North South University

Department of Electrical & Computer Engineering

LAB REPORT- 02

Course Code: **EEE141L**

Course Title: **Electrical Circuits Lab**

Section: **07**

Lab Number: **02**

Experiment Name:

KCL, Current Divider Rule with Parallel and Ladder Circuit

Experiment Date: **14th March, 2024**

Date of Submission: **21st March, 2024**

Submitted by Group Number: **02**

Group members:

Serial	Name	ID	Marks
01	Abrar Tazwar Aziz	1813399642	
02	Sudipto Roy	2222756042	
03	Rezuan Islam Samir	2021092642	
04	Sadman Sakib Prodhan	1510748642	
05	Md Tamim Ahamed	2014286642	

Course Instructor: **Dr. Mahdy Rahman Chowdhury (Mdy)**

Submitted To Lab Instructor: **Md. Masud Rana**

1. **Experiment Name**: KCL, Current Divider Rule with Parallel and Ladder Circuit

2. **Objectives**:

- Learn how to connect a parallel circuit on a breadboard.
- Validate the current divider rules.
- Verify Kirchhoff's current law.
- Verify KCL and KVL in ladder circuit.

3. **Theory**:

In electrical circuits, the current divider rule is a fundamental principle used to determine the distribution of current among parallel branches of a circuit. It is derived from Ohm's Law and is based on the principle that in a parallel circuit, the voltage across each branch is the same, while the current through each branch may vary.

The current divider rule states that the electrical current entering the node in a parallel circuit is divided into the branches. Current divider rule is used to calculate the magnitude of **divided** current in circuits.

A parallel circuit with 'n' number of resistors and an input voltage source is illustrated below. The goal of the experiment is to find the current through each resistor connected in parallel.

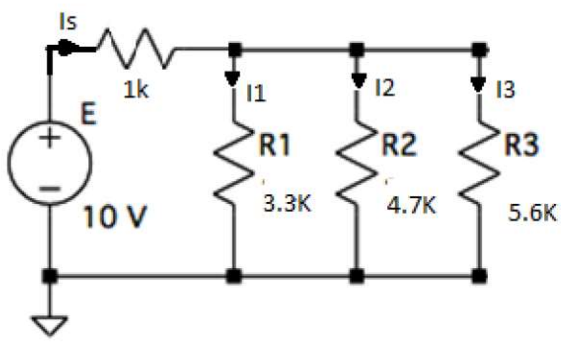

Figure 1: A parallel circuit

The formula for Current Divider rule: $\boldsymbol{Ix} = \frac{\boldsymbol{R1}}{\boldsymbol{Rx}} * \boldsymbol{Is}$

Kirchhoff's Current Law (KCL) states that the algebraic sum of currents entering and leaving a junction (or node) in an electrical circuit is zero. In simpler terms, it implies that the total current flowing into a junction is equal to the total current flowing out of that junction.

In equation form, the above statement can be written as follows:

$$\sum Ii = \sum Io$$

Here I_i represents the current entering, and I_0 represents the current leaving.

KCL is based on the principle of conservation of electric charge, where the charge cannot accumulate at a point within a circuit. If more current flows into a junction than out of it, it would imply a net accumulation of charge, violating the conservation law.

The combination of series and parallel circuits is called a ladder circuit. The following circuit is an example of a ladder circuit:

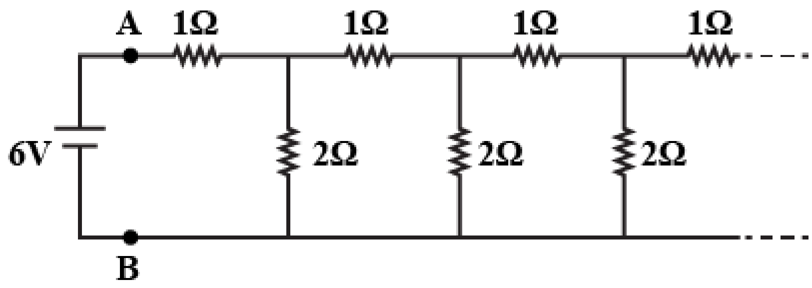

Figure 2: A Ladder circuit

A color code table is used to identify the values of resistors to be used in a circuit. Color code holds the value of a resistor and its tolerance.

