# Experiment No. 10: Resistors in Series and Parallel

## 1. Objective

The objective of this experiment is to examine the effect of resistors in series and parallel.

## 2. Apparatus

- Resistors (Different values)
- Bread Board
- Digital Multi-meter (DMM)

## 3. Theory

Resistors can be connected in a series connection, a parallel connection or combinations of both series and parallel together, to produce more complex networks whose overall resistance is a combination of the individual resistors. Whatever the combination, all resistors obey Ohm's Law and Kirchhoff's Circuit Laws.

### 3.1 Resistors in Series

Resistors are said to be connected in "Series", when they are daisy chained together in a single line as shown in Figure 10.1. Since all the current flowing through the first resistor has no other way to go it must also pass through the second resistor and the third and so on. Then, resistors in series have a Common Current flowing through them, for example:

$I_{R1} = I_{R2} = I_{R3} = I_{AB} = 1mA$

In the following example the resistors $R_1$, $R_2$ and $R_3$ are all connected in series between points A and B.

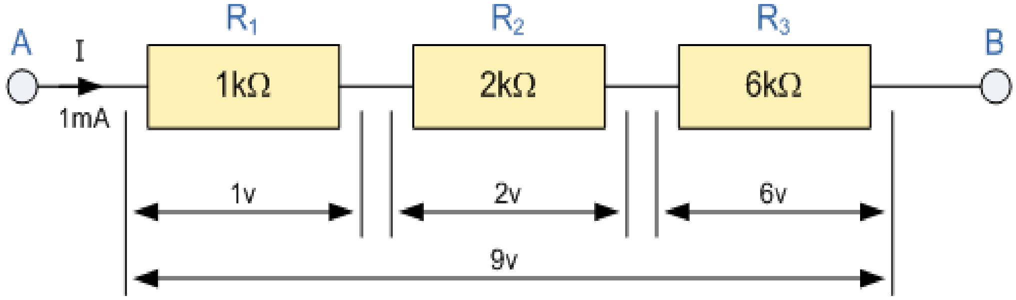



**Figure 10.1: Resistors in series**

As the resistors are connected in series the same current passes through each resistor in the chain and the total resistance, $R_T$ of the circuit must be **equal** to the sum of all the individual resistors added together. As given in Equation (10.1).

$$R_{eq} = R_1 + R_2 + R_3 \qquad (10.1)$$

By taking the individual values of the resistors in our simple example above, the equivalent resistance is $R_{eq} = 9k\Omega$. Therefore, we can replace all 3 resistors above with just one single resistor with a value of 9kΩ.

When 4, 5 or even more resistors are all connected in series, the total resistance of the series circuit $R_T$ would still be the sum of all the individual resistors connected. This total resistance is generally known as the Equivalent Resistance and can be defined as;" a single value of resistance that can replace any number of resistors without altering the values of the current or the voltage in the circuit". Then the equation given for calculating total resistance of the circuit when n resistors are connected in series is given in Equation (10.2).

$$R_{eq} = R_1 + R_2 + R_3 + \ldots . R_n \qquad (10.2)$$

### 3.2 Resistors in Parallel

Resistors are said to be connected in "**Parallel**" when both of their terminals are respectively connected to each terminal of the other resistor or resistors as shown in the Figure 10.2. The voltage drop across all the resistors in parallel is the same. In the following circuit the resistors $R_1$, $R_2$ and $R_3$ are all connected in parallel between the two points A and B.

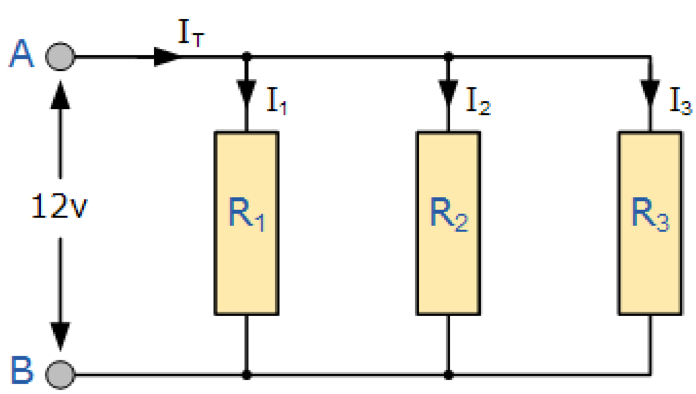



**Figure 10.2: Resistors in Parallel**

The equivalent resistance of the circuit of Figure 9.2 is given in Equation (10.3).

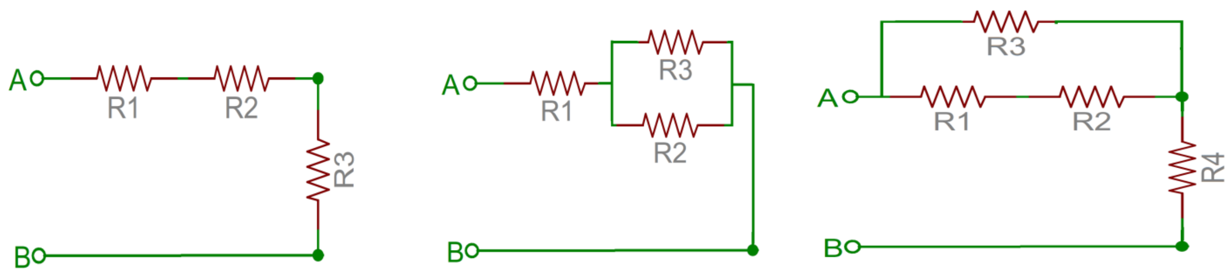
$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \qquad (10.3)$$

## 4. Procedure

11. Construct the circuit as shown in the Figure 10.3 (a).
12. Calculate the equivalent resistance $R_{eq}$ by using the Equations (10.2) and (10.3), where applicable and record in the Table 10.1.
13. Measure the value of equivalent resistance $R_{eq}$ across A and B by using DMM and record in the Table 10.1.
14. Compare the calculated and measured values of equivalent resistance $R_{eq}$.
15. Repeat the steps 1-4 for the figure 10.3 (b) and 10.3 (c).

**Table 10.1: Observations**

| S. No. | Resistances | Case a | Case b | Case c | Req Calculated (kΩ) | Req Measured (kΩ) |
|---|---|---|---|---|---|---|
| 1 | $R_1$ | 1kΩ | 220Ω | 1kΩ | | |
| 2 | $R_2$ | 5.6kΩ | 470Ω | 220Ω | | |
| 3 | $R_3$ | 470Ω | 4.7kΩ | 4.7kΩ | | |
| 4 | $R_4$ | - | - | 5.6kΩ | | |




(a) (b) (c)

**Figure 10.3: Resistors in series and Parallel**

## 5. Conclusions