EXPERIMENT 3
Series Circuits &Voltage Measurements, DMM as DVM

3-1 OBJECTIVES:

After finishing this experiment, you will be able to:

- Construct a series circuit using MultiSim simulation tool.
- Get familiar with the MultiSim components.
- Get familiar with MultiSim DMMs.

3-2 Voltage Reference and Potential Difference:

All voltage measurements are either measured from a certain point with respect to a reference point (mostly called the ground reference) or the voltage difference between any two points in a circuit which is normally the voltage across a component in the circuit such as the voltage across a resistor, capacitor, Inductor, diode, transistor etc.… Whether it is in reference to ground or across a circuit component, the voltage between any two points is called the potential difference between those two points.

The above explanation is illustrated in the following circuit example:

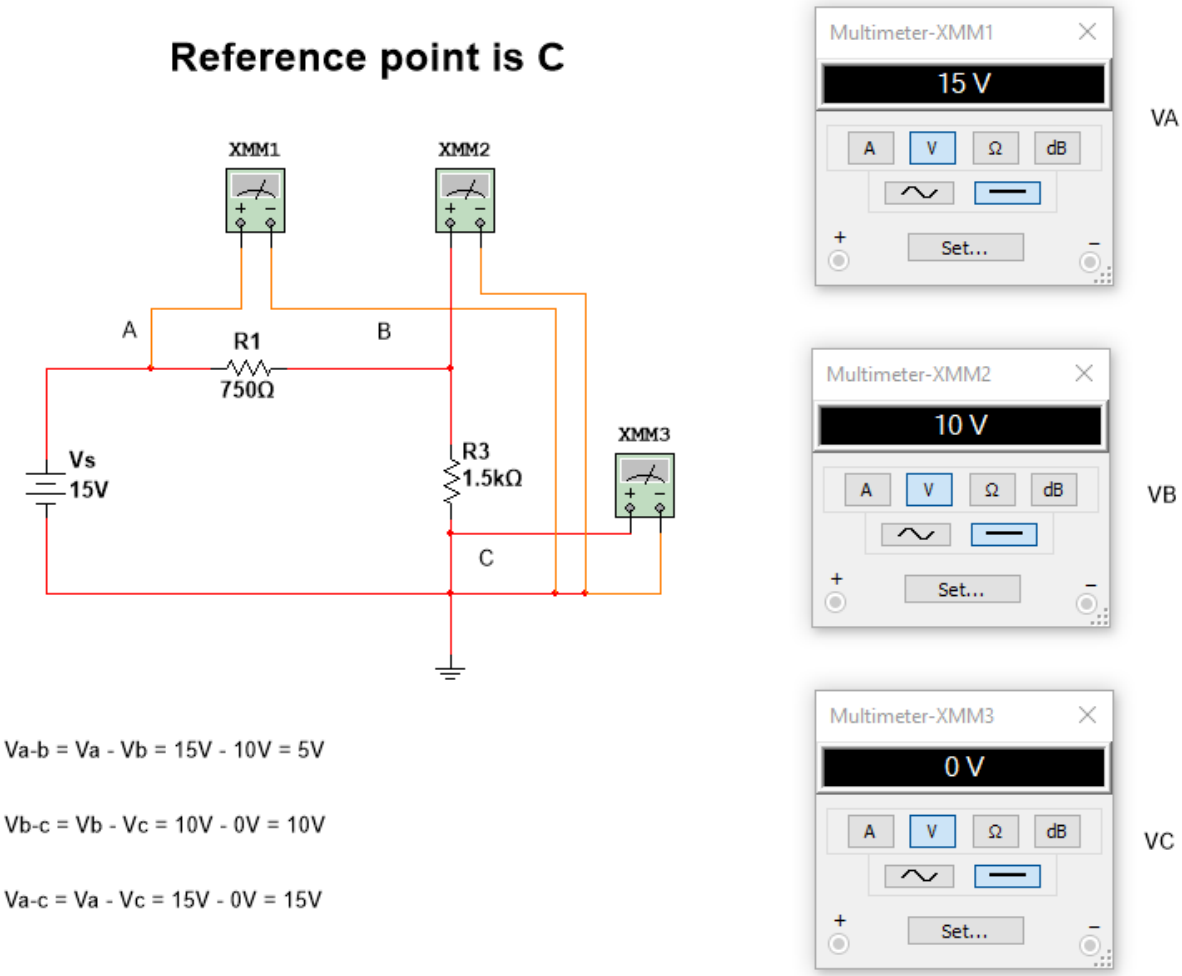
Notice that regardless of where the reference point is, the potential differences between any two points remains the same and they are given by:

$$V_{AB} = V_A - V_B.$$

$$V_{BC} = V_B - V_C.$$

$$V_{AC} = V_A - V_C.$$

See below for simulation results.