4. Apparatus:

- Trainer board.
- Resistors (1KΩ, 3.3 KΩ, 4.7 KΩ, 5.6 KΩ, 10 KΩ)
- Digital Multimeter (DMM)
- Connecting Wires

5. Circuit Diagram:

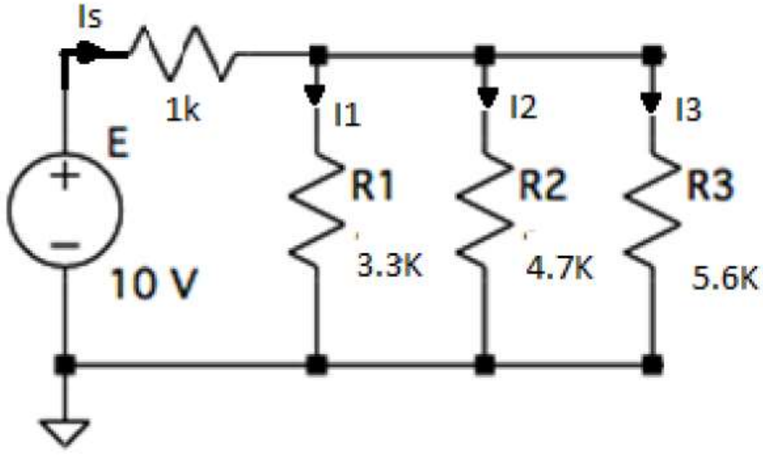

Figure 3: Circuit 1

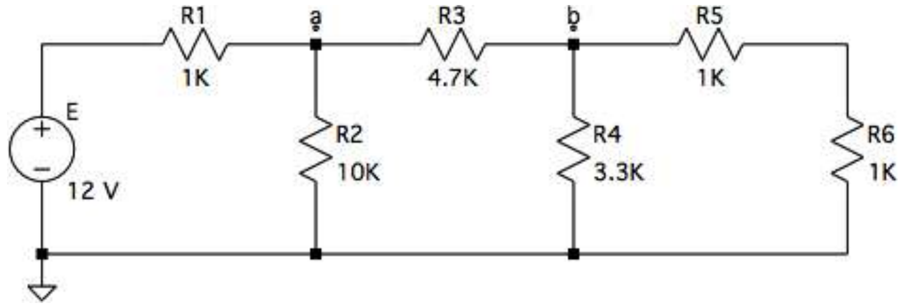

Figure 4: Circuit 2

6. Experimental Procedure:

1. Firstly, we identified all the given resistors using the color-coding chart and filled the required columns in Table 1.
2. Then, we measured the actual resistance of the resistors using the DMM and filled in the required column in Table 1.
3. We calculated the percentage errors of the resistance values using the formula, Percentage Error = | (Practical value – Theoretical value) | / Theoretical value.
4. Build the circuit 1 on the Trainer board.
5. we measure the currents Is, I1, I2, and I3 using the DMM. The readings were recorded in Table 2.
6. Table 3 was filled with the Is value and sum of individual current.
7. We disconnected the voltage source from the circuit and measured the total load resistance and Req of the circuit using DMM. The values were then noted down in Table 4.
8. Then, we constructed Circuit 2.
9. Using a DMM, the potential differences across all the resistors in circuit 2 were measured. All the readings were recorded in Table 5.
10. Using a DMM, the current through all the resistors was measured and recorded in Table 5.

7. Results:

Table 1:

Resistance using colour coding					Resistanc eusing DMM	% Error
Band 1	**Band 2**	**Band 3**	**Band 4**	**Resistance ±tol**		
Orange(3)	Orange(3)	Red(2)	±5% Gold	33 X 10^2 ±5%	3.267 KΩ	1%
Green(5)	Blue(6)	Red(2)	±5% Gold	56 X 10^2 ±5%	5.500 KΩ	1.79%
Brown(1)	Black(0)	Red(2)	±5% Gold	10 X 10^2 ±5%	0.998 KΩ	0.2%
Yellow(4)	Violet(7)	Red(2)	±5% Gold	47 X 10^2 ±5%	4.650 KΩ	1.06%

