

# Picking the Right Hipot Tester for the Job

Understanding the testing requirements and standards will ultimately save testing time and cost

By: Kevin Clark, CEO, Vitrek Inc.

**H**ipot testers offer a range of capabilities starting with dielectric withstand and insulation resistance testing but also, in many instances, providing accurate low-resistance measurements and low-resistance/high-current outputs to test ground resistance and ground bond integrity. Selecting the right one for your application will ultimately save both time and expense in performing these essential tests.

## Product Safety Certification

Before getting into the individual functions, it is important to point out that hipot testing is a generic term. Actual testing will require meeting different specifications, depending upon where in the world the product will be sold and used. The details of what constitutes a certified product is dependent upon a daunting number (hundreds) of safety standards and the region of the world where the device will be sold and used. Standards setting organizations include:

- EN / IEC (European)
- UL (US)

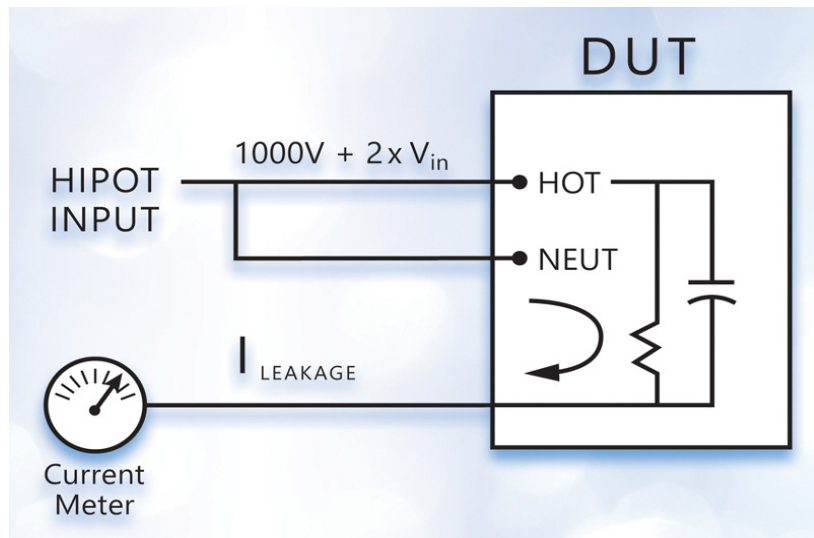


Figure 1: Hipot is applied to both conductors and leakage is measured in return circuit through the ground connection

- CSA (Canada)
- CCC (China)
- JEIDA / MITI (Japan)

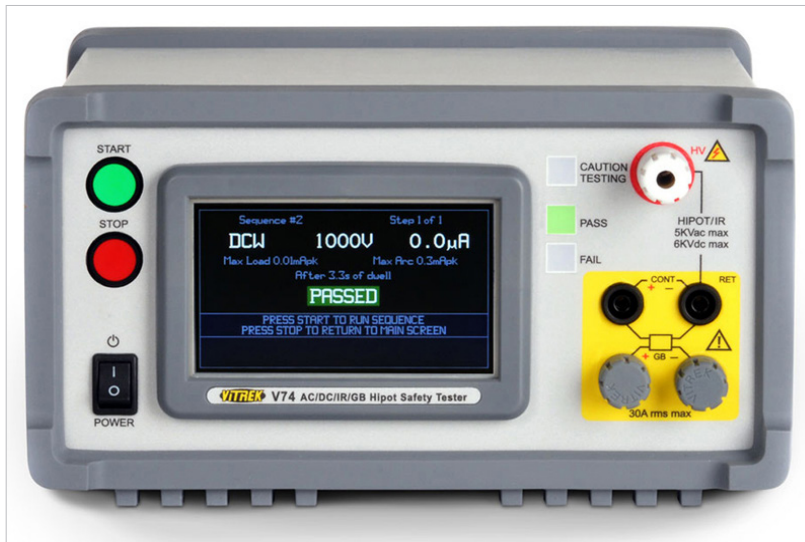
Manufacturers must submit samples of their products to recognized certification agencies. Nationally Recognized Certification Laboratories (NRTLs) include UL, VDE, FM, ETL and others. The agency certification process is conducted to confirm compliance with the relevant standard(s).

It is vitally important that your selection of hipot tester is capable of being set up to perform testing to meet the relevant standards.

Periodic inspection and calibration of test equipment is a standard requirement to maintain NRTL certification. Agency inspection will include check of hipot instrument calibration certification. This “cal cert” is typically required on an annual basis. (UL and other NRTLs require compliance certification with ISO17025.) Another common requirement prescribed by most NRTLs is a daily functional test of the hipot equipment.

## Dielectric Withstand - Hipot

The basic hipot test applies a high voltage from the conductors to the



*Figure 2: Vitrek's V7X Hipot Tester is well-suited to the requirements of electrical safety production testing.*

chassis of the device-under-test (DUT). This test is often referred to as “dielectric” or “voltage” withstand. Its purpose is to confirm that the insulation and isolation of the non-conducting surfaces from the operating voltage is sufficient to avoid a shock hazard. The typical specification for this test is: 2 x (normal operating voltage) + 1000V.

Both AC and DC hipot tests are possible and, in general, the test should use the same type of voltage as it would be during normal operation. However, if a DC hipot test is used on an AC circuit, the hipot voltage should be two times the peak (2 x 1.4 x RMS) + 1000V.

