New Technologies for Product Safety Testing

by Dwayne M. Davis, Associated Research

The GFI circuit, once for household use only, has another assignment: protecting operators from electrical shock during product safety testing.

Recent advancements in product safety testing technology have provided several enhanced capabilities to protect the safety of the operator. A key concern of any manufacturer always has been the safety of operators performing electrical safety tests. Now, new technologies in safety testers address many of these concerns.

Standard GFI Circuits

Ground fault interrupt (GFI) circuits are designed to protect individuals from severe electrical shock by interrupting an electrical circuit when there is a difference in current between the hot and neutral wires. This difference indicates that an abnormal transfer of current is occurring.

The difference happens when some of the current returns to the source through a ground path rather than through the neutral wire. This could occur when the insulation within a product fails and the product shorts to ground. The ground path also could be an individual who has come in contact with the electrical circuit.

Typical household GFI circuits have a current trip level around 7 mA, much lower than the actual circuit they are protecting, which could be fused for 15 A. If this current level is exceeded, then a high-speed trip-circuit shuts down the power, usually in less than 10 ms.

GFI Circuits in Electrical Safety Testing

The GFI circuit theory now is applied to electrical safety testing to provide operators with a similar type of protection from electrical shock. In typical high-voltage testing applications, operators are exposed to the risk of electrical shock. Some hipot testers can provide output currents ranging from 5 mA to 100 mA. These current levels could create severe shock hazards and even be fatal if an operator came into direct contact with high voltage.

One key safety concern always has been where the device under test (DUT) has a fault and the hot wire touches the case. This condition provides a path for the high-voltage output of the safety tester to reach the DUT's case.

This is not a key concern when the DUT's case is grounded since the current will follow the path to ground and bypass an operator who might come in

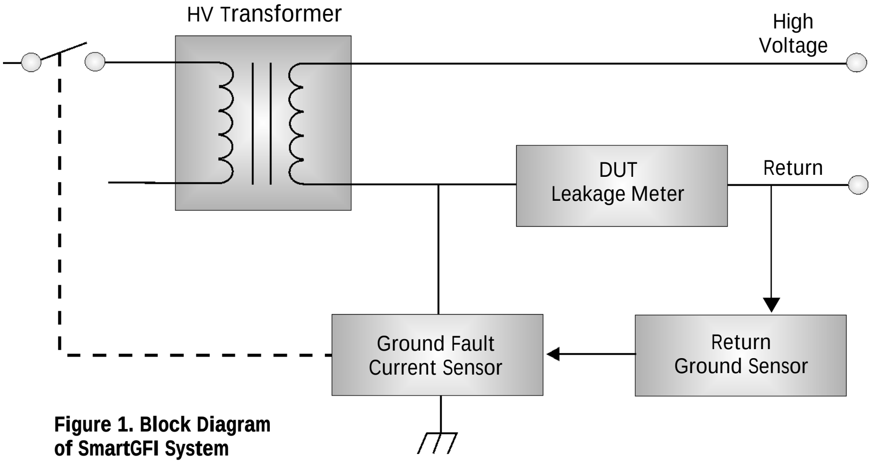


Figure 1. Block Diagram of SmartGFI System

contact with the DUT. However, if the DUT's case is floating, a safety risk now is present. If the return lead becomes disconnected or is open, then there is no path for the current to return to the source. Since the case of the DUT does not have a path to ground, an operator coming in contact with the DUT could complete the circuit.

A safety circuit similar to that used in household GFI applications can be applied to electrical safety testing. This reduces the risk of the operator receiving an electrical shock in ungrounded DUT conditions. The GFI circuit also can protect operators who come into direct contact with the high-voltage output of the electrical safety tester. When performing a test on a grounded DUT, the GFI circuit must be disabled to prevent false ground fault failures.

High-Voltage GFI

One example of GFI for high-voltage applications is the Associated Research SmartGFI™ system, which recognizes the DUT's configuration and automatically enables or disables the GFI circuit accordingly (**Figure 1**). In applications where the DUT case is earth grounded, the return ground sense circuit automatically disables the GFI circuit, and the instrument operates in a grounded return mode of operation.

This mode allows the tests to be performed normally without the operator manually changing the instrument's configuration. But even though the system is disabled in the grounded return mode, it is most likely because the DUT case is grounded. In itself, this provides a level of safety for the operator since, during a fault condition, the current will bypass the operator and return directly to the source.

> **It is an active circuit that monitors the configuration of the return connection and automatically sets itself accordingly.**

Once the test conditions change from grounded return back to floating return, SmartGFI automatically will be enabled. Unlike some conventional GFI circuits used on safety testers, SmartGFI does not use a comparison measurement to detect ground fault current.

