

## PH102 Software & Hardware Introduction

In the next few laboratories, we will explore the behavior of current and voltage in various alternating and direct current circuits. For these labs, you will encounter certain hardware and software repeatedly, which we will now familiarize you with.

### LAB REPORT

You will be asked below to record specific measurements, and answer qualitative questions. The required questions are listed under subheadings “*In your report.*” You may type and print these reports, or simply write them out at your discretion. Certain plots need only be visually inspected by an instructor, and do not need to be printed out. In this case, in your lab procedure, there will be a place for an instructor to initial if they have found the plot acceptable. **At the end of the class period, one hard copy should be turned in per group.**

### HARDWARE

**Bamalab box:** This is a computer controlled, USB-driven box that has four basic functions: (1) sourcing current, (2) sourcing voltage, (3) measuring current, (4) measuring voltage. In subsequent labs, you will apply potential differences (voltages) to devices and measure the resulting current, and *vice versa*.

**Current sourcing:** current must always have a closed path to flow through. When using the current source (+ Iout, - Iout), imagine that current flows from the RED positive terminal (+Iout), through your device, back to the BLACK negative terminal.

**Voltage sourcing:** the red terminal is positive, the black is the negative. Applying a potential difference of, e.g.,  $\Delta V = 1$  Volt means that  $V_{\text{red}} - V_{\text{black}} = 1$  Volt.

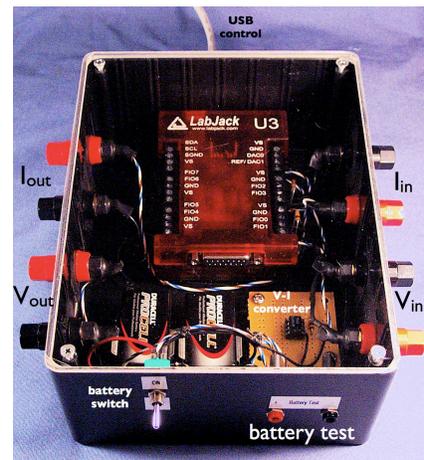
**Voltage measurement:** the same polarity convention applies - red is positive, black is negative. Measuring a potential difference of, e.g.,  $\Delta V = 1$  Volt means that  $V_{\text{red}} - V_{\text{black}} = 1$  Volt.

**Current measurement:** the same polarity convention applies - red is positive, black is negative. Measuring current is slightly different, however: current must flow into the “+I in” terminal and back out the “-I in” terminal to be measured, so the current measurement is in *series* with your device.

**Resistor:** A resistor in general obeys Ohm’s law,  $\Delta V = IR$ . Current can pass through a resistor, and the amount of current grows linearly with the potential difference  $\Delta V$ . The flow is not perfect however. For a given potential difference  $\Delta V$ , the current that can flow is  $I = \Delta V/R$  - the larger the R, the less I for the same  $\Delta V$ . Your resistor should look something like the image at right - it has several colored stripes.



**Capacitor:** A capacitor stores electrical energy, and can be charged to a potential difference  $\Delta V$ , but will not support a constant current. If we apply a potential difference, it stores energy (in the amount  $1/2 C \Delta V^2$ ) by building up a static charge separation. If we increase  $\Delta V$ , the capacitor will store more energy, but no current will flow. Your capacitor should look something like the image at right, a little metal can.



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**Diode:** A diode allows current to flow, but only in one direction. More precisely, it has an enormously high resistance if current flows through it in one direction, and a fairly low resistance in the other. Diodes have two wires, just like resistors or capacitors, but when you apply a potential difference to a diode, current will only flow if it is connected in the right direction



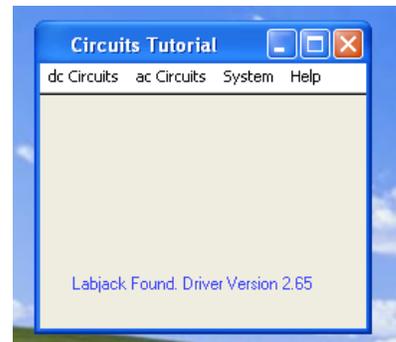
Diodes are useful for controlling current flow in devices, but we will use a special sort of diode: the Light Emitting Diode (LED). When connected in the right direction current flows through the LED, and when there is enough current, it lights up. Your diode looks something like the image at right.

The polarity is important for an LED - the longer leg of the LED should be connected to the positive potential or current (red plugs), the shorter leg to the negative (black plugs).

