CONCENTRIC RING

PRF-911

User Manual

PROSTAT®

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PROSTAT® PRF-911 CONCENTRIC RING

I. Introduction

The PRF-911 Concentric Ring and PTB-920 Dual Test Bed work together, and in conjunction with the Prostat PRS-801 and PRS-812 Resistance Instruments for measuring Surface and Volume Resistance of materials. The size, portability and construction make this fixture system convenient for auditing flat materials and films in the field. The concentric Ring with one 5 Ib electrode weight on top approximates currently recommended resistance and resistivity measurement procedures.

A. PRF-911 Concentric Ring consists of a spring loaded center electrode (D_1) and an outer electrode ring (D_2). Both electrodes are covered with highly conductive rubber.

   1. Direct surface resistance measurements generally conform to the guidelines as outlined in the ANSI/ESD STM11.11 Surface Resistance test method.

   2. The dimensions of the fixture allow estimation of surface resistivity in ohms/square. This estimate is obtained by multiplying surface resistance results obtained herein by 10 times, i.e., adding one order of magnitude.

   3. The fixture connections allow the device to be used for making Volume Resistivity measure ments generally described in ASTM D-257 and ANSI/ESD STM11.12 Volume Resistance Measurements. The fixture correction for the area of its center electrode (D_1) is 6.9 cm^2.

B. The PTB-920 Dual Test Bed consists of a four inch metal test bed laminated to an insulated test bed.

   1. The insulated acrylic surface is used for surface resistance measurements made using the ANSI/ESD STM11.11 guidelines.

   2. The metal (plated aluminum) surface is used for volume resistance and resistivity measure ments made using ANSI/ESD STM11.12 guidelines.

C. A BNC/Dual Banana Receptacle adapter is provided for use with the PRF-911 Concentric Ring fixture.

II. Cautions & Warnings

A. As with any electrical device, use proper electrical precautions to avoid personnel shock.

   1. The PRF-911 Concentric Ring fixture operates with power input from resistance measurement instruments at 10 to 100 volts. An annoying shock to any person touching it may be possible.

   2. Although the current capability is limited, a distinct **HAZARD EXISTS** in the person's reaction to a low level electric shock.

   3. To avoid personnel shock, do not touch the electrode when power is applied.

CAUTION
To avoid electrical shock, do not touch the fixture, electrodes or test bed when power is being applied.

B. The PRF-911 is designed to be used in audit environments at test voltages of 100 volts or less. Exceeding 100 volts greatly enhances the risk of personnel shock hazards, and may damage or change materials being measured.

1. Do not exceed 100 volts in the audit environment.

CAUTION
Operational test voltages should not exceed
100 volts in the audit environment.

2. Only qualified instrument repair and test personnel should exceed the 100 volt operation guideline, and do so only under controlled conditions using precautions against personnel shock.

3. Never exceed 100 volts during instrument test or repair.

C. DO NOT USE THE PRF-911 CONCENTRIC RING if it fails to function during its continuity inspection test.

CAUTION
Should the continuity check indicate improper connection to the electrodes, OR the fixture becomes damaged, do not use the PRF-911 Concentric Ring. Contact Prostat Customer Service Department for further instructions.

D. DO NOT USE THE PRF-911 CONCENTRIC RING if it becomes damaged in any way.

E. Only qualified instrument repair personnel should open terminal connections or repair the PRF-911

F. Do Not Touch Electrode Surfaces: Electrodes will become contaminated with skin oils.

G. Do not store or use in damp environments

H. Always store the PRF-911 with its protective cap in place.

III. Equipment Inspection & Initial Preparation for use

A. PRF-911 Concentric Ring – Equipment and Accessories

1. PRF-911 Concentric Ring with protective cap

Figure 1: PRF-911 with protective cap

OPERATIONAL HINT

The Red Cap over the Concentric Ring Electrodes must be removed prior to making a measurement. The PRF-911 will not operate while the cap is in place. Replace the red cap for protection when not in use.

