PAT 451/551 INTERACTIVE MEDIA DESIGN I

MORE_SENSORS

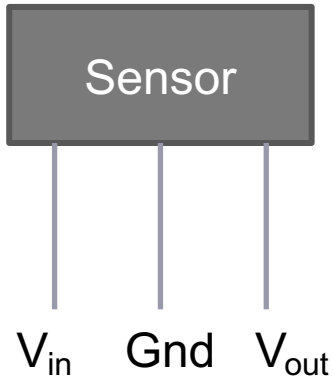
VOLTAGE-OUTPUT SENSORS

- Some sensors have integrated circuits built in that output a varying voltage directly.

- Usually have 3 pins: V_{in}, GND, and V_{out}
  - V_{out} can normally be connected straight to Arduino Analog Input

- Pay attention to the rated input voltage. Some may be 5V, some may be 3.3V

- V_{out} may also not go all the way from 0 to 5V

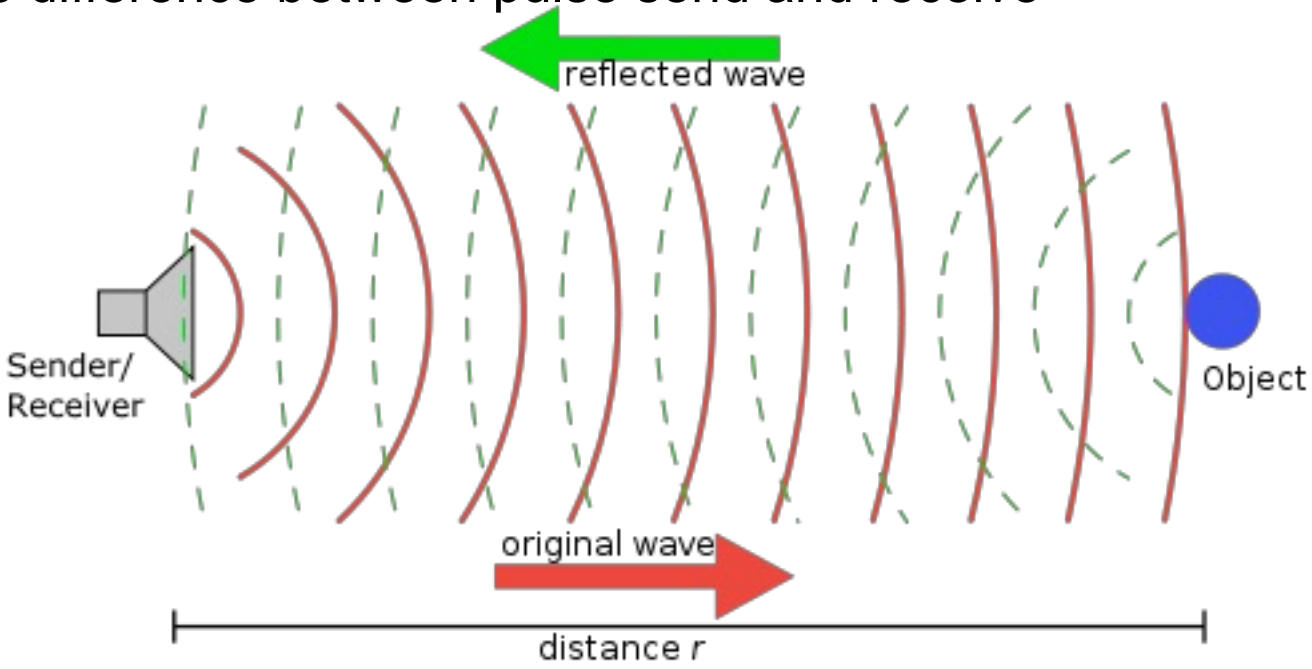


~For illustration purposes only!~
~Not a real sensor!~
~Pin order may be different!~

