DOWNLOAD PDF POWER FACTOR

Chapter 1 : Power Factor (PF)

In electrical engineering, the power factor of an AC electrical power system is defined as the ratio of the real power absorbed by the load to the apparent power flowing in the circuit, and is a dimensionless number in the closed interval of âˆ’1 to 1.

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Chapter 2 : Omni Calculator logo

Power factor PF) is defined as a ratio between working power P (watts) and apparent power S (volt-amps): PF = P/S = watts/VrmsÃ—Irms It is a quantity that tells us how effectively your device utilizes electricity.

Resistance, reactance, and impedance This power factor calculator is a handy tool for analyzing the alternating current AC flowing in electrical circuits. In the case of AC, this task is not that simple, as such circuits contain both real and reactive power. This calculator will help you not only find out what are the values of the different types of power in the circuit, but will also supply you with a power factor formula that expresses the relationship between the real and apparent power. Real, reactive, and apparent power If you want to understand what the power factor is, you first need a deeper understanding of its components: Real power also called true or active power , denoted with P, performs the real work in an electrical circuit and is dissipated in resistors. It is the only form of power that appears in a DC circuit. In an AC circuit, the values of current and voltage are not fixed - they change sinusoidally. This power is measured in watts. Reactive power, denoted with Q, is transferred when the current and voltage are 90 degrees out of phase. In such a case, the net energy transferred in the AC circuit is equal to zero, and no real power is dissipated. Apparent power, denoted with S, is the combination of the real and reactive powers. It is the product of the RMS root mean square values of voltage and current in the circuit, omitting the influence of the phase angle. It is also a vector sum of P and Q. Apparent power is measured in Volt-Amps VA. The power triangle As the apparent power can be found by vector addition of the real and reactive power, you can use a graphical method to represent these three values in the form of a triangle, called the power triangle. Each side of the triangle represents one of the three forms of power being transmitted in an AC circuit. The legs of the right triangle represent the real and reactive power, and the hypotenuse - the apparent power. One of the consequences of using the power triangle is that you can easily establish the mathematical relationship between the three values with the use of the Pythagorean theorem: Power factor formula Power factor is the ratio between real and apparent power in a circuit. If there is no reactive power, then the power factor is equal to 1. If, on the contrary, the real power is equal to zero, then the apparent power is also 0. The power factor formula is: How to calculate the power factor? The power factor can also be calculated using the power triangle. Of course, instead of running the numbers manually, you can just use this power factor calculator! Resistance, reactance, and impedance The three main components of an AC circuit are resistors, capacitors, and inductors. You can use this power factor calculator not only to describe the power that is transferred through each of these components, but also to establish what happens when an electric current passes through them - namely, what resistance, reactance, and impedance do such elements possess. This value is directly linked to the real power flowing in an AC circuit. It is present mostly in capacitors and inductors. If you run an AC through a component with high reactance, the voltage drop will be 90 degrees out of phase with the current. It is present in all components of all electric circuits. The relationship between resistance, reactance, and impedance is analogical to the power triangle: Perfect inductors or capacitors have zero resistance, but nonzero reactance. All components of an electric circuit possess some impedance. Bogna Haponiuk Get the widget! Power Factor Calculator can be embedded on your website to enrich the content you wrote and make it easier for your visitors to understand your message. It is free, awesome and will keep people coming back! Get the HTML code.

Chapter 3 : Practical Power Factor Correction | Power Factor | Electronics Textbook

Power Factor. In AC circuits, the power factor is the ratio of the real power that is used to do work and the apparent power that is supplied to the circuit. The power factor can get values in the range from 0 to 1.

