POWER QUALITY SOLUTIONS

Acme Electric offers a large selection of power quality solutions able to handle most electrical disturbances.

Acme Electric®

Power Quality

The quality of the power we receive has become quite a topic of discussion in recent years. It's hard to find anyone that hasn't been touched by power quality problems to one extent or another. It might just be the inconvenience of the loss of power during a thunderstorm or it could be fire or downed equipment caused by excessive neutral currents.

Our market today is heavily impacted by electronic systems, which are sensitive and vulnerable to power quality problems in the electronic infrastructures. Although electrical utilities attempt to provide clean, well-regulated power, the simple truth is that our power demands are outstripping our power supply. Bottom line, this means that the power we're getting is more prone to power anomalies.

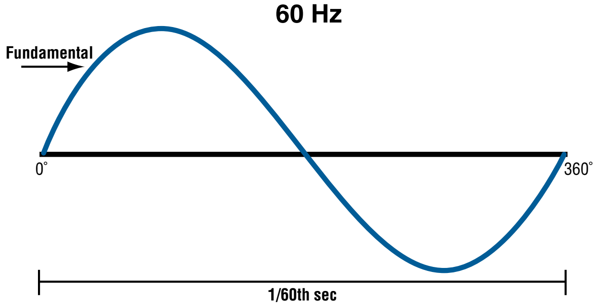
Power quality issues can take a variety of forms: power outages, spikes/ electrical noise on the transmission line, fluctuating voltages and harmonics. On average, a computer installation is subjected to over 120 disturbances a month; luckily most of these are minor. Identification of different types of problems has created the need for the use of true RMS meters, ground continuity meters, harmonic analyzers, oscilloscopes or specialized data logging equipment. It is imperative that we correctly identify the issues before products can be put in place to combat them.

Annually, power quality problems in the United States account for over $35 billion in equipment damage, productivity loss and loss in revenues. Surprisingly, less than 15% of these problems can be categorized as "acts of God". The majority of the problems are generated locally. It is not unusual to find 80% generated internal to a facility and an additional 20% coming from the folks next door.

Harmonics

The convenience and escalating use of electronic equipment is causing severe harmonic distortion on networks. Most electronic devices are non-linear loads, which create harmonic currents. The major source of harmonics is attributed to the switch-mode power supply (SMPS). Although they generate harmonics, switch-mode power supplies are responsible for the growth of the electronics industry. These devices have enabled electronic products to decrease significantly in size, dramatically decrease heat output and become universally affordable. Harmonics can cause a variety of problems ranging from overheated transformers and motors (at what appears to be nameplate load or less), to equipment failure, tripping of overcurrent devices and more.

60 Hz

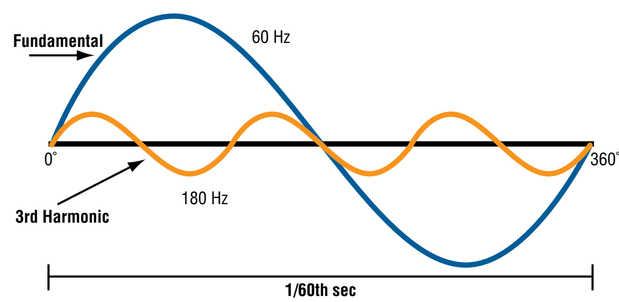


What Are Harmonics?

Utilities distribute electricity in an alternating current format. Alternating current flows in the form of a sine wave. The power we utilize in the United States is 60 hertz power, sometimes called 60 cycle power (60 cycles per second). Other places in the world may receive 50 hertz power from their electrical utilities.

