

UNDERSTANDING THE HOW AND WHY OF ELECTRICAL PRODUCT SAFETY TESTING - PART II

By Homi Ahmadi

TEST REQUIREMENTS

Most safety standards require the following parameters for conducting the ground bond test:

- The EUT must be subjected to a high AC or DC current with a low test voltage for a certain period.
- The voltage drop between the protective earthing terminal or earthing contact and the part to be earthed must be measured.
- The resistance must be calculated from the current and the resulting voltage drop using Ohm’s law.

The resistance should not exceed certain values as stated in various safety standards. For example, IEC 60950 requires that the test voltage not exceed 12 V. The current can be either AC or DC at 1.5 times the current consumption of the product or 25 A, whichever is greatest. The test duration must be 1 minute, and the resistance of the connection between the protective earthing terminal or earthing contact and parts required to be earthed must not exceed 0.1 W. This value does not include the resistance of the power cable. Some standards, such as CAN/CSA-C22.2 No. 60950-00 or UL 60950 with Canadian deviation, require the test to be conducted at 30 A and for 2 minutes if the current rating of the circuit under test is 16 A or lower.

UNDERSTANDING RESISTANCE VALUES

With the exception of the Canadian standard, most standards require 25 A for 1 minute. The value of 25 A for 1 minute represents the worst current and the longest operation time of a mains over-current device. The maximum 25 A is approximately 1.5 times the mains circuit breaker value installed for most pluggable type A cord-connected equipment

rated up to 16 A. The Canadian National Wiring Code requirements are very similar to these in the sense that they assume that fuses are expected to operate no more than 1 minute at twice their rated current. Because most mains circuits are protected with a 15–16 A fuse, the fault current would be 30 A for no more than 2 minutes.

tronic shock because, by definition, the protective conductor is connected to earth.

If touch current is excessive, an operator could receive an electric shock which could result in a serious injury, depending on a person’s body weight. Typically, currents of more than 1.0 mA can cause an electric shock to an operator. The shock may or may not be serious, depending on the amount of the current and the body weight.

Like the other tests, the leakage current test is also a very important safety test, and most safety standards require the test to be conducted under various conditions such as normal operating condition, switches open as well as closed, reversed line polarity, and so on. The measured earth leakage current must not exceed specified limits during any of the tested conditions. Table I shows some typical limits.

If peak values of touch current are measured, the maximum values are obtained by multiplying the rms values by 1.414.

One of the biggest contributors to leakage is the capacitance between AC lines and earth, i.e., the Y capacitors. These Y capaci-

tors are normally placed in the circuit to control electromagnetic interference. It should be noted that some standards, such as IEC 60950, allow higher earth leakage current than 3.5 mA only for Class I stationary equipment that is either permanently connected equipment or that is pluggable equipment type B, provided certain conditions are met. These conditions are listed in Clause 5.1.7 of IEC 60950.

Type of Equipment	Terminal A of Measuring Instrument Connected To	Maximum Touch Current mA rms	Maximum Protective Conductor Current
All equipment	Accessible parts And circuits not Connected to Protective earth	0.25	-
Handheld		0.75	-
Movable (other Than handheld but Including Transportable Equipment)		3.5	-
Stationary, Pluggable type A	Equipment main protective Earthing terminal (if any)	3.5	-
All other stationary Equipment	- not subject to the conditions of 5.1.7	3.5	-
	- subject to the conditions of 5.1.7	-	5% of input current

Table I. Typical earth leakage currents.

EARTH LEAKAGE CURRENT

Some standards, including IEC 60950, 3rd ed., have named the leakage current test “touch current”. This refers to the electric current through a human body or through an animal body when it touches one or more accessible parts of installation or equipment. There is also another concept known as “protective conductor current,” and this refers to the current that flows in a protective conductor. A protective conductor current, therefore, can never be the source of an elec-

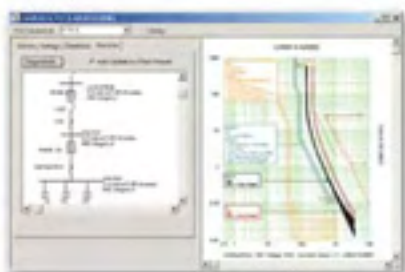
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Arc Flash Evaluation

- Design safer power systems while ensuring compliance with NEC 110.16, OSHA, NFPA 70E and IEEE 1584 standards
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⚠ DANGER	
NO PPE AVAILABLE	
ENERGIZED WORK PROHIBITED	
Flash Protection Flash Hazard at 18 inches: 44.2 cal/cm ² Flash Protection Boundary: 27.5 inch Glove Class: 000008 Recommended by IEC Class Found:	Flash Protection Flash Hazard when cover is removed: 440 VAC Limited Approach: 42 inch Restricted Approach: 12 inch Prohibited Approach: 7 inch
NO OPERABILITY OR PPE BY	

⚠ WARNING	
Arc Flash and Shock Hazard	
Appropriate PPE Required	
8 inch	Flash Hazard Boundary
0.26 cal/cm ²	Flash Hazard at 36 inches
Category 0	Untreated Cotton
4100 VAC	Shock Hazard when cover is removed
1	Glove Class
60 inch	Limited Approach
26 inch	Restricted Approach
7 inch	Prohibited Approach
Location:	009-TX C PRI
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SKM Systems Analysis, Inc. 1040 Manhattan Beach Blvd. Manhattan Beach, CA 90266 (909) 232-6789	
Job#: 200874 Prepared on: 06-06-09 By: Engineer	
Warning: Changes in equipment settings or system configuration will invalidate the calculated values and PPE requirements.	

