

# Electronics Test Equipment

Name \_\_\_\_\_ ID \_\_\_\_\_ TA \_\_\_\_\_

Partners \_\_\_\_\_

Date \_\_\_\_\_ Section \_\_\_\_\_

**Do not set the multimeter to “Current Mode” unless you are sure that you will not exceed the maximum current for the fuse.**

- 1. Variable Resistors:** Record the resistance values measured between the various connector strips for the control positions indicated. (For each trial, please check the units, **kΩ** or **Ω**, carefully.)

	top-to-middle	middle-to-bottom	top-to-bottom
100k, full CCW	_____	_____	_____
100k, 10 o'clock	_____	_____	_____
100k, 12 o'clock	_____	_____	_____
100k, 2 o'clock	_____	_____	_____
100k, full CW	_____	_____	_____
1k, full CCW	_____	_____	_____
1k, 10 o'clock	_____	_____	_____
1k, 12 o'clock	_____	_____	_____
1k, 2 o'clock	_____	_____	_____
1k, full CW	_____	_____	_____

◇ Notes:  
 For the top-to-middle and middle-to-bottom positions, the resistance increases toward the direction of the arrow. However, for top-to-bottom, it does not change. Please think about why.

2. **DC Voltages:** Report your measured voltages between Ground and the strips labeled:

+5V \_\_\_\_\_ -12V \_\_\_\_\_ +12V \_\_\_\_\_

-VOLTS: full CCW \_\_\_\_\_ 12 o'clock \_\_\_\_\_ full CW \_\_\_\_\_

+VOLTS: full CCW \_\_\_\_\_ 12 o'clock \_\_\_\_\_ full CW \_\_\_\_\_

3. **AC Voltages:** Report your measured AC voltages between the indicated strips:

➤ **Multimeter observations**

left-to-center \_\_\_\_\_ center-to-right \_\_\_\_\_ left-to-right \_\_\_\_\_

➤ **Oscilloscope observations:** Be sure to connect the center strip to Ground always.

peak-to-peak voltages: left-to-center \_\_\_\_\_ right-to-center \_\_\_\_\_

Amplitude (maximum magnitude of voltage)

$$V_{m1} = (\text{left-to-center})/2 \text{ _____ } V_{m2} = (\text{right-to-center})/2 \text{ _____}$$

Effective Voltage (average of AC voltage)

$$V_{\text{eff}_1} = V_{m1}/\sqrt{2} \text{ _____ } V_{\text{eff}_2} = V_{m2}/\sqrt{2} \text{ _____}$$

Do the observations by the multimeter correspond to the effective voltages from the oscilloscope observations? \_\_\_\_\_

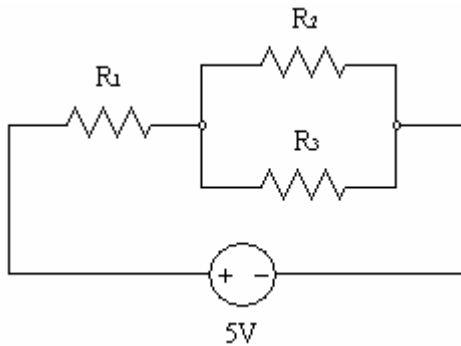
What is the period? \_\_\_\_\_ (⇐ Please be careful about the units.)

What is the frequency? \_\_\_\_\_ (Hz) ⇐ (This should be about 60 Hz.)

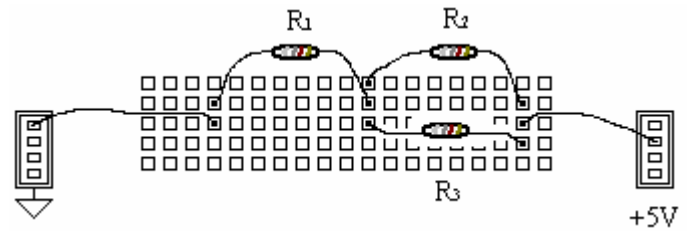
#### 4. Implementing circuits; measuring voltage and current

- Example:

Circuit diagram

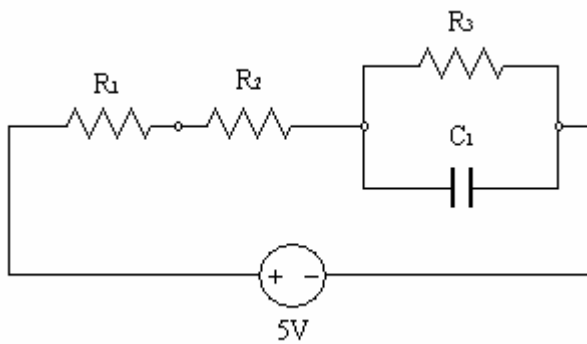


Actual connections



- Make the following circuit. (Draw the connections.)