Power factor PF is defined as a ratio between working power P watts and apparent power S volt-amps: Suppose you connect an ideal capacitor "C" across an AC line. Since AC voltage is continuously changing its polarity, half of the time the cap will be charging from the input and half of the time it will be returning the stored energy back to the source see animation below. As a result, certain current will be continuously circulating in the line, but there will be no net energy transfer. So, we will have both volts and amps, but not useful power. The volt-amp product "VA" is called apparent power because it is just a mathematical quantity which has no real physical meaning. In such a case, all the electric energy entering the load is consumed and converted to other forms of energy, such as heat. All real circuits operate somewhere between these two extremes. In circuits analysis a sinewave signal can be represented by a complex number called phasor whose modulus is proportional to the magnitude of the signal and angle equals to its phase relative to some reference. These vectors and corresponding ones for active and reactive components of power can be presented by a triangle see the diagram below. Of course, voltage is an electric field and current is a flow of electrons, so the so-called angle between their phasors is nothing more than another mathematical quantity. By convention, inductive load create positive volt-amp reactive VARs. It is associated with so-called "lagging" power factor because current is behind the voltage. Likewise, capacitive load create negative VARs and "leading" power factor. Inductors and caps are not the only reasons of low PF. Except for ideal R, L and C, all practical electrical circuits are non-linear, particularly because of the presence of active components, such as rectifiers. In such circuits current I t is not proportional to the voltage V t , i. According to Fourier theorem, any periodic function is a sum of sine waves with frequencies that are whole multiples of the original one. These waves are called harmonics. When voltage is sinusoidal, only first harmonic I1rms can deliver real power. However its amount depends on the phase shift between I1rms and V. These facts are reflected by the general formula for PF: If you want to see how this formula is derived, check out math analysis of AC power.

Chapter 4 : How to Calculate Power Factor Correction: 8 Steps (with Pictures)

Power factor can be an important aspect to consider in an AC circuit because of any power factor less than 1 means that the circuit's wiring has to carry more current than what would be necessary with zero reactance in the circuit to deliver the same amount of (true) power to the resistive load. If our last example circuit had been purely.

For example, the triplen, or zero-sequence, harmonics 3rd, 9th, 15th, etc. In a delta-wye transformer , these harmonics can result in circulating currents in the delta windings and result in greater resistive heating. In a wye-configuration of a transformer, triplen harmonics will not create these currents, but they will result in a non-zero current in the neutral wire. This could overload the neutral wire in some cases and create error in kilowatt-hour metering systems and billing revenue. In generators and motors, these currents produce magnetic fields which oppose the rotation of the shaft and sometimes result in damaging mechanical vibrations. Historically, these very-low-cost power supplies incorporated a simple full-wave rectifier that conducted only when the mains instantaneous voltage exceeded the voltage on the input capacitors. This leads to very high ratios of peak-to-average input current, which also lead to a low distortion power factor and potentially serious phase and neutral loading concerns. A typical switched-mode power supply first converts the AC mains to a DC bus by means of a bridge rectifier or a similar circuit. The output voltage is then derived from this DC bus. The problem with this is that the rectifier is a non-linear device, so the input current is highly non-linear. That means that the input current has energy at harmonics of the frequency of the voltage. This presents a particular problem for the power companies, because they cannot compensate for the harmonic current by adding simple capacitors or inductors, as they could for the reactive power drawn by a linear load. Many jurisdictions are beginning to legally require power factor correction for all power supplies above a certain power level. Regulatory agencies such as the EU have set harmonic limits as a method of improving power factor. Declining component cost has hastened implementation of two different methods. The filter consists of capacitors or inductors, and makes a non-linear device look more like a linear load. An example of passive PFC is a valley-fill circuit. A disadvantage of passive PFC is that it requires larger inductors or capacitors than an equivalent power active PFC circuit. Active power factor correction can be single-stage or multi-stage. In the case of a switched-mode power supply, a boost converter is inserted between the bridge rectifier and the main input capacitors. The boost converter attempts to maintain a constant DC bus voltage on its output while drawing a current that is always in phase with and at the same frequency as the line voltage. Another switched-mode converter inside the power supply produces the desired output voltage from the DC bus. This approach requires additional semiconductor switches and control electronics, but permits cheaper and smaller passive components. It is frequently used in practice. For a three-phase SMPS, the Vienna rectifier configuration may be used to substantially improve the power factor. That feature is particularly welcome in power supplies for laptops. Dynamic PFC[edit] Dynamic power factor correction DPFC , sometimes referred to as "real-time power factor correction," is used for electrical stabilization in cases of rapid load changes e. DPFC is useful when standard power factor correction would cause over or under correction. Importance of power factor in distribution systems[edit] 75 Mvar capacitor bank in a kV substation Power factors below 1. This increases generation and transmission costs. For example, if the load power factor were as low as 0. Line current in the circuit would also be 1. Alternatively all components of the system such as generators, conductors, transformers, and switchgear would be increased in size and cost to carry the extra current. Utilities typically charge additional costs to commercial customers who have a power factor below some limit, which is typically 0. Engineers are often interested in the power factor of a load as one of the factors that affect the efficiency of power transmission. With the rising cost of energy and concerns over the efficient delivery of power, active PFC has become more common in consumer electronics. According to a white paper authored by Intel and the U. Small customers, such as households, are not usually charged for reactive power and so power factor metering equipment for such customers will not be installed. Techniques for measuring the power factor[edit] The power factor in a single-phase circuit or balanced three-phase circuit can be measured with the wattmeter-ammeter-voltmeter method, where the power in watts is divided by the product of measured voltage and current. The power factor of a balanced polyphase circuit is the same as that of any phase. The power factor of an unbalanced poly phase circuit is not uniquely defined. A direct reading power factor meter can be made with a moving coil meter of the electrodynamic type, carrying two perpendicular coils on the moving part of the instrument. The field of the instrument is energized by the circuit current flow. The two moving coils, A and B, are connected in parallel with the circuit load. One coil, A, will be connected through a resistor and the second coil, B, through an inductor, so that the current in coil B is delayed with respect to current in A. At unity power factor, the current in A is in phase with the circuit current, and coil A provides maximum torque, driving the instrument pointer toward the 1. At zero power factor, the current in coil B is in phase with circuit current, and coil B provides torque to drive the pointer towards 0. At intermediate values of power factor, the torques provided by the two coils add and the pointer takes up intermediate positions. The field coils are connected either directly to polyphase voltage sources or to a phase-shifting reactor if a single-phase application. A second stationary field coil, perpendicular to the voltage coils, carries a current proportional to current in one phase of the circuit. The moving system of the instrument consists of two vanes that are magnetized by the current coil. In operation the moving vanes take up a physical angle equivalent to the electrical angle between the voltage source and the current source. This type of instrument can be made to register for currents in both directions, giving a four-quadrant display of power factor or phase angle. Digital instruments exist that directly measure the time lag between voltage and current waveforms. Low-cost instruments of this type measure the peak of the waveforms. More sophisticated versions measure the peak of the fundamental harmonic only, thus giving a more accurate reading for phase angle on distorted waveforms. Calculating power factor from voltage and current phases is only accurate if both waveforms are sinusoidal.

