SIERRA COLLEGE	MECH 10 - Lab 04 Ohm's Law Validation	Mechatronics Real Skills Real Jobs
Name: Cayce Beames Date: September 11, 2019 Professor Steven Gillette		

Abstract

In this lab, I measured the "as found" resistance of three different resistors, leveraged their marked values to calculate percent error and then used 2 multimeters to measure current through and voltage across the three different resistors. I further used ohm's law to calculate the percent error between the expected and measured values.

Introduction

Learning Objectives

- Construct a simple circuit with source, load, control and conductors
- Measure electrical values using a digital voltmeter
- Use Ohm's Law to validate field measurements

Notes:

1. Take all voltage measurements relative to ground (unless otherwise stated)
2. Record relevant measurements and calculation results in data tables
3. Record all measured values on the circuit schematics
4. Use all available precision in calculations, round off answers to 3 significant figures

Materials

Quantity	Description
1	Global Specialties Circuit Trainer
2	Digital multimeters (DMMs)
1	1k Ω resistor
1	3k Ω resistor
1	4.7k Ω resistor

Procedure – Power Supply Characterization

1. Used the digital multimeter (DMM) to measure the circuit trainer adjustable power supplies. Recorded the as-found (measured) range of voltages for the circuit trainer positive and negative 1.3 to 15 VDC supplies.

Power Supply	Low Range Voltage	High Range Voltage
Positive	1.30Vdc	20.84Vdc
Negative	-1.33Vdc	-20.31Vdc

Resistance Measurements and Results

2. Selected three resistors with different values between 5K to 10K Ω
3. Used the DMM to measure and record the R1, R2 & R3 resistance values.
4. Used the resistor color codes to record the expected resistor values.
5. Calculated the error between expected and measured values using the % Error formula
6. Connected the R1 resistor as shown on diagram MECH10-04 (between ground and the +1.3 to 15 V supply terminal.) ***Adjusted and recorded*** the power supply voltage V_S to +5V ±0.2V

	Measured	Expected	% Error
R1	1k Ω	1k Ω	0%
R2	3.03k Ω	3k Ω	1%
R3	4.68k Ω	4.7k Ω	-0.43%

Current Experiments and Results

7. Set up the DMM for current measurement and ***measured & recorded*** the current flow through the first test resistor**.** Observed proper polarity for the meter test leads with the red positive lead on the positive voltage side of the circuit and the black negative lead on the negative side.
8. ***Measured and recorded*** the current value for the first source voltage (V_S) and load resistance (R1). Calculated the expected current using Ohm's Law and recorded the values in the Data Tables below.
9. Adjusted and recorded the power source voltage V_S to +10V ±0.2V. ***Measured and recorded*** the new voltage and current readings for R1 in the data table below.
10. Repeated steps 6 to 9 for each of the other two resistors.
11. Recorded my initial readings in the data tables below.
12. Recorded all final data in spreadsheet provided with this lab to avoid math errors and for maximum documentation points.

Resistor 1, 1kΩ Data Table

E (VDC)	R1 (Ohms)	$I_{expected}$ (Amps)	$I_{measured}$ (Amps)	% Error
(5) 4.99Vdc	1kΩ	4.99mA	5.01mA	0.40%
(10) 10.00Vdc	1kΩ	10mA	10.05mA	0.50%
(15) 15.06Vdc	1kΩ	15.06mA	15.18mA	0.80%

E (VDC)	R1 (Ω)	$I_{expected}$ (A)	$I_{measured}$ (A)	% Error
4.99	1.00E+03	**4.99E-03**	5.01E-03	**0.40%**
10.00	1.00E+03	**10.00E-03**	10.05E-03	**0.50%**
15.06	1.00E+03	**15.06E-03**	15.18E-03	**0.80%**

