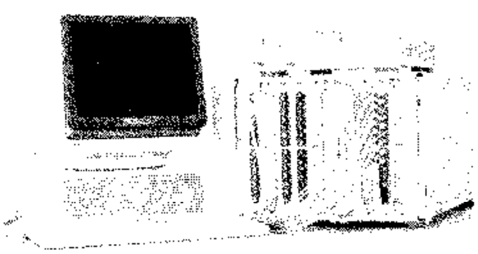
HEWLETT PACKARD

Application Note 1224-6

# Effective Insulation Resistance Testing using a Scanner

## - HP 4339A High Resistance Meter -



## INTRODUCTION

With increasing requirements for size reduction and higher reliability design, it is important to evaluate the insulation resistance of electronic components such as capacitors and multi-layer pc boards for high density mounting.

In a production line or QA section, multi-channel testing using a scanner has become necessary to reduce the test time. The following solutions offered by the HP 4339A high resistance meter and the HP 3235A switch/test unit describe use of these products together.

## HP 4339A and HP 3235A BRIEF DESCRIPTION

The HP 4339A is a high resistance meter which can output the internal dc power supply from 0.1 V to 1000 V, and measures the insulation resistance up to 1 x $10^{16}\,\Omega$ with high stability and high speed (max. 10 ms (typical)).

The HP 3235A is a flexible and easy-to-use switch/test unit with its wide variety of plug-in modules. The various switching plug-in modules route signals from external instruments to your DUT (device under test).

## SYSTEM CONFIGURATION

The multi-channel insulation resistance system can be built with both the HP 4339A and the HP 3235A as shown in Figure 1.

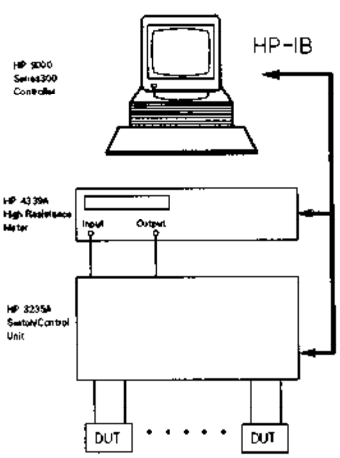



Fig.1 System Configuration

To route the signals, the HP 34512C switched-shield triaxial matrix module and the HP 34515B 1 kV high voltage relay multiplexer module are used. These modules with the HP 3235A allow up to 8 ch. (max.40 ch. when installing each of 5 modules) as shown in Figure 2.

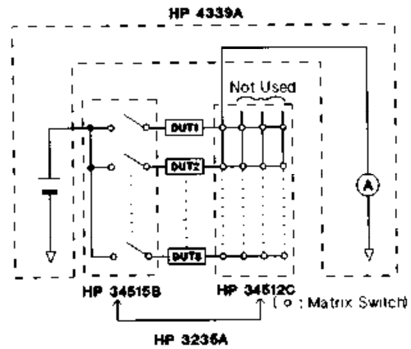



Fig 2. HP 34512C, HP 34515B

When the leakage current of the insulation resistance is measured by using a scanner, the channels except for the tested channel are set to OPEN states which are considered to be the insulation resistances. Then, when the DUT's insulation resistance is bigger than the resistance of the scanner relay's OPEN states (> $10^8\,\Omega$), the scanner's OPEN states causes the measurement error. This error mechanism can be explained as follows:

Figure 2 configuration can be modeled to be the simplified block diagram as shown in Figure 3.

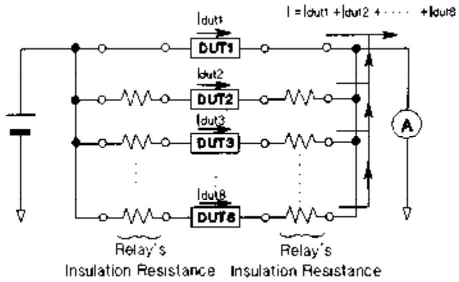



Fig.3 OPEN State Modeling

When the leakage current Idut1 through DUT1 is measured, the leakage currents (Idut2 to Idut8) through OPEN state channels are added to the Idut1. So the ammeter measures the sum of Idut1 through Idut8, and Idut1 cannot be measured correctly. To solve this problem, a resistor R (typically, 1 MΩ to 5 MΩ) absorbing the leakage current must be inserted. The leakage currents of the scanner's OPEN states are almost flew through R, and the ammeter can measure the actual Idut1 only as shown in Figure 4.

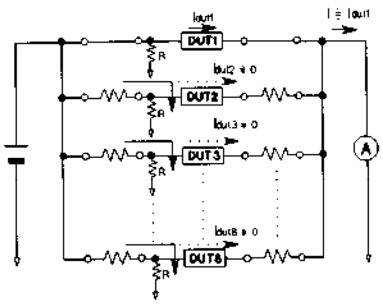



Fig.4 Resistors to absorb leakage current of OPEN states

## MEASUREMENT ERROR

When the leakage current of the pure resistors ($10^{10}$ to $10^{12}$ Ω) are measured at MEDIUM mode in the above configuration, the typical additional error is listed in Table 1.

In case of capacitor testing, the dc voltage source noise such as line frequency ripple flows through the capacitor because the capacitive reactance is smaller than the insulation resistance, and it increases measurement instability. Consequently, the additional error including the error of the scanner system is below 10 % when the device is below 1 GΩ$\mu$F, and its leakage current is above 100 pA. When the device is greater than 1 GΩ$\mu$F, or the leakage current is below 100 pA, the appropriate resistor (typically 100 kΩ to 100 MΩ) must be connected in series with the DUT for reducing the measurement instability caused by the power noise. For more detailed information about this, refer to Chapter 7. Measurement Basics in HP 4339A Operation Manual (PN 04339-90000).

## CONCLUSION

The HP 4339A with the HP 3235A offers you effective multi-channel testing.

Table 1. Additional Error for the leakage current measurement using a scanner

| DUT | DC Voltage | Leakage Current | Error |
|---|---|---|---|
| $10^{10}\Omega$ | 100 V | 10 nA | 0.1% |
| $10^{11}\Omega$ | 100 V | 1 nA | 0.1% |
| $10^{12}\Omega$ | 100 V | 100 pA | 0.1% |
| $10^{12}\Omega$ | 10 V | 10 pA | 0.5% |
| $10^{12}\Omega$ | 1 V | 1 pA | 3.0% |

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