Chapter 5 : Understanding The Power Factor - Laurens Electric Cooperative

What is Power Factor Power Factor is the cosine of the phase angle between current and voltage. Power Factor is the ratio of true power to apparent power.

When expressed as a fraction, this ratio between true power and apparent power is called the power factor for this circuit. Because true power and apparent power form the adjacent and hypotenuse sides of a right triangle, respectively, the power factor ratio is also equal to the cosine of that phase angle. Using values from the last example circuit: It should be noted that power factor, like all ratio measurements, is a unitless quantity. For the purely resistive circuit, the power factor is 1 perfect , because the reactive power equals zero. Here, the power triangle would look like a horizontal line, because the opposite reactive power side would have zero length. For the purely inductive circuit, the power factor is zero, because true power equals zero. Here, the power triangle would look like a vertical line, because the adjacent true power side would have zero length. The same could be said for a purely capacitive circuit. If there are no dissipative resistive components in the circuit, then the true power must be equal to zero, making any power in the circuit purely reactive. The power triangle for a purely capacitive circuit would again be a vertical line pointing down instead of up as it was for the purely inductive circuit. If our last example circuit had been purely resistive, we would have been able to deliver a full The poor power factor makes for an inefficient power delivery system. Inductive reactance can only be canceled by capacitive reactance , so we have to add a capacitor in parallel to our example circuit as the additional load. Since we know that the uncorrected reactive power is Figure below Parallel capacitor corrects lagging power factor of inductive load. V2 and node numbers: The power factor for the circuit, overall, has been substantially improved. The main current has been decreased from 1. The power factor is much closer to being 1: Since the impedance angle is still a positive number, we know that the circuit, overall, is still more inductive than it is capacitive. If our power factor correction efforts had been perfectly on-target, we would have arrived at an impedance angle of exactly zero, or purely resistive. If we had added too large of a capacitor in parallel, we would have ended up with an impedance angle that was negative, indicating that the circuit was more capacitive than inductive. The SPICE circuit file has a zero volt voltage-source V2 in series with the capacitor so that the capacitor current may be measured. The start time of msec instead of 0 in the transient analysis statement allows the DC conditions to stabilize before collecting data. The reference is Vtotal, to which all other measurements are compared. This is because the applied voltage, Vtotal, appears across the parallel branches of the circuit. There is no single current common to all components. We can compare those currents to Vtotal. Zero phase angle due to in-phase Vtotal and Itotal. Note that the total current Itotal is in phase with the applied voltage Vtotal , indicating a phase angle of near zero. This is no coincidence. Note that the lagging current, IL of the inductor would have caused the total current to have a lagging phase somewhere between Itotal and IL. However, the leading capacitor current, IC, compensates for the lagging inductor current. The result is a total current phase-angle somewhere between the inductor and capacitor currents. Moreover, that total current Itotal was forced to be in-phase with the total applied voltage Vtotal , by the calculation of an appropriate capacitor value. Since the total voltage and current are in phase, the product of these two waveforms, power, will always be positive throughout a 60 Hz cycle, real power as in Figure above. Negative power is fed back to the generator. It cannont be sold; though, it does waste power in the resistance of electric lines between load and generator. The parallel capacitor corrects this problem. Note that reduction of line losses applies to the lines from the generator to the point where the power factor correction capacitor is applied. In other words, there is still circulating current between the capacitor and the inductive load. This is not normally a problem because the power factor correction is applied close to the offending load, like an induction motor. It should be noted that too much capacitance in an AC circuit will result in a low power factor just as well as too much inductance. You must be careful not to over-correct when adding capacitance to an AC circuit. You must also be very careful to use the proper capacitors for the job rated adequately for power system voltages and the occasional voltage spike from lightning strikes, for continuous AC service, and capable of handling the expected levels of current. If a circuit is predominantly inductive, we say that its power factor is lagging because the current wave for the circuit lags behind the applied voltage wave. Conversely, if a circuit is predominantly capacitive, we say that its power factor is leading. Thus, our example circuit started out with a power factor of 0.

Chapter 6 : Definition of Power Factor - Electrical Installation Guide

Power factor is the ratio of working power to apparent (Working+Reactive) power where a high power factor means electric power is being utilized effectively. For example, the motor draws active power (kW) to rotate while using reactive power (kVAR) to set up the magnetic field for its working.

