

Final Projects

Form teams this week (2-3 people best)

Project proposal ideas and hints

\$50 parts budget per team; need to submit receipts

Fill out form with teammates GitHub repo (due midnight Mon Mar 5)

Discuss scope and feasibility with staff and teammates in lab

Submit proposal (due midnight Thu Mar 8)

Have progress to show the following week during lab

Class demos (9-11:30 am Fri Mar 23)

Final code and writeup submission (due midnight Mar 23)

CS107e

Sensors and Sound

Pat Hanrahan

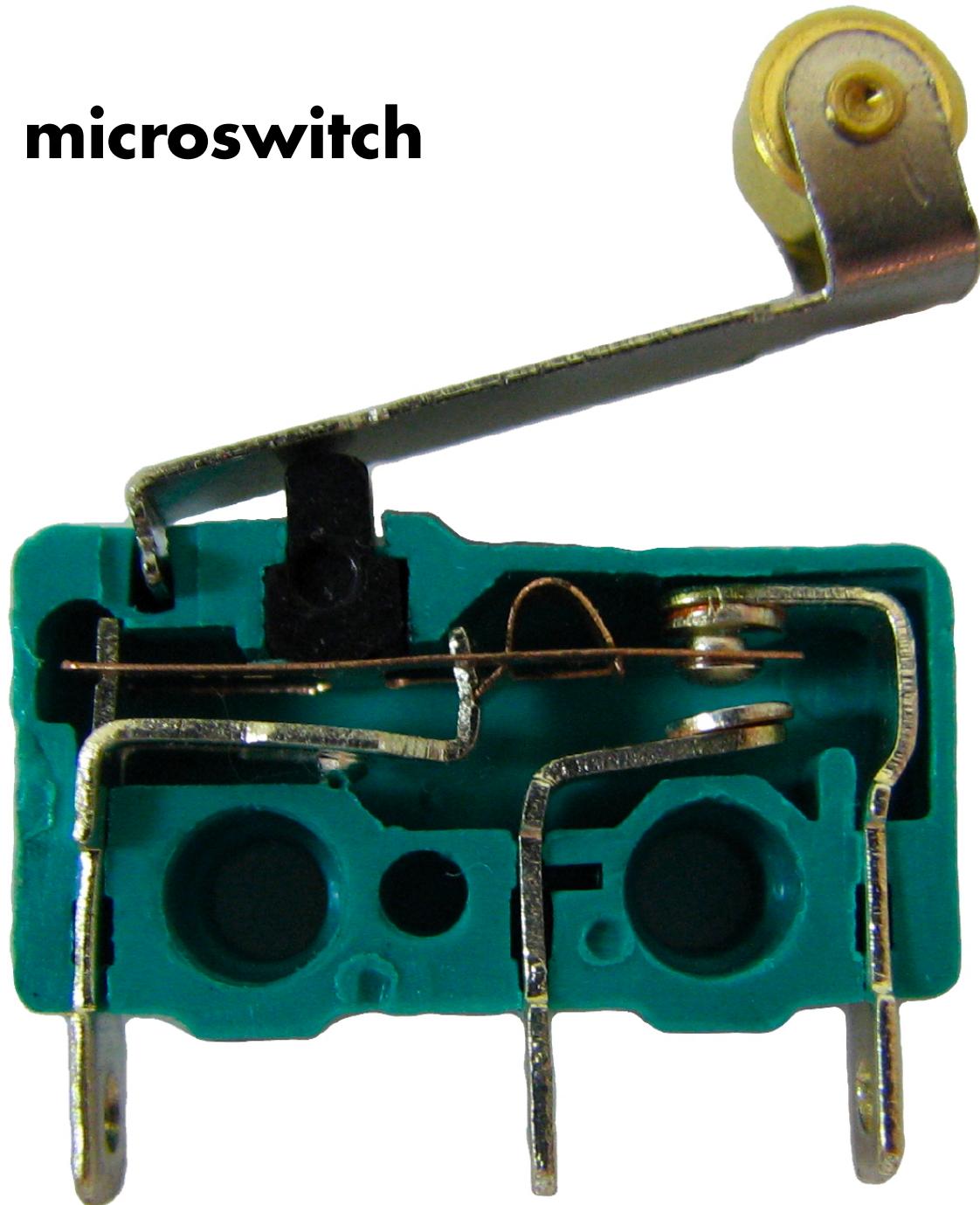
iPhone7 teardown



How many sensors?



snap-action microswitch



https://en.wikipedia.org/wiki/Miniature_snap-action_switch

Happ Pushbutton



Happ Joystick

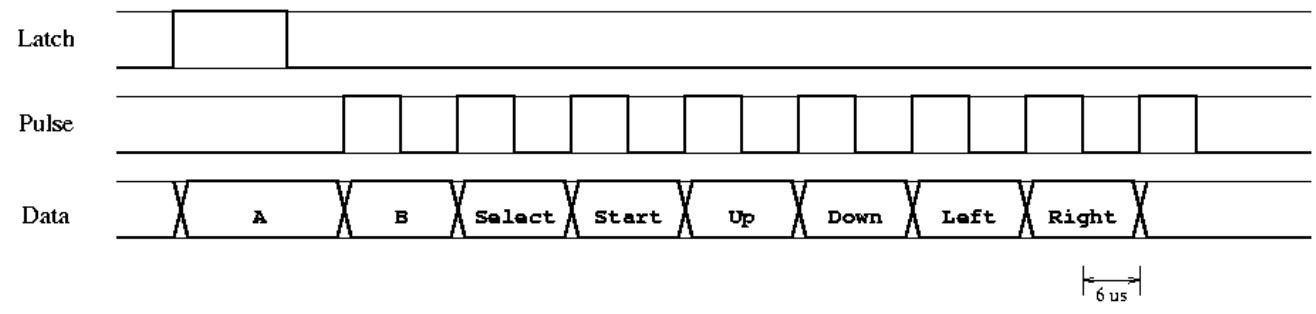
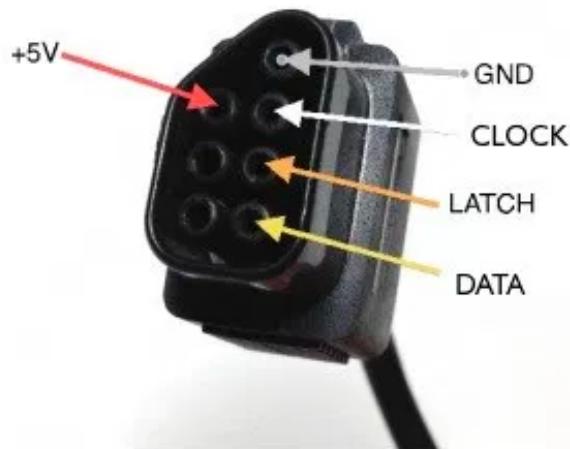


