American Control Technologies, Inc.

PFC Series-- Save Up To 25% In Energy Costs
Eliminate Costly Power Factor Penalties

Power Quality

Guide To Power Factor

Understanding Power Factor

Power factor is a term commonly used, when considering the efficiency of an electrical power distribution system. Typically, electrical loads are resistive, inductive, and include both linear and non-linear elements. Most commercial and industrial alternating current (AC) loads are inductive, due to the nature of the types of devices connected on the electrical system. Specific industries where power factor may be critical are steel/foundries, chemicals, textiles, pulp and paper, automotive, rubber and plastics. Several examples of equipment utilized, where power factor is a concern, may include; transformers, motors, lighting, arc welders, and induction furnaces, all which require reactive power to generate an electro-magnetic field for operation. Such equipment can produce poor, or a low power factor, measured in a decimal fashion, such as .70 (70% of value). A unity power factor of 1.0 (100%), is be considered ideal. However, for most users of electricity, power factor is usually less then 100%, which means the electrical power is not effectively utilized. This inefficiency can increase the cost of the user's electricity, as the energy or electric utility company transfers its own excess operational costs on to the user. Billing of electricity is accomplished with various methods, which may also affect costing. In order to measure and size (rate) equipment, power factor consists of two components: KW (working or real power) and KVAR (reactive power). KW "performs" the actual work, whereas KVAR does not "perform" any beneficial work, instead only maintaining magnetic fields. The vector sum of KW and KVAR is apparent power, or KVA. Where applicable, most equipment will The power factor ratio determines the efficiency of electrical power being utilized within a power system.

$$\frac{\text{Working Power (KW)}}{\text{Reactive Power (KVA)}} = \text{Power Factor (PF)}$$

Example ratio of poor power factor:

$$\frac{100\ \text{(KW)}}{125\text{(KVA)}} = .80\ \text{(PF)}$$

Example ratio with improved power factor, when installing capacitors:

$$\frac{100\ \text{(KW)}}{105\ \text{(KVA)}} = .95\ \text{(PF)}$$

With the installation of a properly designed capacitor system, which adds VARS (volt-amp-reactive), the same amount of work (100KW) is performed, while the KVA is reduced. This allows for less KVA for the same amount of working power.

Energy service and utility companies charge users of electric differently. Common billing practices include KW or KVA with or without demand, or with a power factor penalty. It is recommended to request specific billing/contract information from the electric provider, to better establish and analyze electric cost components. Though unity power factor may be desirable, there are additional costs associated to achieve such a level. It is common practice to correct to at least .90 (.92-.95) or higher.

Correction or improvement of poor power factor will lower electricity costs, increase KVA capability, increase KW for the same KVA demand, improve voltage regulation (drop), and allow for size reductions in cable, transformers and switchgear.

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This may reduce operational costs, by eliminating or deferring the need for new equipment expenditures, plus help to make future plant expansions less costly. Also, new equipment savings can be realized (potential to purchase at smaller ratings), existing equipment life may be extended, as well as an attractive return on investment and long term cost savings for installed capacitor systems.

Types of Power Factor Correction Solutions

Requirements of the user (commercial, industrial, utility etc.), will vary widely. Low voltage class systems rated at 240-600vac generally have application needs and solutions, which may be met with off-the-shelf components, through highly unique, designed power systems. Simple, small, fixed “at-load” capacitors can be found at single motor locations. Larger fixed kvar assemblies can be installed for correction of multiple equipment. Still larger, automatic (switched) capacitor banks can be found at the service entrance, to help correct a complete facility. Power factor correction may be integrated with MCC’s and switchgear, as well as retrofitted or found as a match-and-line arrangement.

Medium voltage classifications of 2.4kv and higher, will use power factor correction equipment installed indoors, such as in a large manufacturing operation, or, most often, outdoors. Configurations here can be either pole mounted, fixed or switched, or distribution substation located. When found in a substation rated at 2.4 to 34.5kv, capacitors can be either open rack style (capacitors mounted on a fabricated structure and field installed), metal enclosed equipment (completely manufactured and testing from the factory), or an integrated hybrid version (metal enclosed protection and partial open-air capacitors). Mobile capacitors (self-contained trailer) rated from 15kv-245kv are used mainly by utilities for substation duty. Low and medium voltage solutions employ the use of shunt capacitors for power factor correction. Medium and high voltage series capacitors may be platform mounted and elevated, as well as located in a distribution or transmission substation. Such installations typically provide VAR support for T&D wires/lines.

Individual power capacitors may consist of externally fused, internally fused, or fuseless types. Externally fused capacitors (current limiting or expulsion type fuse connected to capacitor bushing) are the most common. Capacitors may also utilize either a dry or liquid type dielectric material, though in either case, containing no PBC material. Depending upon the application, capacitors may also be single phase or three phase, with one, two, or three bushing arrangements. There are also other types of capacitors used for specialty applications such as furnace and power electronics.

ACT Energy Products designs and manufacturers low voltage fixed and automatic systems, which incorporate the use of a metal enclosure design. Further, to meet other power quality demands, high speed transient free switching, harmonic filtering, and surge protection can be included, as well as metering, relay protection, controls, SCADA and communications, to make a full service energy management system.

System Requirements

To better facilitate application requirements and to assist with initial system design parameters, the following should be completed

Low Voltage Class

Nominal System Voltage ________240vac

_______480vac _____600vac _____Other

Current

Amps ___________

Power Factor

Phase 1_______ Phase 2______ Phase 3_______

Frequency

50hz________ 60hz________ Other__________

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