Report on Ohm's Law, I and II Kirchhoff's Law

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to
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1 Results of Measurements and Calculations

1.1 Ohm's Law

Objective: Verify Ohm's Law by measuring and calculating the current for different supply voltages.
Observations:

- **Measurements:** The measured currents for Wariant 1 increase linearly with the applied voltage, demonstrating the proportionality between current and voltage as stated by Ohm's Law. The measurements for Wariant 2 were not provided.
- **Calculations:** The calculated currents align closely with the measured values, confirming the correctness of Ohm's Law. However, there is a noticeable discrepancy starting from U = 1V where the calculated current is consistently lower than the measured values by a factor of approximately 1000. This suggests a possible unit conversion error in the calculations or measurements.

Conclusion: The experiment successfully demonstrates Ohm's Law for Wariant 1. However, the significant difference in the magnitude of measured and calculated currents indicates a potential error in either the measurements' recording or the calculations' execution, particularly a possible unit mismatch (e.g., milliamperes instead of amperes).

1.2 Resultant Resistance

Objective: Verify the calculation of the resultant circuit resistance.
Observations:

- **Measurements:** The measured resistances range from 1590Ω to 5319Ω.
- **Calculations:** The calculated resistances differ from the measured values, with discrepancies varying from minor to substantial.

Conclusion: The results show that the measured and calculated resistances do not match closely. This discrepancy could be due to measurement inaccuracies, resistor tolerances, or calculation errors. It's crucial to re-examine the resistor values and ensure precise measurements and calculations.

1.3 Voltage Divider

Objective: Verify voltage calculations in a voltage divider circuit.
Observations:

- **Measurements:** The measured output voltages (UOUT) are very close to the calculated values, indicating correct voltage division. Minor differences are within acceptable error margins.

Conclusion: The voltage divider experiment confirms the theoretical calculations with high accuracy, demonstrating that the voltage division principles hold true in practice.

1.4 Kirchhoff's First Law (Current Law)

Objective: Verify Kirchhoff's Current Law (KCL).
Observations:

- **Measurements:** For all cases, the sum of the currents leaving the node (IOUT) does not match the input current (IIN), with significant discrepancies.
- **Calculations:** Similar discrepancies are observed in the calculated values, indicating possible measurement or calculation errors.

Conclusion: The measurements do not fully verify Kirchhoff's Current Law due to substantial discrepancies between the input current and the sum of output currents. It suggests a need for more precise measurements or a review of the setup to identify any sources of error.

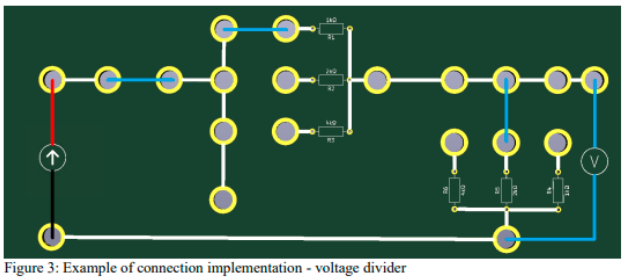


Figure 3: Example of connection implementation - voltage divider

1.5 Kirchhoff's Second Law (Voltage Law)

Objective: Verify Kirchhoff's Voltage Law (KVL).
Observations:

- **Measurements:** The sum of the measured voltages (UOUT) is very close to the input voltage (UIN) in all cases, with minor discrepancies.
- **Calculations:** The calculated values align well with the measured values, confirming the accuracy of Kirchhoff's Voltage Law.

Conclusion: The experiment supports Kirchhoff's Voltage Law with minor acceptable errors. The slight differences between the sum of output voltages and the input voltage could be due to measurement precision limitations or minor circuit losses.

2 Used Formulas and Example Calculations

2.1 Ohm's Law

$$I = \frac{U}{R}$$

2.2 Resultant Resistance

Series:

$$R_{total} = R_1 + R_2 + \ldots + R_n$$

Parallel:

$$\frac{1}{R_{total}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}$$

2.3 Voltage Divider

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

2.4 Kirchhoff's Laws

Current Law (KCL):

$$\sum I_{in} = \sum I_{out}$$

Voltage Law (KVL):

