EE 11L: Circuits Laboratory I

Experiment #1
Analog Discovery and Kirchhoff's Laws

Name: Lawrence Liu
UID: 405749034
Due Date: Nov. 11, 2100

Objectives

To become familiar with basic circuit construction and operation of the Analog Discovery 2 (AD2) device. Specially how to measure voltage, and resistance with the voltmeter and the impedance analyzer on the AD2. And to experimentally verify equivalent resistance and Kirchhoff's Laws.

Theory

Ohms Law

$$IR = V$$

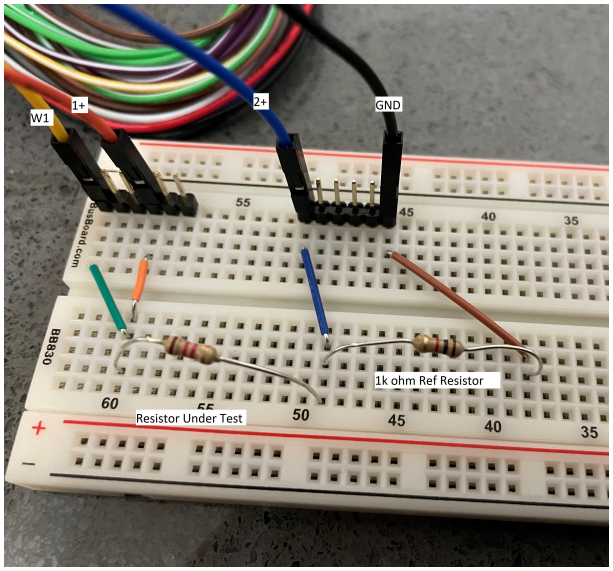
Kirchhoff's Voltage Law (sum of a loop of voltages is 0)

$$\sum V_i = 0$$

Kirchhoff's Current Law (sum of a node's currents is 0)

$$\sum I_k = 0$$

Experiment Setup: Lab 1



Measurements

Resistance (Ω)	Voltage (V)	Current (A)
100Ω		
680Ω		
1200Ω		

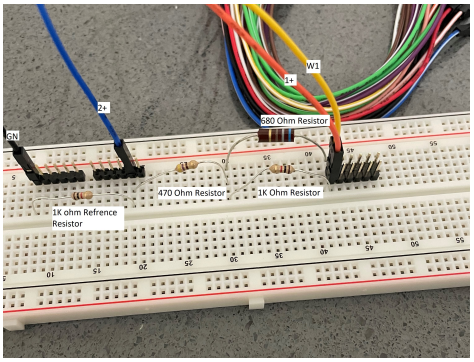
Discussion

The Measured resistances were 100.1Ω, 704.3Ω, and 1194Ω for the 100Ω, 680Ω, and 1200Ω resistors. This falls within the given 5% variance for each resistor.

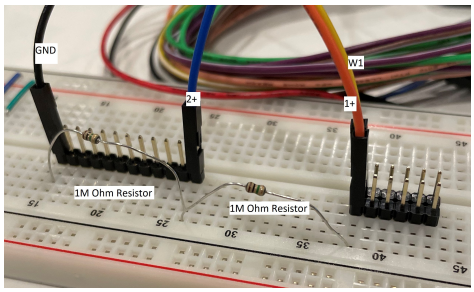
Yes these values

The AD2 unit could measure the current and the resistance of the resistor by measuring the voltage drop across the reference resistor. Since this resistor's resistance is know, therefore, from ohms law the current across it can be calculated. Since the resistor being measured is in series with this one, that amount of current would also have to flow through that resistor. And since the voltage drop across this resistor and the current flowing across is know, its resistance can thus be derived.

Experiment Setup: Lab 2



(a) The simple resistive network



(b) The skin resistor setup

The theoretical equivalent resistance for the simple resistive network is:

$$R_3 + \frac{R_1 R_2}{R_1 + R_2} = 874.76\Omega$$

The measured resistance is 876.6Ω, which agrees with the theoretical resistance given the 5% variance of each resistor.

For the skin resistance experiment, I used a $1M\Omega$ resistor, when measured by the AD2, this resistor had resistance of $R_R = 876.6k\Omega$. When measured in parallel with my "Skin Resistance", it was $R_{eq} = 125.5k\Omega$. Thus my "skin resistance" was

$$R_{skin} = \frac{R_R R_{eq}}{R_R + R_{eq}} = 109.78K\Omega$$

Discussion: Lab 2

Since my skin resistance is $109.78K\Omega$, from ohms law at $50V$, $0.00045A$ would flow through my body.

