POWERED BY SATIC™ TECHNOLOGY

AMERICAN MANUFACTURER

OF

POWER PERFECT™

ENERGY SAVING PRODUCTS

AN ALTERNATIVE APPROACH TO ALTERNATING CURRENT

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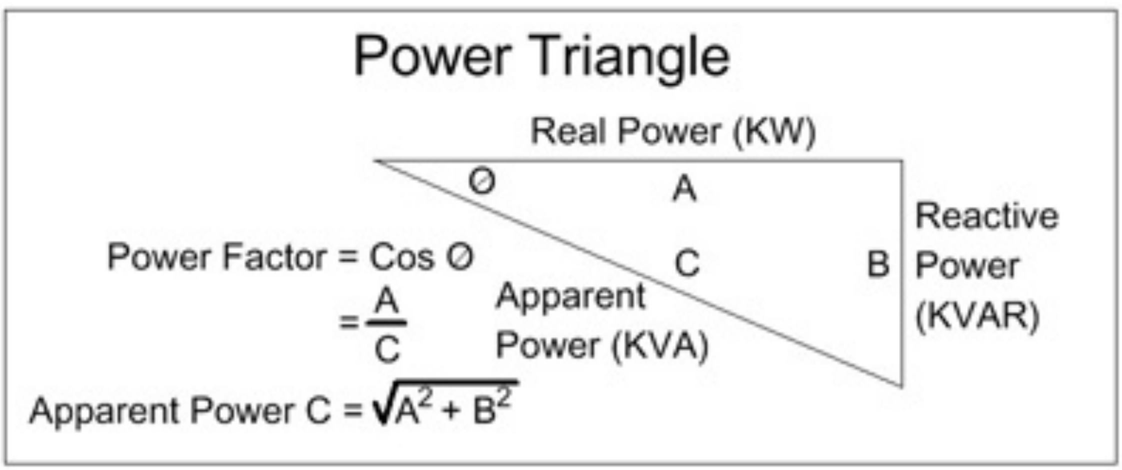
An Alternative Approach to Alternating Current

The purpose of this short paper is to address the historical approach to power reduction, primarily using capacitor banks for power factor correction versus a more modern approach to energy management considering other aspects of electricity in today's modern world.

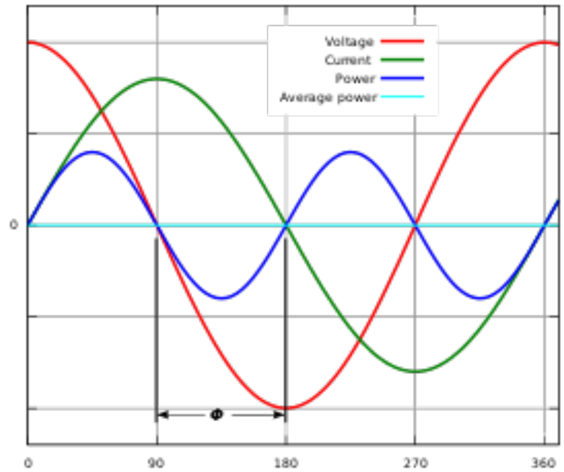
Until recently, electrical systems were less influenced by harmonics. Today's modern technology; switching power supplies, computers, LED displays, appliance controls, CFLs, etc. introduce significant levels of harmonics that has drastically changed electrical system dynamics and how one would affectively address power conservation.

Everyone in our field is familiar with the basic power factor triangle.



This simple illustration shows that in an inductive environment, capacitors provide capacitive reactance, which can eliminate the need for reactive power supplied from the source. As a result, one of the byproducts of a capacitive reactance is a reduction in Total Apparent Power. Another way to demonstrate this is that capacitors are used for phase correction; reducing ∅ which in turn increases power factor and reduces Total Apparent Power.

