Ground Fault Detection
Measuring Battery-To-Ground Voltages

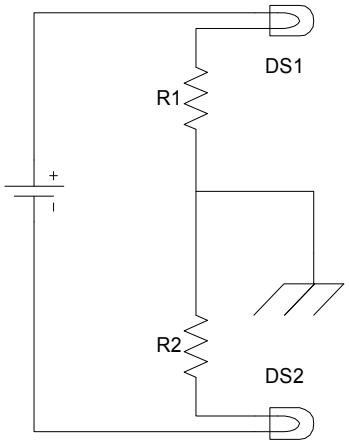
BACKGROUND

In many dc systems, the battery is floating with respect to earth ground. Ground fault detection systems provide a means for indicating or measuring current leakage paths between ground and the positive or negative terminal of a battery or battery charger. This application note describes common methods for dc ground fault detection.

VISUAL INDICATORS

One of the earliest methods for indicating ground faults used a pair of incandescent lamps connected in series across the battery, with their midpoint connected to ground. See **Figure 1**.

Figure 1



In normal operation, both lamps light dimly. If a ground fault develops between battery positive and ground, DS1 and R1 are shunted by the ground leakage resistance. As the ground fault gets worse (that is, the resistance goes down), DS1 gets dimmer, and the DS2 gets brighter. A brighter DS2 indicates a positive ground fault.

In practice, incandescent lamps aren't very useful. The ground fault has to be less than 2000 Ohms (on a 130 V bus) before a significant difference in lamp brightness is evident.

DETECTORS FOR REMOTE SIGNALING

The lamp circuit shown above forms half of a Wheatstone bridge on the dc bus. Other bridge-type ground detection methods offered with battery chargers operate on the same principle. What they all have in common is that they create an ohmic path from both battery terminals to ground. Where they differ is in their sensitivity - the ground leakage resistance that will cause a ground fault indication.

A popular variation of the lamp circuit replaces the lamps with relays. When a ground fault occurs, one of the relays is energized. The relay contact can be connected to a local or remote annunciator. The main problem with this method is that it is even less sensitive than the lamp circuit.

THE ELECTRONIC SOLUTION

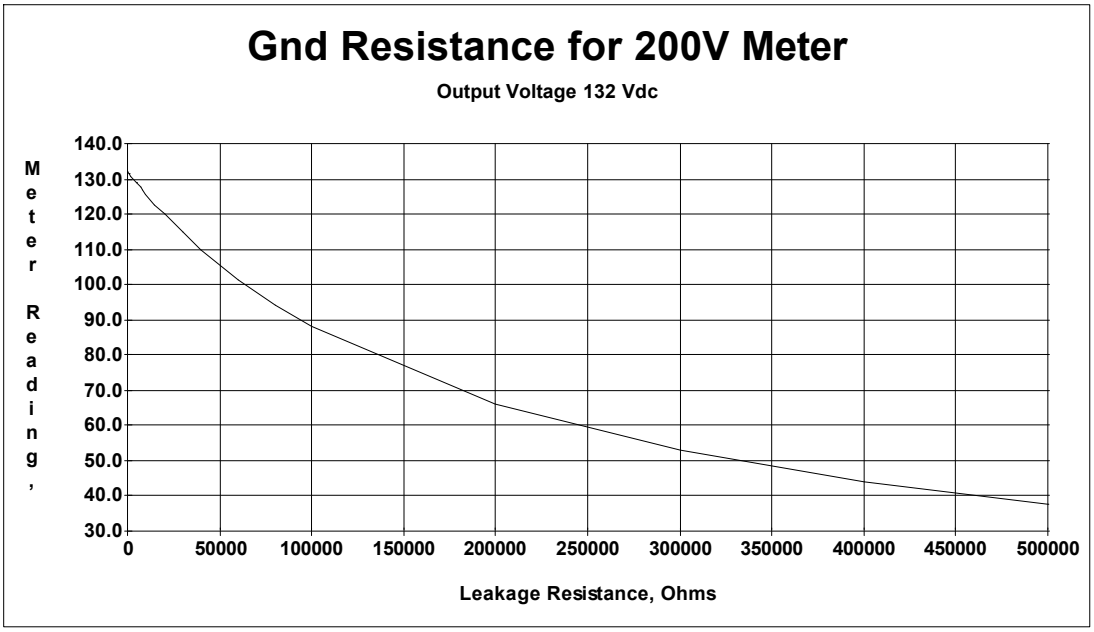
Electronic circuits, such as the detector in the CASM (Combined Alarm-Status Monitor), insert a high-gain amplifier between the balanced Wheatstone bridge and the output relays. This allows the sensitivity to be set at a more useful level (in the CASM, it's 15K – 18K Ohms). Even better, the ground detection circuit in the AT Series allows the user to adjust the sensitivity over a wide range.

DOING IT YOURSELF

You can use a dc voltmeter to check for ground faults yourself. The following steps for a 130 Vdc bus assume that there is no ground fault detection circuit installed in your system.

WARNING: disconnect the ac power and battery from the charger before proceeding. Only qualified service technicians should perform the following procedures. Follow your employer's standard safety procedures. Turning off front panel circuit breakers alone does not remove dangerous voltages inside the charger.

1. Use a dc voltmeter with a 200K Ohm input impedance. If you're using a DVM, connect a 200K Ohm resistor between the probes.
2. Measure the voltage from the battery positive terminal to ground. If it is zero, there is no ground fault on the negative dc bus.
3. Measure the voltage from the battery negative terminal to ground. If it is zero, there is no ground fault on the positive dc bus.
4. If you get a voltage reading that is more than a few volts at either battery terminal, there may be a ground fault in the system. You can estimate the resistance of the leakage path by using the curve in the chart below.



CURVES ARE AVAILABLE FROM THE FACTORY FOR OTHER BUS VOLTAGES

THE SIMPLE VOLTMETER METHOD

The voltmeter ground detection switch option, available on all SCR/SCRF chargers, simplifies making the leakage resistance measurements. However, it should be used only with standard analog meters. It will not work with 0.1% digital meters.

The option consists of two switches. The first selects the meter function: measuring output voltage, or measuring ground voltage. The second selects positive or negative ground measurements. The curve in the chart above is based on using this option to measure grounds.