Digital Multimeter Operations

Digital Multimeter (DMM)

The digital multimeter (DMM) operations are important to understand in order to take accurate measurements without damaging the DMM device. Multimeters measure three different qualities of a circuit: voltage, current, and resistance. These qualities, their symbols, and their basic units of measurement are summarized in Table 1. A typical DMM is pictured in Figure 1.

Table 1. The qualities, symbols, and units of measurement for a DMM.

Measurement	Unit	Symbol
Voltage *V*	Volt	V
Current *I*	Ampere	A
Resistance *R*	Ohm	Ω

Note: *Even if the DMM in Figure 1 looks different than the DMM provided in your kit, the electronic features are similar and the procedures will be the same.*

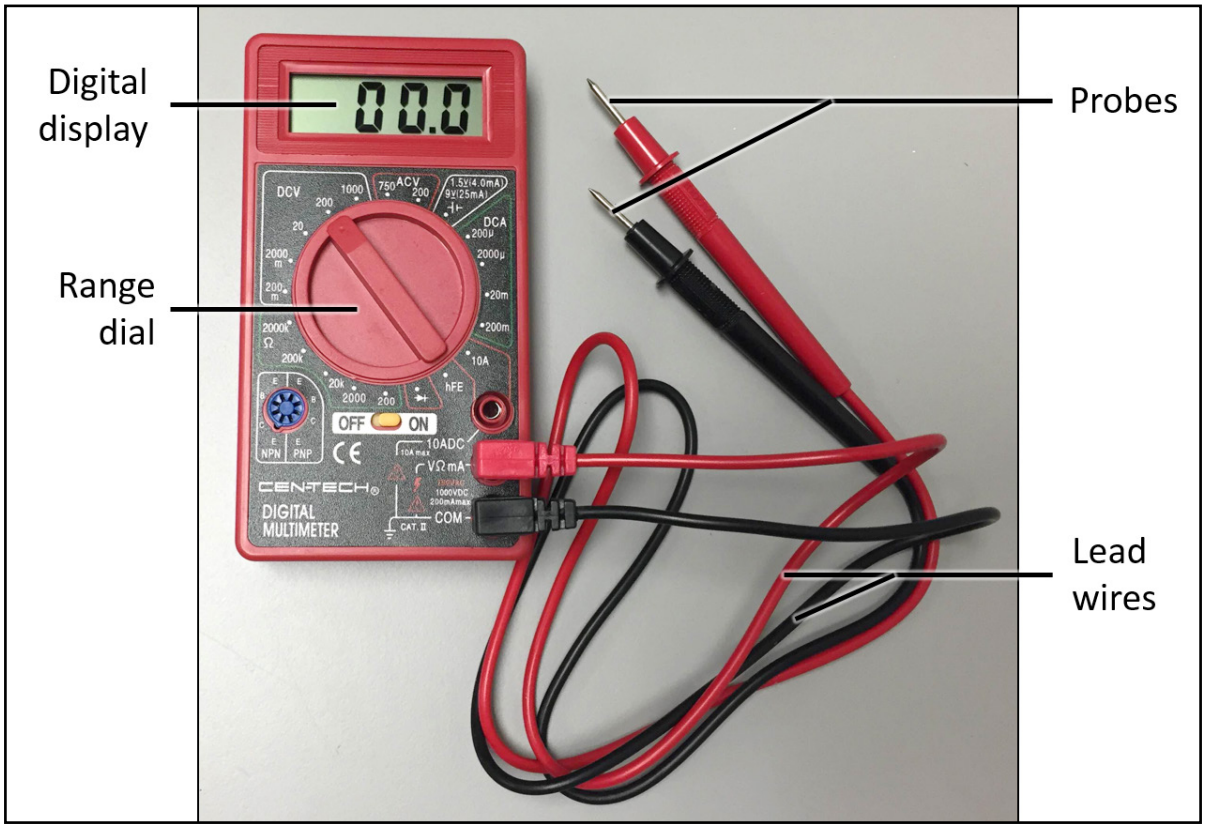

Figure 1. Digital multimeter.

Lead Wires

Lead wires, also known as test wires, must be connected correctly. The black lead will be connected to the terminal labeled *COM* for common, also called ground. The red lead must be connected to the corresponding terminal for the measurement being taken. The terminal labeled *VΩmA* (V = volt; Ω = ohm; mA = milliampere) measures voltage, resistance, or direct current. The *10ADC* terminal measures direct current (DC) above 200 mA. Detailed instructions as to when to use the lower amperage terminal versus the higher amperage terminal for the red lead are provided below.

Always read multimeter instructions carefully to ensure that the lead wires are plugged into the correct terminals.

Basic Operations

The DMM has a circular range dial that must be in the proper position for the operation being performed.

