Digital Multimeters

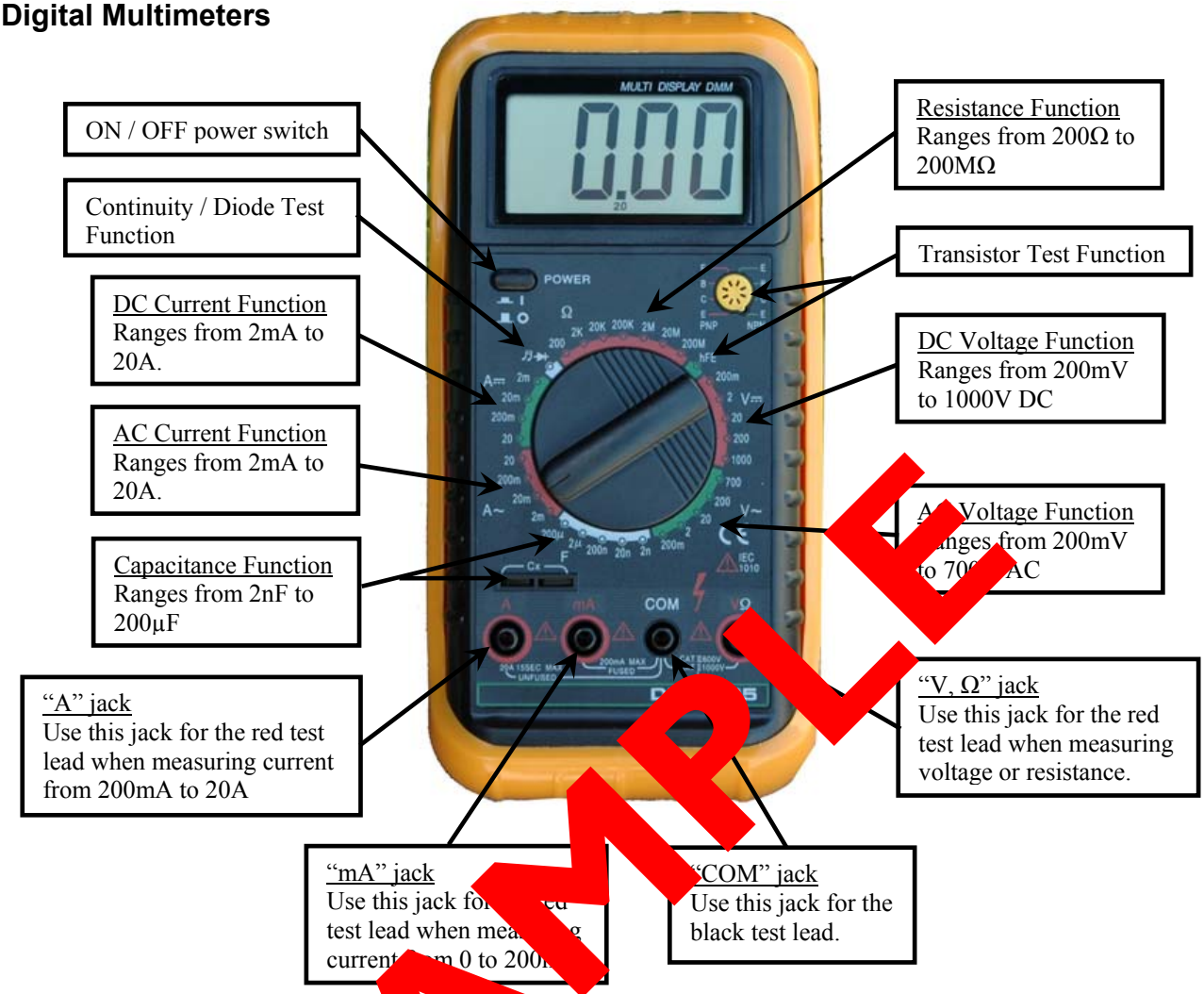


Figure P-1

Multimeters are very useful test instruments. By operating a multi-position switch on the meter they can be quickly and easily set to be used as a **voltmeter**, an **ammeter** or an **ohmmeter**. Some meters have additional features to measure capacitance and frequency as well. They have several settings called "ranges" for each type of meter and the choice of either alternating or direct current measurement.

Voltmeter

To test for voltage, first determine whether the application you're testing uses AC or DC voltage. Then set the dial to the appropriate function and plug the red test lead into the correct jack used to measure voltage.

Like all test procedures, when testing voltage, set the meter to the range just higher than the expected voltage and decrement it down as needed to increase the accuracy of the reading. If you don't know the expected range, set the range to the highest one available. Take the black test lead and place it on the negative polarity point of the circuit you want to measure. The red test lead will go on the more positive polarity point. When measuring voltage, the test leads of the meter must always be connected in **parallel** or "across" the component or circuit to be measured as in Figure P-2 on the next page.

