UDERSTANDING ELECTRONICS

Basic Electrical Principles

Objectives

After working through this chapter, you should be able to do the following:

1. Define what voltage is, know the symbol for voltage and the units used.
2. Understand the basic difference between AC and DC voltages.
3. Define the meaning of an electric current, know the symbol for current and the units used.
4. Know what conductors and insulators are and be able to give examples.
5. Use the formula from Ohms law to calculate resistance, voltage or current.
6. Know how voltages and currents can be measured.
7. Know what power dissipation is and the unit for power.
8. Be able to calculate power dissipation.

What is Electronics?

When we talk about electronics we are normally referring to low currents and in many cases to low voltages as well. But what are currents and voltages?

What is Voltage?

Voltage or **electro motive force** (e.m.f), pushes or forces an electric current through a closed circuit. It can be compared with the domestic water supply in a home. The pressure in the pipe forces the water along, in electronics, voltage forces the electric current along. The unit of voltage is the **Volt** and the symbol used is **V**.

What is Current?

When a battery is connected to a light bulb, it lights up. The applied voltage forces the electric current from the battery, through the bulb and then back to the battery. But there is a little bit more to the story. What is actually happening is electrons are moving from the positive terminal of the battery, through the bulb, and then back to the negative terminal of the battery.

Scientists assumed in the early days that electrons move from positive to negative. They have since discovered that in fact electrons move from negative to positive. However we accept what is known as convention, i.e. that electrons move from positive to negative. So **current** is the flow of electrons through a closed circuit. The unit of current is the **ampere**, sometimes written as **amps**. The symbol used is **I**.

AC and DC voltage

There are two types of voltage, **alternating current** (ac) voltage and **direct current** (dc) voltage. The voltage in a mains plug is 240v AC. This means that the voltage changes from +240v to –240v, and back to 240v and so on. It changes from +v to –v fifty times a second. Anything that changes with time has a frequency. In this case mains voltage has a frequency of 50Hz.
DC voltage remains constant at a given voltage. For example our 9v battery would show a constant line at 9v if plotted against time. In electronics our circuits are supplied with a dc voltage.

UDERSTANDING ELECTRONICS

Resistance

The final part of the story was discovered by a scientist called Ohm. Some materials allow the flow of electrical currents through them. They are known as **conductors.** Examples include gold, silver, copper and aluminium. Although these material are conductors they have some resistance to the flow of electrical currents. Other materials totally resist the flow of electrical currents. These are known as **insulators.** Examples include dry wood, paper, plastics and air. The unit of resistance is the **ohm**. The symbol used is Ω. However we tend to use the letter **R**.

Ohm's law

Ohm discovered that there was a relationship between an **applied voltage**, the **current** flowing through the wire, and the **resistance** of the wire. His law states that" the current flowing in an electrical conductor is proportional to the voltage across it at constant temperature". From Ohm's law we can say that

V (volts) = **I** (amps) x **R** (ohms)

There are also divisions of these units. For example, we may have 1000R which can be written as 1K, the K representing kilo or a thousand. We could have 10mA, which can be written as 0.01A, the mA representing milliamps.
When performing calculations, every time you must ensure that your values are in the units of the formula given above.

Conversion of units

1mA = 0.001A
1uA = 0.000001A

Example

An e.m.f. (voltage) of 9v is applied to a light bulb of resistance 100R. What current is flowing in the circuit?

Using the formula	**V** = **I** x **R**
	9 = **I** x 100
Therefore	**I** = 9/100
	I = 0.09A

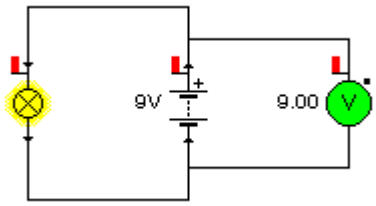
This can also be written as 90mA. (milliamps)

Exercise 1.1

1. A 9v battery is connected to a bulb rated at 60mA. What is the resistance of the bulb?
2. An e.m.f. of 12v is applied to a bulb of resistance 250R. What current is flowing in the circuit?

Measuring voltage

If we want to measure the voltage at a given point in a circuit we use a **voltmeter**. The symbol for a voltmeter is **V**.

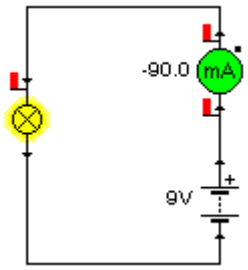


If for example, we want to check the voltage of our 9v battery, we would connect the **red** lead of the **voltmeter** to the **positive** terminal of the battery. The **black** lead of the **voltmeter** would be connected to the **negative** terminal.

UDERSTANDING ELECTRONICS

Measuring current

To measure the current flowing in a circuit we use an **ammeter**. The symbol is **A**. The ammeter has to be part of the circuit, so for example, if we were trying to find the current flowing in a bulb connected to a battery, we would connect the **red** lead of the **ammeter** to the **positive** terminal of the battery.



The **black** lead of the **ammeter** is connected to one side of the **bulb**, the other side of the bulb is connected to the negative terminal of the battery.

In electronics workshops we tend to use multimeters rather than separate volt and ammeters. Multimeters can measure AC and DC voltages, current and resistance.

Power

When for example, you run, your body generates heat. When an electric current flows in a circuit, the components in the circuit generate heat. If you consider a bulb connected to a battery. The bulb emits light, but in doing so, it also generates heat. If the bulb was to overheat it would be destroyed. When we talk about this generated heat, we call it the **power dissipated** or **power rating**. The symbol for power is **P** and the unit is the **Watt**.

(1) **P** (watts) = **V** (volts) x **I** (amps)

(2) **P** (watts) = **I²** (amps) x **R** (ohms)

Either formula can be used according to the information available.

Example

A 6v bulb is rated at 0.06A. What is the power rating of the bulb.

P = **V** x **I**
P = 6 x 0.06
P = 0.36W

Exercise 1.2

1. A bulb has a voltage rating of 240v, and a power rating of 60W. What current would flow once it is connected to the voltage supply?
2. A bulb has a resistance of 10R and the current flowing through it is 0.5A. What is the power rating of the bulb?