HARMONICSLIMITED
The GreenWay to Sustained Energy $avings
by Jefferson Electric

HARMONICS LIMITED CORE TECHNOLOGY

The basis of our harmonic mitigation system is the Harmonics Suppression System (HSS®). Instead of filtering 3rd harmonic currents from the line after they are generated, our patented HSS works at the source to prevent the generation of these currents.

AC power is delivered throughout the distribution system at a fundamental frequency of 60 Hz. (50 Hz in Europe.) Harmonics are defined as, "integral multiples of the fundamental frequency." For instance, the 3rd harmonic frequency is 180 Hz; the 5th is 300 Hz, etc. In the US, the standard distribution system in commercial facilities is 208/120 wye. There are three phase wires and a neutral wire. The voltage between any two phase wires is 208, and the voltage between any single phase wire and the neutral wire is 120. All 120 volt loads are connected between a phase and neutral. When the loads on all three phases are balanced (the same fundamental current is flowing in each phase) the fundamental currents in the neutral cancel and the neutral wire carries zero current. When computer loads and other loads using switched mode power supplies are connected however, the situation changes.

Switch mode power supplies (SMPS) draw current in spikes, which requires the AC supply to provide harmonic currents. The largest harmonic current generated by the SMPS is the 3rd. The magnitude of the harmonic current can be as large as or larger than the fundamental current. Also generated, in smaller amounts, are the 5th, 7th, and all other odd harmonic currents.

Like the fundamental current, most harmonic currents cancel out on the neutral wire. However, the 3rd harmonic current, instead of canceling, is additive in the neutral. Thus if each phase wire were carrying, in addition to fundamental current, 100 amps of 3rd harmonic current, the neutral wire could be carrying 300 amps of 3rd harmonic current. In many cases, neutral-wire current can exceed phase wire currents. This extra current provides no useful power to the loads. It simply reduces the capacity of the system to power more loads, and produces waste heat in all the wiring and switchgear. When the 3rd harmonic current returns to the transformer it is reflected into the transformer primary where it circulates in the delta winding until it is dissipated as heat. The result is overheated neutral wires, switchgear, and transformers. This can lead to failure of some part of the distribution system and, in the worst case, fires. In addition, waste heat in all parts of the system increases energy losses and results in higher electrical bills. 3rd harmonic currents can increase electrical costs by as much as 8%.

Several methods have been employed to try to accommodate the higher currents caused by 3rd harmonics in the phase and neutral wires. The system can be over-sized. If a 115 kVA load is expected, a 150 kVA transformer can be specified, along with larger switchgear, and wires. The neutral wire can be doubled to enable it to carry the extra harmonic current. K-rated transformers, special transformers with more steel, heaver wires, and double neutral connections, designed to withstand the extra heat produced by harmonic currents are available. Harmonic canceling transformers, often called "Zig-Zag" transformers, are designed to cancel the 3rd harmonic currents in the secondary winding thus keeping them out of the primary winding. Unfortunately, none of these methods actually keep the 3rd harmonic currents from flowing throughout the distribution system and none of them reduce waste heat and energy loss.

Rather than accommodating 3rd harmonic current the Harmonic Suppression System keeps the current from ever being generated by the SMPS loads. The HSS consists of a parallel resonance LCR tank circuit tuned to the 3rd harmonic frequency. A property of this circuit is that it has near infinite impedance at the tuning frequency and very low impedance at all other frequencies. When connected at the transformer in series with the neutral wire, the HSS prevents the flow of 3rd harmonic current into the transformer. Since no 3rd harmonic current can flow into the transformer, none can flow out on the phase wires, and the SMPSs cannot generate any. (Basic laws of physics forbid the flow of current into a wire if it has no way of flowing out). Third harmonic currents are eliminated in the distribution system from the transformer out to the furthest outlet. Engineers often ask, "Where does the 3rd harmonic current go?" The answer is, "it doesn't go anywhere…it never exists in the distribution system".

The advantages of the HSS over "accommodation" technology are clear. Gone is the need to oversize a system to allow for extra capacity that cannot be used to support useful loads. Instead, the system can be "right sized," with installed capacity equal to what is really needed. Double neutral wires are eliminated. There is no need for K-rated or zig-zag transformers to handle the extra harmonic currents since these currents do not exist in the system. Waste heat caused by 3rd harmonic currents is no longer generated and system reliability is increased. Electrical power costs can be reduced as much as 8%. Depending on the operating hours of a facility and the cost of power, energy savings can pay back any extra cost of the HSS over accommodation technology in one to three years. The accommodation techniques have no energy payback. An energy savings estimator is available to help you calculate your payback period.

The Harmonics Suppression System (HSS) is extremely reliable, is UL certified, and is fully compliant with the National Electrical Code. It is the only harmonic mitigation system that "prevents" the formation of 3rd harmonic currents throughout the electrical distribution system, rather than just "accommodating" these currents after they are formed. It is the only harmonic mitigation system that reduces wasted energy and has an energy payback. It is clearly the technology of choice for solving 3rd harmonic current problems in electrical systems that power multiple computer and computer-type loads.

Contact Harmonics Limited at customerservice@harmonicslimited.com or call 800-892-3755 to learn more about comparing the technical aspects of these different types of transformers.