MONROE ELECTRONICS

Application Note APNE-0004
Surface Resistivity Measurements Of Narrow Tape Samples Using Model 272A

The usual sample size for surface resistivity measurements using Model 272A and the 96101A probe provided with it is at least 2½ inches across in any direction. The electrode configuration is defined in ESD Association Standard 11.11 and is shown with critical dimensions in Figure 1.

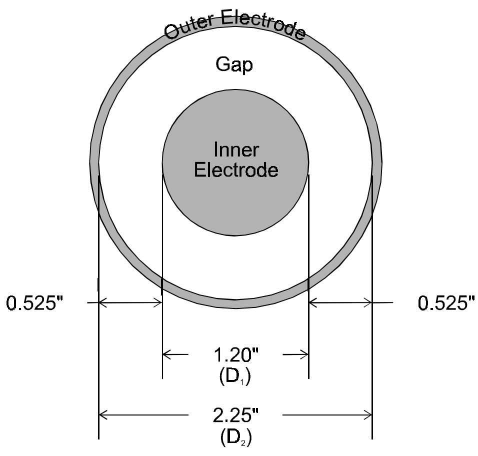

Figure 1

Occasionally, it is necessary to measure samples of smaller dimensions and this usually requires a special probe. Monroe Electronics manufactures custom probes for this purpose on special order. However, when the sample is in the form of a long but relatively narrow tape, the standard probe can be used to measure the surface resistance of the sample and the result can be converted into a resistivity value using the principle outlined in this Application Note.

In the normal use of this electrode, it functions as a "guarded ring" where the resistance of the material in the gap or area between the inner and outer electrodes is measured. A precisely known voltage (-10 or -100 volts) is applied to the outside ring and the current across the interposed material to the center electrode is converted into a value and shown on the panel display as a resultant resistivity value in ohms per square. What may not be so obvious to the casual observer is that there are ten squares of interposed material which can be thought of as resistors in parallel, each of which represents the value of the material's surface resistivity, so the actual measured resistance is ten times less than the value we want to indicate. Not to worry! In normal resistivity measurements, the instrument does the calculation for you.

If you configure the instrument as shown in Figure 2, it displays the value of the <u>resistance</u> between the two elements.

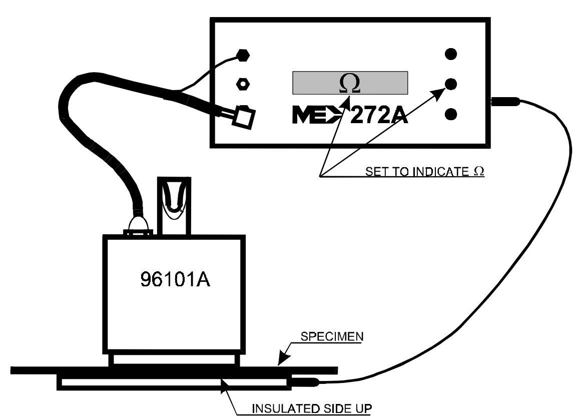

Figure 2

That is, if you were to set the probe on a physical resistor (component) so that the leads contacted the inner and outer electrodes, the meter would indicate the value of that resistor. If you connected two equal resistors across the gap in this manner at two different places (effectively in parallel), the indicated value would be half that of either resistor.

Assuming that the surface of the specimen support plate is not contaminated and is a perfect insulator (this can be confirmed by placing the probe on it and seeing "VALUE

TOO HIGH") a narrow strip of material whose width is known and constant can be measured as shown in Figure 3. The strip should cross the center of the two electrodes as shown. A width of ¼" is used in this example. The numbers will be different for different widths of material.

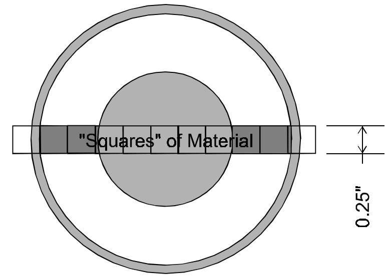

Figure 3

If we view these strings of "squares" as resistors, we can assign a value to the string on the right and an equal value to the string on the left. Just as in the example using physical resistors, these two strings are effectively in parallel. Figure 4a shows the equivalent of one string and Figure 4b shows the equivalent of two in parallel. *<u>In this example</u>* (where the tape is ¼ inch wide), Figure 4a consists of 2.1 squares in series and Figure 4b is 1.05 squares in series. In fact, for widths up to 0.2625", there will always be a resultant of one or more squares in series. The objective is to determine the value of <u>one square</u>.

To calculate the factor necessary to convert the displayed value (resistance in ohms) to resistivity (in ohms per square), simply divide the effective width (two times the strip width or 0.50" in this case — Figure 4b) by the length (always 0.525") and multiply the reading by this amount.

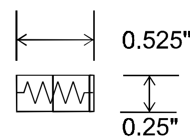

Figure 4a

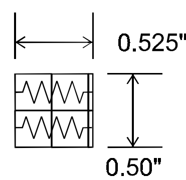

Figure 4b

$$\rho_s = \frac{2w}{0.525} R$$

Where:

ρ_s = Surface Resistivity of the material

w = Width of the strip being measured

R = Resistance reading (in ohms)

Error due to curvature of the electrode is less than 10% for strip widths of less than 0.8".

REFERENCES -

ASTM Standard D-257

ESD Association Standard 11.11

Article *An Analytical Approach To Surface Resistivity Measurements* by D.C. Burdeaux and C.L. Mott, The Dow Chemical Co. — Part LXXIV of the "Coping with Static Electricity" series by Evaluation Engineering magazine