



Solar Panel Testing: Associated Research 3145 DC Ground Bond Tester

Introduction

The photovoltaic (PV) industry has experienced incredibly fast transformation over the past decade as a result of technology breakthroughs and increased consumer demand for solar electrical energy. PV cells are being used to power everything from appliances to automobiles, given the fact that they are a clean energy source. The USA more than doubled the amount of solar electricity installations in 2011 as compared to 2010 and that growth is expected to continue.

Given the rapid growth of solar PV installation, it should come as little surprise that consumers are concerned about the safety and quality of PV electrical systems. In many cases, simple electrical faults, improper grounding or wiring failures can cause serious inefficiencies in the ability of a PV system to produce power, and can lead to dangerous fire and/or electrocution hazards. Elimination of such safety risks can only be achieved by both good system design and careful installation alongside appropriate electrical inspection and testing. In this paper, I will discuss test specifications for solar PV's and how the Associated Research model 3145 tester can help to comply with them.



Figure 1: The Associated Research model 3145 40 Amp DC Ground Bond Tester

Photovoltaic Cells and Testing Guidelines

Photovoltaic cells (solar cells) are electrical devices that convert solar energy directly into electricity. Solar panels are simply a connected assembly of Photovoltaic cells. Each solar panel is rated by its DC output power under standard test conditions. Like every other electrical device, solar panels must be safety tested in order to comply with nationally recognized testing laboratories (NRTL's) such as UL, IEC and TUV.

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Required Tests

Perhaps the most common safety standard addressing the PV industry, UL 1703 (*Flat-Plate Photovoltaic Modules And Panels*) and IEC 61730 (*Photovoltaic Module Safety Qualification*) outlines five main types of electrical safety tests for potential shock and fire

hazards. These are the Dielectric Withstand (Hipot) test, Ground Bond test, Ground Continuity test, Insulation Resistance test and Wet Leakage test.

The [Dielectric Withstand](#) or Hipot test is designed to stress the insulation of the solar panels beyond what it will encounter during normal operation. The resulting leakage current (measured usually in μA) is measured from different points on the chassis of the panels which can come into contact with humans. The assumption is that if the panel insulation can withstand high voltage for a very short period of time, then it should operate without posing any shock hazard throughout its life cycle. A DC Withstand test (negative and positive polarity) is commonly used to test solar panels given the fact that these generate with a DC voltage.

Similar to the Hipot test, the [Insulation Resistance \(IR\)](#) test is also designed to stress the insulation of a solar panel with a high DC potential in both polarities. This test is used to provide manufacturers of solar panels with a quantifiable value for the resistance of their product's insulation. The Insulation Resistance test displays a resistance value in $\text{M}\Omega$ or $\text{G}\Omega$. IR testing is sometimes called out by safety agencies to be performed subsequent to the Hipot test.

The **Ground Continuity** test is often required to be performed with the Hipot test. This test ensures that the solar panels safety ground connections have been made properly, but is only applicable if the panel is built with metallic frame. A small voltage is applied from the chassis of the solar panels to the ground pin in order to determine if the appropriate amount of current flows. The Ground Continuity test is required as a 100% production line test to verify that there is continuity in the ground circuit of the solar panels.

The **Wet Leakage** test is also similar to the Hipot and Insulation Resistance tests. The fact that solar panels can be exposed to different environmental conditions (rain, snow, dew and etc.) is what has given rise to this test being called out for by the safety agencies. In this test, the positive and negative leads of the solar panels are shorted together and connected to high voltage, while the solar panels are placed in a tank of saline solution. This solution acts as a return point for measuring

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the insulation resistance value. This test condition simulates what would happen if someone touches the solar panel while it was wet.

The [Ground Bond or Protective Bonding](#) test is used to determine the integrity of the DUT's ground circuit by running high current from the ground terminal to any accessible conductive part. In other words, this test checks the safety ground circuit of the DUT to

make sure it can handle the fault current if the DUT insulation should fail. This test is only required for Class 1 products (products with a ground pin).

The 3145 and the Ground Bond Test

The Associated Research model 3145 tester with its 40 Amp DC capability was developed specifically for applications such as PV testing, allowing users to efficiently and cost-

effectively meet specifications that require DC Ground Bond test current. The nature of PV testing is such that it can expose the test operator to high voltages and currents and the 3145 provides a safe and convenient solution for test compliance. And once a PV system is installed, ongoing and effective electrical testing is vital both to ensure the continuing safe installation of the system and to verify ongoing functional performance over extended periods.

