Voltage Dividers and Potentiometers (Lab 8)

Experimenting with Voltage Dividers and Pots

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1.0 PURPOSE

- Understand the concept of the *Voltage Divider Rule.*
- Calculating voltage of resistors using *Voltage Divider Rule*.
- Measuring resistance of various positions on a Potentiometer.
- Understanding the concept of the Potentiometer.

2.0 EQUIPMENT NEEDED

- (1x) desktop Power Supply.
- (1x) desktop Digital Multimeter.
- (2x) 4-band (1/4 watt) resistors.
- (1x) Potentiometer.
- (1x) electronics breadboard.

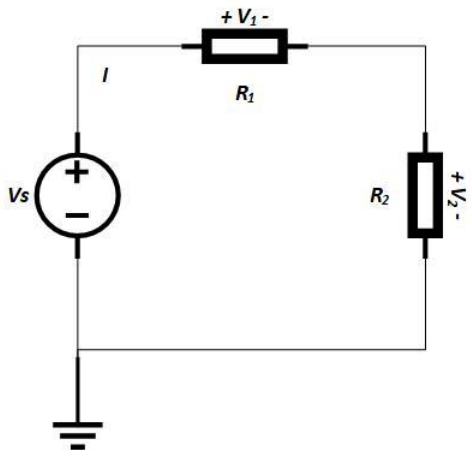
3.0 THEORY

Voltage Divider

- *A **VOLTAGE DIVIDER** is a passive linear circuit that produces an output voltage that is a fraction of its input voltage. Voltage division is the result of distributing the input voltage among the components of the divider. (refer to Fig.1.).*

(Document #1 – Voltage Divider Circuit)

Fig.1.



[To find V_0:]

$R_T = R_1 + R_2$

$I = \frac{V_S}{R_T}$

[Applying Ohm's law:]

$V_1 = IR_1 = (\frac{V_S}{R_T})R_1 = \frac{R_1 V_S}{R_T}$

$V_0 = IR_2 = (\frac{V_S}{R_T})R_2 = \frac{R_2 V_S}{R_T}$

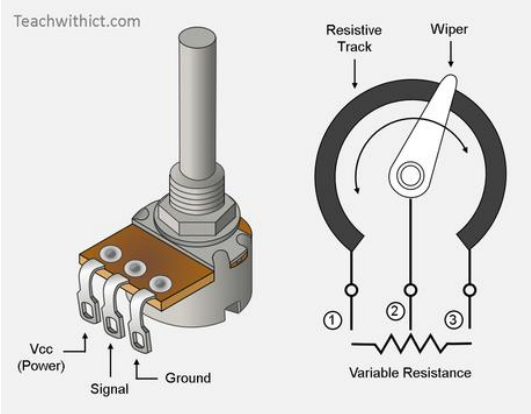
[We can conclude from the above that:]

$V_X = \frac{R_X V_S}{R_T}$ *(Voltage Divider Rule)*

Potentiometers (Pots)

- *A **POTENTIOMETER** is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat (refer to Document #1 for reference).*

(Document #1-Potentiometer)



4.0 EXPERIEMNTAL RESULTS

Results from the Procedure section:

VOLTAGE DIVIDER:

PROCEDURE: ***(V_S = 12V) (Use Circuit Fig.1 from above)***

Step 1: Measure the values of the resistors and copy to Table 1.

Step 2: Calculate the voltages of each resistor using the *Voltage Divider Rule* and copy to Table 1.

Step 3: Calculate the current in each resistor and write in Table 1.

Step 4: Build the circuit of Fig.1.

Step 5: Ask your teacher to verify your circuit before you connect power supply.

Step 6: Set the voltage source to 12V and limit the current to 500mA.

Step 7: Measure the voltages of each resistor and copy to Table 1.

Step 8: Measure the current of each resistor and copy to Table 1.

Step 9: Verify that Voltage Divider Rule is valid.

R_T = 4.3KΩ		Voltage			Current		
Resistor	**Value**	**Calculated**	**Measured**	**%Error**	**Calculated**	**Measured**	**%Error**
R1	1KΩ	2.79V	3.0V	7.5%	2.79mA	2.5mA	10.3%
R2	3.3KΩ	9.20V	8.8V	4.3%	2.79mA	2.5mA	10.3%

CALCULATIONS:

[Calculated Voltage]

$V_X = \frac{R_X * V_S}{R_T}$, $= \frac{1K\Omega * 12V}{4.3K\Omega}$ **= 2.79V**

$V_X = \frac{R_X * V_S}{R_T}$, $= \frac{3.3K\Omega * 12V}{4.3K\Omega}$ **= 9.20V**

[%Error Voltage]

%Error = $\frac{Measured - Calculated}{Calculated}$ * 100 = $\frac{3.0V - 2.79V}{2.79V}$ * 100 = **7.5%**

%Error = $\frac{Measured - Calculated}{Calculated}$ * 100 = $\frac{8.8V - 9.20V}{9.20V}$ * 100 = **4.3%**

[Calculated Current]

