# Lab 1: Ohm's Law

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## Abstract

In this lab we investigate two problems. First we utilize a DC power supply and a multi-meter to find the actual resistance of two resistors, and measure the relationship between voltage and current when a power source is applied to them. Second we build two circuits, one in series and another in parallel, using the 1 kΩ and 3.3 kΩ resistors. We then measure the effective resistance and apply a power current and calculate the effective resistance from the measured voltage and current.

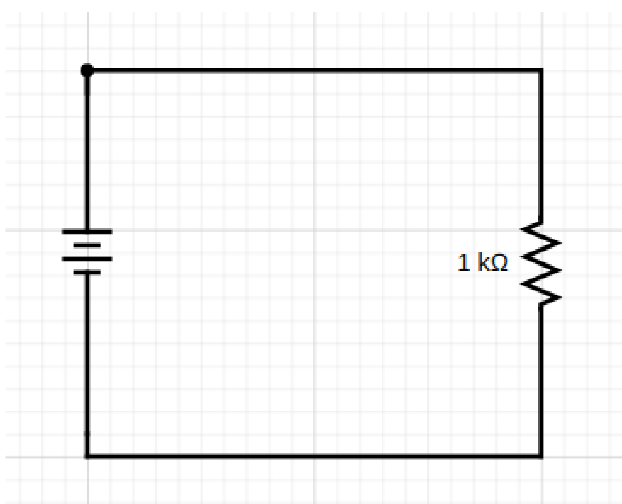

## Equipment

- Extech EX330
- GWINSTEK GPE-3323 Serial: GER901877
- 1,000 Ω Resistor
- 3,300 Ω Resistor

## Procedure

### Part 1: Ohm's Law

1. Construct the circuit as shown below using the 1kΩ resistor.




2. Use the measured value of R for all calculations. Note that the voltmeter is placed in parallel with the resistor with the positive (red) lead connected to the point of higher potential as established by the indicated current direction and that the ammeter is connected in series with the resistor.

3. Adjust the power supply until the source voltage is 1 volt as measured by the voltmeter. Measure and record the voltage across the resistor, VR, and the current, IR, through the resistor.
4. Repeat step 3 for a range of values of the voltage across the resistor, VR, from 1 volts to 10 volts in 0.5-volt increments.
5. Plot the data obtained on a graph with the y-axis, voltage, and the x-axis, current. Find the relationship between voltage and current in a purely resistive circuit using the equation of a straight line, $y = m(x) + b$. The slope of this line represents the resistance of the resistor.
6. Repeat steps 3 through 5 substituting a 3300 Ω resistor. What changed and why? How does this relate to Ohm's Law?

