Unit 3: Ideal Voltage and Current Sources

Voltages and currents in a circuit are imposed by *sources*. In practical circuits there are many types of source, such as batteries and solar cells, but from a circuit analysis viewpoint we need to consider only two *ideal sources*: the voltage source and the current source. In a later unit, we shall see how practical sources can be modelled by a combination of ideal sources and other circuit elements.

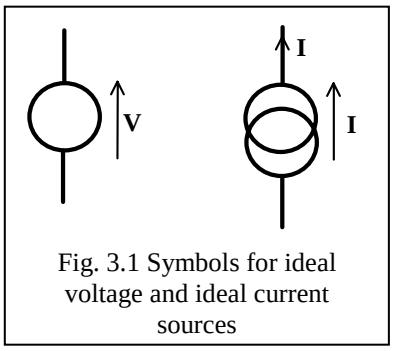
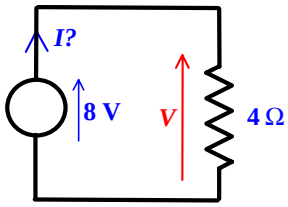


Fig. 3.1 Symbols for ideal voltage and ideal current sources

The circuit symbols for the ideal sources are shown in Fig. 3.1. The ideal voltage source, V, has a voltage V between its terminals (in the direction indicated by the arrow), no matter what current is flowing in the source. For example, an ideal 5 V source has a voltage of 5 V across its terminals, for currents of 1 mA, 1 A or 1000 A. This behaviour contrasts with a real source, in which the terminal voltage reduces as the current drawn increases. The current drawn from an ideal voltage source depends only on the circuit to which it is connected, as demonstrated in the following worked example.

Worked example 3.1

Calculate the current *I* flowing from the 8 V source.



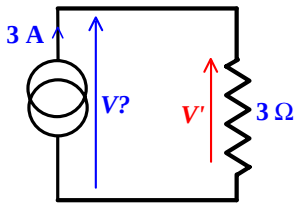
Solution

The first stage of a rigorous solution is to calculate the voltage *V* across the 4 Ω resistance. Using Kirchhoff's Voltage Law around the closed circuit loop: *V* - 8 = 0, and therefore *V* = 8 V. The current I flows from the source into the resistance in a direction consistent with Ohm's Law, so *I* = 8 / 4 A = 2 A

The ideal current source, shown symbolically on the right in Fig. 3.1, produces the specified current, I, whatever the voltage across the source terminals. An ideal current source of 2 A produces the appropriate voltage across its terminals to ensure that 2 A is pushed into the circuit to which it is connected. Therefore, the terminal voltage of the ideal current source is determined by the external circuit.

Worked example 3.2

Calculate the voltage *V* at the terminals of the 3 A current source.



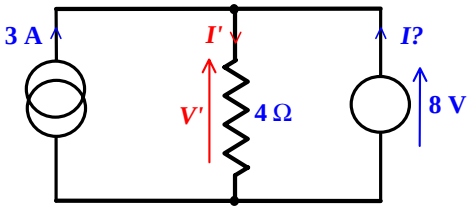
Solution

The current of 3 A flows from the source and through the 3 Ω resistance, so, using Ohm's Law, the voltage *V'* across the resistance = 3 x 3 V = 9 V. From Kirchhoff's Voltage Law *V* = *V'* and therefore *V* = 9 V

Of course, a circuit may contain more than one ideal source, as illustrated in the next example.

Worked example 3.3

Calculate the current *I* flowing from the 8 V source.



Solution

From Kirchhoff's Voltage Law *V'* = *V* = 8 V and from Ohm's Law: *I'* = 8 / 4 A = 2 A. Finally, applying Kirchoff's Current Law: +3 + I – I' = 0, so *I* = -1 A. *(The negative sign indicates that current is flowing into the voltage source.)*