2. BNC/Dual Banana terminal adapter allowing “plug-in” connection to the PRF-911 BNC connector as follows:

   a. Direct connection to the center INNER RING electrode, designated D_1 (BLACK BNC)

   b. The fixture assembly housing ground is designated as FIXT.GRD on the unit label. When properly used, it helps to reduce the effects of extraneous fields on material measurements (GREEN BNC)

Figure 2: BNC adapter and connection

Figure 3: PTB-920 Dual Test Bed

3. Black banana receptacle in the fixture housing allows direct connection to the **OUTER RING** electrode, designated D_2.

B. Laminated PTB-920 Dual Test Bed

1. The upper Acrylic insulated surface is employed during surface resistance measurements in ac cordance with ANSI/ESD STM11.11.

2. The lower metal surface is equipped with a standard banana receptacle and is employed when making volume resistivity measurements as generally described in ANSI/ESD STM11.12.

C. Inspection of the PRF-911 Concentric Ring Dual Test Bed Fixture

1. Before inspecting the PRF-911 Concentric Ring, confirm the calibration of your resistance instrument. Performing low Resistance Calibration on the Prostat PRS-801 and PRS-812 Resistance Instruments.

   a. Insert Reference Shunt
   b. Select Ohms Mode by pressing "**Mode**" once
   c. Press Test to measure shunt. Indication should be 1.02 Ω ± 0.02 Ω
   d. Press Reset to enter data in memory
   e. Press Reset and Clear within ½ second. The display should indicate **CAL**
   f. Press Reset to adjust instrument to reference shunt
   g. Press Test to confirm 1.02 Ω ± 0.02 Ω

2. Carefully install BNC/Dual Banana adapter on the fixture BNC connector. Note that the connection is a bayonet type.

   a. Position adapter on BNC connector while positioning bayonet studs in the adapter slots

   b. Apply slight pressure and twist clockwise to lock the adapter in-place.

   c. **NOTE:** To remove, apply slight pressure and twist counter clockwise.

Figure 4: Installing the BNC Adapter

3. Remove RED protective cap covering the electrode surfaces

4. Confirming the Fixture Ground and BNC Connection

   a. Place PRF-911 Concentric Ring fixture on a flat surface with the electrodes facing UP.

   b. Plug one PRS-801 or PRS-812 Resistance Meter test lead to the GREEN BNC/Dual Banana adapter receptacles.

   c. Attach an alligator clip to the second PRS-801 or PRS-812 test lead.
   NOTE: TO AVOID DAMAGE, DO NOT ATTACH ALLIGATOR CLIPS TO ANY SURFACE OR PORTION OF THE PRF-911 FIXTURE.

   d. Gently touch the tip of the clip to the metal collar of the BNC adapter where the connection is made to the fixture housing. (*see figure 5*)

   e. Select Ohms Mode by pressing "**Mode**" button once.

      i. Push Test Button

      ii. Resistance Should be < 1 Ω

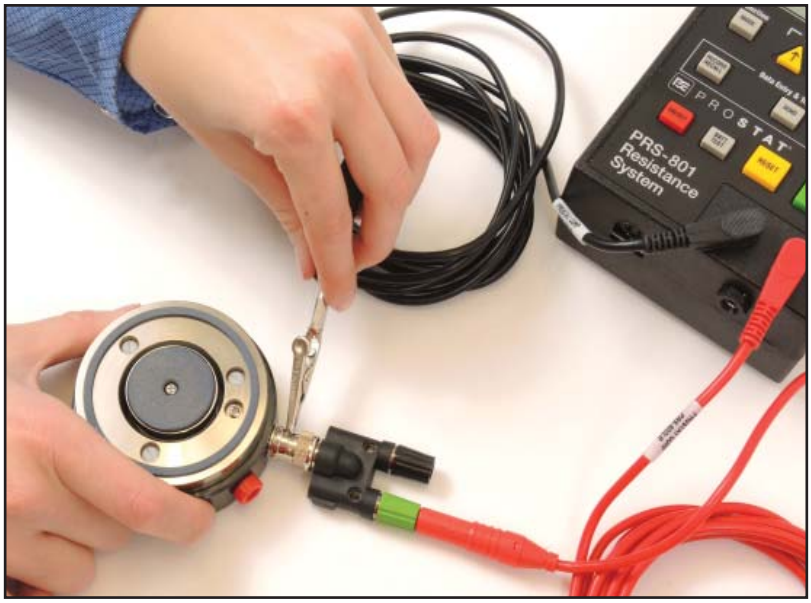

Figure 5: Confirming Fixture Ground & BNC Connection

5. Confirming the Center Electrode

   Use the following procedure to confirm proper connection to the fixture's center electrode (D_1) through the installed BNC/Dual Banana adapter. **NOTE:** Review resistance instrument operating instructions before proceeding:

   a. Place PRF-911 Concentric Ring fixture on a flat surface with the electrodes facing UP.

   b. Plug one PRS-801 or PRS-812 Resistance Instrument test lead the BLACK BNC/Dual Banana adapter receptacle.

c. Attach an alligator clip to the second PRS-801 or PRS-812 test lead.
NOTE: TO AVOID DAMAGE, DO NOT ATTACH ALLIGATOR CLIPS TO ANY SURFACE OR PORTION OF THE PRF-911 FIXTURE.

d. Hold the second PRS-801 or PRS-812 test lead by the insulated collar just behind the alligator clip.

e. GENTLY touch the tip of the alligator clip to the spring loaded center electrode. (*see figure 6*)

f. Select Ohms Mode by pressing the "**Mode**" button once on the PRS-801 or PRS-812 Resistance Instrument.

   i. Push Test Button

   ii. Resistance Should be < 10 Ω

- If proper connection is made to the BNC/Dual Banana adapter the PRS-801 or PRS-812 will indicate low resistance by full meter deflection.

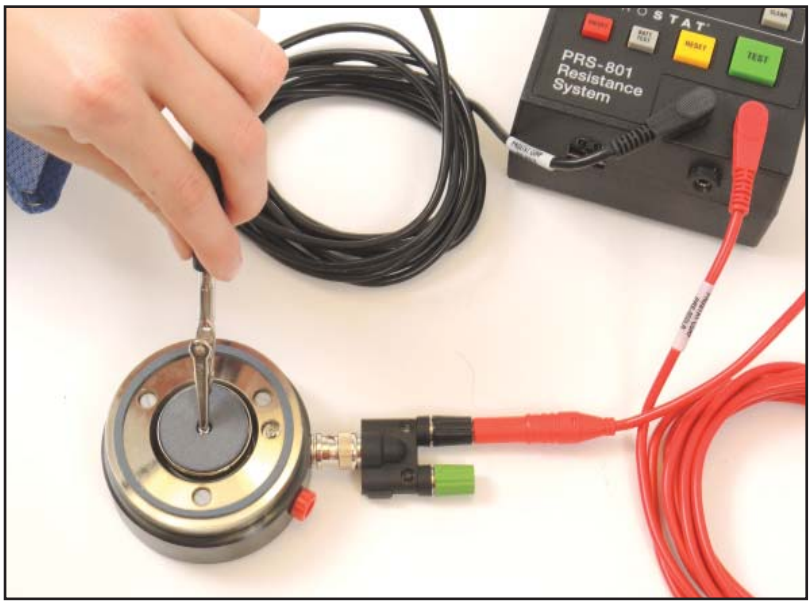

Figure 6: Confirming Center Electrode

- If resistance is high, change the test lead connection to the other BNC/Dual Banana adapter receptacle and repeat the procedure.

- If no continuity indication appears, clean the electrode with 70% solution of IPA, test the PRS-801 or PRS-812 and lead connections per its operating instructions and repeat the procedure. (i.e. Install the supplied shunt and test the low range. Check the cable & connections as well.)

6. Confirming the Outer Electrode

Use the following procedure to confirm proper connection to the fixture's outer ring electrode (D_2) through the frame installed BLACK banana receptacle.
NOTE: Review the resistance instrument's operating instructions before proceeding.

a. Place PRF-911 Concentric Ring fixture on a flat surface with the electrodes facing UP.

b. Plug one PRS-801 or PRS-812 Resistance Meter test lead into the RED OUTER RING banana receptacle located in the side of the fixture frame.

c. Attach an alligator clip to the second PRS-801 or PRS-812 Resistance Instrument test lead. ***NOTE: TO AVOID DAMAGE, DO NOT ATTACH ALLIGATOR CLIPS TO ANY SURFACE OR PORTION OF THE PRF-911 FIXTURE.***

d. Hold the second PRS-801 or PRS-812 test lead by the insulated collar just behind the alligator clip.

e. GENTLY touch the tip of the alligator clip to the narrow outer electrode ring. (*see figure 7*)

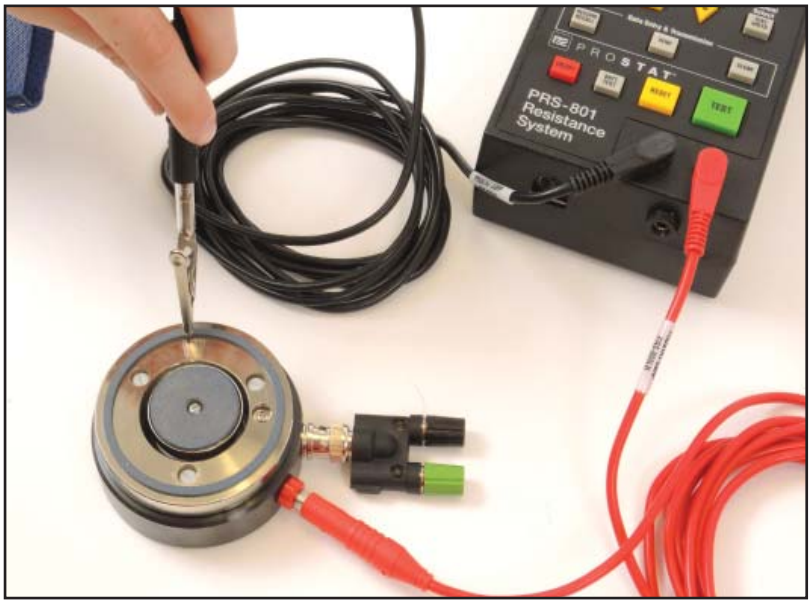

Figure 7: Confirming Outer Electrode

f. Select Ohms Mode by pressing the "**Mode**" button once of the PRS-801 or PRS-812 Resistance Instrument.

i. Push Test Button

ii. Resistance Should be < 10 Ω

- If proper connection is made through the RED receptacle to the outer ring the PRS-801 or PRS-812 will indicate low.

- If no continuity indication appears, clean the electrode with 70% solution of IPA, test the PRS-801 or PRS-812 per its operating instructions and repeat the procedure. (i.e. Install the supplied shunt and test the low range. Check the cable & connections as well.)

CAUTION
Should the electrode continuity check indicate improper connection to the electrodes, do not use the PRF-911 Concentric Ring. Contact Prostat Customer Service Department for further instructions.

7. Confirming Electrode Contact to the Test Bed

   Use the following procedure to confirm positive electrode contact with the PTB-920 Test Bed.

   a. With the BNC/Dual Banana adapter installed, place the PRF-911 fixture on the PTB-920 METAL test surface with the electrodes making contact with the test bed surface.

   b. Connect one PRS-801 or PRS-812 Resistance Meter test lead to the center INNER RING electrode (D_1) BNC adapter receptacle (BLACK)

   c. Connect the second PRS-801 or PRS-812 Resistance Meter test lead to the metal test bed banana receptacle.

   d. Place one five pound NFPA electrode on the PRF-911 fixture housing;

      i. NOTE the compression of the center electrode spring assembly

      ii. Visually confirm that the outer electrode makes direct contact with the metal test bed

Figure 8: Confirming Electrode Contact to Test Bed

e. Select Ohms Mode by pressing the "**Mode**" button once of the PRS-801 or PRS-812 Resistance Instrument.

