

USING A MULTIMETER TO MEASURE ELECTRICITY

OBJECTIVES

1. Students will learn what types of measurements can be performed with a multimeter and which selector switch position should be used for each different type of measurement.
2. Students will learn which test lead is for positive polarity, which test lead is for negative polarity and how to tell which port each test lead should be inserted into to perform each type of measurement.
3. Students will be able to use a multimeter to perform a measurement of the voltage from a battery.
4. Students will be able to use a multimeter to perform a measurement of the electrical current from a battery.

BACKGROUND INFORMATION

It is important to be able to determine how much electricity is present in electrical circuits and devices. Electrical devices typically require specific voltages and electrical currents to operate properly and the electricity in electrical circuits can be hazardous. For example, many cellular telephones require 5 volts for recharging, most automobiles require a battery that delivers 12 volts and microwave ovens typically require 120 volts and at least 5 amperes of electrical current. Standard electrical outlets provide electricity at a voltage 120 volts and may provide as much as 20 amperes of electrical current. If a sufficient voltage is present, electrical currents as small as 50-150 milli-amperes can be extremely painful and even lethal.

One of the most common and simplest instruments used to make measurements of electricity is known as a multimeter. A multimeter is an instrument that combines several different types of electrical measurement functions in a single device. Multimeters are typically capable of performing measurements of voltage, electrical current and resistance and may also be referred to as a VOM (volt-ohm-milliammeter). A Velleman DVM810 Multimeter is shown in Figure 1.

Modern multimeters have a digital display to show the results of measurements but older models may have an analog meter display with several different printed scales. Most multimeters have a large knob that is used to turn the instrument on or off and which serves as a function selector switch to choose the type of measurement to be performed. The function switch also allows selection of different ranges of measurement units such as amps, milli-amps, microamps, volts, and milli-volts. A summary of the primary kinds of measurements which can be made using the Velleman DVM810 Multimeter and the measurement units is shown in Figure 2.

Letters and symbols are used to denote the type of measurements that can be performed and the measurement scale for a particular type of measurement.

Figure 1. Velleman DVM810.

- The white colored "V" with the wavy line beside it (V ~) near the upper right side indicates AC voltage measurement.

- The white colored "V" with the dotted and solid lines beside it (V ---) near the upper left side indicates a DC voltage measurement.

- The green colored "A" with the dotted and solid lines beside (A ---) it indicates a DC current measurement. (Difficult to see.)

- The white "m" on the left side below the white V with the dotted and solid lines indicates DC voltage measurement in millivolts (1×10^{-3} volts, one thousandth of a volt).

- The green colored "Ω" omega symbol near the lower left side indicates a resistance measurement.

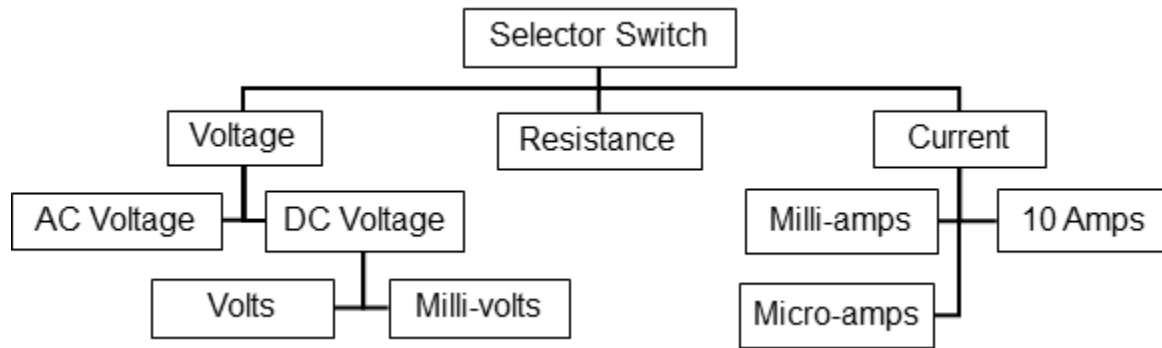
- The green "m" on the right side below the green A with the dotted and solid lines indicates DC current measurement in milliamps (1×10^{-3} amps, one thousandth of an amp).

- The green "μ" mu symbol on the right side below the green A with the dotted and solid lines indicates DC current measurement in micro-amps (1×10^{-6} amps, one millionth of an amp).

- The red "10A" with the dotted and solid lines beside it indicates a DC current measurement using a 10 amp scale.



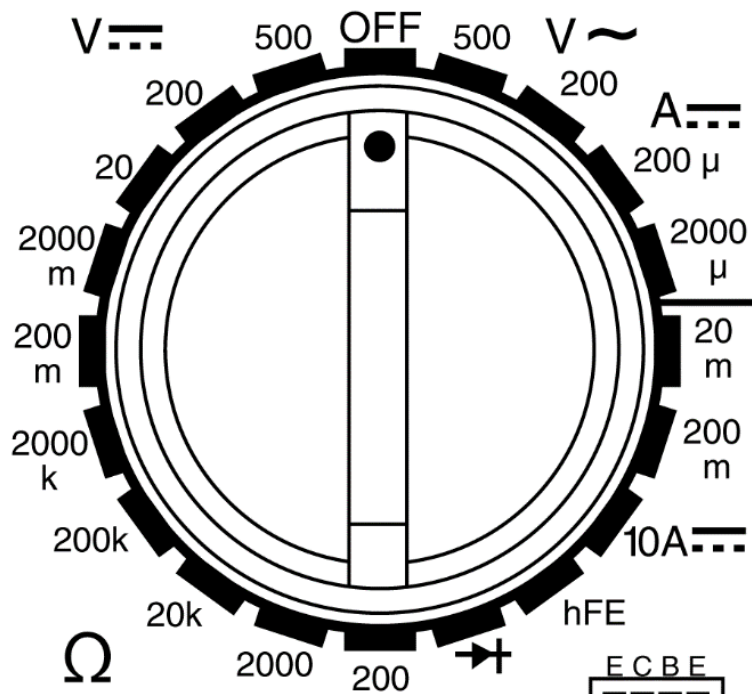
Figure 2. DVM810 Measurement Summary.



