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Project # 1: Sensors		

I. OBJECTIVES

- To learn how to configure a sensor.
- To learn how to read a data sheet to understand device behavior.
- To design an experiment to study the characteristics of a sensor.
- To learn how to filter sensory signals.

LAB PROCEDURE

Part I: Sensor 1 - photoresistor

1. The light sensor you were given today is a photoresistor whose resistance varies with the amount of light intensity that it sees. Connect the photoresistor to a multimeter in the resistance mode. Block the light that falls on it with a paper and use light from your phone or a flash light to vary the intensity and note the value of its resistance.
At default, it is around 2kOhm. After covering the photoresistor, the resistance jumped to about 75kOhm and with bright light it went down to 200 Ohms.

2. To use the photoresistor, the simplest implementation is a voltage divider on a protoboard.

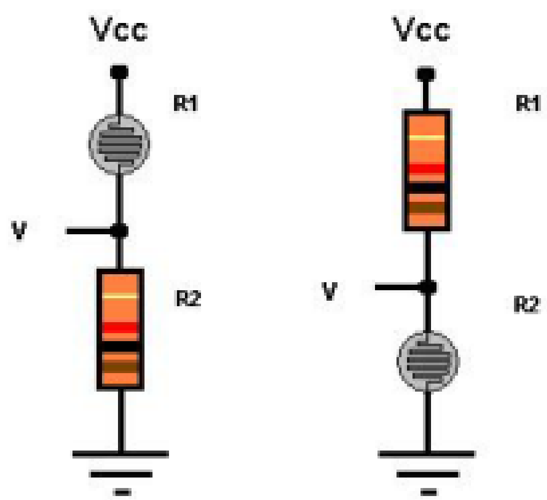


Figure 1 (a) Figure 1 (b)

Figure 1: Two possible Photoresistor configuration

(i) Connect the photoresistor and a 10K resistor provided to you as seen in Figure 1(a) with the photoresistor as R1. Use the 5V and GND for power connections.

(ii) Using a multimeter in voltage mode, note the values of voltage as light changes.

Using the layout in figure 1a as the light decreases the measured voltage decreases.

(iii) Also connect the output to the oscilloscope and observe how the voltage changes.

Using the layout in figure 1a as the light decreases the measured voltage decreases.

(iv) Hold a light one arms-length away from the photo resistor. Use a potentiometer in place of R2 on the previous circuit and produce a 2.5 volt output.

(v) Observe the output on an oscilloscope with the previous circuit as you change the light intensity from dark to bright.

Using the layout in figure 1a as the light increases the voltage increases from 2.5v.

TA Check Point: Complete Part I and demo the results to your TA

Post lab: If you were to connect the photoresistor as R2 and resistor at R1, what changes would you observe as you change the brightness of your light from low to high. (light intensity from dark to bright)

If the photoresistor was R2 and we still measured voltage across R2, then voltage would decrease as we get exposed to more light.

Part II: Sensor 1 - Noise interference on photoresistor

All sensor inputs sometimes have noise from the environment. You have to provide the sensor output after removing this noise.

Scenario A:

The sensor output is a DC voltage generated from the photoresistor configured as in Part I. There is a noise signal at 1 KHz that is interfering with the sensor data. Design a filter that provides only the sensor signal that is DC.

Scenario B:

The sensor is used to detect a light that is pulsing at 10KHz. But the sensor also detects an ambient light at low frequencies that needs to be removed. Design a filter that provides the pulsing information.

1. Figure 2 shows a range of circuits that can be used for signal conditioning. Choose the circuits you would use and explain why you would use them.
   We choose figures 2a and 2b as they are a low pass and high pass filter respectively. They will filter out these noise signals we want to get rid of. Figure 2c is just a voltage divider and won't get rid of the noise.
2. Draw a final schematic for each of the scenarios showing the signal path from sensor output to the scope.

Figure 2(a)

1000 Hz cutoff but we want 2 decades lower so

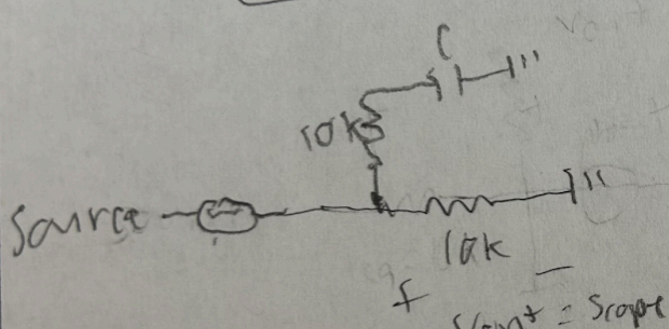
cutoff freq = 10 Hz

$$\frac{1}{2\pi(1\times10^{-6})R} = 10$$

$R = 15915.5\ \Omega$

$\boxed{R = 10k \text{ then freq} = 16 \text{ Hz}}$

we'll go w/ 16 Hz instead so we can use a 10k resis.

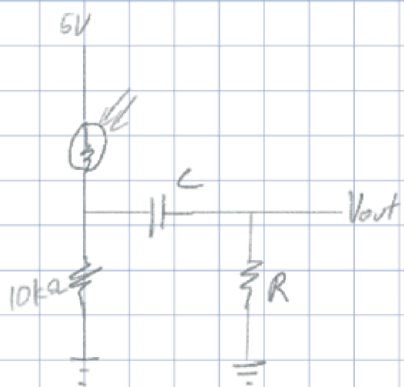


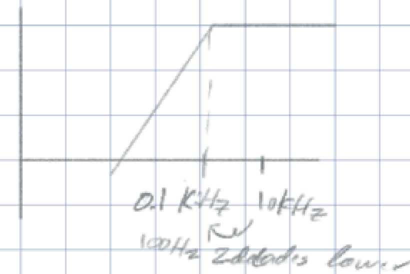
Scenario B

pulse at 10kHz
low freq noise.

$C = 1\mu F.$

so high pass needed.
similar to fig 2b.





$$f_0 = \frac{1}{2\pi RC}$$

$$0.1\,kHz = \frac{1}{2\pi(1\mu F)R}$$

$$R = 1591\,\Omega$$
$$\approx 1600\,\Omega$$

no resistor available
will combine 3 in series

$$= 1.2k\Omega + 200\,\Omega + 200\,\Omega$$
$$= 1.6k\Omega$$

3. Make sure to clearly calculate the values of the resistance and capacitors you would use for the filters.

Figure 2(a)

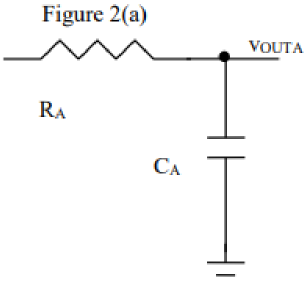


Figure 2(b)

