

## PHYS245 Lab: Light bulb and resistor I: Use of Digital Multimeter (DMM)

### Purpose

- Hands-on experiences on simple d.c. circuits
- Introduction to ELVIS II experimental station
- Simple electric measurements (current, voltage, and resistance) using a digital multimeter (DMM)

### Equipment list:

National Instrument ELVIS II, light bulb, resistors (750  $\Omega$ , 330  $\Omega$  and 200  $\Omega$ ) two cables with banana plugs, two banana-to-minigrabber cables, jump wires with various length

ELVIS II is the acronym for Educational Laboratory Virtual Instrumentation Suite, developed by National Instruments. It is a platform that integrate 12 typical electronics equipments. Most Labs in PHYS245 will involve ELVIS II and you will learn some of the basics of ELVIS II in today's Lab and apply it to simple d.c. circuits.

Most of the ELVIS II functions can be controlled by a desktop computer. You will get familiar with the basics of the software and the hardware in this Lab. In the ELVIS suite, there is a 5 V d.c. power supply, 15 V d.c. power supply, 12 V variable d.c. power supply, a digital multimeter, a function generator, an oscilloscope, a prototyping board, etc.

In today's Lab, you will use the digital multimeter (DMM) to measure the resistance of a light bulb and resistors. You will also learn how to use the prototyping board and jump wires to build a simple circuit. You will power the light bulb and resistor using the 5 V d.c. power supply, and measure the current in the circuit using the DMM. Simple resistance calculations can be done by using Ohm's law.