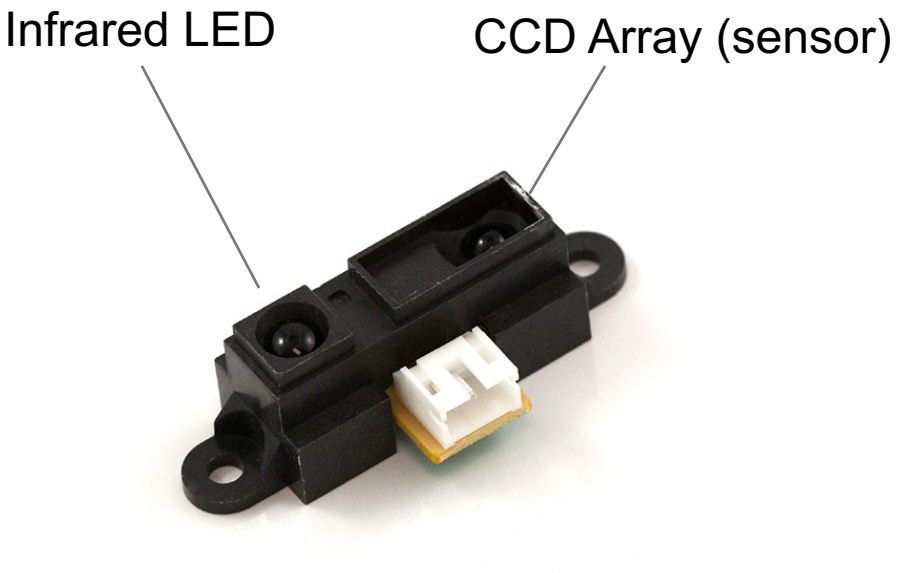
REFLECTIVE SENSORS

Principle: send out a pulse (light, sound), measure either

- Intensity of reflected signal
- Time difference between pulse send and receive

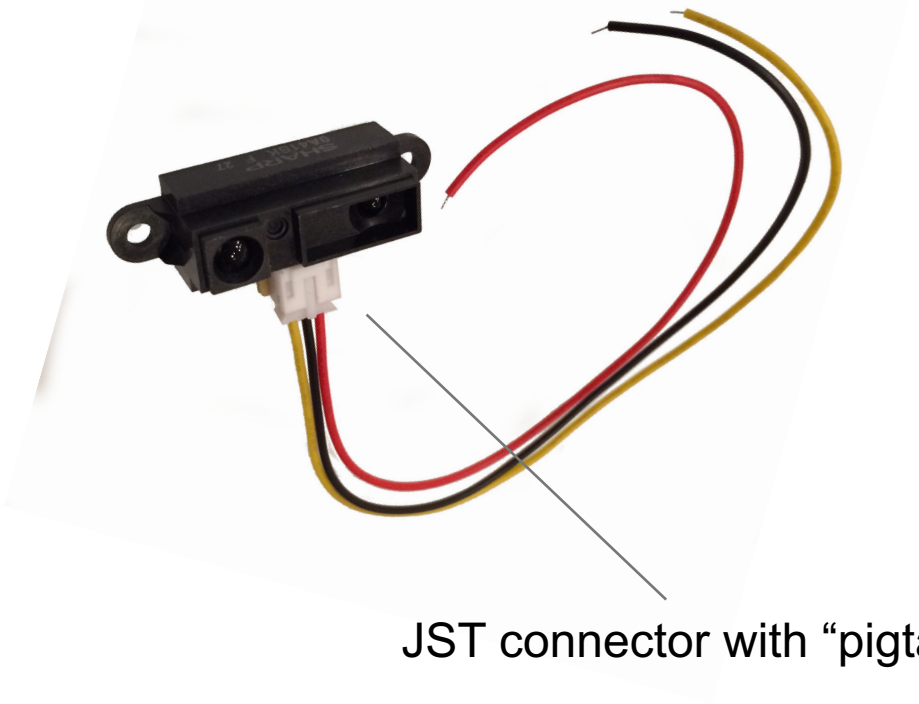


INFRARED PROXIMITY SENSOR



- Made by Sharp
- Several different models with same form factor
- Different ranges
- See the model number printed on the top of the sensor
- Power with +5V and GND
- Commonly used in hobby robotics, simple industrial automation, consumer products

INFRARED PROXIMITY SENSOR

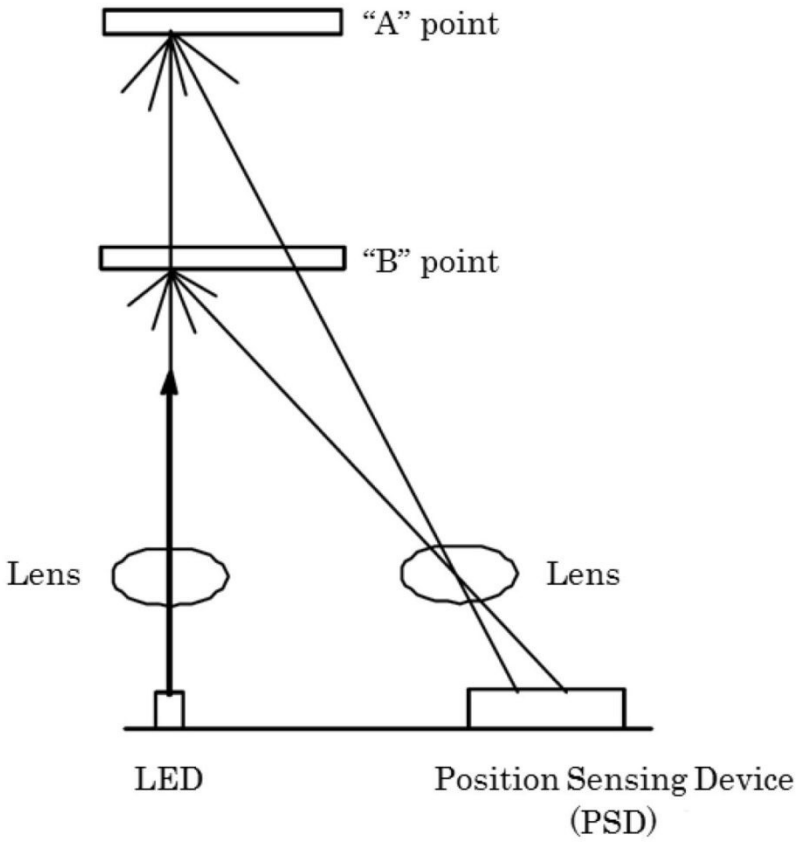


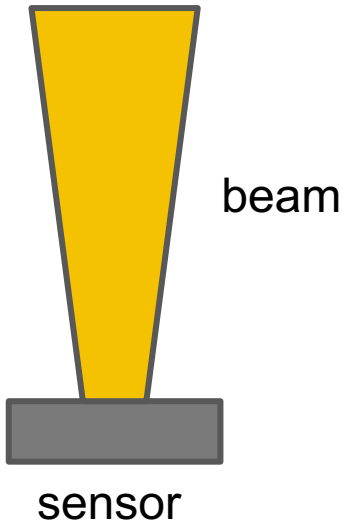
JST connector with “pigtail” wires

Wire color codes

RED: V_{IN} (Power or V_{cc})
BLACK: GND
YELLOW: V_{out} (To Arduino input)

