

# ECE 2054

## Using the Digital Multimeter

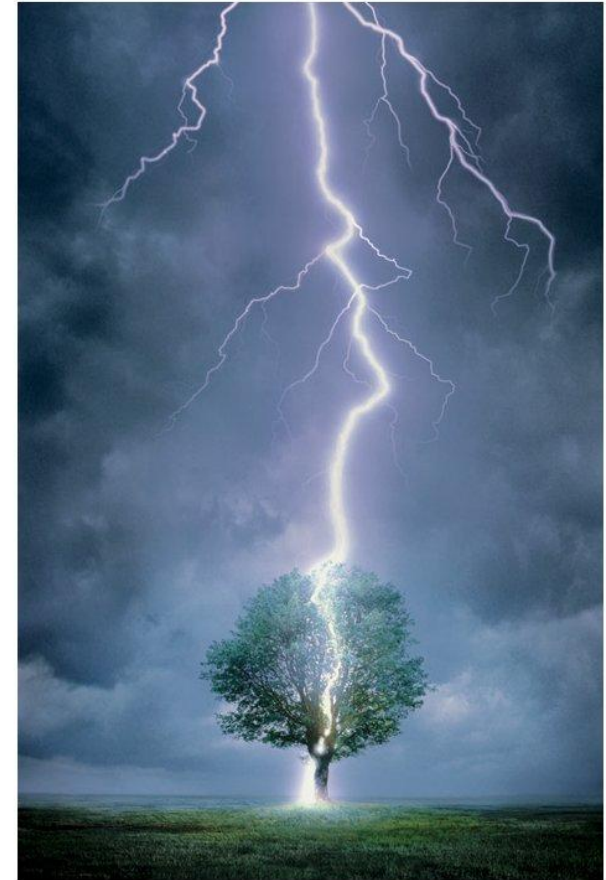


# WARNING! Static discharge can destroy your meter.

In dry conditions, even moving in your chair can create a large charge of static electricity on you. Always ground yourself to something (e.g. touch something metal) before opening the meter case.

The ECE department is not responsible for meters damaged by abuse or static discharge.

If you have any doubts about your ability to perform this procedure, consult with an OpEL GTA.

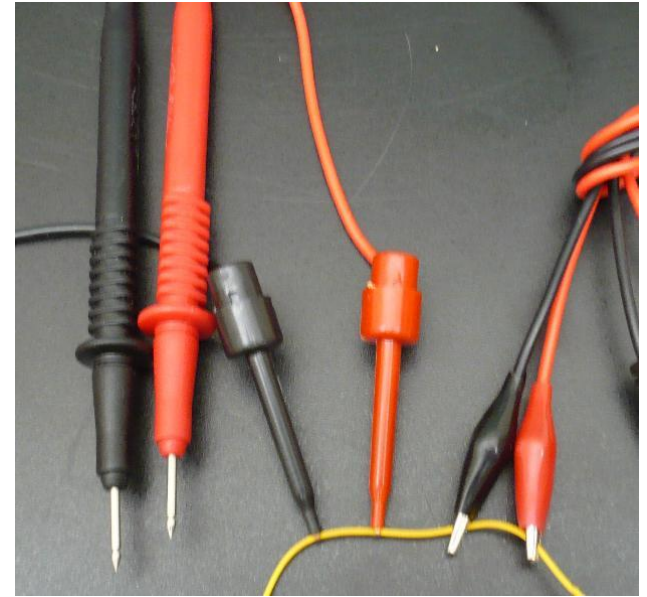


# Meter Leads

Your LiaB kit has several types of leads.

Left to right are:

- Probe
  - IC-hook or mini-grabber
  - Alligator clip
- 
- The probe is good for measuring devices with terminals, but be careful on a breadboard because it is easy to create a short circuit between component leads with a probe tip.

