Battery Charging

Battery Charge Current Control with a Modern DC Battery Charger

Integritas Battery Charger

Description

Lead acid batteries of many types have been employed in telecom DC power systems for many years. Systems designed for this application have become more and more sophisticated, but the principles of battery charging remain the same.

The rectifiers in DC battery chargers and power system are used to power the persistent load and recharge the batteries. When the primary power source, usually the utility power, is interrupted the load current is supplied by the batteries.

When the utility power is restored the rectifiers will resume supplying the load current and any residual capacity will be available to recharge the batteries.

Protecting Batteries

Batteries (particularly lead acid) are especially well suited to supplying reserve power to DC systems. Excessively deep discharge however can seriously limit the useful life of many lead acid batteries. For this reason many users employ Low Voltage Battery Disconnect (LVBD) contactors to protect the batteries from excessively deep discharge.

When a battery is reconnected to a battery charging system following a deep discharge, the charging current can be very high, if not limited by some means. Very high recharge currents are not inherently damaging to a battery that is in a good state of health, but battery manufacturers will usually recommend a maximum charge current for their products. Limiting the recharge current is usually only necessary if the charging current available is very high, or not limited by some other factor. Fortunately the available current is usually inherently limited by the capacity of the charging system.

If the charging system capacity is much higher than the load requirements, it may be desirable to implement a current limiting scheme to limit the current available to recharge batteries. Most OmniOn Power™ digital battery chargers now have an integral Battery Recharge Current Limiting (BRCL) feature.

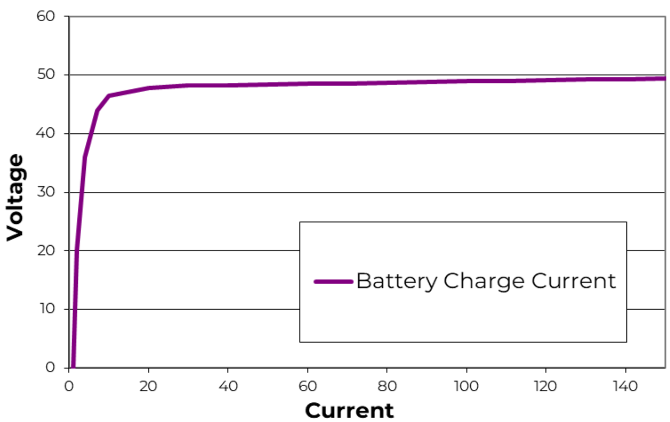
Charger sizing and Charging Current

In a typical telecom or industrial charging system, the charger must be sized to support the load and recharge the batteries in an acceptable amount of time. The quicker the batteries need to be recharged, the more rectifier capacity must be allocated.

If the battery size is 1,000 ampere-hour and it is desired to recharge in 10 hours, approximately 100 amps of charge current will be required. The actual current will depend on the particular batteries and their recharge characteristics.

Most Switched Mode Rectifiers are designed with an internal current limit for self-preservation and system reliability. This has the effect of reducing the output voltage if the current reaches the current limit. The Graph below illustrates the two most popular limiting techniques, constant current and constant power. In both cases as the current increases, the voltage drops once the limit point is reached.

Due to their characteristically low internal impedance, discharged batteries can draw large currents from a charging source. A typical characteristic for recharging a 48V lead acid battery is also shown below:



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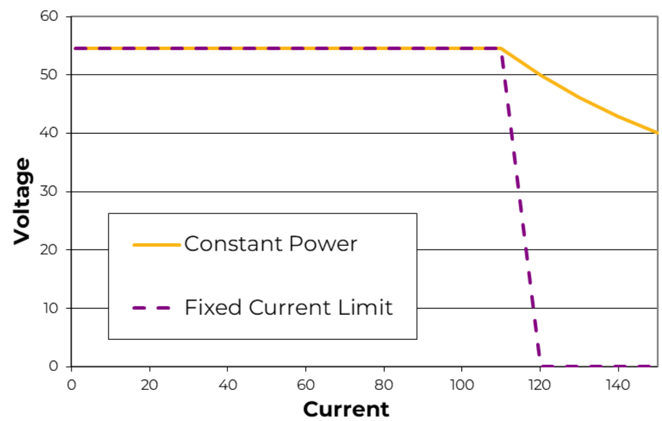
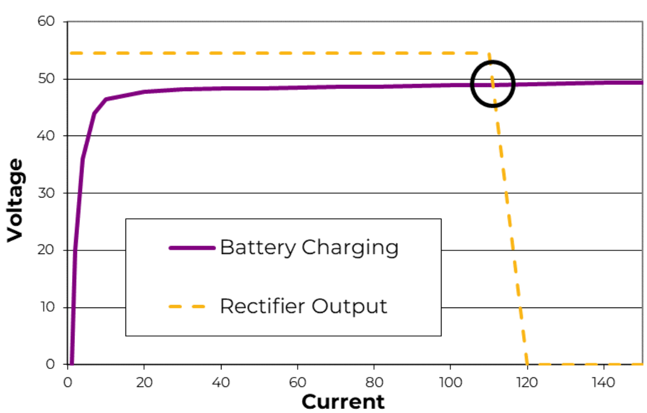


