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

Introduction:

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

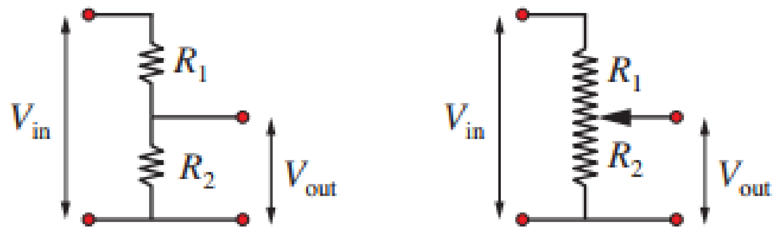


Figure 1: A voltage divider on the left, and potentiometer on the right.

The voltage drop across R2 is the output voltage, Vout. Vout is less than Vin because the total voltage across R1 and R2 must add up to Vin. A potentiometer can also be used to change Vout by changing the resistance R2. As the value of R2 is changed, it allows the output voltage to be adjusted from 0 to Vin.

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: $\boldsymbol{V_{out} = V_{in}\frac{R_2}{R_1+R_2}}$ (1)

- **Say Vin=5v and you need Vout= 3v. How would you set the values of R_1 and R_2 ?**

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

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

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

- **Now say we connect an output load,R_3in parallel to R_2 :**

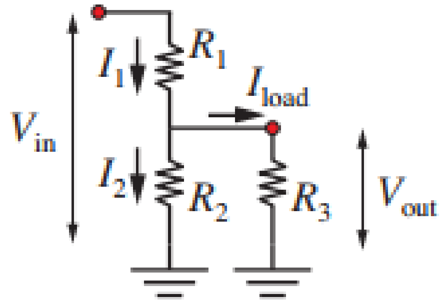


Figure 2: With Output Load Connected.

⟹Do you think keeping the values of resistors same would still give Vout=3v from Vin=5v? Let’s check:

Since you have a Load resistance parallel to R_2, your Voltage divider formula to find Vout is:

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

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

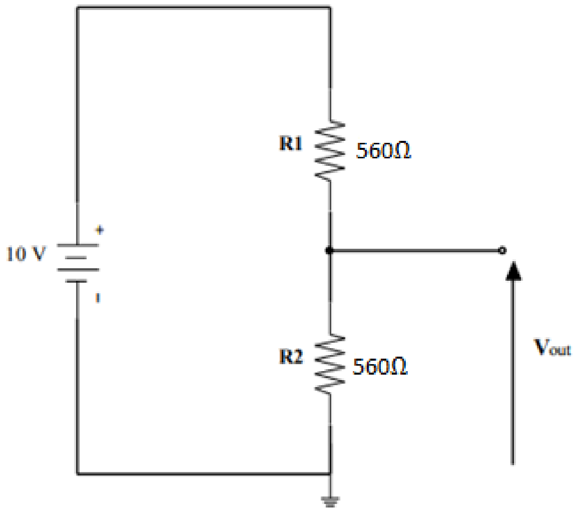
$\rightarrow\ V_{out} =\ 2.68\ v$

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 Vout. Record the value in Table 1.
3. Connect 10 kΩ variable load resistor, parallel with R2 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 Vout for each resistor value in Table 1.

Data Collection for Lab 3:

Group No. ________Instructor's Signature __________

Table 1:

RL	**Vout (Measured)**	**Vout (Calculated)**	**%Error**
No resistor			
1k			
4k			
7k			
10k			

Report Question:

1. Explain the loading effect of your circuit (i.e explain how does your Vout vary with increasing Load resistor)
2. Showing all steps in details, theoretically calculate the value of Vout 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.