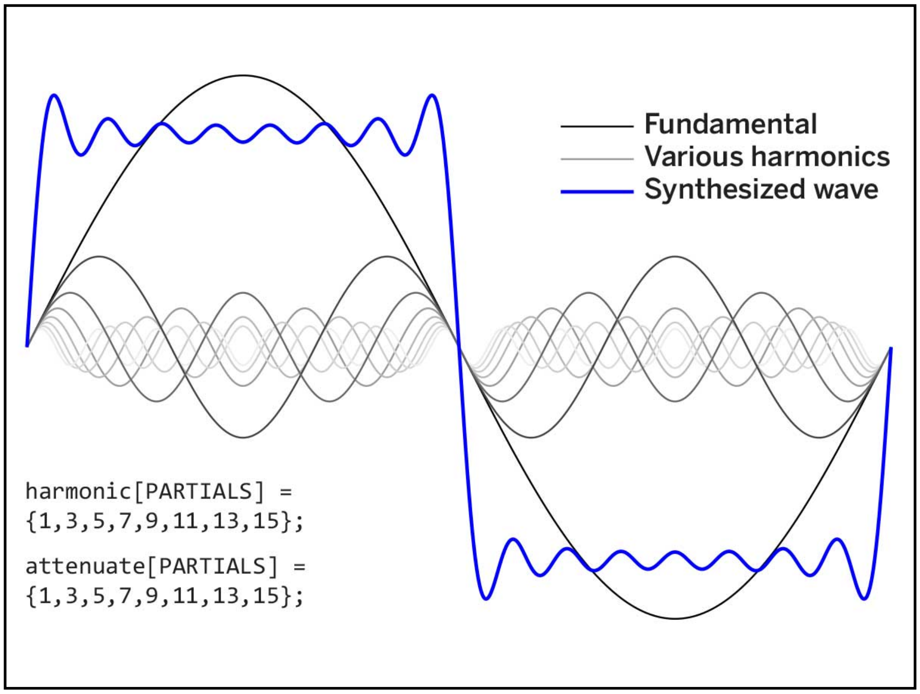
As you can also see by looking at the diagram below, as phase correction is increased ∅ is reduced and power factor increases.



In alternating current (AC) electricity, this has been the traditional role and primary application of capacitors. However, in today's world, with the advent and mass dissemination of compact fluorescent lighting and the vast multitude of digital electronics that run on DC rather than AC, there has been a need to address issues of overall 'power quality' that capacitors can't. One must look at the impact of harmonics as a part of our modern electrical system that in 1960's didn't exist.

Voltage harmonics in an electric power system are a result of non-linear electric loads. Harmonic frequencies in the power grid are a frequent cause of power quality problems. Harmonics in power systems result in increased heating in equipment and wiring, misfiring of variable speed drives and torque pulsations in motors.

Primarily non-linear loads cause current harmonics as well. When a non-linear load is connected to the system, it draws a current that is not necessarily sinusoidal. The current waveform can become quite complex, depending on the type of load and its interaction with other components of the system. Regardless of how complex the current waveform becomes, it is possible to decompose it into a series of simple sinusoids, which start at the power systems fundamental frequency and occur at integer multiples of that fundamental frequency. The image below illustrates the wave-form distortion caused by the additive nature of these harmonics.



Total harmonic distortion (THD) is a common measurement of the level of harmonic distortion present in a power system. THD is defined as the ratio of total harmonics to the value of the fundamental frequency and is calculated as:

$$\mathrm{THD} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \cdots + V_n^2}}{V_1}$$

where V_n is the RMS voltage of the nth harmonic and $n = 1$ is the fundamental frequency.

One of the major effects of power system harmonics is to increase the current in the system. This is particularly the case for the third harmonic, which causes a sharp increase in the zero sequence current, and therefore increases the current in the neutral conductor. This effect can require special consideration in the design of an electric system to serve non-linear loads.

Power factor correction capacitors may actually amplify harmonics to unacceptable values and harmonic resonance can cause capacitor failure due to harmonic over-voltages and over-currents. This can damage both the capacitor and the equipment.

In addition to the increased line current, many different types of electrical equipment can suffer effects from harmonics on the power system. Filtering out harmonics and restoring the fundamental sinusoidal wave-form will decrease reactive power and result in an increase of overall efficiency, less apparent power and an increase of power factor. Traditional capacitors can't increase power factor and condition power in this way.

This is, in part, one reason for Satic's approach to its 'energy management' designs. We believe that lowering heat and loss by filtering and conditioning power is a primary objective in our modern technological world.

The Satic Approach

Satic's approach to energy management does not focus on power factor correction but rather on lowering electromagnetic fields and harmonics and conditioning the power.

