

## UPS selection for servers with active PFC power supplies

### Abstract

Power Factor Corrected (PFC) power supplies are becoming increasingly popular in low-end servers, workstations and desktop PC's in North America. Contributing to this trend is the fact that Energy Star 4.0 compliance as of July 2007 requires the use of PFC power supplies in order to meet the stringent guidelines for energy consumption. Power Factor Correction, or PFC, is a circuit design technique to increase the power factor so that it approaches 1, or unity power factor. These PFC power supplies have been used for a number of years in Europe, and in many higher end servers throughout the world.

This document will explain why some Back-UPS or Smart-UPS SC models may not be the proper choice for loads that consist of large PFC (power factor corrected) power supplies and/or contain redundant supplies. This document provides guidance for selecting and properly sizing models that are more suitable for the demands of PFC loads.

### Introduction

One common definition of the power factor of a load (e.g. a computer power supply) is the ratio between the 'real' power, measured in watts (W), and the 'apparent' power, measured in VA (volt-amperes) that the load draws. Traditional power supplies used to have power factors between 0.6 and 0.7, which means that the real power (e.g. 240W) is lower than apparent power (e.g. 400VA). This is why APC UPS products are rated by VA (e.g. 1500VA) have a lower watt rating (e.g. 865W).

Power Factor Correction is a circuit design technique to increase the power factor so that it approaches 1, or unity power factor. In this case the 'real' and 'apparent' power is equivalent. PFC supplies are not new as they have been used for a number of years particularly in Europe. They come mainly in two different types:

**Passive PFC** – these use passive components (e.g. inductors) to smooth out the AC current to more closely resemble a sine wave. This technique can typically achieve power factors between 0.8 and 0.9. This is an older technology that is not common nowadays.

**Active PFC** – these use semiconductor components (e.g. FETs) to increase power factor to near unity (typically 0.95 or higher). Most PFC supplies used in modern servers & desktop PC's are now the active PFC type.

Another trend in servers is the use of redundant power supplies in order to achieve a higher level of overall system availability. In a redundant configuration, two or more power supplies may be connected to the input mains. This creates additional demands on the UPS and must be considered when sizing the UPS.

Typically server class PFC supplies are rated at 500W or higher, while those in desktop PC's are typically 350W or less. However some of the higher end models may now have power supplies rated as high as 850W or more that are available in redundant configuration. These ratings are generally readily available from the manufacturer and must be considered for proper UPS sizing and selection.

## Implications for UPS Selection

Because of the way active PFC's operate, they can sometimes overload the UPS with momentary high inrush current. This can occur when the UPS transfers from online to on-battery operation, creating a momentary loss of power (<8ms). The PFC supply may respond by temporarily drawing an excessive amount of current. Also some PC's, when awoken from standby (or 'sleep') mode, will draw a momentary high inrush current, potentially overloading the UPS if it happens to be running on battery.

All APC UPS's are designed to protect themselves when there is a severe overload while on battery. Some general server-class UPS's such as APC's core Smart-UPS® models will protect itself by actively limiting the overload to a level that it can manage. Other, more economical UPS designs such as Back-UPS® or the Smart-UPS® SC will protect itself by shutting down quickly when it detects a severe overload. This potential for incompatibility should be considered when selecting a UPS – sometimes the most economical choice is not the best one.

It is important to note that not all PFC power supplies will cause the UPS overload. However, the incompatibility is most acute in the one of the following situations:

- A large server class PFC supply (e.g. rated 500W or more) is used with a Back-UPS or Smart-UPS SC.
- The server is equipped with redundant PFC supplies (has two line cords) that are powered by the same UPS.
- More than one PFC supply is plugged into the same UPS, bringing the total power rating (nominal) of the power supplies to 500W or more.
- A workstation class PC (or high-end gaming PC) is equipped with a PFC power supply rated 500W or more.

In any of these situations, APC recommends that a true, pure sine wave, server class UPS be used. Acceptable models include APC's Smart-UPS®, Smart-UPS® XL and Smart-UPS® RT family of UPSs. However if, a Smart-UPS SC or Back-UPS RS is to be used, the UPS should be sized accordingly.

## UPS Sizing guidelines for Smart-UPS® SC models with active PFC loads

### Consider the nominal power supply rating

A critical factor to consider in avoiding an overload trip fault is the 'nominal' power rating of the power supplies, not the actual steady state power consumption. For example, a server may have two 600W power supplies in parallel-redundant mode, for a total power rating of 1200W. But the steady state power consumption in this case will be less than 600W. In another example, a high-end workstation with an 850W PFC power supply may only consume 350W under normal operation.

So proper sizing of a UPS with active PFC power supplies, to better handle momentary overloads, must take into consideration the maximum power rating of the power supply, not just the actual power consumption of the load.

Also keep in mind that if a power supply is rated for 600W output, it's maximum 'input' power will be higher depending on its efficiency. For example, an Energy Star 4.0 compliant power supply has to be more than 80% efficient. That means when it is delivering 600W output power, its input power can be as high as 750W. This 'input' power should be the basis for sizing the UPS.

Currently not all UPS selectors take these factors into consideration when recommending a proper UPS for servers with active PFC power supplies. Therefore the following guidelines should be followed when recommending a UPS for a PFC load.

### Consider the power supply efficiency

Smart-UPS® SC models should be sized based on the "rated power output" of the supply, divided by its efficiency, not the actual power consumption.

For example, SC1000 (600W) should not be recommended for use with a PFC supplied rated for 500W, even if actual steady state power is far less. Assuming the 500W PFC supply has 80% efficiency, the SmartUPS SC should be rated for at least  $500W/0.8 = 625W$  of output power.

### Consider all accessories

Even when the PC or Server alone meets this guideline, having other loads on the UPS may cause problems.

For example, SC1500 (865W) may support a server with PFC supply rated 600W ( $600/0.8 = 750$ ), but if there is a monitor or external drive plugged in to the UPS, this could cause overloads during transfers.

## Consider the power supply configuration

Today many servers have more than one power supply option that can be configured in a redundant mode. When redundant PFC power supplies are used, the rating of all the connected power supplies should be added up to correctly size the UPS.

For example, a server with two 300W PFC 1+1 redundant power supplies should be backed up by a Smart-UPS® SC rated for at least  $(300+300)/0.8 = 750W$  rated continuous output power

## Alternatives when large PFC supplies or multiple PFC supplies are being protected

Even when sizing guidelines above are followed, there may still be some situations where there is incompatibility between the PFC supply and the Smart-UPS® SC that the customer wants or has specified. In this case it is necessary to recommend an alternate UPS that will work better with the PFC.

Smart-UPS® SC 1000 and 1500 models with a non-sine wave output are positioned for entry level servers and small network gear only and may not be suitable for the active PFC loads found on many higher end, name brand servers. For this reason, a better choice for these applications is to consider a pure sine wave, server class UPS like APC's Smart-UPS® or Smart-UPS® XL 1000 and 1500VA or larger.



Smart-UPS SC



Smart-UPS and Smart-UPS XL Family