# Using a Multimeter

The multimeter (volt-ohm-meter, VOM) is the basic troubleshooting tool for electrical systems and controls. The two most common functions are to test continuity (is the circuit connected) and voltage.

## TESTING CONTINUITY

**Turn the power OFF to the circuit of whatever it is you are testing before performing the test. This is extremely important.**

On your multimeter you will notice a bunch of different settings. You are going to want to set your tester to read ohms. This is the symbol that looks like "Ω", commonly known as the Greek Omega symbol.


If you look at your tester when the probes are not touching anything, you should see a reading of infinity or OL. Touch the two probe tips together and you should see the reading change to zero. If your tester features an audio alert, it too will sound as you touch the probes together.

Now what you are going to want to do is touch one probe tip to one end of the item to be tested and the other probe tip to the other end. If the circuit is "closed," the tester will read zero and you should hear the audio beep if it has that feature. If the circuit is "open," the tester's reading will not change.

Here is a clarification on what an "open" or "closed" circuit means:

Open circuit: When the circuit is not complete, meaning that no voltage is able to flow through. This can be caused by a blown fuse, resistor or a switch.

Closed circuit: When the circuit is complete, meaning that voltage is able to flow through it.

You can perform a simple continuity test on a light switch that is not wired to anything. With the switch off, probe the terminals. You should not get a reading on your tester. But, when you turn the switch on, you will notice that the tester will read zero and the beep should be heard, signaling that the circuit is closed or complete.

### Sample Problem #1 – Fuse or circuit breaker

Obtain a sample fuse. This can be a cartridge fuse, knife fuse, or an automotive fuse. A fuse or circuit breaker (in the on position) should have continuity so current can flow through it. Place the probes on the connections. If the fuse is good the circuit should be "closed" or have zero resistance.

### Sample Problem 2 – A 3-way switch:

Obtain a 3-way light switch. Remove the screws (these are usually color coded and give away the internal wiring). Label the terminals A, B, and C.

Using the multi-meter test each pair of terminals and determine which terminals are connected (have continuity or a "closed" circuit) with the switch in one position. Record your results. Repeat with the switch in the other position. Record your results.

| Position | Test | Result |
|---|---|---|
| 1 | A-B | |
| 1 | B-C | |
| 1 | A-C | |
| 2 | A-B | |
| 2 | B-C | |
| 2 | A-C | |

The terminal that is “common” to both tests of a closed circuit is the “common” terminal. For example if your results were:

| Position | Test | Result |
|---|---|---|
| 1 | A-B | Closed |
| 1 | B-C | Open |
| 1 | A-C | Open |
| 2 | A-B | Open |
| 2 | B-C | Closed |
| 2 | A-C | Open |

“B” is always connected to the closed circuit so it would be “common” to both positions of the switch. You can describe what you find this way:

With the switch in position 1; A and B are connected. With the switch in position 2; B and C are connected. A and C are never connected.

## Sample Problem 3 – Coil Tests:

Coils are used in many applications such as relays and transformers. They are simply a long wire wrapped into a “coil” in a relay they create form an electromagnet to move a contact. In a transformer they induce voltage into another coil. A common problem in these devices is that they the wire in the coil breaks and they cease to work. Testing continuity is a simple was to confirm that the coil wire is not broken. Unlike a switch the coil is a long wire and has some resistance. A few ohms is common. So in this test we look to see if the circuit is open and the coil is broken or has a resistance near zero.

The following are common tests for coils:

- A relay has a coil to activate the contact. Motor controllers are relays. You can usually visually identify the coil wires. Check these for continuity between the contacts.
- Transformers are very common. If you own a cell phone the charger is a transformer! Test the contacts on the plug. Note: Transformers have two coils. You can easily see this on a door bell transformer or a sprinkler controller transformer. One connection goes to the AC power and the other to controller or door bell. If the circuit is “open” on either set of terminals then the coil is bad.
- Sprinkler valve solenoids are coils. Test the lead wires. If the circuit is “open” then the solenoid is bad.

## Sample Problem #4: - Test a wire in place

Sometimes you will want to test a wire in a cable or conduit. Since the ends are physically too far apart you need another method. **Always test for voltage first (see below) to ensure that the circuit is not hot.** To do this connect two wires together with a wire nut in one box, then test the continuity of the two wires in the other box. For example if you want to test the red wire below connect red to green. If the circuit is open (bad) then one or both wires are bad. Try connecting green to black and testing. If this circuit is closed (good) then the green wire is OK and the red wire is broken.


## TESTING VOLTAGE

CAUTION: Voltage is tested on live circuits so a shock hazard exists. Always test carefully.

Determine if you are testing AC or DC. DC is common on cars and machinery. Set your meter to the appropriate test


DC Voltage Setting


AC Voltage Setting

Some meters will have ranges so set the range to the appropriate voltage range.

## Sample Problem #1 – Test a battery.

Set your meter to DC and a lowest range. Obtain a few common flashlight batteries. A common AAA, AA, C, or D cell will have about 1.6 volts when new. Connect the red probe to the positive (+) terminal.

## Sample Problem #2 – Test a car battery.

Set your meter to DC and a range of 20 volts. Connect the red probe to the positive (+) terminal. A fully charged "12 volt" car battery will read 13.2 volts. Any voltage less that 12 is discharged.

## Sample Problem #3 – Test an outlet

CAUTION: A shock hazard exists. Hold the probes by the insulated handles only.

Set you meter on AC and a range of 200 or more volts. Carefully place the probes in the slots of the outlet. You should read from 115 volts to 125 volts. If the outlet is correctly wired a test from the short slot (hot) to the ground (round hole) will read voltage and from the long slot (neutral) to ground will read zero volts.

Turn off the outlet circuit at the breaker panel. Repeat your test. If the circuit is really off then no voltage should exist between the slots.