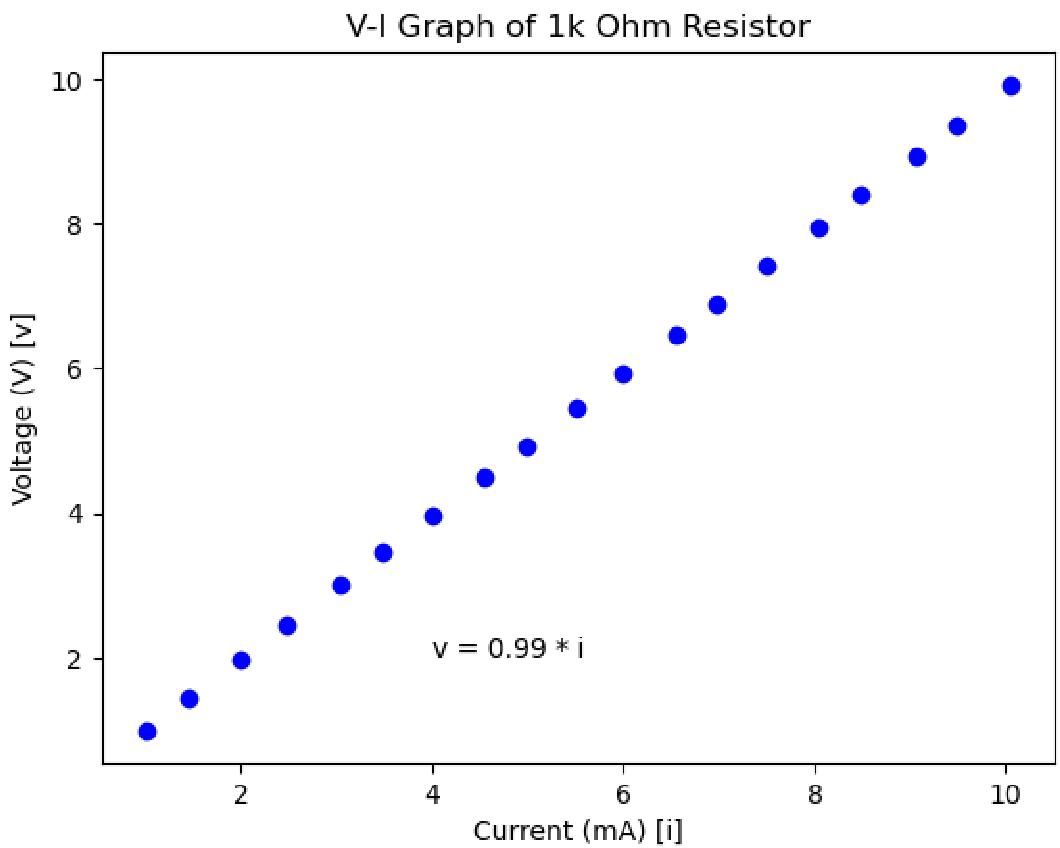
## Data

**Resistance of 1k Ω and 3.3k Ω Resistor**

| Nominal | Precision | Actual |
|---|---|---|
| 1 kΩ | 0.99 kΩ | 0.99 kΩ |
| 3.3 kΩ | 3.26 kΩ | 3.26 kΩ |

