ESD check
BY PROSTAT

Surface Resistance/Resistivity Indicator

ESI-870

Operations Manual

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ESD Check® ESI-870 RESISTANCE/RESISTIVITY INDICATOR

Before using this, or any other electronic piece of equipment, carefully read the instruction manual completely.

I. Before Using the Instrument

Examine the instrument for damage, contamination (excessive dirt, grease, etc.) and defects. If any abnormal conditions exist, do not attempt to make any measurements.

II. Safety

A. The following safety information must be observed to insure maximum personal safety during the operation of this meter.

1. DO NOT use the meter if the meter looks damaged, or if you suspect the meter is not operating properly.

2. DO NOT touch the Brass Electrode Bars while operating this meter.

III. Description

The ESI-870 is an LED indicating, wide range resistance measurement instrument with broad application flexibility. It measures surface resistance in accordance with ESD Association STM11.11, surface resistivity in accordance with ASTM D-257, resistance to ground, and resistance point to point. This instrument gives simple, repeatable measurements to indicate whether a material is conductive, static dissipative or insulative. The ESI-870 employs parallel bar sensing and features an easy to read LED light scale. The instrument may be used to measure a wide variety of ESD materials, products and equipment.

A. Functions

The ESI-870 is designed to perform several functions accurately and conveniently.

1. Measures Surface Resistivity of Packaging materials in Ohms/Square per Electronic Industries Association Packaging Standard EIA-541, in accordance with test methods described in ASTM D-257.

2. Performs correlated measurements of Surface Resistance of Packaging Materials in Ohms per ESD Association Standard ANSI/ESD STM11.11.

3. Makes general Point to Point Resistance and Resistance to Ground measurements of Floors, Chairs, Carts, Worksurfaces, and other ESD Controlled materials and products.

B. Controls & Electrodes

1. The ESI-870 has one active control, a green "Press to Test" button on the front panel of the instrument. This button performs two functions:

   a. It turns the instrument ON, activating the test circuit and LED's.

   b. It applies test voltage to the electrode(s) and auxiliary connections.

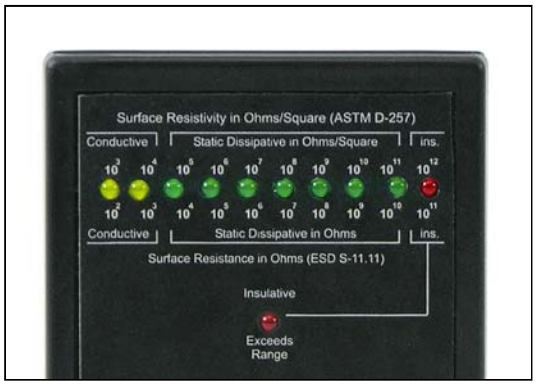
C. Indication & Resistance/Resistivity Scales

1. Eleven (11) LED's provide Resistance and Resistivity measurement indication in one decade increments. (See Figure 1, below.)

   a. Ten (10) LED's represent resistance or resistivity measurements.

   b. One (1) LED is used to indicate when the measurement exceeds normal testing range, and the range of the ESI-870.

2. The row of 10 LED's is labeled with two scales. Both scales are designed for packaging materials measurement in accordance with EIA-541 and ESD Association standards, and correlate to ASTM D-257 and ANSI/ESD STM11.11 measurement procedures.



   a. The **Upper Scale** is labeled for *Surface Resistivity measurements in Ohms/Square per ASTM D-257*. While the ESI-870 measurements are in keeping with ASTM D-257 bladed fixture procedures, these measurements also *correlate* directly to ASTM D-257 measurements made with a precision concentric ring fixture.

   b. The **Lower Scale** is labeled for *Surface Resistance measurements in Ohms per* ANSI/ESD STM11.11 *standard*. The ESI-870 measurements *correlate* directly to ANSI/ESD STM11.11 measurements made with its defined, precision concentric ring fixture. The ESI-870 does not reproduce the ANSI/ESD STM11.11 procedure; it correlates to ANSI/ESD STM11.11 data.