Va-b = Va - Vb = 15V - 10V = 5V

Vb-c = Vb - Vc = 10V - 0V = 10V

Va-c = Va - Vc = 15V - 0V = 15V

Figure 3-1

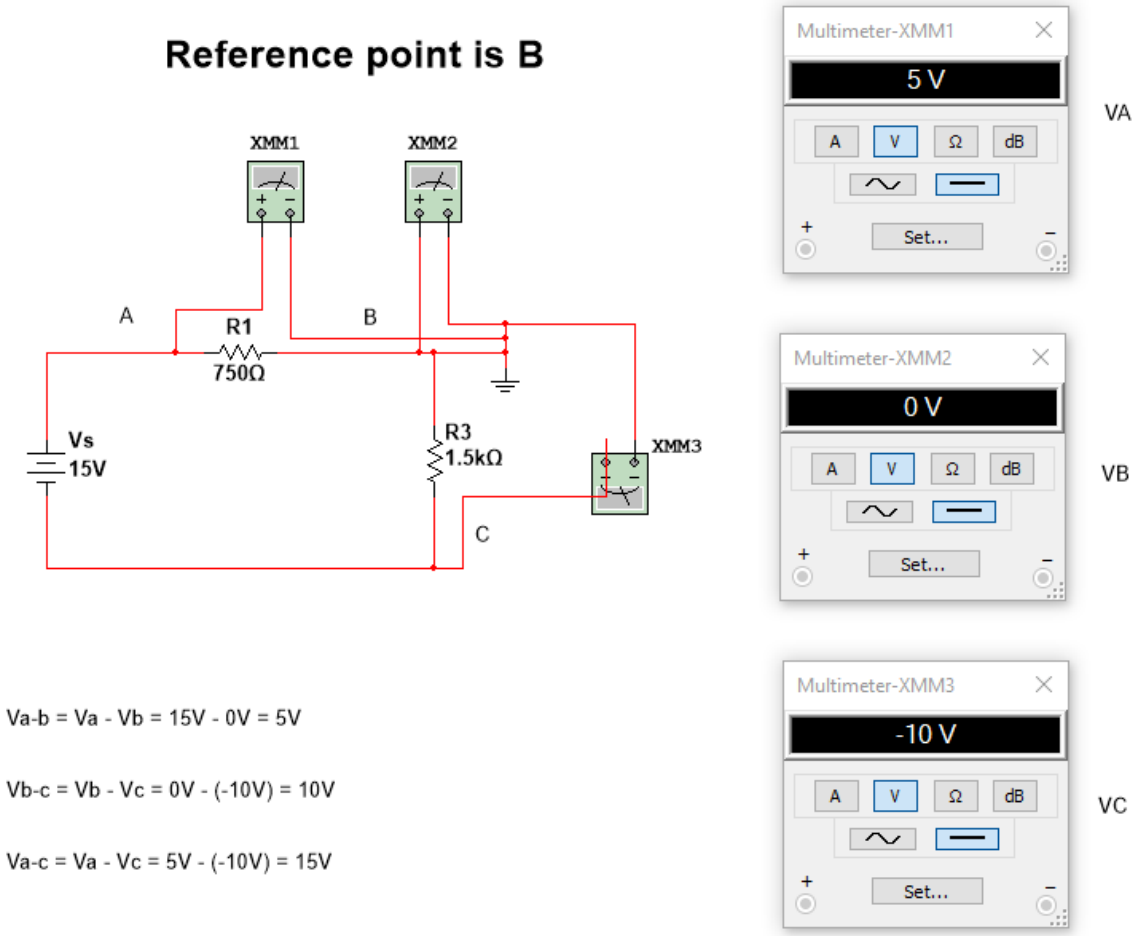


Figure 3-2

3-3 DISCUSSION:

The following is a series resistive circuit. To find the total current and the individual voltages across R1 & R2, either the traditional ohm's law or the voltage division formula can be used.

