Experiment 3

Resistors in Series, Color Codes & Power Rating

Introduction

This experiment is about measurement of resistance directly and also through voltage and current measurement. The experiment has two parts – the first part using *Multisim Electronics Workbench*, and the second part through hardware components.

PART I: RESISTORS IN SERIES (USING MULTISIM)

Objectives

1. Measure the equivalent resistance of a series circuit
2. Determine current in each resistor
3. Determine voltage across each resistor
4. Determine equivalent resistance
5. Demonstrate Kirchhoff's voltage law

Materials

One dc voltage supply
One multimeter
Five dc 0-10 V voltmeters
Five dc 0-5mA ammeters
Assorted resistors

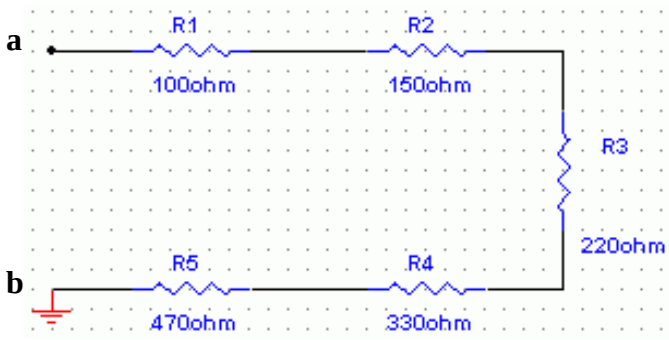


Figure1. Measurement with multimeter

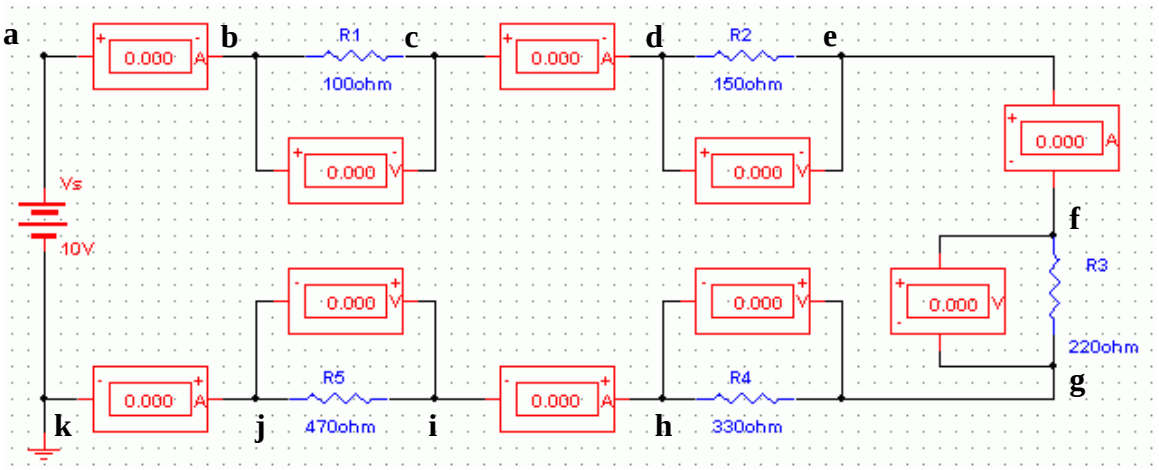


Figure 2: Resistors in series

Procedure

1. Draw Figure 1 using the Multisim simulation software. Connect the multimeter as ohmmeter between 'a' and 'b'. Click the simulate switch to run analysis. Record the measured resistance. Calculate the total value just by addition and record it.

R_{eq} (measured) = R_{eq} (calculated) =

Question: How did the measured value compare with the calculated value? Comment.

2. Draw Figure 2. Run the simulation and record the currents and voltages.

I_{ab}	I_{cd}	I_{ef}	I_{hi}	I_{jk}	V_{bc}	V_{de}	V_{fg}	V_{gh}	V_{ij}

3. Based on the equivalent resistance R_{eq} calculated in step 1 and value of the voltage source (V), calculate the source current (Is).

Is =

Question: How did the measured current I_{ab} compare with the calculated current (I)?

4. From the measured value of voltages across the resistances, calculate the current. Compare these calculated values of currents with the measured values of currents.