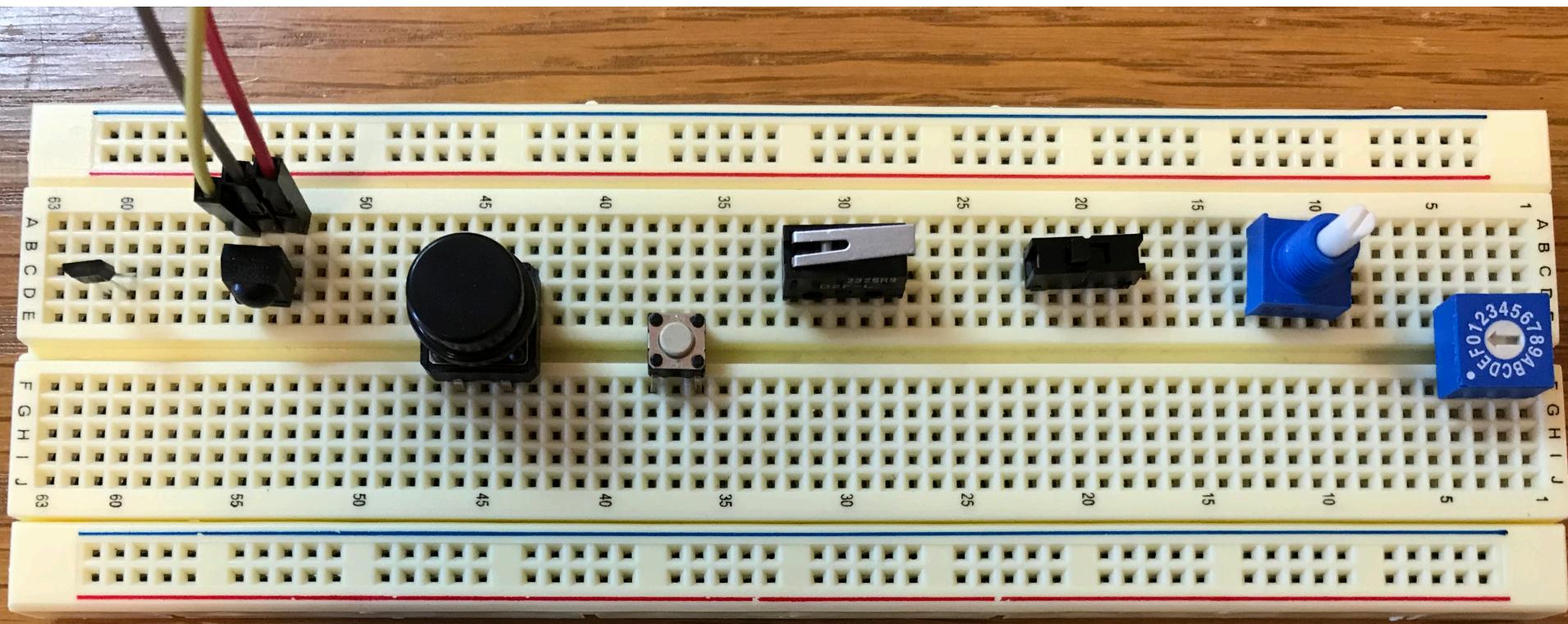


Famicom D-pad



NES D-pad



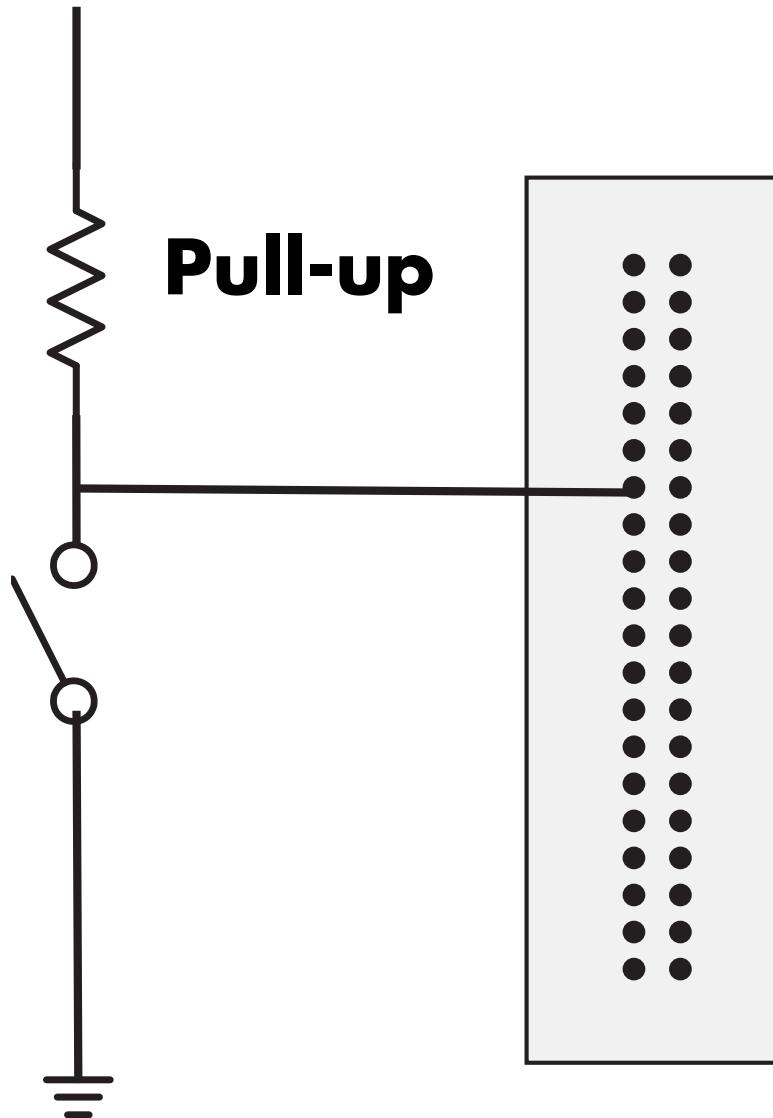


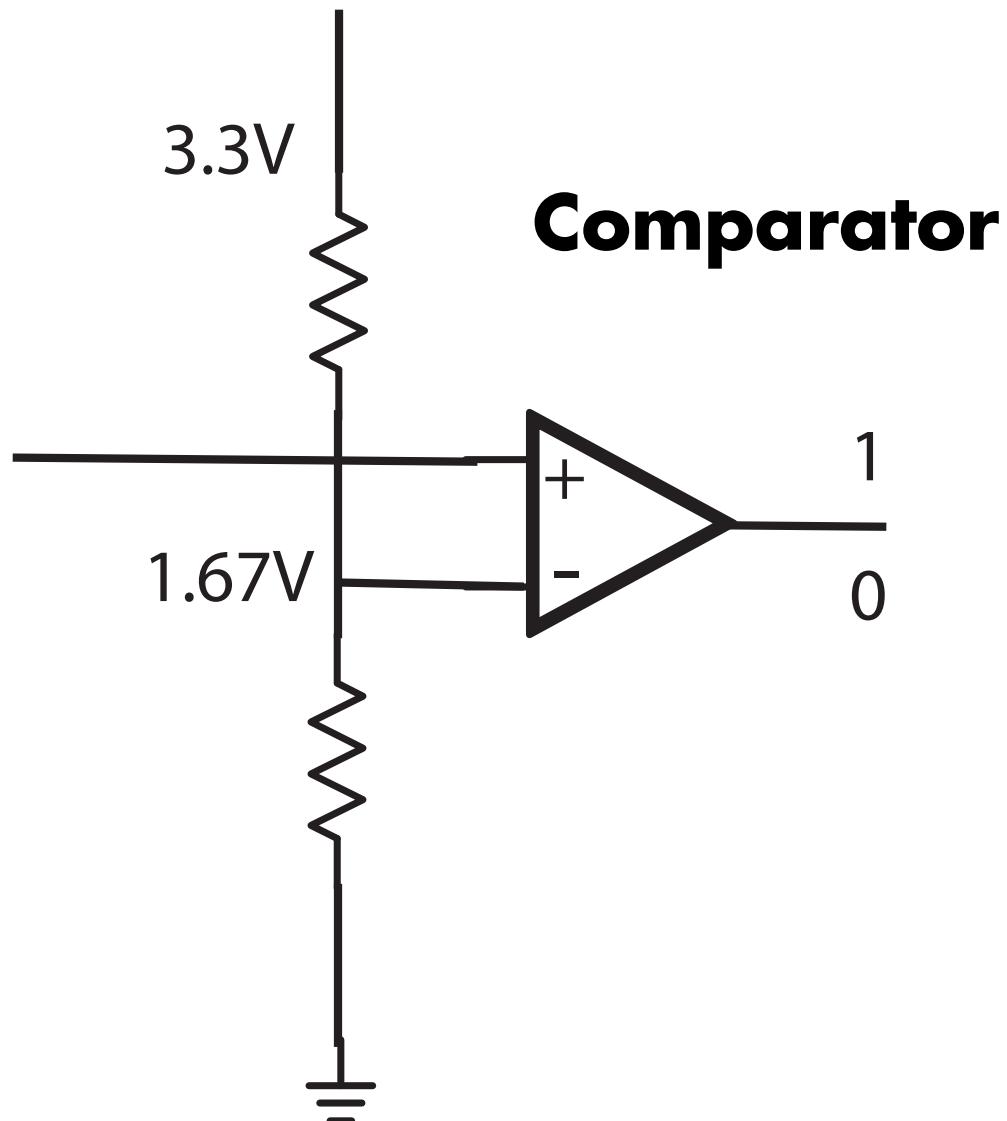
Hall Effect Sensor

IR phototransistor

3.3V

Pull-up



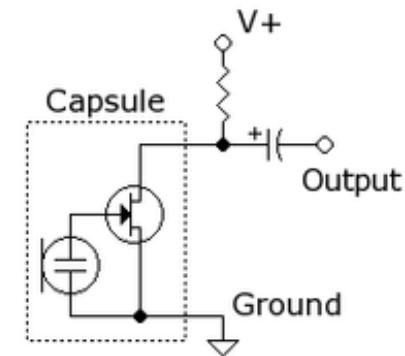


Analog to Digital

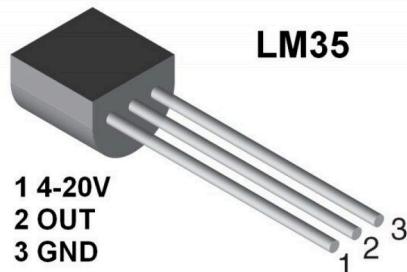
Analog Sensors



**Phototransistor
(light)**



**Electret Microphone
(pressure)**



(temperature)



**Hall Effect
(magnetic field)**

Analog to Digital (ADC)