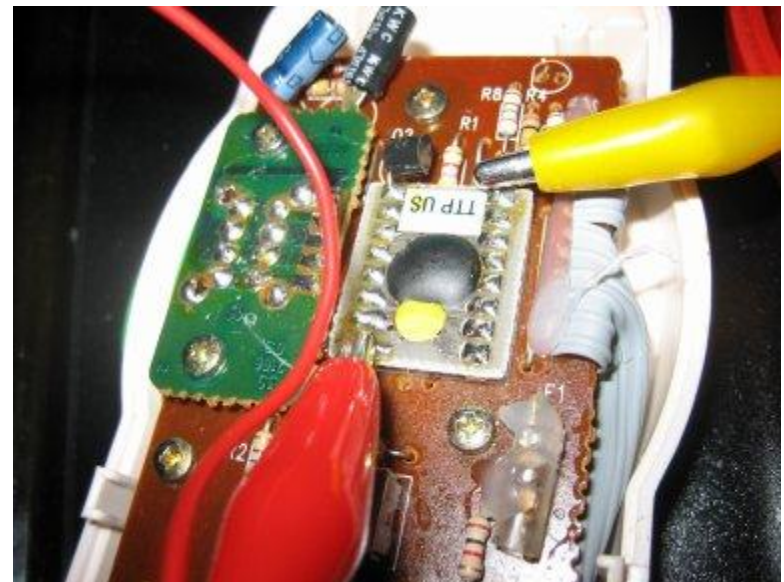


- The IC-hook / mini-grabber is useful for attaching to component leads and wires.



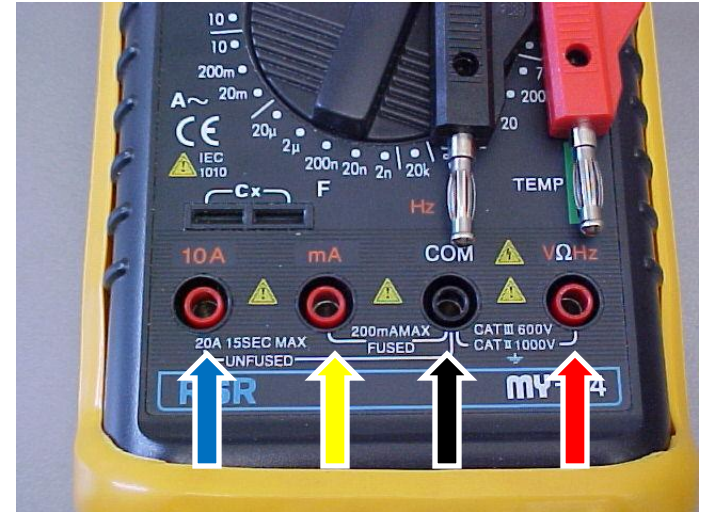
- The Alligator clip is useful for attaching to wires, larger parts, and ground connections.

Clipping an Alligator to a small terminal, as shown in the photo on the right, is asking for trouble.



# Connecting Leads to the Multimeter

- The meter uses “Banana Jacks” for lead connections – insert the banana plugs into the appropriate meter jacks.
- COM (black arrow) is the common or ground lead used as a reference for all measurements.
- VΩHz (red arrow) is used to measure voltages, resistance, and frequency.
- 10A (blue arrow) is used for high current AC and DC measurements.
- mA (yellow arrow) is used for low current AC and DC measurements.  
**Caution: Fused at 200mA!**





# Meter Tip for easier scale setting

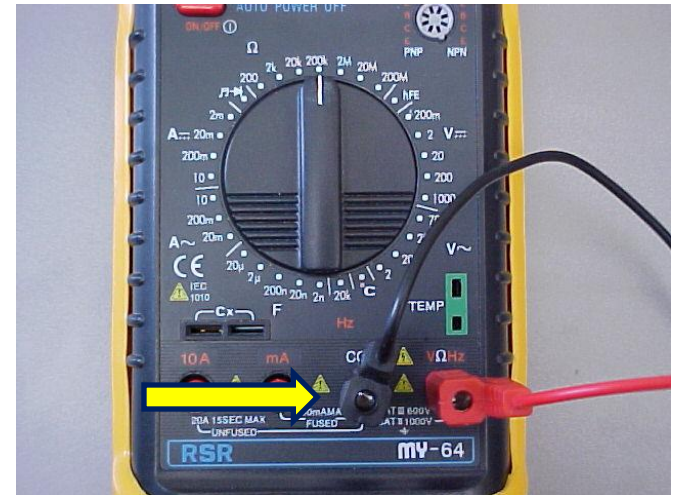
The range switch has a notch in the end of the knob to show the chosen scale. This notch is difficult to see in poor lighting.