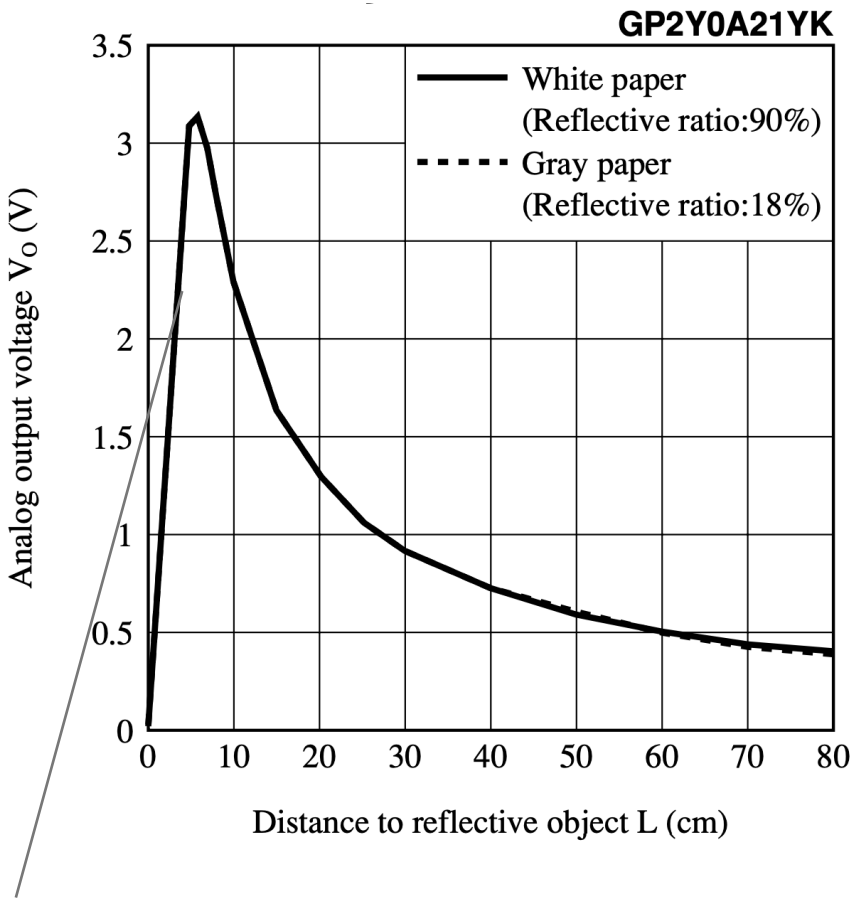
INFRARED PROXIMITY SENSOR





Detector array senses the distance by the minute changes in position of the reflected beam.

INFRARED PROXIMITY SENSOR

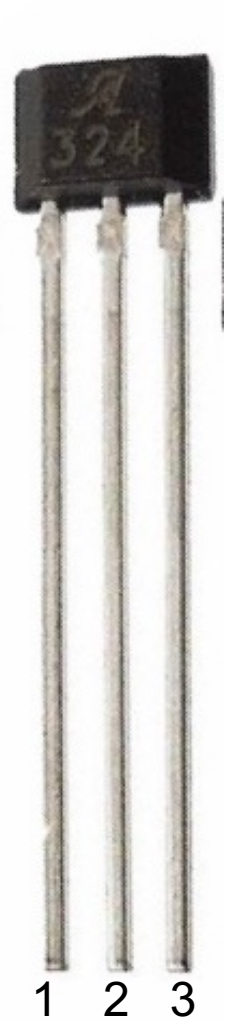


Note that for this sensor, distance < ~6cm is unusable.
Also note that response is not linear.

https://www.sparkfun.com/products/242

HALL EFFECT SENSOR

- Senses the presence of a magnetic field
- Supply +5V and GND
- Analog output, centered on 2.5V
- Magnetic South: V_{out} increases -> 5V
- Magnetic North: V_{out} decreases -> 0V
- V_{out} is proportional to magnetic field strength

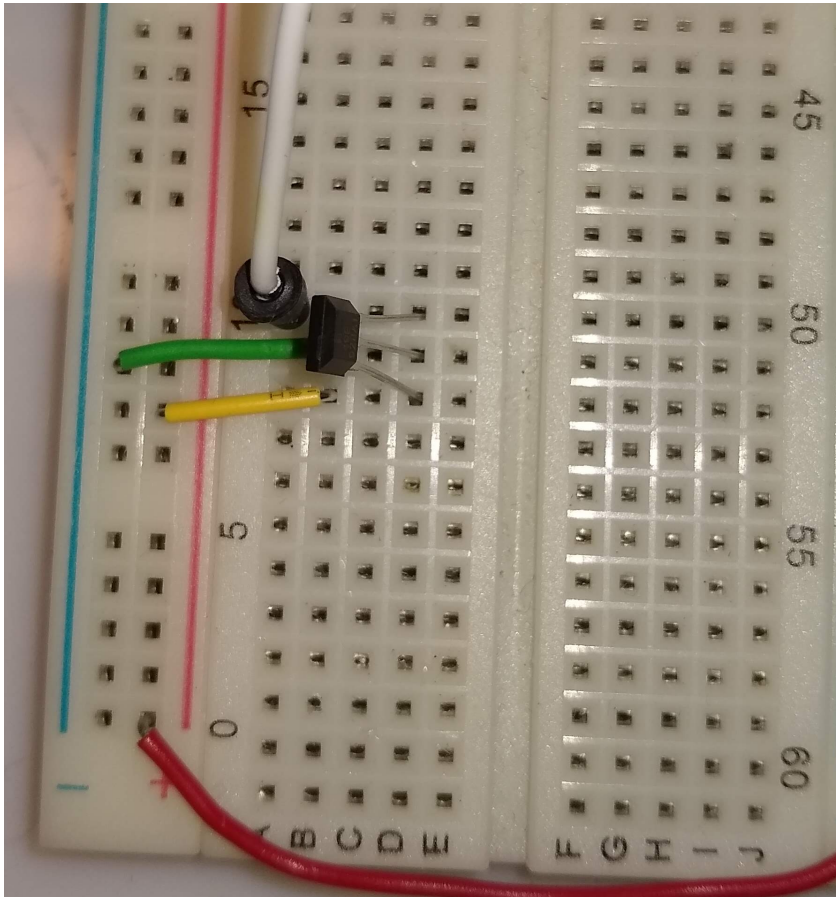


1 – V_{cc}
2 – GND
3 – V_{out}

Allegro A1324 Linear Hall Effect Sensor:
https://www.allegromicro.com/en/products/sense/linear-and-angular-position/linear-position-sensor-ics/a1324-5-6