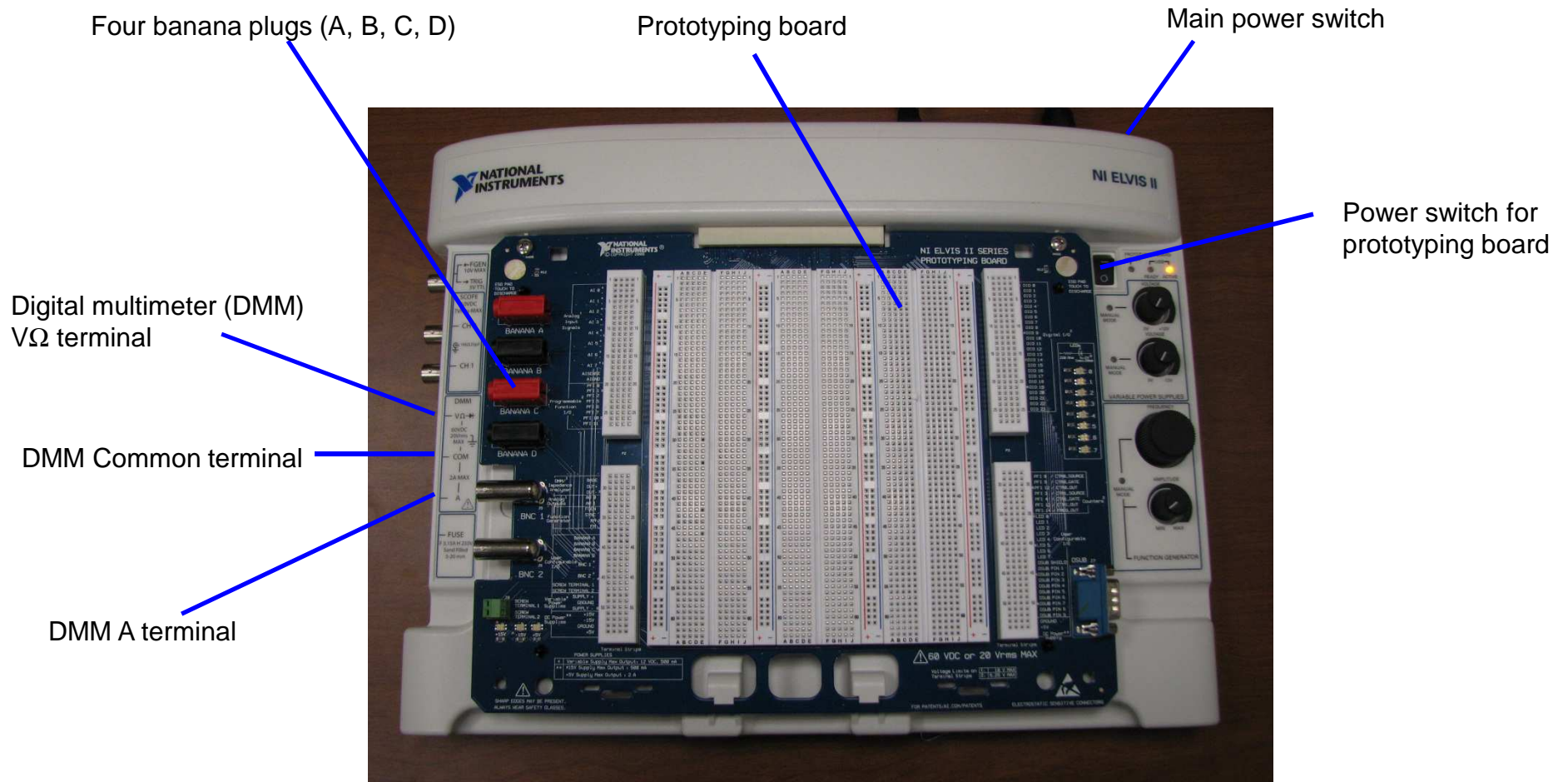
## Pre-Lab Exercises

Thoroughly read through the brochure and answer the following questions.

- Each row of five clips in the distribution stripe is electrically connected, true or false?
- Each column of clips in the terminal stripe is electrically connected, true or false?
- Each column of clips in the bus stripe is electrically insulated, true or false?
- The d.c. power is available from bus stripe without any jump wire connections, true or false?
- The DMM can be connected to the prototyping board through the banana plugs, true or false?

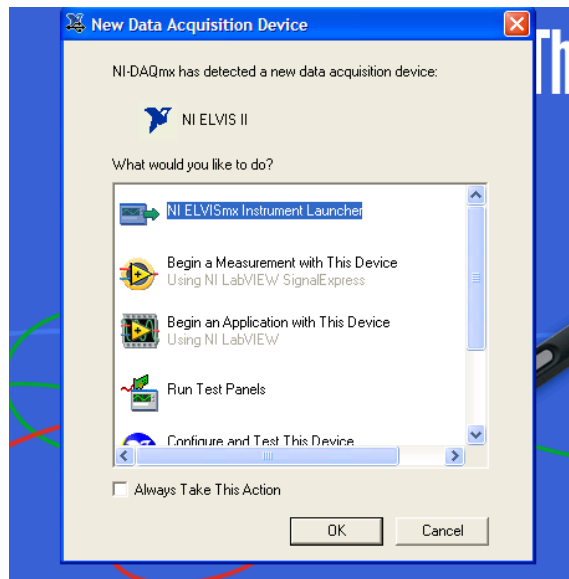


# Introduction to ELVIS II



The above picture shows the major components on ELVIS II.

Now, check the main power switch, and make sure it is turned to “1”.

