AC Power Sorces

HELIOS POWER SOLUTIONS

• Power Sources

Sources of electricity (most notably rotary electro-mechanical generators) naturally produce voltages alternating in polarity, reversing positive and negative over time, known as alternating current (AC).

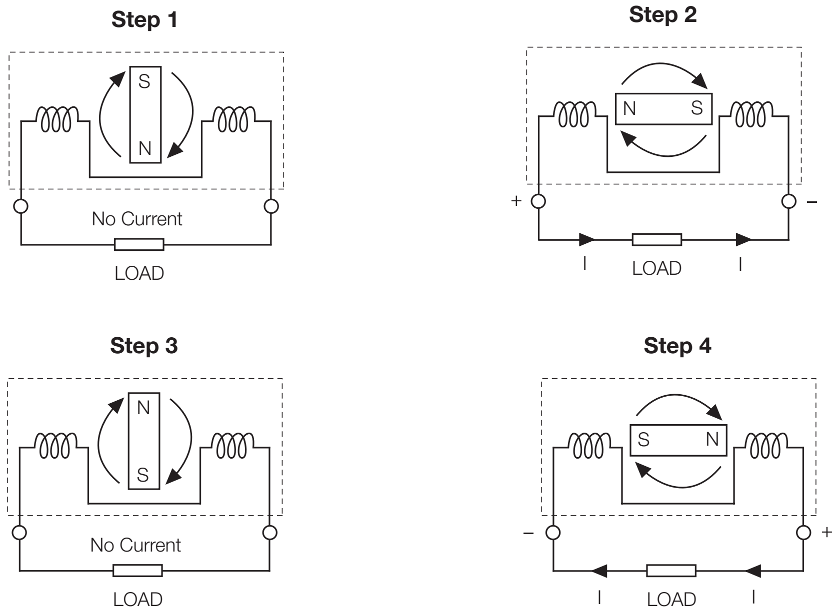
AC power is typically derived from the local power company grids, either as single or three-phase source. This is then converted to DC within the majority of electronic equipment.

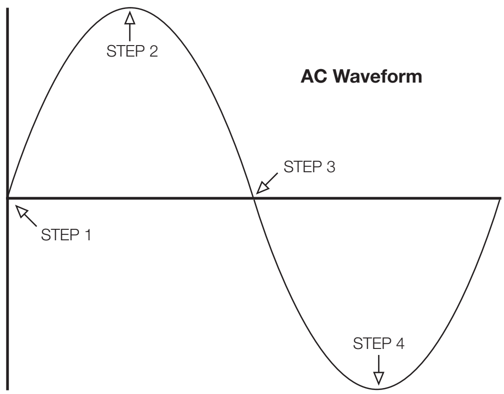
AC Power Sources

In applications where electricity is used to dissipate energy in the form of heat (heaters, light bulbs), the polarity or direction of current is irrelevant so long as there is enough voltage and current to the load to produce the desired heat (power dissipation). However, with AC it is possible to build electric generators, motors and power distribution systems that are far more efficient than a DC equivalent. For this reason, AC is used predominantly in high power applications.

AC generator/source:

In order to construct an AC generator, a magnetic field is rotated around a set of stationary wire coils, the resultant AC voltage/potential produced as the field rotates being in accordance with Faraday's Law of electromagnetic induction. The basic operation of the AC generator, also known as an alternator, can be seen below:





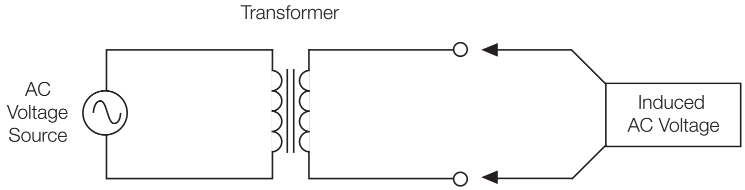
The polarity of the voltage across the wire coils reverses as the opposite poles of the rotating magnet pass by. Connected to a load, this reversing voltage polarity creates a reversing current direction in the circuit.

