Choosing the Right UPS for your Lenovo ThinkServer System

Introduces key terminology

Reviews major UPS technologies

Provides guidelines for UPS selection

Describes important recommendations for ThinkServer compatibility

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Abstract

This guide provides an overview of uninterruptible power supply (UPS) technologies and the information necessary to select a UPS that is compatible with a Lenovo ThinkServer system. Although the information that is presented in this guide is universal, the recommendations are for ThinkServer products only and do not apply to Lenovo System x servers because these servers use different power supplies that might not have the same requirements as those described in this paper.

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Introduction

An uninterruptible power supply (UPS), also known as a “battery backup”, is designed to provide continuous power if there is a power loss. It provides continuous power by charging an internal battery during normal operation and then discharging the battery when a power failure occurs to keep connected devices running. A UPS is similar to a generator in that both provide emergency power except that a UPS discharges stored electrical energy while a generator produces power from other sources, such as fuel. This difference gives UPS units a shorter run time, which often is measured in minutes, but allows for extremely fast failover without an interruption in service. For critical applications, a UPS and generator are often used together with the UPS providing seamless backup power until the generator comes online.

Regardless of its design, all UPS units have the following basic parts in common:

- A battery that stores energy for emergency use
- A charger that charges the battery during normal operation
- An inverter that converts the battery’s Direct Current (DC) into the Alternating Current (AC) that is used by its devices

Figure 1 shows the two operating modes of a UPS and the major components in the UPS.

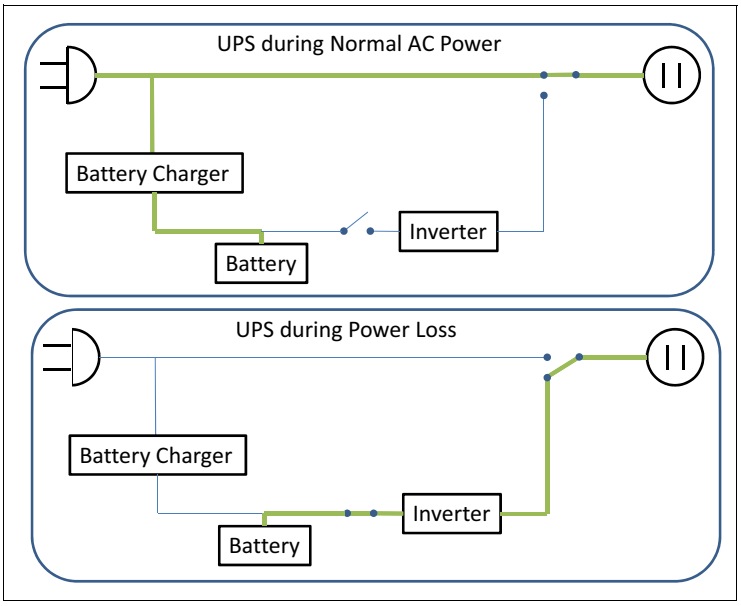

Figure 1 Example of a Standby UPS in operation

In addition to this basic function, UPS units can have other features, such as overvoltage protection or faster switching to battery power. Most important for compatibility with Lenovo® servers and other complex digital electronics are the power and shape of the AC electricity that is provided by the inverter. The power is measured in Watts (W) and the shape is measured by Total Harmonic Distortion (THD).

Power and Watts

Watts (W) are the basic unit of power consumption for electronics and they are defined as the product of voltage across a device, which is measured in Volts (V) and current that is flowing through it, which is measured in Amps (A). For a UPS to power its devices if there is a power failure, the UPS must have a wattage rating at least as high as the sum of all of the devices that are connected to it.

For a Lenovo ThinkServer®, its power rating is the maximum power consumption of its power supply unit (PSU). For servers with redundant power supplies, the maximum power consumption of one power supply is sufficient as both PSUs do not consume their maximum power rating at the same time under normal operation. However, when a server with redundant power supplies is first connected to AC power, both PSUs briefly consume their maximum power as they charge up.

To ensure the correct long-term operation of equipment, Lenovo recommends that you choose a UPS with a power output that is 15 - 20% greater than the sum of the maximum power consumption of all devices that are connected to it, as shown in the following equation:

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UPS Power Output (in Watts) >= UPS Maximum Wanted Output + 15-20%
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Waveform shape and Total Harmonic Distortion

Describing the shape of an electrical signal can be complicated, but it is normally done by referring to a graph of the signal's voltage as it changes over time. This graph is called the "voltage waveform". For AC power, the waveform is a pure sine wave that repeats approximately 60 times every second (the exact frequency varies between countries). This repetition is called the signal's frequency and is measured in Hertz (Hz).

Figure 2 shows an example waveform with a peak voltage and frequency of approximately 156 V and 60 Hz.