Circuit diagram



Actual connections



- Measure the voltage and current. (Note: **Please follow the manual!**)

Voltage on the second resistor,  $R_2$  \_\_\_\_\_ (V)

Current flow of this circuit,  $I$  \_\_\_\_\_ (A)

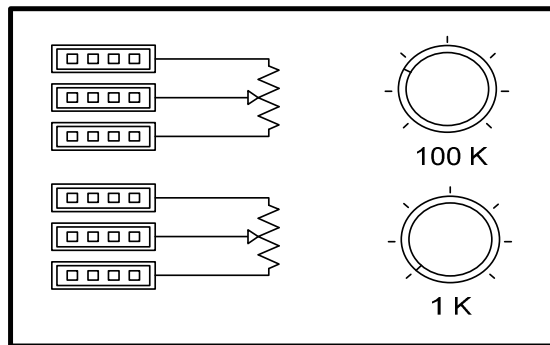
Did you succeed in measuring the voltage and current without burning the fuse in multimeter?

## Lab Procedure for Electronics Test Equipment

**Please turn off power of to the Circuit Design Trainer each time you put on and take off any wires to avoid damage to the device.**

### 1. Variable Resistors

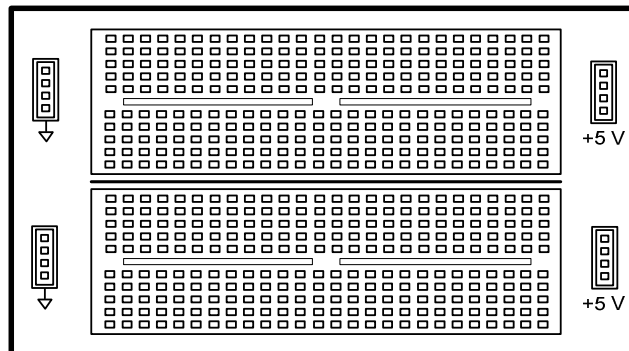
- **Keep the power off. Look for the variable resistors on the Circuit Design Trainer. Connect two wires to each strip in the positions of top-to-middle, middle-to-bottom, and top-to-bottom. Then measure the resistances for the specified cases with a multimeter.** You can find the variable resistors on the bottom right of the Trainer. You should change the resistors gradually, and see how much it will be altered.



### 2. DC Voltages

- **Connect the wires to ground and +5V, and turn on the power; then measure the voltage with a multimeter.**

The black wire of multimeter should be connected to Ground (the arrow represents ground in this section); otherwise, you will have negative voltages.

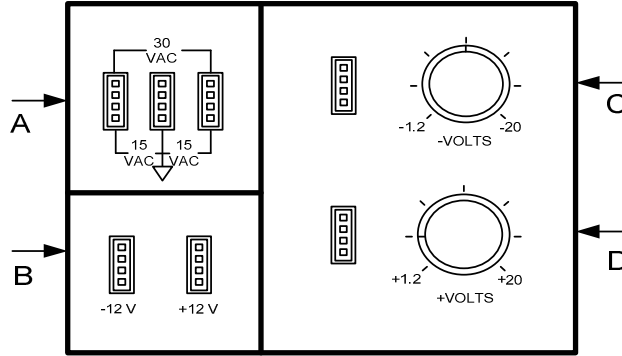


- **Connect the wires to ground and +12V or -12V, and turn on the power; then measure the voltage with the multimeter.**

Use section “B” in the following figure.

- **Connect the wires to ground and the variable DC voltage sources ( $\pm$ ), and turn on the power; then measure the voltage with multimeter.**

Use the “C “ and “D” in the following figure. This will be similar procedure to the first part of this lab (measuring variable resistors).



