Study of Resistance Components

Purpose:
The purpose of this exercise is to apply fundamental electrical circuit concepts to determine the response of electrical components subjected to a mechanical input with the intent that the information gathered can be applied to the development of a sensor.

Resources:
Electrical Components:
thermistor, 10 turn potentiometer, linear slide potentiometer, and a carbon strip
Measuring Components:
multimeter with a 0 to 200 k-ohm resistance range, temperature probe (thermocouple based or one with a fast response).
Additional Components:
Two alligator clip leads (each a different color), a ruler with mm scale, 4 temperature sources (or 1 source that is variable (incandescent bulb on a dimmer switch, or and incandescent lamp and readings taken at set distances from lamp).

Procedure:
Rotary Potentiometer:
1.1) Configure the multimeter so that it can measure resistance and connect an alligator clip to each lead. Select the lowest scale to start with.

1.2) Examine the pins on the potentiometer. Draw a picture of the potentiometer noting where the connection tabs are located and label them.

1.3) Connect one alligator clip to the connection tab close to the rotary stem and connect the other clip to the tab that is on the backside of the potentiometer, but in line with the front tab.

a. Observe the reading on the multimeter. If no numbers appear, adjust the range setting until numbers do appear. To verify, turn the stem. If the number displayed does not change significantly, then the clips are attached to the correct tabs.
b. Record the value observed and the scale used on the multimeter. This value is the resistance across the entire potentiometer.
c. Be sure to include a sketch showing how the test circuit was wired.

1.4) Turn the potentiometer stem counter-clockwise until it stops. Reconnect the lead on the back tab to the tab that is off-set to the left. Place a mark on the stem so that the amount of rotation can easily be observed.

a. Record the value displayed on the multimeter.
b. Turn the potentiometer 1 full revolution clockwise and record the value displayed on the multimeter.
c. Continue until 10 revolutions are completed.
d. Be sure to include a sketch showing how your test circuit was wired.

1.5) Plot the results showing resistance versus degrees input.

a. Determine the slope of the curve for the linear portion of the graph.

b. Question: If the potentiometer was set at the midpoint of operation and 12 volts was applied across the full resistance of the potentiometer, what would be the change in voltage relative to the front tab if the potentiometer was turned a half of a revolution?

Slide Potentiometer:

2.1) Configure the multimeter so that it can measure resistance and connect an alligator clip to each lead. Select the lowest scale to start with.

2.2) Examine the pins on the potentiometer. Draw a picture of the potentiometer noting where the connection tabs are located and label them.

2.3) Connect one alligator clip to connection tab 1 and connect the other clip to tab 3.

a. Observe the reading on the multimeter. If no numbers appear, adjust the range setting until numbers do appear. To verify that the full resistance is being observed, slide the stem. If the number displayed does not change significantly, then the clips are attached to the correct tabs.
b. Record the value observed and the scale used on the multimeter. This value is the resistance across the entire potentiometer.
c. Be sure to include a sketch showing how the test circuit was wired.

2.4) Slide the stem on the potentiometer toward connection tab 2 until it stops. Reconnect the lead on tab 3 to tab 4. Place a ruler so that a cm marking aligns with an edge of the stem so that the amount of travel can easily be observed.

a. Slide the stem as far as it can travel and record this distance. Return the stem back to its starting point.
b. Record the value displayed on the multimeter.
c. Slide the stem 5 mm and record the value displayed on the multimeter.
d. Continue measuring in 5 mm increments until the stem stops.
e. Be sure to include a sketch showing how your test circuit was wired and how the stem travel was measured.

2.5) Plot the results showing resistance versus mm input.

a. Determine the slope of the curve for the linear portion of the graph.
b. Question: If the potentiometer was set at the midpoint of operation and 12 volts was applied across the full resistance of the potentiometer, what would be the change in voltage relative to the front tab if the potentiometer was moved 7 mm?

Thermistor:

3.1) Set thermometer/temperature probe to either ^{0}F or ^{o}C, and pick a spot for the temperature probe to sit so it won't experience sudden changes of temperature.

3.2) Set the multimeter to the lowest ohm scale setting. Carefully connect an alligator clip to each lead from the thermistor. Let thermistor rest next to the temperature probe for a couple of minutes making sure that no one gets close (5 or 6 inches) to it. Adjust the ohm scale until a reading is observed and record this value as well as the observed temperature. Be sure to include a sketch of the test setup.

3.3) Have a lab partner hold both probes between the thumb and forefinger of one hand. Observe the change in temperature and change in resistance. When the temperature stabilizes, record the temperature and resistance.

3.4) Go to, or setup your variable temperature source. Set the source to a low power setting and turn on. Place the temperature probe and thermistor at the same point from the source. Record the temperature and resistance once the change in temperature has stabilized. Repeat for a medium setting, and then again for a higher setting. Be sure to record the results for each test.

3.5) Plot the results showing the change in resistance versus temperature.

Carbon Black Strip:

3.1) Connect the ohmmeter leads to the carbon black strip so that they are separated by 4 cm. Read the resistance value from the ohmmeter.

3.2) Fold a paper towel to a 2.5 cm width and moisten it with water.

3.3) Start timer and set the wet swab between the ohmmeter leads, but don't let the swab touch the leads.

a. Record the ohmmeter reading every 30 seconds for 5 minutes.
b. Plot the graph of change in resistance versus time.

3.4) Sketch the test setup including data regarding the thickness and width of the carbon black specimen, location of swab, and location of test leads.

3.5) Determine how long it would take the resistance to not register a change.

Resistance Data Sheet

Lab Section: _____ Date: _____

Team: _____

Rotary Potentiometer:

1) Sketch of Potentiometer:

2) Full Resistance Measurement: R_T = _____ (be sure to include units)

$$\left(\frac{\Delta R}{\Delta T}\right)_{Theo} = \frac{R_T}{Total\,\#\,turns} = \text{———} = \text{———}$$

3) Sketch of test set-up:

4) Data Table:

Data Point	Revolution (Turn #)	Resistance ( )	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Observations:

Linear Potentiometer:

1) Sketch of Potentiometer:

2) Full Resistance Measurement: R_T = _____ (be sure to include units)

Full distance of travel: L_T = _____ (be sure to include units)

$$\left(\frac{\Delta R}{\Delta L}\right)_{Theo} = \frac{R_T}{L_T} = \text{———} = \text{———}$$

3) Sketch of test set-up:

4) Data Table:

Data Point	D ( )	Resistance ( )	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Observations:

Thermistor:

1) Sketch of thermistor:

2) Resistance Measurement at Room Temperature: R_T = _____ (be sure to include units)

Room Temperature: T_R = _____ (be sure to include units)

3) Sketch of test set-up:

4) Data Table:

Data Point	T ( )	Resistance ( )	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Observations:

Carbon Black Strip:

1) Sketch of Carbon Black Strip (include dimensions, include units):

2) Resistance Measurement at Room Temperature and dry: R_T = _____ (be sure to include units)

Room Temperature: T_R = _____ (be sure to include units)

3) Sketch of test set-up:

4) Data Table:

Data Point	time ( )	Resistance ( )	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Observations: