Measurement of Surface Resistivity in Carrier Tape

A Guide for Determining How to Measure

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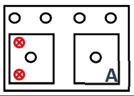
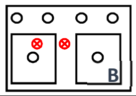
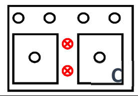
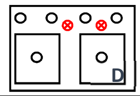
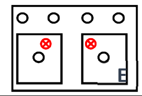
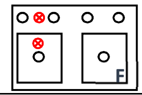
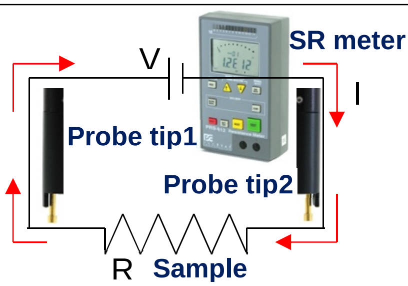
The measurement of Surface Resistivity in carrier tapes is done in many different ways, based on the user's equipment, pocket sizes and shapes, and company policies and practices. Some of the twin probe methods are shown below

A	B	C	D	E	F
					

This methods will potentially get different results depending on the amount of stretch needed to form he pocket, the method use to form the tape, and the type of material used.

<u>Measurement principle</u>

To measure the surface resistance in carrier tape samples, the equipment supplies a current (I) that passes through one probe, then through the sample, through the other probe, then back to the meter, completing the loop. The voltage drop (V) and the current supplied can be measured by built-in volt-meter and ammeter, then the resistance (R) is computed by Ohm's Law. Resistivity (ρ) is then calculated using the probe geometry (usually, ρ=10*R).

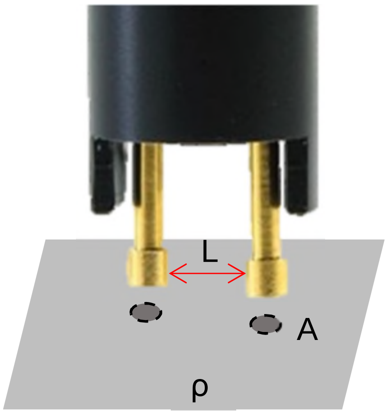


V and I are measured by voltmeter and ammeter respectively.

Ohm's Law: V = IR

Transposing: R = V/I

Figure 1: Resistance measurement loop



Extending Ohm's Law, interactions between the equipment and measured sample can be summarized by the following equation:

$$R = \frac{\rho * L}{\wedge}$$

where

ρ = resistivity constant of a material, which is constant if the temperature is constant

L = length of the sample in the loop, which is just the same as the gap between probes

A = transfer area of charges, or the area of contact between the probe and the sample

Figure 2: Factors controlling a material's resistance reading

The above is based on surface resistance (Ω), but can easily be converted to surface resistivity (Ω/sq). As defined in ANSI/ESD STM11.11 (Surface Resistance Measurement of Static Dissipative Planar Materials), to convert resistance from ohms to ohms per square (surface resistivity) multiply the reading results by 10 (or alternatively if reporting in scientific terms, increase by one full decade. Example: from 1.0x10^5 Ω to 1.0x10^6 Ω/sq). See Figure 3

Designation	Resistance (Ohms)		Resistivity (Ohms/Sq)	
	Standard	Exponential	Standard	Exponential
Shielding $<10^3$	10	10^1	100	10^2
	100	10^2	1000	10^3
Conductive $<10^4$	1000	10^3	10000	10^4
Dissipative $\geq 10^4$ to $<10^{11}$	10000	10^4	100000	10^5
	100000	10^5	1000000	10^6
	1000000	10^6	10000000	10^7
	10000000	10^7	100000000	10^8
	100000000	10^8	1000000000	10^9
	1000000000	10^9	10000000000	11^{10}
Insulative $\geq 10^{11}$	10000000000	11^{10}	100000000000	11^{11}
	100000000000	11^{11}	1000000000000	11^{12}

Figure 3: Resistance and Resistivity

Carrier tape used for active (or ESD-sensitive) devices must have the ability to inhibit accumulation of, or to dissipate, electric charges at a certain rate. The selected testing method should be able to capture this ability reasonably.

As the floor of the pocket seats the device, the measurement method should show if charges from this area can be dissipated well (Figure 4).

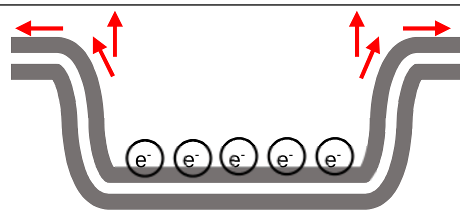


Figure 4: Electric charges in the pocket surface.

As shown in Figure 4, the path of charge dissipation that is most important is along the top-side surface of the planar material.

In summary, any test method must:

Show if connection is established from pocket floor to a grounding location.

Measure the top side surface, which is the one in direct contact with the device.

For consistency from one measurement to the next, the following recommendations are being made

Utilize a 2-point, spring loaded probe such as PRF-922B miniature probe. These generally can fit into a pocket at least 5mm wide and up to a depth of 4mm.

To best meet the requirements, test locations B and F are recommended. Since the charges will flow in the path of least resistance, the location (either B or F) that provides a smaller resistance result will more accurately indicate the charge dissipation path.

In cases where a probe tip is too large to fit the pocket or the pocket is deeper than 4mm (limit of the probe depth) method C or D may be applied. The reason is that draw ratios and material stretch for such pocket sizes are small and would not significantly increase the surface resistance. It is also best to avoid measuring over or across a punched hole.

The chart in Figure 5 shows the recommended measurement locations in the preferred order.

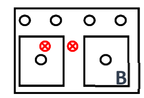
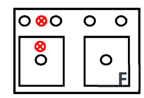
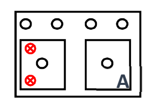
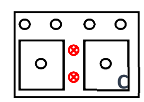
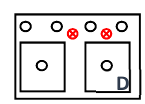
Recommended test locations	1. SR is measured along a dissipation path. The first choice in location is from pocket bottom to bridge (if wide enough), other wise move to location 2	
	2. Measure from pocket bottom to flange. If unable, move to location 3	
	3. Measure across the pocket bottom. Avoid measuring across the pocket hole if possible. If unable, move to location 4	
	4. If 1-3 cannot be done, such as in very small pockets, but the bridge width is 3.5mm or more (probe tip diameter = 3.18mm), it is recommended to measure on the bridge.	
	3. If 1 -4 cannot be done and bridge width is less than 2.6mm, it is recommended to measure in the sealing area, avoiding the sprocket holes if possible	

Figure 5: Recommended test locations for standardization