

## Lab 3.1.2 Voltage Measurement – Instructor Version



### Objective

- Demonstrate the ability to measure voltage with the multimeter safely.

### Background

The digital multimeter is a versatile testing and troubleshooting device. This lab covers both direct current (DC) and alternating current (AC) voltage measurements. Voltage is measured in either AC or DC volts, indicated by a V. Voltage is the pressure that moves electrons through a circuit from one place to another. Voltage differential is essential to the flow of electricity. The voltage differential between a cloud in the sky and the earth is what causes lightning to strike.

**Note:** It is very important to be careful when taking voltage measurements to avoid an electrical shock.

**Direct current (DC):** DC voltage rises to a set level and then stays at that level and flows in one direction, positive or negative. Batteries produce DC voltage and are commonly rated at 1.5v or 9v and 6v. Typically, the battery in a car or truck is a 12v battery. When an electrical “load” such as a light bulb or motor is placed between the positive (+) and negative (-) terminals of a battery, electricity flows.

**Alternating current (AC):** AC voltage rises above zero, positive, and then falls below zero, negative. AC voltage changes direction very rapidly. The most common example of AC voltage is the

wall outlet in a home or business. In North America, these outlets provide approximately 120 volts of AC directly to any electrical appliance that is plugged in. Examples of appliances are a computer, toaster, or television. Some devices, such as small printers and laptop computers, have a small black box called a transformer, that plugs into a 120V AC wall outlet. The transformer converts the AC voltage to DC voltage for use by the device. Some AC outlets can provide a higher voltage of 220V for use by devices and equipment with heavier requirements, such as clothes dryers and arc welders.

Prior to starting the lab, the teacher or lab assistant should have one multimeter available for each team of students, and various items for testing voltage. Work in teams of two. The following resources will be required:

- Fluke 110, 12B, or equivalent multimeter
- An assortment of batteries: A cell, C cell, D cell, 9 Volts, 6 V lantern
- Duplex wall outlet, typically 120v
- Power supply for laptop or other networking electrical device

**The following resources are optional:**

- A lemon with a galvanized nail stuck in one side and a piece of uninsulated copper wire stuck in the opposite side
- Solar cell with leads attached
- Homemade generator, wire wound around a pencil 50 times and a magnet

## Step 1 Select the Proper Voltage Scale

The method of selecting the voltage scale will vary depending on the type of meter. The Fluke 110 has two separate positions for voltage, one position with a wave over it for AC and one position with a solid and dashed line above it for DC. With the Fluke 12B, move the rotary selector to the V symbol for voltage, black V, in order to be able to measure voltage. Press the button that has the VDC and VAC symbol to select between direct current (DC) and alternating current (AC) measurements.

**direct current measurements:** The screen will show a V, for voltage, with a series of dots and a line over the top. There are several scales available depending on the voltage to be measured. They start from millivolts to voltages up to hundreds of volts. Millivolts is abbreviated mV = 1000th of a volt. Use the Range button to change the range of DC voltage to be measured based on what voltage is expected to be measured. Batteries less than 15 volts can typically be measured accurately with the VDC scale and 0.0 range. DC voltage measurements can be used to determine if batteries are good or if there is voltage coming out of an AC adapter. These are common and are used with hubs, modems, laptops, printers, and other peripherals. These adapters can take wall outlet AC voltage and step it down to lower AC voltages for the device attached or can convert the AC voltage to DC and step it down. Check the back of the adapter to see what the input, AC, and output voltages, AC or DC, should be.

**alternating current measurements:** The screen will show a V, for voltage, with a tilde (~) after it. This represents alternating current. There are several scales available depending on the voltage to be measured. They start from millivolts to voltages up to hundreds of volts. Millivolts is abbreviated mV = 1000th of a volt. Use the Range button to change the range of AC voltage to be measured based on what voltage is expected to be measured. Voltage from power outlets 120v or greater can typically be measured accurately with the VAC scale and 0.0 range. AC voltage measurements are useful in determining if there is adequate voltage coming from an AC outlet to power the equipment plugged in.

## Step 2

Use a Fluke 110, 12B or equivalent multimeter to measure the voltage of each of the following. Be sure to turn the meter off when finished.

Item to Measure the Voltage Of	Set Selector and Range Scale to	Voltage Reading
Batteries: A cell (AA, AAA), C cell, D cell, 9 Volts, 6 V lantern	<u>Answers will vary. For Fluke 12B, selector is set to V, VDC is selected with button on left, and range is 0.0 V. For Sperry DM-350A, set selector to 20 DCV for 6 or 9 V batteries, and 2 DCV for other batteries. For other meters requiring a range scale, set to the next voltage level above what is being measured (see next column).</u>	<u>Answers will vary. A, AA, AAA, C, and D cell batteries are all 1.5 V batteries. Fresh batteries will read at or above their specified voltages. Older batteries will read less than their specified voltages.</u>
Duplex wall outlet (typically 120v) <b><u>This portion of the lab should be performed ONLY by the instructor! Performing it incorrectly could severely damage the multimeter and may be hazardous to the students.</u></b>	<u>Answers will vary. For Fluke 12B, selector is set to V, VAC is selected with button on left, and range is 0.0 V. For Sperry DM-350A, set to 600 ACV. Use caution when instructing students to measure wall outlet voltages!</u>	<u>Answers will vary between 120 and 150 volts.</u>
Power supply (converts AC to lower AC or DC) for laptop, mobile phone, or other networking electrical device	<u>Answers will vary. Most power supplies will output a DC voltage, but be careful to select an AC voltage position if the power supply outputs AC. For Fluke 12B, selector is set to V, VDC or VAC is selected with button on left, and range is 0.0 V. For other meters requiring a range scale, set to the next voltage level above what is being measured. The power supply should have text on it that indicates its voltage level.</u>	<u>Answers will vary depending on what is being measured. Answers should be within 5% of voltage specified on power supply.</u>
(Optional) A lemon with a galvanized nail stuck in one side and a piece of uninsulated copper wire stuck in the opposite side	<u>Answers will vary. For Fluke 12B, selector is set to V, VDC is selected with button on left, and range is 0.0 V. For other meters requiring a range scale, use a VDC position between 2 and 5 volts.</u>	<u>Answers will vary, but will typically be less than 1 V.</u>

## Reflection

Why might it be important to measure voltage when troubleshooting a network?

It might be useful to check wall outlet voltage to determine if an outlet is bad, or to check power supply voltage on a power supply used for networking equipment.