The range position is much easier to see if you fill the notch with paint or whiteout.



# Resistance Measurement

1. The red cable Banana plug is inserted into the “VΩHz” jack of the multimeter.
2. The black cable Banana plug is put into the “COM” (ground) jack of the multimeter.

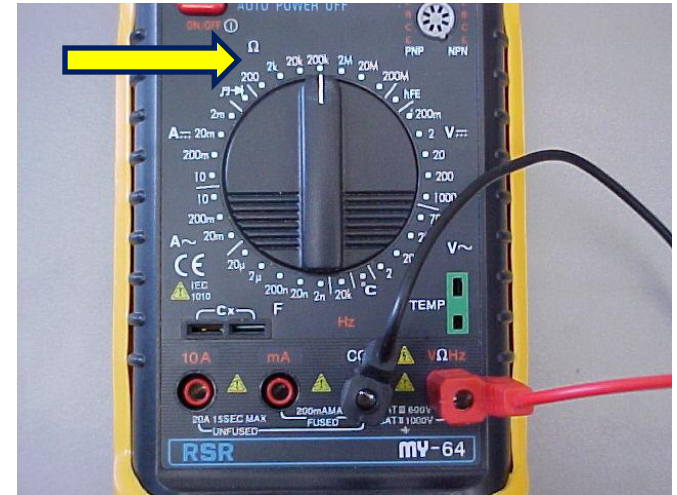


3. Clip the leads to a resistor.



# Resistance Range

- Adjust the  $\Omega$  range switch for best resolution.
- For ANY meter measurement, adjust the range for maximum resolution without an overflow.





# Measuring a Resistor Value

1. Clip the meter leads to the 100 $\Omega$  resistor. Adjust the meter for maximum accuracy, and write the range setting and measured resistance on Part A of the worksheet.
  2. Replace the 100 $\Omega$  resistor with the 10k $\Omega$  resistor. Adjust the meter for maximum accuracy, and write the range setting and measured resistance on Part A of the worksheet.
- You may (just for fun) measure the resistance of your body between your two hands (one lead in each hand). Try different scales, try it dry, try it wet.



# DC Voltage Measurement

- The red cable is inserted into the “VΩHz” jack.
- The black cable is put into the “COM” (ground) jack.
- The meter range switch is turned to one of the DC volts settings.
- The other end of the cables may be used directly on the circuit (with caution) or you can add short lengths of wire to the IC-clip or Alligator to assist with the measurement.
- Voltage measurements are made by placing the meter leads across (in parallel with) a component or from one point on a circuit another point on a circuit.



# Measure the voltage of your old battery

1. Set the meter to measure DC Volts. It is best to set the range above the expected voltage
2. Use the probes or clips with wires to touch the battery terminals. The positive (+) battery terminal is the smaller (male) terminal.
3. Adjust the meter range for best resolution. Record your measurement on Part B of the worksheet.
4. Swap the lead connections and notice how the meter reads negative voltage when the leads are reversed.