The frequency of the resultant wave form is dependent on the speed of the rotating magnetic field.

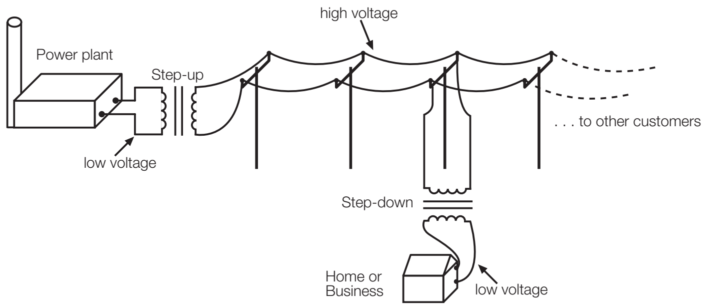
Frequency	**=**	**No. of cycles/second**
	=	**No. of revolutions/second**

AC generators and AC motors are generally simpler in construction than DC generators and DC motors. In addition to this, AC generators & motors benefit from the effect of electromagnetism, also known as mutual induction, whereby two or more coils of wire are positioned so that the changing magnetic field created by one induces a voltage in the other.

The diagram below shows two mutually inductive coils. Energizing one coil with AC voltage creates an AC voltage in the other coil. This device is known as a transformer:



The transformer's ability to step AC voltage up or down gives AC an advantage unmatched by DC in power distribution. When transmitting electrical power over long distances, it is far more efficient to do so with stepped-up voltages and hence stepped-down currents (smaller-diameter wire with lower resistive power losses), then to step the voltage back down and the current back up for industry, business, or consumer use.



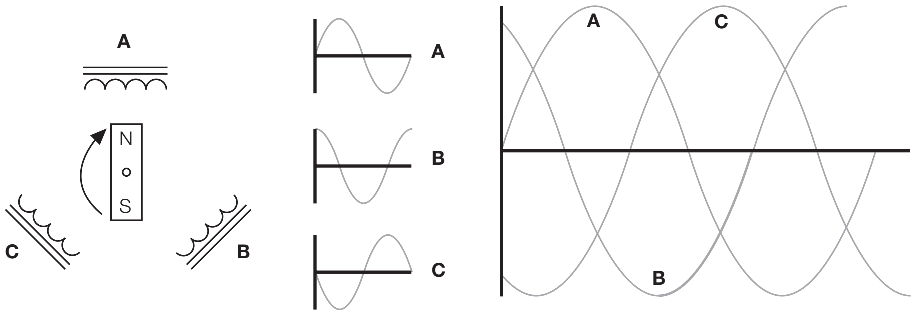
Power distribution

Transformer technology has made long-range electric power distribution practical. Without the ability to efficiently step voltage up and down, it would be prohibitively costly to construct power systems for anything but close-range use, within a few miles at most.

Three Phase AC Source

The power delivered by a single-phase system pulsates and falls to zero during each cycle, whereas the power delivered by a three-phase circuit also pulsates, but never to zero. In a balanced three-phase system, the conductors need be only about 75% the size of the conductors for a single-phase two-wire system of the same kVA rating.

If three separate coils are spaced 120° apart, the three voltages are produced 120° out of phase with each other, when the magnetic field cuts through the coil.

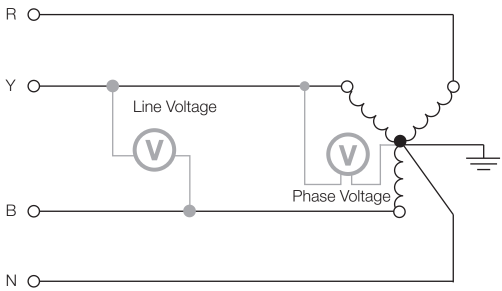


Three-phase supply

There are two basic three-phase connections used:

Star or Wye Connection

Connecting one end of each of the coils together as shown right makes a star or wye connection. The phase voltage (or phase to neutral voltage) is the voltage measured across a single coil. The line voltage (phase to phase voltage) is measured across two coils.