In electrical domain, electrical power is the amount of electrical energy that can be transferred to some other form heat, light etc per unit time. Mathematically it is the product of voltage drop across the element and current flowing through it. Considering first the DC circuit s, having only DC voltage sources , the inductors and capacitors behave as short circuit and open circuit respectively in steady state. Hence the entire circuit behaves as resistive circuit and the entire electrical power is dissipated in the form of heat. Here the voltage and current are in same phase and the total electrical power is given by Now coming to AC circuit, here both inductor and capacitor offer a certain amount of impedance given by, The inductor stores electrical energy in the form of magnetic energy and capacitor stores electrical energy in the form of electrostatic energy. Neither of them dissipates it. Further, there is a phase shift between voltage and current. Hence when we consider the entire circuit consisting of resistor , inductor and capacitor, there exists some phase difference between the source voltage and current. The cosine of this phase difference is called electrical power factor. The other fraction of electrical power is stored in the form of magnetic energy or electrostatic energy in the inductor and capacitor respectively. A fraction of this total electrical power which does our useful work is called as active power. The other fraction of power is called reactive power. Reactive power does no useful work, but it is required for the active work to be done. This reactive power oscillates between source and load. To help understand this better all these power are represented in the form of triangle. Mathematically it is the cosine of the phase difference between the source voltage and current. It refers to the fraction of total power apparent power which is utilized to do the useful work called active power. Hence higher the pf lower will be the current flowing. A small current flow requires a less cross-sectional area of conductors, and thus it saves conductors and money. From above relation we see having poor power factor increases the current flowing in a conductor and thus copper loss increases. Further large voltage drop occurs in alternator , electrical transformer and transmission and distribution lines which gives very poor voltage regulation. Further the KVA rating of machines is also reduced by having higher power factor as, Hence, the size and cost of the machine also reduced. So, electrical power factor should be maintained close to unity. Methods of Power Factor Improvement Capacitors: Improving power factor means reducing the phase difference between voltage and current. Since the majority of loads are of inductive nature, they require some amount of reactive power for them to function. The capacitor or bank of capacitors installed parallel to the load provides this reactive power. They act as a source of local reactive power, and thus less reactive power flows through the line. They reduce the phase difference between the voltage and current. They are 3 phase synchronous motor with no load attached to its shaft. The synchronous motor has the characteristics of operating under any power factor leading, lagging or unity depending upon the excitation. For inductive loads, a synchronous condenser is connected towards load side and is overexcited. Synchronous condenser makes it behave like a capacitor. It draws the lagging current from the supply or supplies the reactive power. This is an ac exciter mainly used to improve pf of induction motor. They are mounted on the shaft of the motor and connected to the rotor circuit of the motor. It improves the power factor by providing the exciting ampere turns to produce required flux at slip frequency. Further, if ampere-turns increase, it can be made to operate at leading power factor. Power Factor Calculation In power factor calculation, we measure the source voltage and current drawn using a voltmeter and ammeter respectively. A wattmeter is used to get the active power. Value of capacitor is calculated as per following formula: In power factor improvement, the reactive power requirement by the load does not change. It is just supplied by some device in local, thus reducing the burden on source to provide the required reactive power.

Chapter 7 : Power Factor for AC Power

Power factor is the ratio of the real power to the apparent power. There are two different ways to compute the power factor: displacement power factor and apparent power factor. Both give identical results for sinusoidal (non-distorted) voltage and current waveforms.

