Section	
Bench No.	

ECE110 Introduction to Electronics

Pre-Lab 2: DC circuits and tools

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Pre-Lab 2: DC Circuits and Tools

In Experiment #1 we learned how to take measurements using the multimeter at our lab bench. In Experiment #2, you will employ these skills to explore the behaviors of simple circuits. This pre-lab assignment will provide a deep understanding of multimeter and DC power, as well as introduce some background topics and terminology that we will need for Experiment #2. Finally, you will build a small circuit in preparation for experiment 2's procedure.

The Interpretation of Basic Circuit Laws

Around 1825, Georg Ohm performed some experimentation in circuits and formulated a mathematical description that we now refer to as Ohm's Law. **Ohm's Law** says *that when a voltage differential, V, is applied across a resistive device (of resistance, R), the current that flows through that device is directly proportional to that voltage*. Mathematically

$$I = \frac{V}{R} (one\ formulation\ of\ Ohm's\ Law)$$

The constant resistance, R, depends on the construction of the device and is assumed to remain constant. You will need knowledge of Ohm's Law to answer some of the question in this procedure.

R

Question 1: For a given resistor, what happens to the voltage drop across that resistor if the current flowing through it is cut in half?

$I = \frac{V}{R}$. $\frac{1}{2}I = \frac{V}{2R}$ $V \to \frac{1}{2}V$.

the voltage drop was cut in half as well

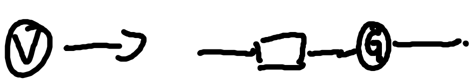
Background and Terminology

In the previous lab we learned best practices in taking measurements, plotting graphs, and drawing basic circuit schematics. In this lab we will be employing these skills when we take measurements on some basic *direct-current* (***DC***) circuits. Although the term "direct current" is commonly used in reference to systems with electric charge flowing in a single uniform direction, it is often achieved by supplying the circuit with a constant voltage. Such a supply is often called a *DC-voltage supply* or a *DC-power supply*. Let us consider the equipment most used in an electrical engineering laboratory for conducting experiments. The term ***source*** will refer to *a device that is capable of supplying energy to the circuit*. In your lab experiment, you will use the DC-power supply, model DP832A, as your source. It will be able to generate a user-determined

DC voltage (constant-voltage mode) or a user-determined DC current (constant-current mode). The term ***load*** (also known as a **power sink**) will refer to *a device that absorbs power* (often dissipating it as heat). A resistor is a typical load device. Finally, we have ***measurement devices***. A measurement device may contain sources and loads but is intended to have minimal impact on the circuit being measured. A measurement device often utilizes electromagnetic principles (consider, for example, a galvanometer) to achieve its purpose. The upcoming lab's measuring device is a digital multimeter, model DM3068. It can measure the voltage across an electrical device, the current flowing through a circuit path and the resistance of devices. The DP832A and the DM3068 devices also have additional functionality which you can learn about by reading their user manuals.

Question 2: Do you think a measurement device (like, say, a voltmeter) might be considered a power sink? Explain.

yes. for a volmeter has resisence it self, although the impact is minimized.



↑ huge resistor,

The Power Supply as an Ideal Voltage Source

It is important that you become familiar with both the physical diagrams and the more-abstract circuit schematics and recognize the one-to-one relationship between them. **Figure 1** introduces the symbols used for the ideal voltage source. While physical representations are often used in training, professionals will use the more-succinct circuit schematic.

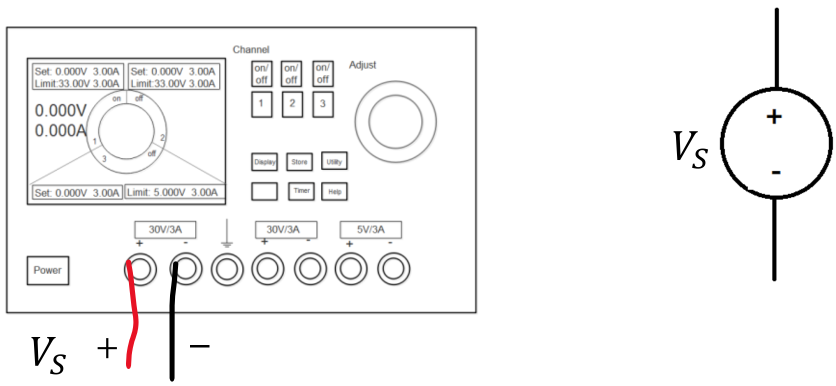


Figure 1: Circuit symbol of (a) a physical symbol of model DP832A and of (b) an ideal voltage source.

An ***ideal voltage source*** provides *a constant voltage no matter what circuit is connected between its terminals and no matter how much current is drawn from it*. Unfortunately, cost and physical limitations make this impossible in practice. However, a great deal of the circuitry inside the DC power supply is dedicated to approximating an ideal device over a very wide range of voltages and a very wide range of load resistances. As you learn more about loads and how they affect the current drawn from a source, you will gain a better understanding of the difficulties.