Resistor 2, 3kΩ Data Table

E (VDC)	R2 (Ohms)	$I_{expected}$ (Amps)	$I_{measured}$ (Amps)	% Error
(5) 5.05Vdc	4.7kΩ	1.07mA	1.07mA	0.42%
(10) 10.00Vdc	4.7kΩ	2.13mA	2.13mA	0.11%
(15) 15.15Vdc	4.7kΩ	3.20mA	3.24mA	1.12%

E (VDC)	R2 (Ω)	$I_{expected}$ (A)	$I_{measured}$ (A)	% Error
5.05	4.70E+03	**1.07E-03**	1.07E-03	**-0.42%**
10.00	4.70E+03	**2.13E-03**	2.13E-03	**0.11%**
15.06	4.70E+03	**3.20E-03**	3.24E-03	**1.12%**

Resistor 3, 4.7kΩ Data Table

E (VDC)	R3 (Ohms)	$I_{expected}$ (Amps)	$I_{measured}$ (Amps)	% Error
(5) 5.03Vdc	3kΩ	1.68mA	1.64mA	-2.19%
(10) 10.10Vdc	3kΩ	3.31mA	3.31mA	-1.68%
(15) 14.98Vdc	3kΩ	4.99mA	4.95mA	-0.87%

E (VDC)	R3 (Ω)	$I_{expected}$ (A)	$I_{measured}$ (A)	% Error
5.03	3.00E+03	**1.68E-03**	1.64E-03	**-2.19%**
10.10	3.00E+03	**3.37E-03**	3.31E-03	**-1.68%**
14.98	3.00E+03	**4.99E-03**	4.95E-03	**-0.87%**

Formulas

$$E = IR, I = \frac{E}{R}, R = \frac{E}{I}$$

Where;
E = voltage (Volts)
I = current (Amperes)
R = circuit resistance (Ohms)

$$\%Error = \frac{measured - expected}{expected} x100\%$$

Where;
%Error = % change between measured and expected values
measured = a value taken from direct measurement
expected = a value taken from component or process specifications

Questions / Conclusions

1. What happens to current in a circuit when the voltage doubles?

When the voltage in a circuit doubles, the current in the circuit doubles.

2. What happens to current in a circuit when the resistance doubles?

When the resistance in a circuit doubles, the current halves.

3. Why are DMM voltage measurements taken in parallel with the load and current measurements taken in series?

Voltage is the potential across a circuit. It will measure 0V when measured in-line of the circuit as we demonstrated in the shock current lab. Therefore, measurements for voltages are only meaningful when taken in parallel with a load within a circuit. Current flows through a circuit. To measure the rate of flow, similar to measuring water flow in a river, the meter must be placed in-line of the flow. Therefore, measurements of current are only meaningful when taken in series of components within a circuit.

4. Why does voltage drop across a resistor?

Voltage drops across a resistor because a resistor absorbs current by a relatively precise amount and converts it into heat energy that is dissipated by the resistor. (All about Circuits, DC Chap 2. https://www.allaboutcircuits.com/textbook/direct-current/chpt-2/resistors/)

Conclusion

This lab was an exploration of the interrelationship between voltage, current, and resistance in a circuit as well as understanding the significance of the tolerance factors of the resistors themselves. Not all resistors were measured to be equal to their markings.

Additionally, though the current within the circuit was relatively low, the resistors in the circuit absorbed the current without significant noticeable heat, though were warm to my touch. It would be interesting to measure the temperature increases across the resistors during these experiments.

Appendix A – Lab Notes

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Materials

Quantity	Description
1	Global Specialties Circuit Trainer
1	Digital multimeter (DMM)
1	R1, R2 & R3 – resistor; all with different values between 5K to 10K Ω

Procedure – Power Supply Characterization

1. Use the digital multimeter (DMM) to measure the circuit trainer adjustable power supplies. Record the as-found (measured) range of voltages for the circuit trainer positive and negative 1.3 to 15 VDC supplies.

