



### Experiment 7 — Volt-Amp Characteristics

#### EL 111 - DC Fundamentals

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#### Objectives:

1. For the student to investigate the voltage, current, and resistance relationships that exist with linear and nonlinear two terminal devices.
2. For the student to present these relationships in a graphical format.

#### Equipment and parts:

- Meters: Digital Multimeter (DMM);  
Ammeter or Handheld MM such as the Agilent 971A
- Power Supply: Agilent E3631A DC power supply (0-20 V DC)
- Resistors: 750  $\Omega$ , 1/2 W; 390  $\Omega$ , 1/2 W; 50  $\Omega$  5 W ceramic; #1819 Tungsten pilot lamp; “glow bar” resistor (carbon resistance element, high power)
- Misc: Lamp socket

#### Introduction:

A very important and frequently-used way of describing how a two terminal device (e.g., resistor, diode) and a three-terminal device (e.g., transistor) behave is by making a graph of current through the device versus voltage across the device. This graph is known as a *volt-amp characteristic*, or *V-A characteristic*.

#### Information on graphing:

Normally, the graph is produced by taking data in the laboratory, and then plotting that data on linear graph paper. The voltage across the device is set to a certain value, and the current that flows is measured. Then the voltage is changed, and the process is repeated.

Since the data is taken this way, the voltage is the parameter that is set independently, and the current that flows is dependent on the voltage. Thus, voltage is the *independent variable*, and current is the *dependent variable*. The independent variable is plotted on the horizontal axis, and the dependent variable is plotted on the vertical axis. These two axes are called the *abscissa* (horizontal) and the *ordinate* (vertical).

#### Information on V-A graph linearity:

A fixed, color-coded resistor has a certain resistance, which essentially does not vary when the resistor is used within its power rating (e.g., 1/2 Watt). Thus, the graph of current versus voltage is a straight line. Other two-terminal devices, like tungsten lamps and globars, have resistances that vary widely with temperature. The graphs of current versus voltage for these devices is NOT a straight line, since the resistance depends on temperature, the temperature depends on power, and the power depends on the applied voltage.

In addition to the V-A graph, another useful visual description of how a two-terminal device behaves is a graph of resistance versus voltage. The resistance data for this graph can be calculated from the voltage



and current measurement data. The curves of resistance versus voltage will show that fixed resistors have essentially a constant resistance no matter what the applied voltage, that the resistance of the tungsten bulb increases as voltage increases, and that the resistance of the globar decreases as voltage increases.

**Procedure:**

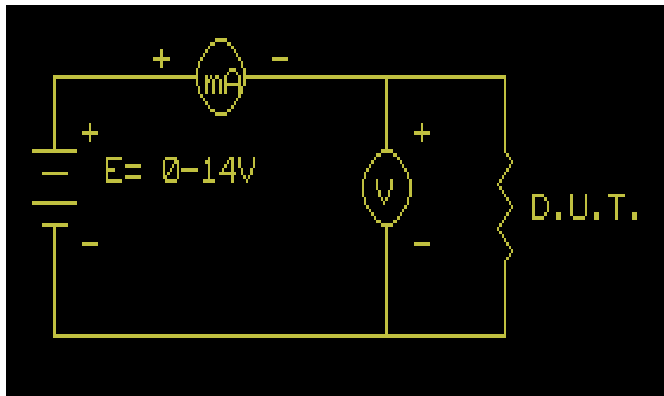
1. Refer to the schematic diagram in Figure 1. The five devices under test (D.U.T.), listed on the schematic, will each be measured separately. Construct the circuit, using the 750 ohm resistor. Set the current limit control on the power supply to maximum (fully clockwise position).
2. Start with the applied voltage equal to 2 VDC, and record the current in the data table provided. Then increase the voltage in 2 V steps, making the last measurement at 14 VDC. Record all currents in the data table provided.
3. Repeat step 2, using the 390 ohm resistor.
4. Repeat step 2, using the 50 ohm, 5 Watt ceramic resistor. Be careful; it will get HOT
5. Repeat step 2, using the tungsten lamp. Be careful; it will get HOT.
6. Repeat step 2, using the globar. Note: you will only be able to increase the  $V_{DUT}$  until the current limit of 400 mA is reached. Allow enough time after changing voltage for the current through the globar to stabilize. The globar will take time to reach its operating temperature for each applied voltage. Be careful; it will get HOT.
7. Now that you have measured the voltage across and the current through each D.U.T., you can calculate the resistance of each D.U.T. at each test voltage. Do so, and record the results in the data table.
8. **Make a graph of current vs. voltage** for each D.U.T., using the same piece of graph paper. Be sure to use the same voltage scale and current scale for all five plots. Identify the plot points for each D.U.T. using different symbols for each. [See sample graph in lab and/or refer to handout What makes a Good Graph (1-29-97)]. You will need to use a French curve to draw the curves. Ask your instructor for assistance in using this tool.
9. **Make a graph of resistance vs. voltage** for the 50 ohm resistor, the tungsten lamp and the globar, using the same piece of graph paper. Be sure to use the same voltage and resistance scale for all three plots. Identify the plot points for each D.U.T. using different symbols for each. [See sample graph in lab and/or refer to handout What Makes a Good Graph]. You will need to use a French curve to draw the curves. Ask your instructor for assistance using this tool.



**DATA TABLE**

$V_{DUT}$	750 ohm		390 ohm		50 ohm		Tung. lamp		Globar	
	I	R	I	R	I	R	I	R	I	R
2 V										
4 V										
6 V										
8 V										
10 V										
12 V										
14 V										

**Figure 1**



**Devices under test:**

1. 750 ohm, 1/2 W resistor
2. 390 ohm, 1/2 W resistor
3. 50 ohm, 5 W ceramic resistor
4. Tungsten Lamp, #1819, mounted on test board
5. Globar, carbon, mounted on test board

Use the digital voltmeter for measuring voltage and the digital or analog ammeter for measuring current.