An Innovative Alternative to the Traditional AC UPS

Introduction

Modern technology is on a constant journey, one that is always pushing the envelope to improve performance and value. Smaller, faster, lighter – whatever the objective, the intent is always to advance forward.

At times we may focus on particular objectives and can miss unintended benefits in related areas. This can be the case when individual components, required as part of a system, are optimized at the component level. Typically, we assume that the system is improved at the component level which leads to system efficiency gains. But sometimes, a component-level improvement can have a bigger impact when system-level optimization is considered instead.

Such is the case in datacenter power infrastructure. It is time to take a fresh look at the way power is transformed and distributed from the Grid to IT equipment.

Traditional AC UPS Datacenter Power Architecture

Today's most common datacenter power architecture is based on the AC UPS. Figure 1 shows a typical example. The AC UPS provides an AC source that continues to operate "uninterrupted" even if the primary AC input is disrupted.

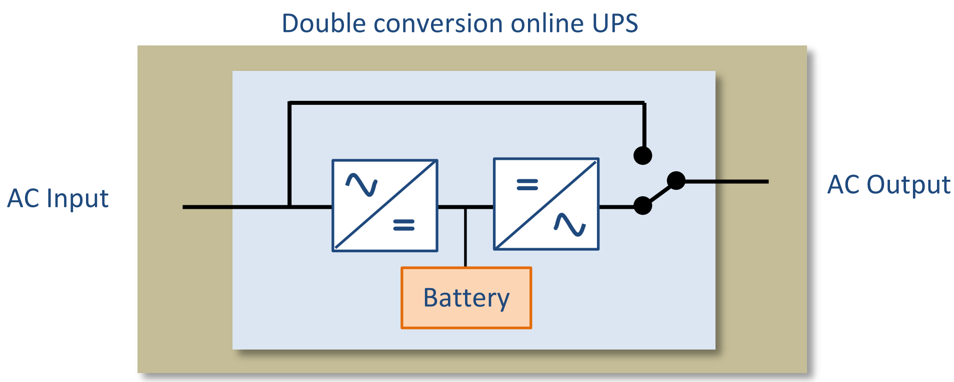

Figure 1 – Typical datacenter AC UPS architecture

The downstream IT equipment uses modern switch-mode AC/DC power supplies that convert the AC output of the UPS to the required voltage levels for the IT equipment.

The AC UPS and the switch-mode AC/DC power supply are components in the datacenter power system architecture. Each has realized tremendous performance improvements over time driven by both system-level objectives and competitive advances at the component level.

The Switch-Mode AC/DC Power Supply

The introduction of switch-mode power supply technology led to revolutionary performance improvements. The fundamental operation of switch-mode technology is the DC/DC converter in which one DC level is converted to another DC level using a combination of switches and passive energy storage elements. During the 1970's, advances in semiconductor technology allowed for higher switching frequencies in a DC/DC converter. This led to size reduction and significant efficiency gains over the previous 60Hz-based technology.

Switch-mode technology rapidly became the primary choice for all types of electronic equipment. Since the conversion topologies were DC/DC, AC inputs required an AC to DC conversion. The early systems used basic half wave, or full wave, rectification feeding a large capacitor for the AC to DC conversion, as shown in Figure 2.

