Fişa suspiciunii de plagiat / Sheet of plagiarism's suspicion	Indexat la: 57/06

Opera suspicionată (OS) Suspicious work	Opera autentică (OA) Authentic work

OS	Rotar, D., Wind generator reactive power compensation with microcontroller solution, Modelling and Optimization in the Machines Building Field (MOCM) 12, Vol.2, 2006, p.120-125.
OA	* * *, Power factor studies, http :// www . electrotek . com / pfactor . htm, 2002

Incidența minimă a suspiciunii / Minimum incidence of suspicion	
p.1:5 - p.1:10	p.1:3 – p.1:7
p.1:20 - p.1:31	p.1:8 – p.1:10; p.1:12 – p.1:13; p.1:15 – p.1:21
p.2:2 – p.2:36	p.2:2 – p.2:9; p.2:11 p.2:39
p.4:Figure 2	p.1:Figure
p.5:Figure 4	p.2:Figure

Fişa întocmită pentru includerea suspiciunii în Indexul Operelor Plagiate în România de la www.plagiate.ro http://www.electrotek.com/pfactor.htm

ELECTROTEK CONCEPTS

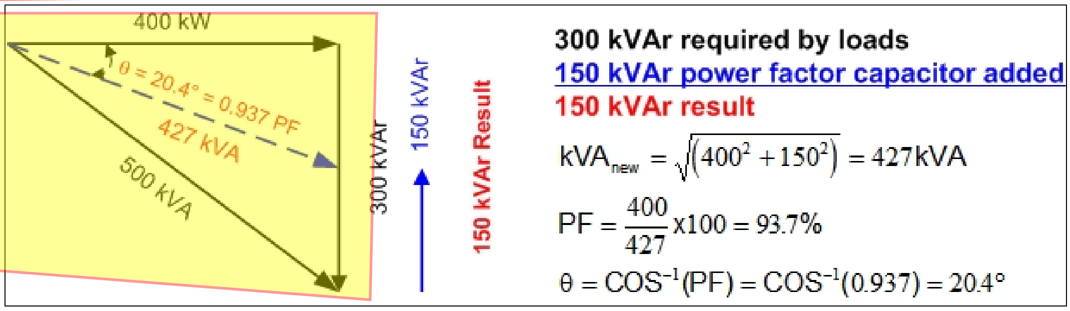



Power Factor Studies

Background

Power factor is a measurement of how efficiently a facility uses electrical energy. A high power factor means that electrical capacity is being utilized effectively, while a low power factor indicates poor utilization of electric power. However, this is not to be confused with energy efficiency or conservation which applies only to energy. Improving the efficiency of electrical equipment reduces energy consumption, but does not necessarily improve the power factor.

Power factor involves the relationship between these two types of power. Active Power is measured in kilowatts (kW) and Reactive Power is measured in kilovolt-amperes-reactive (kVAr). Active power and reactive power together make up Apparent Power, which is measured in kilovolt-amperes (kVA). This relationship is often illustrated using the familiar "power triangle" that is shown in the following figure.



