Lab Exercise No. 3 Series- Parallel DC Circuits

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Abstract—**This laboratory exercise demonstrates the key differences in energy flow between series and parallel circuits. It helps us understand how each type is useful in various electrical applications, highlighting their distinct advantages in circuit design. By exploring both configurations, we learn how to build efficient circuits while minimizing potential hazards. This knowledge is essential for preventing incidents and ensuring the safe construction of electrical systems..**

Keywords-potentiometer, current, voltage

I. Introduction

The potentiometer is a type of variable resistor used to control electrical resistance and regulate voltage in circuits, which is measured in Ohms (Ω). It consists of three terminals: the outer terminals which present a constant nominal resistance and a wiper that moves along the resistive track, adjusting the output voltage according to its position. These terminals then allow for the potentiometer to act as a voltage divider, which is useful in some devices like volume control and audio equipment. When only one outer terminal and the wiper are used, this then functions as a rheostat. Examples of potentiometers are the Linear Potentiometer, Rotary Potentiometer, and the like, but the ones we used in the experiment is the Panel Mount Potentiometer (Figure 1).

Figure 1.1: Panel Mount Potentiometer

A panel mount potentiometer is a type of potentiometer designed to be securely mounted on the front panel of an electronic device, allowing users to easily adjust settings from outside the enclosure. It typically features a threaded shaft that passes through the panel, with a knob or slider accessible for adjustments. This design is commonly used in applications like audio equipment and control panels for functions such as volume control or tuning. Panel mount potentiometers come in various forms and configurations, including rotary and slide types.

II. Procedure

1. A typical potentiometer is shown in Figure 1.1, Using a 10 k pot, first rotate the knob fully counter-clockwise and using the DMM, measure the resistance from terminal A to the wiper arm, W. Then measure the value from the wiper arm to terminal B. Record these values in Table 3.1. Add the two readings, placing the result in the final column.

2. Rotate the knob 1/4 turn clockwise and repeat the measurements of step 1. Repeat this process for the remaining knob positions in Table 3.1. Note that the results of the final column should all equal the nominal value of the potentiometer.

3. Construct the circuit of Figure 2.1 using E = 10 volts, a 10 k potentiometer and leave R_L open. Rotate the knob fully counter-clockwise and measure the voltage from the wiper to ground. Record this value in Table 3.2. Continue taking and recording voltages as the knob is rotated to the other four positions in Table 3.2.

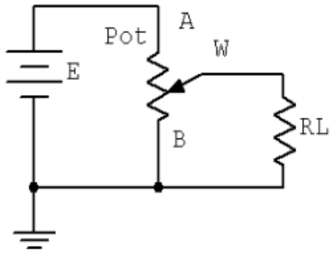

Figure 2.1

4. Set R_L to 47 k and repeat step 3.

5. Set R_L to 4.7 k and repeat step 3.

6. Set R_L to 1 k and repeat step 3.

7. Using a linear grid, plot the voltages of Table 3.2 versus position. Note that there will be four curves created, one for each load, but place them on a single graph. Note how the variance of the load affects the linearity and control of the voltage.

8. Construct the circuit of Figure 2.2 using E = 10 volts, a 100 k potentiometer and R_L = 1 k. Rotate the knob fully counterclockwise and measure the current through the load. Record this value in Table 3.3. Repeat this process for the remaining knob positions in Table 3.3.

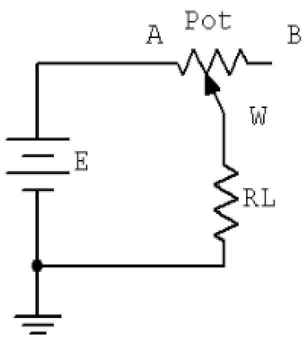

Figure 2.2

9. Replace the load resistor with a 4.7 k and repeat step 8.

III. Results and Analysis

This section will show our results and calculations for each activity, showing the formulas used and the Data gathered. As well as the insights and analysis we gain from these experiments.