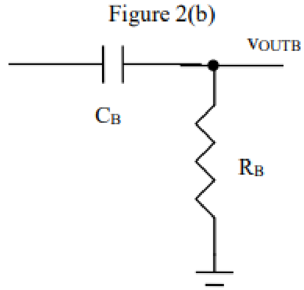
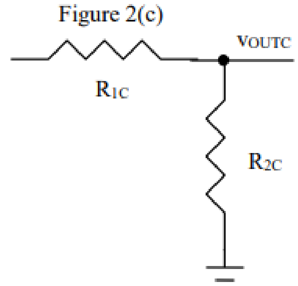
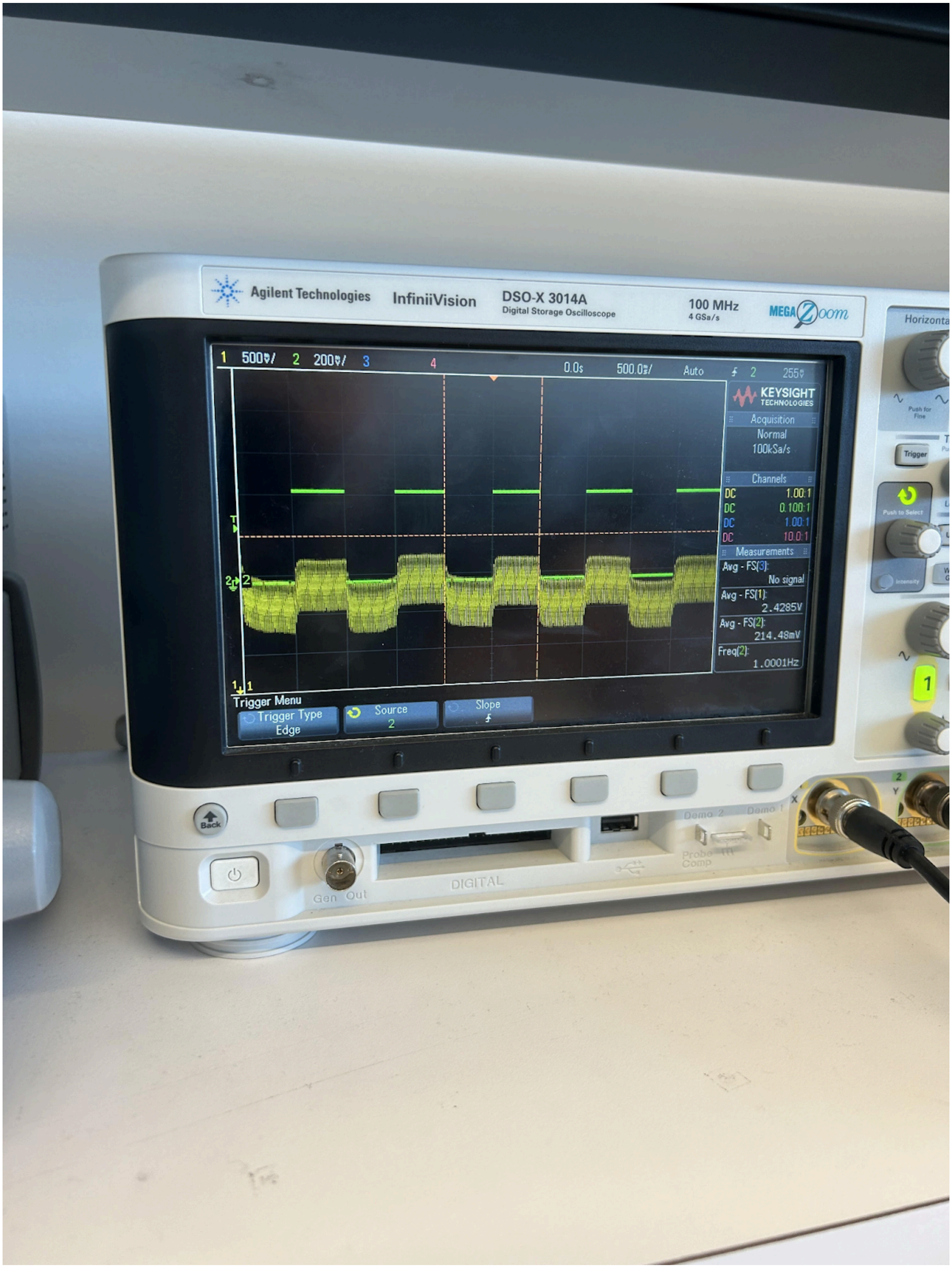


Figure 2(c)

