

## Transformers

### Why do we need transformers?

When an electric current flows through a conductor it emits heat. The larger the current, the more heat is emitted. This means that the electrical energy you get out of the wire is always a bit less than the electrical energy you put in as some of it is always lost as heat. It is usually difficult to avoid this.

However, the heating effect can be kept to a minimum by keeping the current as low as possible, but as electrical power is given by:

$$\text{power (watts)} = \text{current (amps)} \times \text{voltage (volts)}$$

This means that the power delivered at a set voltage will also be reduced.

So, if we reduce the current but want to keep the power level the same we need to compensate by increasing the voltage. That is exactly what a transformer does.

### How do you build a transformer?

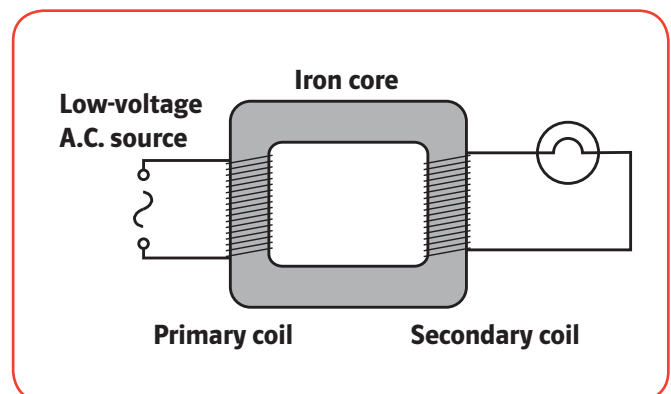
Transformers are one of the simplest electrical machines and one of the most efficient. They are made from a laminated iron or steel core and two coils of wire.

The coil connected to the electrical supply is called the primary coil and the coil connected to the load is called the secondary coil.

The relationship between input and output voltages is given by

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

Where  $V_p$  is the voltage across the primary coil,  $V_s$  is the voltage across the secondary coil.  $N_p$  is the number of turns on the primary coil and  $N_s$  is the number of turns on the secondary coil.



### How does a transformer work?

A transformer will only work properly with alternating current (AC).

This is because the constantly changing current in the primary coil produces a constantly changing magnetic field in the iron core. Because the magnetic field is constantly changing, it induces a constantly changing current in the secondary coil. Energy is therefore transferred between the input and out put by the magnetic field.

As part of the process some heat is produced, so larger transformers need to be cooled. The exact method of cooling depends on the power of the transformer.