Electrical Installations and Circuits

Types of Current

Current delivering electricity to any device can come in two forms:

1. Direct Current (DC)
2. Alternating Current (AC)

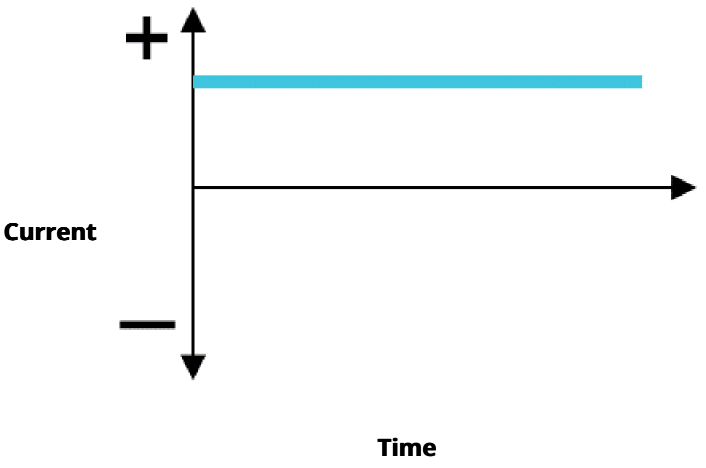
When connecting any device to any circuit, it is important to know which form of current is being used.

There are devices that can convert current from one format to another, or from a higher voltage current to a lower voltage current and vice versa are universally referred to as “transformers.” Any time voltage or current type is transformed, there will always be some energy loss, even if very small.

- A transformer that converts a higher voltage current to a lower voltage current is called a “step down” transformer, and works by either converting high voltage low current loads to low voltage high current loads, or by adding resistance between two circuits to limit the voltage output, resulting in lower power being received on the output side.
- A transformer that converts to a higher voltage is called a “step up” transformer, and works by converting low voltage but high currents into high voltage but low currents. A step up transformer does not add additional electrical power to the circuit, it only increases overall voltage.
- A transformer that converts a current from DC to AC is called an inverter, and physically induces an alternating current on the output side. Inverters typically consume electrical power for the conversion process, and thus are less energy efficient than other forms of transformers.
- A transformer that converts a current from an AC to DC can be called a "battery charger" (for charging batteries) or a "power supply" (for direct powering of a radio, etc.), depending on how the conversion process works.

Direct Current (DC)

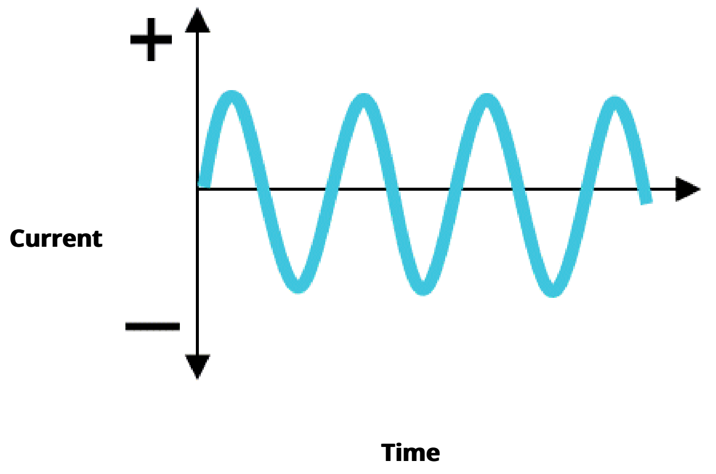
The main characteristic of a Direct Current – or DC – is that the electrons within the current always flow in the same direction, from the side with a deficit to the side with a surplus. This is the kind of current supplied via the chemical effect by batteries, or via the photovoltaic effect by solar panels. The terminals are marked + and – to show the polarity of the circuit or generator. The voltage and current are constant in time.



- **Advantages:** Batteries can supply DC directly and it is possible to add the sources in parallel or series.
- **Disadvantages:** In reality, the use of the batteries limits the voltage to a few volts (up to 24 volts in some vehicles). Those low voltages prevent the transportation of this type of current.

Alternating Current (AC)

In alternating current – or AC - the electrons reverse direction at a given frequency. As the current continually alternates there is no fixed + or –, but “phase” and “neutral”. Voltage and current follow a sinusoidal curve. While voltage and current continually vary between a maximum and minimum value, measurement masks this variation and shows a stable average value—such as 220V.



The frequency is defined as the number of sinusoidal oscillations per second:

- 50 oscillations per second in Europe (50Hz).
- 60 oscillations per second in the US (60Hz).