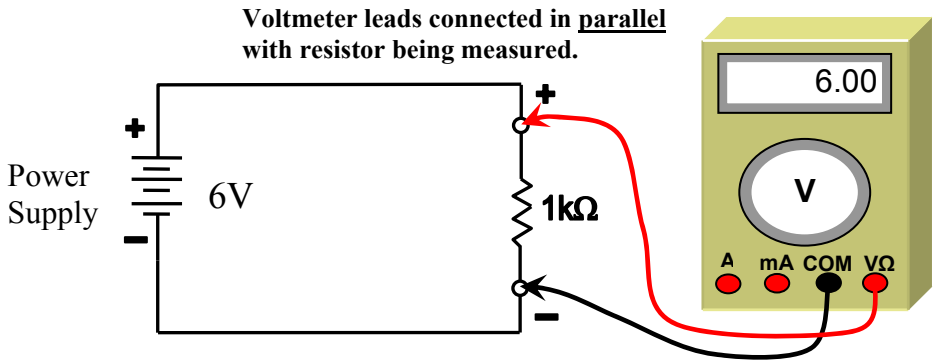


Figure P-2

Ammeter

To measure current, break the circuit where you want to take the reading. Set the meter to AC or DC current depending on the source being tested. Plug the test lead into the correct jack to measure the expected current.

Note: Most meters have a separate jack that needs to be used to measure current from 0 to 200mA and from 200mA to 10A or sometimes 20A.

Insert the meter in **series** or "in line" with the circuit to be measured by placing the red test lead on the positive polarity point and the black lead on the negative polarity point (see Figure P-3). Similar to the voltage, the correct current range needs to be selected. Start by selecting the next range higher than the expected reading. If the meter ever reads "0" when actual flow should be present, check the fuse for the 200mA port.

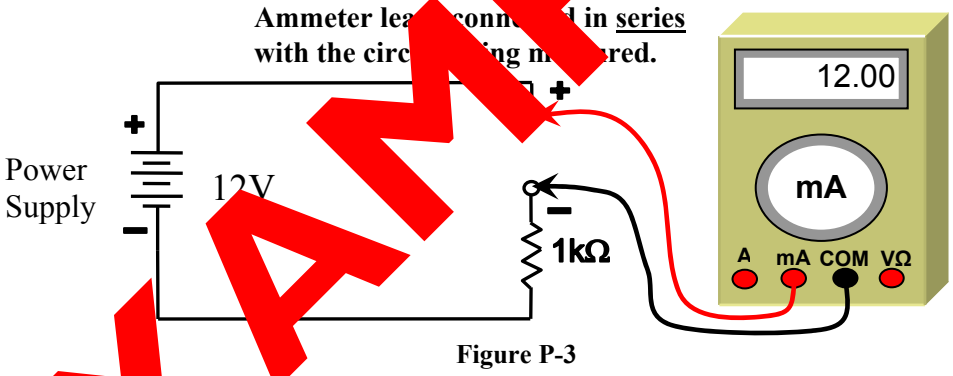


Figure P-3

Ohmmeter

To test for resistance, first remove the power from the circuit component to be tested. This prevents the meter from becoming damaged by the source. After ensuring that all power is off, set the dial to the resistance function. Select the appropriate range on the dial. Remove the component to be measured from the circuit (this prevents false readings from any other components in the circuit). Make sure the test leads are plugged into the correct jack to measure resistance. Connect your test leads to the component and read the reading.

It's important that you have good contact between the test leads and the component being tested. Dirt, oil and poor test lead connection can undesirably alter resistance readings.

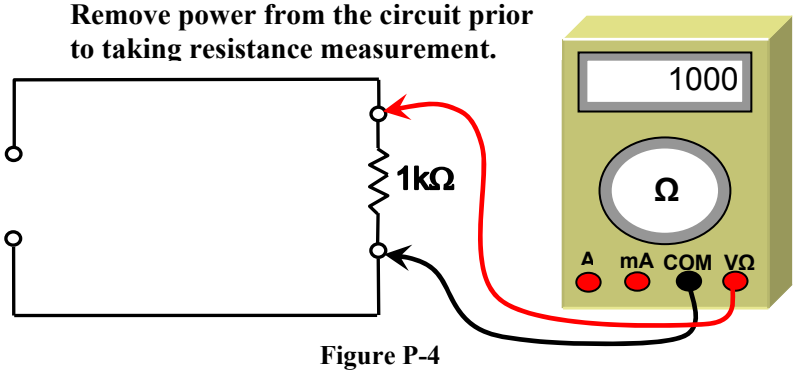


Figure P-4

The Elenco XK-700 Electronic Trainer

This guide will explain the basic operations and features of the Elenco electronic trainer that you will be using for the majority of the lab experiments in this course. Please take a few minutes to read through this guide and study the illustrations so you will become familiar with the different functions of this trainer.

In this user guide you will identify the five main sections of the trainer. You will also learn the purpose and the function of each section.

The five sections of this trainer are listed below. See Figure P-5 for a pictorial diagram of the trainer.