Our products have been designed, and components selected to address each of the seven key aspects of Alternating Current:

1. Volts – Pressure
2. Amps – Current
3. Watts – Real Power
4. THD – Total Harmonic Distortion
5. EMF – Electromagnetic Fields
6. Resistance – Losses as electricity travels
7. Frequency (Hz) – Frequency of repeating events (60 Hz)

Volts – Voltage Regulation

Charged harmonic rectifier banks are able to push the dips, providing voltage regularity at the nano-second level. This doesn't act as a battery for sustained voltage but rather are resistant to voltage change, which is good for all electronics and appliances.

In addition, our products provide robust surge protection. We stage 3 metal oxide varistors (MOVs) as surge protectors to assist voltage regulation in our single phase products and 6 MOVs in our three phase products to trim the peaks, regulate voltage and protect equipment.

Amps – Phase Correction

Our integrated circuit board design allows our units to reduce amp draw through phase correction without the use of metal capacitors. In addition, a common reason for not using capacitors for phase correction is that they can also push PF over unity, creating leading voltage, decreasing efficiency and increasing power consumption.

We have neither run capacitors nor start capacitors and yet we manage power factor and inrush (eg. when an inductive motor first starts up) with smart control built into our design. Although we don't emphasize power factor correction, reduced amps does show a small but consistent and measureable savings.

For example, a 120V motor with a .29 PF will require 5.0 amps of current for 175 real watts of power; whereas the same 120V motor with a .91 PF will only require 1.6 amps of current for the same 175 real watts of power. The first motor is using 3.4 more amps to accomplish the same amount of work. This unusable power is what we have referred to as reactive power. When the motor releases the 3.4 amps of reactive power, significant heat is generated. Heat is detrimental to almost all electrical devices.

Watts – Reduced Electrical Consumption

Watts represent real power being turned into work or heat. Inductive motors turn electricity into mechanical work. Only the real power is converted into work and the rest is either turned into heat or returned to the power grid via the neutral.

Battery powered devices such as iPods, laptop-computers, tablets, cell phones etc. have power supplies that convert AC to DC (direct current). The AC watts are converted into chemical work by charging the battery, which will then supply DC to the device. If these DC power supplies are provided reactive power it will be converted to heat in the device. This is why devices get so warm when charging. Heat reduces the lifetime of all electronic devices.

When you draw fewer amps of cleaner power to do the same amount of work, you have reduced the amount of electricity turned into heat and these devices will run cooler and last longer. Running cooler saves watts in several ways that will be summarized later.

THD – Negative Harmonics Reduction

We also provide negative harmonics filtration, which is another reason for our use of harmonic rectifiers versus capacitors, as capacitors may increase THD. LEDs and CFLs are notorious for adding significant harmonic distortion to load centers. Typically THD is shrugged to the neutral path, something that many DC powered devices are notorious for doing. Our products constantly filter the neutral path while at the same time filtering the incoming power. Removing harmonics results in cleaner power. Recapturing some of the return path power lost to neutral also provides the ability to meet the inrush demands that occur throughout the day. Resulting in less demand from the utility, which will help in reducing overall power consumption and increased savings.

EMF – Electromagnetic Field Reduction

Our products also provide electromagnetic field and electromagnetic interference (EMI) reduction for cleaner more efficient power, resulting in the reduction of electromagnetic radiation (EMR).

Numerous medical studies have reported that exposure to certain frequencies of EMF can be detrimental to plant, animal and human health. Wind and solar inverters add high levels of potentially hazardous EMF to load centers. Our products reduce that significantly. 3rd party studies have shown that our products reduce EMI voltage by as much as 98%.

Resistance – Reduced Amps Results in Reduced Resistance

Most of us are familiar with Ohm's Law. As line current increases, the heat produced increases. This is due to the wire impeding the flow of current. With DC current it is called resistance whereas in AC current it is called impedance. As might be expected the further the current has to flow, the more resistance or impedance occurs. By increasing efficiency, lowering impedance and reducing the amps required for work there is a correlated reduction in resistance, less power is lost and temperatures are lowered consistently and measurably.

Frequency – Keeping Alternating Current Consistent

Frequency is the number of times an event occurs within a specific time period. The frequency for alternating current in the U.S. oscillates at 60 times per second or 60 Hertz (Hz) and 50 Hz in other parts of the world such as Europe. Satic's products operate within the primary frequency whether in the U.S. or abroad, saturating out and discharging at the primary frequency. This reduces EMI and assists consistent power at the primary frequency.