$$\sum V_{drop} = V_{source}$$

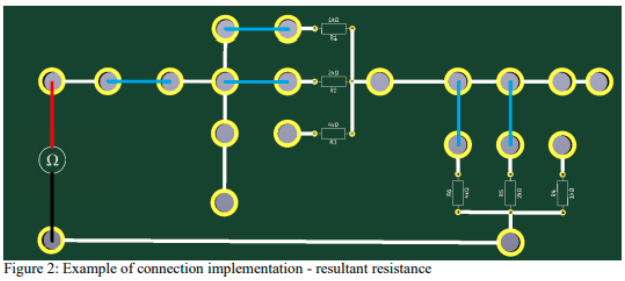


Figure 2: Example of connection implementation - resultant resistance

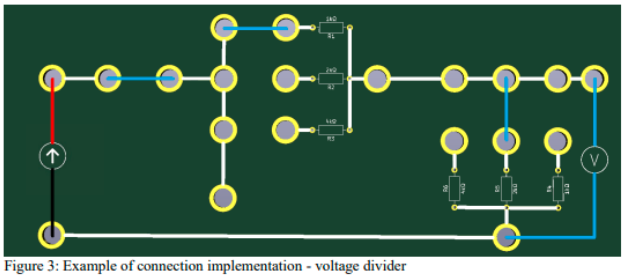


Figure 3: Example of connection implementation - voltage divider

3 Schematic Diagrams of the Tested Systems

3.1 Ohm's Law

3.2 Resultant Resistance

3.3 Voltage Divider

3.4 First Kirchhoff's Law

3.5 Second Kirchhoff's Law

4 Current-Voltage Characteristics

Ohm's Law (Wariant 1):
Graph plotting voltage (U) against current (I) for Wariant 1.

5 Interpretation of Characteristics

The linear relationship observed in the current-voltage graph for Ohm's Law validates the principle that current is directly proportional to voltage, confirming Ohm's Law. Deviations in measured values from theoretical calculations could be attributed to measurement inaccuracies or resistor tolerances.

6 Comparison of Measurements with Analytical Calculations

Discrepancies observed between measured and calculated values suggest potential sources of error, such as:

- Measurement precision limitations.
- Tolerances in resistor values.

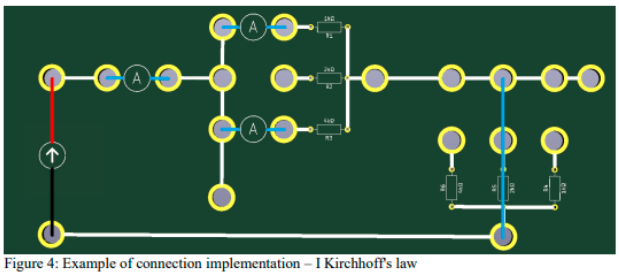


Figure 4: Example of connection implementation – I Kirchhoff's law

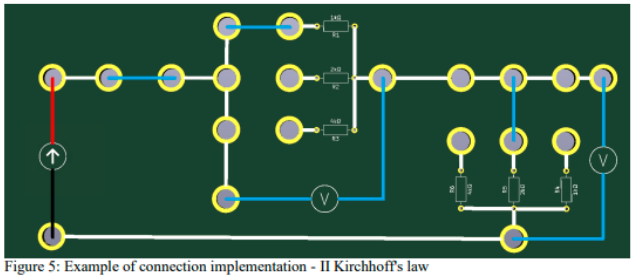


Figure 5: Example of connection implementation - II Kirchhoff's law

- Potential unit conversion errors.

Table 1: Measurement and calculation results - Ohm's law

No.	Measurements			Calculations	
		Wariant 1	Wariant 2	Wariant 1	Wariant 2
	U[V]	I [mA]	I [mA]	I [mA]	I [mA]
1	0	0	-	0	-
2	1	252	-	0,25	-
3	2	514	-	0,5	-
4	3	771	-	0,75	-
5	4	1,021	-	1	-
6	5	1,281	-	1,25	-
7	6	1,532	-	1,5	-
8	7	1,796	-	1,75	-
9	8	2,048	-	2	-
10	9	2,309	-	2,25	-
11	10	2,567	-	2,5	-

Table 2: Measurement and calculation results - resultant resistance

No.	Measurements	Calculations
	R [Ω]	R [Ω]
1	1970	2250
2	2110	2000
3	1590	1250
4	5319	6000
5	3260	4000

