North South University

Department of Electrical & Computer Engineering

LAB REPORT

Course Code : EEE/ETE 141 L

Course Title: DC Circuit Lab

Course Instructor: Md. Nazmul Bari

Experiment Number: 03

Experiment Name:

Loading Effect of Voltage Divider Circuit.

Date of Experiment: 16/07/2021

Date of Submission: 28/07/2021

Section: 12

Group Number: 04

Submitted By	Score

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1.NAME OF THE EXPERIMENT: **Loading Effect of Voltage Divider Circuit**

Title: Loading Effect of Voltage Divider Circuit.

Objectives:

→ To analyze how the voltage divider circuit behaves when there is no load resistance connected

→ Evaluate the performance of voltage divider due to the loading

Equipment list:

→ Trainer Board

→ DMM

→ 2 x 560Ω resistors

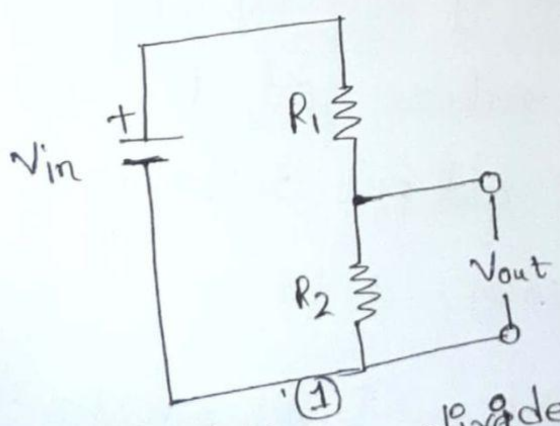
→ 1 x (0-10kΩ) variable resistor

4.THEORY:

4. Theory:

Loading Effect of Voltage Divider Circuit.

The voltage divider is a circuit used to create a voltage less than or equal to the input voltage. The voltage divider is used only there where the voltage is regulated by dropping a particular voltage in a circuit. Most commonly the voltage divider is used in potentiometres.



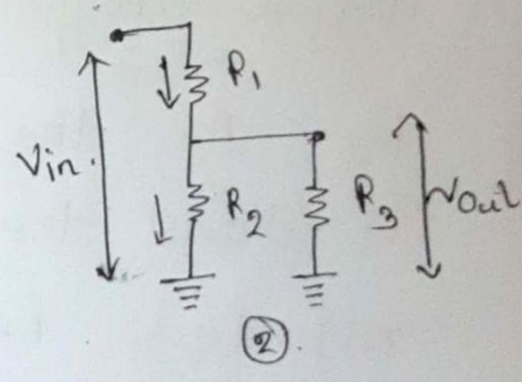


Fig1: Voltage divider circuit.
Fig 2: Voltage divider with Load Connected.

Voltage divider circuit provides a simple way to convert a DC voltage to another Lower DC voltage.

A voltage divider is basically an electronic
eti circuit network using resistors. In
this network resistors are connected
in series across the supply voltage,
and the output is extracted across one
of the resistors for getting the desired
equivalent dropped voltage. A potentio-
meter can also be used to change
output voltage by changing the resistance
R_2. As the value of R_2 eh is change
it allows the output volatage to be
adjusted from 0 to V_{in}.

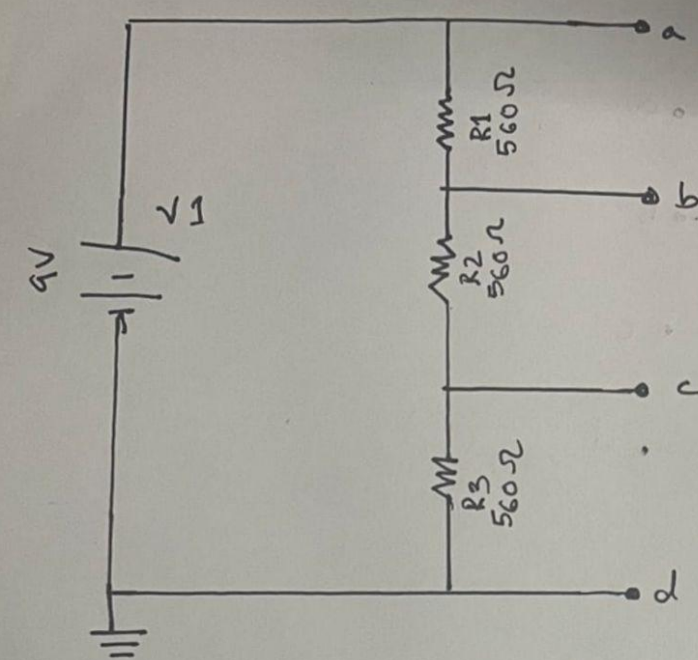
According to Voltage Divider rule:

$$V_{out} = V_{in} \frac{R_2}{R_1 + R_2} \quad \text{——(1)}$$

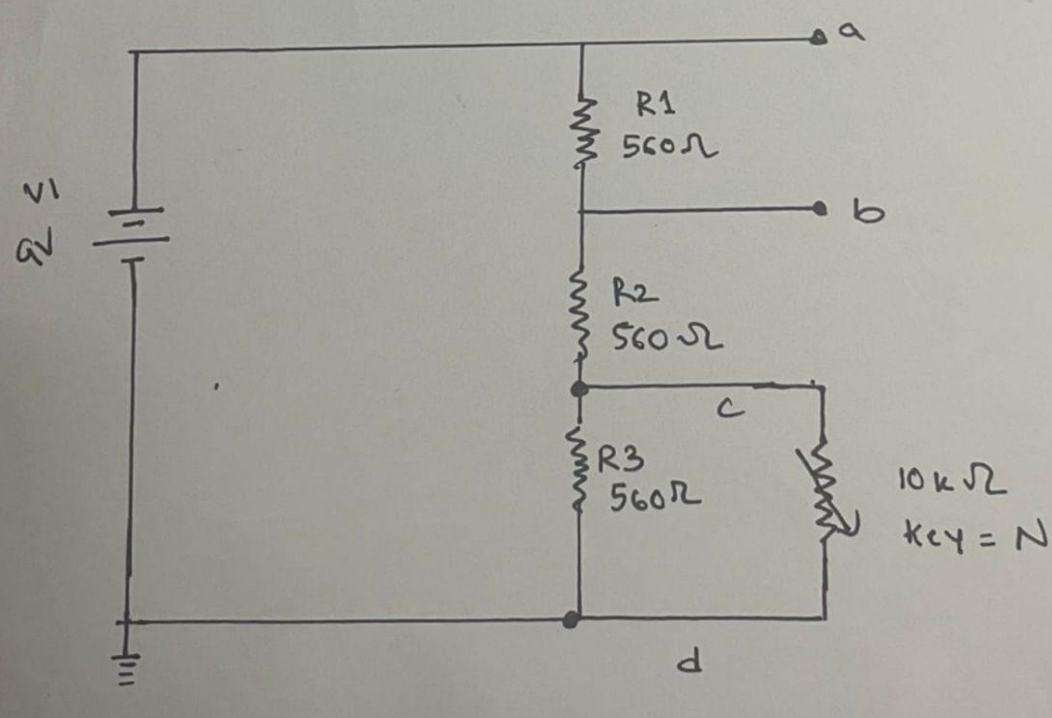
When we have a Load resistance parall
to R_2, the $V_{out} = V_{in} \frac{(R_2 // R_3)}{R_1 + (R_2 // R_3)}$

5.CIRCUIT DIAGRAM:

Circuit Diagram :



Circuit 1



Circuit 2

6.RESULTS:

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Data and Table :

	Circuit 1	Circuit 2 (R4 = 1KΩ)	Circuit 2 (R4 = 4KΩ	Circuit 2 R4 = 7KΩ	Circuit 2. R4 = 10KΩ.
R_T	1.680kΩ	1.205kΩ	1.535kΩ	1.623kΩ	1.65kΩ.
E	9V	9V	9V	9V	9V
I	5.357mA	7.47mA	5.864mA	5.547mA	5.454mA.
V_{R1}	3V	4.183V	3.284V	3.106V	3.054V.
V_{R2}	3V	4.183V	3.284V	3.106V.	3.054V
V_{R3}	3V.	633.80mV	2.432V.	2.788V	2.892V.
I_{R1}	5.357mA	7.47mA	5.864mA	5.547mA	5.464mA
I_{R2}	5.357mA	7.47mA	5.864mA	5.547mA	5.454mA.
I_{R3}	~~1.132mA~~ 5.357mA	~~4.344mA~~ 1.132mA	4.344mA	4.978mA.	5.164mA.

