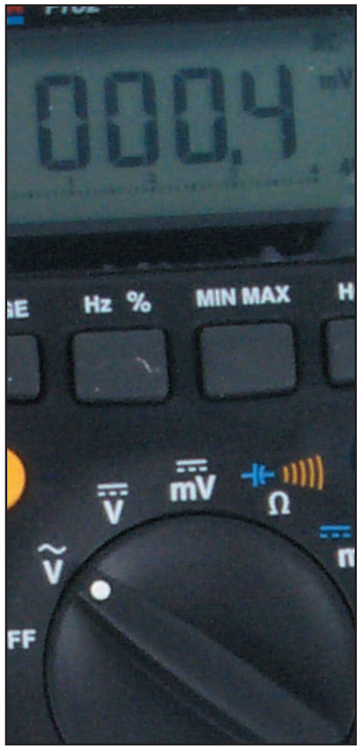
How To Guide

Multimeters

- **Why do I need a multimeter?**
- **Analogue or digital?**
- **What ranges do I need?**
- **How do I use it?**
- **Safety**

Why do I need a multimeter?
A multimeter combines a lot of different test instruments into one compact package. All multimeters can measure Voltage, Resistance (in Ohms), continuity, and most will measure Current (in Amps), although low cost multimeters are likely to have limited current measuring abilities. Multimeters can measure DC or AC voltages, and more advanced meters will display AC current as well as the more common DC current. More complex multimeters have extra ranges that allow you to test diodes or transistors (often including current gain), measure frequencies (in Hertz), read the value of capacitors, and even read temperatures.

All multimeters are very good for discovering open circuits, broken connections, short circuits, crossed wires and so on. A last minute check with a multimeter before the power is switched on for the very first time can save an expensive bang or smoke filled room.



So, for anyone working with electronic circuits, electrical wiring in houses or cars, in car entertainment, security systems, and almost any application where electricity is in any way involved, a multimeter is an essential and valuable investment that will repay you many times in tracking down problems and saving a lot of frustration.

Analogue or Digital?
Analogue multimeters have the traditional moving needle and printed scale to allow you to take readings of the circuit or wiring under test. They are simple to use and sometimes easier to read than a digital display.

If the voltage or current in the circuit being tested fluctuates rapidly over time, a needle on an analogue display will wobble from side to side, giving a good indication of the fluctuation and the approximate range of values involved. A digital meter in the same situation will sometimes jump between a rapid sequence of numeric readings, making it very difficult to see what is happening, although some digitals have a bar graph display under the main digital readout.

Basic analogue meters present an added load to delicate circuits under test however, which means that use of the meter may actually affect the behaviour of the circuit. This isn't usually desirable as it may stop the circuit working normally, but on the other hand you might want to use this feature to test the robustness of your circuit. This really only applies to delicate electronic signal circuitry such as radio and amplifier stages, or to some digital electronics.

Digital Multimeters offer a very precise reading of the value under test, present a minute load to the circuit and affect it very little and often have extra functions and ranges for more complex tests of components. Some digital meters are auto ranging, meaning that you can check a wide variety of voltages without having to keep rotating a range switch to select the correct measuring range.

Better digitals have the ability to hold peak readings for measurements in difficult or dangerous circumstances where your eye really needs to be on where your hands are and some are even able to log readings over a period of time, allowing you to let them do your work unattended.

Safety
This is fairly self evident. Tests made on circuits with the power disconnected, or on small battery powered circuits are very unlikely to give rise to any personal safety considerations, but remember that capacitors in high voltage circuits and power supplies can retain a hefty charge even hours after the power has been disconnected, as can TV tubes. It is still a good idea to think twice about whether the power really is disconnected before plunging those probes (and your hands) into the wiring.

Those working on car electrics, home or office wiring, and particularly industrial power wiring need to be very, very careful about what they are doing.

Does the circuit really need to be live in order to carry out the tests?
If it doesn't, make very sure that it is properly isolated, that any live connection is disconnected before applying the leads of your meter. If the isolation is via a switch, is it really switching the live connection? Can someone switch it back on while you are working on it unaware?

If you do have to take measurements on a live circuit, think about where your hands are, what the tips of your probes are touching, what range you are set to on the meter, and whether earthed parts around the area to be measured are a hazard. DO NOT wear earth straps or touch earthed objects whilst you are taking measurements.