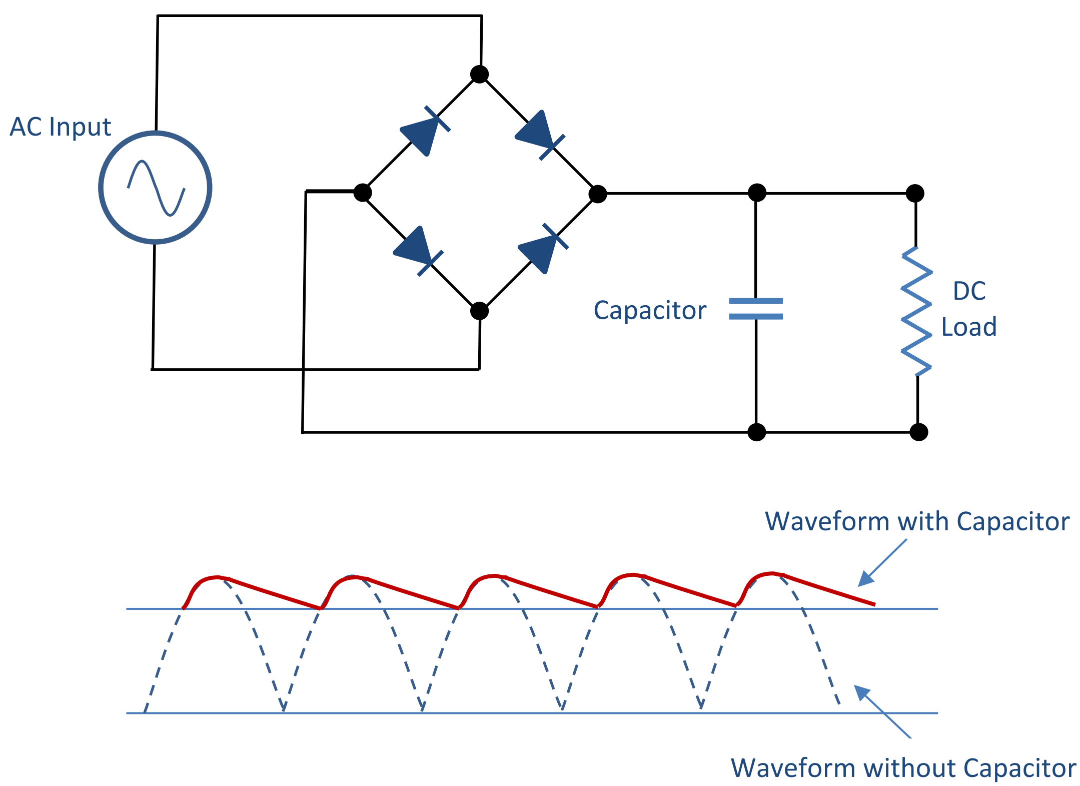

Figure 2 – Full wave peak charge rectification, simple solution for AC to DC conversion

This approach created a simple and inexpensive AC to DC conversion, but there was a downside. The peak charging of the capacitor leads to very poor power factor. The proliferation of this type of conversion quickly created the need to improve Power Factor Correction (PFC).

Power Factor Correction

While there are many ways to implement PFC, the most popular technique utilizes a DC/DC topology called the "Boost" converter. Figure 3 shows an AC input feeding a full wave rectifier, but now the peak charging capacitor has been replaced with a boost DC/DC converter. The switching frequency of the Boost converter is much higher than the 50/60Hz input AC voltage such that the incoming full-wave rectified voltage can be considered a slow-moving input voltage that can be regulated via the PFC controller.

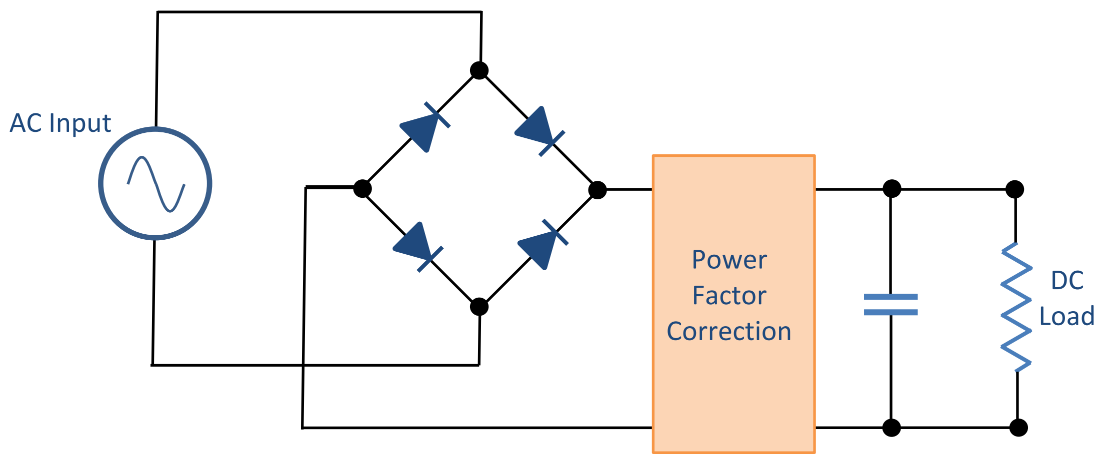

Figure 3 – Full wave rectification followed by Boost DC/DC converter

The PFC control manages the switching characteristic such that input current tracks the input voltage, thereby improving power factor.

The Modern Switch-Mode AC/DC Power Supply

The output of the Boost converter is a regulated DC voltage. In contemporary AC/DC switch-mode power supplies, this Boost output voltage is an intermediate rail that feeds a DC/DC power supply providing isolation and the desired output voltage for IT equipment.