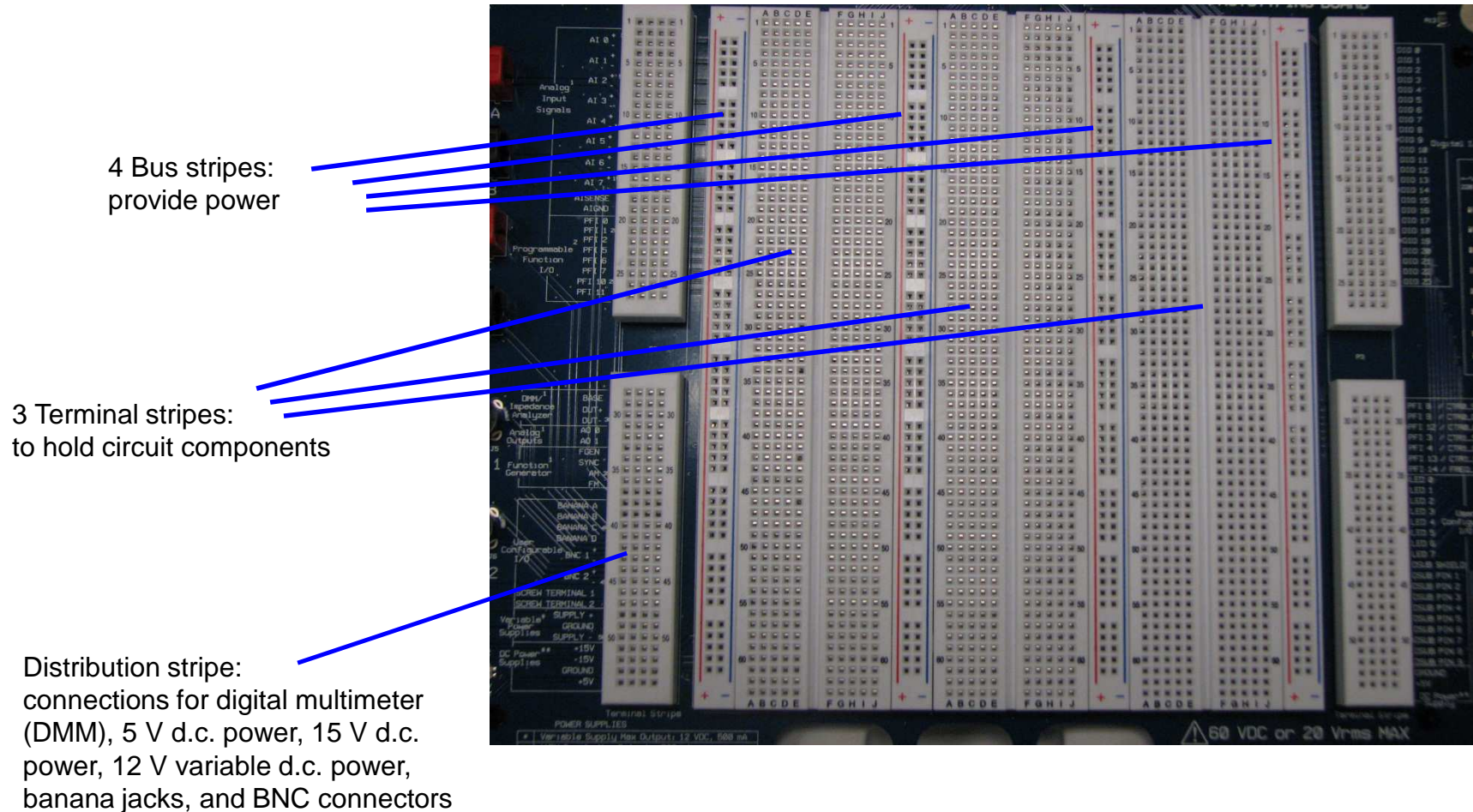


When the main power is turned on, a window will pop up, as shown on the left. Click on “NI ELVISmx Instrument Launcher”. Then the Instrument Launcher will appear, as shown in the picture below.



## A closer look at the prototyping board

The prototyping board (breadboard) consists of perforated block of plastic with numerous tiny spring clips under the perforation. The spacing between the clips is 0.1". The board provides an area for building electrical circuits, and has necessary connections to signals and power for common purposes. The circuit components (resistors, capacitors, inductors, and IC chips) can be inserted into the spring clips, and jump wires can also be inserted into the spring clips to complete the circuit.





## More on the prototyping board

Labels of each row in the distribution stripe

The five clips in a row are all electrically connected in the terminal stripes and distribution stripes. Thus it is easy to accommodate multiple connections to one point

