To: Professor Darish
From: Trever Wagenhals
Subject: Ohm's Law, Series & Parallel, Current & Voltage Divider Circuits

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Course & Section Number:
Partner(s):
TA:

SUMMARY

Section 1: Ohm's Law: V = IR

This section involved measuring known resistances to see the actual values and measuring current at different voltages.

Section 2: Series Resistors

This section involved creating series circuits and determining total resistance. After resistance was calculated, voltages were run through different test groups to calculate current, which then was used to calculate actual resistance, which was higher in the system because of system resistance.

Section 3: Parallel Resistance

This section involved parallel circuits with the exact same dependent variables as section 2 and same data recorded.

Section 4: Voltage divider

This section involved having resistors in series and determining how much of the initial supplied voltage was dropped at each resistor. This voltage should always total the original.

Section 5: Current Divider

This section involved having resistors in parallel and determining how much current was able to pass through each resistor.

EXPERIMENTAL APPROACH

Equipment and Materials

- Resistors
- Breadboard
- Power Supply
- Multimeter
- Test Leads

Procedure

Section 1: Ohm's Law: V = IR

This section consisted of determining the resistances of three varying resistors and recording the measured value in comparison to the nominal value. Once this was recorded in **Table 2-1**, we then created a circuit and supplied voltage in increments of 2 from 2 to 10, measuring the current through the resistors at each voltage. This information is shown in **Table 2-2, 2-3,** and **2-4.**

Section 2: Series Resistors

In this section, we took resistors and began pairing them up in series to determine how it affected current at varying voltages. In series, the resistors are simply added together. This can be found in **Table 2-5.** Once we have calculated resistance, we then set Combination A to 1V, Combination B 2.6V, and Combination C to 3.5V and measured the current through these circuits. From this circuit, we calculated the actual resistance in the system, which is actually higher than the theoretical resistance because of natural resistance in the rest of the system. All of this is located in **Table 2-6.**

Section 3: Parallel Resistance

Similar to section 2, we used the same resistors, except we placed them in a parallel circuit this time. Parallel resistors act differently than series resistors, and instead are the multiplication of resistors over the sum of the resistors. With the cases that involved 3 resistors, you must first combine two of them using this method into one, then repeat with the new resistor and other unused one to get one total. Just like in the series resistors, we ran the same voltage measurements through the same combinations and determined the current through the system. From this current, we discovered the calculated resistance, which was once again higher than expected because of the natural resistance in the system. This data is found in **Table 2-7** and **2-8.**

Section 4: Voltage divider

In this section, we wanted to create a series circuit with two resistors and determine how the voltage was dropped over these two resistors. Voltage drop is the voltage x the resistance of Rn/ the overall resistance in the circuit. When both voltages are calculated, they should add up to the initial voltage. This information can be found in **Table 2-9.**

Section 5: Current Divider

Similar to section 4, we made a circuit with two resistors, but in parallel, and determined the resistances of each resistor and differences in current across each resistor. This can be compared to the calculated current to see how close our results are. In order to make this section work, one resistor must remain in the completed in the circuit while the other is isolated and connected with the test leads to add it back to the circuit and get an accurate measurement of current.

DISCUSSION OF RESULTS

Section 1-1 Voltage is equal to how much current flows times the resistance, current is equal to how much voltage there is over the resistance, and resistance is equal to how much voltage there is over the current.

Section 1-2 V = RI   R = V/I   I = V/R

Section 1-3

Section 2-1 Taking the given resistor in the circuit, and using the given voltage through that resistance, we could get a reading for current. From here, we could use R = V/I to determine what the resistance actually was in the system.

Section 3-1 The more parallel resistors, the lower the overall resistance because the sum of two parallel resistors is always less than the original, so adding more will mean more fractions of the original resistances.

Section 3-2 When the resistance in each resistor in a parallel series is increased, the overall resistance is also increased because the minimum resistance is now higher, allowing the sum of resistances to be higher.

Section 3-3 Total resistance in parallel circuits is equal to Rt = (R1R2/R1+R2) between two resistors and repeated until there is only one resistor left.

Section 3-4 I(total) = I1 + I1 + I3 = V/R1 + V/R2 + V/R3

Section 4-1 The initial voltage supplied to the system is equal to the voltage dropped over R1 and R2.

Section 4-2 In order to have a 7.5V output with a 10V input and two resistors, one resistor must be ¾ of the overall resistance and the other must be 1/4. This is possible with any resistors, such as a 3k and 1k resistor, 2k and 6k resistor, etc.

