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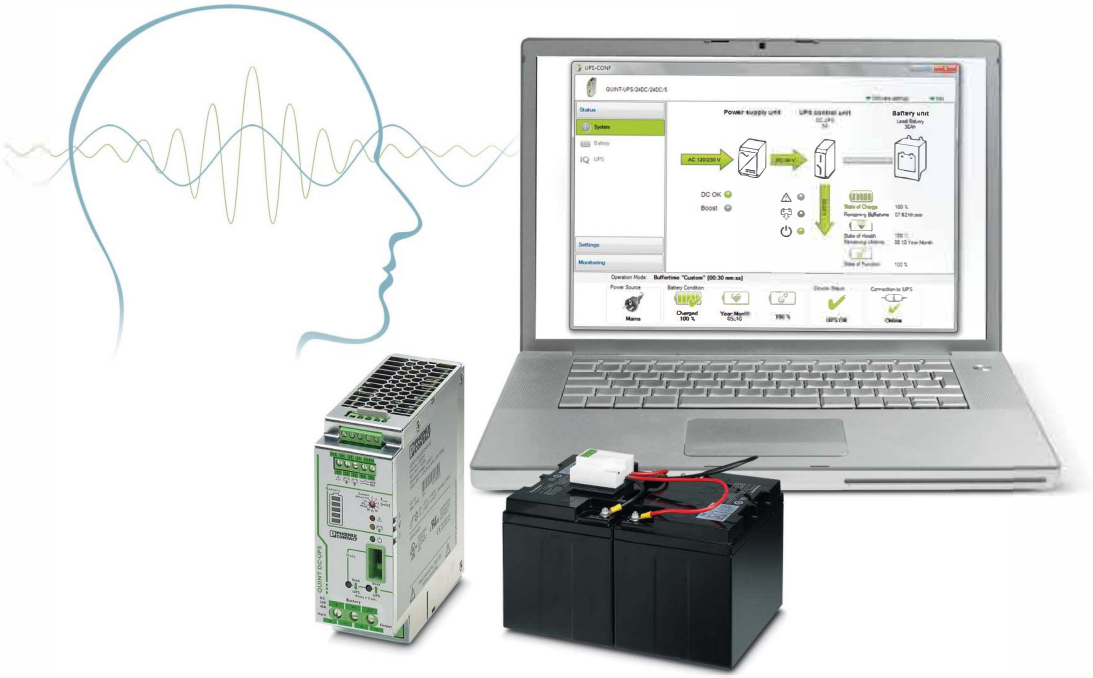

Control panel UPS Battery selection considerations

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Introduction

When a control system requires battery backup, several factors drive the selection for the uninterruptible power supply (UPS) battery. Designers must understand the temperature range for the application, voltage, current, and back-up time requirements for the load. These requirements will determine the best type of technology and battery size for the job.

Life cycle aspects, such as expected battery life, available status, and general serviceability, also need to be considered. In addition, batteries for these systems will either be integrated or externally connected to the UPS.

For an externally connected/modular battery solution, the designer needs to choose the size and battery technology. For a control cabinet UPS with an integrated battery, there are limited choices to be made.

Selecting a UPS battery

To ensure battery reliability throughout the life phases of an application, here are a few questions to consider:

- What type of battery should I use?
- What size battery do I need?
- How much charge is left in the battery?
- How much "life" is really left in my battery?
- Can my battery still provide the capacity it once did when it was new?

To determine the type of battery that makes sense for a particular application, a designer first must consider what type of battery the UPS will charge and monitor properly. From there, application variables, such as temperature, required backup time, lifetime, and costs, need to be determined.

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Selecting a UPS battery (continued)

There are several types of commonly used batteries in a control panel. These choices include valve-regulated lead acid (VRLA) batteries, lithium-ion batteries, ultra- or double-layer capacitor-based energy storage devices, and wide-temperature range (WTR) VRLA batteries. Each type has advantages and disadvantages (Table 1).

Table 2 shows a side-by-side comparison between these battery types powering a 24 V/10 A load. Please note the comparison is for one battery unit. These characteristics can be higher as more batteries are cascaded in a modular battery solution.

Table 1. Control panel batteries: advantages and disadvantages

	Advantage	Disadvantage
VRLA	Many suppliers Cost-effective Large selection of amp-hour (Ah) sizes Extended back-up time possible	Short life Weight Greatly influenced by temperature
Lithium-ion	Wide temperature range Long life Lightweight Non-toxic	Cost Backup time
Double-layer capacitor (10 and 20 kilojoules)	Lightweight Very long life Wide temperature range	Cost Backup time
WTR VRLA	Wide temperature range Back-up time	Weight Cost

Table 2. Battery type comparison

Type	Back-up Time @ 10 A	Temp	Life @ 20°C	Life @50°C	Charge/Discharge Cycles @20°C	Average Weight
20 kJ capacitor	<5 minutes	-40 to 60°C	>20 yr	8 yr	>500,000	5.5 lbs
120 WH Lithium-ion	>40 minutes	-20 to 58°C	15 yr	2 yr	7,000	6.4 lbs
WTR VRLA	>5 hours	-40 to 60°C	15 yr	1.5 yr	300	17 lbs
VRLA	>8 hours	0 to 40°C	6 to 9 yr	1 yr	250	13 lbs

Note: Batteries are commonly connected in parallel to increase the amp-hour (Ah) rating of the UPS system. This often comes into play when the designer wants to keep the battery packs light and DIN rail-mounted. Keep in mind that cascading batteries also increases the charging time.