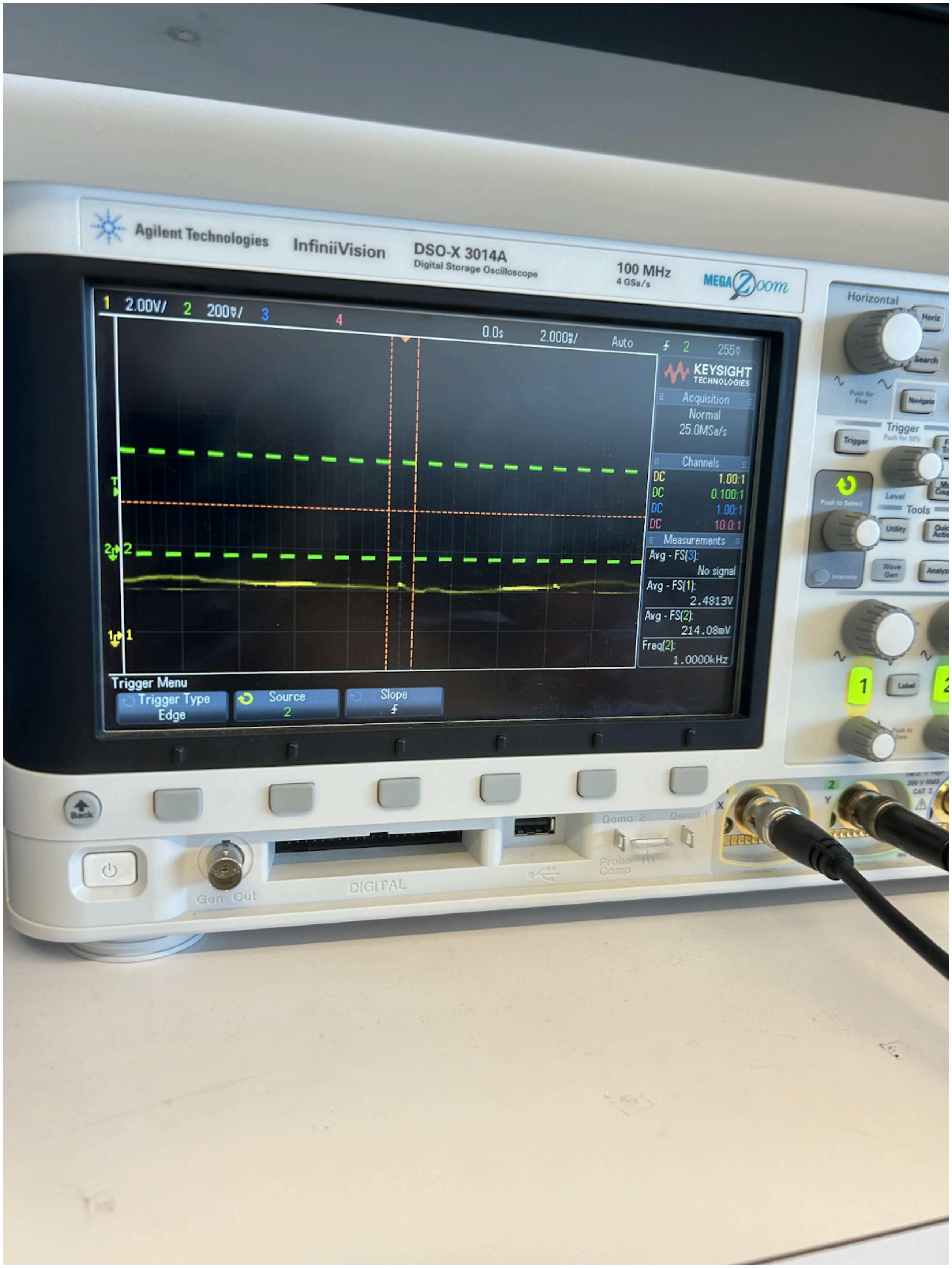


4. Show your TA your filter calculations.
5. Build your two filter circuits. Test the effectiveness of your filters by testing it against the demo noise generating circuit that your TA has built.