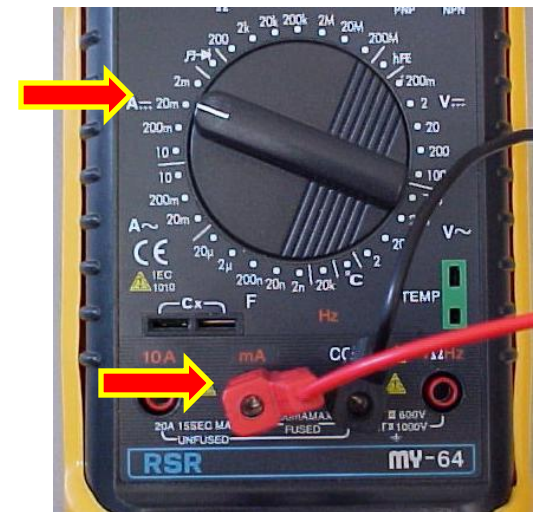


# DC Current Measurement – very tricky!

1. The red cable is inserted into the 10A jack (set the meter switch to measure 10A DC) or into the mA jack (set the meter switch to measure 2m, 20m, or 200m DC).

**CAUTION: the current shunt acts as a short circuit. It is very easy to blow the mA fuse if you connect the meter leads to a circuit incorrectly.**

2. The black cable is put into the COM (ground) jack.
3. For polarity, positive current flows into the red lead and back out of the black Common lead.
4. Measurements are made by placing the meter leads in series with a component (move a component lead to open the circuit, and use the meter leads to complete the circuit).



# To measure an unknown current

## 1. Always measure with the 10A scale first!

- This reduces the chance of blowing the mA fuse.

## 2. Make sure that you have the scale set to 10A DC and the lead in the 10A jack.

- If you fail to do this, the meter will display 0 even if there is a large current flowing!

## 3. If your measured current is less than 0.2A, change the range to 200m and move the red lead to the mA jack. Adjust the range for maximum resolution.

## 4. After the current measurement is complete, always move the red lead back to “VΩHz”. This is easy to forget!



# Current measurement accuracy (AC and DC)

From the owners manual and the [Specification Sheet](#):

- For polarity, positive current flows into the red lead and back out of the black Common lead.

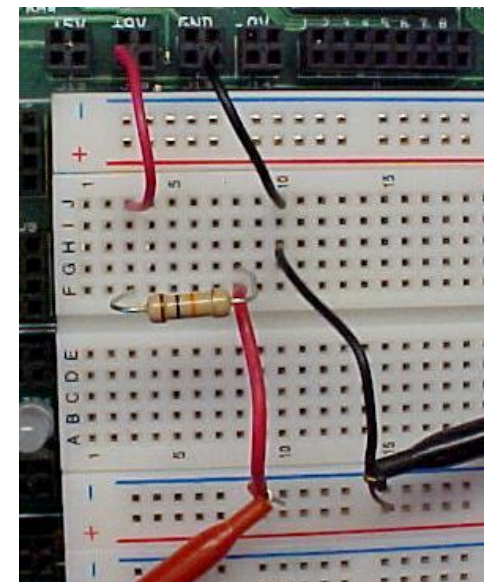
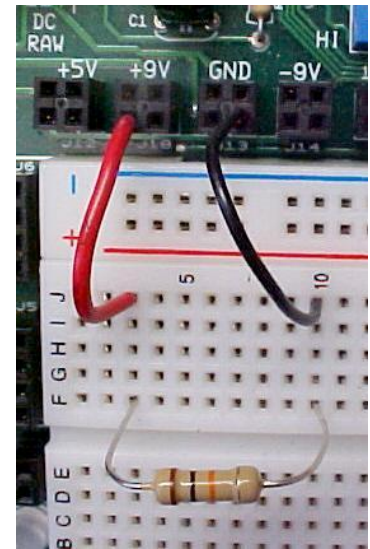
Range	Resolution	Accuracy	Burden Voltage
2mA	1 $\mu$ A	+/-0.8% of reading $\pm$ 1 digits	110mV/mA
20mA	10 $\mu$ A	+/-0.8% of reading $\pm$ 1 digit	15mV/mA
200mA	100 $\mu$ A	+/-1.5% of reading $\pm$ 1 digit	5mV/mA
10A	10mA	+/-2.0% of reading $\pm$ 5 digits	0.03V/A

The Burden Voltage is the voltage drop across the shunt.