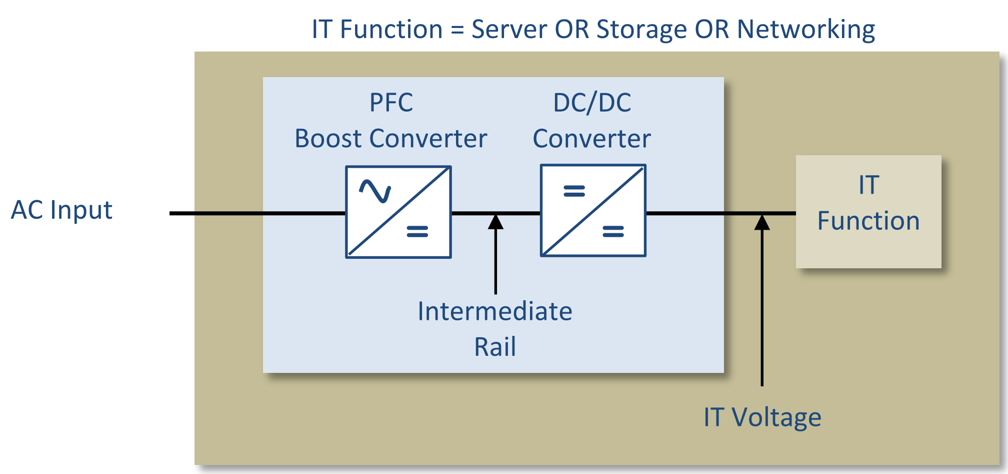

Figure 4 – Typical IT hardware with an internal AC/DC switch-mode power supply

Innovative Alternative to the Traditional AC UPS

The traditional AC UPS works from the presumption that an AC output is required because an AC input is required to feed power supplies for IT equipment.

But does modern IT equipment require an AC input?

The answer to this question represents a significant opportunity to improve system level performance. Recognizing that the PFC implementation is based on a DC/DC topology introduces an attractive opportunity to simplify system operation when battery backup is required. The PFC stage enables the power supply to accept either AC or DC voltage at its input.

Given that the PFC stage in the IT AC/DC power supply can operate with a DC input, the UPS inverter can be eliminated by changing the front end AC to DC rectification to a DC voltage that is compatible with the downstream PFC stage.

The AC UPS front-end AC/DC rectifier can also be simplified. The traditional AC UPS has a rectifier that is sized for both the full load output requirements and the charging battery. Along with inverter elimination, the rectifier can now be sized for battery charging only.

The fact that the power supply is compatible with a DC voltage enables us to use a much simpler approach to provide uninterruptable power to IT equipment.

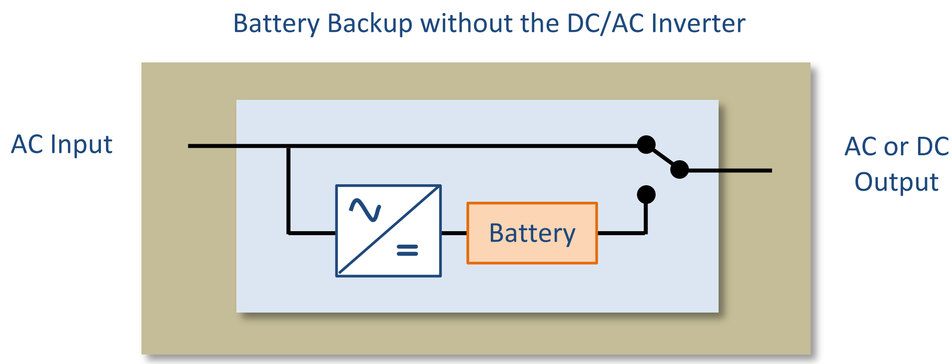

Figure 5 – Innovative Alternative to the Traditional AC UPS

Introducing “Virtual Power On Call” (VPOC™)

VPOC™ is a unique Lite-On innovation that leverages the operational capability inherently found in the PFC stage of a modern switch-mode power supply. The 1U, VPOC™ design dramatically improves system performance and efficiency as compared to a traditional AC UPS by eliminating the inverter stage and using a smaller rectifier circuit to create a more cost-effective and space-saving alternative.

Technology is constantly changing and the VPOC™ backup system is the next step for improved performance, efficiency, and lower costs which lead to better "Total Cost of Ownership" (TCO). As an added benefit, the VPOC™ is significantly smaller than traditional AC UPS systems leaving more room for critical IT equipment.

About the Author

Gary Edmonds is the VP of System Engineering for Lite-On Power System Solutions. He received his Master's degree in Electrical Engineering from California Institute of Technology and has over 30 years of experience designing power systems and working customer applications.

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