WHITE
PAPER

LifeSafety Power®

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Being Smart about Back-up Batteries

Intrinsic intelligence keeps power solutions always on

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Introduction

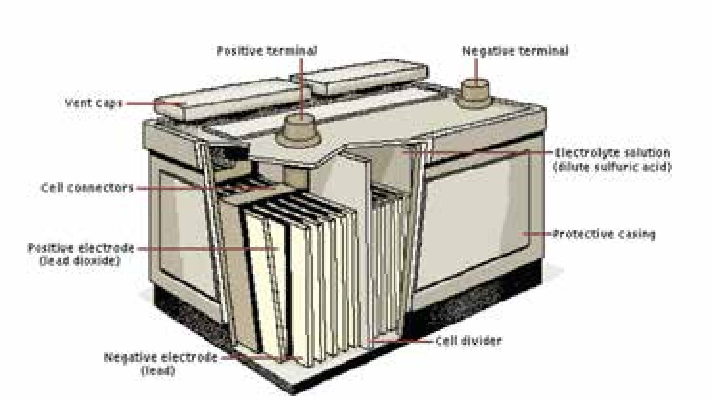
Whether it's for single point back-up capability or for a larger scale UPS attached to a POE switch or mid-span injector, the back-up battery is the unseen component that is expected to operate when the unexpected happens. Too often, this component is ignored, and, most often, little thought or action is given to maximizing its lifetime and efficiency.

The Basics

First, let's provide a little background on batteries. Most batteries used in the security and fire alarm industry are of the lead-acid type, the same basic technology used in most conventional automobiles. Despite their larger size versus other types of batteries, the cost per watt still makes them suitable in many applications where size is not a large detriment. Invented in 1859, lead acid batteries are the oldest type of rechargeable battery.

The battery has several main components: electrodes, plates, electrolyte, separators, terminals, and housing. The positive and negative electrodes are rigid metallic grids; usually perforated or grooved to maximize surface area; constructed of lead dioxide and lead, respectively; and employing separators between them to avoid short circuiting .

The electrolyte is a sulfuric acid, containing aqueous H+ and SO4-2 ions. A cell will produce 2.1 - 2.3 volts and is usually connected in series with other cells to produce higher voltages, typically 12 or 24 VDC. Terminals are fastened to the end positive and negative electrodes and protrude through the plastic case housing.

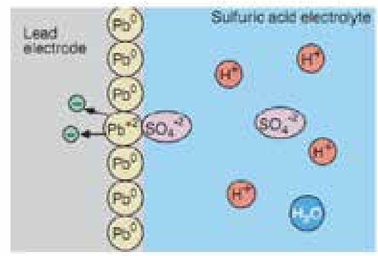


Lead Acid Battery Construction (Graphic courtesy of www.reuk.co.uk)

In an oxidation-reduction (Redox) reaction, the charged sulfate ions react with the uncharged lead atoms at the negative electrode, producing free electrons, as follows:

$Pb + SO_4^{-2} \rightarrow PbSO_4 + 2e^-$

(solid) (aqueous) (solid)



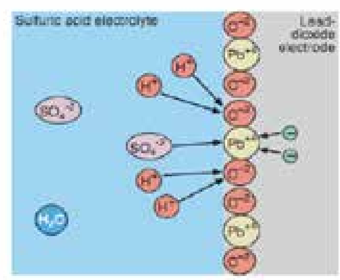
Electrons flow through the load, where they are provided back to the electrolyte through the positive electrode, as follows:

$PbO_2 + SO_4^{-2} + 4H^+ + 2e^-$

(solid) (aqueous)

$\rightarrow PbSO_4 + 2H_20$

(solid) (liquid)



When a load is connected to the battery terminals, current (electrons) begins to flow. The electrolyte, which was at a chemical equilibrium, produces more electrons to maintain the current flow and results in lead sulfate forming on the electrodes with a corresponding weakening of the acid solution. Peukert's equation is commonly used to determine battery "capacity", which is how long a battery can supply power when discharged at the specified rate. The original Peukert equation was based on a 1 Amp discharge rate, rarely used today to publish a battery rating. The equation has since been modified to incorporate various discharge rates.

