



## 3-Phase Power - What's the point?

An introduction into what you may need to know.  
by Ian Jackson



### A Simple introduction to AC Power

To make sense of 3-Phase Power it needs to be compared to the more domestic Single Phase Power and how this relates to *other* fundamental sources such as the basic DC battery found in a cars, toys and mobile phones.

Batteries have a designated positive and negative end. When applied to a DC motor, swapping these two connections will change the direction the motor rotates. Most electronics, including the modern LED torch, are sensitive to this polarity and requires the correct connection for the equipment to work. The simple light globe does not care about polarity and will shine just as bright connected either way. If some kind of mechanical contrivance were to unplug a battery from a lamp circuit, reverse it and put it back again very fast, at say fifty times per second, the lamp would appear to remain steadily lit and we would have something approaching a 50 cycle (or Hertz), Single Phase AC (*alternating current*) power source. The energy we receive from the domestic power outlet resembles this reversing battery effect, except it runs at a higher 230 Volt level and it has very smooth changes in polarity.

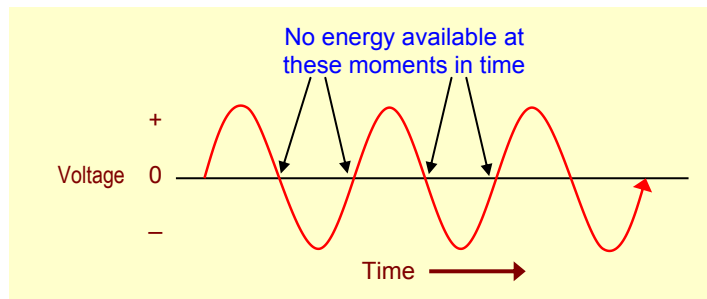
### Some Good and Bad points about Single Phase AC power

There is a lot of value in using AC over DC because AC can pass through a power transformer to easily increase or decrease the voltage to suit our needs with few energy losses in the change. However, you don't get something for nothing, so if the voltage is stepped up by passing it through a transformer, then the available current to flow through the circuit will fall proportionally. The overall energy reaching the equipment to be operated via a transformer will remain about the same.

The **Single Phase AC supply** is really versatile. It can be conveyed along long distances with relatively few losses on just two wires. Sometimes only one wire is needed if the Earth is being used as a return path. This makes it fine for lighting and electronic appliances in domestic households, but it still has a couple of issues. As the voltage passes from Positive to Negative, it must also pass through a *zero voltage* point. This means that there are instants in time when no energy is being delivered to the customer load.

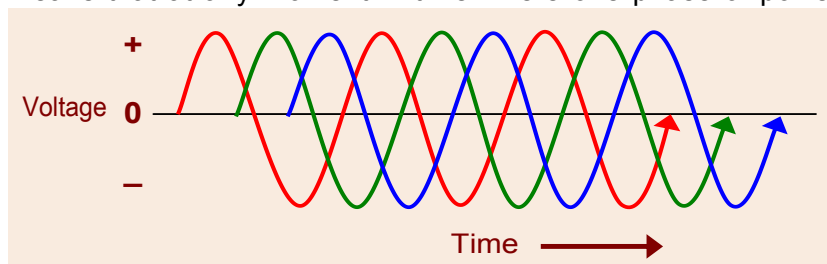
This is not a problem for small loads, but when trying to drive larger loads, such as electric motors, this effect can impact the energy levels reaching the equipment.

Another small limitation is that without the addition of a component called a *capacitor*, most types of Single Phase motors have difficulty in deciding which way to turn when first activated, or may not turn at all.



### Introducing Three Phase Power

Back in 1882 John Hopkinson, a British engineer patented the Three Phase system for distributing power. Essentially it is **three** single phase power sources staggered one-third of a cycle apart. This means that at any moment in time where one phase of power is passing through the zero point, the other two phases are still delivering worthwhile power to the load.



Usually 3-Phase power is delivered over three wires called the **Delta** format. These three wires are generally labeled L1, L2 and L3.

Sometimes a fourth common or **Neutral** wire is added and this is described as the **Star** format.

### **Sounds complicated. Is it worth the extra effort?**

The Australian voltage standard for Single Phase Power is **230V**, but with Three Phase Power the standard voltage between each of the three wires will be close to **400V**. There are good reasons for this arrangement. The higher voltage helps to deliver more energy to commercial and industrial loads.

Apart from the higher voltages used, the real advantage to 3-Phase Power is in how electric motors perform. The staggered phasing arrangement instantly tells the motor which way to rotate, so complicated start capacitor stages are not needed. As the energy in a 3-Phase circuit is spread over all three connections, the peak start current is about half of the level needed for similar sized Single Phase motors. This means that there are fewer issues with power dips and flickering lights when larger motors are being started.

Three Phase motors are cheaper to manufacture and are more efficient to operate than their single phase counterparts. All this adds up to many manufacturers of equipment like metalworking machines, car hoists and refrigeration systems actively use three phase motors in their designs. This pretty much forces the customer to install a 3-phase connection if they want their machine to work.

### **Getting Three Phase Power connected to your home or workshop**

If a 3-Phase connection does not already exist at your location, organising access can be an onerous task. First you need to check with the power company to see if 3-phase power is available in your area. It is likely that the cable from the street to your switchboard may need to be replaced with a new one with the three wires inside. An electrician will also need to upgrade the switchboard with a new tariff meter and fit special three phase circuit breakers. If the existing switchboard is small, then the entire switchboard may need replacement and re-wiring. Lastly, new cables will need to be installed from the switchboard to each machine that uses 3-Phase power. Unfortunately all of this preparation work often exceeds the cost of the 3-phase machinery to be operated! It is not uncommon for a 3-Phase upgrade process to be spread over several months, so allocate sufficient time if this work must be carried out with a particular deadline in mind. Contact the power company for a quotation early as possible.

It is important to note that some parts of Australia charge an extra daily connection fee for the privilege of having a three phase connection present in a building, so consumers must be prepared for an increase in operating costs, even if the actual energy being used by their 3-phase appliance is small.

### **Is there an easy way to convert Single Phase to Three Phase Power?**

Some techniques do exist for taking a standard 230V Single Phase supply and converting it into a useable form of 3-Phase Power. The better of these methods are Rotary Power Converter units. Typically, this is a box the size of a short filing cabinet which uses a pilot motor and power transformer to create 3-Phase from available single phase power. These are a semi-portable device that generate 400V, 3-Phase power where needed from around 1.5 to 50 Horsepower. While the cost of such units usually start at around two thousand dollars, they often work out to be the cheaper option as they become an asset that can be easily relocated. An internet search for *3 phase power converter* will reveal more specific information about this type of technology.

Whichever way you look at it, 3-Phase Power is a convention that will be with us for many years to come. Taking time to learn more about such systems is a sound investment for the future.