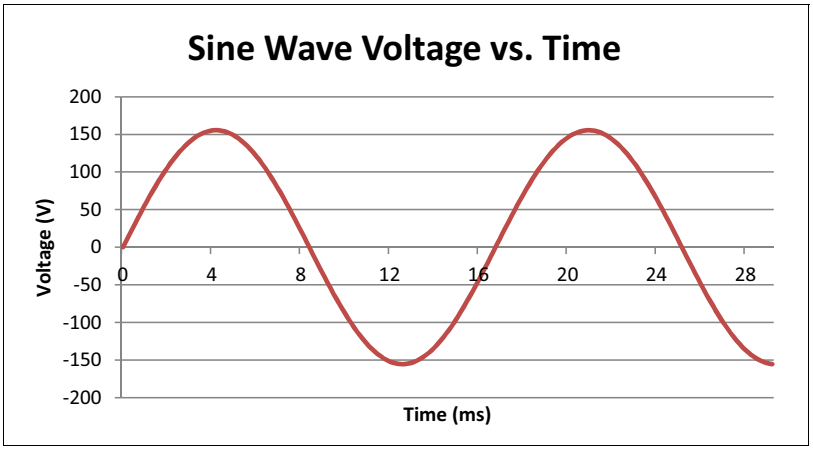

Figure 2 Example sine waveform

The waveform of the AC signal that is provided by a utility company closely approximates a pure sine wave; however, some signals (including those signals from certain designs of UPS) can look different and match an ideal sine wave only in frequency and average voltage. This difference is enough for simple electronics, such as light bulbs, but it can be a problem for more sensitive devices, including servers.

THD provides a way to measure how different a signal's shape is from the sine wave ideal. It expresses this difference as a percentage with a higher percentage representing that the signal is more distorted. An ideal sine wave has a THD of 0% and normal utility power can be as high as 5%.

Related to THD is *dead time*, which is the amount of time that a signal spends at 0 V and therefore provides no power. This state contributes to a signal's THD but is especially important to electrical devices because the devices rely on continuous power to function. UPS units also have a switch-over time, which is the dead time that occurs between a loss of power and the UPS' inverter turning on.

Lenovo THD recommendation

Lenovo recommends the following THD configuration:

- Total Harmonic Distortion (THD): <= 10%
- Switch-over Time: <= 2 ms
- Dead Time: <= 2 ms

Power Factor Correction

Inside a Lenovo ThinkServer PSU is a device that is called an active Power Factor Corrector (active PFC), which is responsible for ensuring that the rapid on-off switching of electronics inside the server does not affect the power quality for other devices that are on the same circuit. A PFC ensures good power quality by trying to correct the server's power factor, which is a measure of power quality that is used for loads instead of sources. Active PFCs are a common component in server power supplies and computer power supplies in general, but they function poorly when supplied by power that has a high THD.

PSUs with active PFCs installed might shut off or draw excessive current when supplied from these sources. This excessive current draw is within the safe operating range of Lenovo ThinkServer systems, but place increased stress on the power supply that can lead to equipment failure over time.

UPS outputs

Although the Wattage of a UPS is an important characteristic, the shape of the waveform that is providing that power also is an important consideration for sensitive electronics, such as servers. This shape is determined by the UPS inverter and comes in the following main categories (not all of which are well-suited to powering server PSUs):

- Square wave
- Simulated sine wave
- Pure sine wave

These waves have the same frequency and average voltage, but different waveforms and, therefore, different THDs and dead times. These waves are described next.

Square wave

Square waves are the simplest type of wave, with only two voltage levels and sharp, nearly vertical transitions between them. These waves are easy to produce from a DC battery, but have extremely high THD and are not suitable for Lenovo ThinkServer systems. Figure 3 shows a square wave.

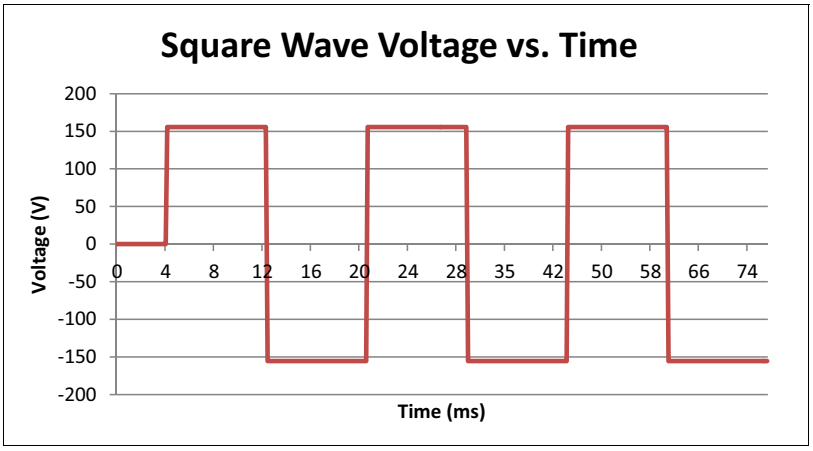

Figure 3 Square wave

Simulated sine wave

Simulated sine waves also change suddenly from one voltage to another. However, unlike true square waves, simulated sine waves use three or more voltage levels to produce a smoother shape. These waves also are called *stepped square*, *stepped sine*, or *modified sine* waves. The waves have less THD than square waves, but are still rarely less than 10%. Simulated sine waves also can have long periods of dead time.