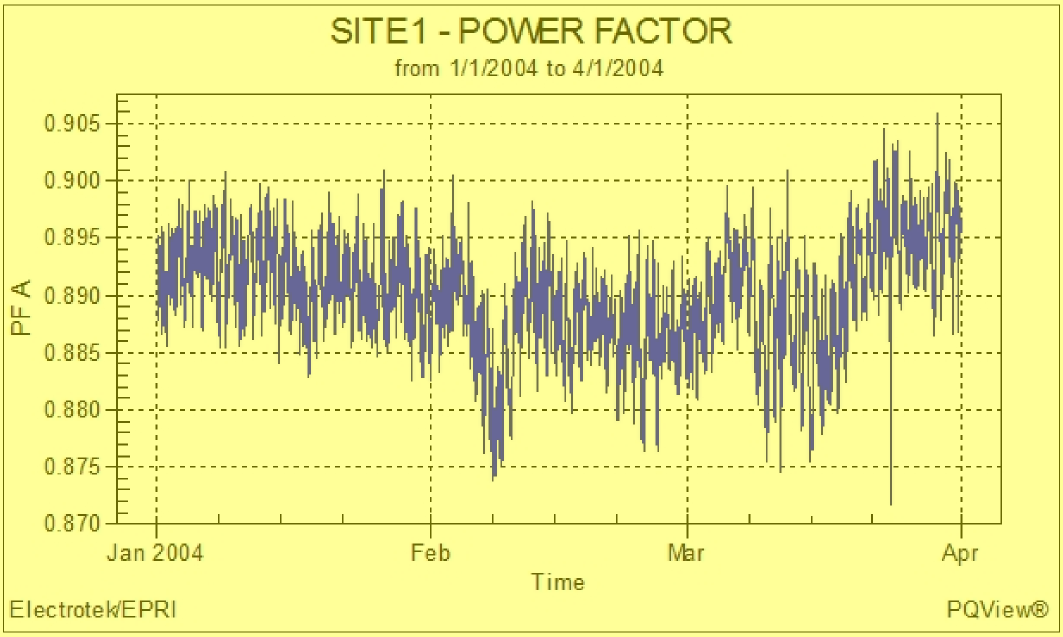
Power Factor Compensation

Power factor is the ratio between active power and apparent power. Active power does work and reactive power produces an electromagnetic field for inductive loads. Using the values in the power triangle example shown above, the facility is operating at 400 kW (Active Power) with an 80% power factor, resulting in a total load of 500 kVA.

Lightly-loaded or varying-load inductive equipment such as HVAC systems, arc furnaces, molding equipment, presses, etc., are all examples of equipment that can have a poor power factor. One of the worst offenders is a lightly loaded induction motor (e.g., saws, conveyors, compressors, grinders, etc.).

End users should be concerned about low power factor because it means that they are using a facility's electrical system capacity inefficiently. It can cause equipment overloads, low voltage conditions, greater line losses, and increased heating of equipment that can shorten service life. Most importantly, low power factor can increase an electric bill with higher total demand charges and cost per kWh.

The power factor in a facility will vary over time. An example trend of a facility's power factor over three-months is shown in the figure below. Power factor will also vary with different types of loads, and the overall mix of various types of loads. Inductive loads, such as motors, will tend to reduce the power factor. Linear loads, such as lighting, will tend to increase power factor.



Power Factor Trend

Correcting Poor Power Factor

Low power factor is generally solved by adding power factor correction capacitors to a facility's electrical distribution system. Power factor correction capacitors supply the necessary reactive portion of power (kVAr) for inductive devices. By supplying its own source of reactive power, a facility frees the utility from having to supply it. This generally results in a reduction in total customer demand and energy charges.

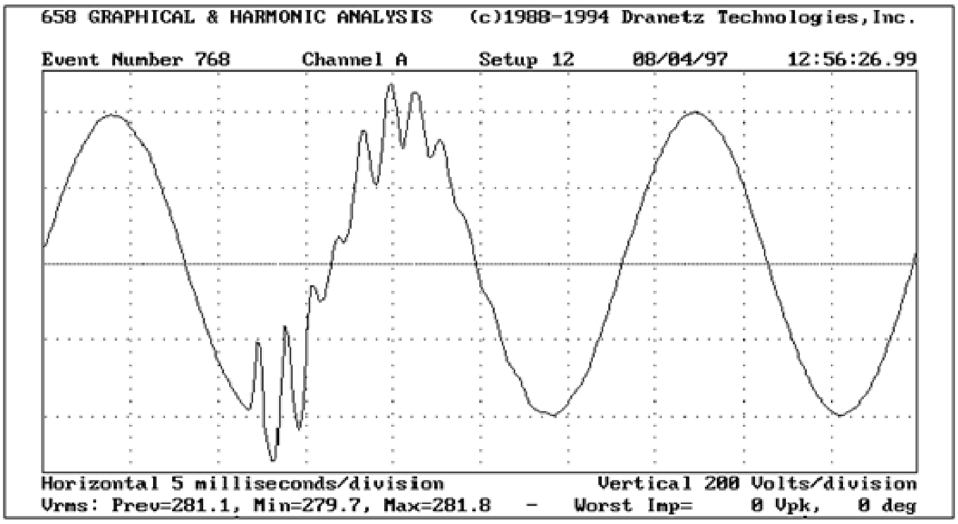
Power factor correction requirements determine the total amount of capacitors required at low voltage buses. These capacitors can be configured as harmonic filters if necessary. The power factor characteristics of plant loads typically are determined from billing information, however, in the case of a new installation, typical load power factors will determine the required compensation.

Impact of Power Factor Correction Capacitors on Power Quality

A properly designed capacitor application should not have an adverse affect on end user equipment or power quality. However, despite the significant benefits that can be realized using power factor correction capacitors, there are a number of power quality-related concerns that should be considered before capacitors are installed. Potential problems include increased harmonic distortion and transient overvoltages.

