Lab 3: Loading Effect of Voltage Divider Circuit

Objective:

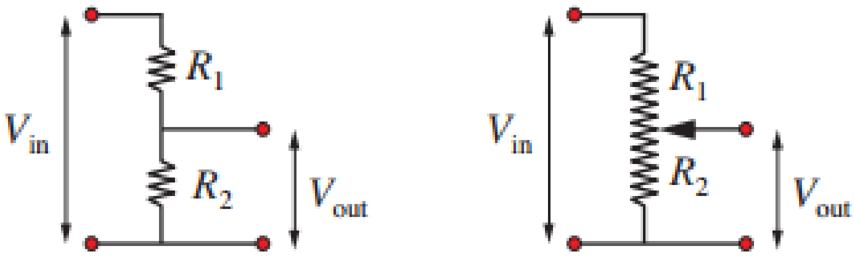
- To analyze how the voltage divider circuit behaves when there is no load resistance connected.
- Evaluate the performance of voltage divider circuit due to loading.

List of Equipment:

- Trainer Board
- DMM
- 2 × 560Ω resistors
- 1 × (0-10kΩ) variable resistor

Theory:

Voltage Divider circuit provides a simple way to convert a DC voltage to another lower DC voltage. Consider the following voltage divider circuit.



(a) (b)

Figure 1: (a) A Voltage divider, (b) A Potentiometer

The voltage drop across R_2 is the output voltage, V_{out}. V_{out} is less than V_{in} because the total voltage across R_1 and R_2 must add up to Vin. A potentiometer can also be used to change V_{out} by changing the resistance R_2. As the value of R_2 is changed, it allows the output voltage to be adjusted from 0 to V_{in}.

In Figure 1, there is no output load (R_L) connected in parallel to R_2 hence we call it a No-Load circuit.

According to Voltage Divider Rule: $$\boldsymbol{V_{out} = V_{in}\frac{R_2}{R_1 + R_2}} \qquad (1)$$

- **Say V_{in}=5v and you need V_{out}= 3v. How would you set the values of R_1 and R_2 ?**

$$\boldsymbol{\frac{V_{out}}{V_{in}} = \frac{R_2}{R_1 + R_2}}$$

Choice of resistor value should follow the ratio: $\boldsymbol{\frac{R_1}{R_2} = \frac{2}{3}}$

One possible combination: $R_1 = 2k \quad and\ R_2$= 3k

- **Now say we connect an output load, R_3 in parallel to R_2 :**

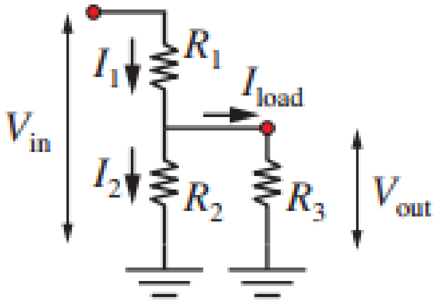


Figure 2: With Output Load Connected

⟹ Do you think keeping the values of resistors same would still give V_{out}=3v from V_{in}=5v?
Let's check:

Since you have a Load resistance parallel to R_2 , your Voltage divider formula to find V_{out} is:

$$\boldsymbol{V_{out} = V_{in}\frac{(R_2 // R_3)}{R_1 + (R_2 // R_3)}} \qquad (2)$$

Let R_3 = 10k.
$R_2 \; // \; R_3 = 2.31$k

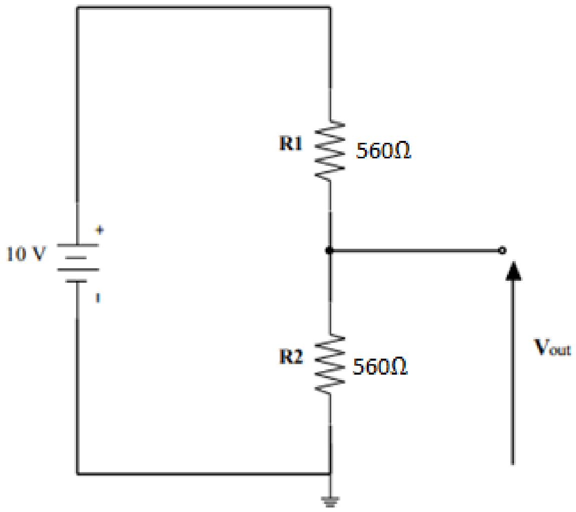
→ $V_{out} = \; 2.68 \; v$

So, our Designed value was 3v, but connecting a load resistor reduced it to 2.68v.

Design Criteria:

To minimize the loading effect, choose the load resistor to be much larger than its parallel resistor.
If R_3 is much greater than R_2 then $R_2 \; // \; R_3$ (parallel combination of $R_2 \; and \; R_3$) is approximately equal to R_2

Circuit Diagram:



Procedure:

1. Construct the voltage divider circuit as shown in figure above.
2. Measure the unloaded output voltage V_{out}. Record the value in Table 1.
3. Connect 10 kΩ variable load resistor, parallel with R_2 to the circuit. (Connect 1 middle pin of variable resistor and one of the other pins).
4. Change the value of the variable resistor according to Table 1, and record V_{out} for each resistor value in Table 1.

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EEE141L/ETE141L

Data Collection for Lab 3:

Group No. ________

Table 1:

R_L	V_{out} (Measured)	V_{out} (Calculated)	%Error
No resistor			
1k			
4k			
7k			
10k			

Questions:

1. Explain the loading effect of your circuit (i.e explain how does your V_{out} vary with increasing Load resistor)
2. Showing all steps in details, theoretically calculate the value of V_{out} for each load resistor.
3. Comparing the theoretical data to the experimental data, comment how far the loading effect of your circuit supports the theory.