Section 5-1 v= I * R(total) = I(R1R2/ R1+R2)   I1 = I(R2/R1+R2)   I2 = I(R1/+R1+R2)

Section 5-2 In order to have a 7mA output with a 10mA input and two resistors in parallel, one of the resistors must equal 3/10 of the overall resistance to put out 7mA, while the other will be 7/10 of the total resistance and put out 3mA. An example would be a 3k resistor and a 7k resistor, a 6k resistor and a 14k resistor, etc.

Table 2-1

Compares expected resistance to the measured resistance.

Component	Nominal value	Measured value
R_1	91 Ω	89.99Ω
R_2	3.3 kΩ	3.262kΩ
R_3	470 kΩ	472.4kΩ

Table 2-2. For R = R_1 = 91Ω

Shows expected and measured current at different voltages over the 91Ω resistor.

Voltage		2.0 V	4.0 V	6.0 V	8.0 V	10.0 V
Current	Calculation	0.0219A	0.0439A	0.0659A	0.0879A	0.1098A
	Measurement	0.0193A	0.0393A	0.0592A	0.0791A	0.9945A

Table 2-3. For R = R_2 = 3.3 kΩ

Shows expected and measured current at different voltages over the 3.3kΩ resistor.

Voltage		2.0 V	4.0 V	6.0 V	8.0 V	10.0 V
Current	Calculation	0.0006A	0.0012A	0.0018A	0.0024A	0.003A
	Measurement	0.0006A	0.0012A	0.0018A	0.0024A	0.003A

Table 2-4. For R = R_3 = 470 kΩ

Shows expected and measured current at different voltages over the 470kΩ resistor.

Voltage		2.0 V	4.0 V	6.0 V	8.0 V	10.0 V
Current	Calculation	0.0042mA	0.0085mA	0.0127mA	0.0170mA	0.021mA
	Measurement	0.005mA	0.009mA	0.014mA	0.018mA	0.022mA

Table 2-5.

Compared expected series resistance and actual series resistances

Combination	Resistor rated value, ^			R_T	
	R_1	R_2	R_3	Calculated	Measured
a	6.8	91		97.8Ω	97.09Ω
b	6.8	91	220	317.8Ω	313.71Ω
c	91	3.3 k	470 k	473.39kΩ	475.67kΩ

Table 2-6.

Uses resistances from **Table 2-5** and a given current to calculate actual resistance in system.

Combination	Voltage	Current	R_T
a	1 V	9.239mA	108.23Ω
b	2.6 V	8.013mA	324.47Ω
c	3.5 V	0.008mA	475.67kΩ

Table 2-7.

Compare expected parallel resistance and actual measured resistance.

Combination	Resistor rated value, Ω			R_T	
	R_1	R_2	R_3	Calculation	Measurement
a	6.8	91		6.327Ω	6.62Ω
b	6.8	91	220	6.15Ω	6.45Ω
c	91	3.3 k	470 k	88.54Ω	87.59Ω

Table 2-8.

Uses resistances from **Table 2-7** and a given current to calculate actual resistance in system.

Combination	Voltage	Current	R_T
a	1 V	57.9mA	18.21Ω
b	2.6 V	100.63mA	25.83Ω
c	3.5 V	35.3mA	99.15Ω

Table 2-9.

Determine the voltage drop between two different resistors when 12V is supplied and compares it to the expected amount.

Resistor	Calculation: $Vx = Vs(Rx/R_T)$	R_X (measurement)	Vx (measurement)
R_1 = 7.5 kΩ	9.08V	7.363kΩ	9.076V
R_2 = 2.4 kΩ	2.91V	2.36kΩ	2.92V
Total	11.99V	9.723kΩ	11.96V

Table 2-10.

Determine the current between two different resistors when the 12V is supplied and compares it to the expected amount.

Resistor	Calculation: $I_x = I(R_{T-X}/R_T)$	R_X (measurement)	Ix (measurement)
R_1 = 7.5 kΩ	1.584mA	7.363kΩ	1.627mA
R_2 = 2.4 kΩ	4.94mA	2.36kΩ	5.046mA
Total	6.53mA	9.723kΩ	6.669mA

Plotting the Voltage vs Current for **Table 2-2, 2-3,** and **2-4,** you can easily see that all three resistors share similar properties. As voltage is increased, the current increases, no matter what the initial resistance was. Also, because this chose represents I/V, the slope at any given point will actually be the inverse resistance of the given resistor.