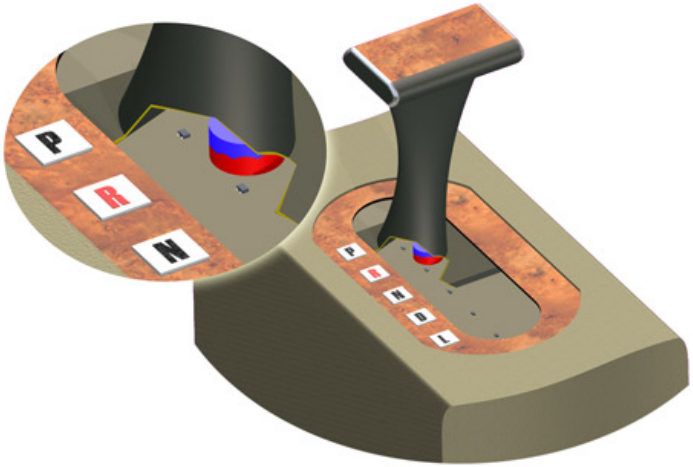
HALL EFFECT SENSOR

- Extremely useful for precise linear or rotation sensing
- No contact between moving object and the sensor!
- Digital switch versions or latching versions are ubiquitous

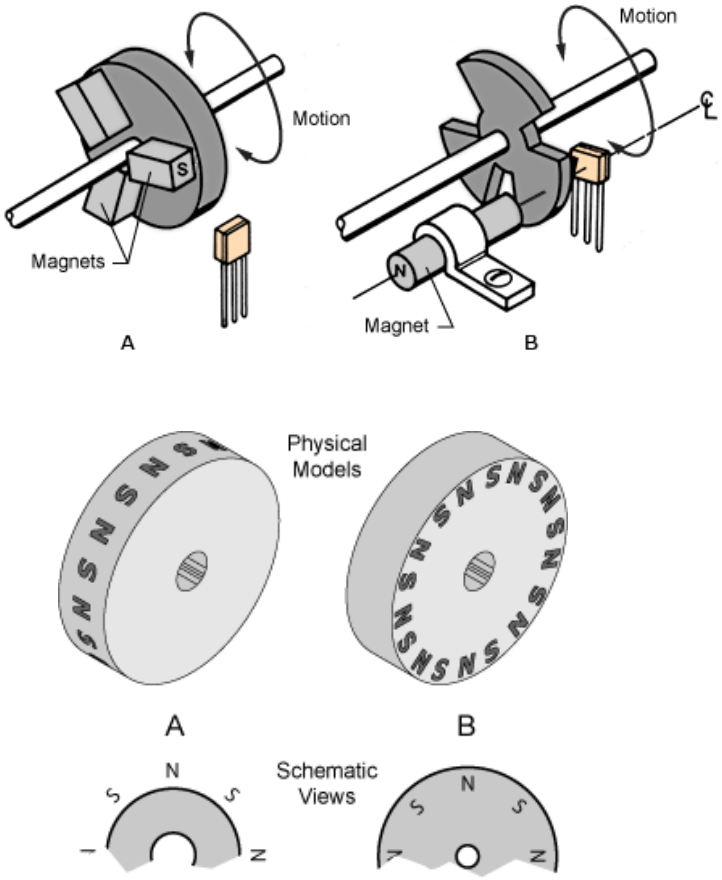


SS49E Sensor Circuit

HALL EFFECT SWITCH

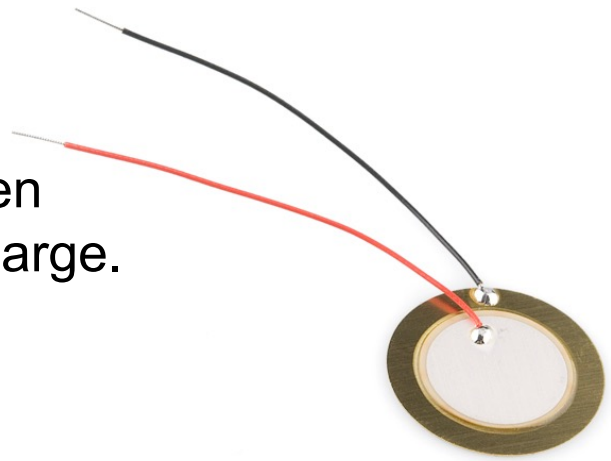


Sensing shifter position



Rotation sensing

PIEZO DISC



Piezoelectricity is a property of some crystalline materials to transduce between mechanical deformations and electric charge.

The effect works both ways:

If you apply varying pressure to the crystal, it generates a varying voltage.

If you apply a varying voltage to the crystal, it will mechanically vibrate.

It is both a kind of microphone and a kind of loudspeaker.