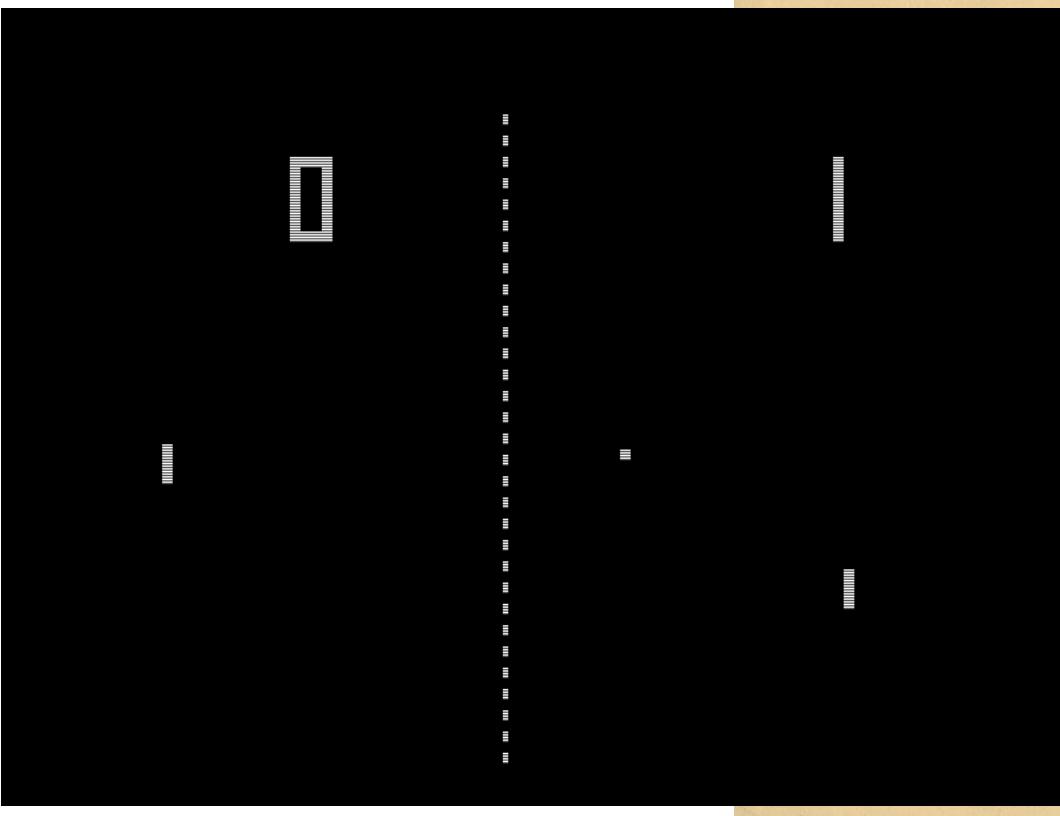


THE NEWEST 2 PLAYER
VIDEO SKILL GAME

PONG

from ATARI CORPORATION
SYZYGY ENGINEERED

The Team That Pioneered Video Technology



TRACT MODE
AUTOMATICALLY
MOVES POSITION
OF BALL
ACCORDING TO
MOVEMENT OF
PADDLE
CONTROLS
BY COMPUTER
SYSTEM
TO TELEVISION
SCREEN.
TIME AND
DISTANCE
ARE LONG,

COMPUTER

PROFITABLE
LOCATION
SUITABLE
FOR ALL
LOCATIONS

FROM YOUR LOCAL DISTRIBUTOR

Maximum Dimensions:

WIDTH - 26"

HEIGHT - 50"

DEPTH - 24"

SHIPPING WEIGHT:

150 Lb.



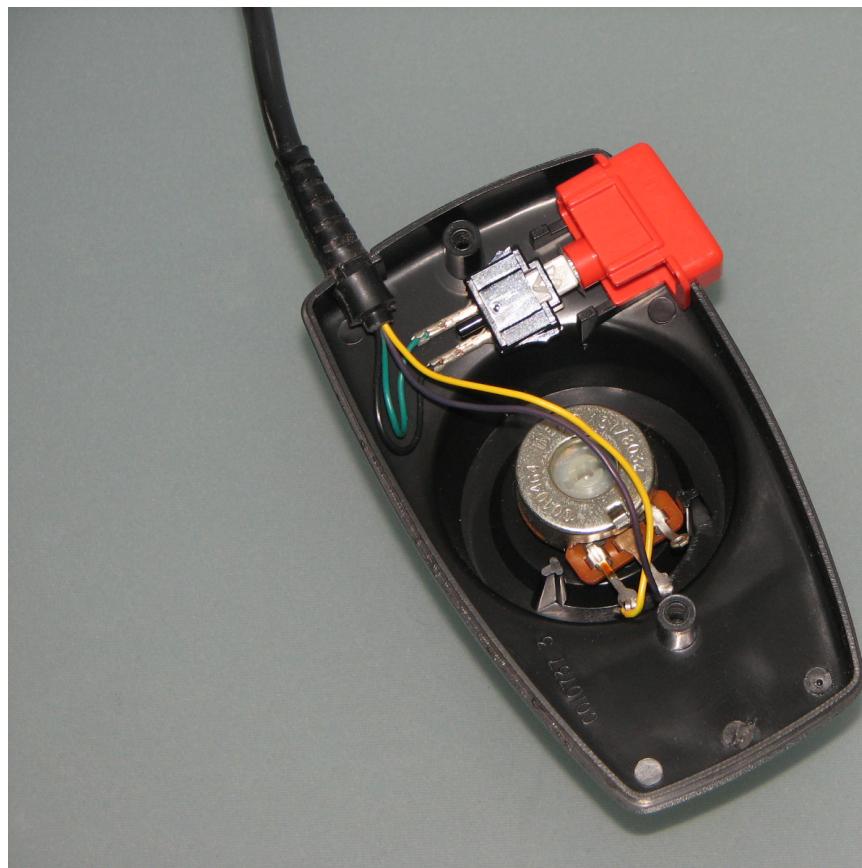
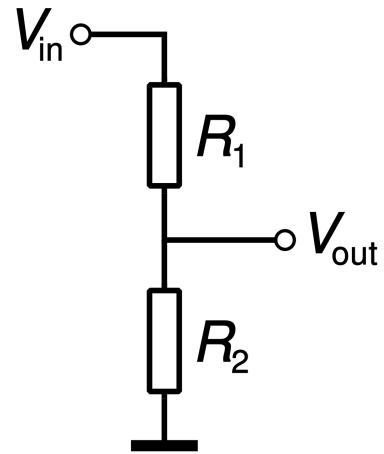
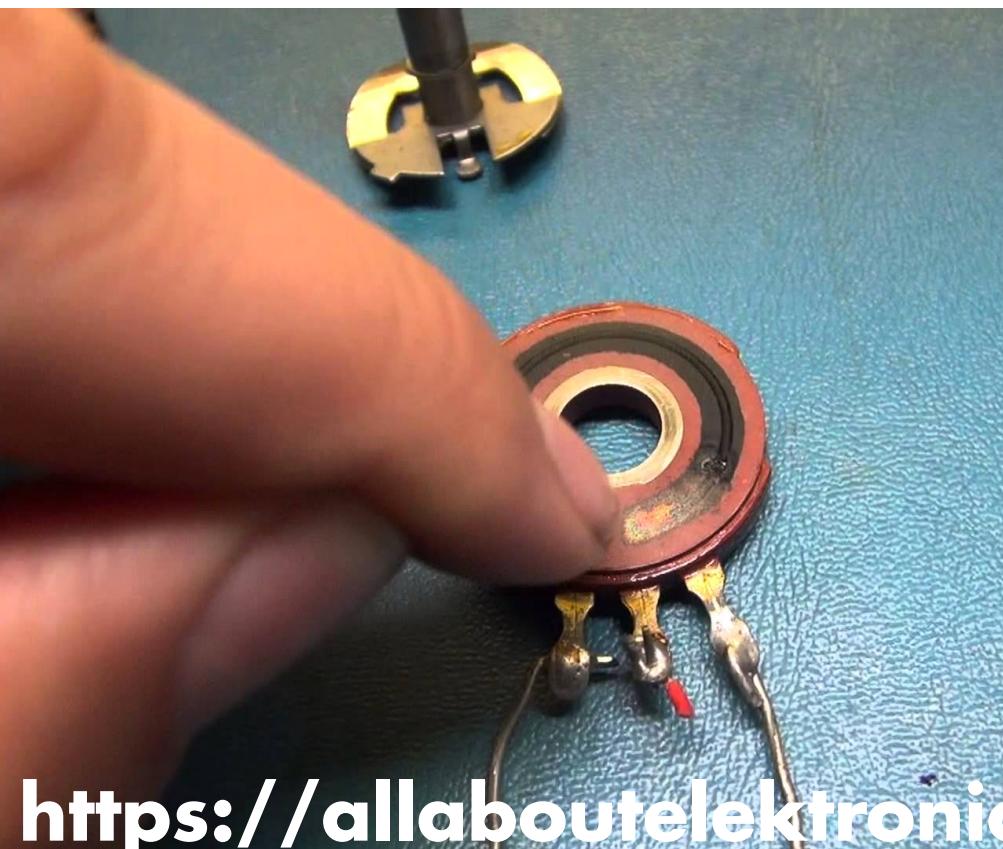
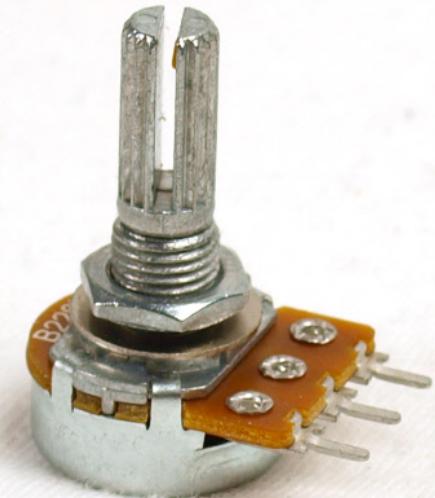