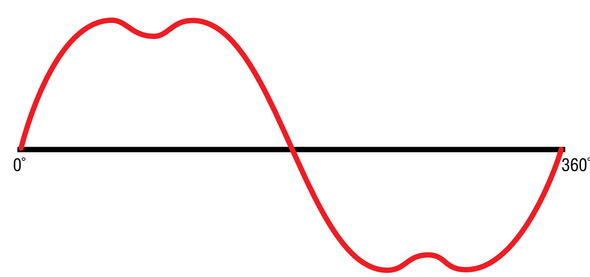
Harmonic Distortion

60 Hz & 180 Hz



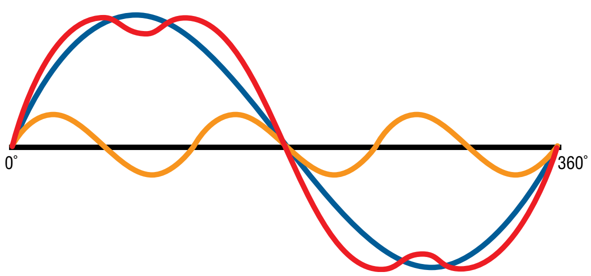
The pure power we receive (i.e. 60 Hz) is our fundamental power, sometimes referred to as the fundamental or first order harmonic. Switch-mode power supplies have the ability to generate their own sine waves, which are multiples of the fundamental, then feed them back onto the source power. This occurs because non-linear devices require current only during part of a cycle. Second order harmonics on a 60 Hz system run at 120 Hz, third order – 180 Hz, fourth order – 240 Hz, fifth order – 300 Hz, etc. Although there are more of them, they are of a lesser magnitude.

Sum of 60 Hz & 180 Hz



As these harmonics are fed back onto the primary or fundamental power, the wave forms are added together, resulting in a distortion of our power. Of prime importance are odd numbered harmonics as even numbered harmonics only result in a shifting of the fundamental waveform, odd numbered harmonics result in a distortion. As more non-linear loads are added to the system, waveform distortion becomes more pronounced.

60 Hz & 180 Hz & Sum



So why the problem? Simply put, if we looked at the harmonic distortion of voltage, the voltage supplied to a device would now be lowered. Any device requires a certain amount of power to operate. Electrical power has two major components, voltage and amperage, if the load does not receive enough voltage, it tries to compensate by drawing more amperage. This harmonic current draw coupled with normal current draw results in increased heat, shortened life and other problems such as tripping of overcurrent devices.

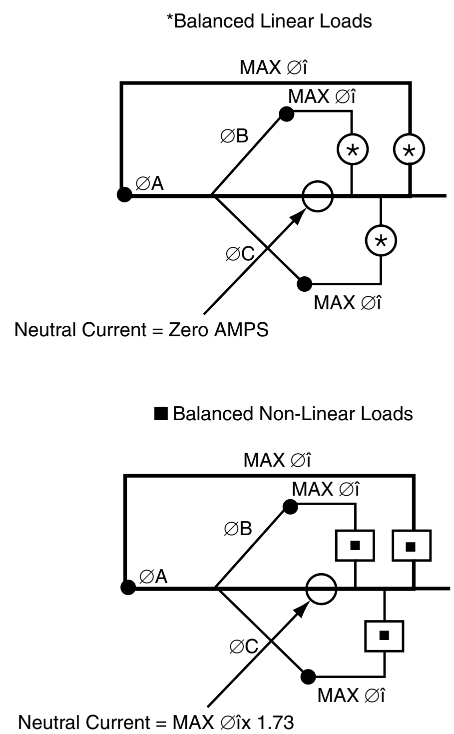
What impact does harmonics have on a system?
Harmonics, or the effects of them, can pop up in different areas of an electrical system causing problems and possible damage. Most of the harmonic generating equipment out there are single phase devices. Problems occur when harmonics are fed back upstream onto a three phase distribution system.

The majority of three phase 600-volt class transformers being used on standard distribution systems have a delta connected primary and a wye connected secondary. When harmonics reach the wye connected output one of these transformers, the odd numbered, non-multiple of third harmonics begin to cancel themselves as they are out of phase with one another. The more the system is balanced with harmonic producing loads, the more effective the cancellation will be. The odd numbered, multiple of third harmonics... called triplens, are in phase with one another and pass from the transformer secondary directly into the delta primary winding with little to no opposition.

Triplen harmonics trapped in the primary windings exhibit themselves as circulating currents causing transformers to run above normal operating temperatures. The transformer appears to be overloaded even though checks on the loads show it is not. Transformers are not the only targets. Any delta circuits in the distribution system are potential problem areas and could exhibit overheating, motors are one example.