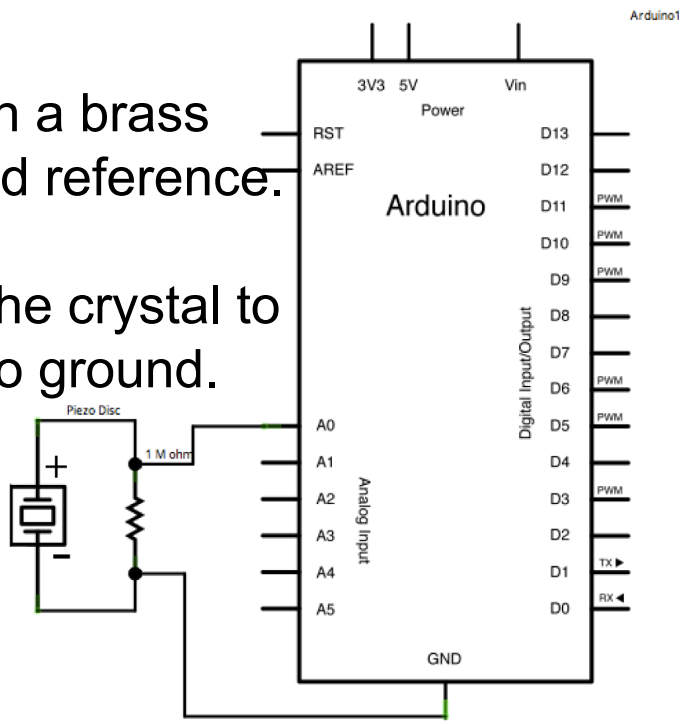
PIEZO DISC

We typically use piezos to detect the pressure of a sudden impact – “knock sensor”

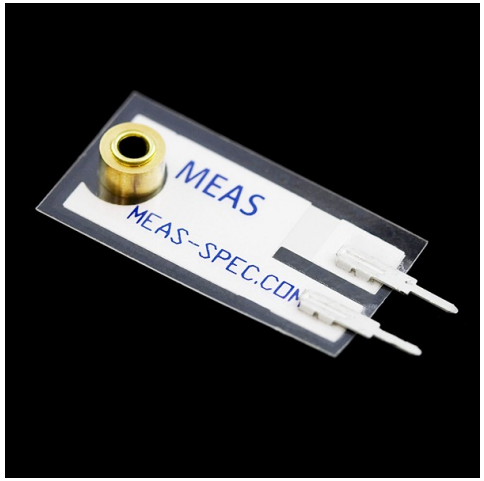
The crystal is normally mounted on a brass backing, which provides the ground reference.

The simplest circuit is to connect the crystal to an analog input, and the backing to ground.

Put a ~1MΩ resistor in parallel. This reduces the current to the analog pin.



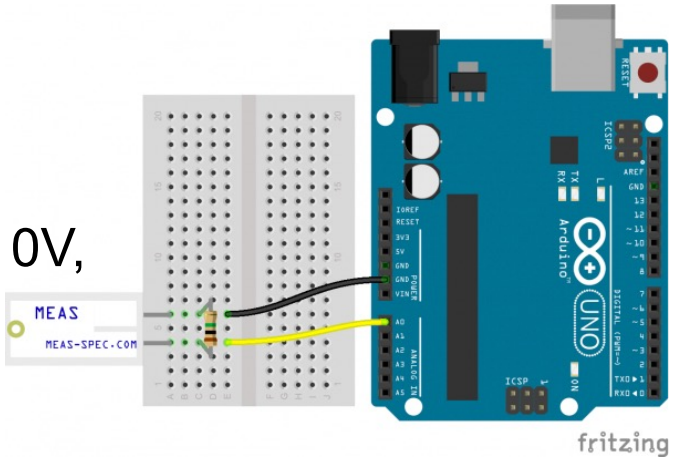
PIEZO VIBRATION SENSOR



Another form of piezo sensor is a crystal mounted in a plastic film, sometimes with a mass attached to it.

This sensor can be “plucked” and caused to vibrate.

We connect it the same way.



Note that the piezo outputs a bipolar (positive and negative) voltage centered on 0V, but the Arduino can only detect the positive part of the signal.

With additional circuitry, we convert to a signal that varies between 0-5V, centered around 2.5V.

REFLECTIVE OPTICAL SENSOR

Turn on an infrared LED

Use an IR photodiode to measure intensity of reflected light

Advantages:

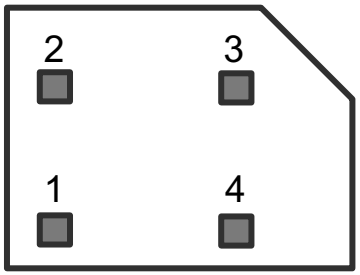
- Fast
- Inexpensive
- Minimal circuitry
- Some give direct voltage output

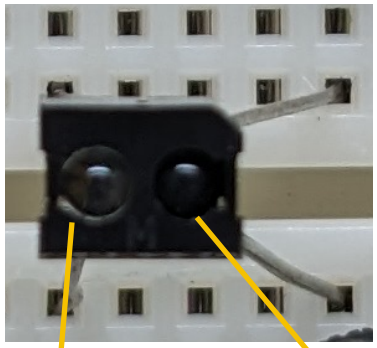
Disadvantages

- Subject to interference
- Shorter range

REFLECTIVE OPTICAL SENSOR (RPR-220)

