Chroma Systems Solutions, Inc.

Advanced Technique for Dielectric Analyses

190xx Series Hipot Testers

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Title: Advanced Technique for Dielectric Analyses

Product Family: **19020, 19032, 19035, 19052, 19053, 19054, 19055, 19056, 19057, 19071, 19073**

Advanced Techniques for Dielectric Analysis

Although certain industries and standardized tests require destructive testing of insulation and dielectric material, the area of non-destructive testing is far more prevalent and is growing in popularity. Destructive testing may be useful for characterizing a material, component or system, but is not usable in a production environment for Quality Assurance of safety testing. It is in the area of production, requiring 100% testing of product, that non-destructive testing is most useful.

The present method uses a current-limited high voltage source with a high-speed detection circuit that shuts down the source when a specified current is exceeded. This rapid removal of the source voltage, combined with a limitation of the maximum current, in most cases avoids irreparable perforations or erosion of the dielectric. This also prevents the associated deposits of carbonized residues on the surface or within the dielectric. This method has proven a fairly reliable means of testing on production lines for a wide variety of insulation, dielectric, and product types.

However, this method has proved unsatisfactory for some classes of dielectric material that cannot withstand even limited current without damage and for devices containing a significant amount of capacitance. In these cases a different approach is required.

Current Threshold Detection

Consider the test circuit of Figure 1. A high voltage source is connected to the DUT (device under test) with an internal current-limiting resistor Ri, and a current sensing resistor, Rs.

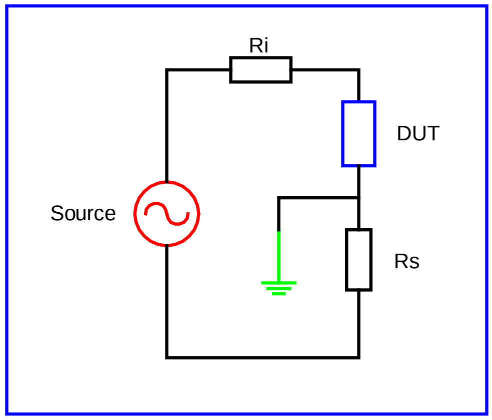

Figure 1: Current Threshold Test Circuit

A typical current versus voltage curve is given in Figure 2. Note that above a certain threshold voltage Vc, the current Ir, increases rapidly up to the limit of the tester source. The tester measures the voltage across Rs to determine the current flow. If the current flow exceeds a specified amount, Is, the DUT is considered to have FAILED and the voltage source is removed. The most widely used current limit is 1mA. Although the use of this detection method and the choice of this value does not offer any difficulty for tests on purely resistive components (Ic being around ten micro-amps) it can be destructive for tests on capacitive elements. A DUT with substantial capacitance will also cause an in-rush of current immediately when the test voltage is applied, giving a false FAIL of the DUT.

