Lab: Set current, measure voltage

A useful circuit for exploring the relationship between voltage and current is shown in Figure 4. Here "Black Box" means I can place any analog component there. By controlling the input voltage and selecting an appropriate value of the resistor, I can control the current flowing through the "Black Box". By measuring the output voltage of the lower op-amp, I can measure the resulting voltage **across** the Black Box.

First, try to understand this general circuit using our rules when op-amps are wired in negative feedback

- No current flows into the op-amp's inputs.
- The input voltages are equal.

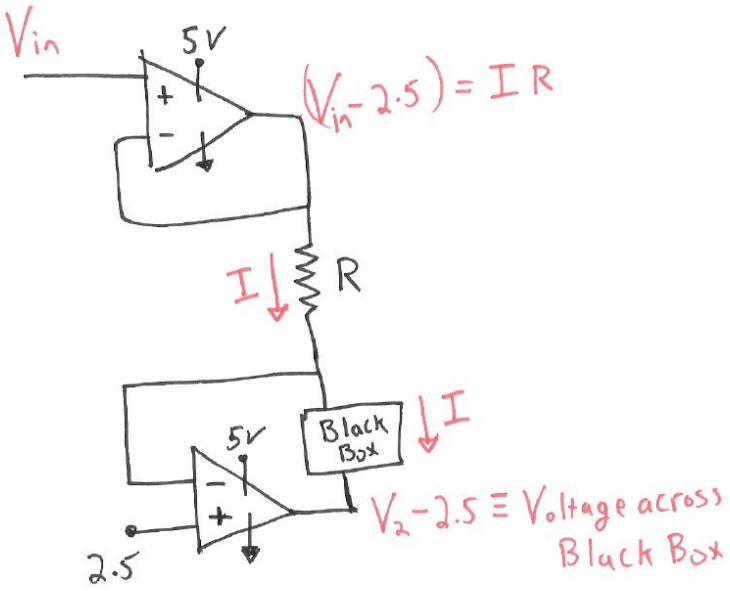

Figure 1: Generic source current, measure voltage circuit.

Now let's test the voltage and current relationship for two devices. First, is the capacitor. Build the circuit shown Figure 5a. For the components:

- Your "Black box" should be a 0.1 uF capacitor.
- Your resistor should be 1 M
- Your input voltage should be 1 V amplitude, 2.5 V offset, 0.5 Hz **square wave**.
- Measure the output of op-amp 1 with Ch1+ and output of op-amp 2 with Ch 2 +. Place Ch1- and Ch2- into 2.5 V.

For each step change in Vin (the current through the capacitor) you should observe that the voltage across the capacitor changes linearly, until the system saturates. Using the scope's cursor measure dV/dt for the voltage across the capacitor. Change the input amplitude to 5 different values (therefore changing the current through the capacitor) and measure dV/dt across the capacitor. **Note the max value the wavegen can output when plugged into only the computers USB is 5V – therefore do not make the amplitude greater than 2.5V**. Make a table that provides your different values of current, your measured dV/dt, and therefore the measured value of the capacitance. Did you verify our basic capacitor law, $\frac{dV}{dt} = I$?

Second black box to test, is a light emitting diode, LED. Build the circuit shown Figure 5b. For the components:

- Your "Black box" should be a red LED.
- Your resistor should be 100 Ohms
- Your input voltage should be 1 V amplitude, 2.5 V offset, 10 Hz **SINE wave**.
- Measure the output of op-amp 1 with Ch1+ and output of op-amp 2 with Ch 2 +. Place Ch1- and Ch2- into 2.5 V.
- On the scope, add an x-y plot. Look up what a V-I curve for an LED is and check that your x-y plot makes sense to you.

Save the data for Channel 1 and Channel 2. In your lab report you will want to make a plot where voltage across the LED is on the x-axis and current through the LED is on the y-axis. Note that you are measuring only voltage, but you can infer the current since you know that the circuit has a 100 ohm resistor.

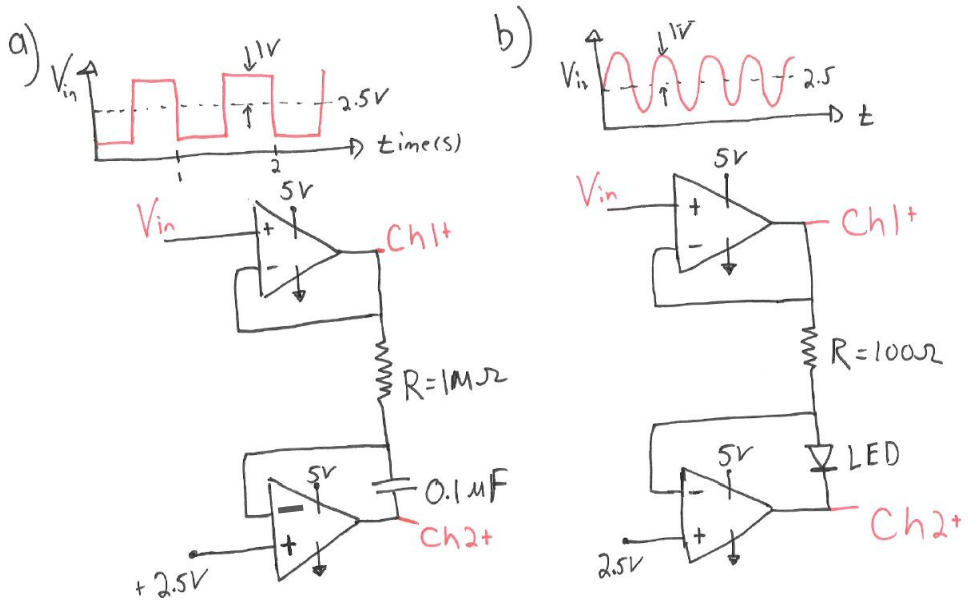

Figure 2: Check the V-I behavior of a capacitor and a LED.