Section III

Sources and Instrumentation

(i) Sources

Two types of electrical power sources are available:

1) Voltage Sources

2) Current Sources

Ideal Voltage Sources

An ideal voltage source will provide a stable voltage (dc or ac) regardless of the circuit it is supplying.

By Definition:

The ideal voltage source is a two-terminal element with the property that the voltage across its terminals is specified at every instant in time and does not depend on the current flowing through it.

Ideal Current Sources

The ideal current source will provide the specified current regardless of the nature of the circuit.

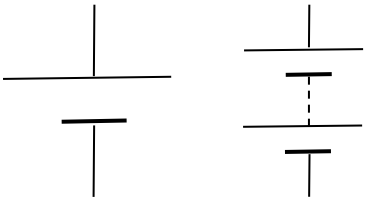
By Definition:

An ideal current source is a two-terminal element with property that the current flowing through it is specified at any instant in time and does not depend on the load connected to it.

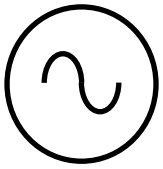
Examples of electrical symbols for voltage and current sources are:

Electrical Symbols for Voltage/Current Sources:

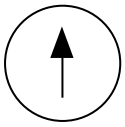
dc voltage source (ideal)



Cell/Battery (non-ideal dc source)



ac voltage source (ideal)

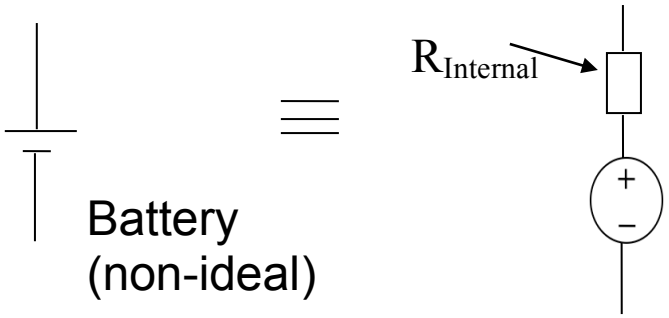


Current Source (ideal)

Deviation from the Ideal:

In practice, sources are not ideal. Sometimes sources can be well modelled or assumed to be ideal – the mains for example. Other times it cannot – a battery near depletion or having a high current drawn from it is not an ideal scenario.The deviation from the ideal is well modelled using a resistor (known as the 'internal resistance' of the non-ideal source) in series with the ideal source (for voltage sources). (For current sources the resistor is placed in parallel)

i.e.



If $R_{Internal}$ is small enough to be ignored, then we can simply consider the source to be ideal.

Note: An ideal voltage source has zero internal resistance.

(ii) Earthing

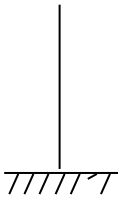
Earthing is a safety feature for electrical appliances. Metal parts, not used in the internal circuitry (e.g. chassis) are connected to the earth via an earth wire (green and yellow).

If, due to a circuit fault (corrosion, faulty manufacture, mice knowing at cables, etc.), one of the ‘live’ wires comes into contact with the metal there is a significant risk to the user who may get an electric shock.

If the metal (chassis) is earthed, this danger is averted since the current will flow to the earth via the earth wire as this is the path of least resistance (as opposed to flowing through the human body).

There are two other wires in the mains cables – ‘live’ (brown) and ‘neutral’ (blue).

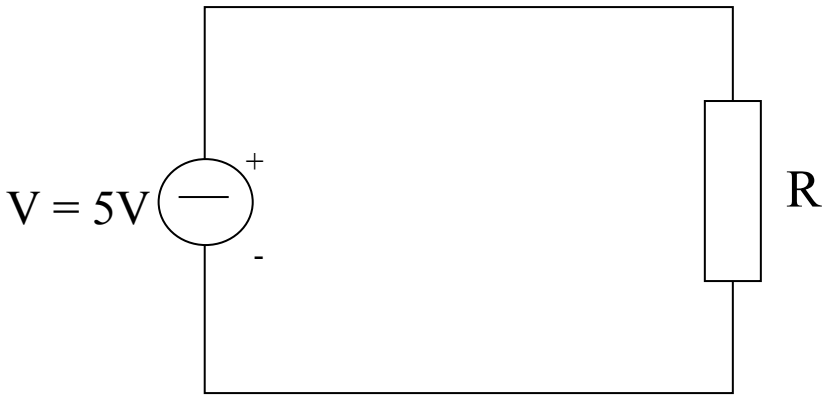
The earth itself is at zero electrical potential and acts as a current sink. Other examples of earthing are lightning rods and static dischargers in cars. The electrical symbol for earth is:



(iii) Grounding

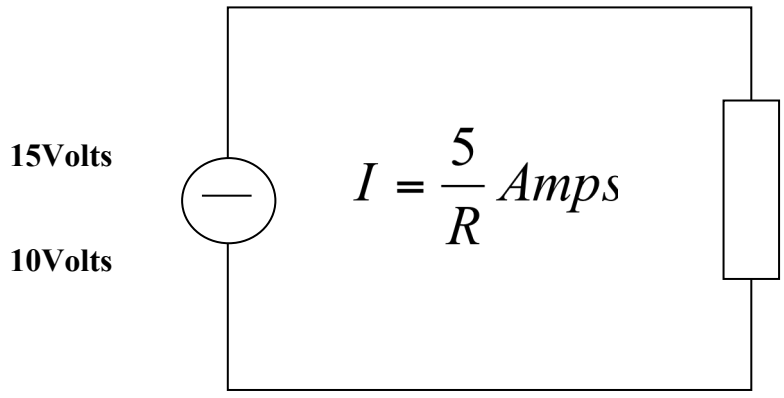
Grounding has a very different meaning to earthing and it is essential to understand the concept of grounding because it is of great practical importance.

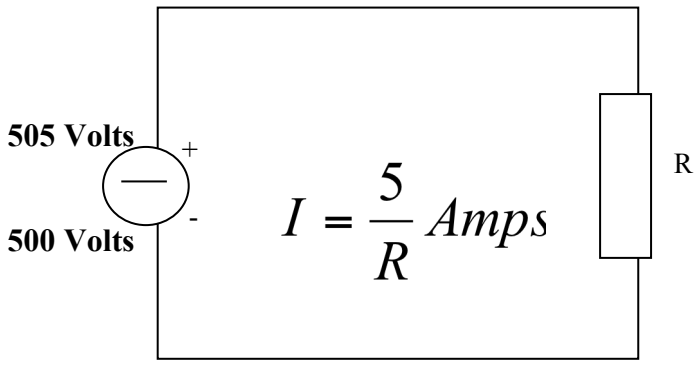
Consider the following setup:



In this isolated setup there is a potential difference of 5V across the supply and R.

However the absolute potentials (with respect to earth – 0V), may be:



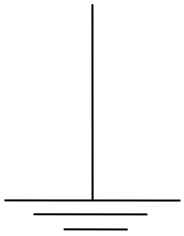


In both cases the same current flows – i.e. it is the potential difference across the supply (and consequently the load) that is important when determining the current flow in a network. The absolute potentials are irrelevant for this purpose. For simplicity of analysis, we assign the 'return' or bottom wire a potential of zero volts. We call this the ground wire or 'zero reference'.

A good analogy is that with cartography, where terrain height is measured with respect to sea level. It is important to remember that ground does not necessarily have the earth's zero electrical potential.

In short, Ground = Zero Reference.

The electrical symbol for ground is:



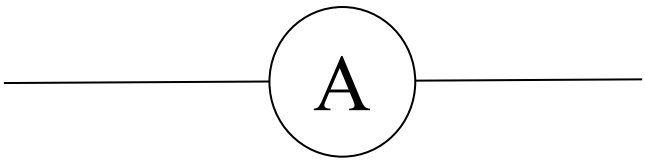
Note: All the supplies in a circuit should have their ground wires connected at the same point. This is referred to as grounding the circuit.

Convention for the Flow of Current

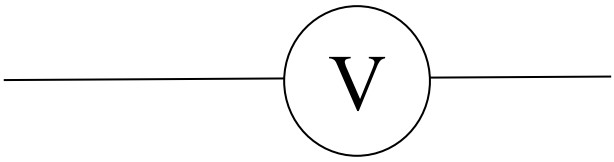
By convention current is said to flow from regions of positive electrical potential to regions of relatively negative potential.

In fact current is normally the case of negatively charged electrons flowing from negative to positive. However, the convention stands.

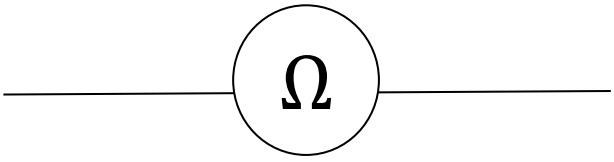
(iv) Instrumentation



The Ammeter measures current. It is connected in series.



The Voltmeter measures potential difference. It is connected in parallel.



The Ohmmeter measures resistance. It is connected in parallel.

Reading Work:

1. The Ammeter
2. The Voltmeter
3. The Ohmmeter

    - Read up on these topics in Meade and Boylestad.