# Measuring Current

Both water molecules and electrons are small. We don't measure water flow in molecules per second but by gallons (many molecules) per minute. We measure electron flow in much the same way.

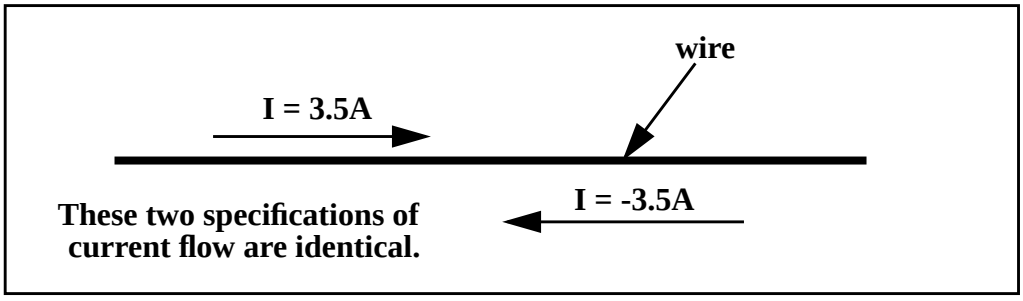
Electron flow is measured in Coulombs/sec. A Coulomb (C) is $6.25 \times 10^{18}$ electrons. The term that refers to one Coulomb per second of current flow is the Ampere (A). It is informally referred to as an "Amp". Thus 1A = 1 C/s of electron flow. To restate, the rate of electron movement that would cause one Coulomb of electrons to move across a plane surface bisecting a wire in one second is called 1 Ampere of electron flow.

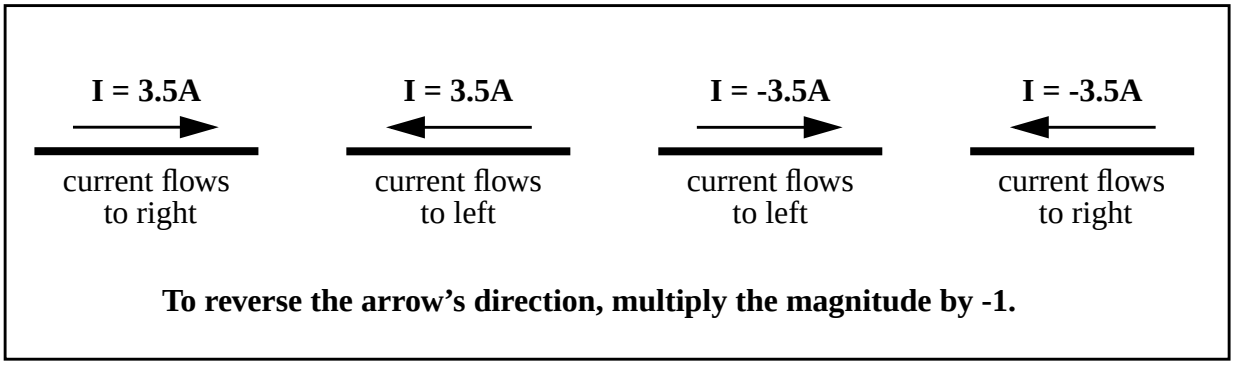
We cannot simply refer to the rate of current flow; a direction must be specified. When solving for unknown currents in a circuit, neither magnitude or direction of the current will be known. In such cases, we assume a reference direction of current flow. Based on this assumption, the mathematical solution will result in a positive or negative value for the unknown current.

## Specifying electrical current flow in a wire

To accurately specify electrical current flow, a wire must be specified through which the current to be measured is flowing. In addition, the magnitude and direction of current flow is required. All three bits of information are necessary to accurately speak about a current. We label wires by giving them names which we will see later. The magnitude and direction of the current are given by a numerical value and an arrow indicating the reference direction to which the numerical value refers.