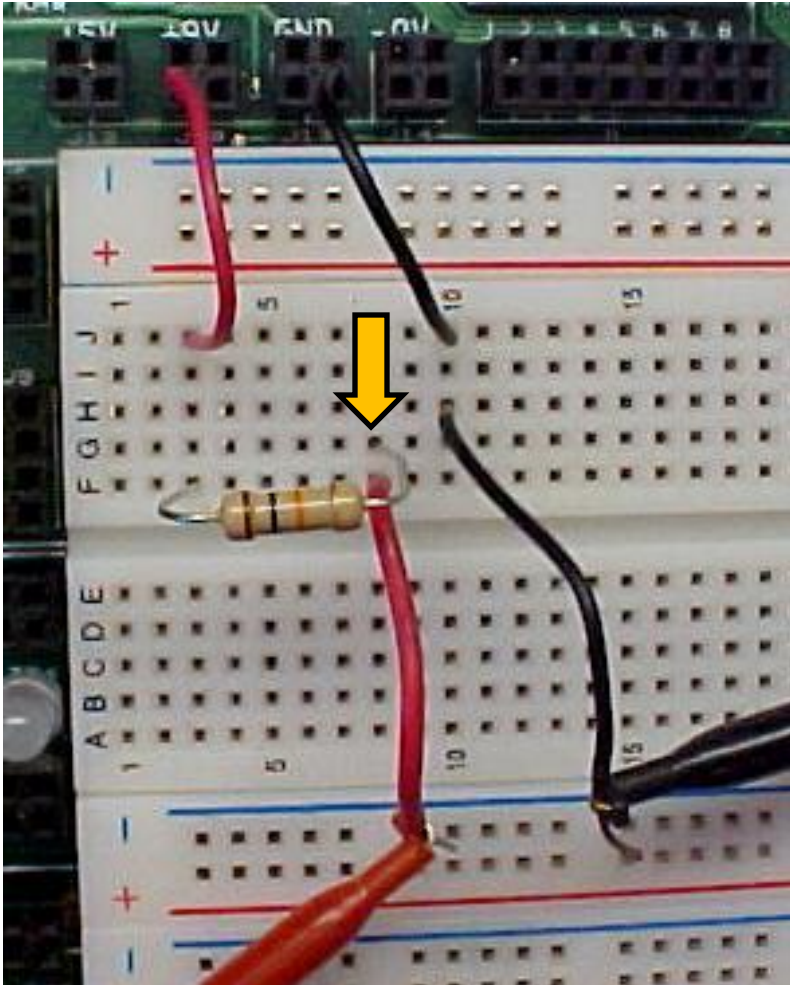
For example, a 10mA current with the meter set to the 20mA scale, will produce a 300mV drop between the red and black leads (20mA X 15mV/mA = 300mV). This drop can significantly affect measurements of low voltage circuits.

# ANDY Board current measurement

1. Begin with your original circuit (upper photo).
2. Lift one end of a component and move the lead to a new column (lower photo).
3. Connect the red meter lead (plugged into the 10A jack) into the column to the component's moved end (lower photo).
4. Connect the black meter lead to the original column where the component's end was before you moved it. (lower photo)
  - You have now opened the circuit and re-completed it by inserting the meter in series with the resistor.
4. Set the meter scale to 10A, power up the ANDY board and read the current. It should be low for most circuits.