1. Power supply section
2. Variable resistance section
3. Function generator
4. Digital section
5. Breadboard section

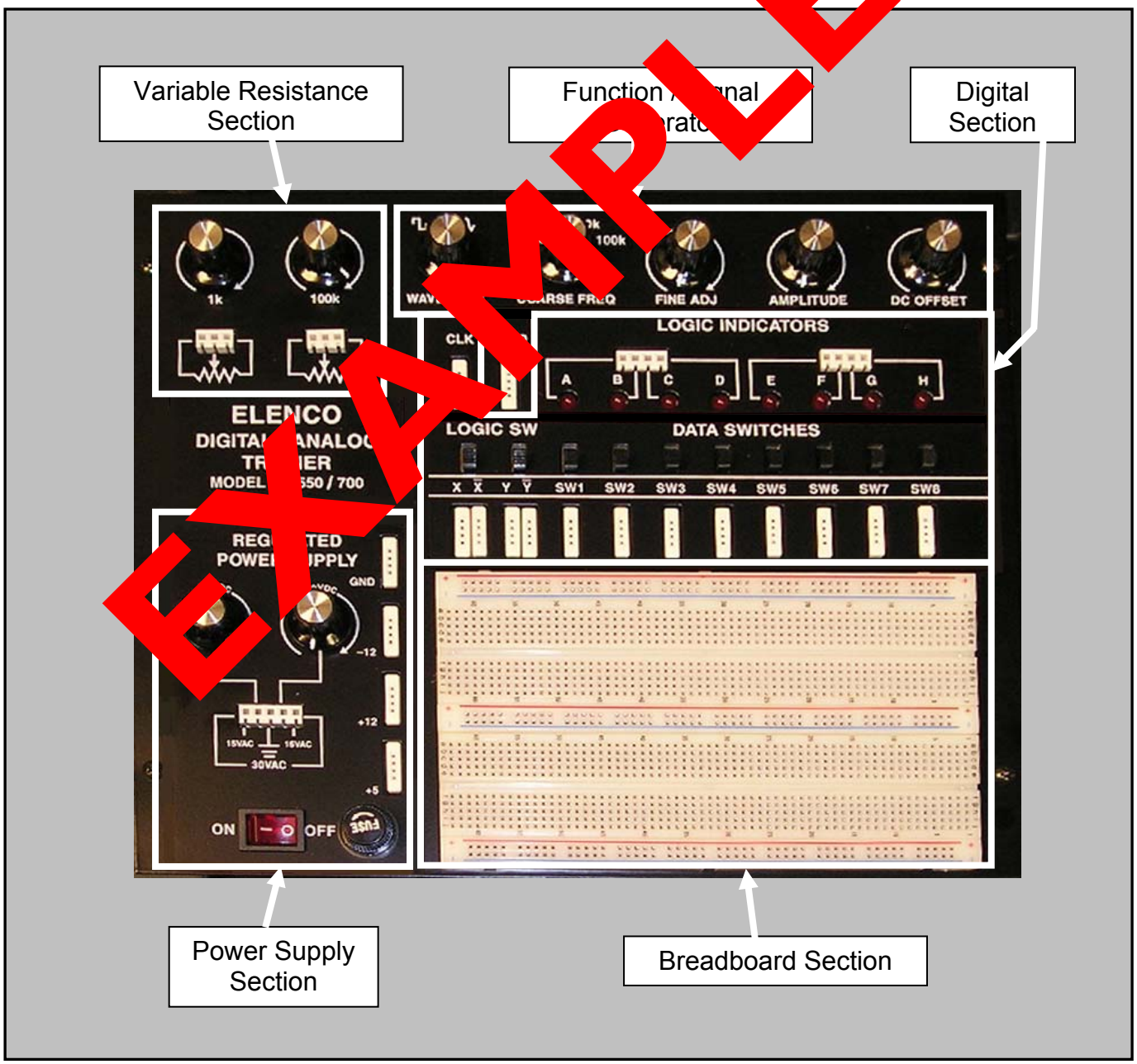


Figure P-5

Power Supply

The Elenco trainer has several built in DC power supplies to satisfy most electronic design needs.

The two variable DC power supplies produce up to +20 volts and -20 volts at 500 milliamps. Below 15v the available current is over 1 amp.

Three fixed power supplies produce +12vdc, -12vdc, or +5vdc at 1 amp each.

All of the power supplies are regulated to within 150 millivolts. In other words, if you increase the current draw from no load to 500 milliamps, the voltage will change less than 150 millivolts.

