Resistors

Air Washington Electronics ~ Direct Current Lab

Resistors

Overview

In this lab, students will identify resistors using the standardized color code and explore the relationship between voltage, current, and resistance. Basic troubleshooting of potentiometers will also be covered.

Requirements

To meet all requirements for this lab, you must complete all activities, questions, critical thinking activities and questions, and observations and conclusions.

Course Objectives

- Demonstrate proper measurement techniques for Voltage, Current, and Resistance
- Demonstrate proper operating techniques and evaluate for proper operation the following list of test equipment: DC Power Supply, Digital Multimeter
- Demonstrate acceptable techniques to construct circuits from schematic drawings on solderless and/or solder type breadboards
- Demonstrate knowledge of basic electronic components

Module Objectives

- Identify resistor value using color code
- Calculate percentage of difference
- Explain the percentage of difference between nominal and measured values
- Analyze voltage and current measurement in a simple resistive circuit
- Analyze effects of multiple resistors in a simple resistive circuit
- Take measurements and analyze those measurements to determine the resistance value of a potentiometer
- Identify potential uses for variable resistance
- Demonstrate knowledge of basic electronic components

Activities

1. Resistor Measurement
2. Simple Resistive Circuit
3. Variable Resistance

1: Measuring Resistance

Resistors tend to be too small to write their value directly on them; therefore, a color-coding system has been devised and standardized. The different colors correspond to specific numbers while the band number corresponds to different things depending on the number of bands and their placement.

Below is the color code scale for 4-band resistors. Gaining an understanding of the color code takes time, but, with regular use and practice, it becomes second nature.

Color	1st Band	2nd Band	Multiplier	Tolerance
Black	0	0	1	± 20%
Brown	1	1	10	Military ± 1%
Red	2	2	100	Military ± 2%
Orange	3	3	1,000	Military ± 3%
Yellow	4	4	10,000	Military ± 4%
Green	5	5	100,000	
Blue	6	6	1,000,000	
Violet	7	7		
Grey	8	8		
White	9	9		
None				Military ± 20%
Gold			0.1	± 5%
Silver			0.01	± 10%

As evidenced by the tolerance column, acceptable resistor values can vary significantly. When a device is designed using specific resistances, it needs to be taken into account that there will be an acceptable range of variance, or tolerance. For example, a resistor with a nominal (or labeled) value of 100 Ω and a tolerance level of ± 5% is considered "within tolerance" if it's measured value is between 95 Ω and 105 Ω. Precision resistors are available, but with greater precision come greater cost.

How would you know if a resistive circuit is within tolerance? The percent difference formula allows you to input nominal values and measured values and calculates the difference in percent. The formula subtracts the nominal (named, calculated, or expected) value from the measured (or actual) value. The result is then divided by the nominal (named, calculated, or expected) value. The end result is multiplied by 100 to provide the result as a percentage.

$$\%\,difference = \left(\frac{measured\ value - nominal\ value}{nominal\ value}\right)100$$

Components & Equipment Needed

- Digital Multimeter (DMM)
- Resistors with values cooresponding to the following color codes:
    - Brown-Black-Red-Gold
    - Orange-Orange-Brown-Gold
    - Brown-Red-Green-Gold
    - Yellow-Orange-Gold-Gold

Procedure

Step 1: Using the values determined by color code, record this value in the “Nominal Value” Column

Step 2: Using the DMM, measure the value of each resistor and record in the table.

Step 3: Calculate the percentage of difference between the nominal value and the measured value and record in the table.

Resistor	Nominal Value	Measured Value	Percent Difference	Within Tolerance?
Brown-Black-Red-Gold				
Orange-Orange-Brown-Gold				
Brown-Red-Green-Gold				
Yellow-Orange-Gold-Gold				

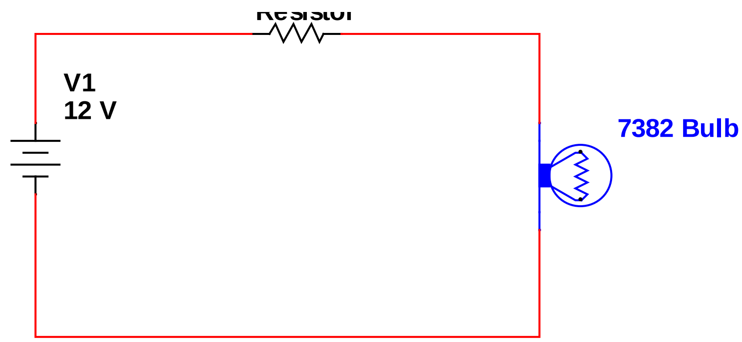
2: Simple Resistive Circuit

A resistive circuit is a circuit comprised of an ideal power source and a resistor. The relationship that exists between voltage, current and resistance is a major foundation of electronics. Experimentation with a resistive circuit allows you to observe that relationship.