Maintaining Power Quality
Wye connected loads are supposed to be nearly balanced between the phases of a three phase transformer. Without harmonics, the current flow in the neutral is insignificant. Even with the load currents unbalanced as is shown in the following diagram, the neutral conductor rarely carries current more than one third the phase conductor current triplen. Harmonics on the system changes the situation significantly. This neutral current could now be nearly twice the value of the load current. Since the neutral is not over current protected, per NEC this excessive neutral current can cause wire insulation to fail and in extreme cases – even cause fires. The increase in harmonics is directly tied to the increased use of electronics. Switch-mode power supply technology has made electronics affordable and desirable in the workplace. Desk top computers, data processors, AC motor drives, copiers, fax machines, lighting ballasts, etc. have dramatically changed our working environment. Electronic devices are regulated under IEEE specification 519, which limits the amount of "garbage" that can be put back onto the line. Each device in itself does not produce enormous amounts of harmonics but the rapid increase in the number of devices has produced the problems we see today.

Figure 1



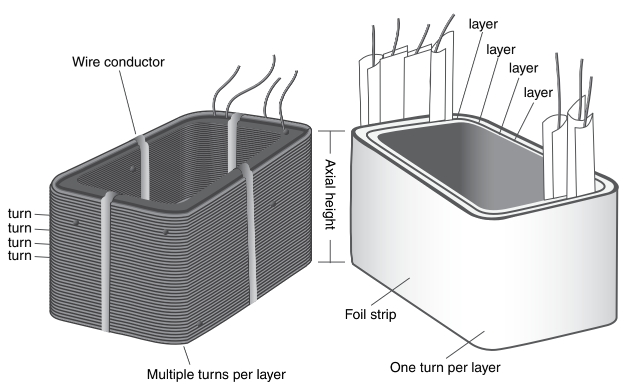
What happens to the transformers?
As we said earlier, the triplen harmonics "take up residence" in the first delta they can find in the distribution system, quite frequently it is in the primary delta circuit of a transformer.

If the harmonic currents were evenly dispersed within a conductor, the quick and easy solution would be to utilize a larger transformer. Unfortunately the harmonic currents remain on the conductor surface, a condition referred to as "skin effect". These harmonic currents result in excessive transformer heating, a breakdown in the transformer's insulation and eventually transformer failure. As the harmonic currents are coming from the load, the transformer will not be drawing more from the supply side of the system. A transformer can fail even though the current the transformer draws from the service appears to be well within the capacity of the unit. The good news is that the delta circuit of the transformer contains the harmonics and prevents them from going further upstream.

Ultimate Clean Power Solution
The ultimate solution lies in the utilization of Acme Electric Harmonic Mitigating Transformers. Acme combines a unique winding style construction with a special secondary winding connection to not only deal with harmonics but effectively cancel triplen harmonics. The more balanced the system with harmonic devices and the more heavily loaded, the more effective Acme's Harmonic Mitigating Transformers will be.

Industry leading technology - foil strip winding construction
The excess heating caused by harmonic currents in a transformer's delta circuit can be eliminated by increasing the amount of conductor surface or "skin" to promote more efficient cooling. Just increasing the size of the conductor won't solve the problems. If we were to double the size of a wire, we would see that the cross sectional area grows at a much more rapid rate than the wire's circumference. To combat this situation, some manufacturers have gone to multiple parallel conductors. By doing this, they can keep the cross sectional area of the conductor in check but increase the surface area. It is effective but creates manufacturing challenges in trying to keep each of the single conductors the same length as the others.

Most harmonic grade transformers are wound with insulated wire conductor. Acme electric uses foil conductor windings. Utilizing a foil conductor does two very important things: maximize the conductor surface area for optimum cooling and dramatically reducing voltage stress between winding layers. Instead of the multiple turns of wire per layer of winding, foil winding has one turn. If a transformer design calls for 10 volts per turn, wire windings may contain ten 10-volt turns. If the transformer had two layers of turns, the wire design would exhibit stresses of 200 volts (ten volts per turn times ten turns times two layers).



The Acme Electric Advantage
With foil windings, one layer is a ten volt turn. The foil conductor design would exhibit stresses of 10 volts (one turn times two layers). Since Acme Electric Harmonic Mitigating Transformers are foil wound, both the primary and secondary windings can be wound to the same axial height, which greatly reduces eddy current losses. If the load current is 180 Hz (third harmonic current), eddy current losses will be nine times the square root of the third harmonic current. Acme Harmonic Mitigating Transformers offer the best solution for combating harmonics associated with non-linear loads. These foil wound transformers will, by nature, be smaller, more efficient, and have lower eddy current losses than their wire wound counterparts.

