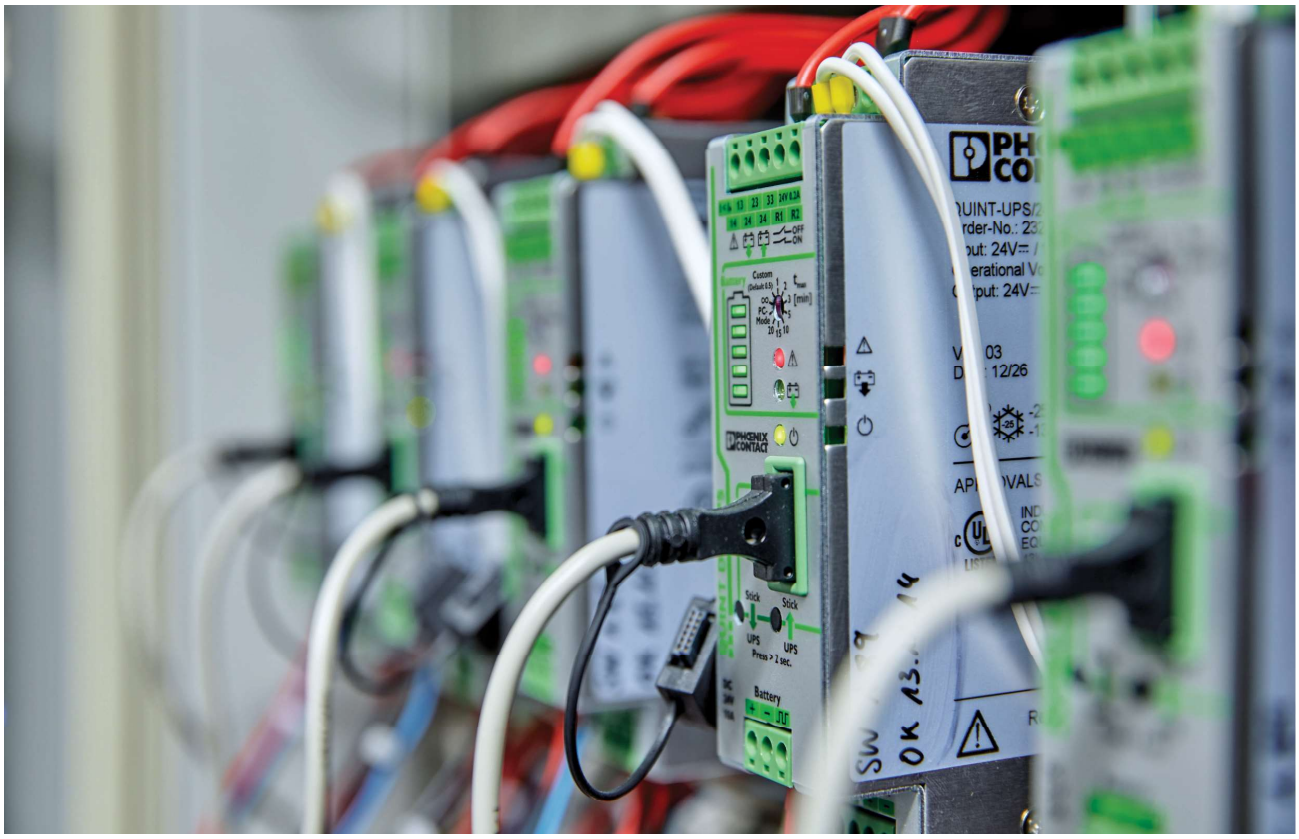

Low-voltage power design: Control panel battery backup

AC versus DC UPS?

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Introduction

When a control system requires battery backup, several factors drive the design for the uninterruptible power supply (UPS) section. First and foremost, the designer must understand the voltage, current, and back-up time requirements for the load. Depending on these requirements, the designer can determine what type of UPS is needed: an AC or a DC UPS system. Both systems have specific characteristics to be analyzed.

Maintaining these systems also needs to be considered. Expected battery life, available status, and general serviceability are important factors. The batteries for these systems will either be integrated or externally connected to the UPS. For externally connected/modular battery solutions, size and battery type are additional required choices.

INSIDE

AC versus DC UPS systems

It would seem that the choice between an AC UPS and a DC UPS should be quite simple. This is true for the up-front reality. For example, a programmable logic controller (PLC) or industrial PC (IPC) powered by 120 V AC has to be backed up by an AC UPS, and a DC UPS should back up a 24 V DC PLC or IPC.