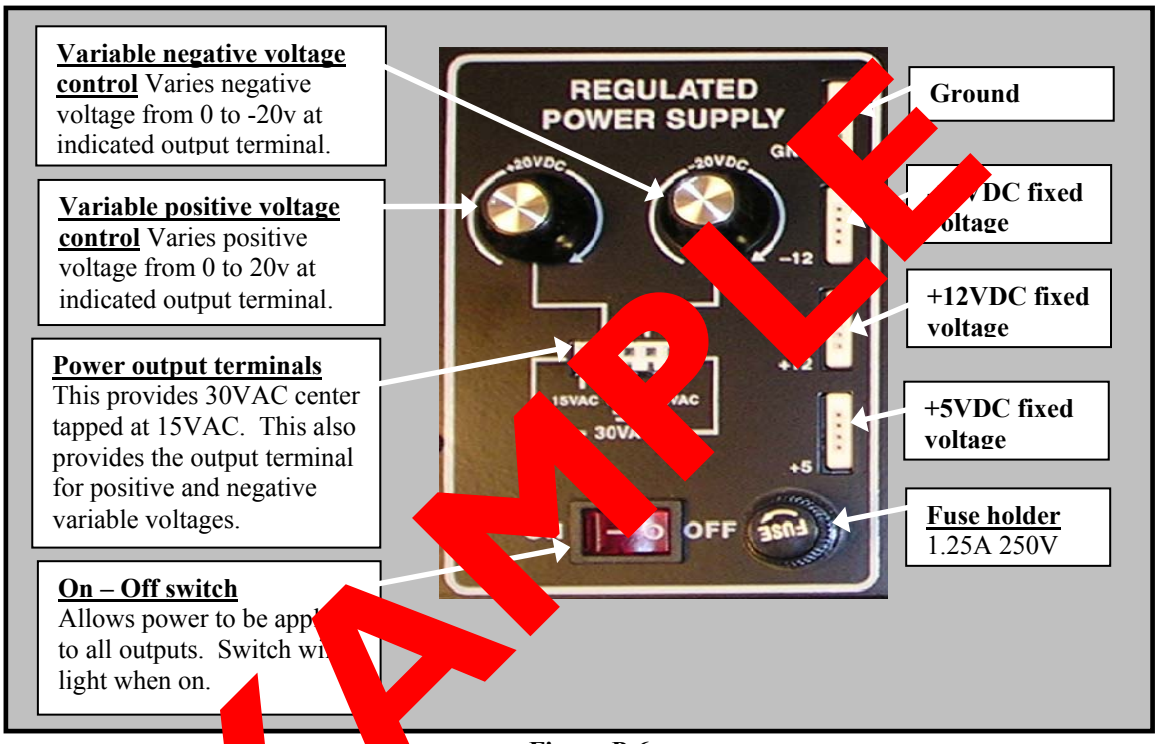


Figure P-6

A variety of different voltages are available at the trainer output terminals. Because the Elenco trainer uses both the +20v and -20v adjustable voltage controls, a combined voltage of up to 40vdc is possible. (See Figure P-7)

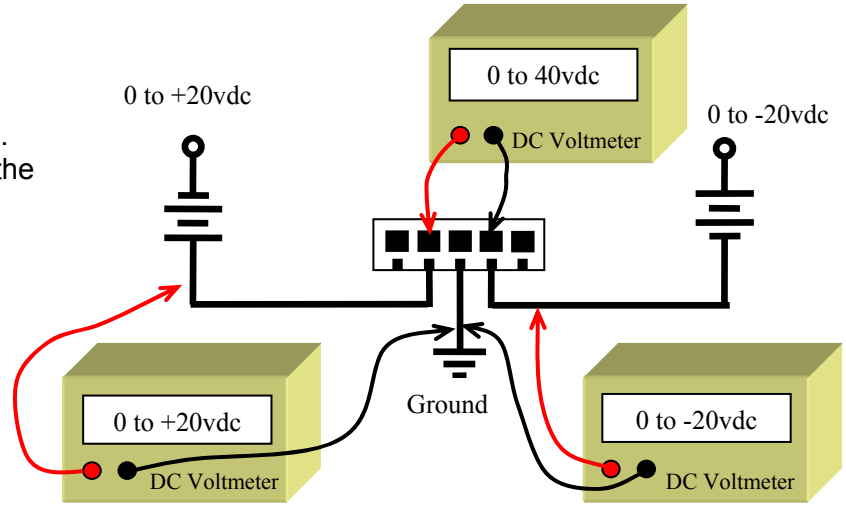


Figure P-7

The power supply section's output terminal block also allows for the stepped down AC voltage to be used direct from the center tapped transformer. The transformer provides a voltage of 30VAC from line to line or 15VAC from either line to the center tapped ground (See Figure P-8).

WARNING:
Do not short the 15 VAC output to ground!

