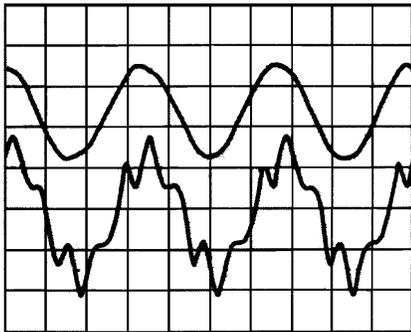


What's the harm in harmonics?



This is the result - a variety of harmonic frequencies superimposed on the desirable sine wave frequency - passed back along the local power grid to other equipment throughout an entire office building or local neighborhood. The effect is measured by %VTHD, a measure of the amount of voltage variation within the waveform.



The Powerware Series 9 UPS is the best way to protect critical computer equipment from all potentially harmful power problems.

A concise report on the effects of harmonic distortion on computers

1. The adverse effects of harmonics on electrical power systems are well known. International standards exist to help manage the injection of harmonic currents into the power system

2. A pure sine wave consists of a single fundamental frequency. Most waves are complex and can be broken down into a series of harmonics. For instance, the 3rd harmonic of the fundamental frequency 60 Hz is 180 Hz. The opposite end of the scale from a pure sine wave is a square wave - which contains of all the odd harmonics of a fundamental frequency starting with the 3rd harmonic and extending to infinity.

3. Harmonic distortion is a measure of the ratio between the fundamental and the harmonics that are present in a waveshape.

4. Distortion is caused by non linear loads drawing non sinusoidal currents.

5. Non linear loads include such office equipment as: computers (draw 3rd and 5th harmonics); lighting (ballasts produce 3rd and 5th), Transformers (3rd component), Power converters (variable speed drives, UPS, Electronic ballasts produce 3rd, 5th, 7th and 11th), commercial appliances such as photocopiers and printers.

6. The harmonic currents in a distribution system have the following undesirable effects:

a. significant effects on the performance of computer power supplies

b. heating of magnetic devices which can cause premature insulation failure and breakdown.

c. Triplen harmonics produce higher than expected neutral currents potentially resulting in insulation damage and breakdown due to temperature rise.

d. High neutral currents cause additional voltage drops, reducing available voltage and introducing even more distortion at the load. The resulting neutral to ground voltage also causes parasitic ground currents.

e. additional losses resulting in higher energy costs

f. failure of power factor correction capacitors or increased resonance that leads to an even higher order of distortion.

G. high frequency fields that can introduce buzz into telephone lines and corrupt data in adjacent data lines.

h. stray magnetic fields can introduce annoying interference patterns in VDTs.

I. Undesirable ground currents may cause upstream GFI (Ground Fault Interrupts) to trip — degrading power availability.

Computer loads

Computer power supplies are usually designed to operate over a range of AC input voltages. They produce a DC voltage that is affected by the waveshape of the AC waveform. Harmonic distortion has the effect of actually reducing the computer power supply's operating voltage. That variation is compounded by the normal variation of 10%. The end result is that the computer supply may malfunction, hiccup or fail to provide the required output logic voltages, resulting in potential bit errors.

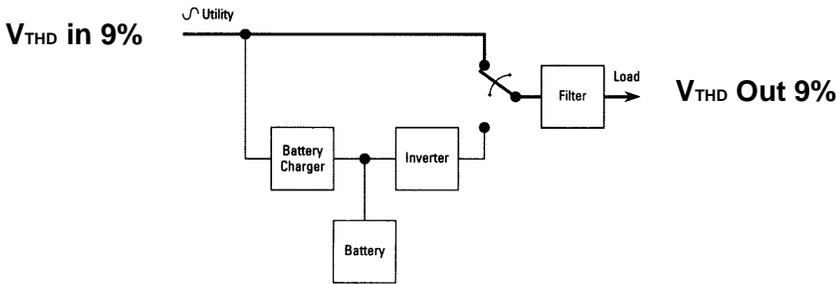
A further negative side effect of effectively lowering the computers operating voltage range is the reduction of "hold-up" time -- essential for the ability of the power supply to "ride through" power sags (caused by other equipment's start ups). The result is more potential bit errors.

The simple fact is that the Harmonic Distortion prevalent in the modern office has a direct pathway to your customer's computer power supplies and once there it can cause data loss and other operating errors.

The full discussion of harmonics and their effects on the computer is available in a Powerware white paper "Harmonics and their Effect on Computer Loads".

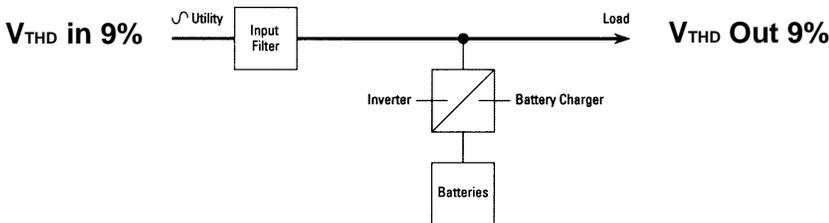
Level 3 UPS

Level 3 UPSs offer a low price solution to environments that require minimal power protection. Utility power is provided during normal operation. Harmonic Distortion present in the utility line passes through to the load.