# Larger image of measurement connection

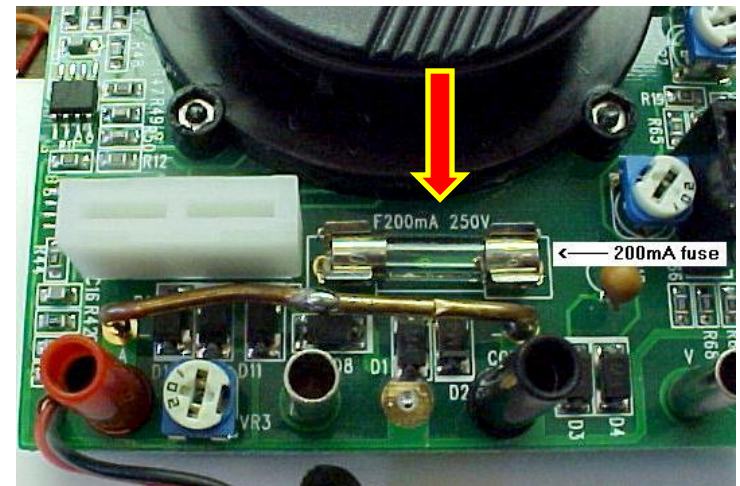
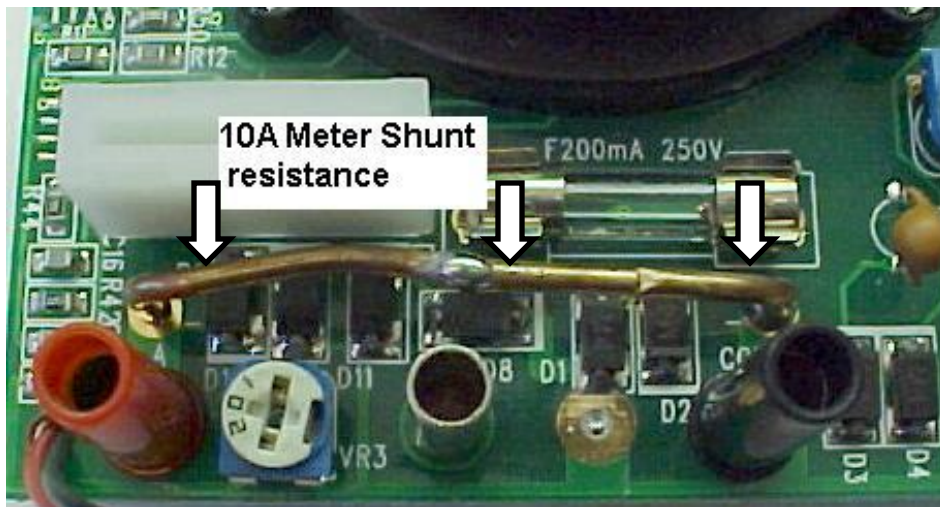


- If your measurement is greater than 0.2A, do not use the mA scale.
5. If the 10A range measurement is less than 0.2A, move the red lead to the mA jack on the meter, and adjust the range for maximum resolution.



# How you can get into trouble....

- The DMM's ammeter is nothing more than a very low value resistor with a voltmeter connected across the resistor. As current flows through the resistor, a voltage drop proportional to the current is created (Ohm's Law). The meter converts this measured voltage to a current value for the display.
- On the 10A scale, the resistor is a piece of wire.
- On the mA scales, the resistor is smaller and protected by a 200mA fuse.



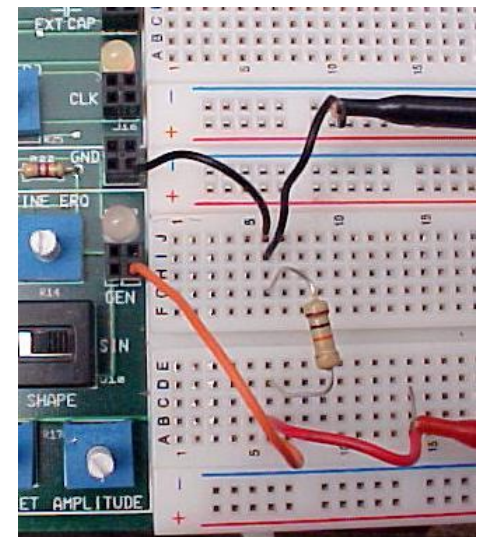
# Frequency Measurement

1. The red cable is inserted into the V $\Omega$ Hz jack.
  2. The black cable is put into the COM (ground) jack.
  3. Set the range switch to 20k at the Hz indicator.
  4. Measurements are made by placing the meter leads across (in parallel with) a component or from one point on a circuit another point on a circuit.
- The meter will measure the frequency of a waveform up to 250V, but accuracy is only guaranteed for inputs up to 10Vrms.