Avoid wearing jewellery whilst taking measurements, a chain or crucifix dangling into the wiring as you lean across to reach that connection will connect YOU to the circuit very effectively and may result in severe shocks or burns.

12 volt or 24 volt vehicle electrics are unlikely to be a shock hazard (although modern electronic ignition and EHT wiring can be lethal) but a very high risk of burning exists if you either accidentally short out a wire whilst testing. The current capability of a car or lorry battery is awesome and even thick wires will glow white hot melting insulation along the whole length in choking clouds of toxic smoke if you slip and short the battery.

The very high voltages involved in both car EHT wiring and TV tube wiring are not necessarily contained by plastic insulation, or even air gaps of 25mm or so, especially if old wiring, damp or dust are present. Give all EHT circuits a healthy respect and don't prod your meter at them.

As with all these electrical jobs, if in any doubt about what you are doing, call in a qualified person. The safety of you and your family may depend on the work you are carrying out.

However, those of you who are confident that they can tackle these jobs may use their multimeters to confirm connections, isolations and a host of other measurements that empower you to really know what is going on in that apparently still and silent circuit in front of you.

Take the guesswork out of your work. Buy a modern multimeter from Maplin today.

What ranges do I need?
All multimeters have a good general purpose set of ranges. However, it is worth giving some thought to your main intended use for the meter. If you will use it for car wiring, you will find a high DC current range essential. Electricians working with three phase may wish to look for a meter with a 1000 Volt AC range, as may those working with high voltage valve circuits, TV's and so on.

Alternatively you may be working with sensitive preamplifier circuits or sensor signal circuits. If you need to measure very small currents or votages, look for a meter with those very low value ranges and very low figures for resolution, which is the smallest change a meter can measure. A digital meter is often a good choice here as they have very sensitive input amplifiers. For example, a meter with a smallest AC voltage range of 200 mV and a resolution of 10uV will allow very tiny voltage levels to be accurately measured.

Digital meters with more digits may have the same selection of ranges as those with fewer, but the resolution of a $4\frac{1}{2}$ digit meter will be ten times better than a similar $3\frac{1}{2}$ digit instrument. Take a while to look at and compare the different ranges offered before you choose a multimeter. Do you want to be able to test transistor gains and capacitor values? Will you need to measure frequencies? Is AC current something you need to measure? Do you ever need to check the inductance of coils? A little thought and consideration here will let you choose the right instrument for your needs.

How do I use it?
A multimeter is easy to use. Switch it on, select a range whose maximum reading is a little higher than the value you expect to measure and apply the leads to the circuit under test, but not without giving a little thought to what you are doing first.

If you are measuring continuity or resistance, make sure that the circuit under test is not switched on.

Make sure you select a voltage range if you expect to read a voltage and remember that Voltages are measured by applying the red and black leads directly across (or in parallel) with the circuit you wish to measure. Analogue meters will deflect the needle backwards off the scale if you get the polarity of a DC test connection wrong, but digital meters will simply show a minus sign to the left of the reading. For a current reading, you break the current flow through the circuit by disconnecting a wire or component and then reconnect it via the multimeter after selecting the correct current range (series connection).

The above is very important to remember. Connection of a meter set to read current across a voltage source or power supply instead of in line with it can result in the destruction of the meter and perhaps the circuit as well, not to mention a loud and frightening bang as you short out the power with your meter!

To check for open or short circuits, or continuity (is point A really connected to point B?) just set the meter to its lowest resistance range (some meters have a dedicated continuity range that will sound a buzzer if the value measured is very near to zero resistance) and connect the two leads to the two points to be checked.

A reading of zero will indicate continuity or connection. Remember that this means the needle of an analogue meter will actually move right across to the extreme right hand side of the scale, which is the opposite to what you might expect for a zero reading. Digital meters are so sensitive that they will rarely display an actual reading of 0.00 but will show a few ohms or tenths of an ohm as they show the minute resistance of the wires or connections under test.

The high current ranges of many multimeters often require you to pull the red probe from the socket on the meter and replace it into a special high current test socket. Remember to do this if you expect to read currents above about 2 Amps, depending on the meter you have chosen.