Depending on the applicable standard, units pass this test if either:

- the leakage current measured

is less than the maximum allowable current.

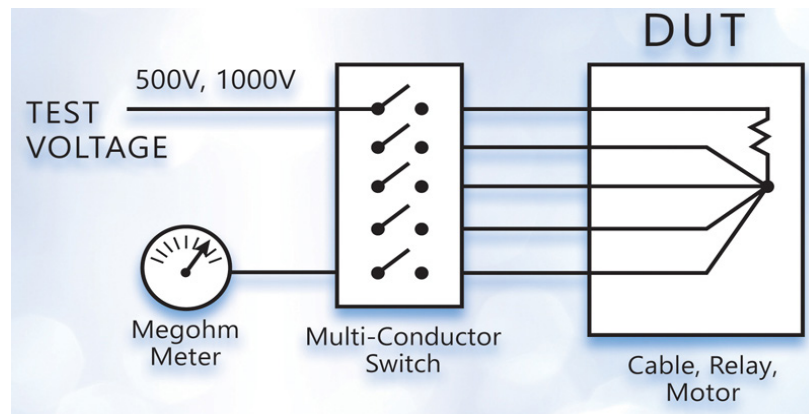
- no breakdown occurs, i.e., no sudden and uncontrolled flow of current

For double-insulated products, higher voltages will often be specified in the test standard. In addition, this class of device typically requires special fixturing to connect the non-conductive outer shell to a conductive element.

Defects that are often detected with the hipot test include contamination (dirt, debris) and lack of proper spacing (creepage and clearance) of components. Creepage is measured across surfaces, clearance is the air gap between components. Contamination would likely cause an unacceptable level of leakage current. Clearance problems could result in breakdown.

#### Desirable Dielectric Withstand Test Features

- Adjustable maximum output voltage:
- 5KV is adequate for many applications
- Higher voltages (up to 30KV) may be required
- AC and DC outputs
- Excellent regulation – both line and load
- Controllable ramp rates, dwell times and discharge features
- Phase angle measurement of leakage current – capacitive coupling detection
- Some standards allow for



*Figure 3: Voltage is applied to one conductor at a time while adjacent conductors are bundled. Resistance is calculated based on leakage current.*

in-phase and quadrature current to be measured separately. Leakage current due to capacitive coupling may not be a safety concern

- Min / max pass / fail current limits
- Separate limits during ramp
- Programmable multichannel testing

**Insulation Resistance**

Insulation resistance testing is likely to be required in motor winding, transformer winding and other applications involving cabling or insulated wire. Insulation resistance testing typically involves confirming that the resistance exceeds a defined high resistance value.

In many instances, insulation resistance needs to be measured between several conductors. Examples include cable/connector assemblies, multiconductor cables and relays. To make this measurement, all the conductors except one are shorted together and the test voltage is applied from the remaining conductor across the bundled ones. Each wire is then, in turn, tested in this fashion (Figure 3).

**Desirable Insulation Resistance Test Features**

- Wide range of selectable test voltages
- Accurate/repeatable high-resistance measurement
- Programmable high-voltage switching accessory

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**V7X & 95X Hipot & Ground Bond Testers**

- Wide range of AC/DC Outputs up to 30 KV AC & 15 KV DC.
- Optional Switching System and Automated Software available.

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  - Harmonics
  - Power Data
  - Scope View
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**4700 Precision High Voltage Meter**

- Measures up to 10 KV directly, up to 140 KV with Smart Probes.
- Chart Mode provides graphic documentation of HV drive ramp time, overshoot and sag.

**964i High Voltage Switching System**

- Automatic switching of up to 64 test points per chassis.
- Easy to set-up, compact mainframe.
- Routes HV test signals to any desired test points.

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- Multichannel programmable testing
- “Pass” on steady and Increasing voltage

**Ground Continuity**

Ground continuity testing is performed to confirm that the conductive chassis of a device is safely connected to the earth

ground pin on the power plug. This assures protection against shock hazards even if the equipment suffers an internal short to the chassis. The current would be shunted via the ground wire and would likely trip the breaker or blow the fuse.

Ground continuity is performed



Figure 4: Vitrek's 964i offers automated multi-conductor, multi-point hipot testing.

by measuring by applying a low current (e.g., 50 mA) and calculating the resistance from the ground pin on the power plug to selected locations on the exposed surfaces of the DUT.

**Desirable Ground Continuity Test Features**

- Accurate, repeatable low resistance meter
- Plug adaptor accessory to speed testing

**Ground Bond**

Where ground continuity

measures the resistance of the safety ground connection, the ground bond test assures the integrity of the connection. Using the same test setup, a high current is passed through the circuit. If the ground bond is solid, the current passes without a change in resistance. If weak, the resistive heating of the current would induce a failure of the bond.

**Desirable Ground Bond Test Features**

- Accurate high current source

- Programmable test currents and test times
- Plug adaptor accessory to speed testing
- 4-wire milliohm meter - providing a Kelvin connection for highly accurate low resistance measurements.

**Conclusion**

Electrical safety testing is a universal requirement for electrical and electronic equipment. Testing to the specific regional requirements can be a daunting task that is simplified by the programmable features and functionality of advanced hipot testers. Reviewing the desirable features of testers, based on the actual testing requirements, can and will result in more efficient and reliable testing.



Figure 5: The Vitrek 952i is representative of the highest performance hipot testers featuring up to 40A ground bond capability and 4-wire tera-ohm insulation resistance measurement capability.

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