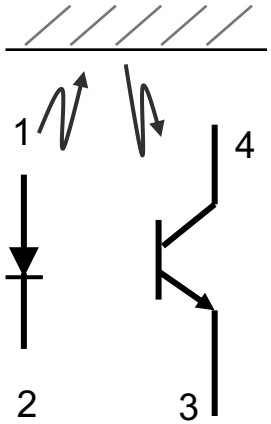
Top view



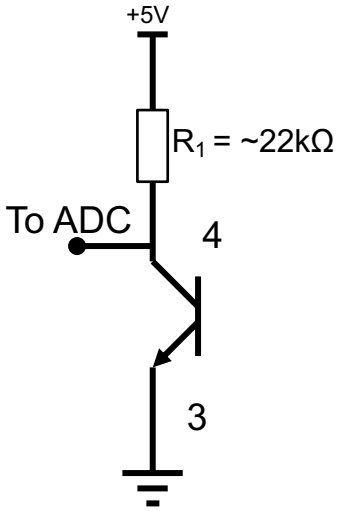


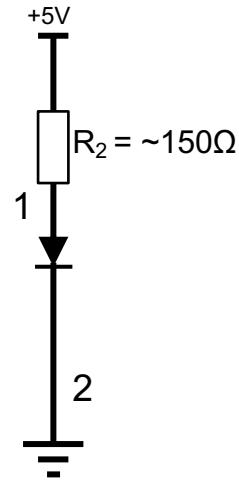
led

phototransistor



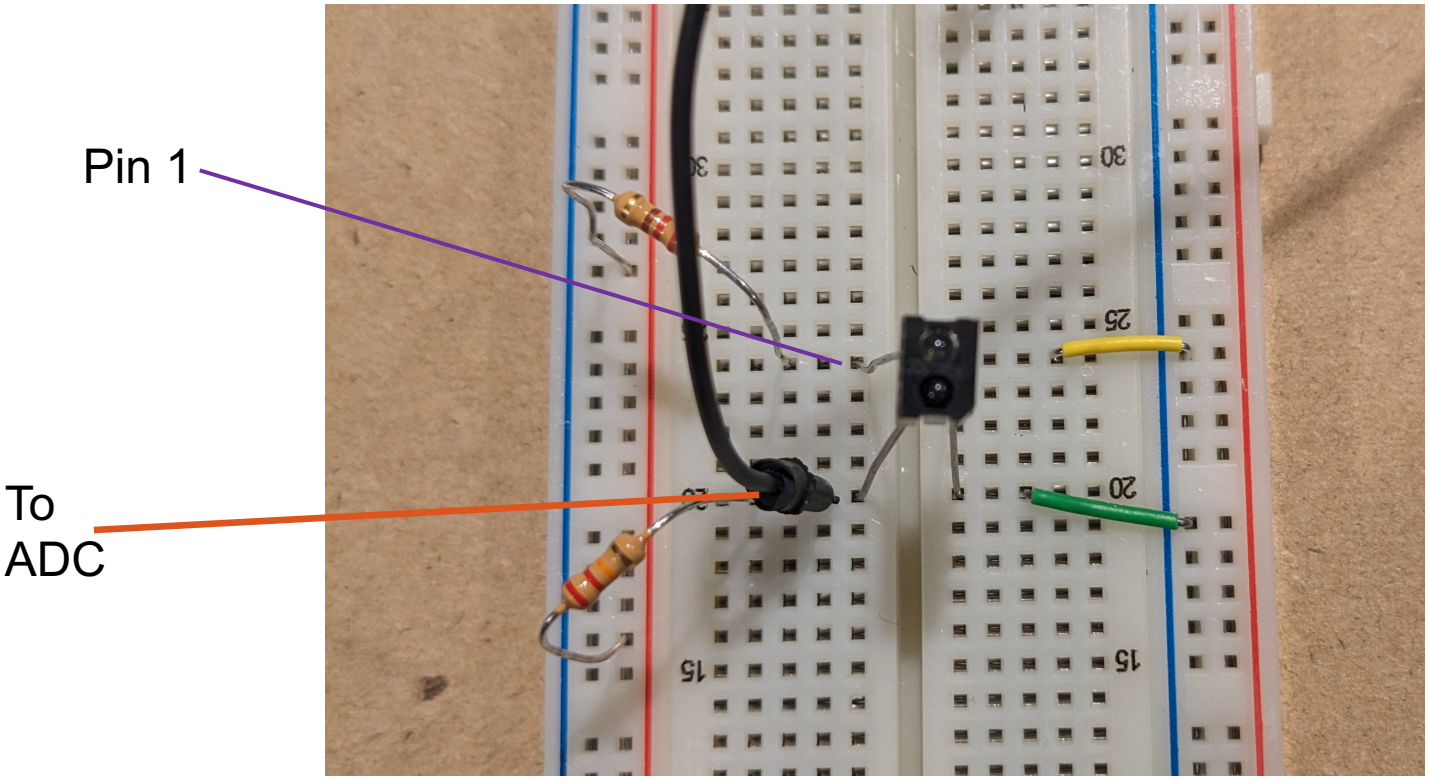
Internal schematic





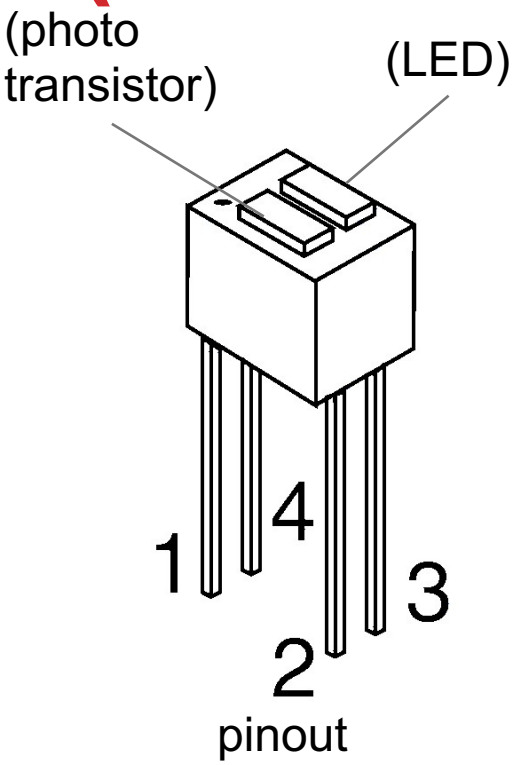
Circuit diagram

REFLECTIVE OPTICAL SENSOR (RPR-220)