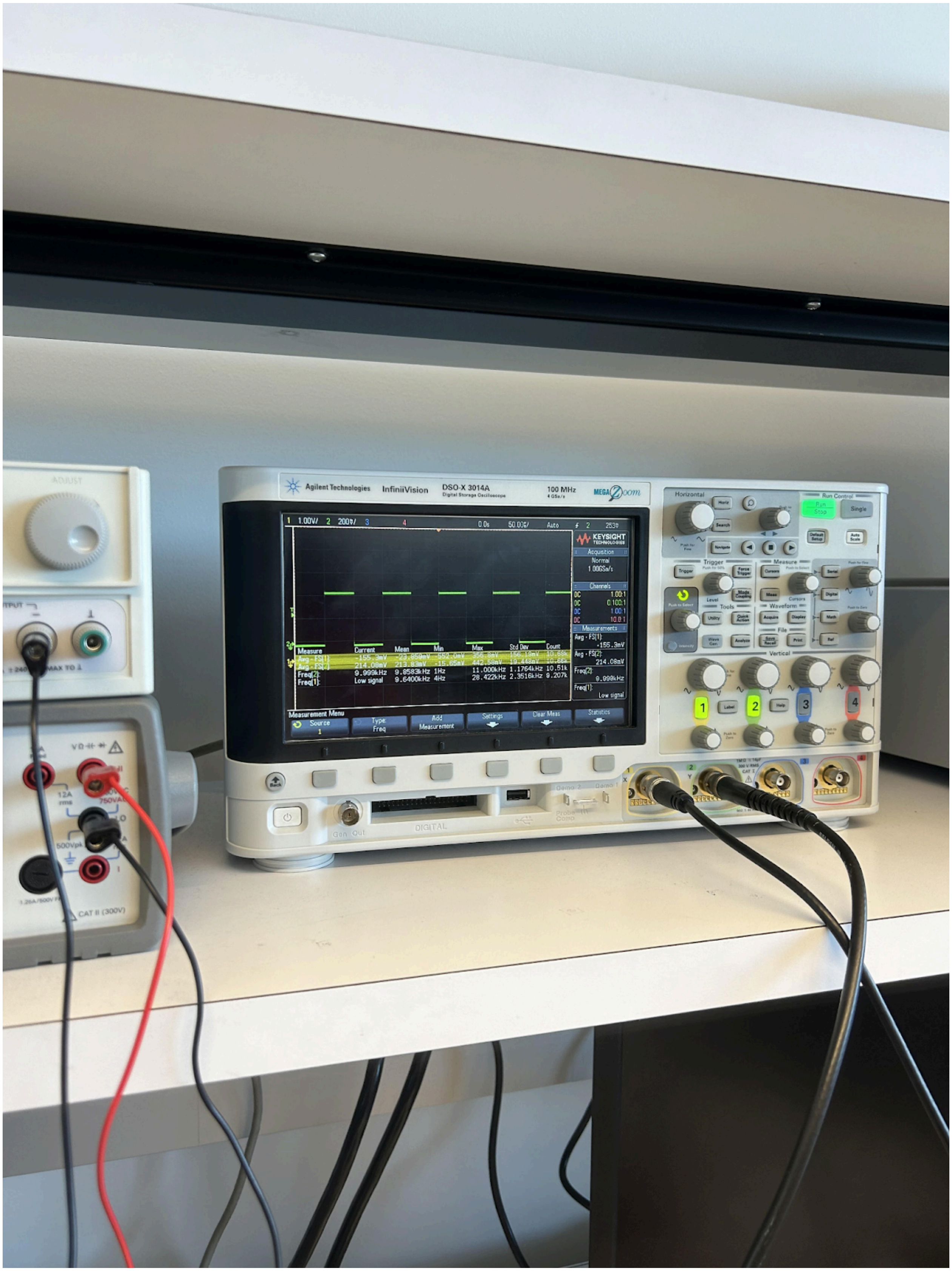
1 hz frequency on the low pass. It is allowed through but noisy.



1KHz on the low pass filter. The signal is not allowed to pass.



