ISIM Lab 6

Sara Ballantyne

November 12, 2015

1 Voltage Source

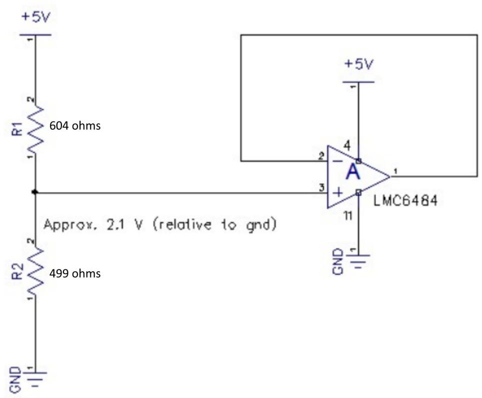

Figure 1: Voltage Source w/Specified Resistances

Across the two electrodes that we want to fix, the voltage is about -400 mV. Due to the fact that we are using 2.5 V as our reference (zero), we need to create a voltage source of approximately 2.1 volts. The two resistors that I chose were 604Ω and 499Ω, yielding a V_{out} of 2.262 V based on the calculations below.

$$V_out = V_in * \frac{R_2}{R_1 + R_2}$$

$$V_out = 5V * \frac{499\Omega}{604\Omega + 499\Omega}$$

$$V_out = 2.262V$$

2 Voltage Meter

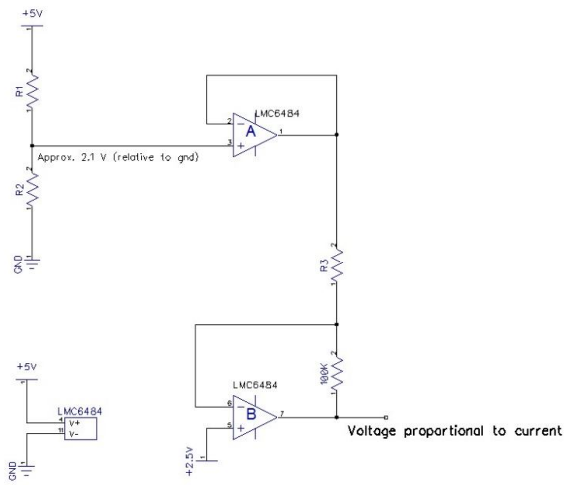

Figure 2: Circuit 2: Resistance Meter

Based on the fact that the voltage at the negative input of the first op amp is 2.262 V and the voltage at the negative input of the second op amp is 2.5 V, therefore approximately -0.238 V are being dropped across the resistor R3. This is the same as that flowing through the 100K resistor due to the fact that no current can go into the op amp inputs, meaning that we can easily calculate the current through the 100K resistor by using Ohm's Law.

$$V = I * R$$

$$\frac{\Delta V}{R3} = I$$

$$\frac{-0.238}{R3} = I$$

$$\frac{2.5 - V_{out}}{100,000} = I$$

$$R3 = \frac{-23800}{2.5 - V_{out}}$$

When we test V_{out} with 3 different resistor values, we get the measurements in the table below.

Expected Resistance	Measured Resistance
15.8kΩ	16.02kΩ
158kΩ	155.90kΩ
499kΩ	498.74kΩ

Table 1: Measured vs Expected Resistor Values

3 Integrator

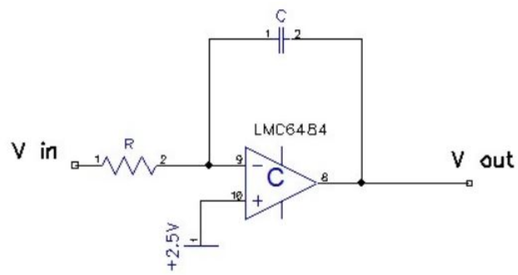

Figure 3: Circuit 3: Integrator circuit

Circuit 3 integrates the input voltage with respect to time, which can be proved by using laws for the resistor, capacitor, and op amp. Based on our understanding of op amps, the voltage on the negative input should be the same as the positive input, making the voltage at the negative input be 2.5 V. Ohm's Law also says that the current through the resistor follows the equation below:

$$\frac{V_{in} - 2.5}{R} = I$$

We also know that the op amp input draws no current, letting us know that this calculated current is also the same amount of current flowing through the capacitor. We can also calculate the V_out through the use of the capacitor law, as seen below.

$$i = C\frac{d(2.5 - V_{out}}{dt} = -C\frac{dV_{out}}{dt}$$

$$V_{out} - V_{out}(t = 0) = \frac{1}{RC}\int (V_{in} - 2.5)dt$$

Due to these equations, we can see that V_{out} will reflect the integral of the current.

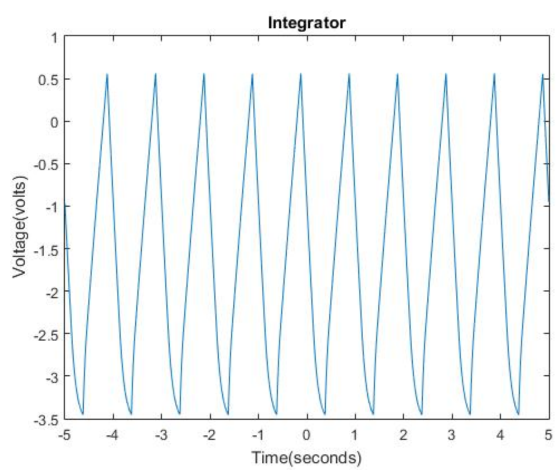

Figure 4: Circuit 3: Integrator Voltage over Time

To prove that my integrator circuit works, I ran a wave through it and saw that it stopped at the rails, when it switched. The figure above shows that it is functioning.