### 3. AC Voltages

- Find the AC voltage source (Section “A” in the above figure). Measure the voltages with the multimeter.**  
First select the AC mode on the multimeter. Measure the three cases, left-to-center, center-to-right, and left-to-right.
- Using oscilloscope, measure the peak-to-peak voltages (y-axis) for left-to-center and right-to-center.**  
 One calibration is 0.2 cm. Therefore, one square will be 1.0 cm. You will find the distance between peak-to-peak in centimeters, and multiply it by the indicated voltage in the VOLT/DIV dial. After this measurement, calculate the effective voltages. (Just follow the data sheet.)
- On the x-axis, find the period, which is the time to complete one cycle.**  
 You will find the distance between peak-to-peak in centimeters, and multiply it by the indicated time in the TIME/DIV dial.
- By following the data sheet, calculate the frequency.**  
 The frequency is 1/period. ( $f = 1/T$ )

### 4. Implementing circuits; measuring voltage and current

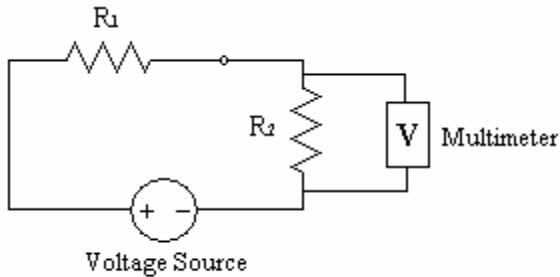
- First, look at the example on the data sheet.**  
 Each column has 5 holes. In the same column, those 5 holes are connected. However, different columns are disconnected from each other.
- Then, implement the next circuit.**  
 Draw the actual connections as the example shows.
- Measure the indicated voltage and current of the circuit that you implement. (Ⓜ Please ask the TA if you are not sure.)**  
 Please follow the manual provided on each table. Otherwise, you might burn the fuses in multimeter. (Be careful about it when you measure the current flow.)

### 5. Lab report

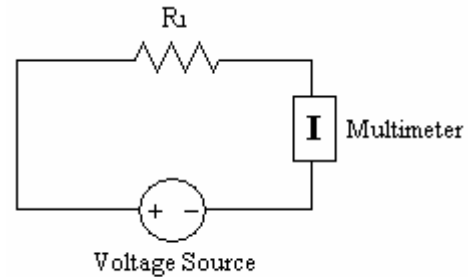
Please write down what you learned, and discuss if you obtained consistent results. If not, please state why.

## The manual of how to measure voltage and current

According to the electronics properties, one has to use a multimeter for measuring voltage and current with different alignments. Schematically, the following figures explain the alignments respectively.



**Fig 1**



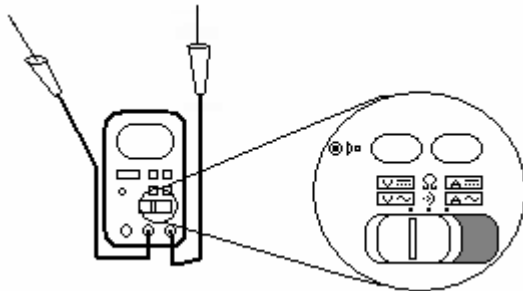
**Fig 2**

In figure 1, the voltage in resistor,  $R_2$ , is being measured. In figure 2, the current flow in the whole circuit is being measured. As you notice, when measuring voltage, you have to align the multimeter parallel with a specific circuit element (in this case, it is resistor,  $R_2$ ); and when measuring current, you have to connect the multimeter in series with respect to the circuit.

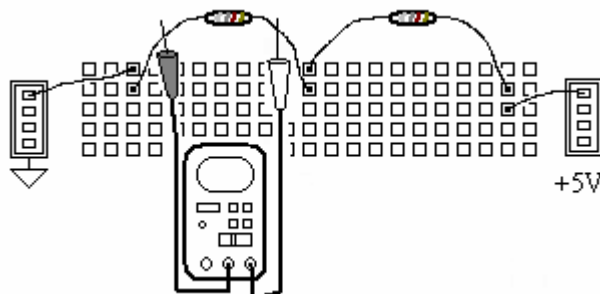
Now, following is the actual measurement of voltages and current flows with the circuits on the breadboard.