# AC Voltage Measurement

- The red cable is inserted into the “VΩHz” jack.
- The black cable is put into the “COM” (ground) jack.
- The range switch is turned to somewhere in the AC volts group (AC volts appears as V~ on the meter).
- Voltage measurements are made by placing the meter leads across (in parallel with) a component or from one point on a circuit another point on a circuit.



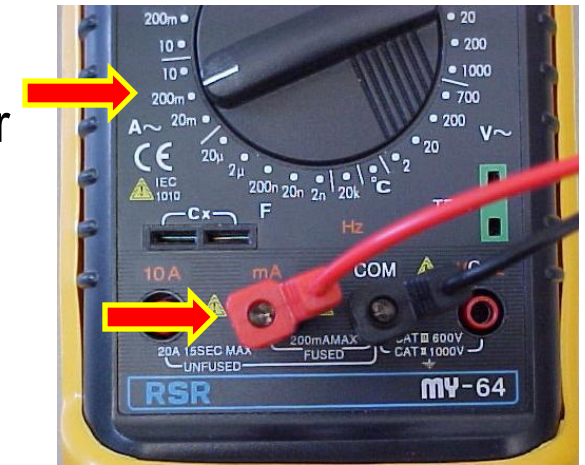
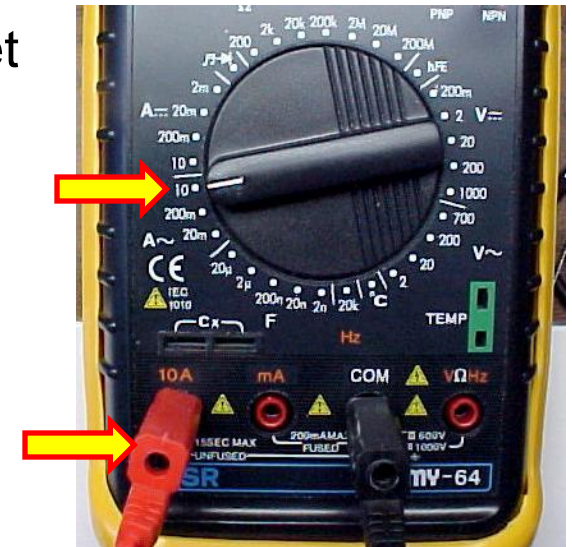
# AC Current Measurement – also tricky!

1. The red cable is inserted into the 10A jack (set the meter switch to measure 10A AC) or into the mA jack (set the meter switch to measure 2m, 20m, or 200m AC).

**CAUTION: As with DC current, the AC current shunt acts as a short circuit.**

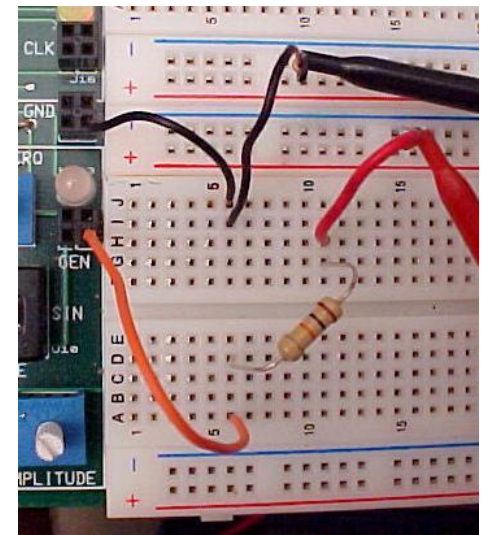
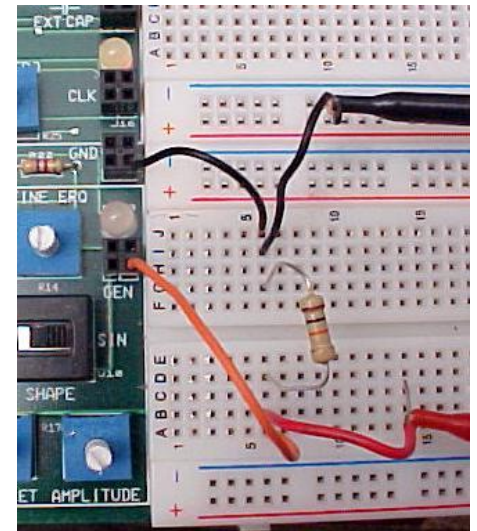
2. The black cable is put into the COM (ground) jack.

