Laboratory Experiment #2, The Series Circuit
Patrick Hoppe, 02/17/02

The purpose of this experiment is to investigate the relationship between voltage, resistance, and current as described by Ohm's law. The DC analysis of a series resistance circuit should support Ohm's Law and the formula for total resistance in a series circuit.

Ohm's law describes the relationship as: $V = I \times R$

The formula for total series resistance is: $R_T = R_1 + R_2 + R_3 + ... + R_n$

The circuit to be analyzed is shown in figure #1

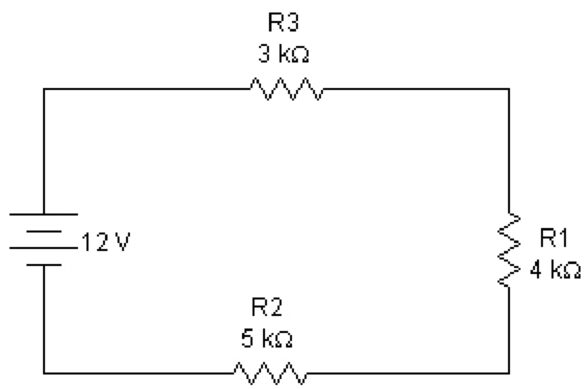

Figure 1, Series circuit in question

The first step is the determination of R_T

$R_T = R_1 + R_2 + R_3 + ... + R_n$
$R_T = R_1 + R_2 + R_3$
$R_T = 3\ k\Omega + 4\ k\Omega + 5\ k\Omega$
$R_T = 12\ k\Omega$

Ohm's law states: $V = I \times R$

This formula can be re-arranged to solve for current.

$I = V / R$ (Since I am looking for the total current flowing in the circuit, I will use V_T, R_T & I_T)

$I_T = V_T / R_T$

$I_T = 12V / 12\ k\Omega$

$I_T = 1\ mA$

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The voltage drop across each resistor can also be calculated, using Ohm's Law.

$V = I \times R$ $V_{R1} = I_T \times R_1$ $V_{R1} = 1\text{ mA} \times 3\text{ k}\Omega$ $V_{R1} = 3\text{ V}$	$V = I \times R$ $V_{R2} = I_T \times R_2$ $V_{R2} = 1\text{ mA} \times 4\text{ k}\Omega$ $V_{R2} = 4\text{ V}$	$V = I \times R$ $V_{R3} = I_T \times R_3$ $V_{R3} = 1\text{ mA} \times 5\text{ k}\Omega$ $V_{R3} = 5\text{ V}$

Kirchhoff's Voltage law tells us that the sum of the voltage drops in a closed loop, must equal the applied voltage. This can be verified with the above findings.

$V_T = V_{R1} + V_{R2} + V_{R3} + \ldots + V_n$
$V_T = V_{R1} + V_{R2} + V_{R3}$
$12V = 3V + 4\text{ V} + 5V$

The data collected from the theoretical analysis is shown in Table #1.

Table #1, Theoretical DC Analysis

R_T	12 kΩ
I_T	1 mA
V_{R1}	3 V
V_{R1}	4 V
V_{R1}	5 V
V_T	12 V

The circuit in Figure # 1 was constructed in Electronic WorkBench. The total resistance was measured as shown in Figure #2

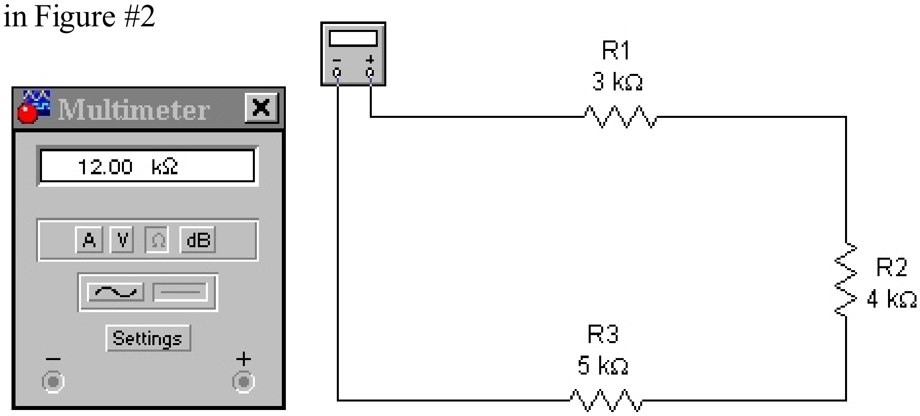

Figure 2, EWB Resistance Reading

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The voltage source was inserted into the circuit and the total current was measured, as was the voltage dropped across each resistor.

