THE LOW VOLTAGE DIRECTIVE & PRODUCT SAFETY TESTING

THE LOW VOLTAGE DIRECTIVE

The Low Voltage Directive (LVD) and the CE marking requirements became mandatory on January 1, 1997. The provisions of the directive require that only electrical equipment, which does not jeopardize the safety of people, domestic animals and property, may be placed on the market.

The equipment must be constructed following good engineering practices in relation to safety matters to ensure that it does not cause a safety risk when used in applications for which it was made. Harmonized safety standards are drawn up by common agreement between bodies notified by the Member States. The Low Voltage Directive does not define the actual product safety tests that must be performed. It does state that any electrical product designed for use with a voltage rating between 50 V and 1,000 VAC and between 75 V and 1,500 VDC must comply with the unified standards if the products are to be marketed in the European Union (EU) after January 1, 1997. The following equipment is exempt from the directive:

- Electrical equipment for use in an explosive atmosphere.
- Electrical equipment for radiology and medical purposes.
- Electrical parts for goods and passenger lifts.
- Electric meters.
- Plugs and sockets outlets, for domestic use.
- Electrical fence controllers.
- Radio-electrical interference.
- Specialized electrical equipment used on ships, aircraft, or railways, which complies with the safety provisions drawn up by international bodies in which the Member States participate.

Under the Low Voltage Directive, harmonized safety standards provide one certification to comply with and to be recognized by all members of the EU. This achieves one of the goals of the EU which is “to provide a standardized means of allowing commerce between member countries”. The standards once approved by CENELEC become the European Norm (EN) Safety Standards which define the specifications for safety of the products produced for sale within the EU.

PRODUCT SAFETY TESTING REQUIREMENTS

Electrical equipment must be designed and constructed to ensure that it is safe when connected to the electric supply system by providing a level of protection against electric shock which relies on a combination of insulation and the protective earthing conductor. The equipment is presumed to satisfy this requirement if it is constructed to include protective earthing, or double insulation to provide an equivalent level of safety.

Each standard provides a series of safety tests with specific test parameters and limits appropriate to the category of the equipment covered. Three common examples of Product Safety Tests, which check the protective earthing circuits and the insulation within the electrical equipment, are as follows:

- Earth Ground Bond Test
- Dielectric Withstand Test
- Line Leakage Test

EARTH GROUND BOND TEST

The ground circuit is the second level of protection against electric shock over and above the basic insulation within a product. The Ground Bond Tests is normally specified to test the protective earth circuit within a product. An example of the requirements is taken from EN 60335-1, *The Safety of Household and Similar Electrical Appliances,* states;

"A current from a source having a no-load voltage not exceeding 12 V (AC or DC) and equal to 1.5 times rated current of the appliance or 25 Amperes, whichever is the greater, is passed between the earthing terminal or earthing contact and each accessible metal parts in turn. The voltage drop between the earthing terminal of the appliance or the earthing contact of the appliance inlet and the accessible metal part is measured. The resistance is calculated from the current and this voltage drop, the resistance shall not exceed 0.1 ohms. The resistance of the supply cord is not included in the measurement."

The reason for applying the high current to the earthing conductor is that most fuses or circuit breakers can carry a 200% overload for several minutes before they open the circuit. The resistance of this circuit must have sufficiently low impedance to limit the voltage to ground and facilitate the operation of the circuit protective devices. The reason for performing this test using a source voltage of 12 volts or less is to limit operator exposure to hazardous voltages during the test.

THE DIELECTRIC WITHSTAND TEST

The Dielectric Withstand Test is one of the product safety tests that are commonly specified to test the insulation within the product. It is the insulation within the product that provides the primary protection against electric shock. The adequacy of the insulation must be tested from an engineering standpoint on a new design, and it must also be tested from a manufacturing standpoint to assure it was not damaged during the manufacturing process.