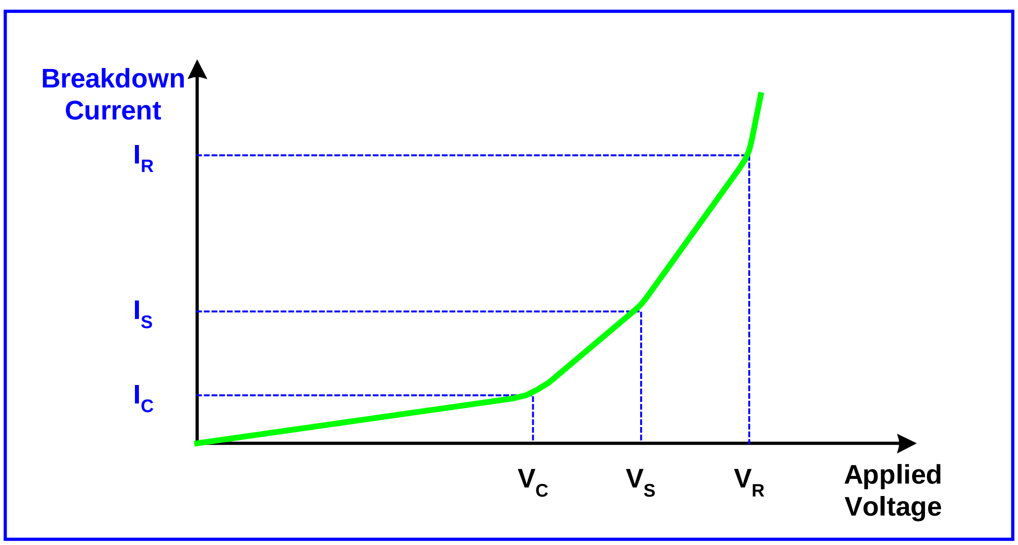

Figure 2: Breakdown Current versus Applied Voltage

Current Variation Detection

The current variation method eliminates many of the problems with the current threshold method by utilizing the nature of the current versus voltage breakdown curve. By observing the current versus voltage on an oscilloscope, it can be seen that the actual breakdown is preceded by a partial discharge phenomenon. The breakdown itself generally has the form of an extremely fast rise time pulse, lasting about 1 micro-second or less and whose peak value is limited by the combined characteristics of the test station and the DUT.

This fact can be used to detect the onset of breakdown even in the presence of capacitance, and regardless of normal leakage current levels, Ic. The in-rush current on application of voltage can be ignored if a suitable ΔI and Δt are chosen. The exact value of ΔI and Δt vary with the DUT. However an extremely wide range of dielectric materials have shown to be testable with settings of 1mA of ΔI and 10μs of Δt. Figure 3 illustrates current variation.

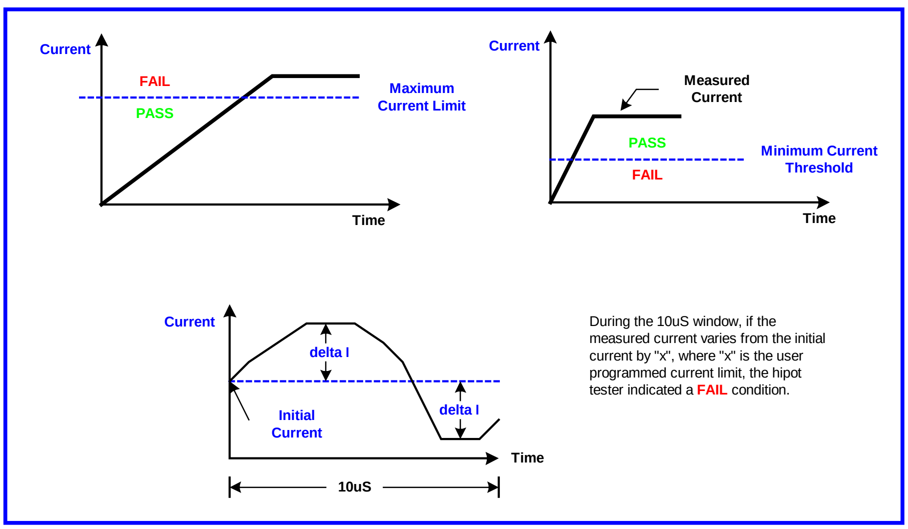

Figure 3: Current Variation Detection

IR Measurement To Determine Test Damage

In spite of all efforts to protect a "GOOD" DUT from damage due to the application of dielectric test voltages, it is inevitable that some units will be damaged. Once the threshold has been reached, the current increases rapidly, and even though the test unit may shut down, a given DUT may have stored sufficient energy to provide enough current to self-destruct! This damage can range from total destruction via severe carbonization to a subtle weakening of the dielectric with catastrophic failure to occur later (upon use by the Customer!).

The case of total destruction is easy to detect by simple operation of the DUT at its normal operating voltages. The subtle weakening or degradation phenomenon is not detectable by this method. If each

DUT is characterized before the dielectric test by measuring its Insulation Resistance and is again measured after test, a comparison of the two values will detect these subtle failures. In many cases the apparent resistance of the dielectric will be greater after the test due to dielectric absorption of the material.

Summary

Testing of dielectric materials in a production environment is both complicated and likely to cause damage to some percentage of the DUT. By using advanced techniques to measure the dielectric characteristics, accurate results can be obtained with much less danger of destroying finished goods.