   i. Push Test Button

   ii. Resistance Should be < 20 Ω

   - If proper connection is made to the BNC/Dual Banana adapter and the center electrode is in contact with the metal test bed, the resistance instrument will indicate low resistance.
   - If proper continuity indication confirms positive contact of the center electrode to the metal plate, proceed with testing the outer electrode continuity, as described in point f.
   - If no continuity indication appears, change the test lead connection to the other BNC/Dual Banana adapter receptacle and repeat the procedure.
   - If no continuity indication appears, clean the electrode surface with 70% solution of IPA, test the PRS-801 or PRS-812 per its operating instructions and repeat the procedure. (i.e. Install the supplied shunt and test the low range. Check the cable & connections as well.)

f. Remove the PRS-801 or PRS-812 test lead from the BNC/Dual Banana adapter and install it in the RED OUTER RING electrode receptacle located on the side of the fixture housing.

Figure 9: Confirming Electrode Contact to Test Bed

g. Select Ohms Mode by pressing "**Mode**" button once.

   i. Push Test Button

   ii. Resistance Should be < 10 Ω

- If proper connection is made through the RED receptacle to the outer ring, and the outer electrode is in contact with the metal test bed, the PRS-801 or PRS-812 will indicate low resistance is < 10 Ω
- If proper continuity indication confirms positive contact of the outer electrode, the fixture check is completed.
- If no continuity indication appears, clean the electrode surface with 70% solution of IPA , test the PRS-801 or PRS-812 per its operating instructions and repeat the procedure. (i.e. Install the supplied shunt and test the low range. Check the cable & connections as well.)

IV. General Operation

A. Surface Resistance Measurement per ANSI/ESD STM11.11. Note that this procedure replaces surface resistivity measurements of electrostatic discharge control materials previously conducted using ASTM D-257. The following procedure is used to measure surface resistance in ohms, and convert it to ohms/square if necessary.

1. Items necessary for this procedure

   a. PRF-911 Concentric Ring Fixture

   b. BNC/Dual Banana Adapter

   c. PTB-920 Dual Test Bed

   d. PRS-801 or PRS-812 Resistance Instrument and test leads

   e. One Prostat PRS-801-W five pound NFPA electrode

   f. One GREEN auxiliary ground reference lead or PRS-801 High Resistance Lead harness if using PRS-801 Instrument. **NOTE:** Connection to instrument ground reference is recommended for measurements of 1.0x10 Ω and higher

   g. Clear worksurface

2. Specimen Preparation for Surface Resistance measurement

   a. This procedure is designed specifically for measuring planar (flat) surfaces having relatively smooth surfaces.

   b. In the laboratory environment, sample preparation usually includes cutting a 3x5 inch specimen of the sample material to be tested. This insures standard specimen size and minimizes fringe voltages that may effect the surface resistance measurement.

   c. In the auditing process, one often must obtain measurement of a large piece of material without cutting sample into a proper size specimen. This type of measurement is considered “indicative”; however, it is sufficient for obtaining a reasonable indication of the material’s surface resistance PROVIDING only one layer of the material is measured as described below.

3. PRF-911 Concentric Ring Fixture Preparation

   a. Install the BNC/Dual Banana adapter on the PRF-911 fixture

   b. Check proper battery level of the PRS-801 or PRS-812 Resistance Instrument and connect the meter leads to the PRF-911 Fixture as follows:

      i. Install the instrument negative (-) lead of the PRS-801 or PRS-812 Resistance Instrument to the BLACK BNC adapter receptacle connected to the center INNER RING electrode (D_1).

      ii. Install the positive (+) lead to the RED receptacle connected to the OUTER RING electrode (D_2).

      iii. To enhance the accuracy of the measurement, connect a GREEN auxiliary ground lead to the BNC adapter fixture ground receptacle, and the other end of the lead to the instrument's ground reference, if so equipped.

   c. Place the PTB-920 Dual Test Bed on a worksurface with the insulated acrylic surface facing UP .