## Positive voltage

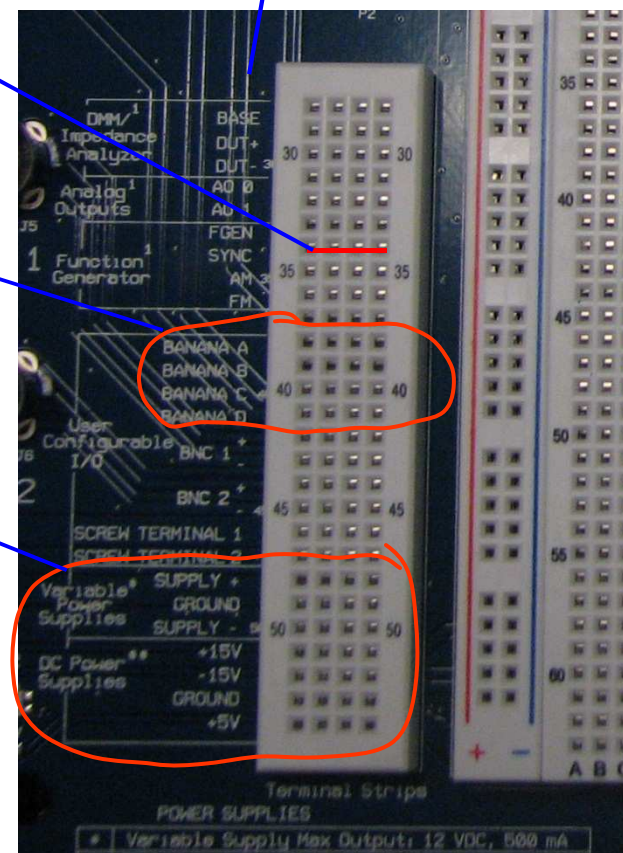
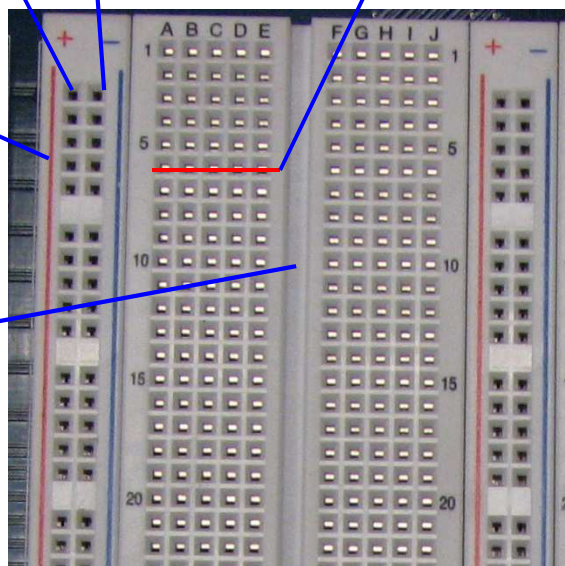
Negative voltage

Connections to banana plugs. Each of the 4 rows is connected to one of the banana plug

All the clips in the same column in the bus stripe are electrically connected

Notch along centerline provides air flow to reduce heating in a complex circuit

## Connections to dc power supplies



## Accessories and parts

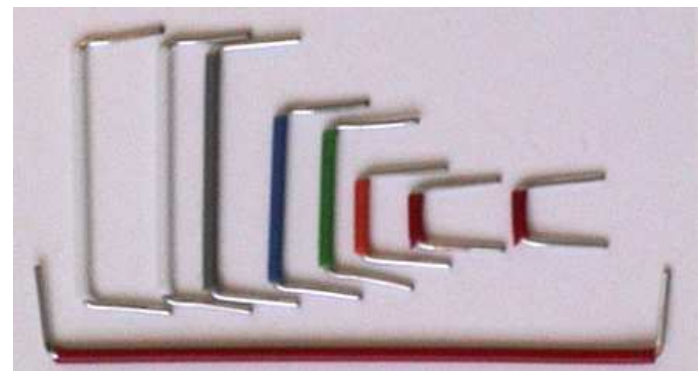


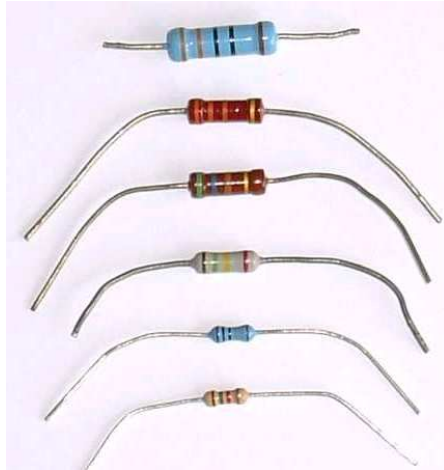
Cables with banana connectors are widely used in electrical measurements. In today's Lab, you will use these cables to establish connections between DMM terminals and the banana jacks on the prototyping board.

Another type of cable you will use throughout the course is a banana-to-minigrabber cable. One end of the cable is a banana plug, and the other end is a minigrabber that can grab the pins of a electronic component (resistor, capacitor, or diodes).