Harmonic Distortion: Harmonic distortion on power systems can most simply be described as noise that distorts the sinusoidal waveshape. Harmonics are caused by nonlinear loads (e.g., adjustable-speed drives, compact fluorescent lighting, induction furnaces, etc.) connected to a facility's power system. These loads draw nonsinusoidal currents (e.g., on a 60 Hz system, the 5th harmonic is equal to 300 Hz), which in turn react with the system impedance to produce voltage distortion. Generally, the harmonic impedances are low enough that excessive distortion levels do not occur. However, power factor correction capacitors can significantly alter this impedance and create what is known as a "resonance" condition. High voltage distortion can occur if the resonant frequency is near one of the harmonic currents produced by the nonlinear loads. Indications that a harmonic resonance exists include device overheating, frequent circuit breaker tripping, unexplained fuse operation, capacitor failures, and electronic equipment malfunction. Ways to avoid excessive distortion levels include altering (or moving) the capacitor size to avoid a harmful resonance point (e.g., 5th, 7th), altering the size (or moving) of the nonlinear load(s), or adding reactors to the power factor correction capacitors to configure them as harmonic filters.

Transient Overvoltages: Transient overvoltages can be caused by a number of power system switching events; however, utility capacitor switching often receives special attention due to the impact on customer equipment. Each time a utility switches a capacitor bank a transient overvoltage occurs. An example of this type of transient is illustrated in the figure below. Generally, these overvoltages are low enough that they do not affect the system. However, high overvoltages can occur when customers have power factor correction capacitors. This phenomenon is often referred to as "voltage magnification". Magnification occurs when the transient oscillation initiated by the utility capacitor switching excites a resonance (refer to previous definition for hresonance) formed by a step-down transformer and low voltage power factor correction capacitors. Magnified overvoltages can be quite severe and the energy associated with these events can be damaging to power electronic equipment and surge protective devices (e.g., transient voltage surge suppressors). Adjustable-speed drives have been found to be especially susceptible to these transients and nuisance tripping can result even when overvoltage levels are not severe.

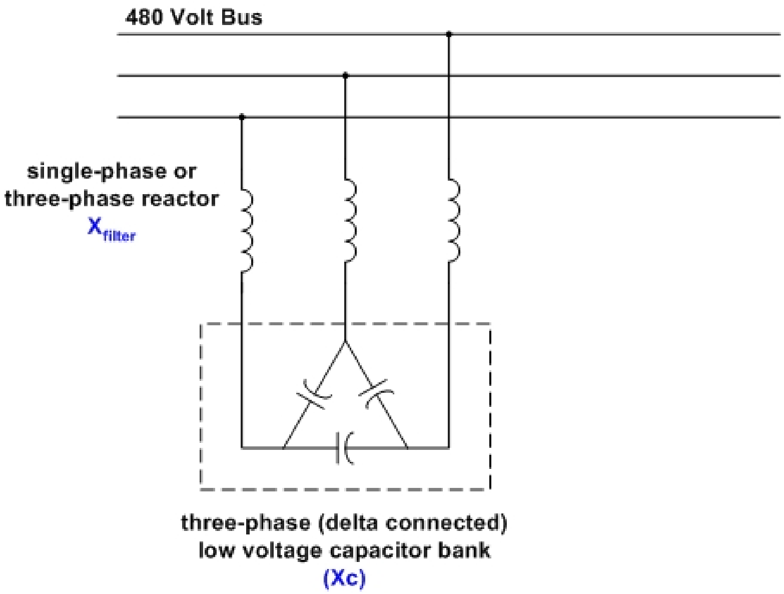


Secondary Bus Voltage Waveform during Utility Capacitor Switching

Electrotek's Power Factor Study

Power factor correction requirements determine the total amount of capacitors required at the low voltage buses. These capacitors can be configured as harmonic filters if necessary. The power factor characteristics of the plant loads typically are determined from billing information, however, in the case of a new installation, typical load power factors will determine the required compensation.

Power factor correction requirements are identified and this data provides input for the harmonic study and the filter design. Harmonic filters are designed as needed based on the minimum reactive power and maximum harmonic current requirements.



Example Low Voltage Harmonic Filter Configuration

When dealing with the power factor of nonlinear loads, it is important to note that the power factor is not simply the cosine of the angle between the voltage and the current. This is known as the displacement factor (df) and is only equal to the power factor for linear loads with sinusoidal voltages and currents. ASDs have distorted current waveforms and this results in a distortion component to the power factor (true power factor is the real power divided by the total apparent power). The power factor indicated in figure below includes the effect of harmonics but only applies to CSI types of drives. The distortion, and therefore the power factor, can be considerably worse for VSI type drives.

The installation of power factor correction capacitors will reduce the kVA demand on the transformers, thereby allowing additional load to be added without transformer resizing. Improved power factor will also help to reduce losses and support the bus voltages.

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