The in-depth reality of the situation is more involved and must be considered at the beginning of the system-design phase.

As background, the trend for a new machine design is to use low-voltage DC devices when possible. There are several reasons for this:

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AC versus DC UPS systems *(continued)*

- The hazardous nature of voltages over 60 V; for example, 120 or 230 V AC failures are far more destructive, even to the point of a potential fire
- The shock potential is also much greater
- Less than 60 V DC allows for a control panel to meet international low-voltage directives
- Most new devices are powered by low-voltage DC because:
  - Products are smaller due to no internal power supply
  - No internal power supply in a device lowers the device cost and improves the overall efficiency of the system

With this understanding, if all of the loads requiring backup are AC, or all of the loads requiring backup are DC, the UPS choice is easy. Unfortunately, a common design flaw is selecting an AC UPS to back up DC loads.

Figure 1 explains the design flaw using a generic AC UPS system. Note that the battery is shown as an external entity. Keep in mind that it's possible (and fairly common) for the battery to be internal to the UPS. At first glance, it's easy to see that the AC UPS products are physically larger than the typical AC-to-DC power supply. The battery is the next observation. It's obvious that there is a conversion from AC to DC to charge the battery and from DC to AC to back up the load. This results in a loss of efficiency. Lastly, there is no way to separate critical and non-critical loads. The battery will need to be sized to compensate for all potential loads connected to the UPS.

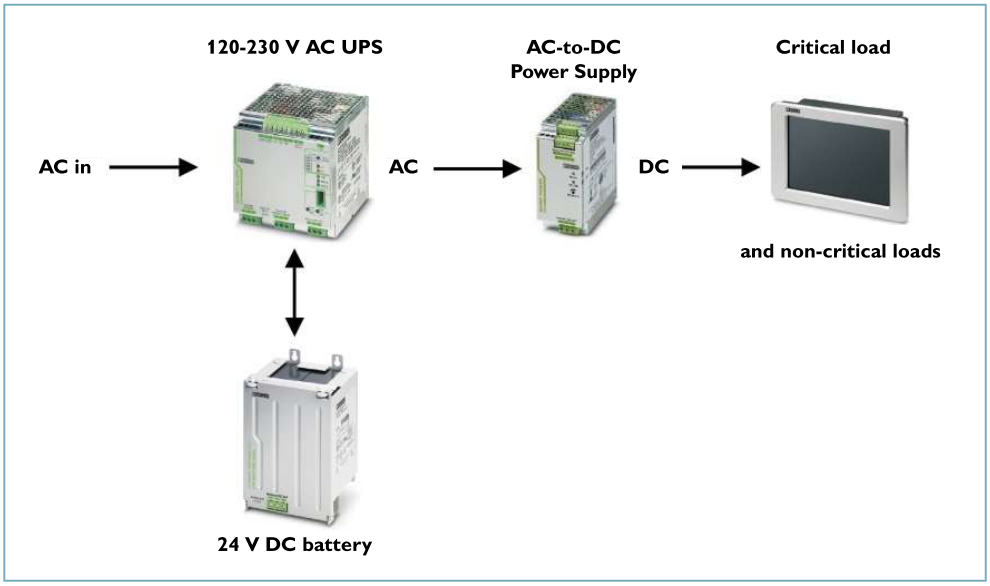

Figure 1: AC UPS Topology

Figure 2 shows a DC UPS system. In this case, the first glance shows us that a DC UPS is a similar size to the AC-to-DC power supply. In this system type, there is no conversion from AC to DC to charge the battery and then from DC to AC to back up the load. There is no efficiency loss for the DC UPS system. Lastly, the critical loads can be separated from the loads that do not require battery backup. This allows for the battery to be sized according to the critical load only.