Experiment Setup: Lab 3

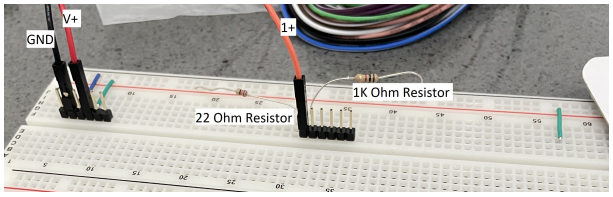


Figure 2: Voltage Divider

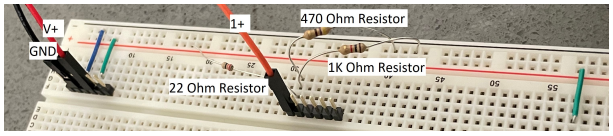


Figure 3: Current Divider

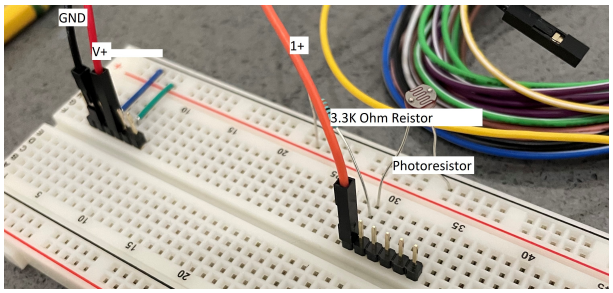


Figure 4: Photoresistor

Data

Voltage Divider

Resistors (Ω)	Theoretical Voltage (V)	Measured Voltage (V)
22Ω	0.108V	0.104V
1000Ω	4.892V	4.896V

Current Divider

Resistors (Ω)	Theoretical Voltage (V)	Measured Voltage (V)	Theoretical Current (A)	Measured Current (A)
22Ω	0.322V	0.318V	0.014A	0.014A
1000Ω	4.678V	4.682V	0.004A	0.004A
470Ω	4.678V	4.682V	0.01A	0.01A

Photoresistor

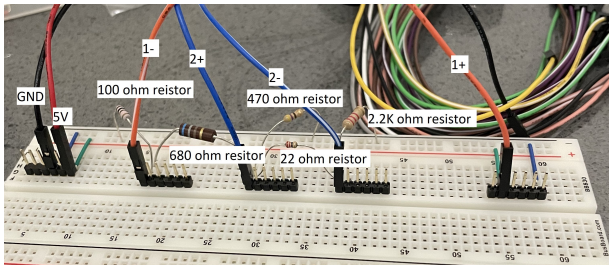
Lighting	Measured Voltage (V)
Standard Lighting	2.562V
Dark Room	4.874V

Discussion: Lab 3

The theoretical and measured values for the voltages and currents were fairly close. For the Voltage dividers the difference between the measured voltages and the actual voltages were only 0.08% and 3.7% for the 1000Ω and 22Ω resistors respectively. For the current Current divider the difference between the measured and theoretical current was 0% for all resistors.

The photoresistor's resistance increased as the amount of light it was exposed to decreased. At standard lighting, its measured resistance was around $3.3K\Omega$, however when it was placed in a dark room, its resistance increased to around $130K\Omega$

Experiment Setup: Lab 4



Measurements: Lab 4

Resistor	Voltage		Current	
	Theoretical	Measured	Theoretical	Measured
100Ω	0.428V	0.434V	4.28 mA	4.34 mA
680Ω	2.911V	2.97V	4.28mA	4.36mA
470Ω	1.66V	1.628V	3.53mA	3.46mA
22Ω	0.016V	0.021V	0.727mA	0.954mA
$2.2K\Omega$	1.64V	1.596V	0.745mA	0.725 mA

Discussion: Lab 4

Yes these results are inline with KCL and KVL.

For instance according to KCL the current flowing across the 100Ω resistor must be equal to the current flowing across the 680Ω resistor. The measured current flowing across the 100Ω and the 680Ω is $4.34mA$ and $4.36mA$. Or in other words, the current across these two resistors vary by 0.5%, which can easily be attributed to observation error.

Furthermore, according to KCL, the current flowing across the 680Ω resistor must be equal to the sum of the current flowing across the 470Ω resistor and $2.2k\Omega$ resistor. The current through the 680Ω resistor is $4.36mA$, and the sum of the current flowing through the 470Ω and the $2.2k\Omega$ resistor is $4.185mA$. The difference between these two values is 4%, which can also be attributed to observation error. Likewise, from KCL we have that the current flowing across the 680Ω resistor must be equal to the sum of the current flowing across the 470Ω resistor and 22Ω resistor.The current through the 680Ω resistor is $4.36mA$, and the sum of the current flowing through the 470Ω and the $2.2k\Omega$ resistor is $4.405mA$. The difference between these two values is 1%, which can also be attributed to observation error.

From KVL we have the sum of the voltages across the 100Ω, 680Ω, and 470Ω resistor is $5V$. The measured sum of these voltages is $5.032V$. The diffrence between these two values is 0.6% which can also be attributed to observation error.

Conclusion