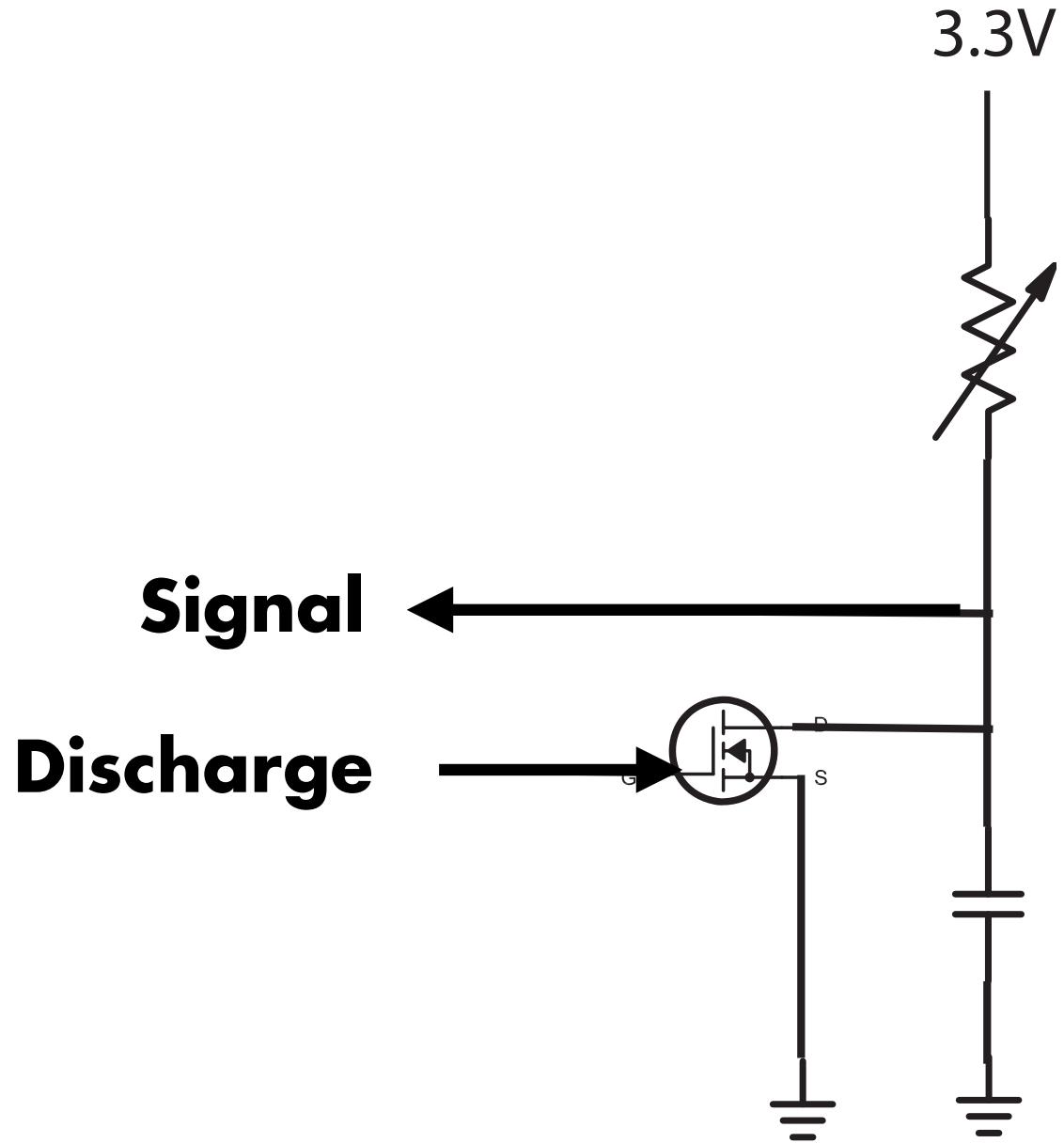
Image © Avon Fox
www.the-liberator.net
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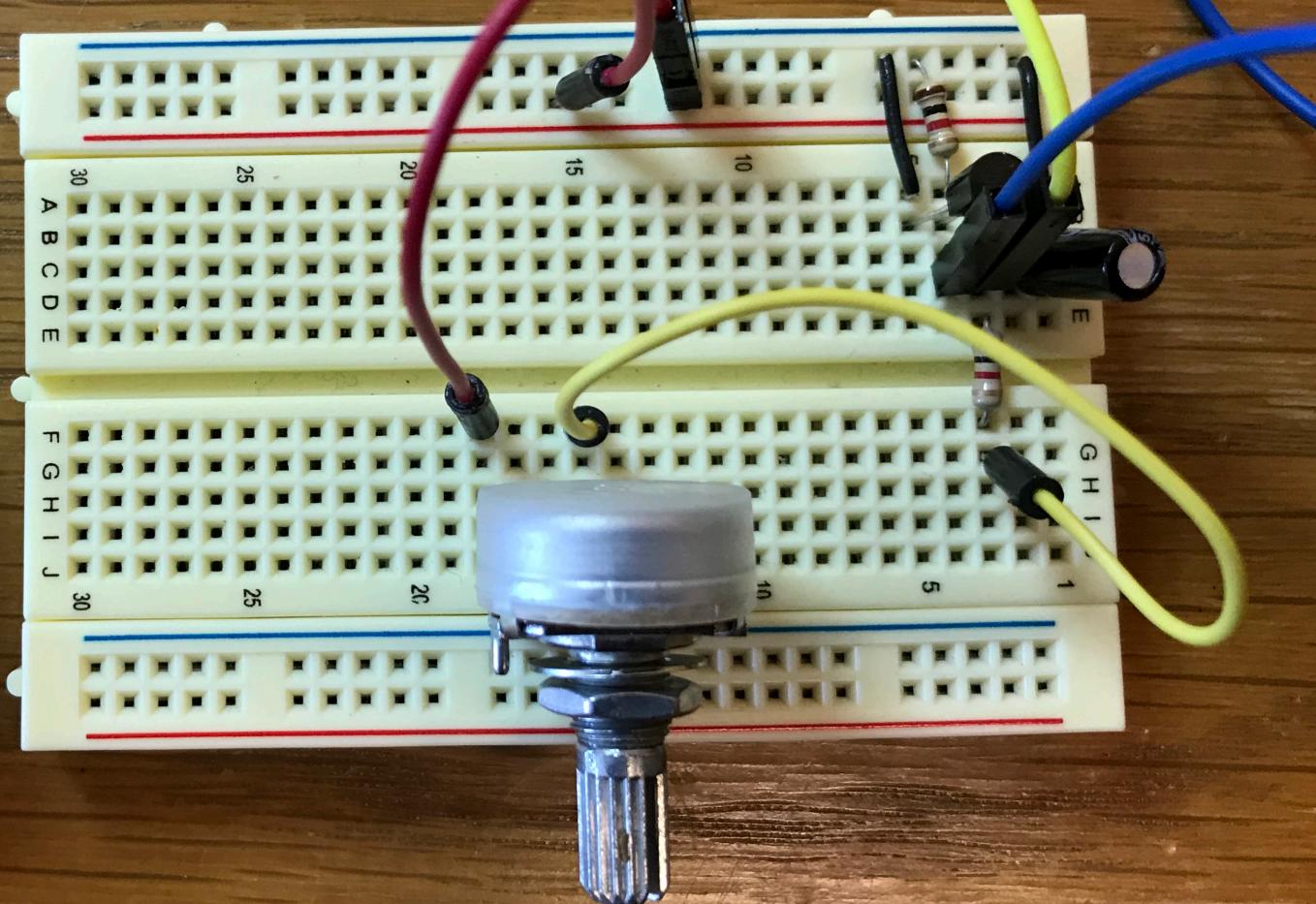
$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$



How would you measure the voltage?