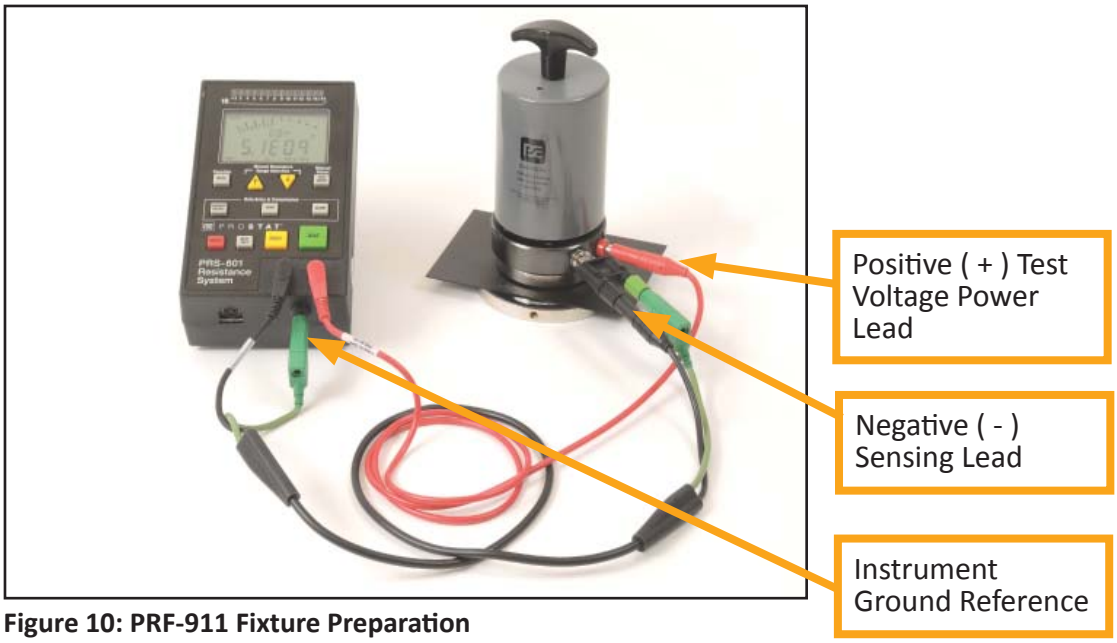

Figure 10: PRF-911 Fixture Preparation

4. To Measure the Material under test

   a. Place the specimen to be tested on the insulated PTB-920 test bed with the surface to be tested facing UP.

   b. Remove the protective cap covering the PRF-911 fixture electrodes and position the fixture on the test material in the approximate center of the test bed.

   c. Place the PRS-801-W 5lb Conductive Rubber Electrode directly on top of the PRF-911 fix ture housing. Note the center electrode spring compression and contact of the outer elec-

trode ring with the material under test.

OPERATIONAL NOTE
The electrode assembly weighs approximately 28 ounces. The center electrode spring counters the fixture weight with approximately 30 ounces when fully extended. When the five pound NFPA electrode is positioned on the fixture housing, both the outer ring and the center electrodes have approximately five pounds total pressure across both surfaces.

d. When operating PRS-801 or PRS-812 Resistance Instruments in Automatic or Automatic/ Manual, simply press the **GREEN TEST** button to initiate the measurement sequence.

The initial test voltage will be less than 10 volts (< 10V), then increase based on the material under test resistance range.

Proper test voltage protocol for resistance measurements of ESD Control materials follows:		
Resistance Range (Ω)	Test Voltage (V)	Remarks
$< 1.0 \times 10^4$	< 10V	Voltage is variable. Electrification 2-5 sec.
1.0×10^4 to $< 1.0 \times 10^6$	10V	Constant Voltage Preferred. Electrification 2-5 sec.
$\geq 1.0 \times 10^6$	100V	Constant Voltage Preferred. Electrification based on system characteristics

i. If the indicated measurement on the PRS-801 or PRS-812 Resistance Instrument is less than 1.0×10^6 Ohms, record the indicated measurement in Ohms after approximately 2 to 5 seconds of electrification.

ii. If the indicated measurement on the Resistance Instrument is greater than 1.0×10^6 Ohms:

- If using the PRS-801 or PRS-812 Resistance Instrument, in Automatic Mode the unit will automatically increase the test voltage to 100 Volts, and control electrification period.

- See instrument operations manual for detailed information on resistance range, test voltage and electrification adjustment details.