10KHz on the high pass filter. It's very noisy and hard to see but the signal is allowed through (Michael approved).



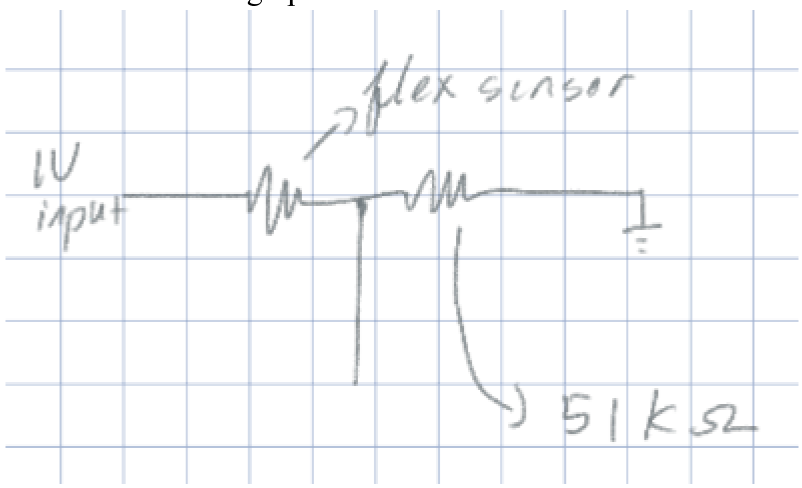
1 hz on the high pass filter. The signal is not allowed through.

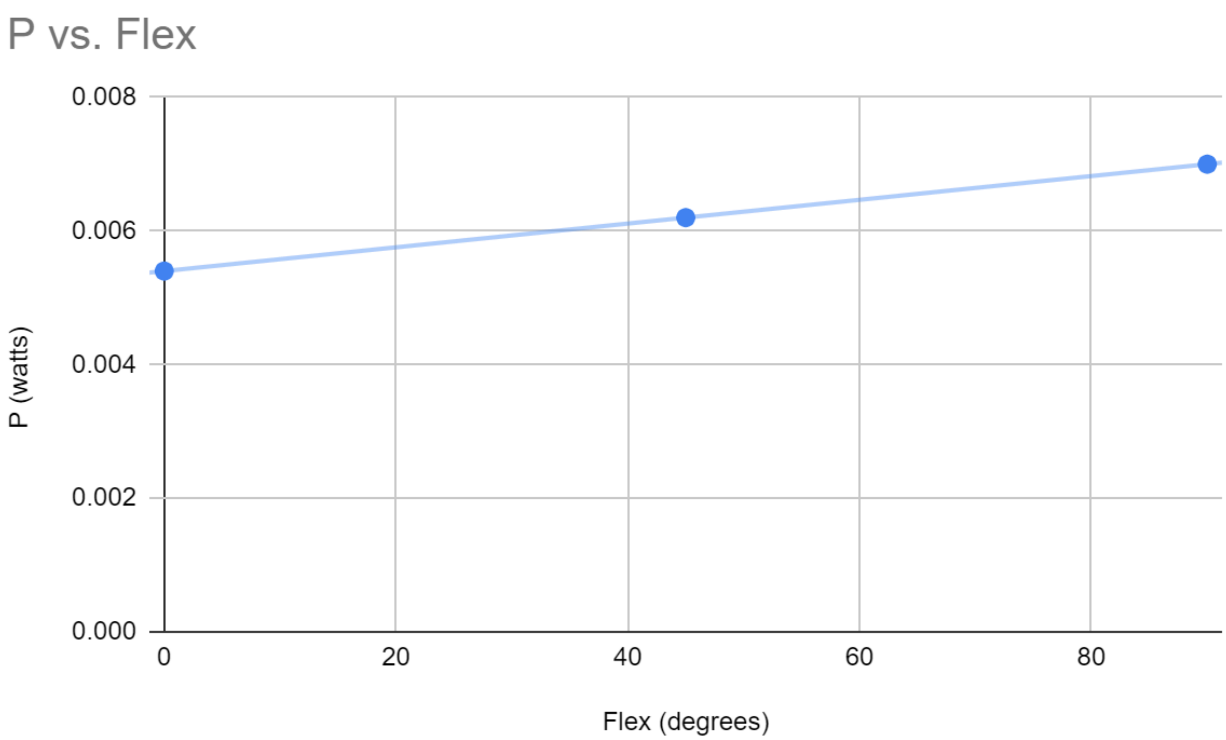
TA Check Point: Complete Part II and demo the results to your TA