According to standards such as UL 1703 and IEC 61730, the Ground Bond test falls under the type test or performance test category. This means that the Ground Bond test is performed in a laboratory environment and in this case, the solar panel is tested on a sample basis by engineers that analyze the data and results. Per UL 1703, the test current is specified to be two times the fuse rating of the DUT. Per IEC 61730-2, a current of two and a half times (+/- 10%) of the maximum over-current protection of the module must be applied for a minimum of two minutes. The measured resistance between the grounding terminal or lead and any conductive part should not exceed 0.1 Ohm for 2 minutes

Associated Research recommends running a Ground Bond test as a 100% production line as well to give manufacturers the peace of mind that they are verifying the integrity of the ground connection rather than just the presence of the ground connection (Ground Continuity). A fault in the solar panel can cause a live conductor to contact the casing which in turn will cause a current to flow in the earth/ground conductor. If this ground connection is not able to handle the fault current, there may be a shock hazard due to the fault current flowing on the casing of the panel.

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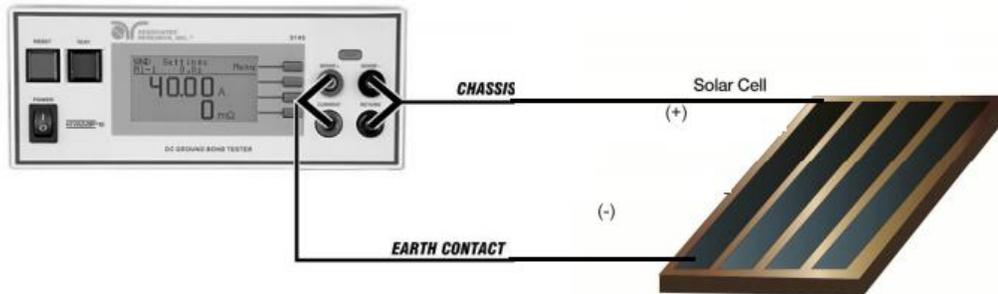


Figure 2: The 3145 Ground Bond Tester connected to solar panel

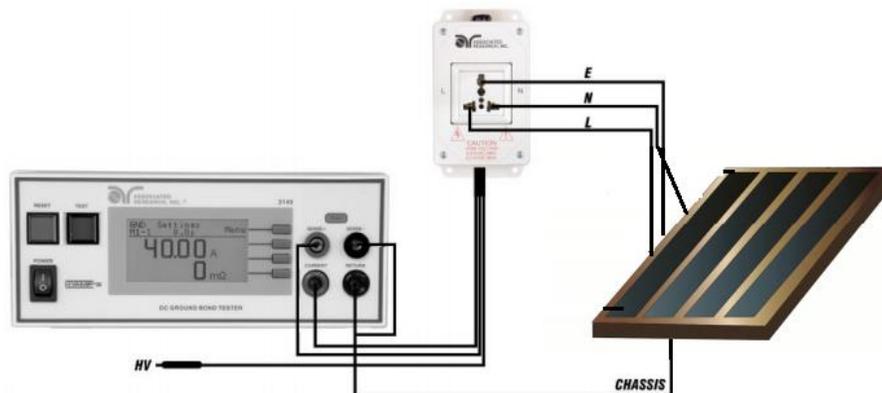


Figure 3: Solar panel connected to the 3145 tester through receptacle box

The 3145 and Electrical Safety Compliance

A major benefit of the 3145 tester is that it was designed to work as a system with the Associated Research HYPOT III series testers in order to satisfy all the requirements listed per UL 1703 and EN 61730. This system will be capable of performing Ground Bond test, Hipot test and Insulation Resistance test using a single high-current and high voltage adapter box.

The 3145 can be connected to a solar panel using high current and return leads or via the Associated Research high current adapter box shown in Figures 2 and 3. As a safety feature, the 3145 tester comes standard with a Remote Interlock without which the output of the tester is disabled. Although solar panel testing applications



may vary, the 3145 can be used in laboratories or in a production environment with its entry level automation option (RS-232 interface) or the PLC option for remote control. Production line testing requires running multiple tests in a short period of time and the 3145 is fully capable of storing and recalling test parameters in order to reduce test time and minimizing operator intervention.

Conclusion

There are many instruments and testers available that are sold under the title of “solar testers” so it is vital to ensure that the instruments selected are capable of performing the tests that are required by the various compliance requirements. Associated Research has a variety of test units available to meet all the requirements of solar panel testing including complete test systems and stand-alone testers such as the 3145. Whether testing to UL 1703 or IEC 61730, the 3145 40 Amp DC Ground Bond tester, is designed to test solar panels and PV modules in a fast, efficient and safe manner.

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