Measured	I_{ab}	I_{cd}	I_{ef}	I_{hi}	I_{jk}
Calculated	$I_{ab}=V_{bc}/R_1$	$I_{cd}=V_{de}/R_2$	$I_{ef}=V_{fg}/R_3$	$I_{hi}=V_{gh}/R_4$	$I_{jk}=V_{ij}/R_5$

Question: How do they compare?

5. Calculate the sum of the voltages V_{bc}, V_{de}, V_{fg}, V_{gh}, V_{ij}

$$V_{bc} + V_{de} + V_{fg} + V_{gh} + V_{ij} =$$

Question: What is the relationship between the supply voltage (V_S) and the sum obtained? Does it confirm Kirchhoff's law? Explain.

PART II: RESISTORS, MEASUREMENTS AND COLOR CODES (HARDWIRED EXPERIMENT)

Objectives

1. Determine the resistance of a selection of carbon resistors by color codes.
2. Compare values obtained with voltage current readings.
3. Observe power dissipation property of carbon resistors.

Materials

DC power supply
Digital multimeter
Assorted resistors

Color Codes

The approximate value of a carbon resistor can be found by 4 color bands on it. The 9 colors in the sequence are black, brown, red, orange, yellow, green, blue, violet, grey and white. Carbon resistors may have a fifth band which indicates reliability of the resistor. Figure 3 shows the color code structure.

Example: Brown Red Orange Gold
1 2 10^3 5% = 12 KΩ, ±5%

Procedure

1. Get 5 carbon resistors of the same value as you used in Figure 1. Find the nominal value and the tolerance of each resistance using the color codes and record in Table 1. Note the relation between the power rating and the physical size of the resistance.
2. Using the digital multimeter as an ohmmeter, measure and record the resistance of each resistor.
3. Connect the circuit as shown in Figure 2. Set the source voltage to 12 V. Measure all the voltages and currents and find the values of resistance using ohm's law i.e. R=V/I. Record your results in Table 1.

Table 1: Resistor values

Resistor	R1	R2	R3	R4	R5
Color codes					
Nominal value					
Tolerance					
Ohmmeter reading					
V / I					
% deviation from nominal value					
Actual value within tolerance?					

Answer the Following Questions

1. An electric heater takes 1.48 kW from a voltage source of 220 V. Find the resistance of the heater.

2. If the current in a resistor doubles, what happens to the dissipated power? (Assume the resistor operates in the linear region).

3. A 4Ω resistor is needed to be used in circuit where the voltage across the resistor is 3V. If two 4Ω resistor with 1W and 3 W power rating are available, which one will you use and why?

4. Consider a resistor with a positive temperature coefficient. The resistor operates at higher power level than its rating when current of 1A passes through it. The resulting voltage across the resistor in this case is 20V. If the current is increased to 1.1A, do you expect the voltage to be:

    a. Less than 22V.

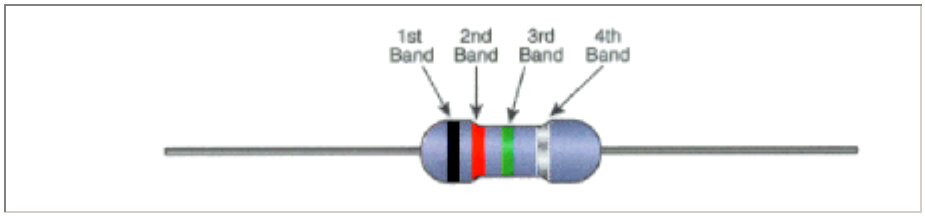
    b. Equal to 22 V.

    c. Higher than 22 V.

   Explain the reason for your expectation.

Any other observations or comments

Resistor Color Code Chart



Color	1st Band (1st Figure)	2nd Band (2nd Figure)	3rd Band (Multiplier)	4th Band (Tolerance)
Black	0	0	10^0	
Brown	1	1	10^1	
Red	2	2	10^2	±2%
Orange	3	3	10^3	
Yellow	4	4	10^4	
Green	5	5	10^5	
Blue	6	6	10^6	
Violet	7	7	10^7	
Gray	8	8	10^8	
White	9	9	10^9	
Gold			10^{-1}	±5%
Silver			10^{-2}	±10%

Figure 3: Resistor color codes