Using Ohm's law:

The total resistance seen by the voltage source is RT = R1 + R2.

The total current is IT = VT / RT.

VR1 = IT × R1.

$V_{R2} = I_T \times R_2$.

Using the voltage division formula:

$V_{Rx} = (V_T \times R_x) / R_T$.

$V_{R1} = (V_T \times R_1) / R_T$.

$V_{R2} = (V_T \times R_2) / R_T$.

To find the voltage drop (potential difference) across two points x & y, use the following formula:

$V_{x-y} = V_x – V_y$

where:

V_x is the voltage between point x and a reference point.
V_y is the voltage between point y and the same reference point

3-4 CALCULATIONS:

For the following circuit, using the two methods explained above (Traditional ohm's law and the voltage division formula) to fill table 3-1. **Show all work including the formulas.**

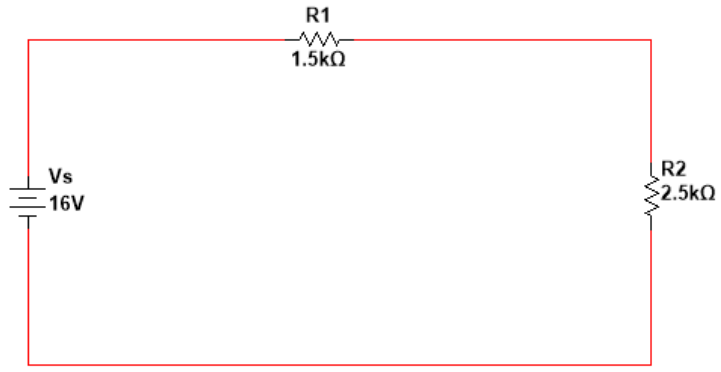


Figure 3-3

VS	RT Calculated	IT Calculated	VR1 Using Ohm's Law Calculated	VR2 Using Ohm's Law Calculated	VR1 Using the Voltage Division Formula Calculated	VR2 Using the Voltage Division Formula Calculated

Table 3-1

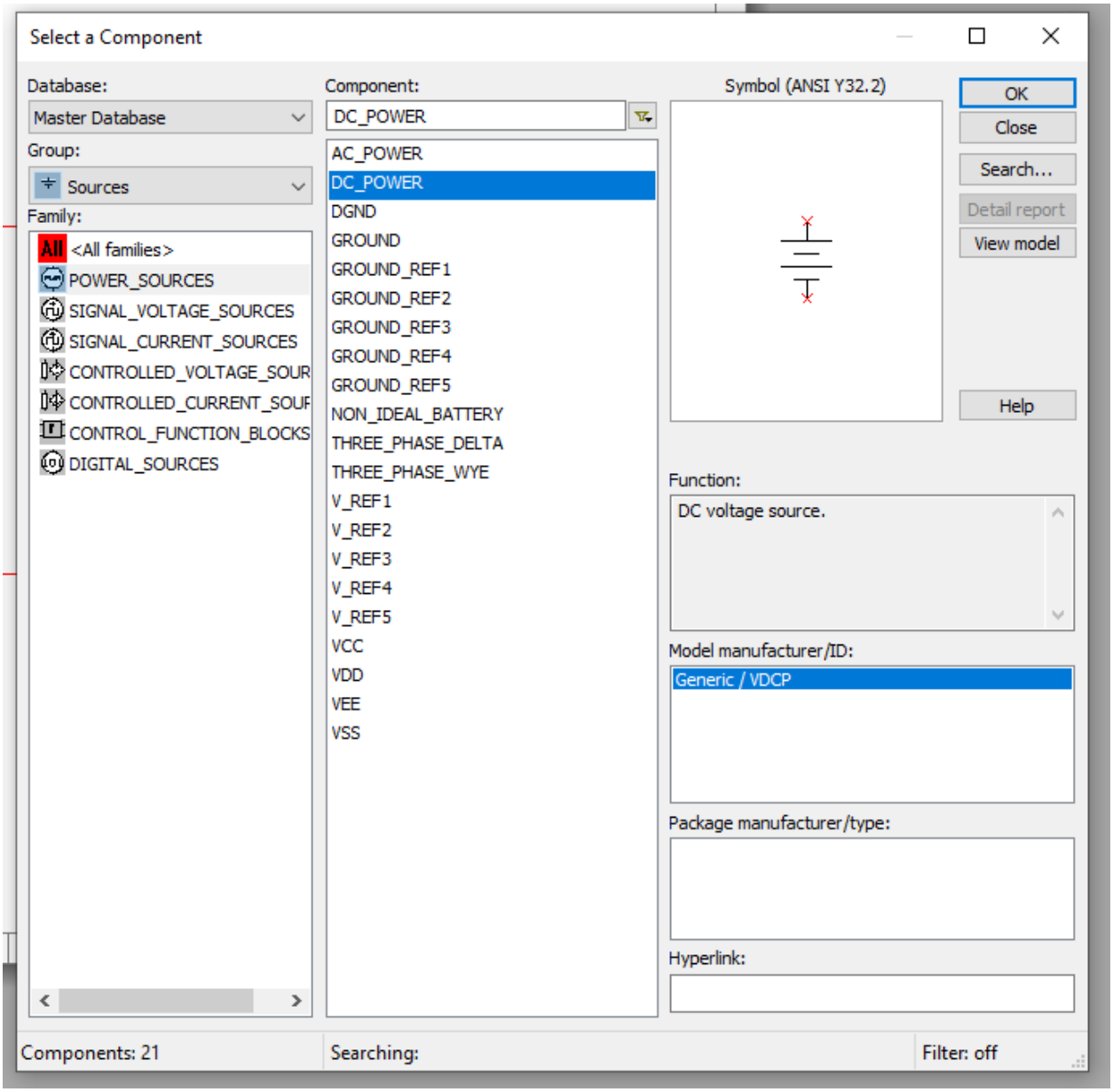
3-5 PROCEDURE:

