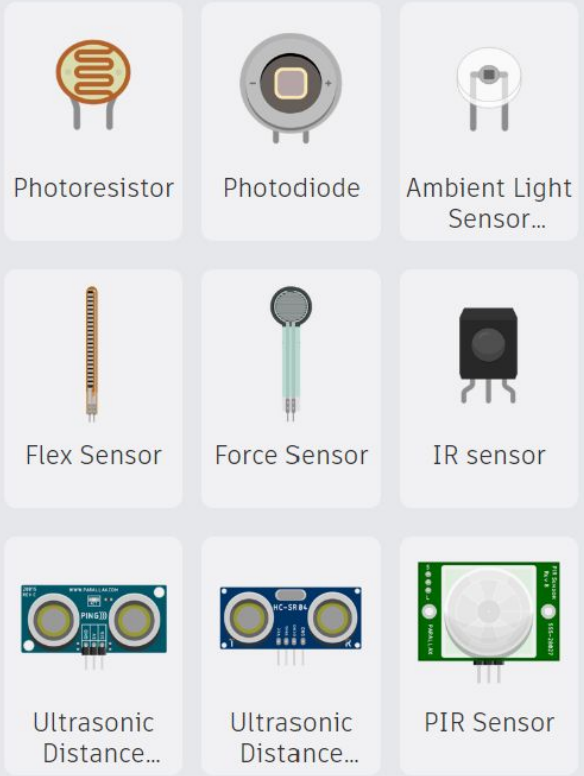
Project 3 - Choose your own

- In tinkercad switch to all components and scroll to the input section
- Choose a sensor from that section to implement
- Use the info (?) tab to learn how to use it



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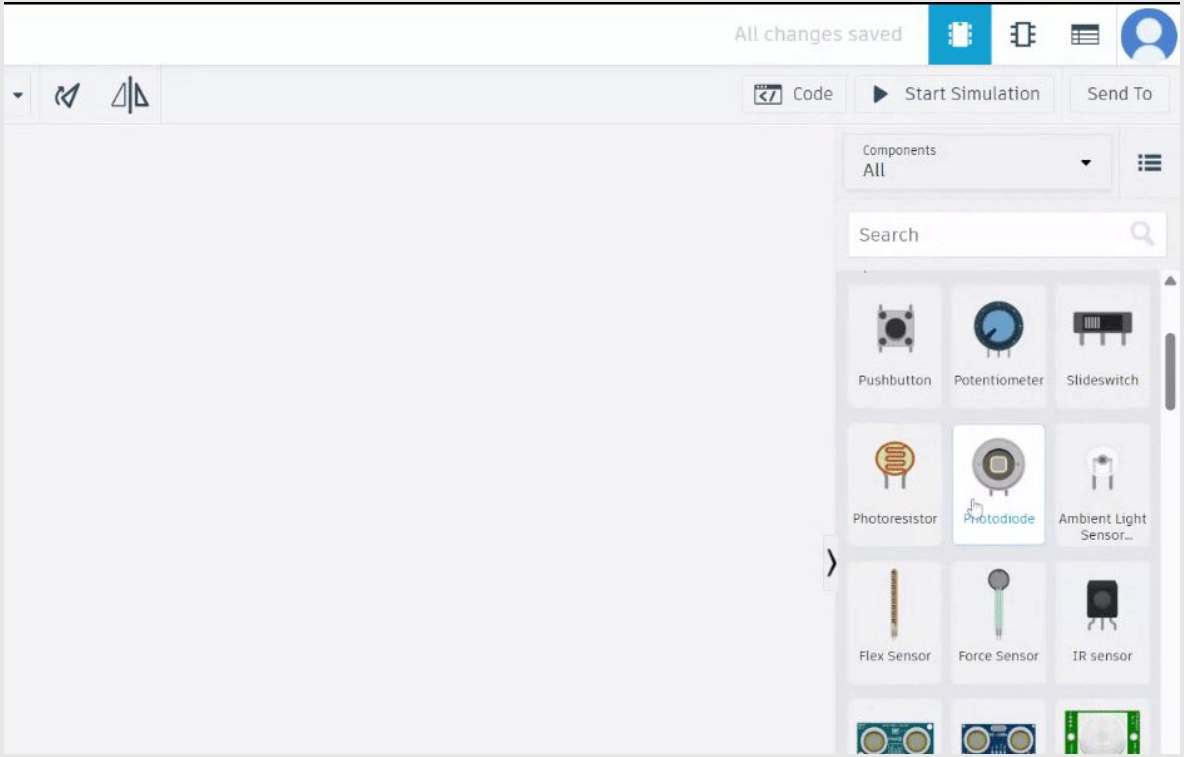
Finding Part Info



To learn about all the cool stuff at Terrapin Works,
Or need tech help with your project, feel free to
Stop by the

Maker Mondays

Where?: Rapid Prototyping Center (IDEA 1102)
When? Mondays! (ofc!) 5pm - 7pm

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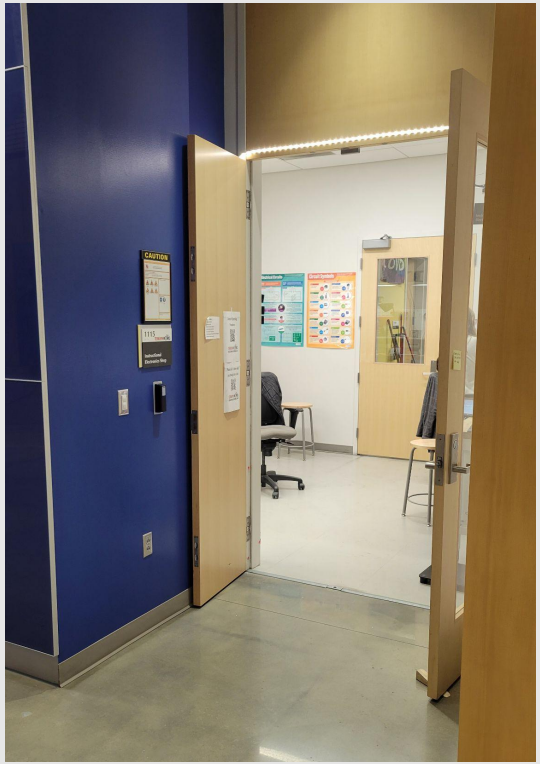
Come visit the IES!



1115 AJC

Open Lab 2:00- 7:00 PM Weekdays

Please give us your feedback!
https://tinyurl.com/6eayw8r8

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