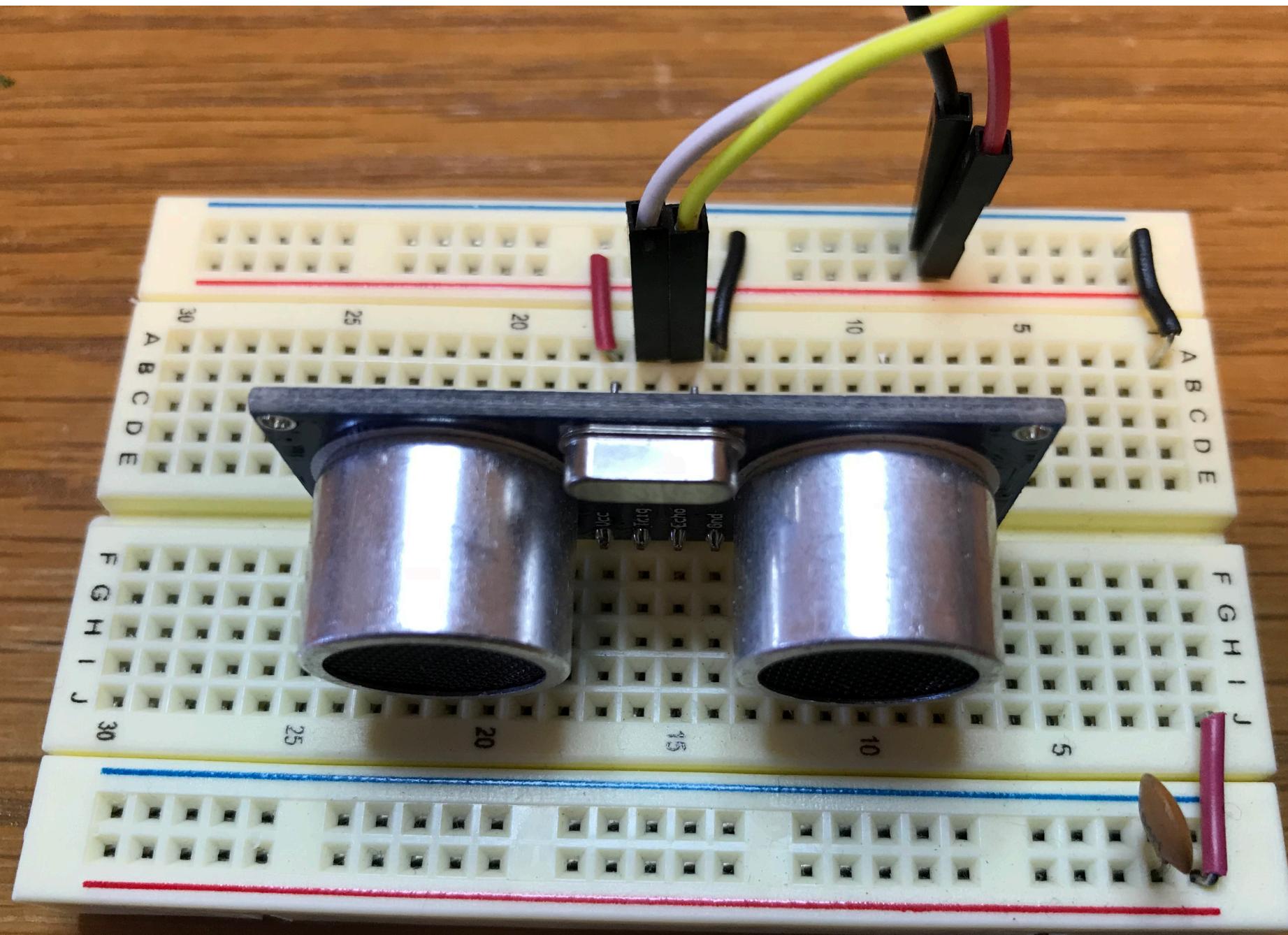
Timing Circuit



```
unsigned int get_charge_time(void)
{
    // discharge the capacitor
    gpio_write(discharge, 1);
    timer_delay_ms(10);
    gpio_write(discharge, 0);

    // time the capacitor charging
    unsigned int start = timer_get_ticks();
    while(!gpio_read(signal))
        ;
    unsigned int end = timer_get_time();

    return (end - start);
}
```