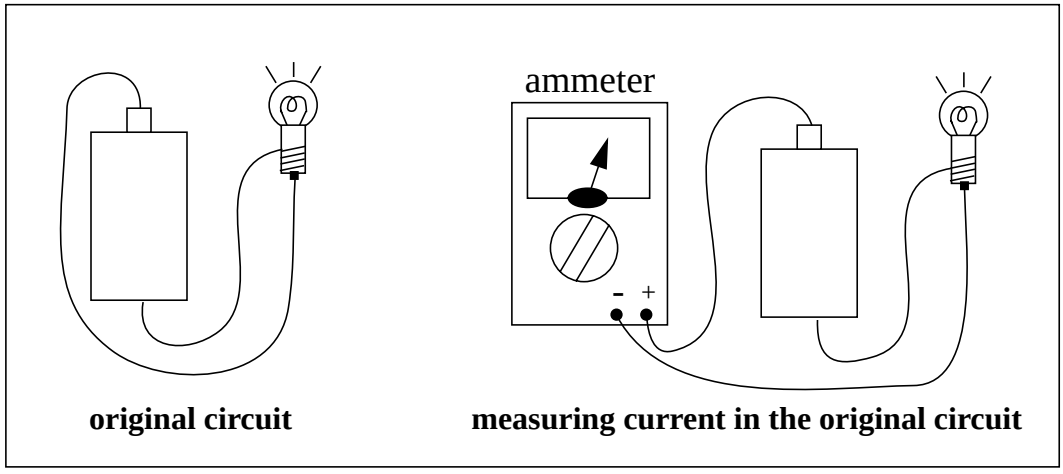
The direction of the arrow alone does not necessarily indicate the actual direction of current flow. However when coupled with the sign of the magnitude, the actual direction of current flow may be determined. See the illustrations below. .



## Making current measurements with a meter

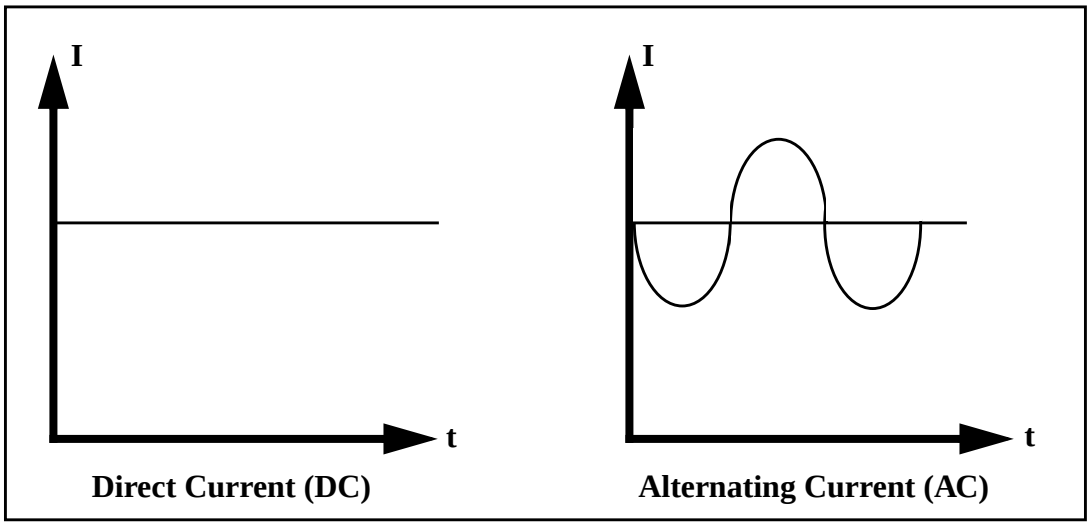
Since currents flow through a wire, to make a current measurement with a meter, we must intercept the current flow and make it flow through our ammeter. Typically this is done by opening a part of the circuit loop and inserting a meter into the loop.




When making measurements, the desire is to make the measurement without disturbing the original circuit. For an ammeter to do this, its internal construction must look much like the portion of the wire it replaced. It is true that the ammeter has a very special calibrated wire inside it that allows a current measurement to be made.

## AC and DC currents

When magnitude and direction of current flowing in a circuit does not vary with time, the current is referred to as *direct current* (DC). If the current continuously varies amplitude and direction, it is referred to as *alternating current* (AC).



## Ranges of Current flow

Typical electrical currents vary a great deal

| | |
|---|---|
| integrated circuit (chips): | 0.1 uA- 10,000mA |
| flashlight | 100 mA - 1A |
| home stereo | 1 - 2A |
| Bathroom heater | 10A (110VAC outlets are 15A - 20A rating) |
| automobile starter motor | 100 - 400A |
| power distribution | 200 - 1 KA |
| lighting bolt | >10 KA |

## Engineering Unit Prefixes

**Table 1:**

| Prefix | Abbreviation | Value |
|---|---|---|
| tera | T | $10^{12}$ |
| giga | G | $10^{9}$ |
| mega | M | $10^{6}$ |
| kilo | k | $10^{3}$ |
| none | | $10^{0}$ |
| milli | m | $10^{-3}$ |
| micro | u | $10^{-6}$ |
| nano | n | $10^{-9}$ |
| pico | p | $10^{-12}$ |
| femto | f | $10^{-15}$ |
| atto | a | $10^{-18}$ |