Other Design Considerations

No other system that we are aware of has this fully integrated design. A combination of harmonic rectifiers, power factor correction modules, voltage regulation with nano-surge filtration, electromagnetic field and negative harmonics reduction with extremely robust surge protection all packaged into our proprietary design. This allows it to be smaller, modularly scalable and affordable than competing products, yet as effective as anything else on the market, at any price.

The single-phase Power Perfect Box has 3 circuit boards. These boards have been built up with the highest quality components available to address each of the seven aspects of alternating current without negatively affecting another.

Each circuit board must act as an independent sub-system as there are three electrical pathways in a single-phase electrical system.

- Phase A – Neutral is a 120V sub-system (phase to neutral)
- Phase B – Neutral is a 120V sub-system (phase to neutral)
- Phase A – Phase B is a 240V sub-system (phase to phase)

In a similar fashion there are 6 electrical pathways in a three-phase systems and the three-phase Power Perfect Box requires 6 independent circuit boards.

- Phase A – Neutral is a 120V sub-system (phase to neutral)
- Phase B – Neutral is a 120V sub-system (phase to neutral)
- Phase C – Neutral is a 120V sub-system (phase to neutral)
- Phase A – Phase B is a 208V sub-system (phase to phase)
- Phase B – Phase C is a 208V sub-system (phase to phase)
- Phase C – Phase A is a 208V sub-system (phase to phase)

Addressing each of these seven attributes on every possible electrical pathway guarantees clean electricity throughout the entire electrical distribution network. This is what we call ~ POWER PERFECT.

Conclusion: What are the savings?

Satic intentionally avoids making specific power savings claims, as every electrical environment is different. System size, wiring, appliances, HVAC, lighting, loads etc. all vary greatly as do utility billing practices and charges. However one can deduce a realistic and measurable decrease in real power (watts) in the following ways:

1. Improving phase quality and reducing amps will consistently create a 2-3% decrease in power lost to resistance (I2R). Our 3rd party testing actually shows consistently greater savings yet for this paper lets use the DOE's estimate of 2%.

2. Watts lowered by providing stored power for inrush, which Satic achieves by recapturing return path power that is cleaned and reintroduced, is unique to the electrical environment. A 1-3% reduction in power consumption is measurable. While 3rd party testing has shown greater potential savings let us use an industry-accepted average of 2% reduction for inrush management.

3. With less motor and component heat build up, combined with greater efficiency, HVAC and refrigeration systems are more effective which consistently results in fewer and shorter duty cycles. Tests show that fewer and shorter duty cycles create consistent electrical savings in relation to ambient temperate and other factors, while industry standards for savings are low at 1-3%.

4. Real power not being converted into heat in devices like TV's computers, appliances and phones saves watts. DOE studies show that as much as 3% of residential utility costs are losses to resistance and heat. These devices running cooler lowers BTU's introduced to the environmental (heat shrug) thus requiring less cycling of air conditioning. Again, even one less cycle or shorter cycles per day for HVAC systems contributes that same, consistent 1-3% savings. 1-2% device heat savings combined with 1-2% HVAC savings give this category a combined 2-4% savings.

While much has been written on energy conservation, make no mistake; this is a game of inches. Yet there are some inches to be gained.

In pursuit of those inches Satic has dedicated millions of dollars, several calendar years and countless man-hours data logging electrical systems, combined with our own research and development invested creating the product line.

With the overly researched and generally accepted analysis of savings outlined previously we can present a logical 6% - 12% reduction in real power consumption while at the same time creating a cooler, healthier and more efficient electrical system.

Satic has subjected its entire line to rigorous 3rd validation testing. The results of those tests include data logging for power consumption, ambient and equipment temperatures as well as HVAC duty cycling before and after product installation. That testing consistently shows savings equal to or greater than listed above. The complete summary of 3rd party testing is available upon request.

Satic Power Perfect Energy Management Systems create cleaner power for home or business and is unlike anything on the market today, manufactured with pride of top quality components in the USA, warranted for 10 years and performance is guaranteed.

For clarification or more information contact us at:

Satic Incorporated
866-997-2842
http://www.saticusa.com