4 Glucose Sensor

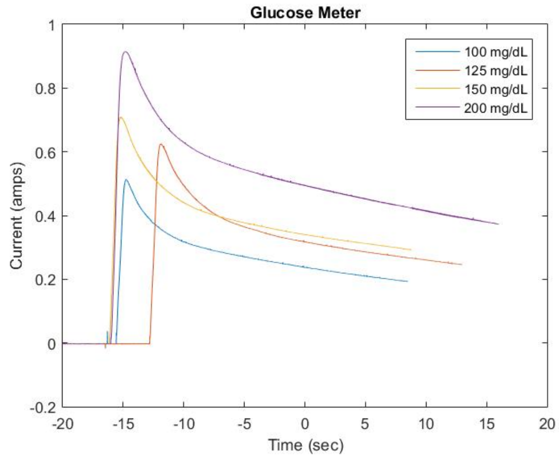

Figure 5: Glucose Concentrations Over Time

The figure above shows current flowing through the strip as a function of time for various glucose concentrations. This behaves as expected because the current spikes then decreases more slowly.

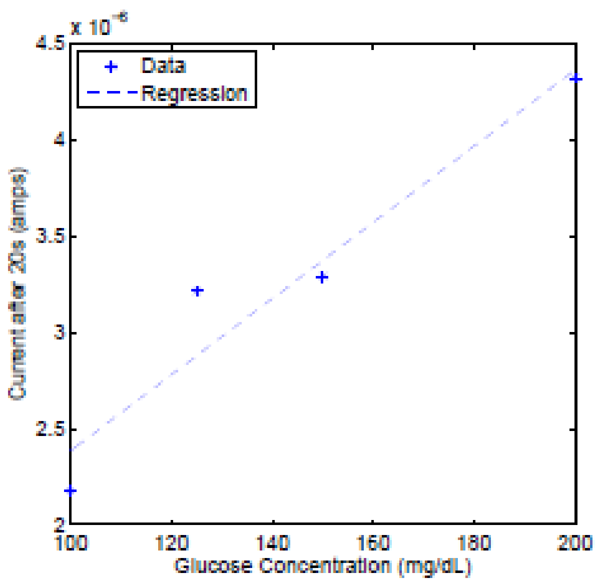

Figure 6: Glucose Concentrations Over Time

The figure above is a plot of measured current after 20 seconds versus the glucose concentration. The conductivity of the strip increases with glucose concentration, increasing the conductivity.

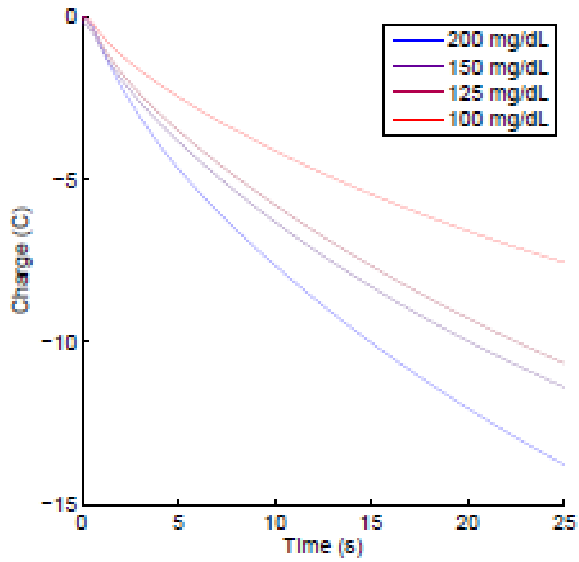

Figure 7: Glucose Charges Over Time

This is a plot of measured charge over time for several glucose concentrations. Once again, we see that charge increases with time which is what we would expect.

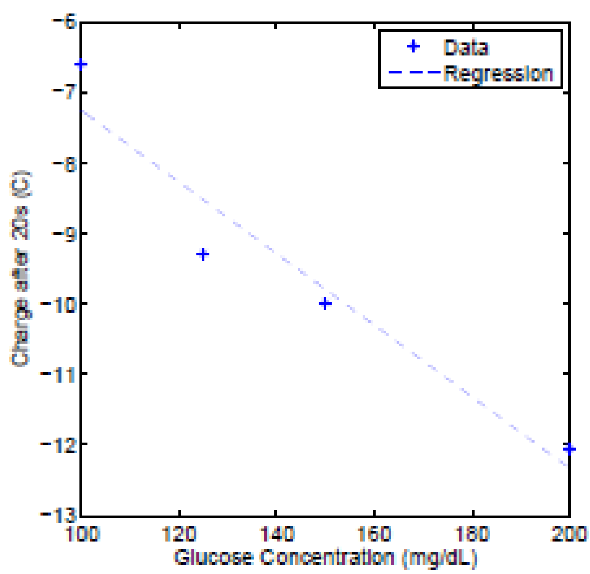

Figure 8: Glucose Concentrations Over Time

The figure above shows that charge becomes greater as glucose concentrations increase. It is a plot of the measured charge after 20 seconds versus the glucose concentration.