POWER QUALITY INTERNATIONAL

Exclusive e-Rated® Provider

PQI Distribution TransFilter™ - Harmonic Mitigating Transformer in lieu of K-Rated

The first signs of the incompatibility between conventional building power distribution systems and nonlinear loads became obvious in the mid-1980s as more and more personal computers appeared in the workplace. A few decades later, personal computers, monitors, powerful workstations, laser printers, and other modem electronic office equipment typically form a large portion of the electrical load in a building. Because these loads are very nonlinear, their load currents are rich in harmonics, causing problems for both the power distribution system and for the electronic equipment itself.

The ill effects due to current harmonics generated by these nonlinear loads include:

1. Large currents in the neutral wires of the power distribution system. The neutral current will generally be larger than the current in any of the phase wires. Because only circuit breakers or fuses protect the phase wires, this is a very real fire hazard.

2. Overheated electrical supply transformers. Overheating shortens the life of a transformer and will eventually destroy it. When a transformer fails, the cost of lost productivity during the emergency repair time far exceeds the replacement cost of the transformer itself.

3. Poor power factor. The harmonic currents caused by the nonlinear loads do not carry any real power (kW) even though they do increase the volt-amperage (kVA). This lowers the power factor (PF = kW/kVA) at the building electrical service entrance. Electrical utilities typically have a monthly penalty charge for major users with a low power factor.

4. Lowered reliability of computer systems and all connected nonlinear loads. Distorted supply voltage and increased the neutral-to-ground voltage may cause

hardware problems which often appear at first to be software problems. IEEE Std. 519-1992 recommends that the voltage distortion for computer use be limited to a maximum of 5% total harmonic distortion of voltage (THDv) and that the largest single harmonic not exceed 3%.

The electrical industry's first response to these four problems was to double the ampacity (current carrying capacity) of the neutral conductors so that they would not overheat.

The second response was to beef-up the distribution transformer so that it would not fail due to the higher heat losses caused by the harmonic currents flowing through it. These transformers are now known as K-Factor rated transformers. The K-Factor is a mathematical formula which predicts that the eddy current losses in a transformer will be increased in direct proportion to the sum of the products of each harmonic current amplitude squared multiplied by its harmonic number squared.

Doubling the neutral and using a K Rated transformer solves the electrical safety half of the harmonics problem. Unfortunately, these two steps do nothing to solve problem 3, poor power factor, nor problem 4, lowered computer system reliability.

On the other hand, using a combination of PQI Distribution TransFilters™ - Harmonic Mitigating Transformers (HMT's), doubling the neutrals, and keeping the distribution panels close to the transformers will solve all four problems at once.

The PQI Distribution TransFilter™ (HMT) transformer is an isolation transformer with a special secondary winding configuration that minimizes the voltage distortion caused by the 3rd and 9th current harmonics that make up the major portion of the neutral current. It is suitable for supplying loads up to K-Factor 20.

The PQI Distribution TransFilter™ (HMT) transformer can be manufactured with a 0 degree, 30 degree, 15 degree, 45 degree, 20 degree or 40 degree phase shift (at the fundamental frequency of 60Hz) between its input and output windings. Different phase shift combinations at the fundamental result in a 180-degree phase shift for the 5th, 7th, 17th, and 19th harmonic currents. We can take advantage of this fact to cancel these harmonic currents from one half of the building against those from the other half. For example, this can be done by supplying one-half of the building through PQI Distribution TransFilter™ (HMT) transformers with a zero degree shift (zero degrees for the fundamental and all the harmonics) and the other half through PQI Distribution TransFilter™ (HMT) transformers with a 30 degree shift at the fundamental (180 degrees for 5th, 7th, 17th, and 19th harmonics). This will remove the balanced portions of all four of the largest current harmonics (3rd, 5th, 7th, and 9th). There will be a substantial improvement in power factor, solving problem 3. For even better performance, a PQI Distribution TransFilter™

(HMT) Dual Output transformer produces the cancellation of 5th & 7th harmonics at the secondary of the transformer using 2 outputs.

Voltage distortion is caused by the interaction of the harmonic currents with the various impedances of the distribution systems at the harmonic frequencies. Canceling the 3rd, 5th, 7th, and 9th harmonic currents with PQI Distribution TransFilter™ (HMT) transformers will result in a substantial improvement in voltage distortion level. Each application is different, but typically the new voltage distortion level will be about half of the original level and comfortably within the IEEE recommended maximum of 5%. As a final step, keeping the distribution panels close to the transformers will limit the length of the 120/208V, 4-wire runs. This will minimize the neutral-to-ground voltage that can develop. Hence, computer system reliability is improved, solving problem 4.

In summary, using a K-Rated transformer will permit solving just the first two problems, albeit, in a very inefficient way. Using PQI Distribution TransFilter™ Harmonic Mitigating transformers will permit solving all four problems, efficiently and ensuring that the computer system loads and the power distribution system are completely compatible with each other.