Components & Equipment Needed

- Bread Board
- Wire (22 AWG)
- DC Power Supply or 9 V Battery
- DMM
- Resistors:
    - 10 Ω
    - 100 Ω
    - 1k Ω
    - 3 MΩ
- 7382 Bulb, or similar

Schematic



Procedure

For this exercie, you will be swapping out resistors to determine the effect that they have on a simple circuit.

Step 1: Connect the circuit as shown in the schematic.

Step 2: Connect each resistor into the circuit one at a time

- ☐ Observe the bulb and record whether it is brightly lit or dim.
- ☐ Measure and record the voltages across the resistor and across the lamp. Add the voltage drops across the resistor and lamp and record.
- ☐ Measure and record the current.

Resistor	Observation	$V_{Resistor}$	V_{Lamp}	$V_{Resistor}$ + V_{Lamp}	Current
10 Ω					
100 Ω					
1 kΩ					
3 MΩ					

Questions

1. Based on your observations and the measurements taken, what can you conclude about the relationship between voltage, current, and resistance?

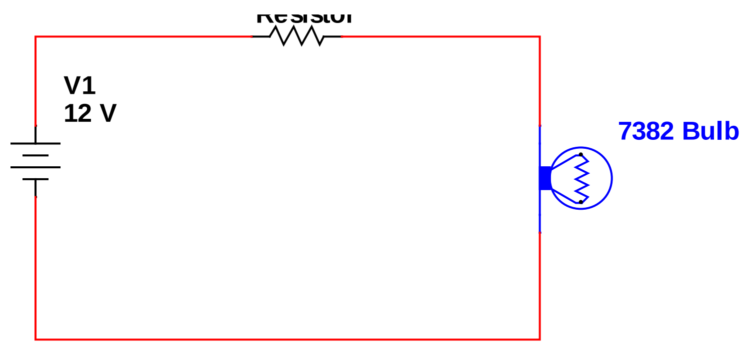
3: Variable Resistance

There are applications where a variable resistance is desired and in these cases, a potentiometer is used. A pot, as it is known for short, allows the user to adjust the amount of resistance in a circuit. Some pots are used for fine tuning precision resistance on circuit boards, others are more general purpose, such as a dimmer dial for lights.

Components & Equipment Needed

- Bread Board
- Wire (22 AWG)
- DC Power Supply
- DMM
- Poteniometer (random)
- 7382 Bulb

Schematic



Procedure

For this exercise, you will be inserting a potentiometer into a simple resistive circuit and analyzing the effects.

A potentiometer provides two different resistances: the full resistance for which it is rated and a variable resistance between 0 and its full rated value. Most potentiometers are linear, meaning that they increase or decrease on an even slope. However, there are potentiometers which are logarithmic in scale.

Step 1: Following the directions below, take three measurements – one with the dial turned all the way to the right, another with the dial midway, and finally another with the dial turned all the way to the left.

☐ Measure and record the resistance between one of the outer terminals and the center terminal of the potentiometer.

☐ Measure and record the resistance between the other outer terminal and the center terminal of the potentiometer.

☐ Measure and record the resistance between the two outer terminals of of the potentiometer.

Measure Between:	**Dial to the Right**	**Dial Midway**	**Dial to the Left**
Outer Terminal 1 and Center			
Outer Terminal 2 and Center			
Outer Terminals 1 & 2			

Step 2: Following the circuit diagram shown, connect the circuit using the variable resistor in place of the static resistor shown. Ensure that it is set up correctly to allow for varying resistances.

Step 3: Vary the setting on the dial and observe the effect this has on the lamp.

Questions

1. What are your conclusions regarding the potentiometer after analyzing these measurements?

2. Based on your observations of the potentiometer and its effect on the lamp, please identify potential applications for variable resistance in a circuit?

3. Describe how a potentiometer can be converted to function as a rheostat.