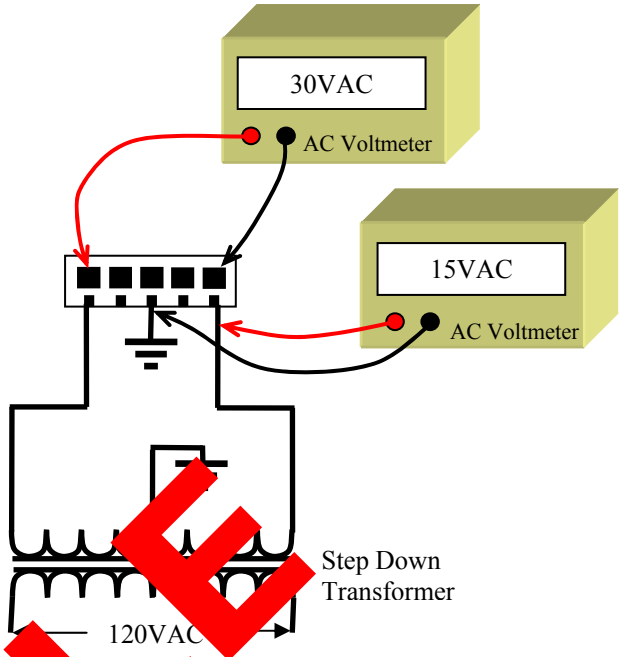


Figure P-8

Variable resistance section

The Elenco trainer has two built in variable resi[illegible] "potentiometers" that are available to use for certain lab experiments. The values of [illegible]e re[illegible]tors are 1k ohm and 100k ohm max. Taking a resistance measurement from one side o[illegible] terminal block to the other will give the full value of the resistor (1k ohm or 100k ohm) regardless o[illegible] position of the knob. If you take a measurement from either end of the terminal block [illegible] middle w[illegible]er connection, you will get a variable value that will change with respect to the posit[illegible] of t[illegible]ob. (See Figure P-10)

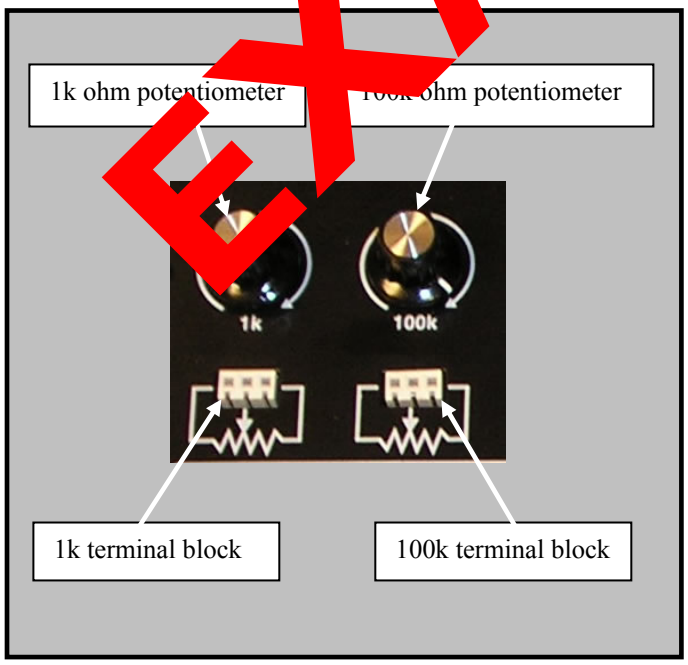


Figure P-9

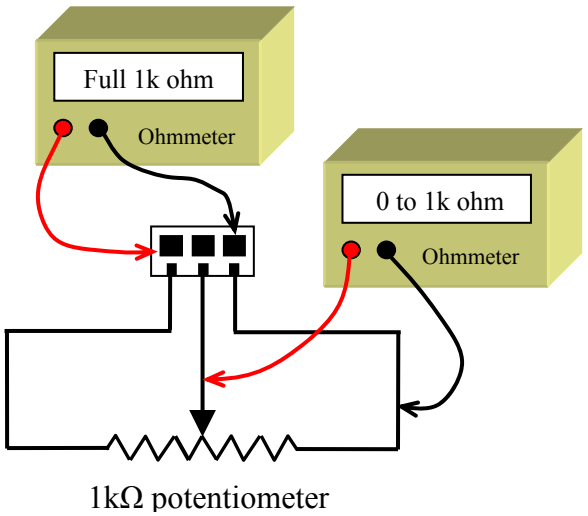


Figure P-10

Function / Signal Generator

The included function generator is capable of producing sine, square and triangle waveforms. The frequency of this generator is variable from one hertz to over 100,000 hertz in the following five ranges: 10-Hz, 100-Hz, 1-kHz, 10-kHz and 100-kHz. A fine adjustment control makes for easy selection of any frequency between these ranges. The output voltage amplitude is variable between 0 and 15-V_{P-P}. The output of the function generator may be taken from the terminal marked "FREQ" with respect to a ground terminal in the power supply section.

