Total Harmonic Distortion

Harmonic problems are almost always introduced by the consumers' equipment and installation practices. Harmonic distortion is caused by the high use of non-linear load equipment such as computer power supplies, electronic ballasts, compact fluorescent lamps and variable speed drives etc, which create high current flow with harmonic frequency components. The limiting rating for most electrical circuit elements is determined by the amount of heat that can be dissipated to avoid overheating of busbars, circuit breakers, neutral conductors, transformer windings or generator alternators.

Definition

THD is defined as the RMS value of the waveform remaining when the fundamental is removed. A perfect sine wave is 100%, the fundamental is the system frequency of 50 or 60Hz. Harmonic distortion is caused by the introduction of waveforms at frequencies in multiplies of the fundamental ie: 3rd harmonic is 3x the fundamental frequency / 150Hz. Total harmonic distortion is a measurement of the sum value of the waveform that is distorted.

Power Measurement

Despite the use of good quality test meter instrumentation, high current flow can often remain undetected or under estimated by as much 40%. This severe under-estimation causes overly high running temperatures of equipment and nuisance tripping. This is simply because the average reading test meters commonly used by maintenance technicians, are not designed to accurately measure distorted currents, and can only provide indication of the condition of the supply at the time of checking. Power quality conditions change continuously, and only instruments offering true RMS measurement of distorted waveforms and neutral currents can provide the correct measurements to accurately determine the ratings of cables, busbars and circuit breakers.

Neutral Currents

High harmonic environments can produce unexpected and dangerous neutral currents. In a balanced system, the fundamental currents will cancel out, but, triple-N's will add, so harmonic currents at the 3rd, 9th, 15th etc. will flow in the neutral. Traditional 3 phase system meters are only able to calculate the vector of line to neutral current measurements, which may not register the true reading. Integra 1530, 1560 and 1580 offer a 3 phase 4 wire version with a neutral 4th CT allowing true neutral current measurement and protection in high harmonic environments.

Harmonic Profiles

There is much discussion over the practical harmonic range of a measurement instrument, however study of the harmonic profiles of typically installed equipment can guide the system designer to the practical solution. A typical harmonic profile graph will show a logarithmic decay as the harmonic frequency increases. It is necessary to establish the upper level at which the harmonic content is negligible.

For Example:

A laptop switch mode power supply causes approximately 25% of 3rd harmonic, 19% of 5th harmonic, 10% of 7th harmonic and 5% of 9th harmonic etc. Therefore it can be seen that almost all the harmonic content in an IT dominated load will be below the 15th harmonic.

In a 3 phase load incorporating 6 pulse bridge technology as is common in many variable speed drives, UPS systems and DC converters, similar profiles will be observed but extending to the 25th and 27th harmonic. It can therefore be deduced that in the majority of industrial and commercial applications an instrument measuring up to the 31st harmonic is ideal.

The Costs

Harmonic currents add to the fundamental load current and can affect revenue billing by introducing errors into kilowatt hour metering systems, which will directly increase the net billable kilowatt demand and kilowatt hour consumption charges.

The commercial effects of harmonic distortion to power quality are dramatically shorter equipment lifetimes, reduced energy efficiency and a susceptibility to nuisance tripping. The costs of supply interruption are high, however caused, resulting in data corruption, disruption of process manufacturing and failure of telecommunications facilities etc.