If not properly designed, these can present non-linear loads which impose harmonic currents and possibly voltages onto the mains power network. Harmonics can damage cabling and equipment within this network, as well as other equipment connected to it. Problems include overheating and fire risk, high voltages and circulating currents, equipment malfunctions and component failures, and other possible consequences. A non-linear load is liable to generate these harmonics if it has a poor power factor. Other loads can present poor power factors without creating harmonics. This post looks at these issues, the circumstances that can lead to damaging harmonic generation, and practical approaches to reducing it. It would present a load that is linear and entirely resistive: Firstly, the current waveform is in phase with the voltage, and secondly both waveforms are sinusoidal. A device has a poor power factor for one of two reasons; either it draws current out of phase with the supply voltage, or it draws current in a non-sinusoidal waveform. We shall look briefly at the displacement power factor before moving on to the distortion case, which is of more immediate concern to electronic power system designers. However it is important to be aware of both cases. For example, some engineering courses discuss the power factor issue only in terms of motors, which causes confusion when their students later encounter poor power factor as exhibited by an SMPS. Electric motors and displacement power factor problems Electric motors create powerful magnetic fields which produce a voltage, or back emf, in opposition to the applied voltage. This causes the supply current to lag the applied voltage. Fitting capacitors across motors reduces the phase lag and improves their power factor. SMPSs and distortion power factor problems Fig 2: Non-sinusoidal current waveform drawn by SMPS with poor power factor Whereas displacement power factor loads do not cause harmonics and their associated problems, distortion power factor loads such as SMPSs will do so unless their power factor is improved. This circuit only draws current from the mains when the line voltage exceeds that across the capacitor. This causes current to flow discontinuously, resulting in the non-sinusoidal current waveform shown in Fig. It is possible to use Fourier transforms, a mathematical process, to analyse this waveform and break it down into a set of sinusoidal components. These comprise the fundamental frequency â€” 50 Hz in Europe, 60 Hz in America â€” and a set of predominantly odd multiples of the fundamental, known as harmonics. The third harmonic is or Hz, the fifth, Hz and so on. The fundamental component is usefully consumed by the SMPS, while the harmonics are reactive and create the problems described above. Class D covers personal computers, personal computer monitors and television receivers. Established and innovative PFC solutions Although passive power factor solutions exist, the general industry view is that active designs offer the best power factor improvements. These are typically based on boost converter technology, as in the example shown in Fig. Active power factor correction circuit using voltage boost In this active power factor correction circuit the incoming line voltage passes through a bridge rectifier, which produces a full wave rectified output Figure 5â€”A. Since the peak value of the line is less than the bus voltage, no current will flow into the holdup capacitor unless the line voltage is boosted above that present on the holdup capacitor. This allows the control circuit to adjust the boost voltage 5â€”B-A to maintain a sinusoidal input current. To do so, the control circuit uses the input voltage waveform as a template. The control circuit measures the input current, compares it to the input voltage waveform, and adjusts the boost voltage to produce an input current waveform of the same shape 5â€”I. At the same time, the control circuit monitors the bus voltage and adjusts the boost voltage to maintain a coarsely regulated DC output 5â€”B. Since the primary function of the control circuit is to supply a sinusoidal input current, the DC bus voltage is allowed to vary slightly. Voltage and current waveforms for active boost circuit of Fig 5 The use of an active power factor correcting circuit results in few discontinuities in the input current and consequently low distortion and harmonic content imposed on the input current drawn from the line. The AC Front End offers a number of improvements for systems designers. In particular, it provides 85 V to Vac universal input, high efficiency and high power density, especially considering that it is a complete solution including isolated and regulated DC output as well as rectification and power factor correction. The device reduces propagation of AC line harmonics, improving overall power quality at system and facility level. Total Harmonic Distortion exceeds EN requirements, while high switching frequency and resonant transitions simplify external filtering and EMI standards compliance.