A. Determining the resistance of the 10 k pot potentiometer

This table has the recorded values of the resistance of the 10k pot potentiometer.

Data:

Position	R_{AW}	R_{WB}	$R_{AW} + R_{Aw}$
Fully CCW	4.68	7.97	12.65
1/4	1.29	6.88	8.17
1/2	4.30	3.86	8.16
3/4	6.91	1.23	8.14
Fully CW	7.97	4.25	12.22

Table 3.1

B. Determining the voltage output of the 10k pot potentiometer with a 1k, 4.7k and 47k resistors

This table has the recorded values of the voltage output of the 10k pot potentiometer with the first resistor being open, and then with a 1k, 4.7k, and 47k resistors

Data:

Position	V_{WB} Open	V_{WB} 47k	V_{WB} 4.7k	V_{WB} 1k
Fully CCW	10 V	9.93 V	9.48 V	9.79 V
1/4	7.27 V	7.32 V	4.63 V	2.50 V
1/2	4.82 V	4.66 V	2.85 V	1.55 V
3/4	2.30 V	2.02 V	1.34 V	0.88 V
Fully CW	1.26 V	1.20 V	0.004 V	0.001 V

Table 3.2

C. Determining the ampere values of the 100k pot *potentiometer with a 1k and 4.7k resistors*

This table has the records of the ampere readings of the 100k pot potentiometer with a 1k and 4.7k resistors.

Position	I_L 1k	4.7k I_L
Fully CCW	10 mA	7.97 mA
1/4	0.45 mA	6.88 mA
1/2	0.26 mA	3.86 mA
3/4	0.19 mA	1.23 mA
Fully CW	0.10 mA	4.25 mA

Table 3.3

D. Questions

- In Table 9.1, does the total resistance always equal the nominal resistance of the potentiometer?
  Ans:
  - No, the overall resistance does not always equal the nominal value due to minor differences in individual resistances and measurement tolerances. These differences are prevalent among practical components.

- If the potentiometer used for Table 9.1 had a logarithmic taper, how would the values change?
  Ans:
  - If the potentiometer used in Table 9.1 had a logarithmic taper, the resistance would rise gradually at first, then more quickly as the knob was moved. This would cause lesser resistance changes at lower places and larger changes at higher positions. In contrast to the even increments seen with a linear taper, the total behavior would be nonlinear.

- In Table 9.2, is the load voltage always directly proportional to the knob position? Is the progression always linear?
  Ans:
  - The load voltage is not proportional to the knob position, and the evolution is nonlinear, as evidenced by the varied voltage increments. This behavior is typical of the potentiometer's interaction with the load.

- Explain the variation of the four curves plotted in step 7.
  Ans:
  - The curves reflect how the resistance varies with wiper position, affecting the total resistance and output voltage. These changes show different ways the potentiometer can control voltage division.
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- In the final circuit, is the load current always proportional to the knob position? If the load was much smaller, say just a few hundred Ohms, would the minimum and maximum currents be much different from those in Table 9.3?
  Ans:
  - The load current is not always proportional to knob position, and a lower load resistance would result in much higher minimum and maximum currents. This is because decreased resistance allows more current to flow.

- How could the circuit of Figure 9.3 be modified so that the maximum current could be set to a value higher than that achieved by the supply and load resistor alone?
  Ans:
  - The circuit could be improved by adding a current amplifier or utilizing a higher voltage supply to raise the maximum current beyond what the resistor and supply alone can give. This would allow for greater currents without affecting the load resistance.

IV. Discussion and Conclusions

This experiment demonstrated how to measure and adjust voltage at different angles of a potentiometer knob. We observed that each angle corresponds to varying levels of voltage and resistance, which can be precisely controlled. The potentiometer's adjustments allow it to send specific signals to connected devices. Overall, we learned how the device modulates voltage output based on knob position, enabling precise control in circuits.

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