Electrical Units

Before going any further, now is the time for an introduction to the units associated with electrical quantities and their symbols, where they come from, and where they are used. Knowing this important information will make it easier for you to understand electronic principles and circuit diagrams as we work through them. Some you will already know, but others will be new to you.

Hot tip

Basic SI units can be combined to form derived SI units – for example, meters per second (m/s).

SI units

Engineers use the International System of Units (Système Internationale d'Unités), which is metric based and usually simply called *SI units*. This system covers not only electrical units but other familiar units, as you can see from these few examples:

Quantity	Unit	Meaning
Electric Current	A	ampere
Time	s	second
Mass	kg	kilogram
Length	m	meter

The SI units can be made to represent smaller or larger quantities by using a prefix. This signifies how much to multiply or divide the value by:

Prefix	Name	Meaning
M	mega	multiply by 1,000,000 (i.e. value x 10^{6})
k	kilo	multiply by 1,000 (i.e. value x 10^{3})
m	milli	divide by 1,000 (i.e. value x 10^{-3})
μ	micro	divide by 1,000,000 (i.e. value x 10^{-6})
n	nano	divide by 1,000,000,000 (i.e. value x 10^{-9})
p	pico	divide by 1,000,000,000,000 (i.e. value x 10^{-12})

Beware

The prefix is case-sensitive so it is important to avoid mistakes by always using the correct upper or lower case letter.

For example, MV would mean megavolt; mA would mean milliamp; and μA would mean microamp.

Work (or energy)

Because electricity is a form of energy, this energy is measured using the standard unit of work or energy, the *joule* (J).

Power

The unit of power is the *watt* (W), and the symbol for power is P. One watt is equal to one joule per second and is calculated by:

power (P) = W/t therefore, energy (W) = Pt

(Where W is energy or the work done in joules, P is the power in watts and t is the time in seconds.)

Charge

The unit of charge is the *coulomb* (C), and the symbol for charge is Q. One coulomb is equal to one ampere second:

charge (Q) = It

(Where Q is the charge in coulombs, I is the current in amperes, and t is the time in seconds.)

Electrical potential (and emf)

The difference in potential between two points in a conductor or electric circuit is called *electrical potential.* A change in that electrical potential is called a *potential difference*. The unit of electrical potential is the *volt* (V), and the symbol is V. One volt is equal to one joule per coulomb. Voltage is calculated as follows:

volts (V) = P/I therefore, power (P) = IV

(Where V is the voltage in volts, P is the power in watts, and I is the current in amperes.)

Electromotive force (emf), symbol E, is also measured in volts.

Resistance

Opposition to the flow of electrical current is called *resistance*. Its unit is the *ohm* (Ω), and the symbol for electrical resistance is R. As one ohm equals one volt per ampere, resistance is calculated by:

resistance (R) = V/I therefore, $V = IR$ and $I = V/R$

(Where R is the resistance in ohms, V is the potential difference in volts across the resistance and I is the current in amperes flowing through the resistance. The above is called *Ohm's law*.)

Hot tip

You may remember Ohm's law from school. Although you probably thought you would never use it, it will now be very handy for simple calculations you may have to make – for example, establishing the current drawn by a circuit you have built so you can protect it with the correct value fuse.

Hot tip

Try not to become confused by all the symbols and abbreviations used. Take some time to study these few pages and all will become clearer later.

Don't forget

A capacitor is very much like a secondary cell in that it will hold a charge when a voltage is applied across it, but as this charge is small, it will release it very quickly compared with a cell.

Capacitance

When a voltage is applied across two parallel conducting plates separated from each other by air, for example, an electric field and hence an electric charge builds up in the area between the plates.

Capacitance is the term used to indicate how much charge can be stored between the plates for a given voltage. The unit of capacitance is the *farad* (F), and its symbol is C. It is calculated by:

$$\text{capacitance } (C) = Q/V \qquad \text{therefore, } Q = CV$$

(Where C is the capacitance in farads, Q is the charge in coulombs and V is the potential difference in volts between the plates. Note that typical capacitance values are in the order of μF, nF or pF.)

Capacitors are covered in more detail in Chapters 2 and 3.

Summary of SI units and symbols

It is important to remember that there is a difference between a unit and a symbol. The unit expresses a value, whilst the symbol is just that: a symbol in a formula. Do not get the two mixed up.

Also, do not confuse the symbols, as they may not always be obvious. For example, it's easy to remember C is for capacitance but then it can't be used again for current, so current is allocated the symbol I, which appears unrelated! Use the table below to help you remember:

Beware

Do not confuse units with symbols and always remember that both upper case and lower case characters have specific meanings.

Quantity	Symbol	Unit Name	Unit
Work (or Energy)	W (or E)	joule	J
Power	P	watt	W
Charge	Q	coulomb	C
Potential Difference	V	volt	V
Electromotive Force	E	volt	V
Resistance	R	ohm	Ω
Capacitance	C	farad	F
Time	t	second	s
Mass	m	kilogram	kg
Length	l	meter	m