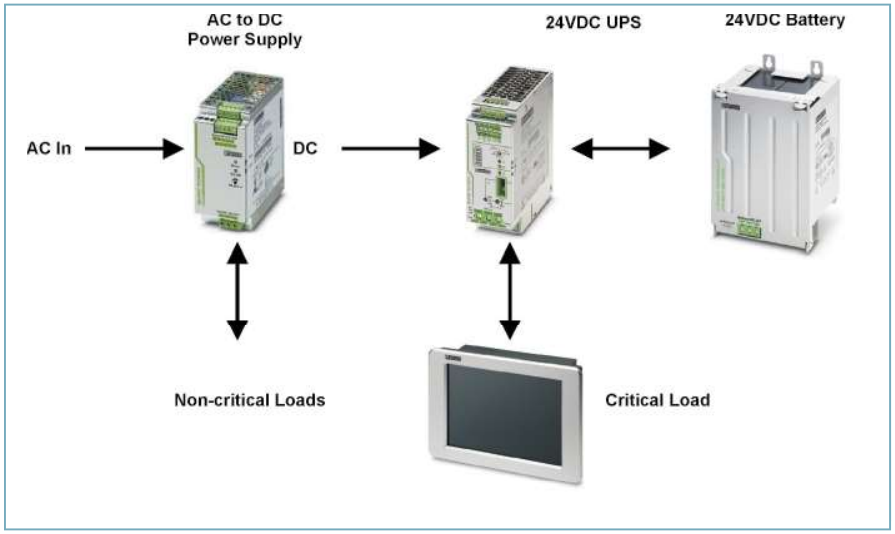

Figure 2: DC UPS topology

System reliability is the next item to consider when making a UPS choice for a control panel with critical DC loads. Either system tolerates the loss of the AC input. Neither system tolerates the failure of the battery or the UPS itself. The differentiator is the AC-to-DC power supply. The AC UPS system will not tolerate the loss of the AC-to-DC power supply. If the power supply is lost in a DC UPS system, the UPS will simply switch the battery to the load in a "bump-less" fashion. (Analyze Figure 2)

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AC versus DC UPS systems *(continued)*

Figure 3 shows an AC UPS system that compensates for the loss of the AC-to-DC power supply. Here, redundant AC-to-DC power supplies are used to allow the AC UPS-based power system to be as reliable as a DC UPS-based design. "Blocking diodes" are also required to ensure that a single power supply failure does not cause the entire DC power bus to fail. The downside of the additional power supply and high-power blocking diode module is the associated cost increase.

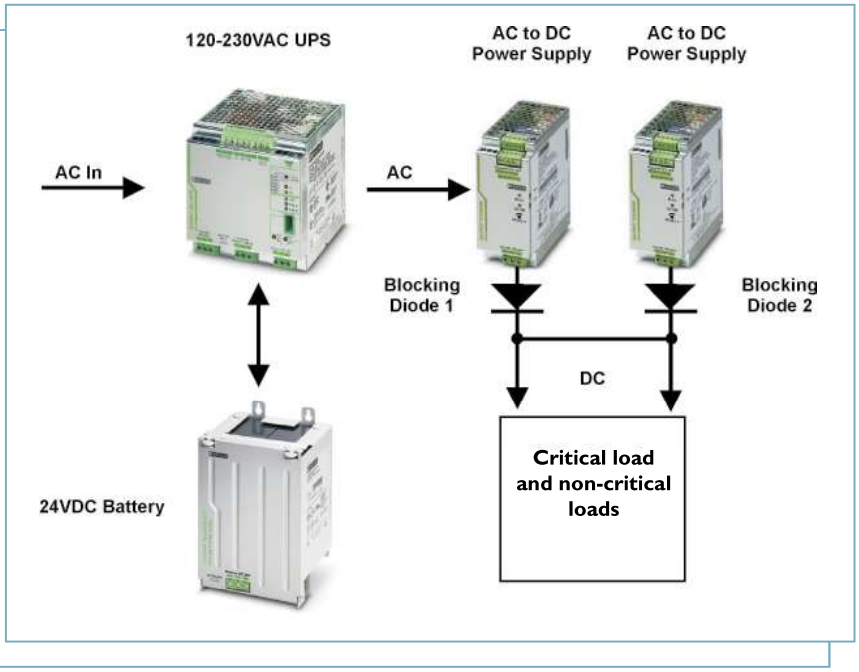

Figure 3: AC UPS redundant power design

Summary

If a DC UPS can be used, the design/application benefits include a lower cost, higher reliability, and an up-front extra level of fault tolerance. If there are non-critical DC loads, they can be directly connected to the DC power source. These non-critical loads will not consume battery power, allowing for either an extended back-up time or the selection of a battery with less capacity.

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Phoenix Contact develops and manufactures industrial electrical and electronic technology products that power, protect, connect, and automate systems and equipment for a wide range of industries. Phoenix Contact GmbH & Co. KG, Blomberg, Germany, operates 50 international subsidiaries, including Phoenix Contact USA in Middletown, Pa.

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