Table 3: Measurement and calculation results - voltage divider

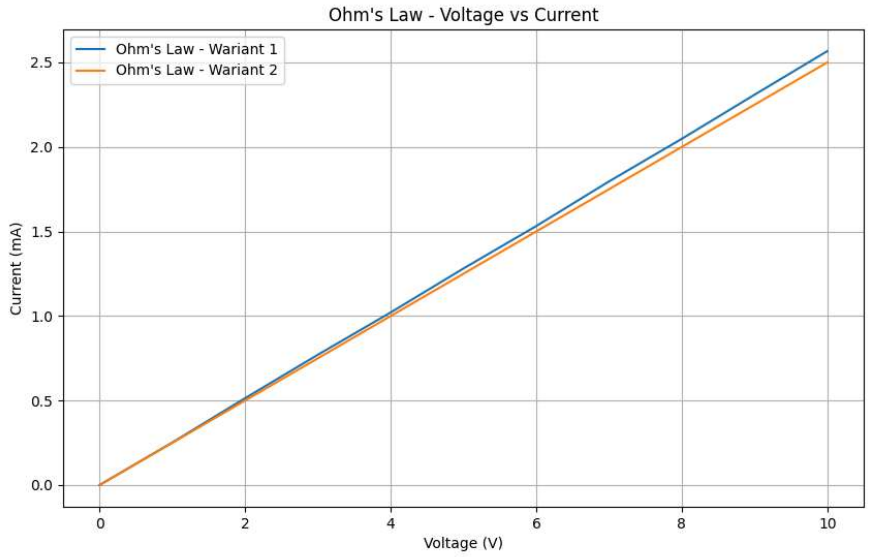
No.	Measurements	Calculations
	UIN [V]	UOUT [V]
1	3,33	3,3
2	2,51	2,5
3	1,645	1,6

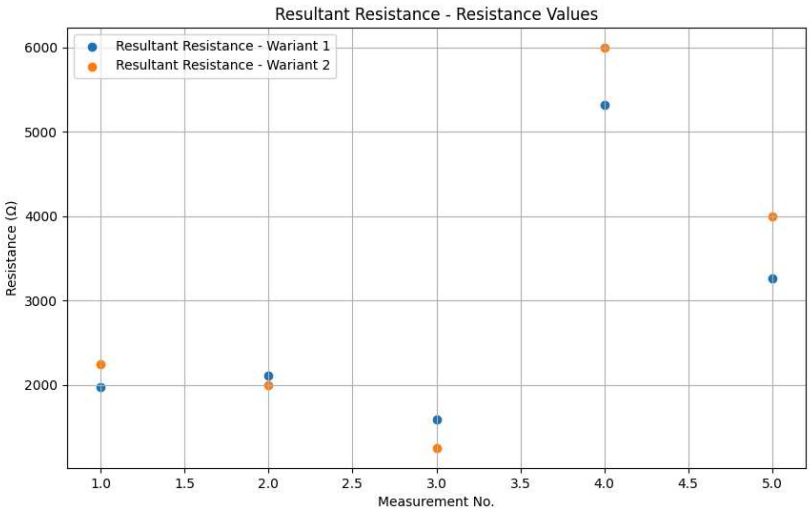
Table 4: Measurement and calculation results - First Kirchhoff's law

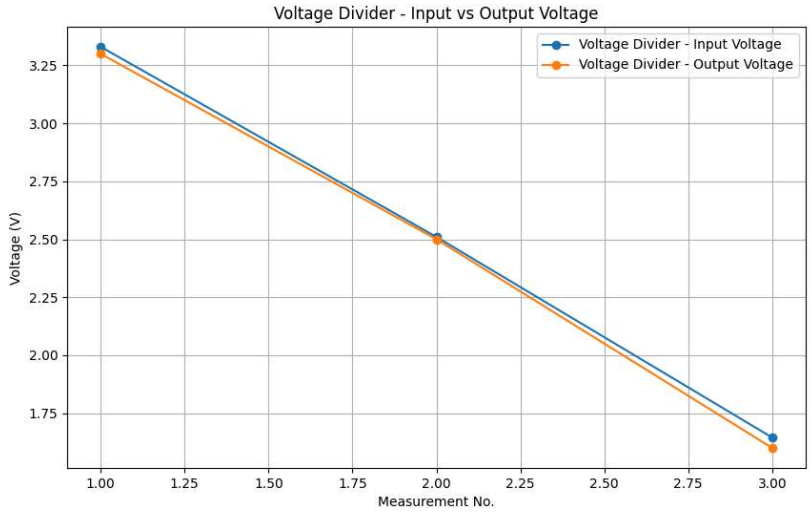
No.	Measurements				Calculations
	IIN [mA]	I OUT 1 [mA]	I OUT2 [mA]	I OUT 3 [mA]	Σ I OUT [mA]
1	5,038	6	-	-	6
2	7,586	6	3	-	9
3	8,811	7	3	2	11