Electrostatically Shielded
Computing equipment, process controllers and many other microprocessor controlled devices are vulnerable to damage or malfunction, when subjected to electrical spikes or noise (transients). While the use of equipment sensitive to transients is on the rise, the generation of transients is also increasing.

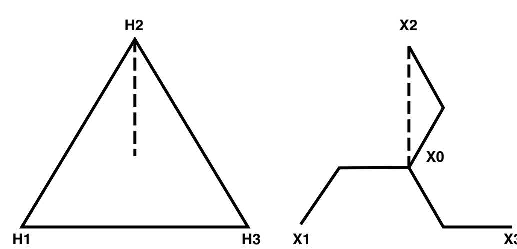
Transients can be caused by lightning, switching surges on the power network, operation of other loads at the local site... especially start-stop motor operations, switching of power factor correction capacitors and welding operations.

The increased usage of sophisticated electronic equipment has heightened the need for transient noise suppression on power systems. Shielded winding isolation transformers fulfill this need and provide a strong first line defense against power quality problems.

Zig-Zag Secondary Winding Configuration
Conventional delta-to-wye constructed transformers are manufactured with one winding per phase on both the primary and secondary circuits. Though a common style of manufacture, conventional one-winding-per- phase units encounter problems when confronted with harmonics. Non-triplen harmonics are out of phase with one another and tend to cancel at the wye connection of the transformer. The more balanced the harmonics are on the system, the more cancellation of non-triplens will occur. Triplen harmonics, however, are in phase with our fundamental power and are coupled back into the transformer's primary circuit, resulting in circulating currents and overheating.

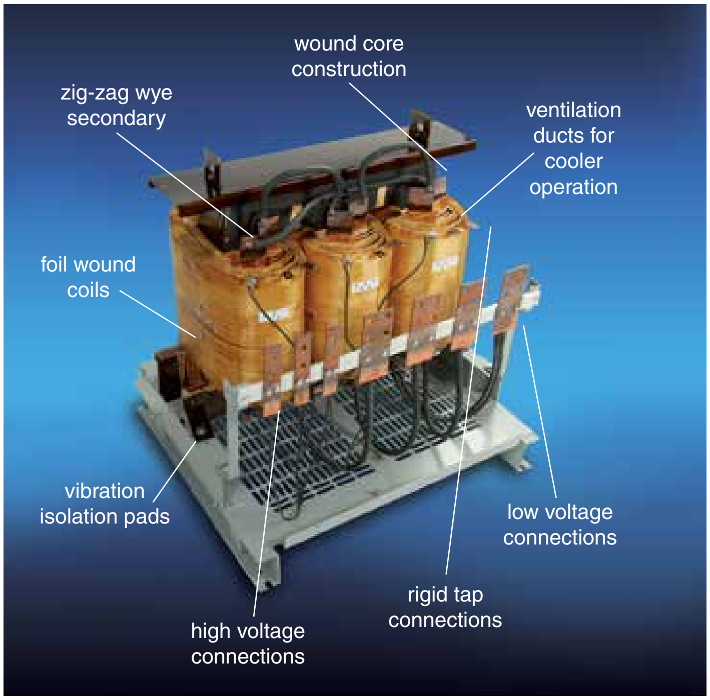
Acme Electric Harmonic Mitigating Transformers utilize a time proven zig-zag connection in the secondary circuit. This construction results in a phase shift of the triplen harmonics, causing them to cancel one another. Rather than "dealing" with harmonics, Acme Electric Harmonic Mitigating Transformers cancel triplen harmonics, and eliminate the overheating and other problems associated with non-linear loads. This technology not only results in cooler operation and "cleaner power", but also provides a more energy efficient means of dealing with harmonic problems, than traditional non-linear or K-rated transformers.

Diagram Showing Delta Primary & Zig-Zag Secondary
(zero degree angular displacement)



Harmonic Mitigating Transformers

Available in sizes ranging from 30kVA to 225kVA with copper foil construction (or aluminum per request),Acme Harmonic Mitigating Transformers are suitable for K-factor loads under low or standard 150°C rise operation, and come standard with electrostatic shielding for cleaner power.