T = C/(I/(C/R))n X (R/C)

Where:

T = time

C = capacity of the battery (amp-hours)

I = discharge (load) current

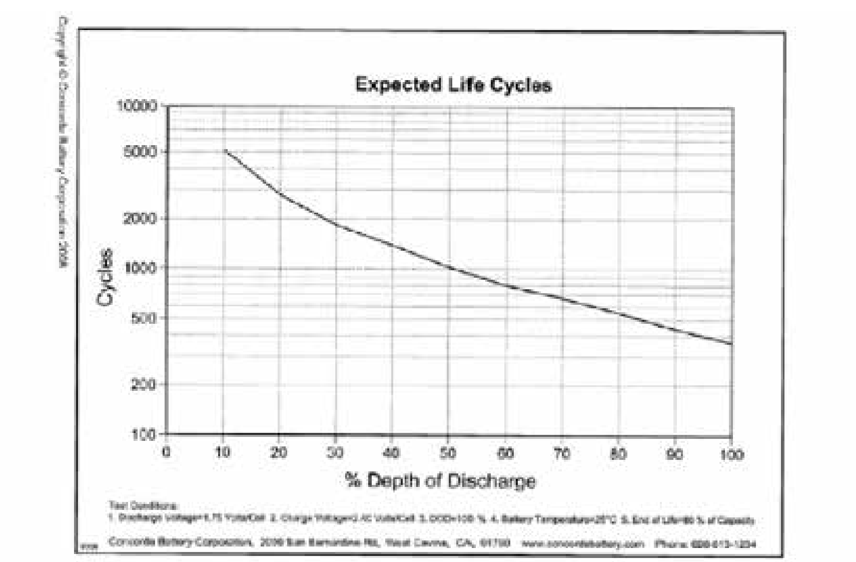
R = battery hour rating, i.e. 100 hour rating, 20 hour rating, 10 hour rating etc.

n = Peukert's exponent for that particular battery type (1.3 for deep discharge batteries)

Under normal powered conditions, the diode is reverse biased and not conducting current, allowing the current to flow through the lock normally.

Discharge

Because of the inefficiencies in the chemical process and imperfections in material and construction, batteries have a limited number of recharge cycles. Over-discharge leads to “sulfation” and the reaction becomes irreversible when the size of the lead-sulfate formations become too large, effectively ruining the battery. Also, this may cause the formation of highly combustible hydrogen gas and other poisonous gases, which may manifest itself in battery “bulging”. In any event, the deeper the discharge of the battery, the fewer recharge cycles are available in the battery as illustrated in the following graph of a representative lead acid battery. Thus, deep discharge is a condition to be avoided.



Charging

When a battery is charged, the electrons flow in the reverse direction (from positive electrode to negative electrode), producing a reverse set of chemical reactions, removing the lead sulfate deposits on the electrodes and “recharging” or strengthening the electrolyte solution. At the beginning of the charge cycle, the efficiency of the process (“coulomb efficiency”) is nearly 100%, but this drops as the charge cycle nears completion.

“Float charging”, the most commonly used charge method, involves the application of a constant voltage (“float voltage”), held constant throughout the battery’s operation or used in a particular phase of charging. The appropriate float voltage varies based on temperature and unique battery characteristics and may usually be kept connected indefinitely without damaging the battery.

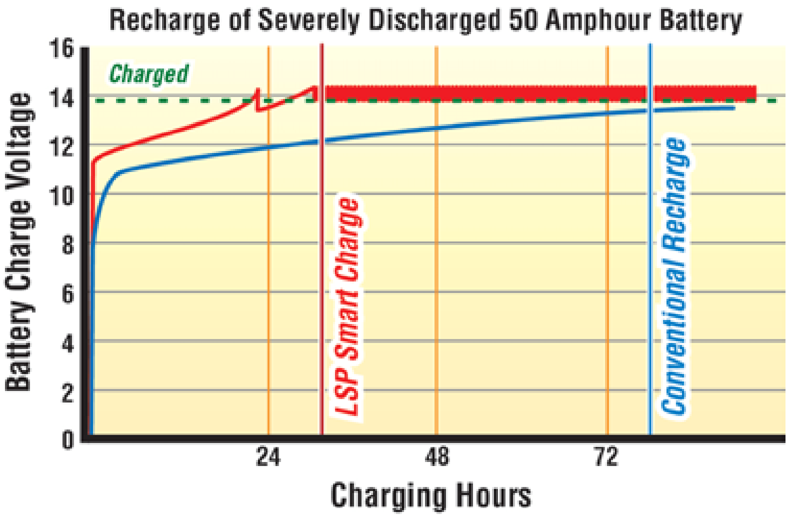
The charging mechanism most often used in power supply battery charging circuits for security and fire employs a positive temperature coefficient (PTC) device, where internal resistance increases with temperature and acts in a self-limiting fashion. This limits the charge current from the power supply into the battery and is set to a low value that is sufficient for float charging. This method has several drawbacks, including the inability of a single PTC device to work across the range of potential battery sizes and adverse temperature effects. More generally speaking, speaking, conventional charge methods suffer from several limitations, including:

- Inability to deliver adequate current at the beginning of the charge cycle
- Using the main power supply as the voltage source for charging the battery. Therefore, the power supply must be set to a value of voltage that is higher than that required by regulatory standards. For example, a 24 VDC battery must be charged at 27.1 - 27.6 volts. However, agency listing standards, such as ANSI/UL-1481, require any equipment holding a regulated listing to be no higher than 10% over the rated voltage, i.e., 26.4 volts maximum for 24 volt equipment. Further, in certain higher temperature environments, the combination of higher voltage and elevated temperatures may result in equipment malfunction.
- The tendency of some installers to utilize that higher value of voltage as a reason to use a smaller wire gauge than necessary, without realizing that the working voltage will be significantly lower when operating from battery. A 24 VDC system will drop to 20.4 VDC as the battery discharges.
- Inability to recharge a battery that has been subjected to deep discharge conditions.
- Non-linear and unpredictable charge time under all circumstances.
- Possibility of battery undercharging - charging a battery to only 90% of capacity will allow sulfation of the battery, per-

manently reducing the amp-hour capacity of the battery by the 10% of battery chemistry not reactivated by the incomplete charging cycle.

Smart Charging

Given a thorough understanding of battery technology and charging, LifeSafety Power Inc.(LSP)has taken a "from the ground up" approach to designing an intelligent battery charge technique that shortens charge time and maximizes battery life. This approach is implemented as a separate circuit in all LSP power supplies and allows the charge voltage to go higher than the main supply voltage, reducing stress and heat generation on attached devices while providing optimum charge to the battery in all phases of the charge cycle. The circuit's "Jump start" feature provides maximum current at the beginning of the charge cycle to get battery chemistry moving and reduce the effects of deep discharge. A microprocessor is used to control the charge cycle such that the charge current is always fully regulated. LSP's "constant current charge" technique applies and regulates the maximum allowable current to the battery for the majority of the charge period, providing for the fastest possible return to full charge. Unaffected by temperature, this produces a linear and predictable charge time for the connected battery. Charge current is programmable based on battery capacity, and, for longer battery life, charge current may be matched to battery size. The primary output of the power supply is thus maintained within the regulated voltage definition of the listing agencies. The following graphic shows a comparison between this "smart charge" and conventional techniques.



Additional options offered by LSP provide much desired capability. The first is a smart microprocessor-based disconnect module, which monitors the battery and will disconnect it when a specific trigger voltage is reached during discharge. This is to prevent deep discharge and resultant permanent battery damage. The second is a network monitoring module, allowing remote supervision of the battery. In addition to graphical representations of battery level, the existing battery state may be determined via continuous sensing of charge voltage and current and remote battery tests may be initiated using the actual connected system as the test load. Time tracking of total installed time and replacement dates, as well as e-mail notification of battery condition and replacement need are also provided.

Given the criticality of maintaining equipment and system up-times, particularly in UPS products powering POE switches and mid-span injectors, it makes good operation and financial sense to insure that everything possible is being done to maintain and monitor the health of the back-up power source. LifeSafety Power's current product offering and planned future innovations in battery test, display, and diagnostics represent an important step in providing overall system reliability and uptime.

Conclusion

LifeSafety Power solutions are purpose built for always-on, mission critical applications, no matter the customer or their vertical market. With deep diagnostics, remote networking and microprocessor techniques such as Smart Charging, customers are assured of robust reliability and guaranteed uptime for their physical security and life safety equipment.

About LifeSafety Power — Power is Knowledge™

LifeSafety Power is the leader in Smart Power Solutions and patented remote monitoring capabilities, providing modular AC, DC, and PoE power systems that meet the growing needs of the life safety and security industries. Realizing that network technology presents new opportunities for active monitoring and management of power supplies connected to access control systems, fire systems, video surveillance and more, the company has built its products from day one with intelligence and functionality in mind. LifeSafety Power's current product offering and planned future innovations in battery test, display and diagnostics represent an important step in providing overall system reliability and uptime.

All of the product features discussed in this white paper are available within LifeSafety Power's product line.

Visit www.lifesafetypower.com for more information, or check these links for additional information:

http://www.lifesafetypower.com/support

http://www.lifesafetypower.com/learning-center

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