Table C.1.

Table 1:

RL.	Vout (measured)	Vout (calculated)	% Error
0	3V.	3V	0%
1K	633.80mV	2.184	70.97%
4k	2.432V	2.744	11.38%
7K	2.788V	2.848	2.11%
10k.	2.892V	2.892	0%.

Calculations:

for 0kΩ.

$R_p = (560 + 560 + 560)\Omega$.

$= 1680\Omega$.

$V = 9V$.

$I = \frac{V}{R_p} = \frac{9}{1680} = 5.357\, mA$.

so, $V_{out} = IR_3$

$= 5.357\, mA \times 560\Omega$.

$= 3V$.

Vout (measured) = 3V.

so, % Error $= \frac{3-3}{3} = 0\%$

For 1K:

$$R_p' = \left(\frac{1}{R_3} + \frac{1}{R_4}\right)^{-1} = \left(\frac{1}{1000} + \frac{1}{560}\right)^{-1} = 358.974\,\Omega.$$

$$R_p^T = (560 + 560 + 358.974)\,\Omega.$$
$$= 1478.974\,\Omega.$$

So, $I_1 = \frac{9}{1478.974} = 6.085$ mA.

V_{out} (real) $= 358.974 \times 6.085$ mA
$= 2.184$ V.

V(measured) $= 0.6338$

% Error $= \frac{2.184 - 0.6338}{2.184}$
$= 70.97\%$

For 4K.:

$$R_p' = \left(\frac{1}{4000} + \frac{1}{560}\right)^{-1} = 491.2280\,\Omega.$$

$R_p^T = 1611.22\,\Omega.$

$I_2 = 5.5858 \times 10^{-3}$ A.

$V_{out} = I_2 R_p'$
$= 2.744$ V.

V(mea) $= 2.432$ V.

~~% error~~ $= \cancel{\frac{2.432 - 2.744}{2.432} \times 100}$

$$\%\ \text{Error} = \frac{2.74 - 2.432}{2.74} \times 100$$
$$= 11.38\%$$

7.DISCUSSIONS:

7) Discussion :

The name of our experiment is loading effect of voltage divider circuit. In this experiment we learned to analyze the voltage divider circuit behaves when there is no load resistance connected. As well as we learned how to evaluate the performance of voltage divider circuit due to loading. In this experiment we can notice that here Vout (measured) and Vout (calculated) are nearly identical. Since we used a simulator for the circuits, for that we got nearly closed values. there was not much differences between theoratical and practical results. Also when we increased resistance, we saw the voltage is increasing too. But at one point the voltage became constant. Here we got percentage errors but the percentage would be higher if we do this practically.

8.QUESTIONS:

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Question / Answer:

1. As the resistance of the loading effect resistors is increased, the volt increases. This is because the R_3 (the load resistor) is in parallel with the R_2 resistor and their combitional resistor is lower than the individual resistor of R_2 and R_3. This cause the current flow across these parallel resistors to be more and the voltage drop across the combined resistance increases. Hence, V_{out} is more as the load resistance is increasing. Now let's look at the issue mathematically, when the load resistance is $1k\Omega / 1000\Omega$, the combined resistance is 35~~8~~ 974 Ω and for

that vout is found to be 3.906 V. when the load resistance is 4kΩ/ 4000 Ω then the combined resistance is 491.228 Ω and for that Vout is found to be 4.673 V. when the load resistance is 7 kΩ/ 7000 Ω then the combined resistance is 518.519 Ω and Vout found to be 4.808 V. when the load resistance is 10 kΩ / 10000 Ω, the combined resistance is 530.303 Ω and for that Vout is found to be 4.864 V.
So, we can conclude, as the

load resistance value increases, the value of the combined resistance increases, the value of V_{out} also increases.