Using MultiSim, connect the circuit in Figure 3-3 like the circuit shown in Figure 3-1 (reference point is point C). You will need to place the following components.

Step 1:

To place the voltage source, do the following:

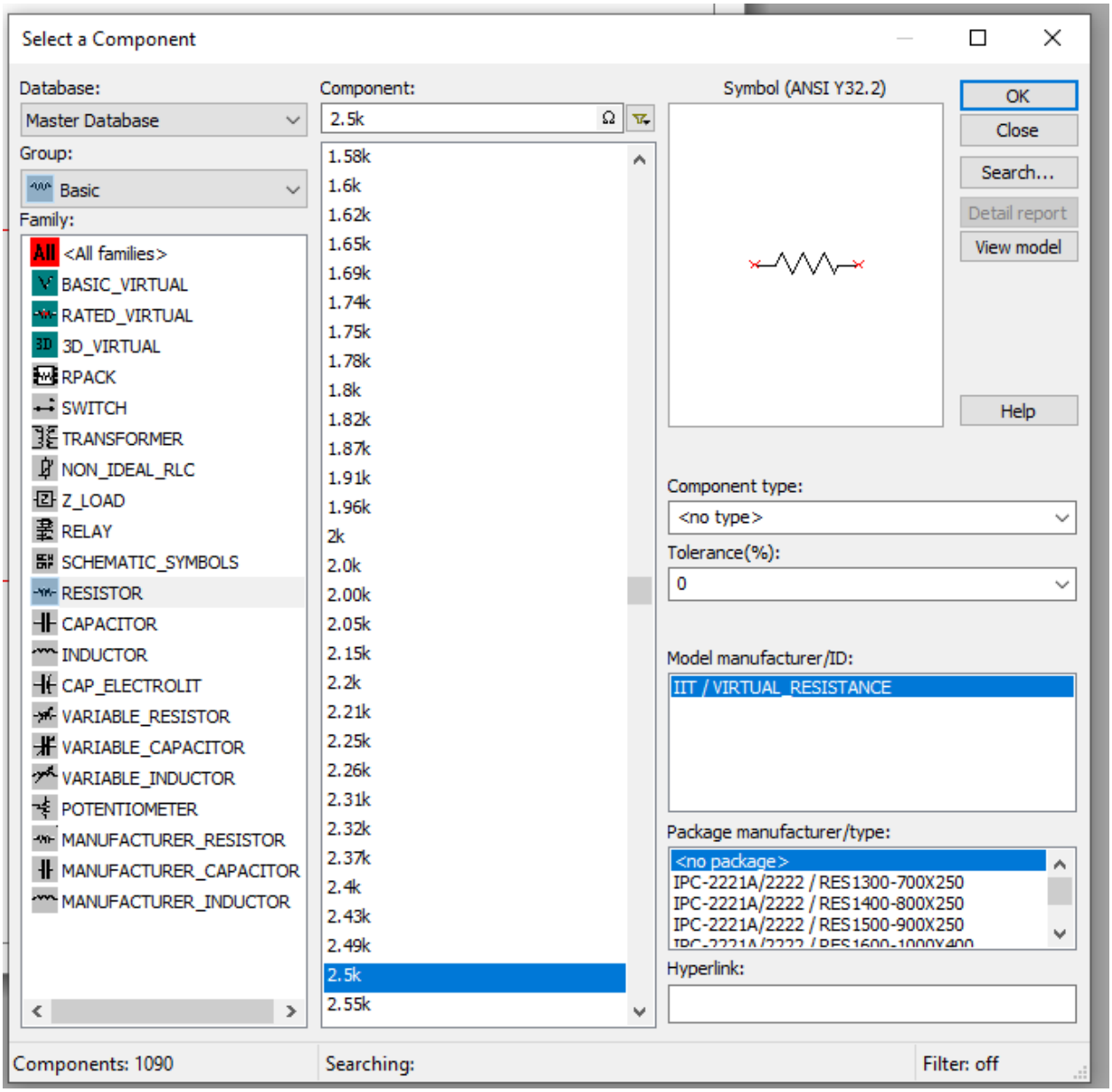
1- From the menu, Press on the Place->Component.
2- From the group submenu, choose Sources-> POWR_SOURCES->DC_POWER.
3- Hit OK.



