



Batt-Safe

Battery String Monitoring System



Technical White Paper
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Introduction

Battery monitoring systems are categorized as either cell monitors or string monitors. Battery cell monitors provide information on individual cells or on individual batteries that contain multiple cells. Battery string monitors provide information on series-wired groups of cells or batteries.

The purpose of a battery monitoring system is to identify defective or weak batteries in order to prevent an outage of the equipment that is powered from the batteries. A battery's condition can be indicated by battery voltage, temperature, current and impedance values. Available monitoring systems collect, interpret and display this information in different ways.

The Batt-Safe Battery String Monitor

The C&C Power Inc. Batt-Safe is a battery string monitor. The Batt-Safe is configurable for monitoring up to eight strings of batteries that are associated with either a DC Power System or an Uninterruptible Power System (UPS). The Batt-Safe works with system voltages from 24 VDC to 650 VDC and can measure currents up to 600A per string. The Batt-Safe functionality is battery chemistry independent allowing it to be used with all types of battery systems.

A Batt-Safe unit is identified as a Master or Slave. A battery system can be monitored with one Master and up to seven Slave units. Each Batt-Safe unit monitors the temperature and current of its respective string. The Master unit also monitors the battery system operating voltage, and the Battery Room ambient temperature. The Master unit is the point of connectivity to a facility network that provides local and remote access to the Batt-Safe system. Critical alarms raised by the monitoring system cause the Master unit to generate both e-mails and SNMP Traps for alerting purposes.

The Batt-Safe System does not require the user to load any unique application software on their PC to monitor the status of the battery system. Entering the IP address of the Batt-Safe Master unit into a web browser is all that is required to access the Batt-Safe System. Once connected and configured, Batt-Safe serves various menu selectable HTML screens that display the complete status of the battery strings being monitored to the parameter limits set by the system user. Second level password protection is provided to prevent unauthorized access to screens with user programmable parameters. The SNMP interface supports Community Strings for added security on remote access.

The Slave units communicate with the Master via an Ethernet connection. When polled, each Slave provides its string temperature and string current information to the Master unit. The Master unit continuously polls the Slaves for updated information. The received information is processed and displayed on the status screens served via HTML pages from the Master unit. In addition to the HTML screens, the Master and each Slave unit have five front panel visual indicators (LEDs) that display the status of their respective string.

Technical Overview

The Batt-Safe determines battery system status using absolute measurements and a comparison technique. Measured values of voltage, current or temperature that exceed programmable preset limits will create an alarm.

Properly installed and maintained battery strings will equally share total battery system charge or discharge currents to within a 5% to 10% difference among strings. The Batt-Safe Master unit sums the measured currents from all strings to determine the average per string value of charge or discharge current. The calculated average value is windowed with a programmable plus and minus percentage that allows/defines an acceptable variance to the average per string current value for each individual string's current without creating an alarm. During battery charge and discharge, strings having a current that measures outside of the window will create an alarm. The Batt-Safe ability to measure and compare the individual string currents while the monitored system is in operation is an absolute indicator of the overall health of the entire battery system.

The Batt-Safe displays the duration of discharge events on the HTML System Status screen. At the end of the discharge, the Batt-Safe calculates the expected recharge time based on the duration of the discharge and the amount of current supplied from the batteries during the battery systems discharge. The amount of charge current available is measured and factored into the recharge time calculation. The remaining charge time is displayed on the System Status screen. At the end of the charge time cycle, the batteries are expected to be in the float state. String current measurements that exceed the programmed float current threshold will cause an alarm.

Alarm conditions are displayed on the HTML System Status screen for both Global Alarms and String Alarms. Global Alarms are alarms that are not unique to a particular string. String Alarms are displayed as alarms that are associated with particular strings. The alarm states for each parameter are displayed as Normal, Warning, or Critical. A green indicator is the Normal (no alarm) condition. A yellow indicator is a Warning condition that is a precursor to a Critical alarm. When the indicator turns red, the Critical Alarm threshold has been reached. If programmed, the Batt-Safe will send an e-mail to a pre-designated recipient with a message that identifies the alarm condition. In addition, the Batt-Safe can be programmed to send an SNMP Trap to a designated destination (IP Address) identifying the alarm condition.