2 Theoretical value of V_{out} for no load resistance is :

$$V_{out} = \{ (V_{in} * R_2) / (R_1 + R_L) \} V$$

$$= \{ (10 * 560) / (560 + 560) \} V$$

$$= 5.000 \, V$$

$$R_T = (R_L \| R_3) = \{ (R_2 * R_3) / (R_L + R_3) \} \Omega$$

Theoretical value of Vout for 1k load resistor is :

when $R_3 = 1K = 1 \times 10^3 = 1000\ \Omega$

$R_T = \{(560 \times 1000)/(560+1000)\}\ \Omega$

$= 358.974\ \Omega$

$V_{out} = \{V_{in} * (R_2 \| R_3)\}/\{R_1 + (R_2 \| R_3)\}\ V$

$= \{(10 * 358.974)/(560+358.974)\}\ V$

$= 3.906\ V$.

Theoretical value of Vout for 4k load resistor is :

when $R_3 = 4k = 4 \times 10^3\ \Omega = 4000\ \Omega$

$R_T = \{(560 * 4000) / (560 + 4000)\} \Omega$

$= 491.228 \Omega$

$V_{out} = \{(10 * 491.228) / (560 + 491.228)\} V$

$= 4.67289 V$

$\simeq 4.673 V$

Theoretical value of vout for 7 k load resistor is

when $R_3 = 7k = 7 \times 10^3 \Omega = 7000 \Omega$

$R_T = \{(560 + 7000) / (560 + 7000)\} \Omega$

$= 518.5185 \Omega$

$= 518.519 \Omega$

$V_{out} = \{(10 * 518.519) / (560 + 518.519)\} V$

$= 4.80769 V$

$\approx 4.8088 V$

theoretical value of Vout for

10k load resistor as :

when $R_3 = 10k = 10 \times 10^3 \Omega = 10000 \Omega$

$R_T = \{(560 \times 10000) / (560 + 10000)\} \Omega$

$= 530.303 \Omega$

$V_{out} = \{(10 \times 530.303) / (560 + 530.303)\} V$

$= 4.86381 V$

$= 4.864 V$

3. We perform this part by multisim (a circuit analysis tool that allows the user to simulate a circuit and extract key voltages and current). This is how, we performed this part successfully.