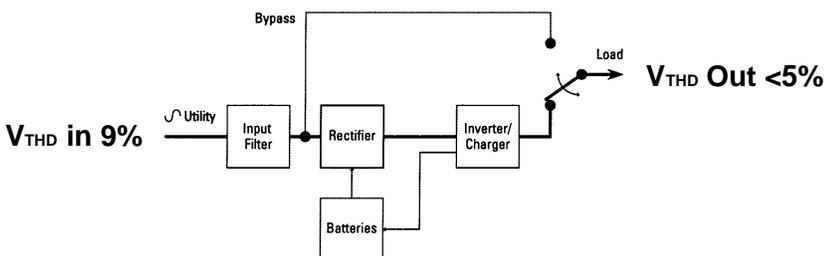
Level 5 UPS

Level 5 UPSs provide basic power protection at mid range prices. Line-interactive UPS provides more voltage regulation than off line, using the battery for voltage regulation, usually at the expense of battery life. Harmonic distortion, however, passes through unaffected.



Level 9 UPS

Level 9 UPSs are ideally suited to critical equipment. Online UPSs protect against all types of power problems and continuously uses the inverter to create clean, new, regulated power. Harmonic distortion, no matter how high, cannot pass through to the load.



What the Experts Say:

Some excerpts from electrical standards bodies and major manufacturers

Ontario Hydro

Although harmonics have existed for a long time, their effects are becoming increasingly important.

Harmonic currents represent a steady-state problem flowing through an electrical system distorting the power seen by all equipment. Pure (laboratory) sine waves are seldomly seen in the field.

Most harmonics result from the operation of loads at residential, commercial, and industrial facilities, and show up at distant points from their source, causing problems for neighboring electrical users.

Digital Equipment Corporation Site Environmental Preparation Guide

Voltage harmonic distortion: The harmonic content of the unloaded power source should have a total harmonic content of 5% or less of the fundamental frequency with no single harmonic exceeding 3%.

IBM System 400 Physical Planning Guide, Installation requirements for UPS system performance

Total harmonic voltage content: The RMS sum of all harmonics (H2 through H60) in output voltage waveform must be less than 5% RMS value of the fundamental equation.

Institute of Electrical and Electronic Engineers (IEEE)

Power Equipment is susceptible to misoperation caused by harmonic distortion

3.3.1 Harmonic distortion limits:

$V_n \leq 69kV$: Individual Harmonic Voltage Distortion 3.0%: Total Voltage Distortion - $THDV_n < 5\%$.

Harmonic Distortion

Levels 3 and 5 Do Not Address Harmonics

Harmonics are Everywhere

CASE STUDY - Electronics:

A large computer chip manufacturer had frequent "untraceable errors" in a product testing lab. This meant that the reason a test failed could not be confirmed or repeated. Was there a problem with the product or was the test environment causing these errors? Measurements revealed excessive levels of harmonic distortion in the voltage supplied to their equipment. When the harmonic distortion problem was treated, the untraceable errors disappeared.

CASE STUDY - Broadcasting:

A broadcaster was experiencing lock-ups of mixing boards and program corruption of video routers. On one occasion, during a live broadcast, a video mixer became inoperable resulting in the completion of the broadcast from a single camera position. Measurements revealed excessive levels of harmonic distortion in the voltage supplied to this equipment. When the harmonic distortion was removed the operational problems disappeared.

There are many similar examples where electronic equipment such as computers, telecommunications and broadcast equipment suffer the consequences of harmonic distortion. The reality is that this equipment is sensitive to the quality of the voltage waveform. In order to ensure the proper operation of this equipment,

Power Consultants Warn:

- A site may not have an overload or unsafe condition now, but the owner needs to be on guard against this harmonic threat.

Effects of Harmonics

- High levels of harmonics result in erratic, sometimes subtle malfunctions of equipment, that can have serious consequences.
- Overheating effects could cause overvoltage damage and premature failure to computers and office equipment
- High harmonic levels can fool certain control circuits into erroneous operation. CPU clock timing operations can be falsely triggered
- Intermittent electrical noise, intense enough to corrupt digital signals and cause malfunctions.
- Distortion of voltage severe enough to impair ride-through capabilities of computers and related equipment.

APC's Response

- Harmonic voltages have virtually no effect on modem computers, but can cause overheating in some cases.
- The UPS may operate in backup mode much more often than usual due to the poor quality of the AC power source (source with severe line voltage distortion).

Independent Evaluation of APC SmartUPS®

- The APC SmartUPS momentary transfers to inverter for almost any voltage anomaly.
- UPS equipment worked properly with harmonic distortion levels below 5% THD. As distortion levels increased more interaction was noted. At 8.66% THD, the APC SmartUPS would not operate from the test voltage until the sensitivity switch on the back of the unit was set to a more tolerant position.

What Does It Mean?

1. Harmonics will cause servers to crash and fail prematurely.
2. Line-interactive technology will not protect the servers from harmonics.
3. Online UPS is recommended to protect servers from harmonics.



Contact Esys for more information about this product:

Esys® The Energy Control Company™
4520 Stine Road, Ste 7
Bakersfield, CA 93313
(661) 833-1902

email: esys@esys.us
website: <http://www.esys.us>

