

# Harmonic Attenuation

## General

The number of electronic devices in the home and the office has increased rapidly over the past 20 years. These devices have raised the standard of living, and made the workplace less costly and more efficient to operate. However, as with any advancement, there are always some drawbacks. Electronic devices such as computers, lighting ballasts, variable frequency drives, electronic light dimmers, and any other device that has electronic controls, generate what are called harmonics.

*Harmonics are defined simply as unwanted frequency components on the source power generated by the loads.* Harmonics cause equipment malfunction, equipment failure, unnecessary high operating costs and in some cases fires.

Harmonics are created when electronic devices draw current in a non-linear fashion. This causes "Line Voltage Distortion", which is an irregularity in the shape of the voltage waveform. Voltage Distortion produces such effects as motors prematurely burning out, clocks running fast, computers freezing up and system crashes. The percentage of harmonics in a waveform is called THD (total harmonic distortion). As the THD increases, the efficiency of the system is greatly reduced. Since harmonics are different frequencies than the source frequency, the wire that is designed to carry 60Hz, now carries frequencies of 180Hz, 300Hz, 420Hz, 540Hz etc. This causes unnecessary heating, power losses and even fires.

So what can be done about harmonics? There are many approaches to dealing with harmonics. The focus is to prevent harmonics from being reflected back to the utility line. Installing devices such as expensive filters, k-rated transformers, and other devices that do nothing more than "hide" harmonics, provide only partial solutions and can be very costly. The best solution is to attenuate (delete) harmonics before they are reflected to the line. This is achieved by implementing the UltraUPS. Using its digitally controlled PFC "power factor corrected" input, the UltraUPS attenuates harmonics before reaching the load and prevents load-generated harmonics from being reflected on the line.

## Harmonic Standards IEC 555 and IEEE 519

So how do you know if your equipment is properly protected? Two major standards exist in the industry dealing with harmonics: IEC 555-2 and IEEE 519. IEC 555-2 is an international standard that states current THD limits on the input of the following devices: cooking and heating appliances, motor operated or magnetically driven appliances, portable tools, light dimmers and radio and television receivers. IEEE 519 is an American

standard that gives guidelines for the design of systems that supply power to nonlinear loads. Some of the guidelines are voltage and current THD limits, and component design recommendations. If your UPS meets either or both of these standards, then your equipment is properly protected by consumer and industry standards. If your UPS does not meet these standards, then the levels of harmonics on the line will cause equipment to malfunction and even fail.

Are there any UPS's that meet these standards? The UltraUPS not only meets IEC 555-2 and IEEE 519, but vastly exceeds them. The number of nonlinear devices is increasing daily. Therefore, new, more stringent, harmonic standards are required for the future. Since the UltraUPS greatly exceeds today's standards for harmonics, it is the perfect UPS in preparation for the future.

## How Does the UltraUPS Attenuate Harmonics?

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The UltraUPS incorporates “bi-directional” harmonic attenuation. This means that the harmonics present at the input of the UPS are attenuated, and the harmonics generated by the load are attenuated before they reflect back on the line.

So how does this work? Suppose there are loads on the system, that produce high levels of harmonics like computers or VFD’s. Once the loads consume the power they need, they dump back on the line high frequency components called harmonics. These harmonics

increase the THD of the voltage waveform, which creates voltage distortion. Suppose an UltraUPS is now supplying power to the loads. The UltraUPS reconstructs the nonlinear current waveform that the load generates, to a linear waveform. This prevents the generation of any harmonics. Consider an AC motor connected to the system with the computers and the VFD’s, and the UltraUPS is removed. The AC motor now feels the voltage distortion created by the other loads. This

distortion is what causes AC motors to burn out prematurely. Now connect the UltraUPS in such a manner that it supplies power only to the motor. The UltraUPS digitally re-masters the distorted waveform created by the other loads, thus deleting almost all harmonics present in the voltage waveform. The UltraUPS provides complete harmonic attenuation for any device connected to the system.

## Summary

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Within the past 20 years the number of nonlinear loads has increased tremendously. With this increase, the generation of harmonics has become a greater problem than in times past. Harmonics are generated when a device draws current in a nonlinear fashion. This distorts the shape of the voltage waveform, which causes certain devices to malfunction and eventually fail.

The percentage of harmonics in a waveform is measured as THD. As the THD rises, the efficiency of the system is decreased. Taking into account the damaging effects of harmonics, the proper course of action is to attenuate them. The UltraUPS is an ideal UPS for the attenuation of harmonics. The UltraUPS meets and greatly exceeds IEC 555-2 and IEEE 519, industry standards for safe levels of harmonics.

The UltraUPS incorporates “bi-directional” harmonic attenuation. This means that harmonics are attenuated on the input of the UPS, before they reach the load and are attenuated on the output before being reflected back on the line. The UltraUPS not only provides total protection of your loads from the damaging effects of harmonics, but also eliminates reflected harmonics to less than 4%.