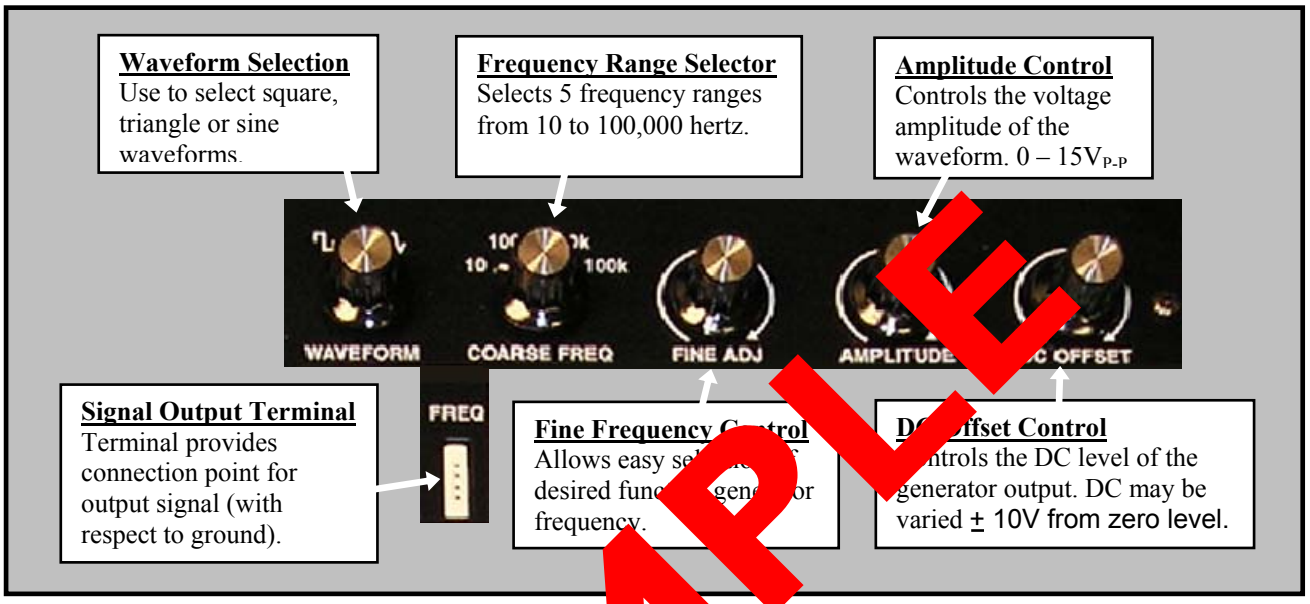


Figure P-11

Digital Section

The digital section of the trainer consists of two "no bounce" logic switches, 8 LED indicator lamps, 8 data switches and a clock generator. The clock generator output is a 5V pulsating square wave. The frequency of the pulsations can be adjusted with the frequency range selector and fine frequency control in the function generator section.

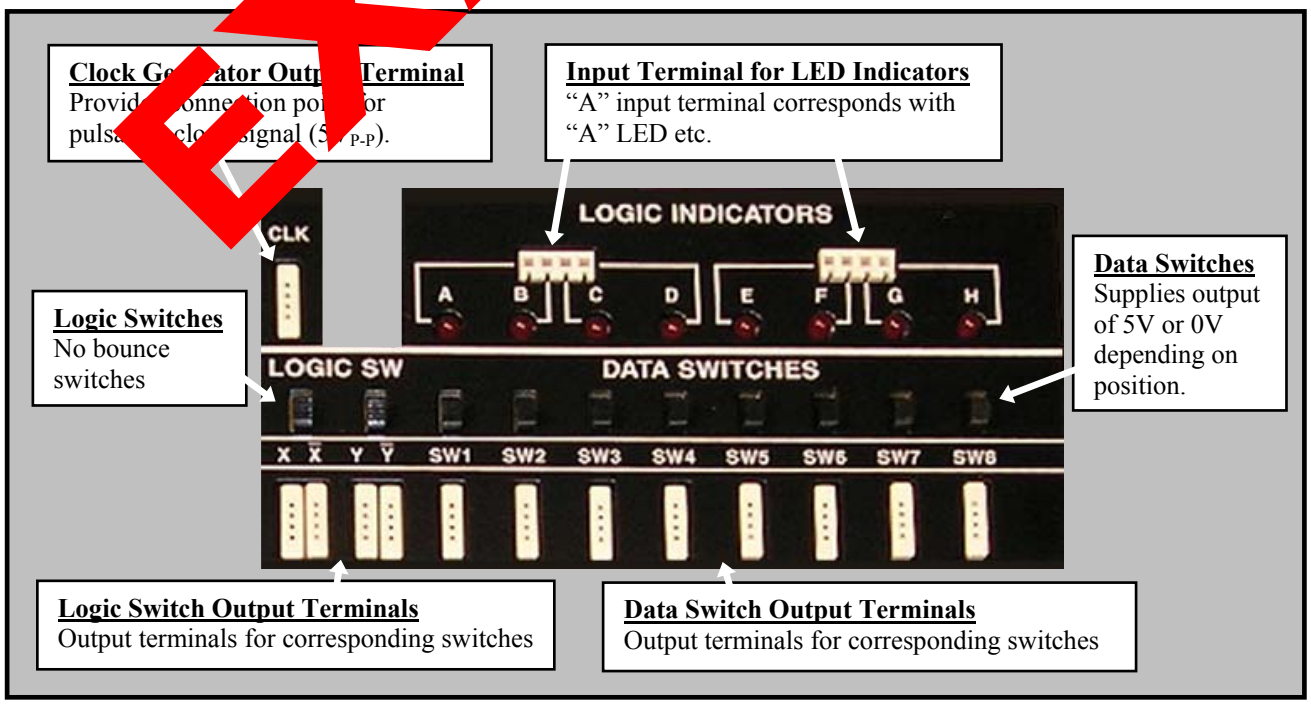


Figure P-12

Breadboard Section

The Elenco trainer is equipped with two breadboards containing a total of 1660 tie points including 6 independent bus lines.