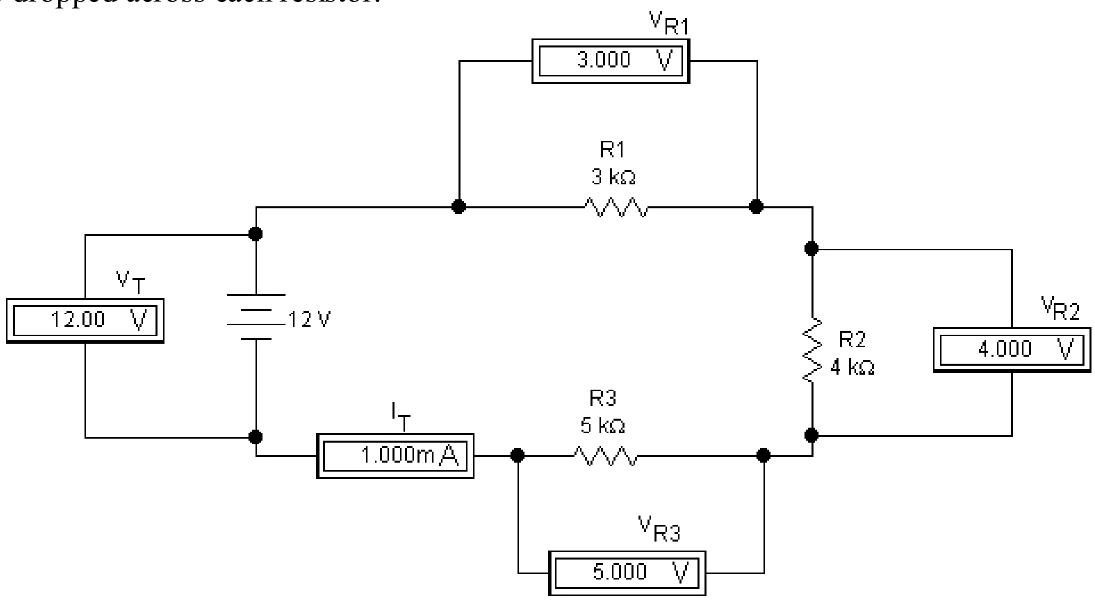

Figure 3, EWB DC Analysis

The data collected from the EWB DC analysis was added to the calculated data in Table #1 and is shown in Table #2

Table #2, Theoretical and EWB DC Analysis

	Calculated	EWB
R_T	12 kΩ	12 kΩ
I_T	1 mA	1 mA
V_{R1}	3 V	3 V
V_{R1}	4 V	4 V
V_{R1}	5 V	5 V
V_T	12 V	12 V

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The circuit shown in Figure #3 was constructed with actual components and the meters were placed as shown. The measured values were added to the values in Table #2 and are shown in Table #3.

Table #3, Theoretical ,EWB and Actual Values

	Calculated	EWB	Measured
R_T	12 kΩ	12 kΩ	12175 Ω
I_T	1 mA	1 mA	986 µA
V_{R1}	3 V	3 V	3.06 V
V_{R1}	4 V	4 V	3.89 V
V_{R1}	5 V	5 V	5.05 V
V_T	12 V	12 V	12 V

Equipment Used
(1) Digital Multimeter, Tenec s/n 32189
(1) Digi-Trainer, s/n 19083781
(1) 3 kΩ ± 10% resistor, measured value 3100 Ω
(1) 4 kΩ ± 10% resistor, measured value 3950 Ω
(1) 5 kΩ ± 10% resistor, measured value 5125 Ω
Electronic WorkBench, Version 5.1
Computer Station #12

The theoretical calculations, EWB calculations, and the actual measured values all support the relationship between voltage, current, and resistance as depicted in Ohm's law. Given any two of the three variables, the third can be calculated. Using the formulas for Ohm's law and the total resistance in a series circuit, a complete DC analysis can be performed. The results can be trusted to match the actual measured results, provided the tolerance of the resistors in taken into account.

Patrick Hoppe *(signature)*
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