Battery Powered Monitors: Good Idea or Not?

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Introduction

More and more battery monitors are being introduced to the marketplace, and with new products come new ideas. One of the newer approaches is to power the monitor modules from the battery being monitored. Almost all of these battery powered monitors are designed to monitor from one to five individual cells or battery modules, and their electronics are powered from that part of the battery string. In other words, the monitors are tapping the battery for the power they need for operation. The voltage required to power the monitor modules ranges from 6 to 16 volts and, in the case of VRLA 12 volt module monitoring, the voltage can be as high as 56 volts.

While powering the monitor from the battery is a good idea from an ease of installation standpoint and managing monitoring equipment cost, it is not a good idea from the effects it has on the battery float current and cell voltages. The serially connected communication method is also a weak link in the chain. This paper will present ten different arguments to explain why.

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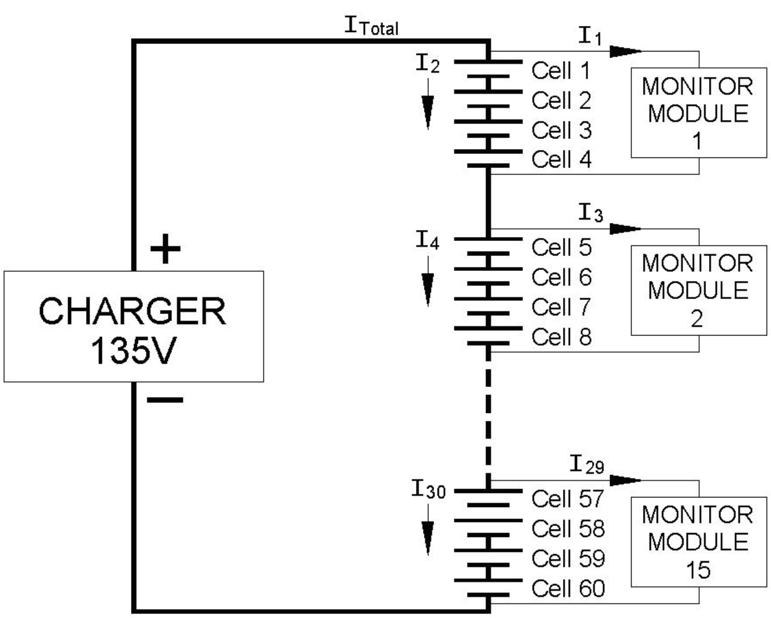
Let's review how current flows through a string of batteries with monitor modules attached. Figure 1 shows how current enters the string from the charger and then divides, with some of the current flowing through the battery cell and some of the current flowing through the monitor module.



A 60 cell, KCR-9, flooded substation battery is being used to illustrate a typical battery monitor application.

The battery is rated at 330 Ah (amp-hours) and draws 50 to 65 ma at 2.25 volts per cell.

Figure 1: Current flowing through a string of batteries and monitor modules.

Circuit Analysis

1. Total current out of the charger is determined by the series/parallel load comprised of battery cells and monitor modules.
2. Each monitor module draws a constant power (P = E x I), which means that the current (I) drawn by the module equals power (P) divided by voltage (E). Thus, a monitor powered by a low input voltage will draw a higher current than a monitor powered by a high voltage.
3. Since cell voltages within a string are never exactly equal, the current drawn by the various monitor modules varies from cell group to cell group.
4. Total current I Total entering the battery equals I1 + I2 and, since the current is constant all the way through, it means that the sum of the current through each cell group plus the current through the monitor module must add up to the total. In Figure 1, the sum of I1 + I2 is equal to the sum of I3 + I4.

Why Powering a Monitor Off the Battery Can be Detrimental to the Battery

1. Current Differences Through the String

Since current drawn by a monitoring device is not the same for each cell group, and knowing that the total current must be constant, it is easy to recognize that the float current through the battery cells varies from group to group. This will obviously lead to float imbalances.

The typical power requirement for today's monitors is 1.5 watts. If the monitor is powered by four cells as shown in Figure 1, then the current drawn can vary about 10 ma, depending on the float voltage of the group and a ±3% variation in the power circuitry of the monitor.

The typical float current for a 330 Ah flooded calcium battery is 50 to 65 ma at a charger voltage of 135 volts. A difference of 10 ma represents a 16% to 20% potential difference between cell groups, which will lead to undercharge and overcharge problems.

2. An Open Circuit Monitor

If a monitor fails open circuit or develops a power lead connection problem (see Figure 2), then that monitor will obviously not draw any current. This means that the total battery string current (I Total) will be forced to flow through the cell group that the monitor is connected to. The current through that group of four cells will increase from approximately 60 ma to around 200 ma. (The monitor draws 1.5 w / 9 volts = 166 ma.) An open circuit failure can cause serious problems by driving the voltage very high on that group of cells. This failure should alert the monitor owner that there are cell voltages in alarm, but since cell voltage alarms are considered maintenance alarms rather than critical alarms, this type of failure may not get attended to right away.