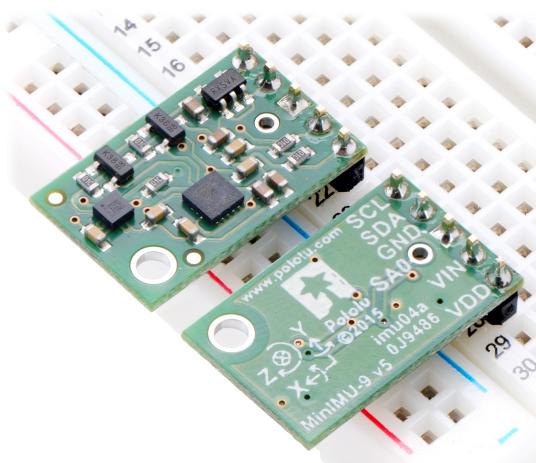


Ultrasonic Sonar

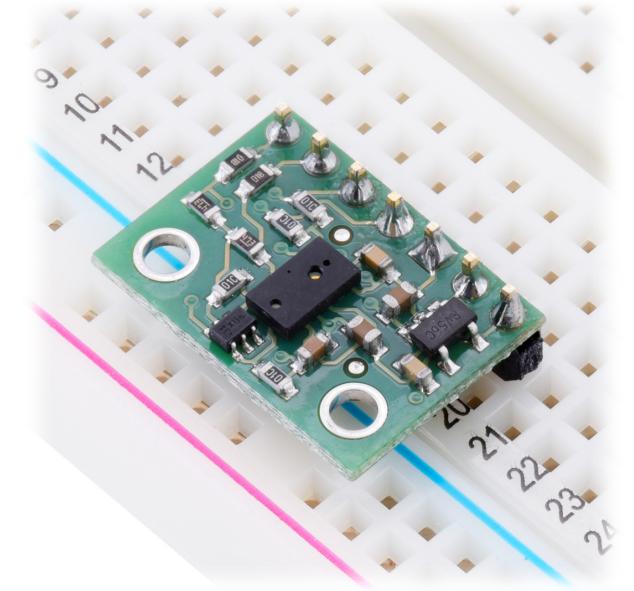
Sound

Smart Sensors

I2C Sensors



**Accelerometer
Gyroscope
Magnetometer**



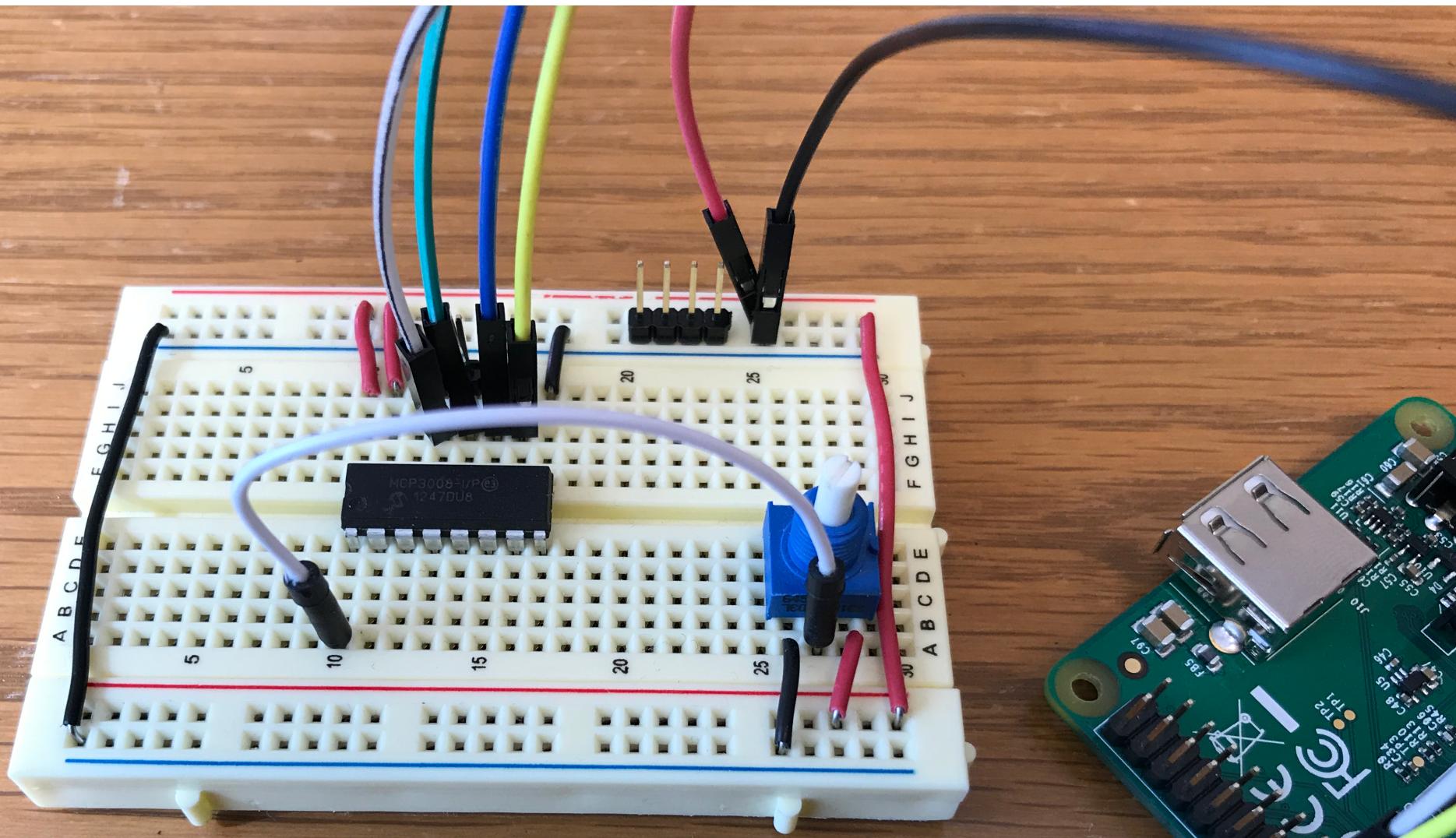
VCSEL Time of Flight



**Temperature,
Humidity,
Pressure**

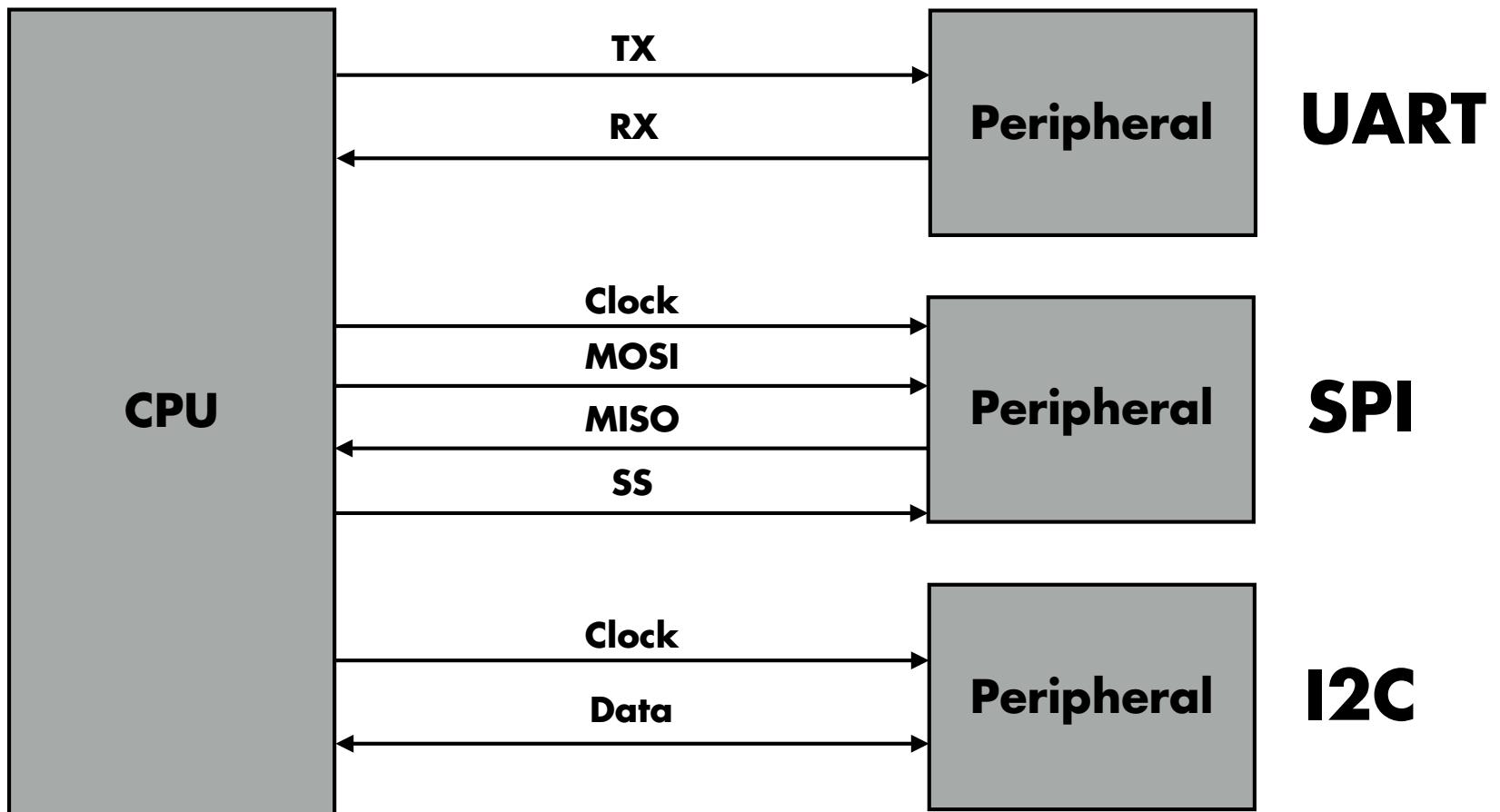


Arducam (SPI and I2C)



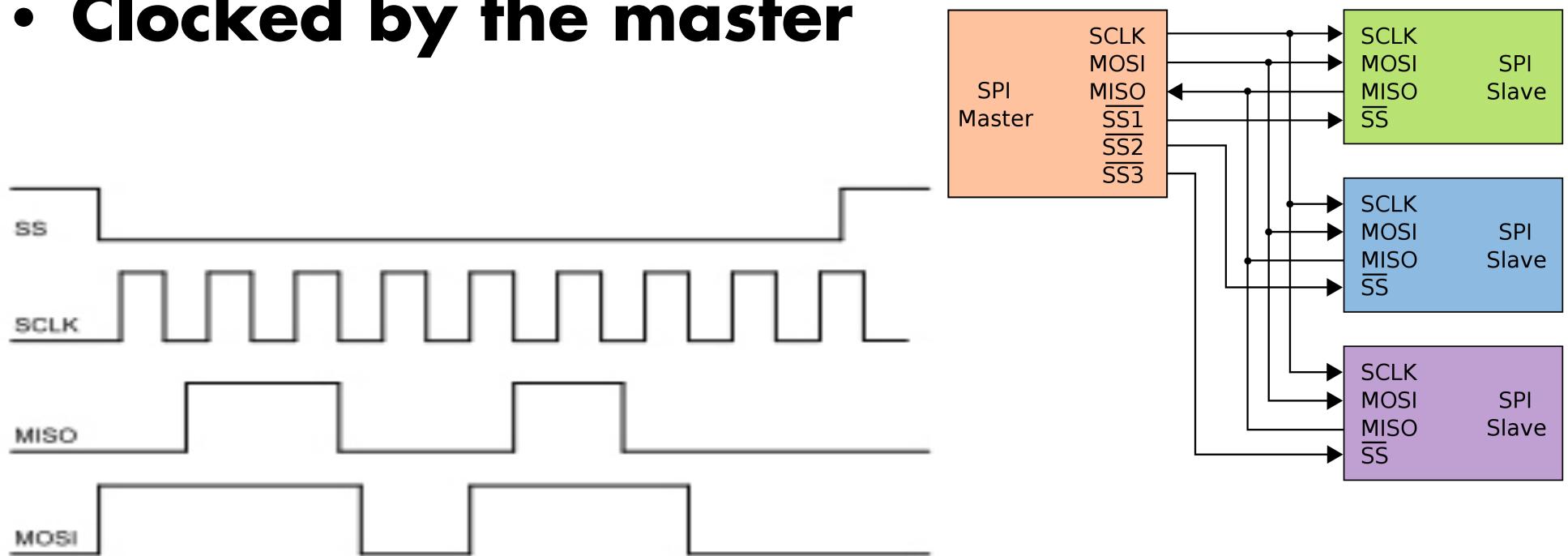
SPI MCP3008 analog to digital converter (ADC)