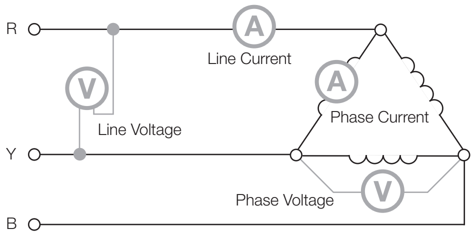
In a star- or wye-connected system, the line voltage is higher than the phase voltage by a factor of the square root of 3 (1.732).

$$V_{LINE} = V_{PHASE} \times \sqrt{3}$$
$$V_{PHASE} = V_{LINE} / \sqrt{3}$$

This system would be a 4-wire plus earth supply.

Delta Connection

The three separate coils are connected to form a triangle in a delta-connected system, which derives its name from the fact that a schematic diagram of this connection resembles the Greek letter delta.



In this configuration the line voltage and phase voltages are the same.

$$V_{LINE} = V_{PHASE}$$

However, the line current is higher than the phase current by a factor of the square root of 3 (1.732). The reason for this difference in current is that current flows through different windings at different times in a three-phase circuit.

At times, current will flow between two lines only, at other times current will flow from two lines to the third.

This system would be a 3-wire plus earth supply.

Worldwide Single Phase Voltages & Frequencies

Africa -	**220-240 V / 50 Hz**	
exceptions:	Liberia	120 V / 60 Hz
	Libya(1)	127 V / 50 Hz
Asia-Pacific	**220-240 V / 50 Hz**	
exceptions:	Philippines, South Korea(2)	220 V / 60 Hz
	American Samoa, Micronesia, Palmyra Atoll	120 V / 60 Hz
	Guam, Taiwan	110 V / 60 Hz
	Okinawa	100 V / 60 Hz
	Japan	100 V / 50/60 Hz
	Tahiti	110/220 V / 60 Hz
Caribbean	**100-127 V / 60 Hz**	
exceptions:	Dominica, Grenada, Guadeloupe, St. Vincent	230 V / 50 Hz
	Martinique	220 V / 50 Hz
	St. Lucia	240 V / 50 Hz
	Antigua, Montserrat, St Kitts & Nevis	230 V / 60 Hz
	Barbados	115 V / 50 Hz
	Jamaica	110 V / 50 Hz
	Cuba(3)	110/220 V / 60 Hz
	Netherlands Antilles(4)	127/220 V / 50 Hz
Central America	**100-127 V / 60 Hz**	
exceptions:	French Guyana	220 V / 50 Hz
	Guyana(5)	240 V / 60 Hz
	Belize	110/220 V / 60 Hz
Europe	**220-240 V / 50 Hz**	
Middle East	**220-240 V / 60 Hz**	
exceptions:	Saudi Arabia	127/220 V / 60 Hz
North America	**120 V / 60 Hz**	
South America	**220-240 V / 50 Hz**	
exceptions:	Colombia	110 V / 60 Hz
	Nicaragua, Venezuela	120 V / 60 Hz
	Ecuador	120-127 V / 60 Hz
	Brazil(6)	110/220 V / 60 Hz
	Peru(7)	220 V / 60 Hz

Notes

(1) Libya - Barce, Benghazi, Derna, Sebha and Tobruk 230 V

(2) South Korea - 110 V can be found in older buildings.

(3) Cuba - older hotels 110 V, new hotels 220 V.

(4) Netherlands Antilles - Saba, St. Eustasius 110 V / 60 Hz, St. Martin 120 V / 60 Hz.

(5) Guyana - both 120 V and 240 V at either 50 Hz or 60 Hz can be found in Georgetown.

(6) Brazil - voltage varies from state to state.

(7) Peru - Talara both 120 V and 220 V available