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Determining the battery size

To determine what size battery a UPS requires, you need to know the load current and how much back-up time is required. Manufacturers often supply tables, such as Table 3 to facilitate the battery choice. For this example, the colored squares indicate a specific type and/or size of battery.

When tables are not available for an easy battery selection, the Ah requirement can be calculated. Please keep in mind that a battery Ah rating is based on a 20-hour discharge rate. If the discharge rate is higher, then the actual capacity of the battery will be less. "Discharge versus duration" charts from the manufacturer are a very good way to determine a specific battery's performance. The chart will show data for various temperature points, which should allow a designer to validate the initial Ah requirement.

Battery charge, aged capacity, and remaining life

Historically, UPS solutions designed for control cabinet applications rely on professional engineering to guarantee the required amount of back-up time based on load current, temperature, and a knowledge of how a battery ages. These older UPS products typically have a "charge" LED. When the LED would stop blinking, the battery was fully charged. When the UPS went into backup mode, the "alarm" LED came on signifying the application knew that the backup time had ended. There was no reliable way to determine what percentage of charge was left in the battery especially when temperature and age of the battery (internal resistance) needed to be considered. The newer generation of intelligent control cabinet UPS products can provide all of these data points. They can be configured to alarm at various stages of charge, life, and/or aged capacity.

Knowing when to replace the battery at the perfect, most cost-effective time has always been a concern. The previous generation of UPS solutions would simply apply a small load once a week in an attempt to determine if there is any life at all left in the battery. If the battery did not pass this test, an alarm was provided. This small load, however, is not a true indication of the health of the battery (internal resistance) and its ability to drive the actual field load (aged capacity).

The latest generation of control cabinet UPS solutions have electronics in the battery housing that can take measurements to determine the exact backup time, expected lifetime (at the connected load demand), and the aged capacity of the battery. These types of UPSs can be configured to provide an alarm when the battery reaches

	Seconds				Minutes													Hours				
	0.2	0.4	2	8	2	3	5	6	7	8	9	10	20	30	40	45	50	1	2	3	5	8
1A					•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		
2A				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
3A				•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				
5A				•	•	•	•	•	•	•	•	•	•	•	•	•	•					
7A			•	•	•	•	•	•	•	•	•	•	•	•								1+1
10A			•	•	•	•	•	•	•	•	•	•	•								1+1	1+1
15A			•	•	•	•	•	•	•	•	•	•							1+1	1+1		
20A			•	•	•	•	•	•	•	•	•	•							1+1			
25A	•	•	•	•	•	•	•	•	•	•	•	•					1+1	1+1	1+1			
30A	•	•	•	•	•	•	•	•	•	•						1+1	1+1	1+1				
35A	•	•	•	•	•	•	•	•							1+1	1+1	1+1	1+1				
40A	•	•	•	•	•	•	•								1+1	1+1	1+1	1+1				

Table 3. Battery selection table

UPS systems with internal batteries typically are limited to less than 10 minutes at 500 VA or 24 V/10 A DC loads. If the application is over these requirements, then there are two choices: either a large centralized UPS or a control cabinet UPS with the ability to connect external batteries. External battery solutions are typically modular. Battery modules totaling from one to five units can be added until meeting the requirement for backup time.

Key to Table 3

- 40 A "buffer" module
- 1.3 Ah VRLA
- 3.4 Ah VRLA
- 7.2 Ah VRLA
- 12 Ah VRLA
- 38 Ah VRLA

blocks with a dot in the middle indicate 120 watt-hour lithium-ion battery

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a certain percentage of life/performance. For example, if the battery goes down to 15 percent of its life, the UPS can trigger an alarm. The alarm can be a contact closure, or if the UPS is connected to a network, then it can send a predefined message. This allows the user to schedule a replacement date for the battery. When serviced, the hot-swappable battery can be replaced while the system is still running.

This is in opposition to older UPS designs. These devices send an alarm when the battery is essentially dead. To avoid this situation, it has become common practice to routinely replace the battery without regard to the health of the battery. This weighs heavily on material and labor expenses.

Maintaining the batteries

It's common for a UPS to have an integrated battery solution. In this case, the UPS must be removed from either the shelf/jig, panel, or DIN-rail mount. As discussed previously, with the office-grade UPS systems, the internal batteries for the DIN-rail mount solutions were not designed well for serviceability. It's not unusual for the entire UPS with integrated battery to be discarded and replaced with an entirely new UPS/battery unit.

This writer recommends the use of external batteries for several reasons. The first is that the UPS itself does not need to be removed. A worst-case scenario is that the battery-mounting bracket needs to be removed. The bracket is disassembled, the battery is removed and replaced, and the bracket/battery assembly is reconstructed. Once again, it's not unusual for the entire battery/bracket assembly to be discarded and replaced with a new battery/bracket assembly. With the latest generation of "modular" DIN-rail/panel-mount UPSs, the batteries can be replaced by putting the UPS in "service mode" (hot swap). The battery module can be removed through the front opening of the battery housing without using any tools (Figure 1).

Figure 1. Servicing the new generation of control panel batteries

Conclusion

Temperature and battery technologies weigh heavily in the control panel UPS battery choice. Once the designer knows these application variables, it makes sense to use intelligent battery packs that can communicate with the latest generation of UPS products to take advantage of the system's ability to interrogate the batteries. This technology will give the user the information to understand the state of charge, how much life is left in the battery, and the aged capacity of the battery at all times.

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