- **When measuring voltage, you will take the following steps.**

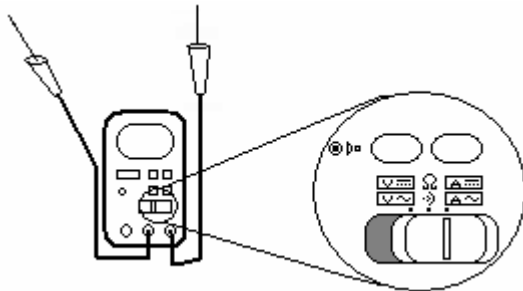
### 1. Select the mode first.



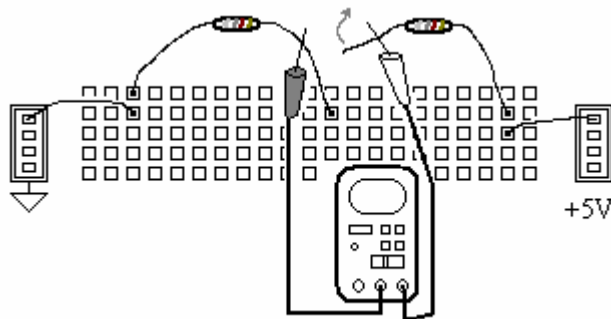
### 2. Measure the voltage (parallel).



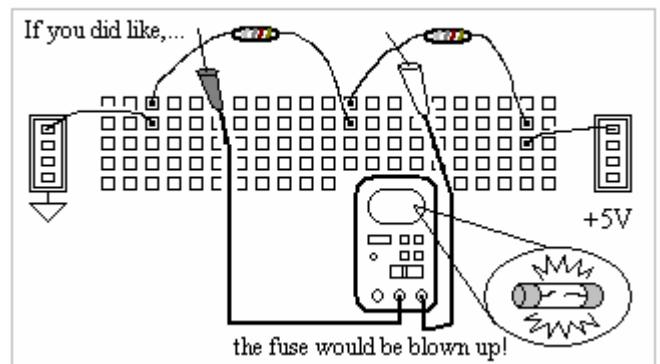
- When measuring a current, you will take the following steps.
  - Change the modes.



- Measure the current (series).



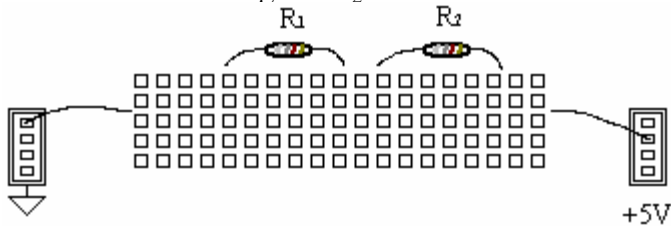
**Don't do this!!**



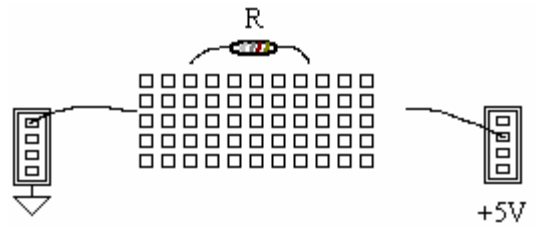
**? Quiz ?**

By sketching as above figures, complete the following measurements. (If necessary, draw the extension of the wires.)

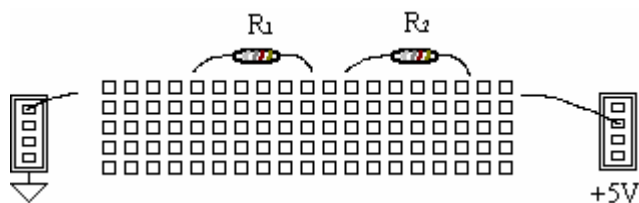
- ① Measure the voltage in  $R_2$ .



- ② Measure the current in  $R$ .



- ③ Measure the whole voltage for the series connection of  $R_1$  and  $R_2$ .



- ④ Measure the current in  $R_1$  for the parallel connection of  $R_1$  and  $R_2$ .