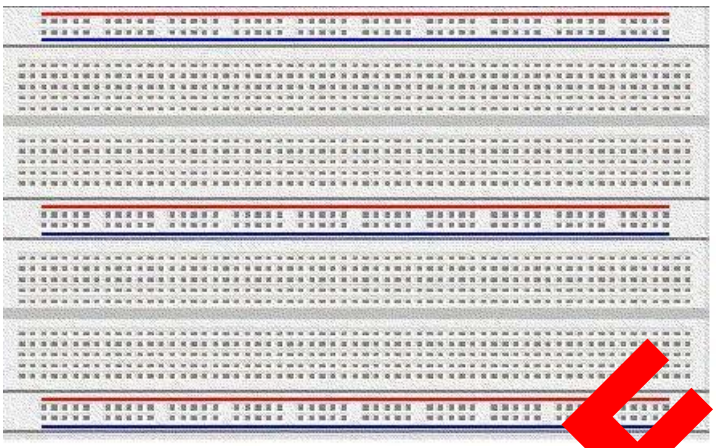


Figure P-13

The board is made of plastic with a matrix of holes. Wires and component leads can be pushed into the holes to make appropriate connections. Each "hole" on the board contains a metal spring contact. When a wire or component lead is pushed down into the hole an electrical connection is made with that hole's spring contact.

The breadboards provide an interconnection between certain holes on the board using metallic "bus" connections made underneath the surface. These holes are internally connected so that each 50 hole horizontal bus line is independent from the others and each small 5 hole vertical bus line is also connected independently. Figure P-14 shows the internal connections of the holes on the breadboard.

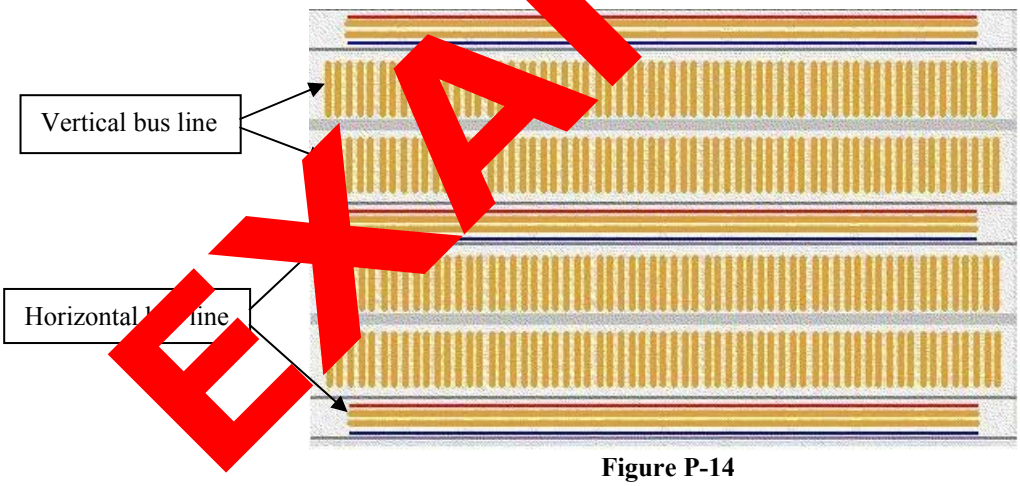
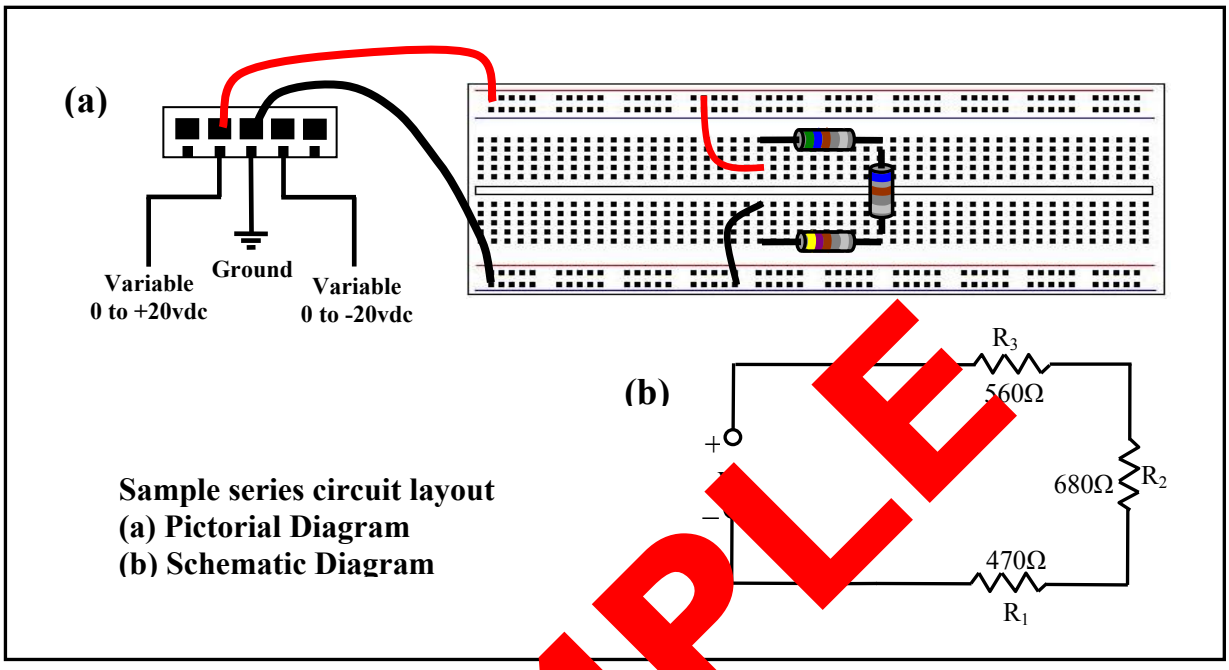