The Batt-Safe uses a closed loop Hall Effect current sensor and a calibrated current divider to provide high resolution current measurements. The sensor can resolve battery currents from less than 0.1A to 600A per string. The high resolution of the sensor allows the Batt-Safe to be very effective in sensing the onset of thermal runaway conditions.

Thermal Runaway Protection

Included in the Batt-Safe is an International Fire Code (IFC) compliant Thermal Runaway prevention capability. The Batt-Safe is able to monitor battery currents and determine when it is necessary to disconnect the current source from the battery string to prevent a fire. Before disconnecting the current source, the Batt-Safe will issue warnings (e-mail alerts and SNMP Traps). When the battery current exceeds the Float Current alarm threshold an alarm is created and sent. Another set of alarms will be sent when the battery current reaches the Critical state threshold and a disconnect timeout timer is activated. If the disconnect timeout timer expires, the string disconnect will occur and again the Batt-Safe will send alarm messages. The Batt-Safe has a back-up current threshold point that will cause an immediate disconnect of the current source if the back-up threshold current is reached before the disconnect timer expires.

The thermal runaway protection is active not only when the battery string is floating, but also when the battery string is in the charge state. This capability covers all conditions of thermal runaway to insure the current source is disconnected before any damage is done. The Batt-Safe can be configured to work with both UV and shunt trip circuit breakers typically found in UPS battery cabinets. Where it is not possible to disconnect an individual string, the Batt-Safe control can be used to shut off the charger in the UPS. The thermal runaway threshold values are factory programmed. The programmed values are based on information from the battery manufactures.

Data Trends

The Batt-Safe includes a battery cycle counter. Each discharge event is counted based on the duration of the discharge. The Batt-Safe counts and displays the number of cycles that are less than 1 minute, 1 to 5 minutes, 5 to 15 minutes and greater than 15 minutes. The total of all cycles is also displayed along with the date, time and duration of the last discharge.

Trending of data is possible using information stored in the System Log. System variables: voltage, temperature and current are logged based on a programmable amount of change for each variable. As an example, if the system voltage were to change by .3 volts, the system log would capture the voltage reading as well as the values of temperature and current for all active strings. The system log is in a Microsoft Excel format and can be downloaded for analysis and graphing of the data. The System Log can be enabled or disabled and cleared by an administrator having read/write access to the Batt-Safe. An alarm is created to alert the administrator that the System Log's available memory is about to overflow and should be downloaded.

An Event Log captures all system events and time and date stamps each entry. The Event Log is useful in trouble shooting alarm conditions that have occurred. Correlating the Event log with the System Log makes it easier to track down and isolate individual string alarms.

Each Batt-Safe unit has a data base for entering data for each battery in the unit's assigned battery string. Information such as the manufacturers date code, installation date and a 19 character field for notes is provided for up to 40 batteries. The data can be entered or edited at any time.

When the Batt-Safe is used with a single string of batteries, the comparison of strings to determine the status of the batteries is not possible. Single string systems depend on absolute measurements of string voltage, current, temperature and the measurement of the Coup de fouet voltage. On the first discharge of the battery string, the measured Coup de fouet voltage value is stored as the initial value along with the load current. On subsequent discharges, changes in this reading greater than a programmable percentage will create an alarm indicating that the batteries are losing capacity. If the load current happens to be at least 10% greater than the initial current reading on a subsequent discharge, the initial value will be adjusted to accommodate a load current change and establish a new baseline voltage value for the next measurement.

Ripple Current Monitoring

AC ripple current is an indicator of several conditions that are important to the overall performance of the battery string. High ripple current can be caused by defective filter capacitors on the output of the UPS charger or it may be an indication of significant phase current differences that should be addressed. Excessive ripple current can cause heating of the batteries and over time, drive them into a runaway condition. The Batt-Safe is equipped with a ripple current monitor that will create an alarm if the ripple current exceeds a threshold that is set at 5% per 100Ah based on the battery type rating. This threshold is not user adjustable.

Conclusion

Batt-Safe is a cost effective way to comply with the IFC Thermal Runaway requirement and at the same time provide the user with useful information on the overall health of the battery system. Monitoring the battery system under actual operating conditions is the best way to assess the true condition of the batteries. The flexibility of use, ease of installation, and the comprehensive collection and real time display of actual battery operation, makes the Batt-Safe a valuable tool for providing thermal runaway protection and visibility to the condition of the overall battery system.