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Introduction to the P4500 Lifeline Charging Management System

Primax Technologies Inc. was founded 20 years ago, since then we have always been committed to Quality, Service and Innovation. Driven by that spirit, we developed the P4500 charger almost 14 years ago. At this time we have equipment operational in more than 40 countries and we are the fastest growing stationary battery charger company in North America.

Using the latest technology in Digital Signal Processing (DSP), we are able to offer a charging system that is unequaled in quality, features and benefits for the end user.

The rationale behind the P4500 Lifeline Charging Management System revolves around these 4 questions:

1. What can go wrong with a charger?
2. What are the various battery failure modes?
3. How can a charger prevent some of these failures from occurring?
4. If these events or failures are unavoidable… How can a charger monitor and test certain parameters in order to predict and annunciate the failures before they actually occur?

The answers we have found for these questions allow us to claim the following.

The P4500 Lifeline Charging Management System will:

Reduce your maintenance expenditure
Maximize battery life
Increase your system's reliability
Reduce your long term cost of ownership

How do we achieve this? We hope the following 3 pages will answer your questions and raise your interest.

First let's answer some of these questions and explore some of our innovative solutions.

- What can go wrong with a charger?

1. It can lose regulation. If a charger loses regulation there are two ways a charger can react; it can fail in under voltage or it can fail in over voltage. If it fails in under voltage, the battery will start discharging, at this point you will get instantaneous notification from the P4500's **Battery discharging alarm**. As a backup we include 2 levels of **Low volt DC alarm.** One of these can be set at the battery's open circuit voltage which will alarm as soon as this Voltage threshold is passed. The other alarm can be set at the battery's final voltage.
   If the charger does fails in overvoltage, most modern chargers will annunciate a Hi Volt DC Alarm, the problem with this is reaction time…Imagine a 125 Vdc charger failing to 162 Vdc, your batteries and your equipment could be exposed to this high Voltage for extended period of times thus damaging your batteries, producing an excessive amount of Hydrogen and also exposing your equipment to potentially harmful Voltage. At Primax we equip our P4500 Lifeline Charging Management System with a **High Voltage Shutdown** which will shutdown the charger instantly should the system's voltage exceed the equalization voltage for more than a preset time value.
2. Its microprocessor can fail. If a charger's microprocessor fails it could mean that the charger is unable to generate any alarms, this is why the P4500 is equipped with a **"Watchdog" circuitry** which constantly interrogates the microprocessor. Should the microprocessor or the **"Watchdog"** fail, the charger will alarm.
3. Capacitors can fail or age. As capacitors age on your charger, ripple will increase. The P4500 is equipped with a **High Ripple Alarm** that can be set as low as 1% of ripple. This feature will help you protect your batteries from micro cycling which will cause accelerated battery aging. Interestingly, if you are using a 3 phase charger, this alarm will let you know if you have lost one phase.

- What can go wrong with a Battery?

1. A battery can be undercharged *(This will lead to sulphation and early loss of capacity)*.
2. A battery can be overcharged *(This will lead to plate corrosion and accelerated end of life).*
3. A battery can have "Lazy" cells that age or sulphate quicker than others. *(This will cause the other cells to overcharge).*
4. A battery can suffer from premature loss of capacity.
5. A battery can suffer from internal bus corrosion (*This might eventually lead to loss of continuity also called open battery failure).*
6. A battery can fail in thermal runaway.

Since some of the P4500 Lifeline Charging Management System features address one or more of these possible Battery problems we will examine each of these P4500 features separately:

- **A fully automatic battery equalization mode**. This system will insure that your battery is never under or over charged after equalization.