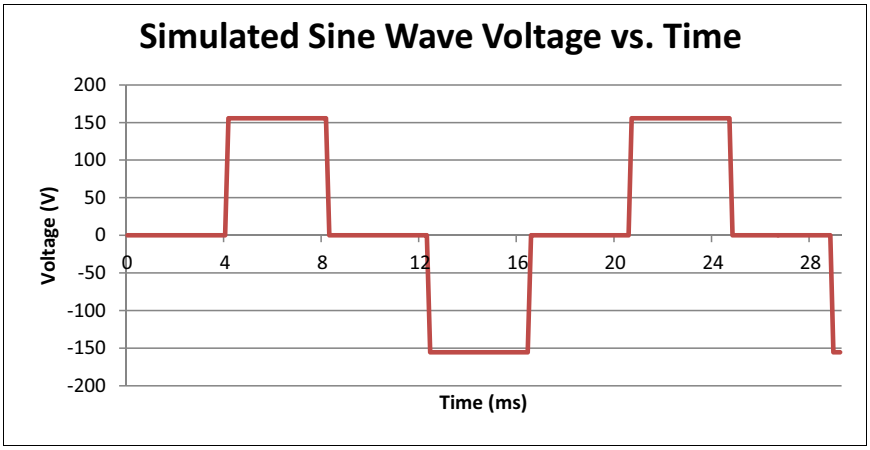

Figure 4 Simulated sine wave with dead time between the peaks

Pure sine wave

A pure sine wave output is a true, curved sinusoid rather than a series of steps, as shown in Figure 5. It accurately simulates the sine wave voltage that is normally provided by a power company.

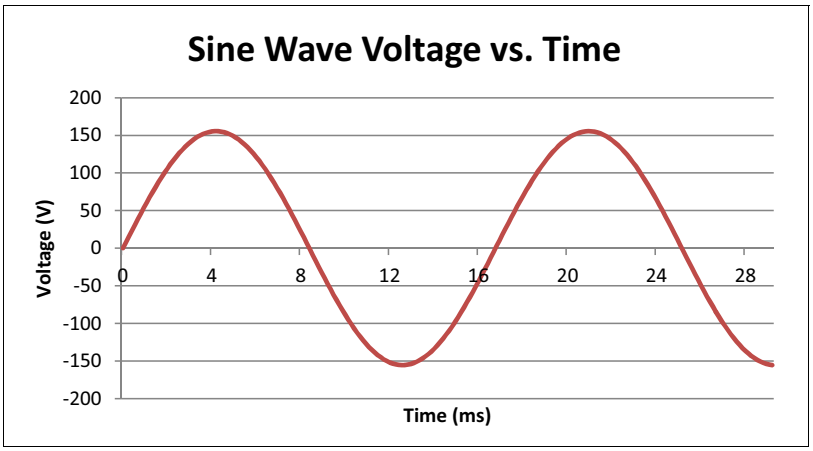

Figure 5 Pure sine wave with a lack of sharp edges or sudden amplitude changes

ThinkServer power supplies require a UPS that supplies power with a THD below 10% and switch-over and dead times below 2 ms. Most pure sine UPS units meet these requirements; however, you should confirm with your UPS vendor that their offerings meet the requirement.

Summary of recommendations

Lenovo recommends that any UPS that is used with a Lenovo ThinkServer system meets the following specifications:

- UPS Power: UPS Maximum Wanted Output + 15-20%
- Total Harmonic Distortion (THD): <= 10%
- Dead Time: <= 2 ms
- Switch-over Time: <= 2 ms

Failure to meet these specifications can result in unwanted behaviors, including unexpected system shutdowns and PSU failures.

As a result of these guidelines, Lenovo does not recommend the use of square or simulated-sine wave UPS units.

Because of their waveforms, square and simulated sine wave UPS units rarely have a sufficiently low TDH. Pure sine wave UPS units are more likely to meet the specifications that are listed in this section but still must be checked to ensure compatibility.

Note: For more information about UPS compatibility for Lenovo System x®, see this website:

http://powerquality.eaton.com/ibmups/default.asp

About the author

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