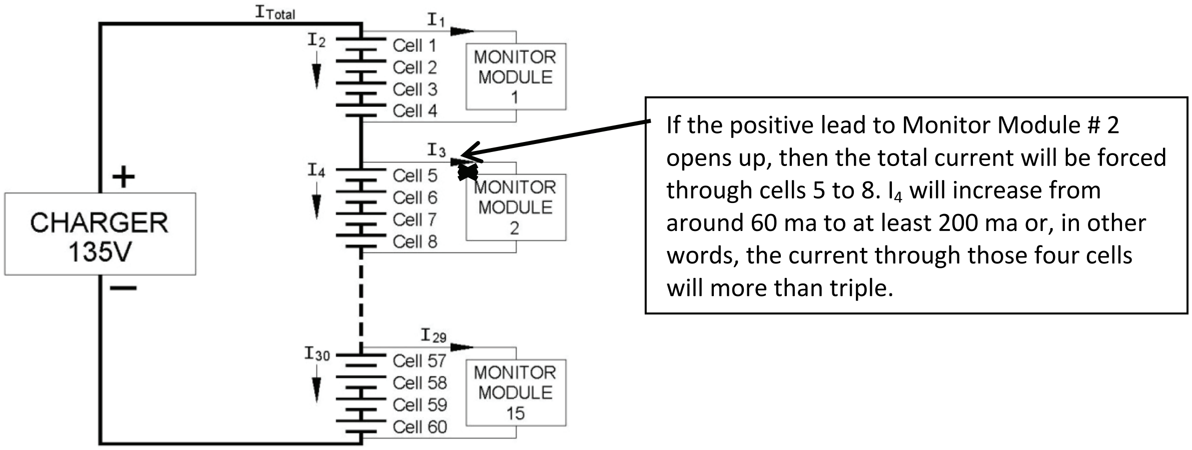


Figure 2: Current not flowing through a failed open circuit monitor module.

3. Cell Reversal During Discharge

During a discharge, it is not uncommon for one or more cells to fail and go into cell reversal or droop to a low voltage level. When this happens, the voltage that powers the monitor for that cell group drops below the level required to keep the monitor active.

The typical battery powered monitor system communicates via a serial optical or wired link. When any one monitor drops out due to low voltage, then the entire string is disabled from communicating data. This means that data necessary for warranty settlements will be missed.

4. Open Cell

If a cell fails open, it will cause a high voltage to develop across the open circuit. This high voltage will very likely damage the monitor module that is connected across the cell group that has an open cell. The worst case scenario is a UPS monitor that bridges two or more cells.

For example:

- Take a standard 240 cell UPS string connected to a 540 volt charger and open up any of the cells.
- When charger current is interrupted, all 239 good cells start drooping down to an open circuit voltage of 2.08 volts per cell. That adds up to a voltage of 2.08 volts x 239 cells = 497 volts.
- Remember, the charger is at 540 volts and the cells in the string are at 497 volts. The difference of 43 volts (540 - 497 = 43V) falls across the open cell.
- At least one model of monitor in service today taps four 12 volt modules for its power (typical UPS application). If a break occurred in the string, then the voltage to that monitor module would increase to a voltage of 90 volts. Most likely the module would suffer damage at this increased voltage level.

5. Uneven Voltage Taps

Some monitors require a fixed input voltage. This becomes a problem when the total number of cells or modules is not an even multiple of the nominal voltage required. For example, a UPS monitor composed of four channel measuring modules will not work properly in strings that are not an even multiple of four cells or modules.

Typical UPS strings today use anywhere from 30 to 50 12V VRLA modules. Let's review a string of 38 12V modules. As shown in the following figure, the first nine monitor modules are connected in increments of four across the first 36 battery modules. The last two battery modules are connected to the tenth monitor module, but that module requires 48 volts to operate, so the power leads must be connected across battery modules 35 to 38.

The result is an uneven load connected across battery modules 35 and 36. The float current through those two cells will be less than that of the rest of the battery string and will lead to undercharging, which results in sulfating and loss of capacity.

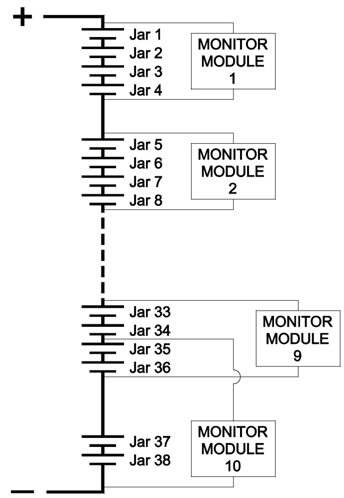


Figure 3: Uneven load of current connected across a battery monitor module.

6. Repair, Replace and Safety Issues

Battery powered modules are normally mounted on the battery or battery rack and then connected via short leads. This becomes a problem in UPS battery cabinet applications.