Chapter 8 : Unsupported Browser - Duke Energy

To calculate Power Factor correction, first use the Pythagorean Theorem to find the Impedance from the Real Power and the Reactive Power. The Impedance is the hypotenuse of the triangle, the adjacent side is the True Power, and the opposite side is the Reactive Power.

Various types of power are at work to provide us with electrical energy. Here is what each one is doing. We express this as kW or kilowatts. Common types of resistive loads are electric heating and lighting. An inductive load, like a motor, compressor or ballast, also requires Reactive Power to generate and sustain a magnetic field in order to operate. Every home and business has both resistive and inductive loads. The ratio between these two types of loads becomes important as you add more inductive equipment. Working power and reactive power make up Apparent Power, which is called kVA, kilovolt-amperes. A high PF benefits both the customer and utility, while a low PF indicates poor utilization of electrical power. Here is an example. Because Laurens Electric must supply both the kW and kVA needs of all customers, the higher the PF is, the more efficient our distribution system becomes. Improving the PF can maximize current-carrying capacity, improve voltage to equipment, reduce power losses, and lower electric bills. The simplest way to improve power factor is to add PF correction capacitors to the electrical system. PF correction capacitors act as reactive current generators. They help offset the non-working power used by inductive loads, thereby improving the power factor. The interaction between PF capacitors and specialized equipment, such as variable speed drives, requires a well designed system. PF correction capacitors can switch on every day when the inductive equipment starts. If a customer complains about fuses blowing on some but not all, of their capacitors, check for harmonic currents. Correction of power factor with capacitors Description: Power factor is the relationship phase of current and voltage in AC electrical distribution systems. Low power factor, electrically speaking, causes heavier current to flow in power distribution lines in order to deliver a given number of kilowatts top an electrical load. The power distribution system in the building, or between buildings, can be overloaded by excess useless current. Generating and power distribution systems owned by Laurens Electric have their capacity measured in KVA kilo amps. Thus we see that lower power factor has an averse effect on generating and distribution capacity. Low power factor overloads generating, distribution, and networks with excess KVA. If you own a large building, you should consider correcting poor power factor for either or both of these reasons: To reduce the possibility of additional power factor charges in event that Laurens Electric starts billing for PF corrections and To restore the KVA capacity of overloaded feeders within the building or building complex. There are several methods of correcting lower power factor. Capacitor Banks The most practical and economical power factor correction device is the capacitor. It improves the power factor because the effects of capacitance are exactly opposite those of inductance. The var of KVAR rating of a capacitor shows how much reactive power the capacitor will supply. Since this kind of reactive power cancels out the reactive power caused by inductance, each kilovar of capacitance decreases the net reactive power demand by the same amount. Capacitors can be installed at any point in the electrical system and will improve the power factor between the point of application and the power source. However, the power factor between the load and the capacitor will remain unchanged. Capacitors are usually added at each piece of offending equipment, ahead of groups of motors ahead of motor control centers or distribution panels or at main services. Switched Capacitors Plants equipped with very large, intermitted inductive loads, such as large motors, compressors etc. Therefore, they are only in action when the motor load is turned on. Or, capacity may be switched on and off at the substation, depending on measured power factor. The switching feature is only required if the capacitors needed are so large that they cause an undesirable leading power factor during times when large motors are turned off. Adobe Acrobat Reader is required to view and print pdf files.