AC is the type of current supplied by electric utility companies because AC voltage can be increased and decreased with a transformer. This allows the power to be transported through power lines efficiently at high voltage and transformed to a lower, safer, voltage for use in businesses and residences. Therefore, it is the form of electrical energy that consumers typically use when they plug an appliance into a wall socket.

- **Advantages:** Can be transported over long distances without too much loss using high tension lines. It is easy to produce.
- **Disadvantages:** AC cannot be stored; it must be created. AC can also pose a greater health hazard for living organisms that come into contact with it.

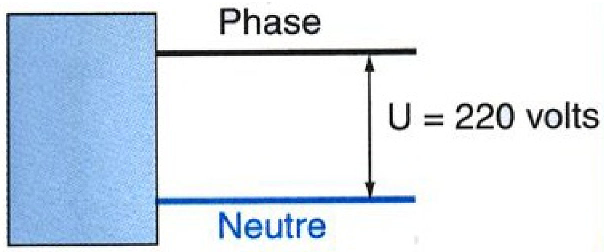
There are two types of AC:

A single-phase current is the most common type of current, and thus is usually the configuration delivered by public networks, but also by a single-phase generator. A single-phase AC is supplied via two lines (phase and neutral), usually with a 220 V voltage difference between them. Plugs can be inserted in both ways.

Because the voltage of a single-phase system reaches a peak value twice in each cycle, the instantaneous power is not constant and is mainly use for lighting and heating but cannot work with industrial motors.

Single-Phase

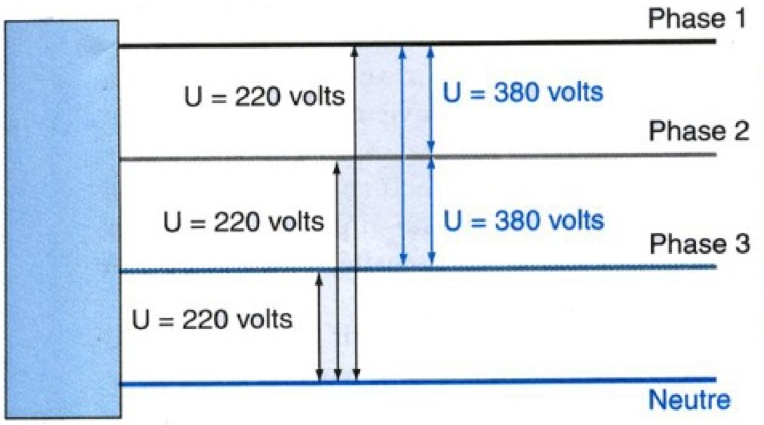
A single-phase load may be powered from a three-phase distribution transformer allowing stand-along single-phase circuit to be connected a three-phase motor, an allowing a three-phase motor to be connected to all three phases. This eliminates the need of a separate single-phase transformer.



If there is an increased need for power, then consistency and balance pay a key role. Three-phase circuit is the common current configuration for electricity companies, and can also be produced with a three-phase generator. A three-phase current is the combination of three single phase currents.

To carry a given power with 3 separate single-phase cables, 9 wires are needed. To carry the same power in a three-phase cable, only 5 wires are required (3 phase, 1 neutral, 1 ground), which it is why there can be significant savings when properly planning a three-phase current. Cost savings include saving on wires, cables, and also in apparatus using or producing electricity. Three-phase motors or alternators will also be smaller than the single phase equivalents of the same power production.

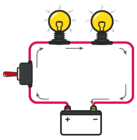
Three-Phase



Grouping Circuit Components

In every circuit there will be resistor(s) and generator(s), the numbers of which will the depend of the power requisites. Both components can be grouped depending on the what is required to keep constant, the current or the voltage. There are two basic ways to groups components in series or in parallel. (additional information in connecting batteries section)

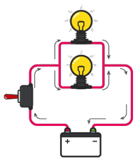
Series



The basic idea of a "series" connection is that components are connected end-to-end in a line to form a single path through which current can flow:

1. **Current**: The amount of current is the same through any component in a series circuit.
2. **Resistance**: The total resistance of any series circuit is equal to the sum of the individual resistances.
3. **Voltage**: The supply voltage in a series circuit is equal to the sum of the individual voltage drops.

Parallel



The basic idea of a "parallel" connection is that all components are connected across each other's leads. In a purely parallel circuit, there are never more than two sets of electrically common points, no matter how many components are connected. There are many paths for current flow, but only one voltage across all components:

1. **Voltage:** Voltage is equal across all components in a parallel circuit.
2. **Current:** The total circuit current is equal to the sum of the individual branch currents.
3. **Resistance:** Individual resistances *diminish* to equal a smaller total resistance rather than *add* to make the total.