Power Supply	Low Range Voltage	High Range Voltage
Positive	1.3 ✓	20.84 ✓
Negative	-1.33 ✓	-20.31 ✓

2. Select three resistors with different values between 5K to 10K Ω
3. Use the DMM to measure and record the R1, R2 & R3 resistance values.
4. Use the resistor color codes to record the expected resistor values.
5. Calculate the error between expected and measured values using the % Error formula
6. Connect the R1 resistor as shown on diagram MECH10-04 (between ground and the +1.3 to 15 V supply terminal.) ***Adjust and record*** the power supply voltage V_S to +5V ±0.2V

	Measured	Expected	% Error
R1	1kΩ	1kΩ	0%
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R3	3.03k	3kΩ	1%

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7. Set up the DMM for current measurement and ***measure & record*** the current flow through the first test resistor. Be sure to observe proper polarity for the meter test leads with the red positive lead on the positive voltage side of the circuit and the black negative lead on the negative side.
8. ***Measure and record*** the current value for the first source voltage (V_S) and load resistance (R1). Calculate the expected current using Ohm's Law and Record the values in the Data Tables below.
9. Adjust and record the power source voltage V_S to +10V ±0.2V. ***Measure and record*** the new voltage and current readings for R1 in the data table below.
10. Repeat steps 6 to 9 for two more resistors.
11. Record your initial readings in the data tables below.
12. Record all final data in spreadsheet provided with this lab to avoid math errors and for maximum documentation points.

Resistor 1 Data Table

1K

E (VDC)	R1 (Ohms)	$I_{expected}$ (Amps)	$I_{measured}$ (Amps)	% Error
(5) 4.99V	1KΩ	4.99mA	5.01mA	.40%
(10) 10V	1KΩ	10mA	10.05mA	.50%
(15) 15.06	1KΩ	15.06mA	15.18mA	.80%

Resistor 2 Data Table

4.7K

E (VDC)	R2 (Ohms)	$I_{expected}$ (Amps)	$I_{measured}$ (Amps)	% Error
(5) 5.05	4.7KΩ	1.07mA	1.07mA	-.42%
(10) 10V	4.7KΩ	2.13mA	2.13mA	.11%
(15) 15.15V	4.7KΩ	3.2mA	3.24mA	1.12%

Resistor 3 Data Table

3KΩ

E (VDC)	R3 (Ohms)	$I_{expected}$ (Amps)	$I_{measured}$ (Amps)	% Error
(5) 5.03V	3KΩ	1.68mA	1.64mA	-2.19%
(10) 10.10 V	3KΩ	3.37mA	3.31 mA	-1.68%
(15) 14.98V	3KΩ	4.99mA	4.95mA	-0.87%

Formulas

$$E = IR, I = \frac{E}{R}, R = \frac{E}{I}$$

Where;
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Questions / Conclusions

1. What happens to current in a circuit when the voltage doubles? the current doubles
2. What happens to current in a circuit when the resistance doubles? the current halves
3. Why are DMM voltage measurements taken in parallel with the load and current measurements taken in series? Voltage is potential across the circuit, current is through the circuit.
4. Why does voltage drop across a resistor?
Because

Grading Criteria

		Points Possible	Points Earned
Documentation	Abstract, introduction, experiment, data results, conclusions, attachments, clarity, spelling, grammar	**10**	
	Power supply characterization complete & accurate	**5**	
	Resistor R1, R2 & R3 measured and expected values recorded, percent error calculated	**5**	
	Data Tables 1, 2 & 3 completed & accurate	**15**	
	Questions answered completely & accurately. State conclusions drawn and lessons learned from the lab	**10**	
On-time submittal	Lab report is submitted in accordance with the assignment due date as posted on Canvas	**5**	
	Total	**50**	

Lab Report Format

Abstract - a summary and high-level overview of the lab and its results
Introduction - State the objectives of the laboratory and list the equipment required
Experiment - Describe the procedure used to carry out the lab
Data Results - list data taken in table or graphical format where appropriate
Conclusion - State the conclusions drawn and lessons learned from the laboratory activities. Answer any questions found within the lab procedure.
Attachments – grading criteria, verification signatures, circuit diagrams, lab procedures & notes

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