3. Measurements are made by placing the meter leads in series with a component (move a component lead to open the circuit, and use the meter leads to complete the circuit).

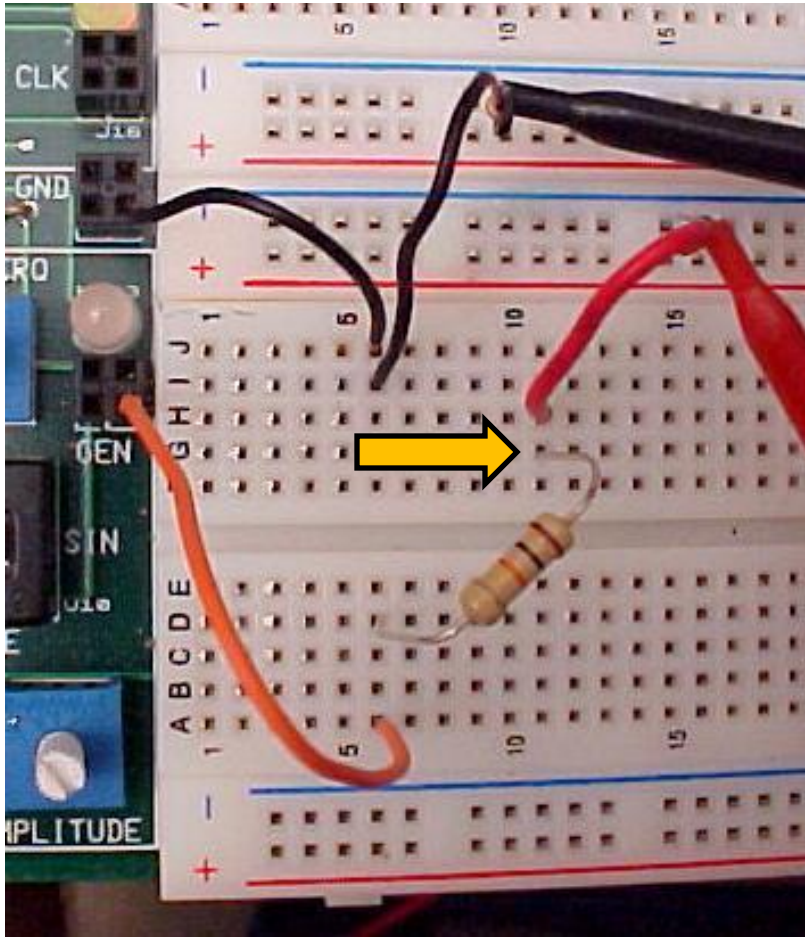


# ANDY Board AC current measurement

1. Begin with your +9V measurement circuit.
2. Lift the negative lead of the resistor and move the lead to a new column (*photo next sheet*).
3. Insert the meter red lead (plugged into the 10A jack) into the column with the moved resistor end.
  - You have now opened the circuit and re-completed it by inserting the meter in series with the resistor.
  - Leave the black COM lead connected to black wire from the GND block.
4. Set the meter scale to 10A, power up the ANDY board and read the current. It should be near 0A.



# Larger image of measurement connection



- If your measurement is greater than 0.01A, troubleshoot your wiring.
- 5. When the 10A range measurement is near 0A, move the red lead to the mA jack on the meter, and adjust the range for maximum resolution. Complete Part F on the worksheet.