Power Factor Correction (PFC) Design Services

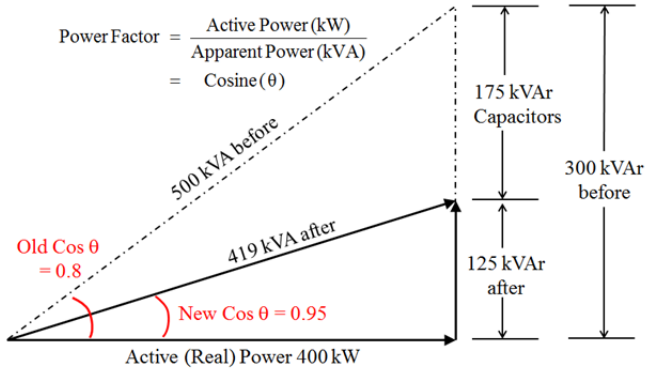
With the recent introduction in Queensland of new electricity demand pricing for large energy users based on kilovolt ampere (kVA) – companies now being charged for power supplied (kVA) rather than power used (kWh) - businesses are encouraged to improve their power factor to use their electricity more efficiently. The simplest way to do this is to install PFC equipment consisting of capacitor banks. These are measured in kilovolt ampere reactive - kVAr. The amount of PFC equipment needed will vary depending on existing demand and power factor, as well as the desired power factor, and calculating this requires certain expertise and guidance. Liberty Consulting Services (LCS) has been carrying out these studies for large energy users around Australia, and offers an independent design service and application advice when dealing with the numerous PFC equipment suppliers in the market.

What is Power Factor Correction?

Power factor indicates how well incoming power is being used. It is expressed as value between zero and 1, and the closer a power factor is to 1, the more efficiently electricity is used. A power factor between 0.95 and 1 is ideal.

For a power factor less than 1, extra power is needed to supply equipment to do their work. This extra power is called Reactive Power. This is the portion of electricity that maintains the electromagnetic fields of a.c. equipment, e.g. motors, transformers. But it also imposes an undesirable burden on the supply.

The “power triangle” here shows how the various active, apparent and reactive power components, as well as power factor are determined.

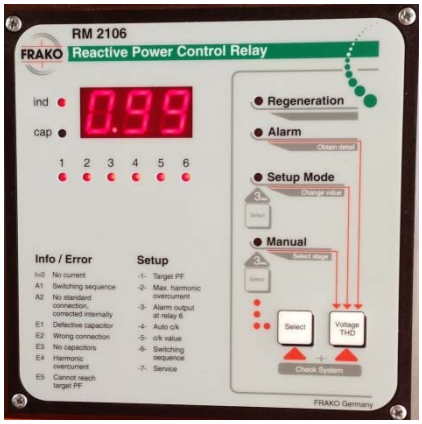


Relevant Australian Standards

- AS/NZS 3000 Electrical Installations (Wiring Rules)
- AS/NZS 60038 Standard Voltages
- AS/NZS 61000 Series, Electromagnetic Compatibility (EMC)
- AS/NZS 3598 Energy Audits

The role of capacitors in PFC

PFC capacitors work as reactive current generators providing needed reactive power (kVAr) into the power supply. PFC capacitors reduce the total current drawn from the distribution system and subsequently increase system capacity by raising the power factor level. Since the capacitor's current is 180 degrees out of phase from the load's inductive contribution to current draw, the capacitor's kVAr will directly subtract from the load's kVAr.



Capacitors are typically installed in banks, which are automatically switched, with a controller to show how many banks are in use in at a time.

Where to install PFC equipment

The strategy we adopt with the design of PFC is to install it as close as practical to the load (at LV), where the kVArs are produced. Several reasons support this.

PFC is more distributed at downstream switchboards, which is safer than single large HV PFC units at a facility's point of entry, means ease of maintenance.

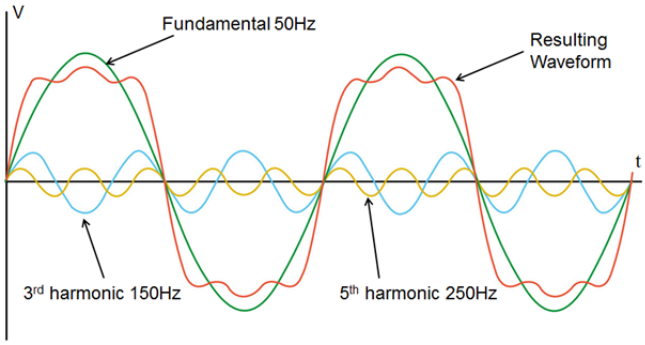
Real power kW reductions (I^2R) occur (up to 2-3% is possible) due to lower current in cables, transformers and switchboards supplying the loads.

The installation of PFC closer to the electrical load will also improve voltage stability. This improved voltage decreases motor currents which reduce heat in motor windings, leading to longer service life.

Harmonics in the power system

The predominance of non-linear loads today has led to harmonic distortion in our electricity distribution systems. These harmonics are created by:

- 3 phase non-linear loads, 5^{th}, 7^{th}, 11^{th}, 13^{th} order harmonics (not multiples of 3); and
- single phase non-linear loads, 3^{rd} order harmonics and higher multiples of 3.



Capacitor banks themselves do not cause harmonics, but they can cause resonance, which amplifies existing harmonics in the system. Careful selection of PFC is therefore required, with knowledge of the type of loads so that this is avoided. Blocking reactors (inductance in series with the capacitor banks) tuned below either the 3^{rd} or 5^{th} harmonic are available, depending on the system load profile.

Benefits of PFC – the payback equation

An improved power factor has the potential to lower energy bills by running equipment more efficiently and reducing the maximum electricity demand.

As an example Ergon have a monthly excess demand charge of $4 per kVAr in excess of permissible PF.

Using the above triangle, a 400kW load at 0.8 PF needs to improve to 0.95 PF to avoid any penalty charges. This means the excess 175kVAr results in $700 per month. If PFC installed costs are $60/kVAr, then this is a payback of 1.25 years.

This will vary from site to site, and an audit of the electrical system layout and connected loads, with power measurements at MCC/MSB locations is able to be done by LCS engineers with RPEQ certification.