V = I*R, 2.79 = I*1KΩ, I = **2.79mA**

V = I*R, 9.20 = I*3.3KΩ, I = **2.79mA**

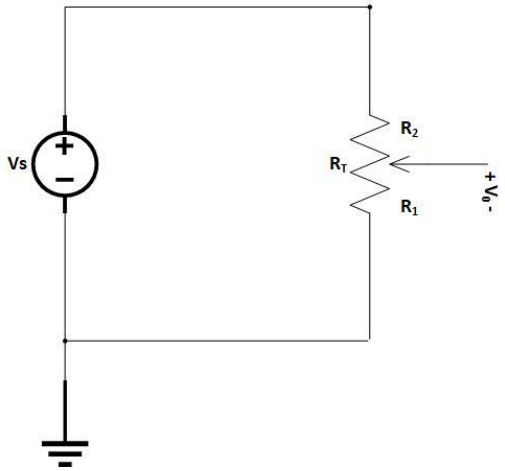
[%Error Current]

%Error = $\frac{Measured - Calculated}{Calculated}$ * 100 = $\frac{2.5mA - 2.79mA}{2.79mA}$ * 100 = **10.3%**

%Error = $\frac{Measured - Calculated}{Calculated}$ * 100 = $\frac{2.5mA - 2.79mA}{2.79mA}$ * 100 = **10.3%**

POTENTIOMETER:

Fig.2.



PROCEDURE: ***(V_S = 12V) (Use Circuit Fig.2.)***

Step 1: Measure the value of the total resistance (Fixed resistance) and copy it to table 2.

Step 2: Divide the fixed resistance in four parts (25%, 50%, 75% and 100%) and calculate the voltages for each part using the *Voltage Divider Rule* to copy to Table 2.

Step 3: Calculate the current in each resistor and write in Table 2.

Step 4: Build the circuit of Fig.2.

Step 5: Ask your teacher to verify your circuit before you connect power supply.

Step 6: Set the voltage source to 12V and limit the current to 500mA.

Step 7: Set the wiper arm to the 4 parts (approximate) and measure the voltages V_0 for each setting and copy to table 2.

Step 8: Measure the current of each resistor and copy to Table 2.

Step 9: You might have a non-linear pot, make a note of that!

Fixed = 7.2KΩ		**Voltage**			**Current**		
Resistor	**Value**	**Calculated**	**Measured**	**%Error**	**Calculated**	**Measured**	**%Error**
25%	1.75KΩ	2.9V	2.7V	6.8%	1.65mA	1.4mA	15.6%
50%	2.8KΩ	4.6V	4.4V	4.3%	1.64mA	1.4mA	14.6%
75%	5KΩ	8.3V	8.1V	2.4%	1.66mA	1.4mA	15.6%
100%	7.2KΩ	12V	11.9V	0.08%	1.67mA	1.4mA	16.1%

CALCULATIONS:

[Calculated Voltage]

$V_X = \frac{R_X * V_S}{R_T}$, $= \frac{1.75K\Omega * 12V}{7.2K\Omega}$ **= 2.9V**

$V_X = \frac{R_X * V_S}{R_T}, = \frac{2.8K\Omega * 12V}{7.2K\Omega} = 4.6V$

$V_X = \frac{R_X * V_S}{R_T}, = \frac{5K\Omega * 12V}{7.2K\Omega} = 8.3V$

$V_X = \frac{R_X * V_S}{R_T}, = \frac{7.2K\Omega * 12V}{7.2K\Omega} = 12V$

[%Error Voltage]

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{2.7V - 2.9V}{2.9V} * 100 = 6.8\%$

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{4.4V - 4.6V}{4.6V} * 100 = 4.3\%$

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{8.1V - 8.3V}{8.3V} * 100 = 2.4\%$

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{11.9V - 12V}{12V} * 100 = 0.08\%$

[%Error Current]

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{1.4mA - 1.65mA}{1.65mA} * 100 = 15.6\%$

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{1.4mA - 1.64mA}{1.64mA} * 100 = 14.6\%$

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{1.4mA - 1.66mA}{1.66mA} * 100 = 15.6\%$

$\%Error = \frac{Measured - Calculated}{Calculated} * 100 = \frac{1.4mA - 1.67mA}{1.67mA} * 100 = 16.1\%$

[Calculated Current]

V = I*R, 2.9 = I*1.75KΩ, I = **1.65mA**

V = I*R, 4.6 = I*2.8KΩ, I = **1.64mA**

V = I*R, 8.3 = I*5KΩ, I = **1.66mA**

V = I*R, 12 = I*7.2KΩ, I = **1.67mA**

5.0 Conclusion

- Understood the concept of the *Voltage Divider Rule.*
- Purpose of this lab has been achieved.
- Understood how to measure voltage of resistors using the *Voltage Divider Rule*.
- Understood how to measure resistance from various positions on a Potentiometer.
- Understood the concept of the Pots.
- Error occurred when measuring the voltage of a position in a Potentiometer: the probes were not connected correctly across the correct terminals.
- Solution: corrected the error from above and using the *Voltage Divider Formula* to double check that my measurements would read somewhat close to what was calculated.