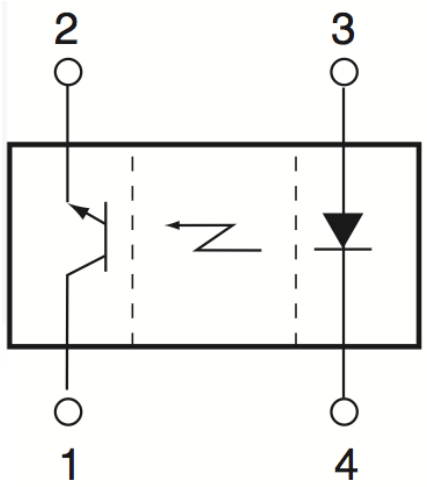


Reflective Sensor circuit

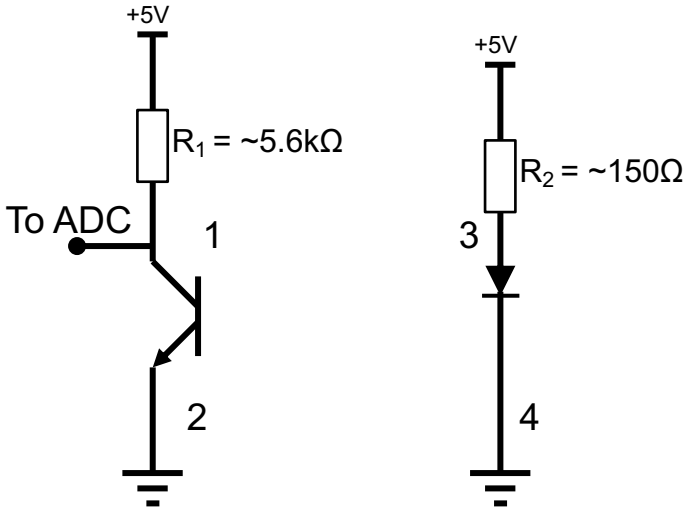
REFLECTIVE OPTICAL SENSOR (QRD1114)



pinout

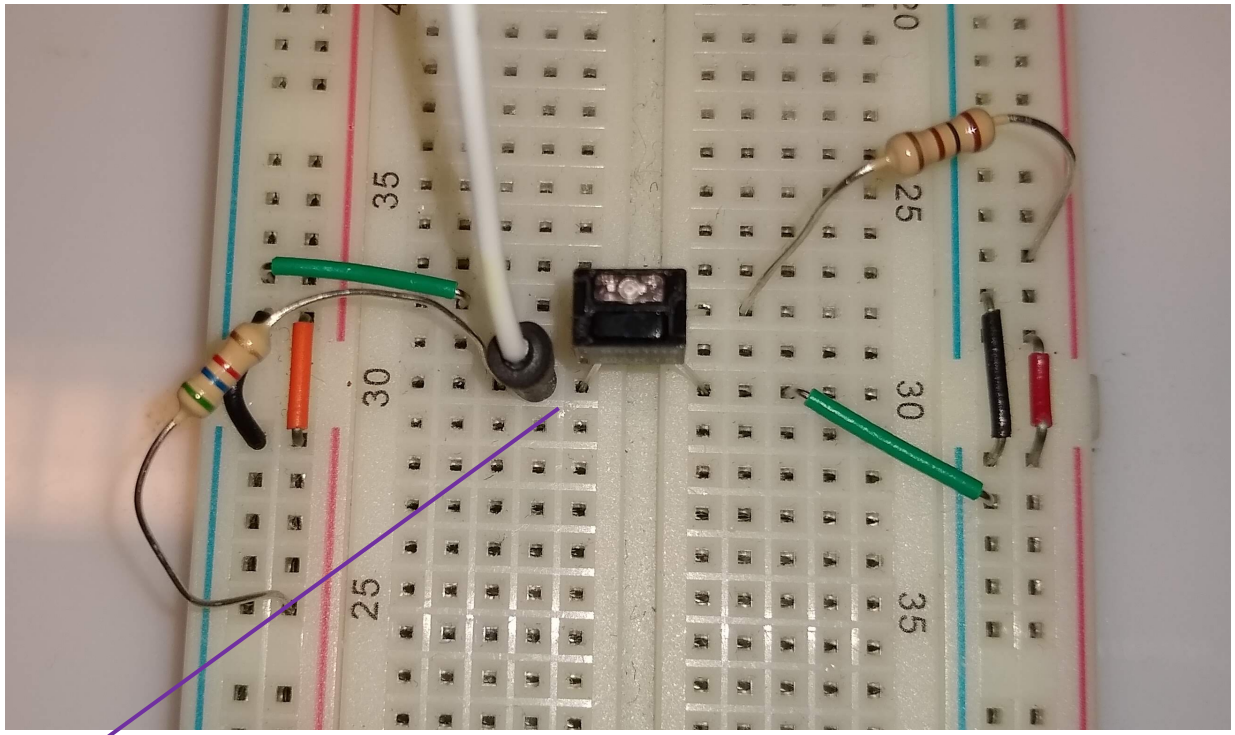


Internal schematic



Circuit diagram

REFLECTIVE OPTICAL SENSOR (QRD1114)