Step 2:

To Place the resistors, do the following:

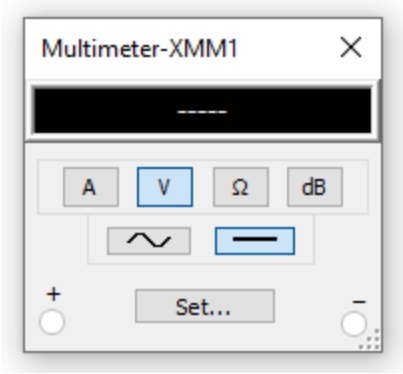
1- From the menu, Press on the Place->Component.
2- From the group submenu, choose Basic-> RESISTOR.
3- Choose the resistors one at a time and hit OK.



Step 3:

To Place the Multimeters, do the following:

1- On the right-hand side of the Multisim screen there is a vertical menu of devices. Click on the Multimeter as shown. Make sure that the Multimeter choices are as follows.



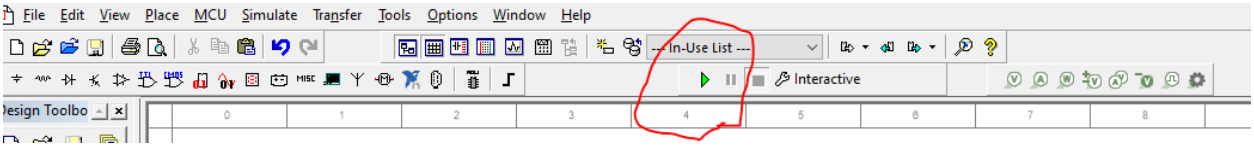
Repeat until you get 3 Multimeters.

Step 4:

Connect the elements to each other by placing the mouse on a device terminal, pressing it, and then dragging it to the element that you want connected, then pressing again.

Step 5:

Once you are done connecting all the elements together including the Multimeter, run the simulation by pressing the green play button from the main menu as shown below.



Step 6:

Double press on all the Multimeters one at a time to display the value of the voltages Va, Vb and Vc. Place those values in Table 3-2 below and then calculate the values of Va-b, Vb-c and Va-c.

Voltage to Reference		Voltage Drop or Potential Difference
Va =		Va-b = Va - Vb
Vb =		Vb-c = Vb - Vc
Vc =		Va-c = Va - Vc

Table 3-2

Step7:

Replace the reference point and the Multimeter leads to comply with the circuit as in Figure 3-2 (reference point is point B) and then fill the value in Table 3-3 below.

Voltage to Reference		Voltage Drop or Potential Difference
Va =		Va-b = Va - Vb
Vb =		Vb-c = Vb - Vc
Vc =		Va-c = Va - Vc

Table 3-3

3-6 SUMMARY:

It does not matter where the reference point is placed in the circuit, the voltage drops across the elements will be the same.

This concludes the experiment.