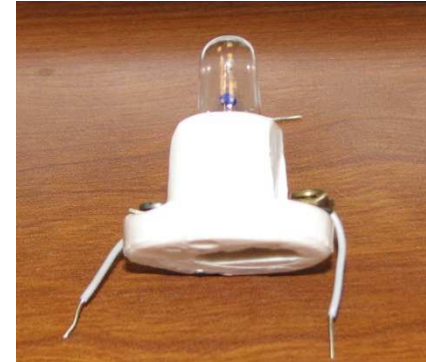


You are given a box of jump wires with different lengths. You will use them to connect components on the prototyping board to complete a circuit. Estimate the length of the wires you need, and then choose accordingly.





Resistors will be used in this Lab. The picture on the left shows some typical resistors.



A light bulb will be used. Two jump wires are connected to the light bulb, so that it can easily fit into the prototyping board.

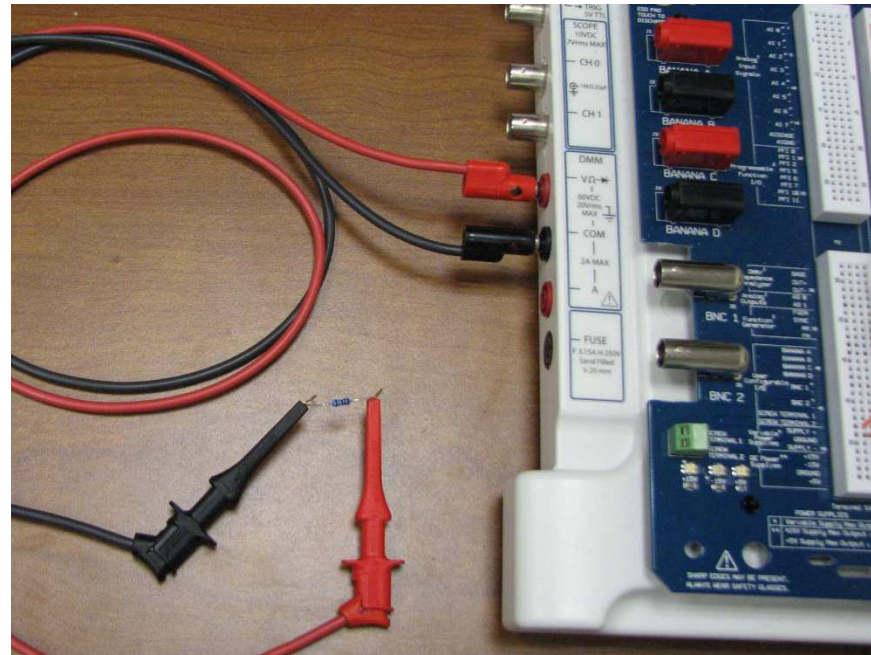


## Experiment I: Use digital multimeter (DMM) to measure resistance

The DMM is a useful tool for electrical measurements. It can measure resistance, current (d.c. or a.c.) and voltage (d.c. or a.c.), etc. In this experiment, you will learn resistance measurement function of the DMM. You will measure the resistance of a light bulb and resistors.

There are three terminals for the DMM, located on the left side of the ELVIS II. Each of the terminals is a banana jack. To measure resistance, use the  $V\Omega$  terminal and the COM (common) terminals. These two terminals are not directly connected to the prototyping board. You will learn two ways to connect the resistors to DMM for measurements. You can use the banana-to-minigrabber cable to connect resistors directly to DMM. You can also use cable with banana plugs to connect the DMM terminals to the two banana jacks on the prototyping board, and then to the resistor using jump wires.

To use the banana-to-minigrabber cable, insert the banana plug of the cable to the DMM terminals. Use the minigrabber to grab a resistor, as shown on the right.



## Software for Digital Multimeter

Step 1:

Click on the DMM icon on the NI ELVISmx Instrument Launcher. The digital multimeter window pops up. See the screen shot on the right.

Step 2:

Click on the  $\Omega$  button on the DMM window. This means “resistance” measurements.

