

The Multimeter

Circuit designers could not test and develop new components and circuits without the use of multimeters and oscilloscopes. Broadly speaking, a multimeter is designed to measure current, potential difference and resistance, while an oscilloscope is designed to display the shape of waveforms. Thus a multimeter combines in one portable, battery operated instrument the facilities for measuring current, potential difference and resistance. These measurements are made on a number of selectable ranges covering both small and large values, e.g. ranges having maximum values of 10 mA and 1000 V. When this multimeter is used as an ammeter to measure current, it is placed in series with a component as shown in

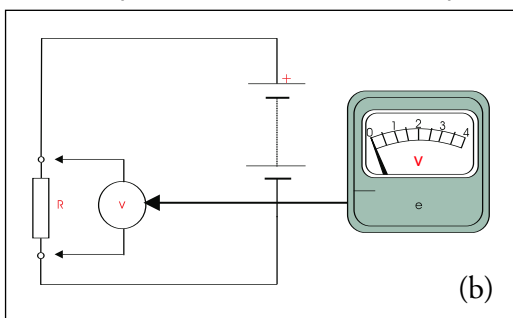


Fig. 4.4a.

The resistance of the ammeter must be small if it is to have a negligible effect on the value of the current being measured. But when the multimeter is used as a voltmeter to measure volts, it is connected in parallel with a component as shown in Fig. 4.4b. Since a voltmeter should not disturb the p.d. being measured, it must have a very high resistance.

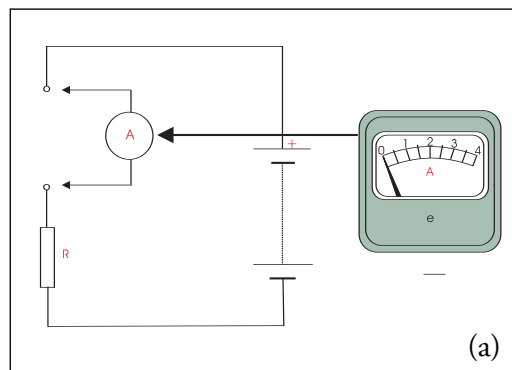


Fig. 4.4 Using a multimeter (a) as an ammeter, and (b) as a voltmeter.

This change of the resistance when switching the multimeter from “volts” to “amps” is achieved very simply. For the measurement of current low value resistors are automatically connected in parallel with meter terminals; this ensures that most of the current flows through this low resistance path leaving a calculated small amount to operate the meter movement. For the measurement of voltage, high value resistors are automatically connected in series with one of the meter terminals; this ensures that most of the applied voltage is dropped across these resistors leaving a calculated small amount to operate the meter movement.

When a multimeter is being used as an ohmmeter to measure the resistance of a component, it brings into action an internal battery which makes a small current flow through the component. As shown in Fig. 4.5, an ohmmeter produces a small current which flows through the component under test, and the display records this current. The smaller the current, the larger the resistance of the component. This is why the resistance scale on an analogue multimeter has the zero of the resistance scale on the right of the display.

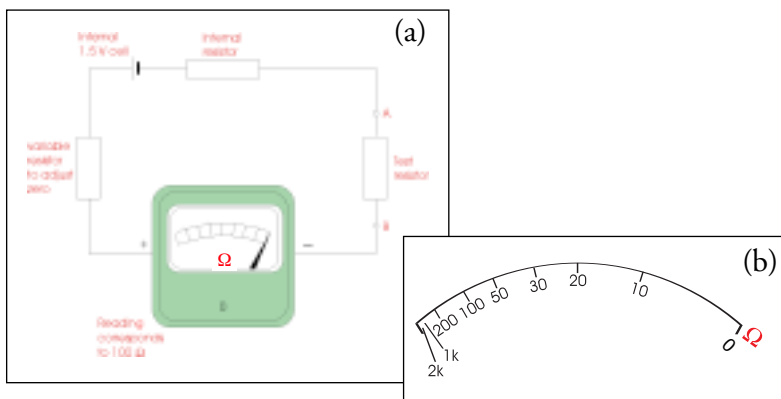
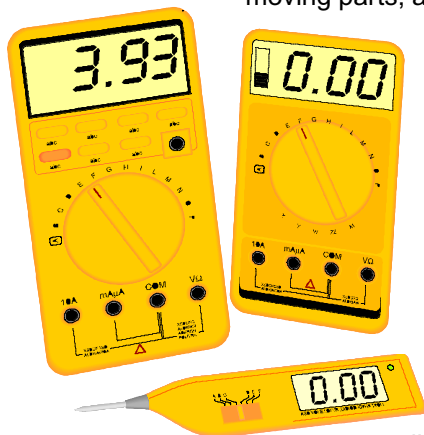


Fig. 4.5 An analogue ohmmeter: (a) the internal circuit, and (b) a typical “ohms” scale.

What do you think is the resistance reading at the left of the scale? A digital multimeter simply displays a number giving the value of the resistance. Note that a component's resistance should not be measured when it is in a circuit, since it has other components connected to it and they may affect the resistance being measured.

An analogue multimeter has moving parts comprising a coil of wire which twists in a strong magnetic field. The angle of twist is proportional to the strength of the current flowings through the coil. Attached to the coils is a pointer which moves over a graduated scale. A digital multimeter does not have any moving parts, and what it measures is displayed on a liquid crystal display (LCD), or



a light-emitting diode (LED) display. Digital multimeters, in common with many other digital instruments, are less likely to be damaged by mechanical shocks and incorporate “user-friendly” facilities such as automatic ranging and a clear indication of the type of signal being measured. By plugging in sensors, a digital multimeter can readily be used to measure quantities such as frequency and temperature. A digital multimeter performs rather better than an analogue multimeter when called upon to measure voltage. This is because a digital voltmeter draws less current from the circuit under test and therefore has less effect on the voltage being measured. This effect is given by the multimeter's sensitivity. Thus a general-purpose analogue multimeter might have a sensitivity of $20 \text{ k}\Omega \text{ V}^{-1}$, or $100 \text{ k}\Omega \text{ V}^{-1}$, while a general-purpose digital multimeter could have a sensitivity of at least $1 \text{ M}\Omega \text{ V}^{-1}$. The sensitivity is inversely related to the current drawn from the circuit under test. Thus

when a meter with a sensitivity $20 \text{ k}\Omega \text{ V}^{-1}$ measures a p.d. of 1 V, it draws a current of $1 \text{ V} / 20 \text{ k}\Omega$ or $50 \mu\text{A}$ from the circuit. This compares with $1 \text{ V} / 1 \text{ M}\Omega$ or $1 \mu\text{A}$ for the digital multimeter. But remember that for a particular sensitivity, the higher the voltage range selected the greater the resistance of the meter and the less it “loads” the circuit under test. Thus the $20 \text{ k}\Omega \text{ V}^{-1}$ voltmeter has a resistance of $20 \text{ k}\Omega$ on the 1 V range and a resistance of $200 \text{ k}\Omega$ on the 10 V range.

(from “Teach Yourself Electronics”, pagg. 42,43,44,45)

a. Answer the following questions and underline the answers in the passage.

1. What operations can a multimeter perform?
2. How can a multimeter be used?
3. What is the difference in the two functions?
4. What is meant by “p.d.”?
5. How can you change the resistance from “volts” to “amps”?
6. Describe the use of a multimeter as an ohmmeter.
7. Why does the resistance scale on an analogue multimeter have the zero of the resistance scale on the right of the display?
8. Why shouldn't a component's resistance be measured while in a circuit?
9. Describe the difference between an analogue and a digital multimeter.

b. The passage lists a series of advantages offered by digital multimeters, what are they?

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c. *Discuss in pairs:*

- In your opinion, are the advantages that you have listed real benefits? Why?
- Can you think of any other advantages or disadvantages in using these two different types of multimeters?

d. *One word in each of these sentences has been deleted, put it back in the right position.*

Example:

Direct current (d.c.) flows in one direction.

- always

Direct current (d.c.) always flows in one direction.

1. An alternating current (a.c.) is one that flows first in one direction and then in the opposite direction.

- regularly

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2. Michael Faraday was an Englishman who performed experiments with coils of wire and electric current.

- early

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3. The term “frequency” is used to indicate how many times the current changes direction.

- alternating

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4. For the measurement of voltage, value resistors are automatically connected in series with one of the meter terminals.

- high

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5. The sensitivity is related to the current drawn from the circuit under test.

- inversely

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6. The higher the voltage range, the greater the resistance of the meter.

- selected

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7. What do you think is the resistance at the left of the scale?

- reading

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