5. To estimate Surface Resistivity in Ohms/square when using the ANSI/ESD STM11.11 Surface Resistance Measurement (Ohms), multiply the measurement results by 10. To accomplish this, simply increase the order of magnitude (exponent) by 1.

For example:

a. If the recorded ANSI/ESD STM11.11 Surface Resistance measurement is $2.0x10^5$ Ohms, increase the 10^5 exponent to 10^6 to obtain $2.0x10^6$ Ohms/square.

b. If the recorded ANSI/ESD STM11.11 Surface Resistance measurement is $5.0x10^8$ Ohms, increase the 10^8 exponent to 10^9 to obtain $5.0x10^9$ Ohms/square.

B. Volume Resistance Measurement per ANSI/ESD STM11.12

1. Items necessary for this procedure

a. PRF-911 Concentric Ring Fixture

b. BNC/Dual Banana Adapter

c. PTB-920 Dual Test Bed

d. PRS-801 or PRS-812 Resistance Meter and test leads

e. One PRS-801-W five pound NFPA electrode.

f. One GREEN auxiliary ground lead (*OPTIONAL*)

g. A micrometer to accurately measure the test materials thickness in cm

h. Clear worksurface

2. Specimen Preparation for Volume Resistance measurement

a. This procedure is designed specifically for measuring planar (flat) surfaces having relatively smooth surfaces.

b. In the laboratory environment, sample preparation usually includes cutting a 3x5 inch specimen of the sample material to be tested. This insures standard specimen size and minimizes fringe voltages that may effect the measurement. However, using the outer electrode as a guard ring, these effects are minimized to some degree.

c. In the auditing process, one often must obtain measurement of a large piece of material without cutting sample into a proper size specimen. This type of measurement is considered “indicative”; however, it is sufficient for obtaining a reasonable indication of the material’s volume resistance.

3. PRF-911 Concentric Ring Fixture Preparation

a. Install the BNC/Dual Banana adapter on the PRF-911 fixture

b. Check proper battery level of the Resistance Instrument and connect its leads to the PRF-911 Fixture as follows:

i. Install the negative (-) lead of the PRS-801 or PRS-812 Resistance Instrument to the BLACK BNC adapter receptacle connected to the center electrode.

ii. Install the positive (+) lead of the PRS-801 or PRS-812 Resistance Instrument to the banana receptacle located on the edge of the PTB-920 metal test bed.

iii. Install the GREEN auxiliary ground reference lead to the GREEN BNC receptacle and the other end of the lead to the instrument ground reference.

c. Place the PTB-920 Dual Test Bed on a worksurface with the conductive metal surface facing UP.

Figure 11: Fixture Preparation (Continued from Fig. 10)

4. To Measure the Material under test

a. Place the specimen to be tested on the metal PTB-920 test bed.

b. Remove the PRF-911 fixture electrode protective cap and position the fixture on the test material in the approximate center of the test bed.

c. Place the PRS-801-W five pound NFPA electrode directly on top of the PRF-911 fixture housing. Note the center electrode spring compression and contact of the outer electrode ring with the material under test.

OPERATIONAL NOTE
The electrode assembly weighs approximately 28 ounces. The center electrode spring counters the fixture weight with approximately 30 ounces when fully extended. When the five pound NFPA electrode is positioned on the fixture housing, the outer ring and center electrodes have approximately five pounds total pressure across both surfaces.

d. Select Test while in the Automatic Mode -- be sure no personnel are in contact with the material or PRF-911.

OPERATIONAL WARNING
TO AVOID PERSONNEL SHOCK, DO NOT TOUCH THE MATERIAL UNDER TEST, THE PRF-911 CONCENTRIC FIXTURE OR TEST BED DURING ANY MEASUREMENT CYCLE.