Electrical products are subjected to high voltage switching transients on a daily basis. Every time an electric motor is started or stopped it produces a counter Electro Motive Force (EMF) which can generate voltage transients that can damage weak insulation. It is assumed that if a product can "Withstand" the potential applied during a Hipot test, it will withstand these switching transients that occur on a daily basis. The term Hipot is short for High Potential test.

The Dielectric Withstand or Hipot test stresses the insulation within the product. The leakage current through the insulating materials are measured between what are normally current carrying and non-current carrying conductors or ground (earth). Hipot

tests may also be performed between primary and secondary circuits within a product to test the isolation between these circuits, or between multiple isolated secondary circuits.

To perform a Hipot test the high voltage lead is connected to the hot and neutral conductors of the Device Under Test (DUT), which are shorted together. The power switch of the DUT is also placed in the "on" position. The return lead is then connected to any exposed dead metal of the DUT. Unlike the Line Leakage test the DUT is not running during the Hipot test. By applying high voltage to both sides of the line you are applying an equal potential across any components within the circuit under test, stressing only the insulation between the current carrying conductors and ground.

The test potential may vary depending upon the application of the product. Test potentials of 1500 volts to 3000 volts AC at a frequency of 50 Hz or 60 Hz are common. In some specifications a DC voltage may be substituted for an AC voltage. The specifications require the DC voltage to be equal to the peak of the prescribed AC test voltage to be used. The voltage is raised gradually from zero to the prescribed test voltage and held for at least 1 second and up to 60 seconds depending upon the test being performed. There cannot be any indication of breakdown during this test. Insulation Breakdown is considered to have occurred when the current, which flows as a result of the application of the test voltage rapidly increases in an uncontrolled manner. The insulation can no longer restrict the flow of current. Corona discharges and single momentary flashovers are not regarded as an insulation breakdown condition.

THE LINE LEAKAGE TEST

The Line Leakage Test is also designed to measure the leakage current which flows through the insulation of the product, but the conditions under which the test are performed are quite different than the Dielectric Withstand test. The Leakage Test is performed at a much lower voltage and monitors leakage currents from accessible parts of the DUT back to the system neutral while the product is operating under both normal and single fault conditions. Leakage currents are monitored through a Measuring Device (MD) which simulates the impedance of the human body. This provides more accurate data as to the potential shock hazards the DUT could produce. The input voltage applied to the DUT is typically adjusted to 110% of the highest rated line (mains) voltage. Leakage currents are measured under all possible combinations of open and closed neutral conductors, normal and reversed polarity, and with open and closed ground connections on the input of the DUT.

The Line Leakage Tests may take on the form of an *Earth Leakage Test* or an *Enclosure Leakage Test*. These test are performed on both Class I and Class II products and have very specific leakage limits unlike the hipot test. Class II products a foil of approximately 10 X 20 cm is attached to the *Enclosure* of the product to simulate a hand contact. The leakage current is then measured from the foil to the system neutral under normal and single fault conditions or to both sides of the line through an isolation transformer.

Leakage Tests are more often specified as Type tests. Some standards require that a sampling of the products be tested during the production process, while other standards like for medical products may require 100% production line test.

SUMMARY

The Low Voltage Directive along with the CE Marking Directive introduced the requirements for a harmonized set of standards for the purpose of removing the technical barriers to trade and to permit free access to the total European Market. The manufacture is responsible for ensuring that his manufacturing process is such that the production of the electrical equipment conforms to these harmonized standards.

It is not always possible ensure that consumers will always use products in a safe manner or that they will not defeat the safety systems. This is why modern product designs incorporate built-in safety features to protect users with several levels of protection. However simply incorporating these into the end product design is not adequate to ensure user safety. These safety systems are subject to variations in production that could render them useless. The only way to be sure that the product has actually been constructed with the intended safety built into to it is to test each product before it is shipped. The basic safety tests described in this article will help to ensure that the product your customer is using is as safe as your design engineer intended it to be.

About the Author

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