Bus Protocols

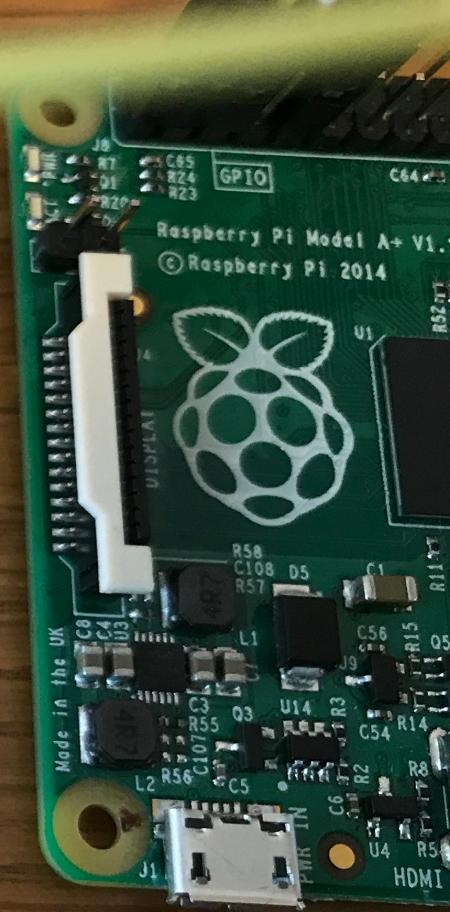
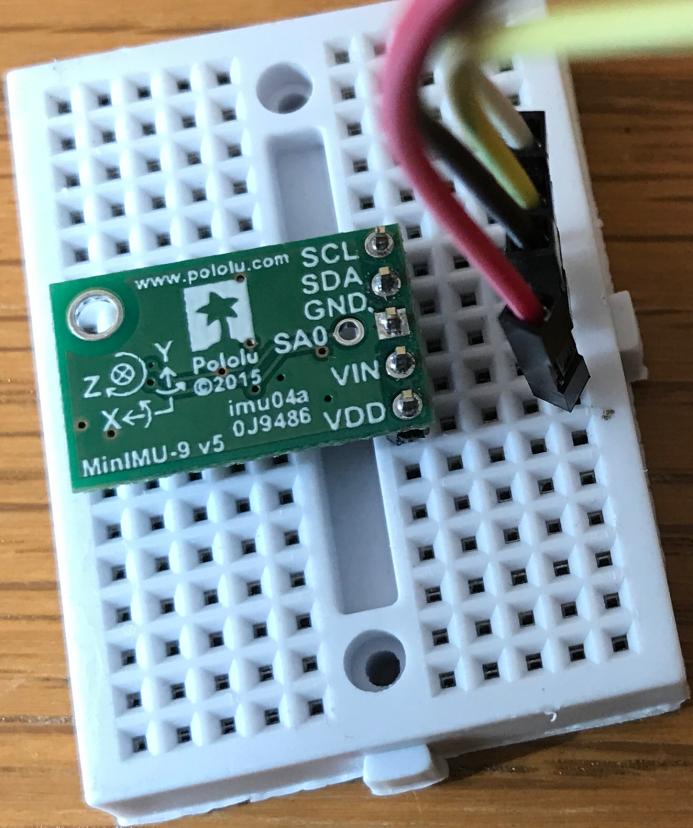


SPI

- **Shared CLK, MOSI, MISO lines**
- **Active low slave select (SS) lines to specify which peripheral is active**
- **Clocked by the master**

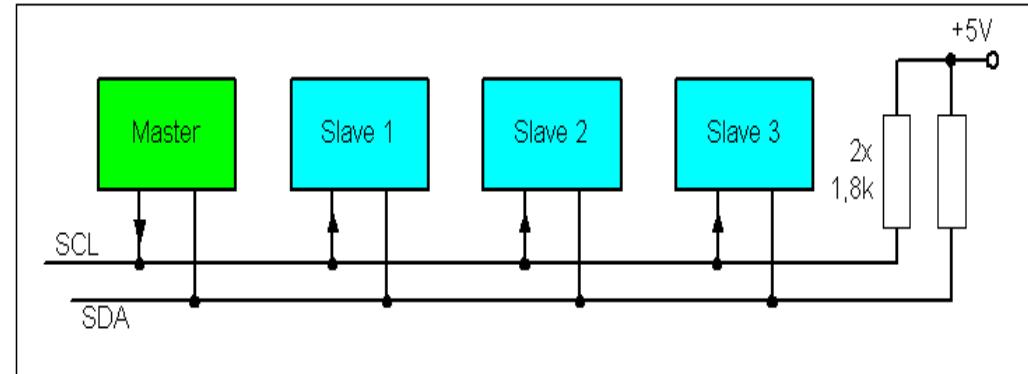


Figures from https://upload.wikimedia.org/wikipedia/commons/thumb/f/fc/SPI_three_slaves.svg/2000px-SPI_three_slaves.svg.png (top), <http://www.tequipment.net/RigolSD-SPI-DS4.html> (bottom)

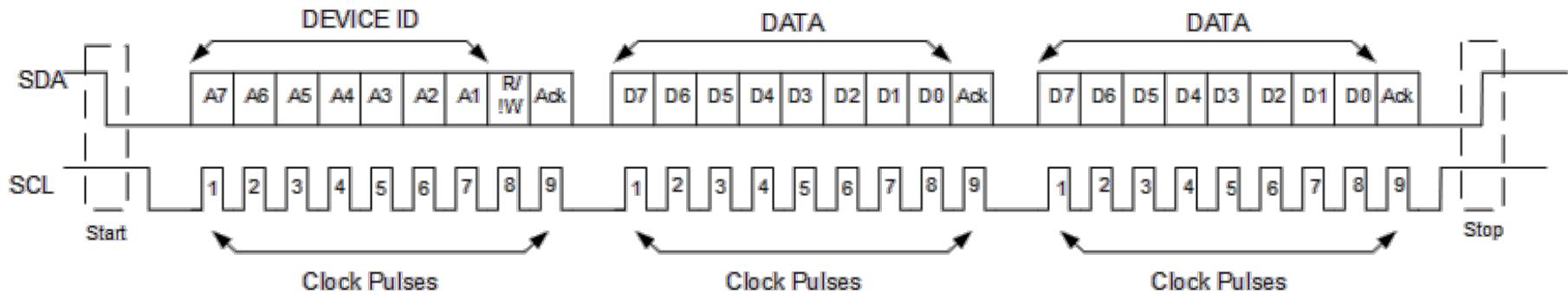


I2C IMU (orientation, gyroscope, compass)

I2C



- Only CLK & DATA lines
- Clocked by master, sides alternate who sends data
- Shared bus, slave identified by 7 (or 10) bit address



Figures from <http://www.cs.fsu.edu/~baker/devices/notes/graphics/i2cbus3.gif> (top)
https://learn.digilentinc.com/Documents/chipKIT/chipKITPro/P08/Fig_1_Waveform.png (bottom)

Sensing the World

Resistance (conduction, impedance, capacitance)-

Light (phototransistor, lidar)

Sound/pressure/deformation (piezo, electret, strain gauge)

Temperature (heat), humidity, pressure

Electromagnetic fields (hall effect, compass, antenna)

Acceleration (force direction)

Orientation (gyroscope)

Special Lectures on Monday

Anna



Lenny



performance

git workflow