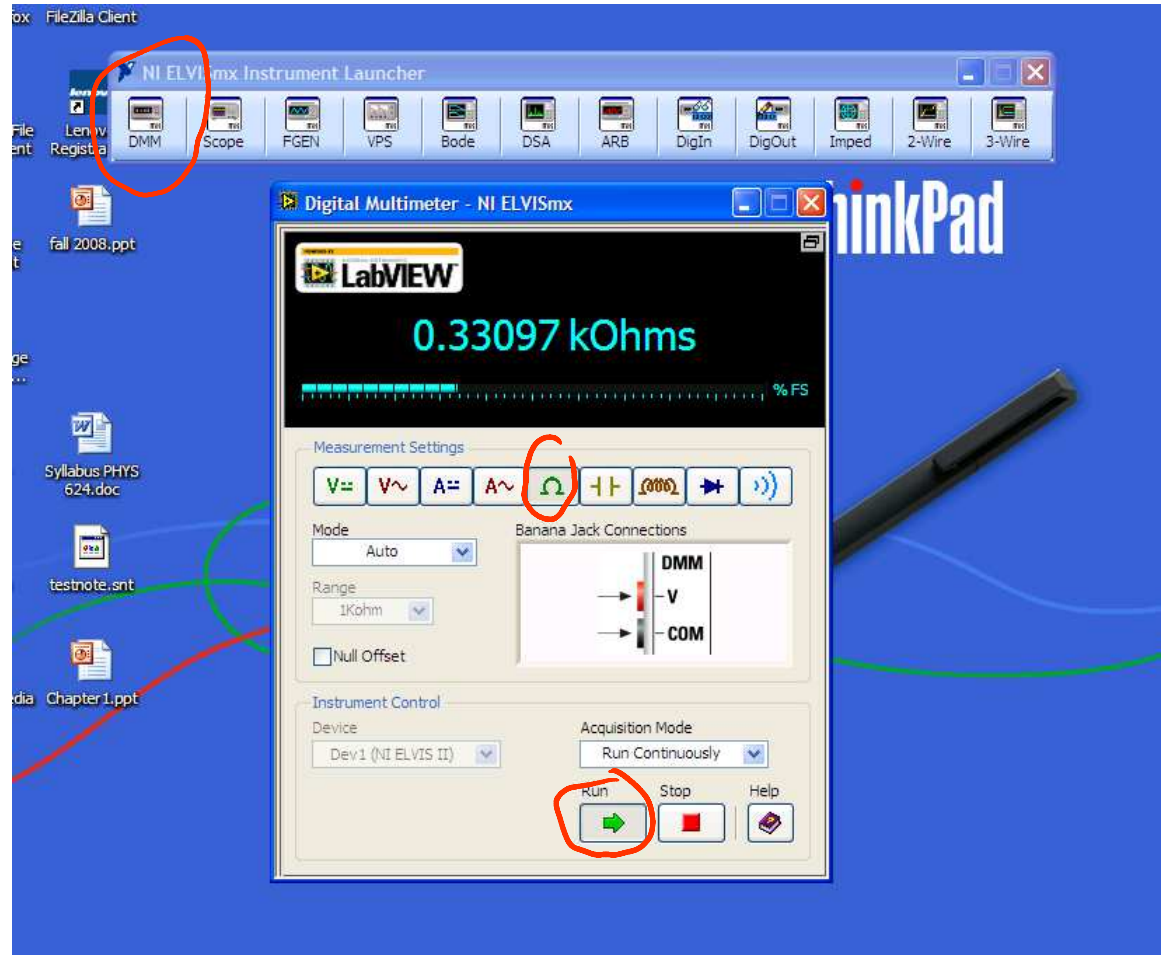
Step 3:

Click on the “Run” button at the bottom of the window.

Then the DMM window will display the resistance value in unit of  $\Omega$ .

Measure the resistance of all three resistors. Then measure the resistance of the light bulb.

Record the resistance values of the resistors and the light bulb.

