

Understanding the Dielectric Voltage Withstand Test

The “Understanding the Product Safety Tests” Series

The *Dielectric Voltage Withstand Test* is a test known by many names including the Dielectric Test and the Hipot Test. This is the most common test of all product safety tests - performed by certification labs as part of all Certifications and also performed by electrical product manufacturers on 100% of production. Let’s review the elements of this test:

Purpose of the Test:

- This test is performed on the product’s electrical insulation system. It is the electrical insulation system that protects the user from a Risk of Shock.
- The test is used to identify any weaknesses in the insulation system that could cause a shock hazard to the user. The product’s insulation system must also be able to withstand overvoltages common on the mains. So we apply high voltage across each critical piece of electrical insulation to test it for weaknesses and to insure it can withstand typical voltage spikes on the mains.

Test Method:

- 1) The Dielectric test is performed on the insulation after the Normal Operating Temperature Test, when the insulation is at its maximum temperature.
- 2) The Dielectric test is also performed on the insulation after each Abnormal Operation Test, to insure that the insulation was not damaged as a result of the fault condition.
- 3) The Dielectric test involves applying high voltage across the insulation system representative (1000V+). The insulation system must be able to withstand this potential for a period of time (1 min.) to demonstrate that the insulation system is adequate (certification testing) and was not damaged during the manufacturing process (production testing).
- 4) The test requires a Dielectric Voltage Withstand tester (aka Hipot Tester). This tester is designed to sense a “breakdown” in the insulation being tested. This breakdown occurs when either there is an arc through or across the insulation or, excessive current is “leaked” through the insulation (i.e. 10mA or more).
- 5) In the case of power supply, motor, and transformer Certification testing, testing on the insulation can include removing the insulation from the product for testing. This involves disassembly of the component in order to test individual pieces or layers of the insulation system.
- 6) In the case of Production testing, only the insulation system that protects the user from a Risk of Shock from the mains voltage is tested = mains to enclosure dielectric test (“mains” refers to the main input voltage to the product; “mains circuit” refers to all circuits conductively connected to the mains).

Test Configuration:

- a) Mains to Ground insulation is tested at the product’s mains connection = the plug on the cord or, the field wiring terminals for the mains conduit connection. This is also a commonly required production line test. As such, many production hipot testers are designed to allow cord connected units to plug directly into the hipot tester.
 - Products without a ground (double insulated products) are tested between the mains connections and aluminum foil that has been wrapped tightly around the enclosure. The test voltage for double insulated products is usually twice that for grounded products (i.e. 3000V).



Test Configuration: (Continued)

- b) Isolating components such as transformers, opto-isolators, and relays are also tested from mains to secondary if they isolate a user accessible circuit.
- c) Dielectric testing individual insulating materials requires a special test stand defined by the standards that holds the material being hipot tested with minimal force and rounded ends to prevent damaging the insulation or affecting the test results.
- d) The test is typically specified as an AC test voltage. However, if the product being tested has EMI filtering components for EMC compliance purposes, it will not pass an AC dielectric. The capacitors to ground (Y caps) will leak excessive current with an AC test voltage, to such an extent that it usually prevents reaching the test voltage – attempting to turn up the voltage will only cause more current to flow. If you are using a production dielectric tester, it will usually trip and indicate a false test failure. However, this is not a test failure because the current flow is not caused by insulation failure. In fact the capacitor is operating as intended, although the excessive current flow from attempting an AC dielectric test is likely to damage the capacitor. The solution is to test with a DC test voltage, at a test potential equal to the peak of the specified AC test voltage ($1.414 \times \text{AC voltage}$).
- e) This test requires additional user precautions and preparation due to high voltage. Perform this test on an insulating surface. Stand back! DO NOT touch the product under test while the high voltage is being applied. Failure of the product's insulation system during testing could cause anyone touching the product when this occurs to receive an electrical shock.
 - NOTE: Most commercial hipot testers will automatically shut-off as soon as they sense a test failure. This is meant to help protect the user. You must still follow safe testing practices as there is some period of time between test failure and high voltage shut-off.

Test Objectives: The objective of the Hipot Test is to verify that the electrical insulation used to protect the user from a Risk of Shock is suitable for the application. Testing is used to identify any failure of the product insulation system that could lead to a shock hazard to the user. The detailed objectives include:

1. Insure all electrical insulation materials can withstand common overvoltages (voltage spikes on the mains caused by events such as switching surges – it is not uncommon to see a 1000V spike on the power coming from a wall outlet).
2. Identify all weaknesses in the electrical insulation system.
3. Identify inadequate electrical spacings on insulating materials or between parts.
4. Identify errors made in the mains wiring of a product during production (i.e. a color blind person connecting the hot lead to ground; strands sticking out from an electrical connection).
5. Identify damage to mains wiring insulation caused during production (hole or slice to wire).

As you can see, we don't simply perform the tests because they are in the standard. Each test in the standard has a set of objectives that relate to the 6 Hazards of Product Safety. The Dielectric Voltage Withstand Test is performed as part of the Risk of Shock compliance review. Verifying reliability of the product's electrical insulation system is crucial to insuring it continues to provide protection from a Risk of Shock, a potentially serious hazard that could lead to death by electrocution. It is therefore a very important test – another test that directly saves lives. This is why the Production Dielectric Voltage Withstand Test is required on 100% of certified products.

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