Since the circuit automatically enables and disables itself, it can be set to monitor actual fault current through ground, simplifying the circuit and improving the overall reliability of the GFI system. The circuit will shut down high voltage in less than 1 ms if leakage in excess of 450 µA is detected through the ground circuit.

The system ultimately provides the most effective safety protection since it is an active circuit that monitors the configuration of the return connection and automatically sets itself accordingly. By eliminating the operator from the equation, the system works as an effective safety circuit because it does not require human interaction that could invite operator error.

Built-In Verification Technology

Another major enhancement in electrical safety testers has been the use of graphic displays. This type of display provides on-screen messages and prompts to guide the operator through the test process and, along with a built-in verification system, ensures that the tester is in compliance with safety-agency regulations.

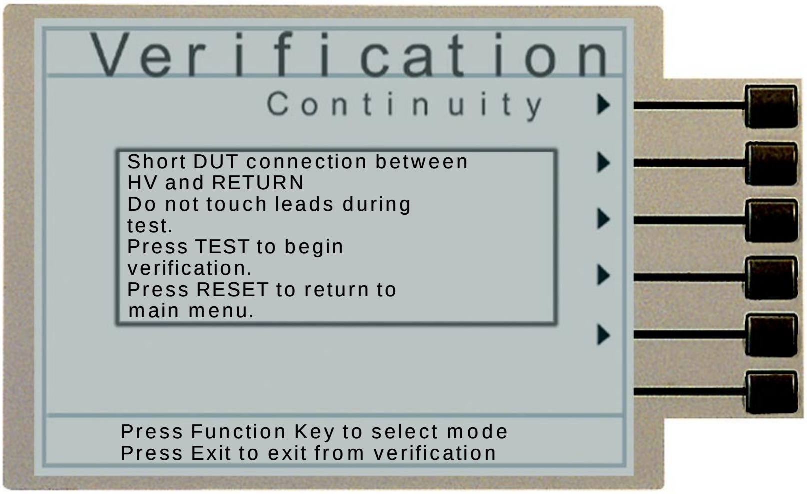
Calibration

Most safety agencies require safety-testing instruments to be regularly calibrated and checked for correct operation. The interval of the calibration period depends upon use and the results of previous calibrations. However, calibration must be performed at least once per year and be traceable to national standards.

Fail Verification

In addition, a functional check or fail verification test usually is required at the start of each shift or on a daily basis. Checks must be conducted at intervals that can reasonably allow previous production to be retested if incorrect functions are detected.

Fail verification is used to confirm that an electrical safety tester is functioning properly and will detect failures in the DUT. In the past, a common way to accomplish this was the use of an external verification box or an external resistor bank that has been available in the industry for many years.



Verification

Continuity

Short DUT connection between HV and RETURN
Do not touch leads during test.
Press TEST to begin verification.
Press RESET to return to main menu.

Press Function Key to select mode
Press Exit to exit from verification

Figure 2. Fail Verification System

While these verification devices have served their intended purpose, they do represent an extra piece of equipment that must be hooked up to the safety tester to perform the test. Mechanical in nature, these verification boxes were needed because many of the available safety testers in use were of the older analog style design and not capable of any software functionality.

Today's safety testers contain microprocessor-controlled technology and software-driven circuits that allow a verification menu to be built into the instrument, as shown in **Figure 2**. These not only eliminate an extra piece of mechanical equipment and save cost, but the tests also are easier and safer to perform since there is nothing external to hook up.

The internal verification system determines whether or not the safety tester will detect a failure condition in a DUT. Various safety agencies have required manufacturers to perform this test, ensuring that unsafe products are not shipped because the test instrument itself is malfunctioning. While it always is possible for an internal component failure to cause an instrument to malfunction, other conditions also can cause inaccurate results during the electrical safety testing process.

- If the high-voltage or the return leads are open, then it is possible the instrument will not detect a failure because of this open-circuit condition. In this case, the DUT actually may never be tested. Verification will detect this condition since one step of the verification process requires the operator to short the test leads together to verify that the failure detection circuits are performing correctly.
- Many safety tests are performed through various types of fixtures that also might have open-contact conditions. This could prevent the high voltage from actually reaching the DUT. This condition can be detected with built-in verification.
- Although newer safety instruments are more tamper-proof, it always is possible that someone with access to setup menus may have changed or disabled the parameters of the failure detection systems. Verification can help test all modes of the required electrical safety tests.
- In cases where the operator has to make manual connections to the DUT, it is possible that connection errors could be avoided by regularly verifying the tests.

Technology is continually evolving and offers capabilities that were not possible even a few years ago. Safety systems and built-in verification are examples of applying technology to make electrical safety testing safer and more reliable.

About the Author

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