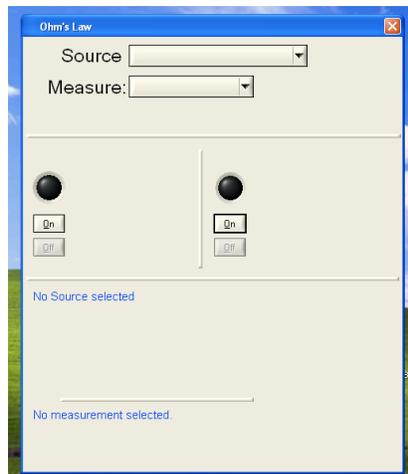
### Software

(1) From the Start menu / All Programs, open “A Circuits Tutorial”. You should get a window like the one at right.

If you see “Labjack Found” on the window, everything is functioning properly. If your window says “Demo Mode,” ask for assistance. This verifies the USB connection to your box.



(2) From the “dc Circuits” menu, select “Multimeter.” This should bring up a new window like the one below. From this window, you can source either current or voltage, and simultaneously measure current or voltage. This is the most useful panel, arguably, for testing your components and verifying the functionality of your Bamalab box.

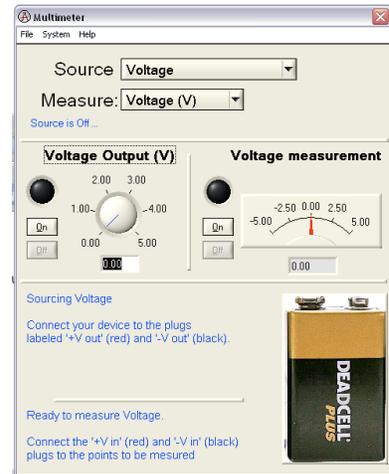


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### Checking your Bamalab box

Occasionally, components of your Bamalab box may stop functioning, or at least you may have reason to believe so. Fortunately, there is a simple procedure for verifying your Bamalab box. This procedure presumes that the previous stage - starting the software and verifying the USB connection - has been successfully completed.

**Voltage input & output:** First, open the “multimeter” panel in the software. From the “Source” pulldown menu, select “Voltage,” and also select “Voltage” from the “Measure” pulldown menu. After performing each action, the middle portion of the window should change to reflect your choices, as shown at right.



Next, using two “banana” cables, connect the voltage input and output together. Do this by connecting “+V<sub>in</sub>” on one side of the box to “+V<sub>out</sub>” on the other side, and similarly connect “-V<sub>in</sub>” to “-V<sub>out</sub>.”

Now click the “on” button under “Voltage Output” portion of the screen. The circle just above the “on” button should now be green. Adjust the voltage output dial to some moderate value, perhaps 1.5 or 2V. You are now supplying voltage from the V<sub>out</sub> terminals.

Next, in the “Voltage measurement” portion of the screen, click “on.” The circle above the “on” button should turn red. Now you are measuring the voltage at the V<sub>in</sub> terminals, which are connected directly to the V<sub>out</sub> terminals. **If everything is functioning properly, the voltage measurement should be very close to your output voltage.** Finally, change the voltage output dial to some new value (say, 3V). You should see the “voltage measurement” indicators change to follow the change in output, in real time.

Variations of 10-15% between output and input are tolerable. If the above is successful, your voltage sourcing and measuring are OK!

**Current input and output:** If you have just performed the previous step, turn off the voltage output and measurement. On the multimeter screen, elect to source and measure **current** now. The output and measurement regions of the screen should change after you do this.

Next, using two “banana” cables, connect the current input and output together. Do this by connecting “+I<sub>in</sub>” on one side of the box to “+I<sub>out</sub>” on the other side, and similarly connect “-I<sub>in</sub>” to “-I<sub>out</sub>.” **Operating the current source also requires you to flip a small switch on the side of the box.** Make sure this switch is set to “on.”

Now click the “on” button under “Current Output” portion of the screen. The circle just above the “on” button should now be green. Adjust the current output dial to some moderate value, perhaps 3 or 5mA. You are now sourcing current from the I<sub>out</sub> terminals.

Next, in the “Current measurement” portion of the screen, click “on.” The circle above the “on” button should turn red. Now you are measuring the current passing through the I<sub>out</sub> terminals, which are connected directly to the I<sub>out</sub> terminals. **If everything is functioning properly, the current measurement should be very close to your output current.** Finally, change the current output dial to some new value (say, 2mA). You should see the “current measurement” indicators change to follow the change in output, in real time.

Variations of 10-15% between output and input are tolerable. If the above is successful, your current sourcing and measuring are OK!