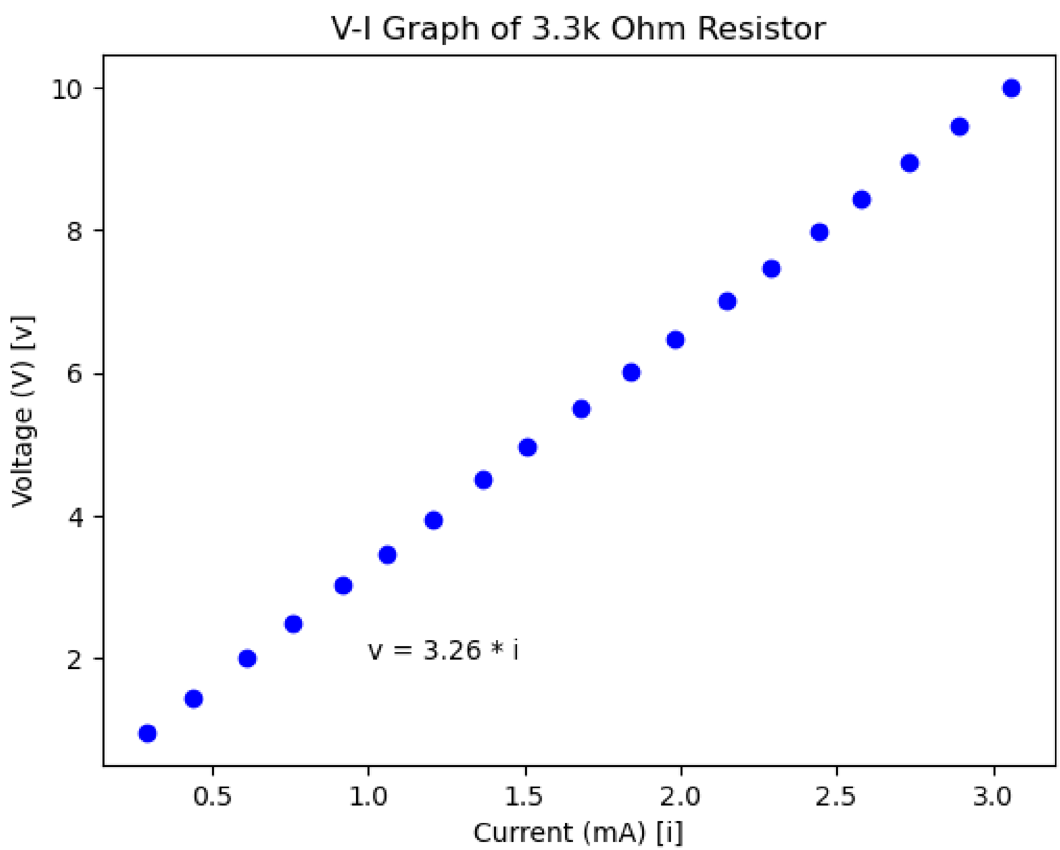
**1k Ω Resistor Data**

| Target Voltage (V) | Measured Voltage (V) | Measured Current (mA) |
|---|---|---|
| 1.0 | 0.99 | 1.00 |
| 1.5 | 1.45 | 1.46 |
| 2.0 | 1.98 | 1.99 |
| 2.5 | 2.45 | 2.47 |
| 3.0 | 3.00 | 3.03 |
| 3.5 | 3.45 | 3.48 |
| 4.0 | 3.96 | 4.00 |
| 4.5 | 4.49 | 4.54 |
| 5.0 | 4.92 | 4.98 |
| 5.5 | 5.44 | 5.50 |
| 6.0 | 5.93 | 6.00 |
| 6.5 | 6.47 | 6.55 |
| 7.0 | 6.88 | 6.97 |
| 7.5 | 7.41 | 7.50 |
| 8.0 | 7.94 | 8.04 |
| 8.5 | 8.39 | 8.49 |
| 9.0 | 8.94 | 9.06 |
| 9.5 | 9.37 | 9.49 |
| 10.0 | 9.92 | 10.06 |


V-I Graph of 1k Ohm Resistor
Voltage (V) [v]
Current (mA) [i]
v = 0.99 * i
10
8
6
4
2
2
4
6
8
10

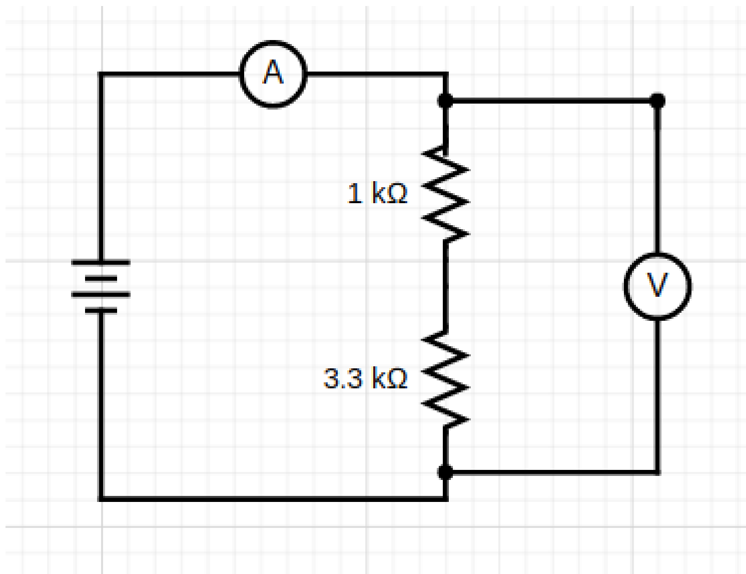
**3.3 kΩ Resistor Data**

| Target Voltage (V) | Measured Voltage (V) | Measured Current (mA) |
|---|---|---|
| 1.0 | 0.97 | 0.29 |
| 1.5 | 1.46 | 0.44 |
| 2.0 | 2.02 | 0.61 |
| 2.5 | 2.49 | 0.76 |
| 3.0 | 3.03 | 0.92 |
| 3.5 | 3.48 | 1.06 |
| 4.0 | 3.95 | 1.21 |
| 4.5 | 4.50 | 1.37 |
| 5.0 | 4.96 | 1.51 |
| 5.5 | 5.50 | 1.68 |
| 6.0 | 6.02 | 1.84 |
| 6.5 | 6.48 | 1.98 |
| 7.0 | 7.02 | 2.15 |
| 7.5 | 7.48 | 2.29 |
| 8.0 | 7.98 | 2.44 |
| 8.5 | 8.45 | 2.58 |
| 9.0 | 8.94 | 2.73 |
| 9.5 | 9.45 | 2.89 |
| 10.0 | 10.00 | 3.06 |