Calculations for Table 2:

$R_T = R_1 \,||\, R_2 \,||\, R_3 = \left(\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}\right)^{-1} = \left(\frac{1}{3.3K} + \frac{1}{4.7K} + \frac{1}{5.6K}\right)^{-1} = 1.44\ K\Omega$

$R = R_T + 1K\Omega = 2.44\ K\Omega$

$I_S = 10V / R = 4.098\ mA$

$\boldsymbol{Current\ Divider\ Rule}: \boldsymbol{Ix} = \frac{\boldsymbol{R1}}{\boldsymbol{Rx}} * \boldsymbol{Is}$

$I1 = \frac{1.44K}{3.3K} X\ 4.098mA = 1.788mA$

$I2 = \frac{1.44K}{4.7K} X\ 4.098mA = 1.256mA$

$I3 = \frac{1.44K}{5.6K} X\ 4.098mA = 1.054\ mA$

$\%\ Error = \frac{|Practical\ value - Theorical\ value|}{Theoretical\ value} * 100$

Example:

$\%\ Error\ of\ Is = \frac{|4.140 - 4.098|}{4.098} * 100 = 1.02\ \%$

Table 2:

Experimental readings				Theoretical values			
IS	**IR1**	**IR2**	**IR3**	**IS**	**IR1**	**IR2**	**IR3**
4.140 mA	1.810 mA	1.270 mA	1.078 mA	4.098 mA	1.788 mA	1.256 mA	1.054 mA

% Error			
IS	**IR1**	**IR2**	**IR3**
1.02 %	1.23 %	1.11 %	2.27 %

Table 3:

IS	4.140 mA	**Is Total Current equal to sum of individual current?**
Sum of individual Current (IR1 + IR2 + IR3)	(1.18 + 1.27 + 1.078) mA = 4.158 mA	**YES**

The value of I_s and sum of individual current are very close to each other. So, it can be concluded that they are equal.

Table 4:

Experimental Req	Theoretical Req	% Error
1.423 KΩ	1.44 KΩ	1.18 KΩ

Calculation:

$$\% \; Error \; of \; Req = \frac{|1.423 - 1.44|}{1.44} * 100 = 1.18 \,\%$$

Table 5:

Component	Voltage / V	**Current/** mA
E	12.00	2.538
R1	2.538	2.538
R2	9.462	0.946
R3	7.480	1.592
R4	1.982	0.601
R5	0.991	0.991
R6	0.991	0.991

8. Discussion:

In this experiment, we constructed two circuits. They were ladder circuits. The first circuit was relatively easier to construct as it consisted of three resistors in parallel and one resistor in series, compared to the second circuit which had a total of six resistors.

For the first circuit, we used four resistors. Initially, the resistance of the resistors was calculated and recorded using color coding. Then, they were placed on the trainer board and their actual resistance was measured using DMM. Circuit 1 was then constructed using the four resistors (1 KΩ, 3.3 KΩ, 4.7 KΩ and 5.6 KΩ). We had to make sure the wires were connected firmly to the trainer board as abnormal readings were being displayed initially. After successfully constructing the circuit, the DMM was connected along each resistor in series to measure the current flowing across them. We had to make sure the DMM's reading mode was changed to mA, and the red wire was also connected to Ampere. The circuit was then disconnected from the source in order to take the reading for R_{eq}, which is the equivalent resistance of the circuit.

For table 3, we added the current flowing through each resistor (I_1, I_2, I_3) in parallel and then compared it to that of the resistor in series (I_s). The values were not exactly equal however, the difference was negligible. So, we concluded that the sum individual current is equivalent to the total current therefore, verifying the current division rule. We also had to calculate the percentage error for each reading taken using the formula:

$$\%\ Error = \frac{|Practical\ value - Theorical\ value|}{Theoretical\ value} * 100$$

Percentage error is usually caused because of environmental error, procedural error, human error or instrumental error.

Circuit 2 was then constructed, which took relatively longer than constructing the first circuit. The voltage across each resistor were measured by connecting the DMM parallelly. Then, current across each resistor was measured by connecting the DMM in series. The values were recorded in table 5.

The experiment was carried out smoothly without any major issues. Minor issues were solved by our lab instructor.