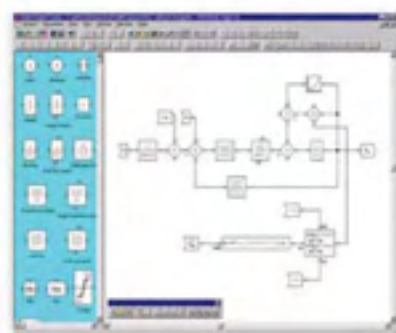


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Load Flow & Voltage Drop
Panel & MCC Schedules
Comprehensive Fault Analysis
- ♦ Short Circuit Analysis
(ANSI C37, IEC 60909/61363)
- ♦ CAPTOR®
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How and Why

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EQUIPMENT

When measuring the earth leakage current of IT equipment, it must be noted that the measuring instruments should satisfy the requirements of Annex D of IEC 60950, which simulates the worse-case impedance of the human body. The use of an isolating transformer during the test is also highly recommended (see Figure 2).

Any capacitive leakage in the transformer must then be taken into account. If for any reason the use of an isolating transformer is not possible, then the EUT must be mounted on an insulating stand, and appropriate safety precautions must be taken. Such measures compensate for the possibility that the body of the EUT may carry a hazardous voltage.

Test Method. Most standards—in particular IEC 60950—require that the EUT be energized for this test. The input voltage applied to the EUT is typically adjusted to 110% of the highest rated mains voltage and the highest rated line frequency. As mentioned previously, for safety reasons, it is highly recommended that the EUT be powered via an isolating transformer.

These tests are performed on both Class I and Class II products. For Class II equipment, the test is made to accessible conductive parts and to a metal foil with dimensions of approximately 10 x 20 cm, which is attached to the enclosure of the product. The metal foil simulates a human hand contact.

This test should also be conducted in all possible combinations such as normal operating condition, switches open as well as closed, reversed line polarity, etc. Equipment designed for multiple power sources, only one of which is required at a time (e.g., for backup), must be tested with only one source connected. Although most standards do not require the earth leakage current test to be carried out for 100% of the units in a production line, some standards, such as those for medical products, do require a 100% production-line test.

SAFETY PRECAUTIONS

Because any electrical safety test

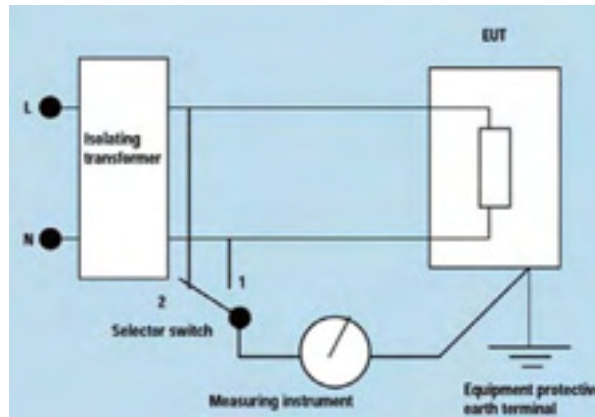


Figure 2. Typical earth leakage current setup.

involves some risk of electrical shock, it is crucial that certain precautions be taken to avoid shock and injury to operators. Listed below is a sampling of precautions that can minimize the danger of electrical shocks and ensure all-around safety:

- Train operators in the basic theory of electrical circuits and explain the object of each test.
- Review and update all safety test procedures regularly.
- Locate the testing area away from walkways and crowded areas on the shop floor.
- Guard the testing area with non-conductive barrier.
- Mark the testing area with a clear and visible sign such as “Danger” or “High Voltage Present”.
- Mark the testing area with a clear sign indicating “Qualified Personnel Access Only”.
- Ensure that all test equipment is properly connected to a reliable earth.
- Reconfigure all testers (where possible) with push-button switches so that operators must use both hands to activate the test equipment or, alternatively, provide the equipment with a safety interlock that automatically shuts down the high voltage when a safety switch on the EUT is opened.
- Connect the complete test setup to a palm-type switch that can shut off the power to the test bench in case of an emergency.

RECORD KEEPING AND IDENTIFICATION

CENELEC has released a standard, EN 50116, which essentially defines the

routine electrical safety tests and their procedures to be applied during or after the manufacturing process of IT equipment certified or declared as complying with EN 60950.

It is extremely important for manufacturers of electrical products to ensure that all test results, including routine production tests, are clearly and adequately documented and kept on file for possible inspection. Although this may not be required by all agencies, keeping accurate test records is not only good engineering practice, but could also be vital in defending a legal action should such a case arise. Most modern test equipment can produce test results in an electronic format that can be stored or printed when needed.

It is also necessary for manufacturers to ensure that all test equipment is calibrated regularly and that such records are kept on file. In fact, most test houses expect to see a log for daily calibration of the hipot tester on the production line. This log confirms that the hipot tester has indeed been applying high voltage to the EUT. It is also vital to ensure that all electrical safety tests are carried out on units that have been returned for repair or service.

On the production line, there are generally three product states: not tested, tested-passed, and tested-failed. The status of any product must be clearly apparent to ensure that untested products are not shipped and that only tested-passed products are shipped. For instance, a red tag attached to the unit can indicate tested-failed. Untested products are those that have neither a tested-passed nor a tested-failed indicator.

CONCLUSION

Electrical safety testing at the design and development stages as well as at the production stage is vital to ensure that all products are safe before reaching the end-user. The four tests described in this article are among the most fundamental tests that manufacturers of electrical and electronic products should conduct routinely. It is important to use correct test equipment and adequate and accurate test procedures so that sufficient testing is conducted and operator safety is considered.

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