Part III: Sensor 2 – Flex Sensor

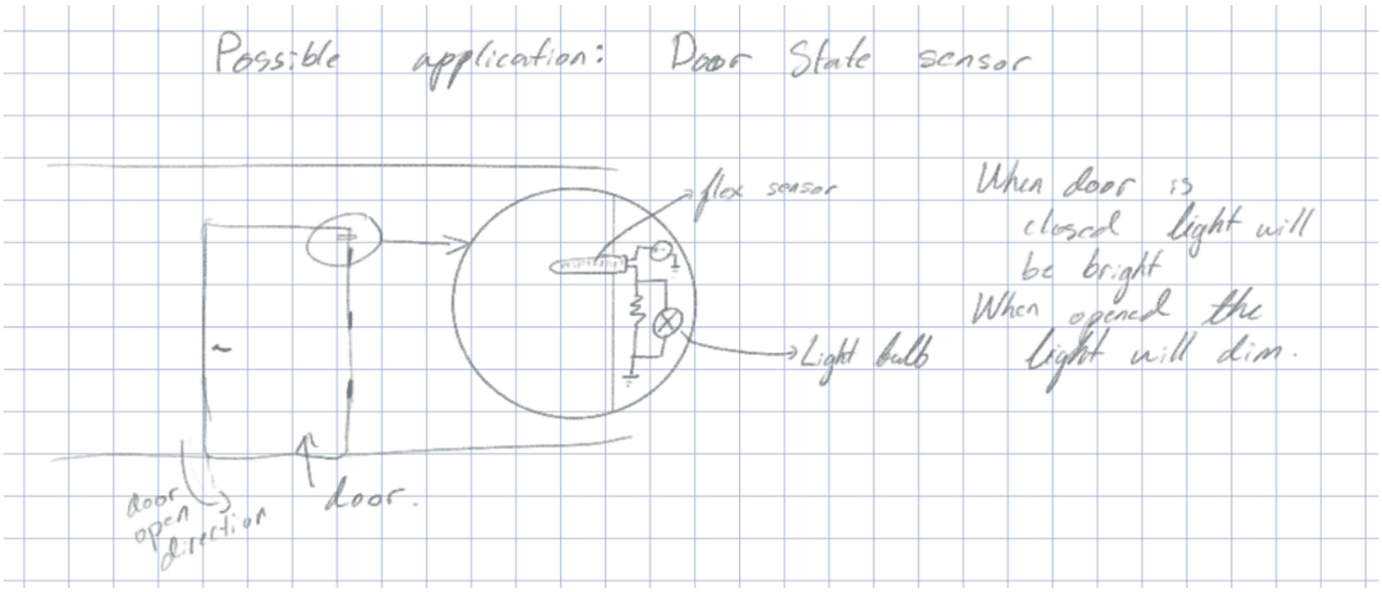
(i) Look up the data sheet of the flex sensor given to you in lab.

(ii) Design an experiment to characterize the sensor you have been given. Make sure to keep the power draw below the data sheet values. The resistors are 0.25 W. Draw the circuit schematic of your final design. **Before you power on the circuit, please ask your TA to check your circuit.** Build the circuit you designed. Make necessary measurements and graph them to show the sensor characteristics.





(iii) Build a possible application for this sensor. Detail how you would design this application.



TA Check Point: Complete Part III and demo the results to your TA