Proper test voltage protocol for resistance measurements of ESD Control materials follows:		
Resistance Range (Ω)	Test Voltage (V)	Remarks
$< 1.0 \times 10^4$	< 10V	Voltage is variable. Electrification 2-5 sec.
1.0×10^4 to $< 1.0 \times 10^6$	10V	Constant Voltage Preferred. Electrification 2-5 sec.
$\geq 1.0 \times 10^6$	100V	Constant Voltage Preferred. Electrification based on system characteristics

i. If the indicated measurement on the PRS-801 or PRS-812 Resistance Instrument is less than 1.0×10^6 Ohms, record the indicated measurement in Ohms after approximately 2 to 5 seconds of electrification.

ii. If the indicated measurement on the Resistance Instrument is greater than 1.0×10^6 Ohms:

- Select 100 Volts on the test instrument if using PRS-801 or PRS-812 Resistance Instruments. They will automatically shift to 100 Volts.
- After instrument's electrification record the indicated measurement in Ohms.

5. To calculate Volume Resistivity in Ohms-cm use the following formula.

$$\text{Volume Resistivity in Ohm-cm} = \frac{6.9\ \text{cm}^2}{t\ \text{cm}} \times R_I\ \text{Ohm}$$

where,

$6.9\ \text{cm}^2$ is the AREA of the center electrode's (D_1) contact surface with the material

t = The thickness of the material in centimeters (cm)
R_I = The Resistance as indicated on the PRS-801 or PRS-812 or the Resistance Instrument of choice in ohms.

V. Maintenance

A. PRF-911 Concentric Ring Fixture

1. The contact electrodes should be cleaned regularly to prevent any accumulation of contaminants. Foreign materials on the faces may cause higher than normal resistance indicaton.

    a. Clean electrodes with a solution of 70% isopropyl alcohol (IPA) and water using a low linting wipe.

    b. Allow surfaces dry for a minimum of 15 minutes before making measurements.

2. Functional testing of the equipment is conducted using the procedures described in Section III. EQUIPMENT INSPECTION & INITIAL PREPARATION FOR USE.

3. Periodically tighten the BNC connection locking nut located on the PRF-911 fixture housing.

4. Calibration of the contact surfaces requires surface dressing and a calibration fixture described in ANSI/ESD STM11.11.

CALIBRATION WARNING
Calibration of the PRF-911 electrode surfaces should be conducted by experienced personnel equipped with the proper fixtures to avoid permanent damage to the fixture. Contact Customer Service for information concerning this service.

B. PTB-920 Dual Surface Test Bed

1. The test bed surfaces should be cleaned regularly to prevent any accumulation of contaminants. Foreign materials on the faces may cause higher than normal resistance indicaton.

    a. Clean surfaces with solution of 70% IPA & water using a low linting wipe.

    b. Allow surfaces dry for a minimum of 15 minutes before making measurements.

2. Periodically inspect the metal test bed receptacle free of foreign particles.

3. There are no other user serviceable parts on the Dual Test Bed.

C. BNC/Dual Banana Adapter

Should the adapter become damaged, discard and replace. Replacement parts are available online at www.esdcheck.com.

PRF-911 Concentric Ring Specifications

Dimensions:	Inner electrode disc (D_1) outside diameter: 1.2 inches (3.05cm) --Spring Loaded counter pressure approximately 2 ounces greater than fixture weight. Outer electrode ring (D_2) inside diameter: 2.25 inches (5.72 cm) Width 0.125 inches (0.32 cm)
Alignment:	$5.0x10^5$ +/- 1% Ohms @ 10 volts per ANSI/ESD STM11.11, Section 8.0
Volume Resistivity Correction:	6.9 cm^2 Total D_1 Contact Area. Allows for D1 mounting screw head.
Fixture Weight:	Approximately 28oz (0.79 kg) without BNC/Banana adapter or connections.
Connections:	Fixture installed BNC for Inner Disc (D_1) connection, and fixture assembly ground; dual BNC/Banana plug adapter supplied. Fixture installed standard banana receptacle for Outer Ring (D_2) connection.
Dual Test Bed:	Diameter: 4.0 inches (10.16 cm). Lamination of ⅛ inch acrylic plastic and ⅜ inch stainless steel, or plated aluminum.
Power:	Not Applicable. The fixture and test bed are used in conjunction with the Prostat PRS-801 or PRS-812 Resistance Instrument and test leads.
Warranty:	PROSTAT Limited One Year

NOTES

NOTES

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