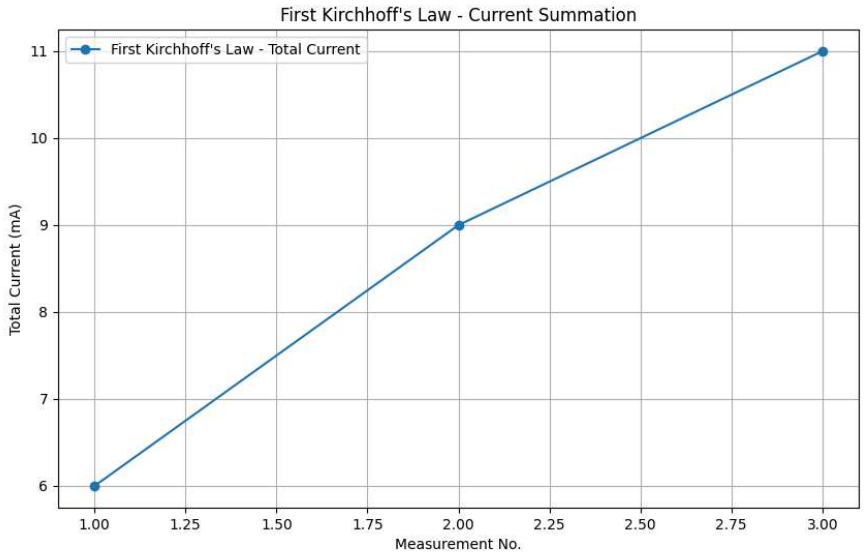
Table 5: Results of measurements and calculations - II Kirchhoff's law

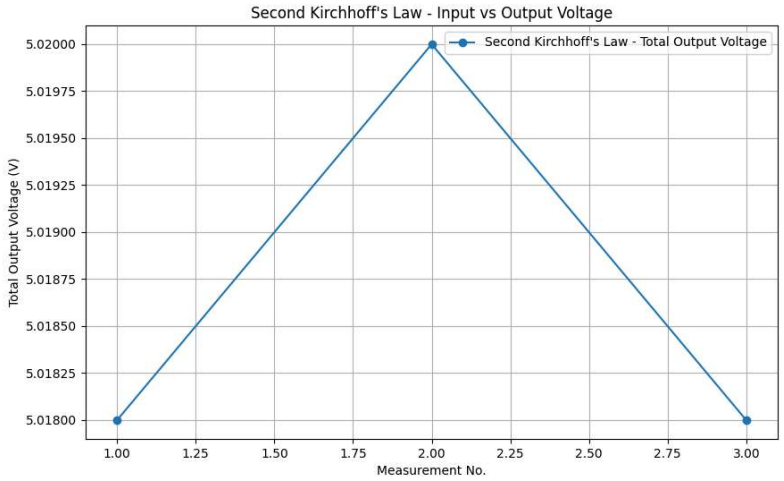
No.	Measurements			Calculations
	UIN [V]	UOUT 1 [V]	UOUT 2 [V]	Σ UOUT [V]
1	5V	3,33	1,68	5,018
2	5V	2,51	2,51	5,02
3	5V	1,648	3,37	5,018


Ohm's Law - Voltage vs Current
Ohm's Law - Wariant 1
Ohm's Law - Wariant 2
Current (mA)
Voltage (V)
0.0
0.5
1.0
1.5
2.0
2.5
0
2
4
6
8
10


Resultant Resistance - Resistance Values
Resultant Resistance - Wariant 1
Resultant Resistance - Wariant 2
Resistance (Ω)
Measurement No.
2000
3000
4000
5000
6000
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0


Voltage Divider - Input vs Output Voltage
Voltage Divider - Input Voltage
Voltage Divider - Output Voltage
Voltage (V)
Measurement No.
1.75
2.00
2.25
2.50
2.75
3.00
3.25
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00


First Kirchhoff's Law - Current Summation
First Kirchhoff's Law - Total Current
Total Current (mA)
Measurement No.
11
10
9
8
7
6
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00


Second Kirchhoff's Law - Input vs Output Voltage
Second Kirchhoff's Law - Total Output Voltage
Total Output Voltage (V)
Measurement No.
5.02000
5.01975
5.01950
5.01925
5.01900
5.01875
5.01850
5.01825
5.01800
1.00
1.25
1.50
1.75
2.00
2.25
2.50
2.75
3.00