Figure P-14

Because of the built-in interconnections and the typical circuit board layout, some of the following techniques are commonly used when working with a breadboard.

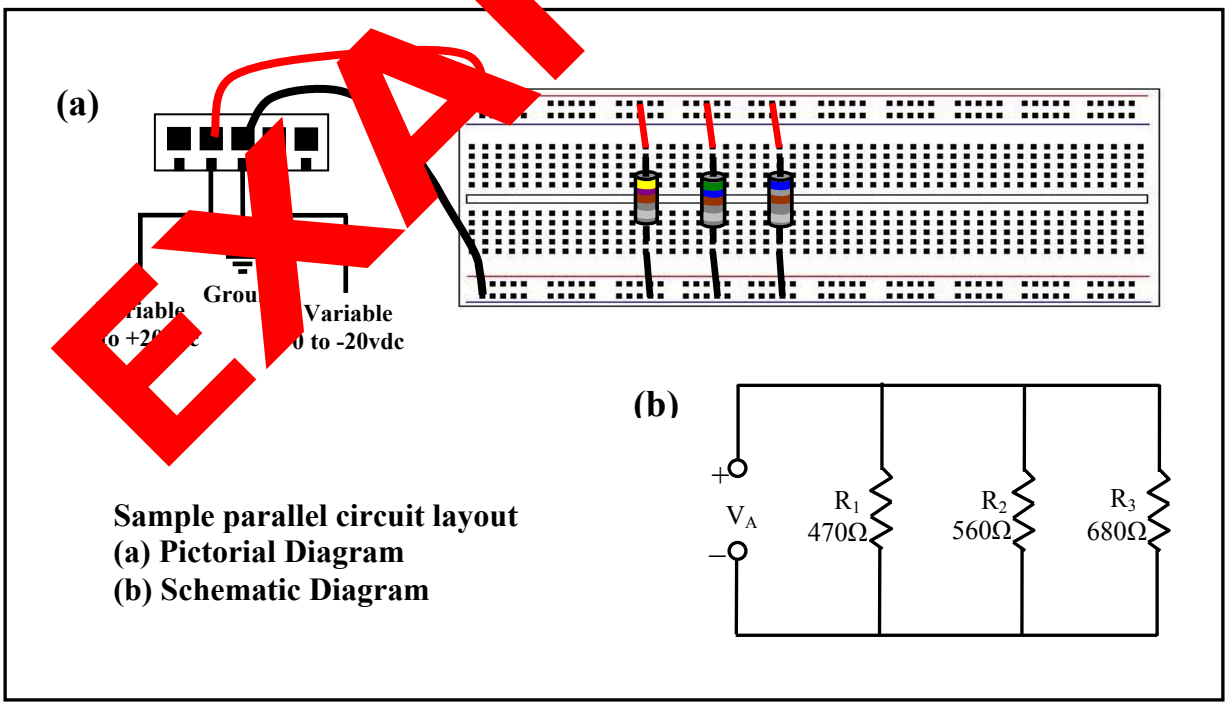
- A jumper wire can be used to connect the positive source lead to one of the horizontal buss lines marked with a "plus" (+) sign.
- Another jumper wire can be used to connect the negative source lead or GND to one of the horizontal buss lines marked with a "minus" (-) symbol.
- A short jumper wire can then be used to connect each horizontal source connection row to the appropriate point(s) in the circuit on the vertical bus line portion of the board.
- When connecting component leads, plug one lead of a component into a vertical column hole and the other lead of the component into another vertical column hole in a separate bus line. Connect the component, spaced as necessary for the size of the component.

Figures P-15 & P-16 are sample series and parallel circuit connections using a breadboard. These are just a small sample of the many different methods and combinations for connecting circuits using breadboards. These examples are shown using the positive variable voltage supply.



Sample series circuit layout
(a) Pictorial Diagram
(b) Schematic Diagram

P-15



Sample parallel circuit layout
(a) Pictorial Diagram
(b) Schematic Diagram

Figure P-16