Measurement scales represent ranges of measured values from zero up to a maximum amount. For example, it is safe to measure DC electrical voltages between 0 volts and 20 volts when the dot on the selector switch is positioned at the 20 V DC scale setting which is located on the upper left hand side of switch.

Figure 3. Velleman DVM810 Selector Switch Shown with Switch in OFF Position.

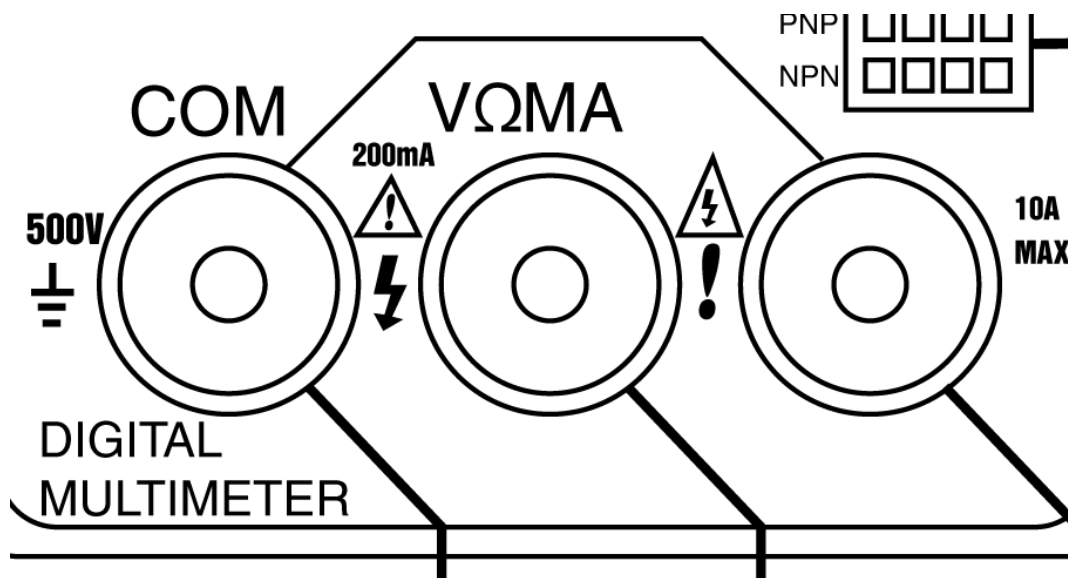
- DC voltage measurement scales include, 500 volts, 200 volts, 20 volts, 2000 milli-volts and 200 milli-volts.
- AC voltage measurement scales include 500 volts and 200 volts.
- DC current measurement scales include 200 micro-amps, 2000 micro-amps, 20 milli-amps and 200 milli-amps.
- A 10 amp DC current measurement scale is at the lower right side.



Most multimeters have several ports into which test leads can be inserted. The Velleman DVM810 has three ports at the bottom of the unit which are labeled by type of measurement to be made to help determine which ports should be used.

- Typically a black colored or negative polarity test lead is inserted into a port labeled "COM" which is an abbreviation for common port. When performing measurements the black colored test lead should always be inserted in the COM port.
- A red colored or positive polarity test lead is inserted into one of the remaining ports which are labelled to indicate what types of measurements can be performed when the test lead is in a particular port.
- When using the Velleman DVM810, the red or positive polarity test lead should be inserted into the center port labelled $V\Omega MA$ when performing all measurements on all voltage scales and all current scales less than or equal to 200 milli-amps.
- The red or positive polarity test lead should be inserted into the right port labelled 10A MAX only when making measurement with the function switch set on the 10 A current scale.

Figure 4. Ports at the Bottom of the Velleman DVM810.



Some multimeters have "auto-ranging" capability which means that they can automatically select the proper measurement scale for a particular type of measurement. Most inexpensive multimeters require that you use the function selector switch to manually choose a measurement scale. When choosing the scale for a measurement, always select a scale with a range that has a maximum value greater than the value you expect to actually measure. To obtain the greatest measurement accuracy choose the scale with the smallest range that encompasses the value you expect to measure. For example, you wish to measure the voltage from a AA battery which is known to have a voltage of approximately 1.5 volts. The following table shows some expected results.

actual battery voltage	DC voltage measurement scale	multimeter indicated voltage
1.5 volts	0 - 200 m (milli-volts)	scale too small could damage meter
1.5 volts	0 - 2000 m (milli-volts)	acceptable scale meter display shows 1564 milli-volts
1.5 volts	0 - 20 volts	acceptable scale meter display shows 1.56 volts
1.5 volts	0 - 200 volts	scale unnecessarily large meter display shows 1.6 volts
1.5 volts	0 - 500 volts	scale unnecessarily large meter display shows of 2 volts

Which measurement scale should you choose? The 0 -2000 milli-volt scale would be expected to give the greatest accuracy but the 0 - 20 volt scale with units of volts may be easier for students to use.

WARNINGS:

- 1. Do not attempt to measure voltages or currents that exceed the scale range or the multimeter may be damaged.**
- 2. Do not attempt to measure electrical currents in alternating current (AC) circuits or the multimeter may be damaged.**