Experimental value of vout for no load resistors: Vout = 5.000 v

Experimental value of vout for 1k load resistors is Vout = 5.000 v

Experimental value of vout for 1k load resistors is Vout = 3.906 v

Experimental value of Vout for 4k load resistor is Vout = 4.673V

Experimental value of Vout for 7k load resistor as, Vout = 4.808V

Experimental value of Vout for 10k load resistor is : Vout = 4.864V

From the Question 2,

theoritical value of Vout,

For No load resistor is = 5.000V

" 1k " " " = 3.906V

" 4k " " " = 4.673V

" 7k " " " = 4.808V

" 10k " " " = 4.864V

% Error for vout for No load resistor

$= \{(5-5)/5\} \times 100\%$

$= 0.00\%$

% Error for vout for 1k load resistor

$= \{(3.906 - 3.966)/3.906\} \times 100$

$= 0.00\%$

% Error for Vout for 4k load resistor

$= \{(4.673 - 4.673)/4.673\} \times 100$

$= 0.00\%$

% Error for vout with 7k load resistor

$= \{(4.808 - 4.808)/\cancel{8}.4.808\} \times 100$

$= 0.00\%$

% Error of Vout for 10k load

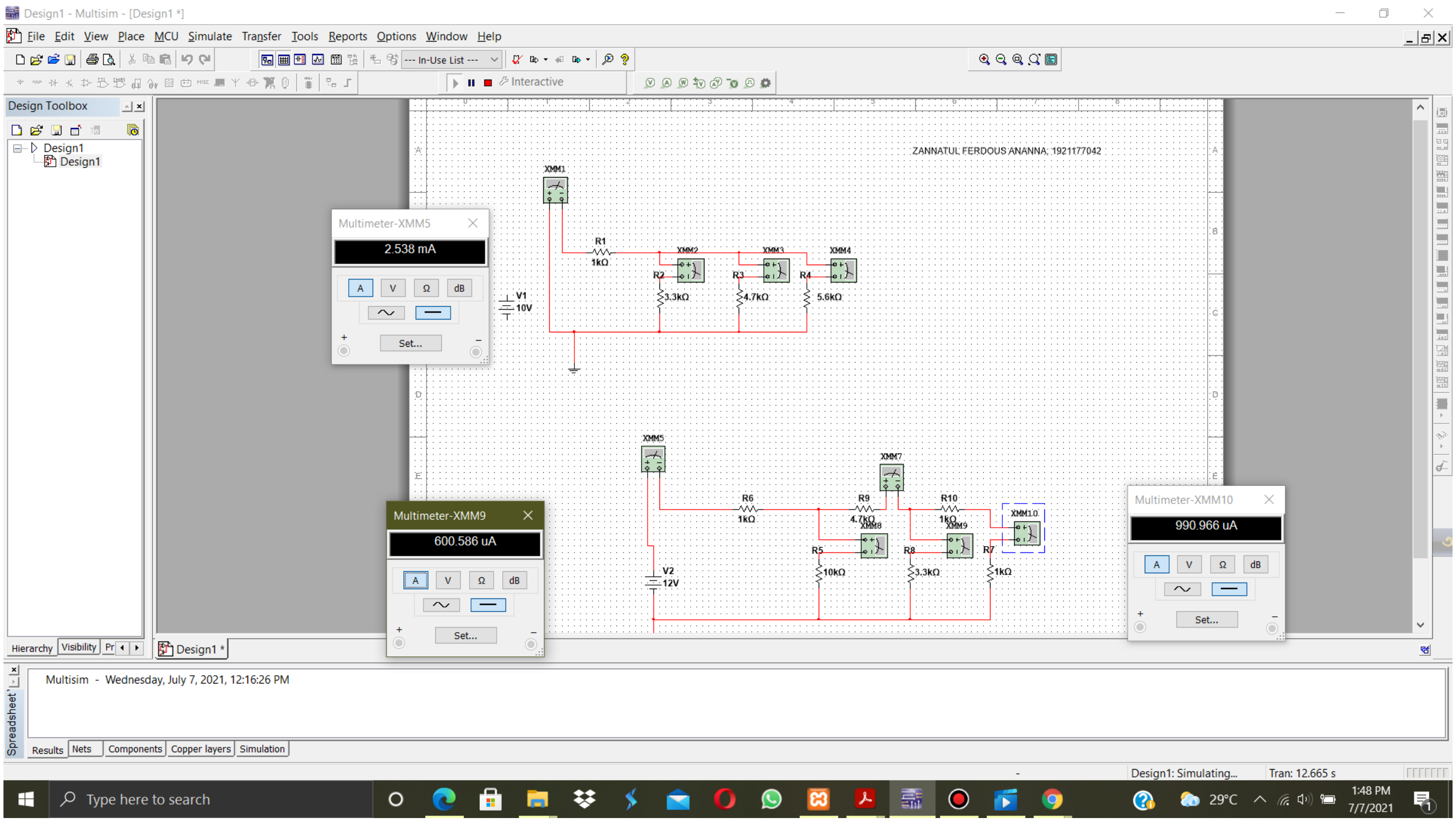
resistor = $\{(4.864 - \cancel{8}4.864)/4.864\} \times 100$

$= 0.00\%$

It is seen that the theoretical values of Vout for each resistors are very close or accurate as the experimental values. So, we can conduct that the loading effect of a circuit supports the theory.

4. Loading effect can be defined as the effect on the source by the load impedence. Usually ~~A~~ loading effect reduces the voltage level of a voltage sources. when load current increases, the voltage drop across intend impedence (resistance in circutis) increases. That is why the lesser output voltage available at terminals. In that case, whenever a load is connectedto any device or machine then it draws more current before and when current increase than the voltage decrease.

Attachments:



Contributions :

1.	Khalid Hasan Prodhan	8(Question & Answer)
2.	Zannatul Ferdous Ananna	4,6(Theory & Result
3.	Nazmoon Nahar Punom	7(Discussion)
4.	Parinda Rahman	1,2,3,5(Title,Objective,Circuit Diagram)

Reference :

1. https://learn.sparkfun.com/tutorials/voltage-dividers/all?fbclid=IwAR3N1H1wfdcnVz3OufLEqEihTwX3V3yo7ClqoLFXJBf5EZVVxh3N2XFjx34