- **Battery temperature compensation**, as your battery's temperature varies, the charger will adjust its output accordingly insuring that the battery is never under or over charged while on float.
- **Battery high temperature alarm,** as you know high temperatures are very detrimental to batteries and can affect their long term ability to perform as per specification; also, should your battery be installed in a climate controlled environment, a rise of temperature could be indicative of an imminent battery failure.
- **Battery high temperature shutdown.** If the battery's temperature rises to a certain level, the charger needs to shutdown because your battery runs the risk of entering into a thermal runaway.
- **Battery imbalance monitor**, by monitoring any imbalance in your string of cells, the battery imbalance monitor can detect a cell with a lower voltage. Also during an actual AC failure or during a capacity or continuity test this monitor will detect that a cell is dropping in voltage faster that its counterparts thus letting you know that your battery has a "lazy cell".
- **Digital Ampere/hour meter**, with this device you will always know exactly how many A/h have been removed from your battery at any given moment during an outage. You will also be able to ascertain if your battery is fully recharged. At any given time you will be able to monitor how many Amps are going into your battery or how many are being removed. It will also allow you to stop battery equalization based on battery capacity, ensuring that your battery is never undercharged or overcharged thus insuring a longer battery life. During an outage, the A/h meter also calculates how much backup time you have left based on current Amp draw and remaining capacity.
- **Automatic Online Partial Battery Capacity Tester**, using the station's load and an integrated load bank, your charging system will periodically load test your battery. Should your battery have lost capacity, the charger will activate an alarm. This test is done automatically without human intervention and without hindering your required backup time. This test is based on a pass/fail rationale and all tests are logged with a date and time stamp.

- **Automatic Battery Continuity Tester & Battery open alarm,** having your battery fail open could have serious consequences. Our automatic tester will periodically test for continuity and report any change that could lead to an open failure. Also, this test will ensure that all of your connections are per specification. Depending on your system the attached load bank can either be a 25A or a 50A. This test is based on a pass/fail rationale and all tests are logged with a date and time stamp.

Registering and Reporting

In order to record and communicate all of this information the P4500 Lifeline Charging Management System also includes:

- A **data logger** which can register up to 250 events that are date & time stamped.
- A **true read - write communication module** that can come in any of the following formats:
  - DNP3
  - MODBUS & MODBUS over Ethernet
  - Web server (Each charger can generate its own webpage)
  - IEC 61850
  - As a backup to the communication module, the P4500 comes equipped with a common alarm FormC contact *(Optional: up to 21 FormC contacts)*

As you can see, the Primax P4500 Lifeline Charging Management System is not just another charger…

Thank you very much for investing the time to read this document.

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EXTRA NOTES:

Battery continuity operation:

1- Lower the float voltage to 1.95V per cell once every period of time (preset to once per month)
2- Draw 25A (or 50A imposed by the optional resistive load) from battery for a period of time (preset at 10 sec)
3- Alarm if battery voltage drops to reduced float within 2 seconds
4- Abort test if any alarm is occurring

This test addresses the issue of open plate bridge in one or more cells or heavy plate sulfation.
Open bridge can be disguised under floating mode. A weak connection can let the float or equalize current through with no problem. Problems occur when the battery is subject to a heavier load current: the weak connection will break open leading the battery voltage to drop abruptly to the pre-adjusted voltage i.e. 1.95VPC. Then after, the charger will automatically and immediately revert to the float mode and sends an alarm.

Heavy plate sulfation shows similar symptoms as an open bridge. Accumulated Lead Sulfate acts as an insulation layer on the top of the plate's active material. It's a result of unbalancing charge among cells. The sulfated cell usually shows a higher voltage than other cells. The plate usually absorbs float and equalize current not showing any weakness. But when it's subject to heavy load current, the cell voltage drops low and in very heavy sulfation cases, current won't pass through. The charge will behave the same as in the previous case.

Battery partial capacity test operation:

The purpose is to give a preventive indication to user to take action when battery has lost significant amount of its capacity caused by its aging process or undercharging.

When sizing a battery, extra capacity is accounted in. Usually 25% (aging per IEEE) and 10% (design margin) are included. More often the next size battery is chosen. Some of that extra margin can be used to test the battery state of capacity. Periodically (preset at once every 6 months) the charger lowers its float voltage and connects the additional resistive load (optional). During this test, the battery will be discharging into the steady substation load and the additional optional resistive-load. The test can last until the preset AH are drawn from the battery. Battery voltage is then read and compared to the original voltage. If the new reading is below the original level, then an alarm is sent for preventive and more thorough action.

If preferred, the automatic test can be replaced by a manual test when the operator activates the test when required. Also, all alarms can be reported locally on the screen, on relays and the optional communication bus (Modbus or DNP....)