Lab 5: OpAmps II

Objective:

- Photodiodes
- Transimpedance Amplifier (TIA)
- Transconductive Amplifier (TCA)

Lab Exercises:

A. Photodiode Basics (30min estimated amount of time)

[L1] At three different light levels create an IV curve for the photodiode. Plot all 3 IV curves on the same plot.

[L2] What differences do you notice about the 3 different IV curves relative to the light levels?

B. Current to Voltage Converter (Transimpedance Amplifier) (45min estimated amount of time)

Build the circuit in Figure 1. Use an LF356 op-amp, and arrange the dual-output power supply to supply +15 V_{DC} to pin 7, -15 V_{DC} to pin 4, and ground to pin 3.

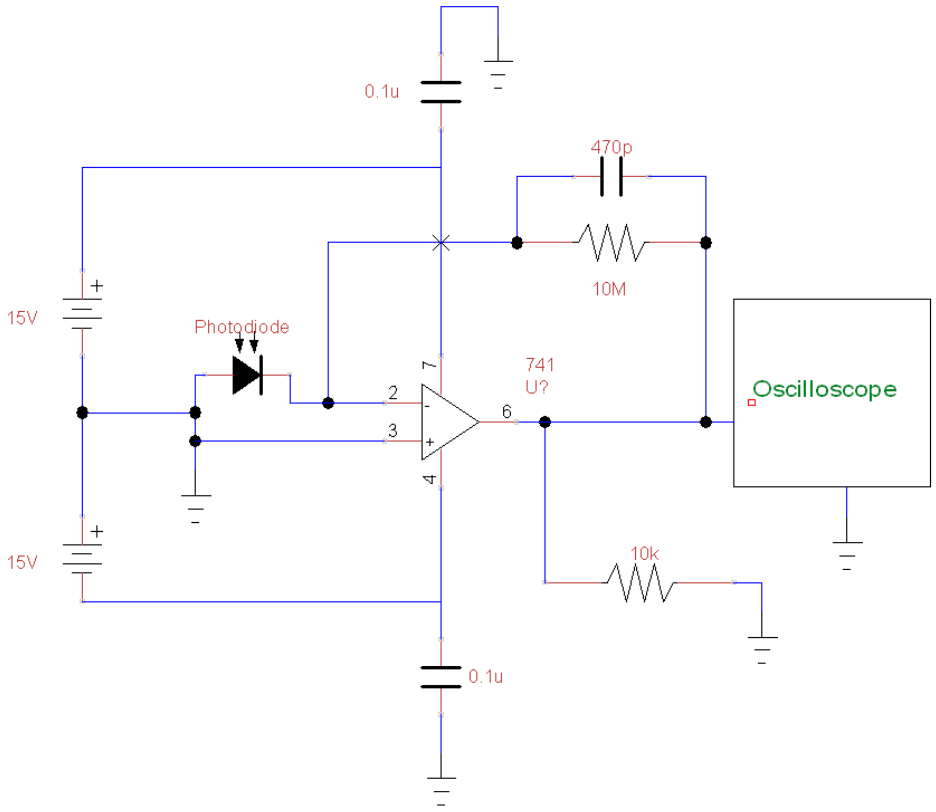

Figure 1. Transimpedance Amplifier (TIA) Circuit

If you see an oscillation in your measurement please perform the section in italics.

Look at the output of the TIA on the oscilloscope. What do you see? The circuit might be oscillating at a very high frequency, which is not a good thing!

[L3] *Measure the frequency of oscillation, in MHz.*

To get rid of this oscillation, place 0.1µF capacitors from the supply pins to ground (from pin 7 to ground, and from pin 4 to ground). These capacitors are small yellow disks marked "104M". They are non-polarized—it doesn't matter which way they are installed. Look at the output on the oscilloscope. Has the high frequency oscillation disappeared?

Cover the photodiode with a black cloth to block all of the light.

[L4] What do you observe on the oscilloscope?
[L5] What DC voltage Vo do you measure?

Expose the photodiode to light from the overhead fluorescent lights. Replace the feedback resistor with other values to make sure that the output voltage is less than ±15VDC.

[L6] What do you observe on the oscilloscope?
[L7] What is the frequency of oscillation?
[L8] What DC voltage Vo do you measure?
[L9] What is the value of the feedback resistor that you used?
[L10] What is the photocurrent, I_{ph} in µA?

Expose the photodiode to light from the portable fluorescent light.

[L11] What do you observe on the oscilloscope?
[L12] What is the frequency of oscillation?
[L13] What DC voltage V_o do you measure?

C. Simple Transconductance (Voltage to Current) Amplifier (45 estimated amount of time)

Use a 0-5V triangle wave as V_{in}. Set the frequency low (~10Hz) so you can visibly see the LED flashing for troubleshooting.

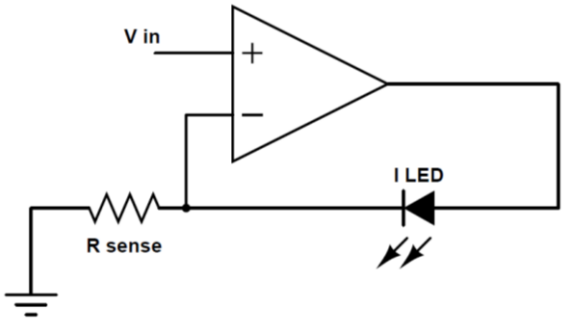

Figure 2. Transconductance Amplifier (TCA) Circuit

- Wire up the TCA circuit (Figure 3) using a 5mm LED (any color).
    - Choose R_{sense} so that (I_{LED} / V_{in}) ≤ 5mA/V.
        - The I_{out} / V_{in} is known as *transconductance*
    - Use V_{CC} = 10V for the OpAmp
- Measure the voltage drop across R_{sense} using Oscilloscope Channel 2.
    - The result should equal Vin
- Now replace the single LED with three LEDs in series.

[L14] Sketch I_{out} vs V_{in} when there are 3 LEDs in the circuit. Comment on the result.

Go back to driving only a single LED

[L15] Does the current change compared to driving only 1 LED? Why or why not?