THE
BATTERY GROUND-FAULT LOCATOR

O. W. Iwanusiw
V.P., New Product Development
MULTI-AMP CANADA LIMITED

INTRODUCTION

The Multi-Amp Battery Ground-Fault Locator is an instrument developed especially for the detection, tracking, and locating ground-faults on live battery systems. There are several unique features about the Multi-Amp BGL, as it is known. These include:

* detection and tracking of faults on floating, or resistor grounded systems.
* tracking of multiple ground-faults.
* no system sectionalizing required.
* measures system-to-ground capacitance in addition to the ground-fault resistance.
* battery operation makes the instrument portable and available where there is no power source available.

PRINCIPLE OF OPERATION

The instrument operates by injecting a 25Hz signal between the battery system and ground. By tracking the resulting currents with a clamp-on probe, the system-to-ground capacitance and resistances can be measured.

This principle in itself is not new, and has been exploited by companies in North America, Europe, and the Far East. What is new, is the sensitivity of the current detection and measuring system. This system is not only synchronously tuned with the injected signal, but is also capable of differentiating between in-phase, and out-of-phase current components. This feature makes the BGL capable of measuring resistance in the presence of capacitance. This feature is also automatic, therefore not requiring the operators intervention to make a valid reading.

The sensitivity of the detection system allows the BGL to inject only a small signal onto the battery system. This greatly reduces any chances of inadvertently tripping any sensitive relays by incorrect connection.

INSTRUMENT SPECIFICATIONS

The important specifications for the instrument are:

Resistance Measuring Range:	1 - 100,000 ohms.
Capacitance Measuring Range:	0 - 100 microfarad.
Highest Battery System Voltage:	240 volts, nominal.
Injected Signal:	25Hz, 3.5 volts maximum, 120mA maximum short circuit current.
Allowable AC Ripple Current:	0.5A typical.
Allowable DC Load Current:	20A maximum.

Some explanations regarding the specifications are required for the complete understanding of the BGL. Although the BGL can detect ground faults of 100kΩ, it can not detect this value in the presence of 100 microfarad of capacitance. The total battery-to-ground capacitance may be very high, but the faulted feeder-to-ground capacitance must be limited to typically less than 1 microfarad for 100kΩ fault, or 10 microfarad for a 10kΩfault.

The highest battery voltage limitation concerns the DC blocking characteristics of the instrument. As the instrument is required to inject and measure 25Hz signals, it must block all DC from the battery.

When operating, the instrument tries to regulate a current of 7mA through the clamp. At maximum output voltage of 3.5 volts, this relates to about 500 ohms resistance or 12 microfarad capacitance at the test frequency. For impedances lower than this, the output of the instrument is limited by means of an internal impedance.

There are some limitations regarding the amplitude of AC ripple current in the measuring circuit. This relates to the instruments ability to reject such signals. When one considers that the instrument can measure with a clamp-on device a current of 35 micro-amps (3.5 volts, 100kΩ), the 0.5 amp ripple current represents a rejection ratio of about 2000 to 1. Normally there is no problem with AC ripple currents, but on occasion when battery chargers do not provide a filtered output current to the battery, such battery chargers need to be turned off during the fault locating process. A BNC connector is available on the instrument that allows the operator to examine the measured current waveform, including any AC ripple. The use of surge suppression capacitors on battery systems has allowed the ripple to be distributed throughout the system, and not limited just to the charger.

Similar limitations apply to the DC load current. To operate properly at 25Hz, the clamp-on device cannot be saturated. 20A DC current will saturate the presently available clamp-on CT. This normally does not present a problem, as the return load current is typically also available. By clamping around both conductors the effect of the load current can be eliminated. The same cancellation effect applies to the AC ripple problem discussed above.

SOME OPERATING HINTS

Most, if not all, utility technical people agree that it is very difficult to inadvertently trip any relays connected to the battery system by the injected 25Hz signal. Some have voiced a concern about the current inrush which occurs when the instrument is connected to the battery system. This current inrush charges the DC blocking capacitor inside the instrument. To ease some of these fears the following needs to be stated.

The DC blocking capacitor is charged through the battery ground-fault resistance. If the ground fault resistance is zero, then this current is limited by the instrument and its' lead resistances. The current is high, typically above 10 amperes, and lasts for a very brief time, typically less than 1 millisecond. If the ground-fault is very high, this charging current will be only milliamperes and persist for a few seconds.

To avoid inadvertent relay tripping, the operator should determine which pole of the Battery is grounded. This can be done with the aid of a voltmeter, or an existing station battery ground detector. He should connect the instrument to the grounded pole. This action will greatly reduce the inadvertent relay tripping, should the ground-fault be on the coil of a relay.

Some concern has been raised the size of the clamp-on CT. It is important to point out that we do have a smaller CT available. Since the size of the CT relates directly to its performance, however, the available CT's accuracy had to be derated somewhat.

As mentioned earlier, the instrument is capable of tracing multiple grounds. When using it, however, it is desirable to find and eliminate lower resistance faults before proceeding to the higher resistance faults.

CONCLUSION

To conclude this brief presentation on the Multi-Amp Battery Ground-Fault Locator, it may be appropriate to mention that principles and systems employed here can be applied to a multi-terminal battery ground-fault alarm and detection system. Such a system, comprising of 10 - 100 measuring points, would be capable of INDIVIDUALLY alarming feeders branch, circuits, or loads, on a battery system.