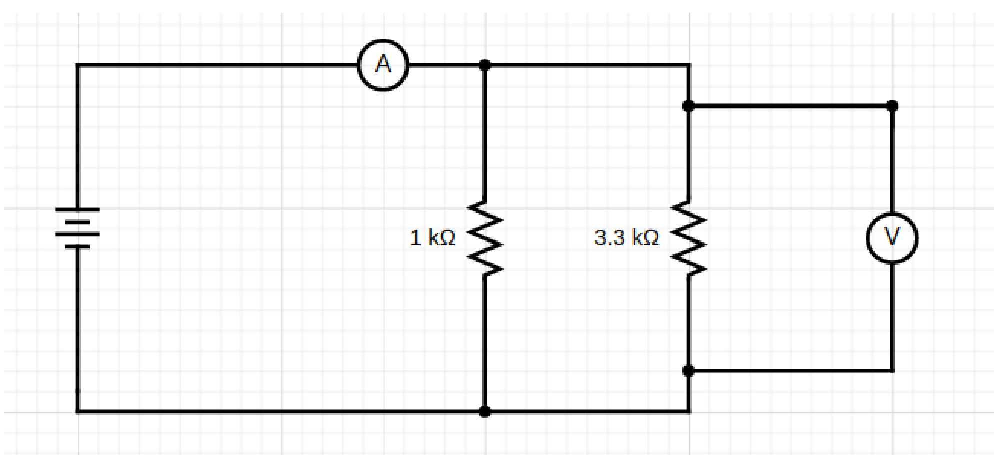


## Part 2: Series and Parallel

1. Connect the 1kΩ and 3.3kΩ resistor in series using the breadboard. Measure the total resistance using an ohmmeter. Record this value.




2. Connect 10 V across the two resistors using the DC power supply and measure the current using an ammeter. Use R = 10 V/I to find the equivalent resistance.
3. Connect the 1kΩ and 3.3kΩ resistor in parallel using the breadboard. Measure the equivalent resistance using an ohmmeter. Record this value.




4. Connect 10 V across the parallel combination of resistors using the DC power supply and measure the current entering the combination. Use R = 10 V/I to find the equivalent resistance.

## Calculations

1. Measure resistance of resistors in series when no current is applied:

**Measured value**

$$R_{tot} = 4.24k\Omega$$

2. Calculate resistance of resistors in series when current is applied using Ohm's Law:

**Measured value**

$$I = 2.35mA \qquad V = 10.00V \qquad R_{tot} = V/IR_{tot} = \frac{10.00V}{2.35x10^{-3}mA} \Rightarrow R_{tot} = 4.255k\Omega$$

3. Measure resistance of resistors in parallel when no current is applied:

**Measured value**

$$R_{tot} = 0.762k\Omega$$

4. Calculate resistance of resistors in parallel when current is applied using Ohm's Law:

**Measured value**

$$I = 13.05mA \qquad V = 9.90V \qquad R_{tot} = V/IR_{tot} = \frac{9.90V}{13.05x10^{-3}mA} \Rightarrow R_{tot} = 0.759k\Omega$$

## Conclusion

In this lab we utilized a table top DC power supply, a multimeter, a 1 kΩ resistor and a 3.3 kΩ resistor to perform our experiments.

In part one, we found that there is a linear relationship between voltage and current when a power source is applied to a resistor. The slope of this line is the effective resistance of the resistor. It's y-intercept is zero for both graphs, when no current is applied to the circuit via the DC power supply the circuit is virtually an open circuit with no voltage difference between the connections of the multimeter. When increasing the resistance from 1 kΩ to 3.3 kΩ we find that the current is approximately 1/3 smaller than when passing through the 1 kΩ resistor. This relates to Ohm's law which states $I = \frac{V}{R}$; if voltage is held constant current is equivalent to the reciprocal of the resistance.

In part two, we investigated series and parallel circuits of resistors. Through our experiment we find that when resistors are placed in series, the effective resistance is the sum of the effective resistance of the individual resistors; when resistors are in parallel the total effective resistance is equal to the inverse of the sum of the effective conductance of the individual resistors.