Rectifier Output

Clearly the current is very small up to the “nominal” voltage of the battery, 48V (1.95 – 2.0 V per cell), above this voltage the current increases very rapidly. The combination of the rectifier characteristic and the battery characteristic will give an operating point that is somewhat above the nominal voltage of the battery. Once the rectifiers current limit value is reached, the voltage will start to decrease to a stable operating point, which will be at a voltage somewhat above the nominal battery voltage. Plotting the two graphs on the same axis gives the operating point at the intercept.



Battery Charging Operating Point

It can be seen that the operating point will usually be in the current limited region of the charging system. In the case of a 48 volt battery reserve system, restoration of the AC power to a system with fully discharged batteries, will actually result in a voltage of at least 48V being available to the load (if it were to drop below that the batteries would not draw any appreciable current), as long as the rectifiers are sized to accommodate the increased load current at reduced voltage of the typical (constant power) electronics load. As the batteries charge the voltage will increase and the current decrease, until the rectifiers cease current limiting and the batteries are supplied with all the current that they require for completion of charging.

Simplified Example

Consider a simple system with a rectifier capacity of 600A, nominally float charging batteries at 54.5V. If the load at 54.5V is 400A, and an AC failure occurs, discharging the batteries to the lowest allowed voltage of 42.0V (LVBD operates and disconnects batteries). When the batteries are disconnected from the load the battery terminal voltage will return to the "open circuit" value of 2.0V per cell or 48V. When AC is restored, the rectifiers will ramp their output voltage up, the LVBD contactor will reconnect the batteries, and when the rectifier voltage reaches 48V the batteries will start to draw current to recharge. At this point the load current (for a constant power load) will be 400 x 54.5 / 48 = 454A, so 600 – 454 = 146A will be available to charge the batteries.

As the batteries charge, the current will start to drop, the voltage rising until eventually the fully charged batteries again float at 54.5V and the load current is back to 400 amps.

It can be seen that the battery recharge current is limited by the rectifier capacity, but at no time during the recharge does the system fail to support the load, albeit at a slightly reduced voltage.

Coping with excess Capacity

Changing conditions are a fact of life in today's telecom and industrial environments. As network overlays and removals take place the load on an existing power plant may vary significantly over its life. If, in the above example, the load had decreased to 200 amps at nominal voltage there would be close to 400 amps available to charge batteries. If this is considered excessive, the available current must be reduced. This is easily achieved by removing rectifiers from the system, recalculating the capacity required to meet the recharge time requirements, while staying within the battery manufacturer's limits.

Modern digitally controlled power plants can also be programmed to limit the battery recharge current to prevent battery damage when loads are removed. All OmniOn Power™ Systems' controllers have this option. The battery current is monitored by an in-line shunt. When the batteries are being recharged the rectifier voltage is adjusted by the controller to limit the current to a user selected value. This value can be programmed to match the battery requirements so that subsequent changes in the load or rectifier capacity do not place the batteries at risk. Only changes to the battery capacity will require a change to the programmed recharge current limit value.

Conclusion

In a correctly sized battery plant, battery recharge current limiting is achieved by the rectifier current limit setting, and external current limiting is not required. External action is only required if the rectifier capacity is so large that the current available to the batteries is larger than the battery manufacturer recommends.

Battery Recharge current limiting by the system controller can effectively manage this issue if excess capacity is to be left installed in the battery charging power plant.

All OmniOn Power™ Battery Chargers and DC Power Systems system controllers offer this feature, without the addition of any additional current limiting hardware.

For more information and / or help in configuring battery charging parameters please contact your local OmniOn Power™ sales representative or our product support hotline.

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