

HiPot Testing of Military/Aerospace Interconnect Components

Advanced-performance electrical safety testers address standards testing requirements for wire/cable/connector/harness/relay components in hi-reliability military and aerospace applications.



INTRODUCTION

Operational performance and safety are paramount concerns when determining the acceptability of a range of interconnection products in military and aerospace applications. Connectors and relays, wires, wire bundled into cables and harnesses, all must be tested against stringent standards. The number and range of these standards is mind-numbing — and this paper makes no attempt to catalog them all. Rather, notable and salient MIL standards and similar aerospace standards will be used to site the key role that high-performance electrical safety testers, ancillary equipment and software play in effecting reliable and cost-effective compliance testing of the components shown in Figure 1.



Figure 1. Wire and cables, connectors and relays designed for mil/aero applications undergo testing to stringent standards.

MILITARY TESTING SPECIFICATIONS

The range of tests and standards that cover wiring, cabling and connectors in military/aerospace applications is extensive. Here is a sampling of these standards:

► Wires: MIL-STD-2223 - Electrical Tests - Class 3000

- Test 3001 - Spark Test of primary insulation
- Test 3002 - Impulse Dielectric
- Test 3003 - Insulation Resistance
- Test 3004 - Surface Resistance
- Test 3005 - Wet Dielectric

► Connectors - The range and complexity of standards for connectors is simply beyond the scope of this paper. Here is a brief sampling of these, each addressing the specific type of connector:

- MIL-DTL-5055 - Circular with solderable or crimped contacts
- MIL-DTL-12520 - Centerlock screw coupling, waterproof, polarized multi-contact
- MIL-DTL-22292 - Multi-contact, heavy-duty, quick disconnect electrical plug/receptacle
- MIL-DTL-24308 - Polarized shell, miniature, rack and panel
- MIL-DTL-26482 - Environmental resisting, quick disconnect, miniature, circular
- MIL-DTL-32139 - Nanominiature
- MIL-DTL-38999 - Miniature, circular, high density, bayonet, threaded or breach coupling

These connector standards include many of the same electrical test requirements called out in the wiring and cable test specifications.

ELECTRICAL SAFETY TESTING EQUIPMENT AUTOMATES TEST PROCEDURES

Electrical safety "hipot" testers are an integral part of electrical and electronic equipment manufacturing. Hipot testers get their name from the high potential (i.e. high voltage) that they produce to perform dielectric withstand and insulation resistance tests. In addition to these tests, advanced-performance hipot testers provide accurate low-resistance measurements and low-resistance/high-current outputs.

The hipot testers' advanced features are of particular importance in military and aerospace compliance testing. Where the principal objective in many consumer and industrial product tests is "product safety," as defined by UL and international safety organizations. In Mil/Aero applications these tests take on added significance since product failure can be costly if not deadly.

Advanced electrical safety testers, like the Vitrek products described later in this article, are necessary for reliable and repeatable conducting of many of these intricate test sequences. The devices can be configured to quickly handle a range of test setups, produce high voltages and currents, accurately measure both very high and very low impedances and they can record the results - all of which are absolutely essential capabilities.

TYPES OF TESTS REQUIRED

Electrical safety test equipment is utilized to perform the range of prescribed tests covered in this paper and it is needed to perform one or many of the following test procedures:

- Spark/Arc Testing
- Dielectric Withstand (AC or DC)
- Insulation Resistance/Leakage
- Ground Continuity
- Ground Bond

SPARK TESTING

A spark test is utilized to identify flaws in the insulation of wiring. The test is conducted by drawing the wire from one spool to a second spool through a bead chain or spark electrode. As the wire is drawn through the test fixture, electrodes from the hi-pot tester are positioned so that the high-voltage applied to the conductor will generate a spark/arc (dielectric breakdown) if there is a flaw in the insulation.

DIELECTRIC WITHSTAND

A hipot dielectric withstand test checks for sufficient insulation and isolation between individual conductors and between conductors and connector body parts and ground connections (Figure 2).

INSULATION RESISTANCE TESTING

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, multi-conductor 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.)

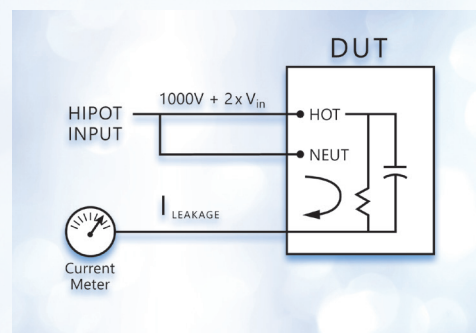


Figure 2. Hipot is applied to both conductors and leakage is measured in return circuit through the ground connection

ADDITIONAL CABLE AND HARNESS TESTS

A wide range of other tests are often required for interconnection products, depending on the applicable standard. For example, the SAE AS4373 standard, "Test Methods for Insulated Electric Wire," describes test methods for insulated, single-conductor electric wire intended for aerospace applications. Electrical safety testing systems are employed. A sampling of the tests prescribed in this standard include:

- 501 - Dielectric constant (capacitance per unit length of wire)
- 502 - Corona inception and extinction voltages
- 503 - Dielectric breakdown
- 504 - Insulation resistance
- 505 - Spark Test
- 506 - Surface resistance
- 507 - Time/current to smoke
- 508 - Dry arc propagation resistance
- 509 - Wet arc propagation resistance

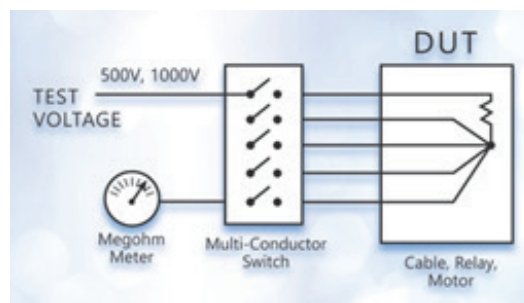


Figure 3. An insulation resistance test: voltage is applied to one conductor at a time while adjacent conductors are bundled. Resistance is calculated based on leakage current.

- 510 - Voltage withstand (wet)
- 511 - Wire fusing time
- 512 - Voltage rating
- 513 - Smoke resistance

VITREK ELECTRICAL SAFETY TESTERS

Vitrek is well equipped to provide the appropriate — and effective — equipment for military/aerospace wire, cable, connector and relay testing. Here's a quick summary of the Vitrek product offering:

► V7X Series Hipot Tester



- V7X Series offers power, speed, accuracy & resolution
- AC & DC output voltages up to 5kV
- Accuracy & speed of calculations exceed industry standard
- Color touchscreen & automated test software available

► 95X Series Hipot Tester



- 95X Series offers power, speed, accuracy & resolution
- Wide range of AC/DC outputs up to 30 kV AC & 15 kV DC
- Accuracy and speed of calculations exceed industry standard
- - 100 pA resolution for current
- Color touchscreen & automated test software available

► 964i High Voltage Switching



- 964i HV switching for automated test systems
- Multi-conductor/Multi-point
- 8 channels of HV switching cards (8 per card for a total of 64 test points)
- Configurable voltage ratings - 3kV, 7kV, 10kV & 15kV

VITREK TEST AUTOMATION SOFTWARE

PC-based software is designed to control operation of the company's V7x and 95x lines of high-performance electrical safety (hipot) testers and 98x series insulation resistance testers. In test situations where multiple test points are involved, the QT Enterprise platform can interface with Vitrek's 964i High Voltage Switching Systems to further automate the process. For complex setups, QT Enterprise can display detailed instructions and images to the operator to ensure proper connections prior to testing.

VITREK TEST AUTOMATION SOFTWARE

QT Enterprise Features include:

- Configurations, test sequences, test results, users and other system settings are stored on a local PC or in a central SQL database accessible through a network.
- Test data is easily accessible, and users may sort and filter a list of results based on their specific needs.
- Integrates with barcode scanner to read DUT model and bring up the correct, ready-to-run test sequence.
- Multimedia setup instructions can be incorporated into test sequences providing operators with visual prompts for easy and accurate DUT hookup.



VITREK APPLICATION EXAMPLES

Cable Testing Application

Customer: United States Navy

Requirement: High Voltage withstand testing on 100 conductor cables



Vitretek Products:

- One 95x (951i) high-performance electrical safety tester
- Three 964i High Voltage Switches
- QT Enterprise Software

Results:

- Instead of taking two hours/cable for testing, the automated test takes two minutes.
- The Vitrek system documents the results for audit purposes
- The system is calibrated and traceable to ISO 17025
- The Vitrek system is designed, manufactured and supported in the U.S.



Relay Testing Application

Customer: Teledyne & Esterline

Requirement: High Voltage withstand, insulation resistance & continuity tests



Vitretek Products:

- One V7x Series (VXi) high performance electrical safety tester
- QT Enterprise Software

Results:

- Replaced in-house system with Vitrek gear and operational within one week.
- The Vitrek system documents the results for audit purposes.
- The system is calibrated and traceable to ISO 17025
- Vitrek's system is designed, manufactured & supported in the U.S.



CONCLUSION

Military and aerospace applications place an exceptional degree of importance on the safety and reliability of electrical interconnections. As a consequence, these components are tested for compliance according to stringent standards. This paper has not attempted to present an exhaustive survey of these standards. Instead, it has made the point that the testing of these materials has in common the need for high performance, accurate and reliable test equipment and systems.

Vitretek's line of electrical safety testers are ideal choices for this application.

- The 95x Series hipot tester features high-output power with a wide range of output voltages combined with exceptional leakage current resolution.
- The V7x Series hipot tester offers outstanding performance in a lightweight, lower-cost format.

Vitretek hipot testers come standard with a variety of computer interfaces to simplify test automation right out of the box and can be used with Vitrek's 964i Multipoint Switching System and QT Enterprise Software.

Vitretek's decades-long experience in providing reliable, accurate and affordable test equipment is complemented by its application expertise - before, during and after the sale. Vitrek products are designed, manufactured and supported in the U.S. Our facility is an American Association for Laboratory Accreditation (A2LA) accredited ISO 17025 Calibration Laboratory. For more information on Vitrek's complete line of Electrical Safety & Test Equipment visit us online at www.Vitretek.com or call (858) 689-2755.