The range dial has the following positions, which may vary between models:

- ACV – Measures alternating current (AC) voltage; settings: 200 V and 750 V
- DCA – Measures DC voltage; settings: 200 μA, 2000 μA (2 mA), 20 mA, 200 mA (0.2 A)
- 10A – Measures DC greater than 200 mA (the red lead must be connected to the *10ADC* terminal for this setting)
- hFE – Measures transistor values
-  – Measures diode voltage drop
- Ω – Measures resistance; settings: 200 Ω, 2000 Ω, 20 kΩ, 200 kΩ, 2000 kΩ
- DCV – Measures DC voltage; settings 200 mV, 2000 mV (2V), 20 V, 200 V, 1000 V

Maintenance

- Always turn off the DMM when the measurements are completed. Otherwise, the DMM battery will be drained and will have to be replaced.
- Remove the battery when the DMM is not in use for prolonged periods of time.
- Store the unit in a dry location.
- The lab kit DMM has no replaceable parts other than the battery and the fuse.

Battery or Fuse Replacement

- Remove the lead wires from the DMM and ensure that the power is switched to *OFF*.
- Turn the unit over and remove both screws with a screwdriver.
- Remove the back cover and set the screws aside.
- Locate the battery and the fuse, as shown in Figure 2.

Figure 2. The back cover of the DMM removed to show the location of the battery and fuse.

- Replace the fuse if the wire inside the clear cylinder is broken. Use the 250-mA fast-acting replacement fuse that is included in the lab kit.
- Replace the battery with a new 9-V battery if necessary.
- Reattach the cover and tighten the screws.

Basic Instructions for Using the DMM as a DC Voltmeter

IMPORTANT! Follow instructions as directed in the experimental procedures. The following are generalized procedures that may be used supplementary to the detailed instructions in experiments containing a DMM device.

To measure voltage difference, the DMM leads are connected to the ends of the component(s) while the circuit is energized. Connect the positive red lead to the positive (+) end of the battery and the negative black lead to the negative (-) end of the battery.

1. Turn the range dial to the appropriate DCV setting. **The setting selected must be higher than the quantity of expected volts or the DMM fuse may blow.** For example, set the dial to the 2 V setting for a 1.5-V system, and set the dial to the 20 V setting for a 9-V system. If you do not know the range of the value, begin with the highest range and switch to a lower range as necessary. Selecting the appropriate setting will prevent damage to the multimeter.
2. Plug the red lead into the *VΩmA* terminal. Plug the black lead into the *COM* terminal.
3. Turn on the DMM.
4. To measure the voltage, carefully touch the appropriate points on the circuit with the tips of the multimeter probes.
5. Record the measurement.
6. Turn off the DMM when testing is complete.
7. Remove the lead wires and store the DMM.

Basic Instructions for Using the DMM as an Ohmmeter

To measure the resistance of a component, such as a resistor, the component must be disconnected from the circuit. If the component is attached to the circuit the measurement will be incorrect. The multimeter may also be damaged if the component is attached to the circuit and the circuit is energized. **This is the only DMM reading that requires the circuit to be disconnected.** Circuit resistance may be measured up to 2000 kΩ.

1. Turn the range dial to an ohm setting higher than the expected ohms. For example, set the range dial to the 200 Ω setting for a 100-Ω resistor.
2. Plug the red lead into the *VΩmA* terminal. Plug the black lead into the *COM* terminal.
3. Turn on the DMM.
4. Touch the probes together. The meter should read close to 0 Ω.
5. Carefully touch the appropriate points on the circuit with the probe tips to measure the resistance.
6. If the reading is “1,” set the range dial to the next higher ohm position and measure the resistance again.
7. Record the measurement.
8. Turn off the DMM when testing is complete.
9. Remove the lead wires and store the DMM.

Basic Instructions for Using the DMM as an Ammeter

The leads of the multimeter must be connected to the circuit to measure current. Wherever the meter is inserted into the circuit, ensure that the red lead is closest to the positive (+) end of the battery and that the black lead is closest to the negative (–) end of the battery. It is important that the multimeter is used in series as part of the circuit when measuring current instead of in parallel outside of the circuit, as when measuring voltage differences. Improper use may damage the multimeter and blow the fuse, making it inoperable.

1. Turn the range dial to the 10A setting. Always start with the highest range if amperage is unknown.
2. Plug the red lead into the *10ADC* terminal. Plug the black lead into the *COM* terminal.
3. Turn on the DMM.
4. Insert the multimeter in series with the circuit to be tested.
4. Read the measurement. If the reading is less than 0.2 A, switch the red lead to the *VΩmA* terminal and set the range dial to the 200 mA setting.
5. If the current reading has only one significant figure, keep turning the range dial within the DCA scale until a minimum of two significant figures are obtained. For example, if the dial is set on 200 mA and the current reading is 0.3, change the setting to 20 mA and a second significant figure can be obtained; or change the dial setting to 2000 µ and a third significant figure can be obtained.
6. Record the measurement. Divide the reading by 1,000 to record the current measurement in amperes instead of milliamperes. Divide by 1,000,000 to convert to amperes from the µ-setting.
7. Turn off the DMM when testing is complete.
8. Remove the lead wires and store the DMM.