Improving overall power factor of the supply system, Acme Harmonic Mitigating Transformers are the ultimate solution for actually treating the triplen harmonics and reducing voltage flat topping cause by non-linear loads.

Powerwise C3 Transformers

Acme Powerwise C3 transformers combine a K-13 rated transformer with a higher efficiency design creating the perfect solution of LEED and Green facilities. Acme C3 transformers exceed the requirements of the US Department of Energy Candidate Standard Level (CSL) 3 and provide the lowest life cycle cost of any transformer on the market. Through more efficient core material and higher-grade electrical steel, losses are reduced and performance is maximized. This can save you thousands of dollars a year in energy costs; hundreds of thousands of dollars over the life of an installation.

Non-Linear Load®
(K-Factor) Transformers

Non-linear loads generate high levels of harmonic currents. When supplying power to these loads, a special transformer design is necessary.

Acme Non-Linear Load Transformers utilize a foil wound design to minimize eddy current losses generated by harmonic currents. A double-sized neutral conductor handles the excessive neutral currents found in nonlinear load applications.

Available in sizes ranging from 15 thru 500 kVA, in all common voltage combinations, aluminum or copper wound, energy efficient – low temperature rise or standard 150°C rise. Acme Non-Linear Load Transformers are available in K-Factor ratings of 4, 13 and 20, complete with electrostatic shielding – at no additional charge. When dealing with problems associated with harmonics on your distribution system, Acme Non-Linear Load Transformers are an obvious choice to cleaner power.

Drive Isolation Transformers
Designed specifically to accommodate the special voltages, kVA sizes and demands unique to AC and DC motor drive applications. Acme Drive Isolation Transformers incorporate strip conductors (above 7.5 kVA) to satisfy the severe electrical and mechanical stress that can be found on motor drive systems.

Available in sizes ranging from 7.5 thru 880 kVA and in all common voltage combinations. Acme Drive Isolation Transformers come complete with electrostatic shielding – at no additional charge.

AC Line Reactors
Protect your equipment from harmful line disturbances with Acme AC Line Reactors. Acme AC Line Reactors help prevent equipment failure and downtime, and can add years to the life of your equipment.

Designed to reduce or eliminate most line anamolies, Acme AC Line Reactors protect against typical problems like nuisance tripping of fuses and/or circuit breakers (caused by DC bus overvoltage), inverter overcurrent and overvoltage, harmonic distortion (resulting in poor total power factor), line notching, etc.

Available in sizes ranging from 2 amp to 600 amp, in standard 3% or 5% impedance versions, in a panel mount core & coil design or an epoxy encapsulated design (2 amp to 160 amp) for out of panel use, Acme AC Line Reactors can be used to provide both line and load power quality protection for a wide range of applications.

Constant Voltage Regulators
Acme Constant Voltage Regulators consist of a leakage reactance ferroresonant transformer, equipped with additional pair of magnetic shunts and a filtered winding. Together they develop a regulated low distortion sinusoidal output. The second pair of shunts and the filter winding soften the secondary core saturation effect, cancelling the harmonic voltages that are present in conventional constant voltage transformers.

Typical ferroresonant transformers have an input limited to 100-130 volts. Acme CVRs have an input range of + 10%/-20% around nominal input voltages of 120, 208, 240 and 480 volts. At a 120 volt input, this relates to 95 to 132 volts.

Typical ferroresonant transformers have an audible hum that can be objectionable in most offices. Acme CVRs are epoxy encapsulated to lower audible sound to acceptable levels. Typical ferroresonant transformers have limited electrical noise suppression capability. Acme CVRs have the ability to attenuate common mode noise by 120 db and transverse mode noise by 60 db. Typical constant voltage products have an output regulation of ±3% for input line changes only. Acme CVRs have an output regulation of ±3% for input line and load changes, making them suitable for operation at any load condition.

Available in sizes ranging from 250 VA thru 15 kVA, Acme CVRs feature a sinusoidal output with less than 3% harmonic distortion – improving input wave forms which have a total harmonic distortion greater than 5%, have a hold up time of 3 msec for complete loss of power, inherent overload and short circuit protection without thermal protectors or fuses or circuit breakers and are UL listed and CSA certified. Acme CVRs truly are designed specifically for applications requiring precise voltage regulation and excellent transient suppression.

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