We know this is not really an ideal source. If you connect a wire from the positive to the negative terminal what do you think will happen? Poof! The power source delivers more power than the load can absorb without damage (something will melt)! Luckily our devices use fuses. Fuses provide a weak point in the load that is designed to fail first. Always think before you apply the power to your circuit, but don't worry if your instructor will have to change the fuses. Mistakes will happen so feel free to get comfortable with the equipment and explore!

Question 3: Any power supply is power-limited (no matter what the setting, the device has an upper limit to the power it can deliver). Knowing that power is the product of voltage and current ($P=VI$), which voltage port, +5V or +25V, would you suspect to be capable of delivering a higher current to a load? Explain.

+5V for a given power, P=VI, while V decreases, I increases. Therefore lower voltage may be capable of delivering a higher current to a load.

constant-voltage mode and constant-current mode of a DC power

The DC power supply we use can operate in two modes, constant-current mode or constant-voltage mode. Each mode refers to how the power supply regulates its output by the load it is driving; it is based on how much current or voltage the power supply is providing.

Constant-current mode (CC) refers to a mode of operation where the power supply regulates the output voltage but maintains a constant current to the load, regardless of the load resistance. It is commonly used when driving LEDs, charging batteries or operating motors. Constant-current mode is ideal for these devices because they have an internal resistance that can vary, and this variation can cause the current passing through the load to fluctuate if voltage mode were used. With constant-current mode, the power supply ensures that the load receives a constant amount of current, regardless of the load's resistance.

Constant-voltage mode (CV) refers to a mode of operation where the power supply regulates the output current but maintains a constant voltage across the load, regardless of the load current. It is commonly used for electronic devices where a constant voltage is necessary, such as for powering computers, cameras, or other digital devices. Constant-voltage mode is ideal for these devices because they require a constant voltage to ensure proper performance, and a fluctuating voltage would cause instability in the device. With constant-voltage mode, the power supply maintains the voltage across the load, regardless of the current flow.

In our lab, mostly we will use the CV mode, but we recommend you to **set the current less than 1A**, it can help you to protect the circuit when you have a short connection.

The Multimeter as an Ideal Measuring Device

In ECE110, we will use a *digital multimeter* (**DMM**) model DM3068 to measure voltage (**voltmeter**), current (**ammeter**), and resistance (**ohmmeter**). **Figure 2** introduces the symbols used for the ideal measuring device in each of these modes. Note that the polarity of the physical symbols is suggested by the terminal names (COM means "common". It is akin to "ground", "negative", or the pointy end of the current arrow).

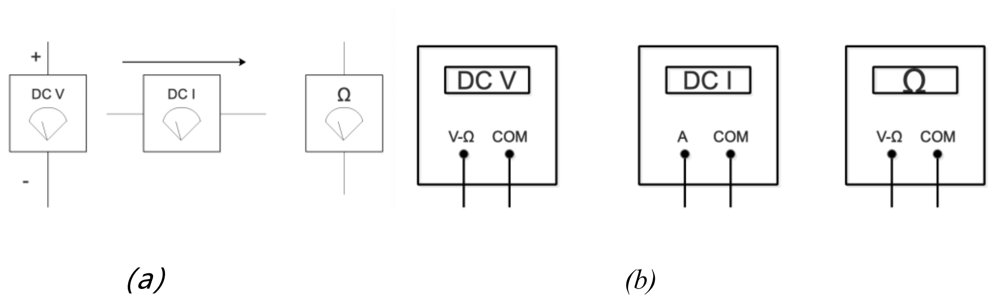


Figure 2 : Circuit symbols (a) and physical symbols (b) of the digital multimeter used in three modes: voltmeter, ammeter, ohmmeter, respectively.

Measurement devices are not considered essential elements in most final circuit designs. Except in the academic setting, a circuit schematic rarely expresses the locations of the measurement devices but, rather, use labels to indicate which voltages and currents are to be measured. Figure 3 demonstrates this with the common use of the + and − symbols to represent the direction of polarity in which to measure the voltage and the → symbol to represent the polarity of current. In simple terms, **polarity** *refers to the location at which the positive and negative terminals* of the measuring device are assumed to be placed. The positive terminal corresponds to the + side of the voltage measurement. The positive terminal corresponds to the base of the arrow (not the pointy side) for a current measurement.