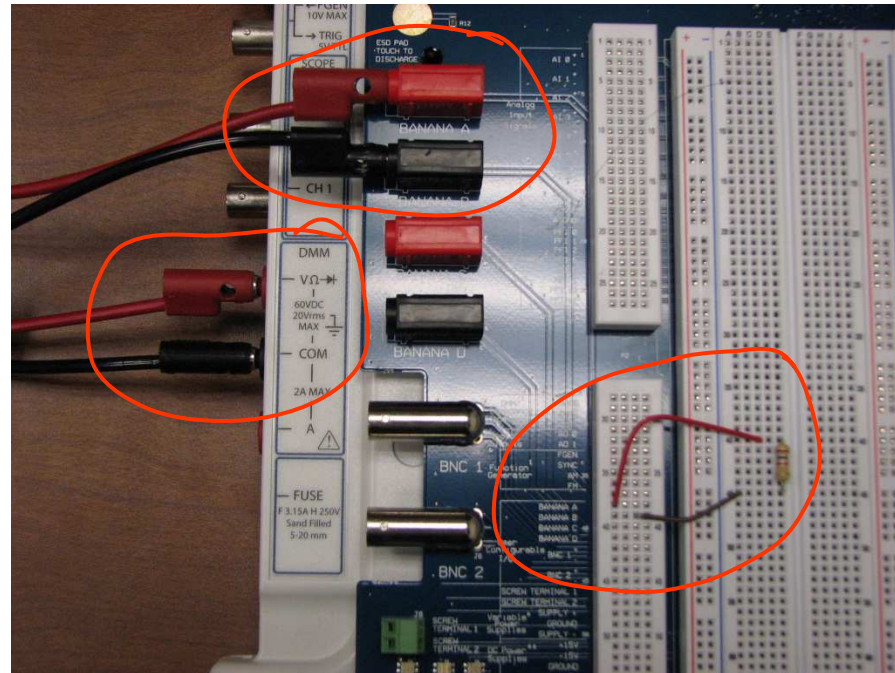


An alternative approach for using the DMM is to connect DMM to the banana jacks on the board. Pick one resistor randomly and use it for this practice. Make hardware connections as shown on the right.

The two cables with banana plugs connect between the DMM terminals and the banana jack A and B on the board.

Insert the resistor on the prototyping board.

Use jump wire to connect between the resistor and the rows on the distribution stripe corresponding to banana A and B.



### Additional exercises for Experiment I:

Now you know how to use DMM to measure resistance. It is very common to use DMM to check the continuity of wirings and circuits. You measure the resistance between two points in a circuit. If the resistance is very low (below 1 ohm), that means the two points are connected electrically.

In the beginning of this Lab, you were told that all clips in the same row in the terminal stripe are connected. Now you can verify that using the DMM. You were also told that clips in each column in the bus stripe are connected. Verify it using the DMM. Route the section to be measured to the banana jacks using jump wire. Then connect between banana jacks and DMM terminals using the banana-plug-cables. Randomly pick two clips in the same column in the terminal stripe, verify that the two clips are insulated. Randomly pick a row in the bus stripe, verify that the two clips in the row are insulated.





## Experiment II: power up the light bulb and resistor!

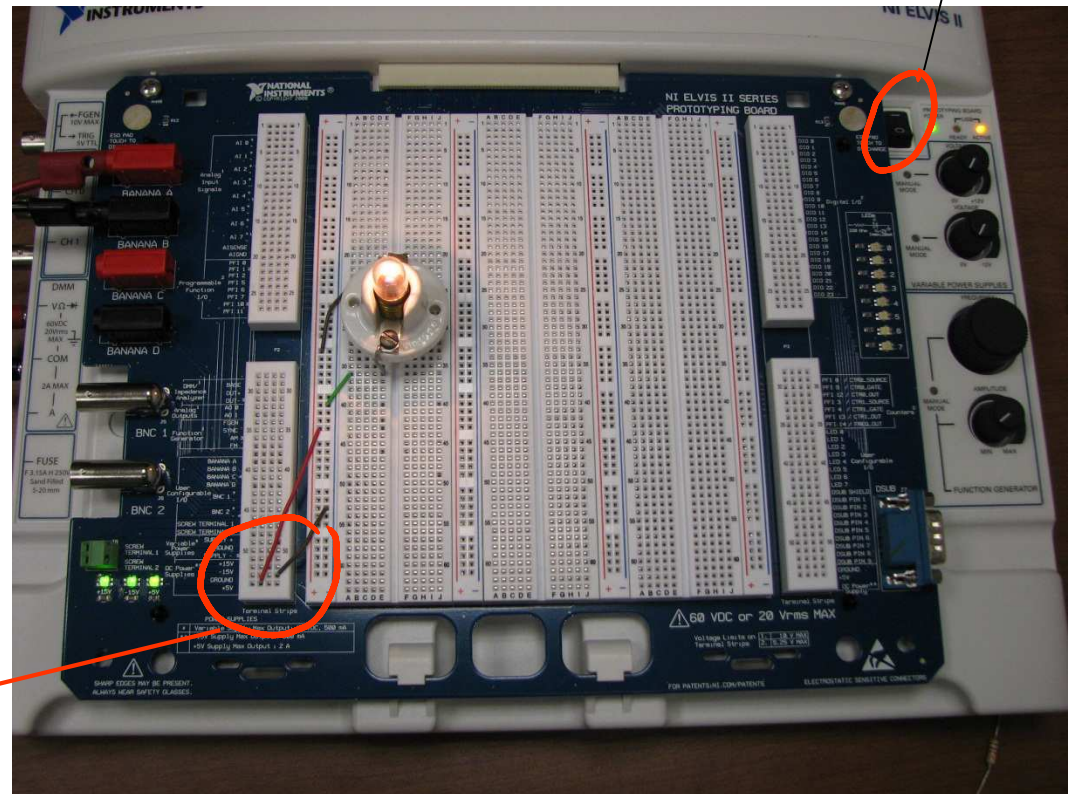
In this experiment, you will connect the light bulb and the resistor to the 5 Volts d.c. power supply, and measure the current through the light bulb and the resistor.