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Chapter 9 : Power Factor, VA, AC Power: Calculation & Formulas

Power factor tests are used to measure dielectric losses, which relate to the wetness, dryness or deterioration of electrical insulation. Power factor is defined as the cosine of the phase angle between voltage and current.

Alternative energy There is a common confusion about the difference between the watt and volt-amp VA measures for electric power, as well as about power factor. In this tutorial you will find a simple explanation of AC power calculation, the usage of these quantities in specifying backup energy sources, conversion formulas, and an online calculator. Power by definition is the rate of work or energy flow which are numerically the same: In this equation v t and i t are instantaneous voltage and current as functions of time t. In alternating current AC circuits all these quantities are continuously varying. The value of the main interest in electrical industry is an average value of p t over a complete AC cycle. This quantity is called real active power and is measured in watts symbol: Electrical systems normally have inductors and capacitors, which are referred to as reactive components. Ideal reactive components do not dissipate any energy, but they draw currents and create voltage drops, which makes the impression that they actually do. This "imaginary power" is called reactive. Its average value over a complete AC cycle is zero because of the phase shift between voltage and current. Contrary to wattage which represents an average value, numerically VAR represents rms value of the reactive power. Besides reactances, practical electrical systems also contain non-linear components such as rectifiers, which distort electric current waveform and create harmonics. If voltage is a pure sinewave, all the current harmonics except for the fundamental one, do not contribute to the net energy transfer. The combination of real, distortion and reactive power makes up apparent or total power, measured in Volt-Amps VA: PF by definition is the ratio of real to apparent power: People are often looking for a calculator to convert volt-amps VA to watts. Well, obviously you need to know the value of PF to do the calculation: Likewise, you can convert watt to VA by using this formula: For old computers it used to be 0. For the motor-driven appliances such as refrigerators and air conditioners this value is typically 0. Enter any two known values and press "Calculate" to find the remaining value. Reset before each new calculation. VA Factor Watts A "power triangle" in which active, reactive and total power are represented as vectors, is often used to visualize the relationship between W and VA in linear circuits with sinusoidal signals. For non-sinusoidal currents this triangle is invalid due to the presence of another component called distortion power. This fact is neglected in many tutorials on electricity. PF value measures how effectively electricity is being utilized. Here is a simple mechanical analogy. We know from physics that when an object is moved by a force, mechanical work is done only by the component of the force in the direction of the motion. At a given force, maximum work is done when the force and the motion are in the same direction. If the force is perpendicular to the direction of motion, no energy is transferred by this force. Similarly, in electrical circuits, the real working energy is transferred by the components of voltage and current which have the same frequency. At given values of V and I, the maximum wattage transfers when they are in phase. They may surcharge you for VAR. However, so far most residential meters in U. Therefore, using power factor correcting PFC devices will not reduce your electric bills as some claim. Nevertheless, PF of the appliances should be taken into account when choosing the size of a backup system, such as a generator or UPS. Also, lower PF will cause larger current in utility lines and additional voltage drop in the wiring. In an extreme case, this can cause overheating and premature failure of a motor and other equipment. Unlike most residential users, for commercial and industrial customers, an electric utility company may assess a surcharge when power factor drops below 0. This is the number you should use when you do sizing.