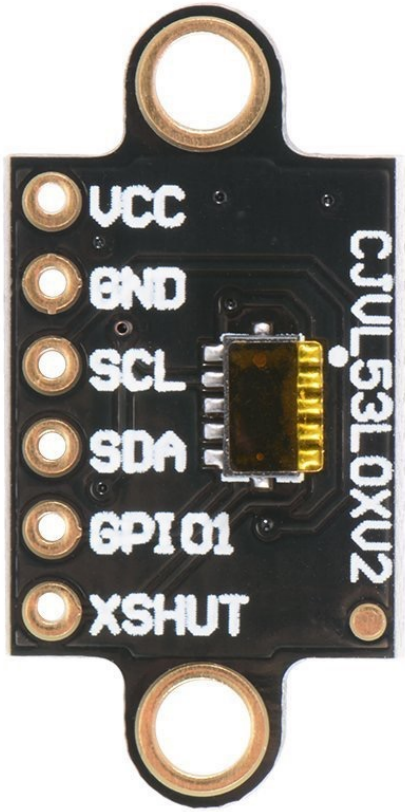
Pin 1

Reflective Sensor circuit

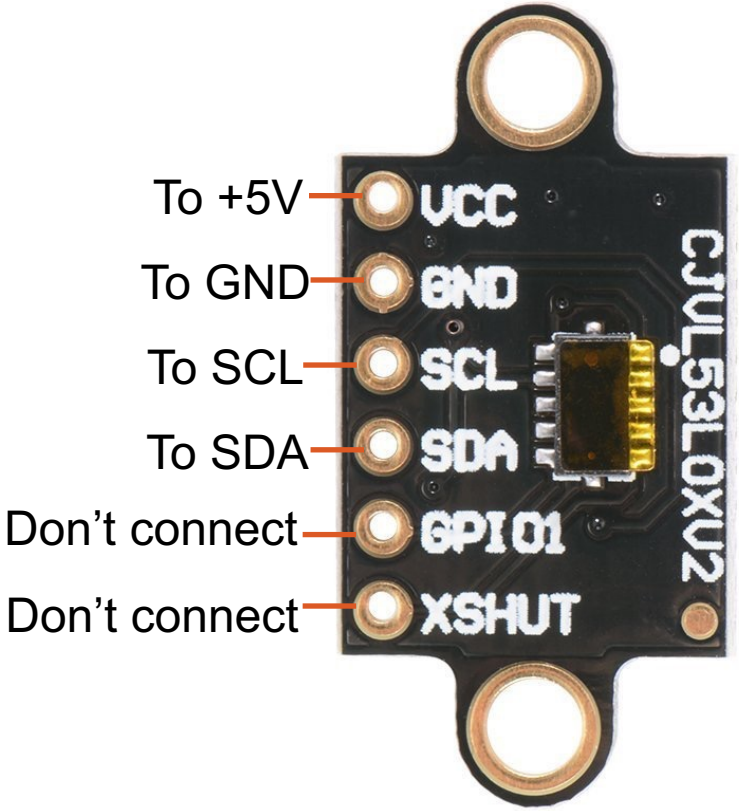
https://www.sparkfun.com/products/246

IR LASER TIME-OF-FLIGHT RANGE SENSOR

- ST Microelectronics VL53L0X
- Infrared Vertical Cavity Surface Emitting Laser (VCSEL) + Single Photon Avalanche Diodes (SPAD)
- 50mm to 1200m in default mode, with 3%-12% accuracy, depending on target and lighting
- Use the Adafruit VL53L0X library (via Arduino package manager)
- Lots of info on a similar board (with different connector) is here: https://www.adafruit.com/product/3317



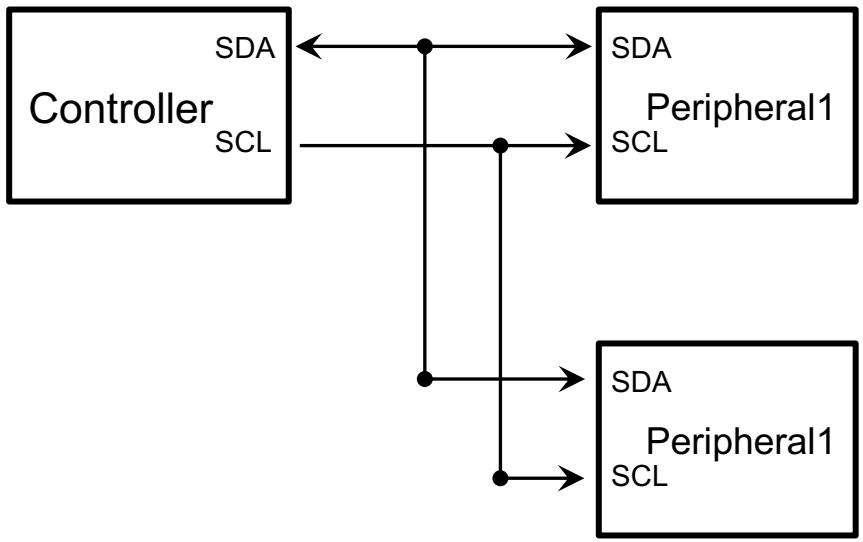
IR LASER TIME-OF-FLIGHT RANGE SENSOR



- Uses I²C protocol to get digital data directly from the sensor
- **NOT** analog output
- **BUT** the I²C pins on the Arduino happen to be shared with A4 and A5

I²C SERIAL PROTOCOL

- Inter-Integrated Circuit, also known as “Two-Wire Interface”
- **Controller** device sends commands to and receives information from **Peripheral** device
  - Controller: Arduino
  - Peripheral: Sensor
- Operates on a **Bus:**
  - each device has an **Address**
  - can easily have multiple peripherals
  - can less easily have multiple controllers
- 2 connections between devices:
  - **SCL**(Serial Clock) – Clock pulses generated by controller to synchronize data transmission
  - **SDA** (Serial Data) – Bidirectional data line for communication between controller and peripheral. Each device has transmit and receive mode.



I²C bus 1 controller and 2 peripherals

I²C SERIAL PROTOCOL

- All devices on the bus share the same 2 connections. Devices know the target of communication according by address
- Sparkfun tutorial:
  - https://learn.sparkfun.com/tutorials/i2c/all
- Arduino library reference:
  - http://www.arduino.cc/en/Reference/Wire
- 2 of the Arduino analog input pins do double-duty as I²C pins
  - A4: SDA
  - A5: SCL
- We don't need to do much to use it directly because we'll use libraries for our I²C sensors that do all the I²C communication for us

OTHER DISTANCE SENSING TECHNIQUES

Check out Sparkfun's excellent Distance Sensing Resource:

https://www.sparkfun.com/distance_sensing