First of all, the unit has to be taken offline, then maintenance personnel have to work in tight spaces while being exposed to high voltages. To save costs, some manufacturers have eliminated connectors between the monitor modules and the batteries. This substantially increases the replacement labor costs and creates safety problems for the repair technician.

Most users do not like any downtime and may delay repair of a faulty module. This goes back to a point made in Statement 2 that addresses an open circuit monitor. A delay to repair or replace an open module will definitely hurt the battery cells that are connected to that module.

7. Incompatibility with Advanced Charging Techniques

Some UPS manufacturers use a battery charging scheme that effectively disconnects the charger from the battery for a period of time, thus allowing the battery to rest. The time is determined by how long it takes the battery voltage to droop to a certain trigger level preset by the manufacturer.

With battery powered monitor modules that require many milliamps of current, it will not take long for the batteries to discharge to the trigger level, thus defeating the battery rest period designed by the UPS manufacturer.

8. Inability to Measure Intertier and Disconnect Switch Resistances

Battery powered monitors do not include circuitry for measuring the resistance of a disconnect switch. The switch is a crucial part of the total conductance path through the battery and should be monitored. If a multicell monitor bridges the disconnect switch, then it will be subjected to very high voltages when the switch is in the open position. (Refer to the open cell explanation.)

These modular, battery powered monitors also don't have provisions for monitoring the ohmic values of intertier or interrow cables. Doing so requires an additional set of sense leads and ways to configure and report the readings. The modular systems have adopted the approach of just monitoring the batteries they are connected across. If they do include the cable connectors as a combined measurement, then this reports as a gross increase in the ohmic readings on only some of the cells/blocs. For example, if a cabinet battery has ten shelves of 40 12V blocs, then the cable from shelf to shelf would be included in every fourth bloc reading. The true value of the bloc will then be skewed and, if an abnormal increase in the readings is indicated, the location of the problem will not be able to be determined.

9. More Points of Failure

The more hardware components required to monitor a battery, the higher the probability of a component failure. As stated earlier, battery powered monitors typically connect across one to four batteries. A 240 cell UPS application employing a single cell monitor requires 240 individual pieces of hardware. Each monitor module has to have its own power supply, A/D converter, and such. These circuits are shared in a non-battery powered monitor that measures large numbers of cells in a data acquisition module.

These modules being installed on the battery are also exposed to being disturbed during battery maintenance intervals. For example, in flooded applications, the exposure to acid is a concern, as drips occur from checking specific gravity readings. This acid can penetrate the communication connectors or go through air vents or part lines on the equipment.

If modules are attached to the battery using double sided tape or Velcro™, then inherent issues arise with this, as the modules will sometimes fall off. Also, the adhesive in the tape must be approved by the battery manufacturer to ensure that the adhesive does not interact with the casing of the battery.

10. Price and Performance Issues

As the old saying goes, "You get what you pay for." This certainly applies to the monitor products on the market today. It may be less expensive to own and install a small battery powered monitor, but what are the consequences? Can a user really justify low cost over performance?

Upon adding up the costs of long term battery damage (shorter life) due to improper charging, along with potential discharge data loss on failing batteries and the hassle of replacing a monitor module in a UPS cabinet application, the initial low cost cannot be justified.

By comparison, a separately powered monitor can be repaired, calibrated, and replaced without interfering with battery operation. It is also safer for maintenance personnel since they don't have to come in contact with the battery.

History

Back quite a few years ago, various power companies and telecoms would tap their batteries to power different pieces of equipment that required different voltages. For example, the normal 125 volt substation battery and the main 48 volt central office battery were tapped to operate other equipment, such as communication and SCADA systems. This obviously led to big float voltage problems, and the practice was discontinued after the companies realized what was happening to the life of the batteries. History shows that tapping a battery is not a good idea.

Summary and Conclusions

There are a number of reasons why tapping a battery to power monitor modules is not a good idea.

- Unbalance is created in the float current. The amount of unbalance depends on the power required by the monitor and the amp hour size of the battery. The lower the power requirement, the less the effect. However, the lower the power draw, the smaller the test current used to make ohmic measurements, and the most important parameter measured by the monitor is internal resistance.
- New government regulations for substation maintenance, coupled with the need for increased UPS reliability, are making battery monitoring an economic necessity. It is important that design engineers who specify this type of equipment, as well as the users of the equipment, understand monitor basics in order to make intelligent choices. Price versus performance has always been a major issue, no matter what the purchase might be. It is very important that both Purchasing and Engineering understand what they are buying.
- Most of the new monitors being introduced today are designed to be powered by the battery being monitored. All of these modules, whether big or small, multiple or single channel, have the same thing in common: they are subject to all or most of the problems described in this paper.

In short, tapping a battery to power a battery monitor is simply not a good idea!

About the Authors

Glenn Albér and Eddie Deveau, the authors of this document, have a combined involvement of over 60 years in battery testing and monitoring. They have co-invented and hold patents relating to battery test equipment, monitoring, and State of Health measurements using internal resistance technologies. Between them, they have pioneered many of the products widely used throughout the industry today.