Connect the light bulb as shown in the Figure. Then turn on the power switch for the prototyping board. The light bulb should light up.

Always finish the wiring of the components first. Then turn on the switch for the power to the board.

In the picture, you may note that the 5 V power is first delivered to the bus stripe. The light bulb is connected to the bus stripe. Note that the bus stripe does not automatically carries power. You have to route the power from one of the power supplies located on the distribution stripe.

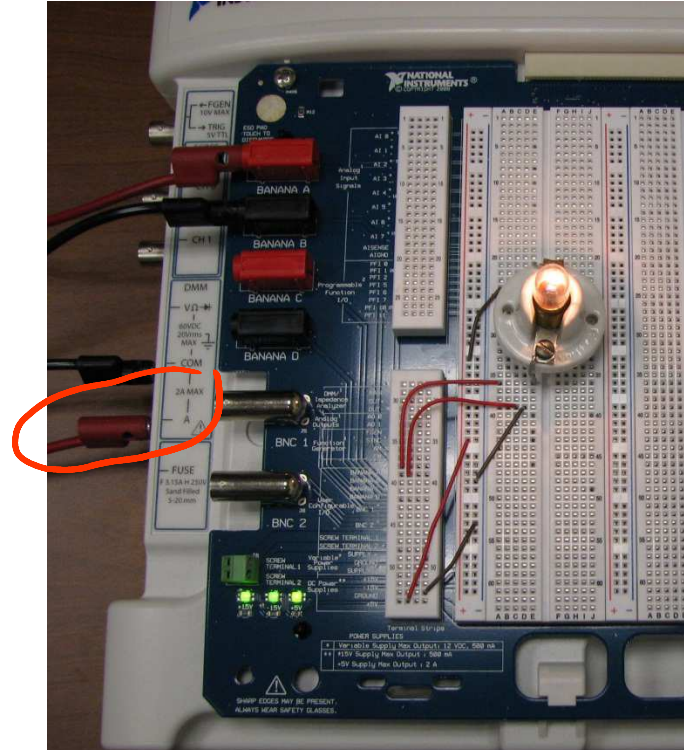
Power switch for prototyping board



5 V d.c. power connection

We could measure the current flowing through the light bulb using the Digital Multimeter (DMM). The DMM can be used as an Ammeter. Switch the Red Banana Plug to the “A” terminal. Complete the circuit as shown in the figure. Note that the DMM is put in series with the light bulb.

Click on the “A-” button on the DMM window. This button means d.c. current measurement. Then click the “Run” button.



Record the value of the current. Use Ohms's law to calculate the resistance the light bulb.

Is the resistance measured here the same as the value measured by DMM in Experiment I? If not, try to explain why. (Hint: the temperature of the light bulb filament is very high when it is lit.)

Replace the light bulb with the resistor. Measure the current through the resistor under 5V.  
Use Ohms law to calculate the resistance.  
Is this resistance value the same as the value measured by DMM in Experiment I?

Questions:

When we use the DMM to measure the resistance, a current is sent through the component we are trying to measure. But if there is a current, why is the light bulb not lit when we measure resistance using the DMM?