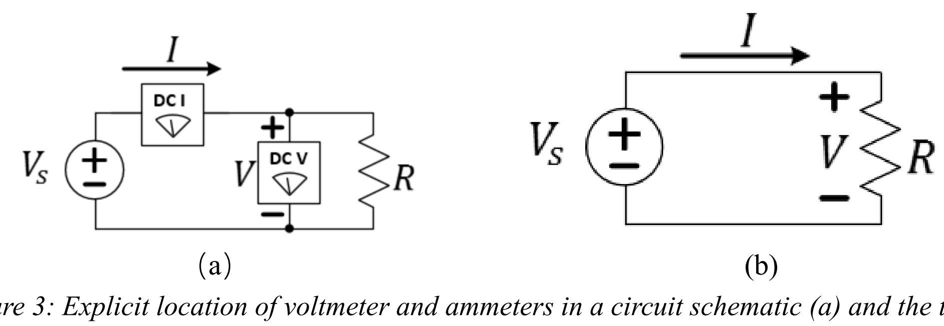
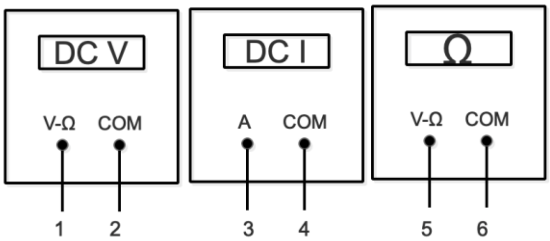


*Figure 3: Explicit location of voltmeter and ammeters in a circuit schematic (a) and the typical implied expression (b). In the latter, a voltmeter is implied to probe the voltage **V** and an ammeter is to be inserted to measure the current **I** according to the polarities indicated by the ± and the arrow, respectively*

Although the color of the insulation on our wires does not affect their electrical properties, it is standard procedure to use black wires when connecting to the negative side of a voltage source or measuring device and to use red wires when connecting to the positive side of a voltage source or measuring device. Maintaining a "standard" or a "convention" in your selection of wires will make you less prone to error when building a circuit and others less prone to mistakes when interpreting your circuit.



(a)

(b)

Figure 4: (a) Common multimeter symbols and (b) the DM3068 multimeter. The alpha-numeric labels are provided for the following question.

Question 4: Use the labels of Figure 4 above and match the terminals 1-6 of the common multimeter symbols with the five labeled ports of the DM3068 multimeter. The first two have been done for you. You may need to discuss with other lab groups to make sure you know which ports they are! Hint: some terminals may be repeated, and we will not use ports A or C.

Multimeter port	DM3068 port
1	B
2	D
3	A
4	D
5	B
6	D

Table 1: Matching game. Match the common multimeter port symbols to the ports on the DM3068 multimeter.

An ***ideal measuring device*** is *a piece of equipment that estimates circuit parameters such as voltage, current, resistance, capacitance without changing the circuit characteristics in any way*. This is also very difficult to accomplish for a wide variety of circuits and there will be times in which we must decide if the assumption is appropriate.

Switching a Circuit

In the next lab, we would like to be able to control our car chassis by "switching" the motors on and off. We will practice first by building a circuit that uses two buttons to turn on and off two light-emitting diodes (LEDS). Locate two push buttons from your kit, as well as two red LEDs and two 330 Ω resistors. These resistors will have the color bands "orange orange brown" plus a third band (likely gold) that indicates tolerance. You may use the 7.6V battery for power. Be very careful not to short your battery when building the circuit. Be ESPECIALLY careful not to accidentally short your battery when storing or transporting your circuit.

Using these parts, we will construct the circuit illustrated in the circuit schematic of Figure 5 and clearly explained in the physical diagram of Figure 6. The proper insertion of the button into the breadboard is explained in Figure 7.

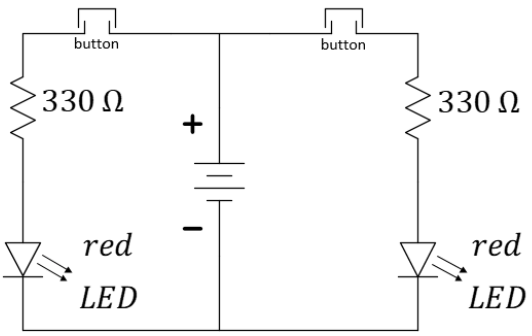


Figure 5: Circuit schematic for switching LEDs.

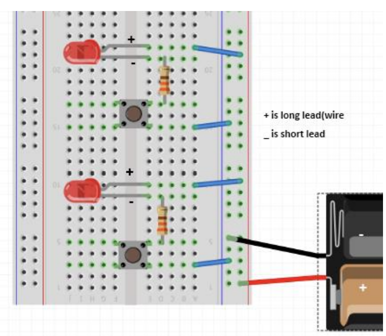


Figure 6: Physical diagram for button-controlled motors.

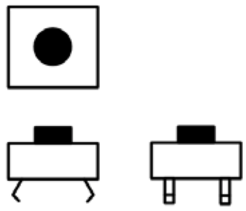


Figure 7: Multiview projection of the button. Two flat wires will span the gap in the middle of your breadboard. These two wires are connected together when the button is pressed.

Question 5: Please build the circuit shows in Figure 5, and attach the physical diagram at the end of this prelab manual.

The graph is seperately uplooded.