IV. Accuracy

A. While the ESI-870 has an automatic resistance range feature, its accuracy is dependent upon the following factors.

1. For Surface Resistance/Resistivity measurements, the material under test should be placed on an "insulated" surface for best accuracy.

2. The instrument must be fully positioned on the material being measured and the electrode switch must be switched “ON”.

3. The instrument should be steadied by your fingers so that the full length of each electrode is making even contact with the material under test.

4. Slight pressure must be applied when pressing the test button.

B. The design of the ESI-870 is based on automatic ranging across reference resistors to provide simple indication of a material's resistance/resistivity.

1. The two machined brass Electrodes form a single "Square" for resistivity measurements.

2. Overall Accuracy of the unit is ±10%.

3. The decade Changeover Point from one decade to another is based on measured resistance; ±1/2 decade on logarithmic scale (i.e., 3.16 x 10n)

4. The accuracy of the Changeover Point is ±1/2 decade.

5. Instrument Resolution: is one order of magnitude.

V. Battery Installation & General Maintenance

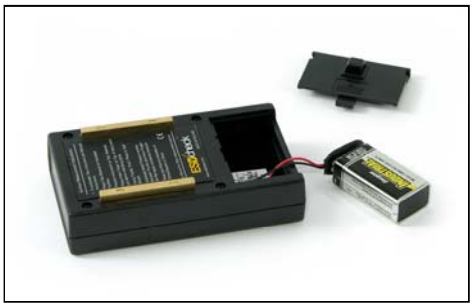
A. Battery Installation

1. Power is supplied by a standard 9 volt battery. One battery will provide approximately 40 hours of continuous operation.

2. Replace the battery whenever the unit will not perform an "Initial Operational Check", described below, or when the unit has not been used for several weeks or months.

3. To replace the battery, remove the battery cover on the back of the instrument by applying pressure to the grid area marked with an arrow, and sliding the panel towards the bottom end of the case.

4. Carefully disconnect the instrument battery power connector from the battery and discard the old battery in manner appropriate for your locale.



5. Connect a fresh battery to the instrument battery power connector and insert the new battery into the case. Take care to position the battery connector wires to allow the battery cover to close easily.

6. Replace the battery cover on the back of the meter by positioning it in the guide grooves and sliding it forward carefully. Use the thumb of one hand to maintain downward pressure on the cover and to keep it aligned. At the same time, use the thumb of your other hand to apply pressure to the end of the battery cover and slide it into its locked position.

   a. Do not over force the cover closed. It should snap into its locked position with firm, yet relatively gentle pressure.

   b. If the cover does not easily lock closed, remove the cover and battery. Reinsert it to obtain a better fit. Be sure connector wires are positioned not to obstruct the battery compartment cover.

7. The ESI-870 is now ready for testing and use.

B. Initial Operational Check

Once the battery is installed in the ESI-870, check its initial function as follows. Note that this procedure should be conducted each time the instrument is used, and whenever the instrument's performance or battery function are in question.

1. Place the instrument, with electrodes down, on a clean metal surface such as the PTB-915 Test Bed. Measure the resistance of the plate using the "ESI-870 Operation Procedures" described below, i.e., Push the "Press to Test" button and observe LED indication.

   a. The Yellow LED located at left end of the scale should light, indicating a very "conductive" material measurement.

   b. Proceed to Step 2, below.

   c. If the lowest decade LED (10^3 UPPER Scale and 10^2 LOWER Scale) does not light, the unit is not functioning properly, or the battery is dead.

2. Place the instrument, with electrodes down, on a clean plastic insulating surface such as the white BOTTOM surface of the PTB-915 Test Bed. Measure the resistance of the plastic sheet using the "ESI-870 Operation Procedures" described below, i.e., Push the "Press to Test" button and observe LED indication.

   a. The Red LED located at right end of the scale should light briefly, then the Red center panel "Insulative -- Exceeds ESI-870 Range" LED should light. This indicates a very high resistance "Insulative" material measurement.

   b. This completes the "Initial Operational Check"

   c. If the highest decade LED "Insulative -- Exceeds ESI-870 Range" does not light, the unit is not functioning properly, or the battery is dead.

B. Cleaning

1. Periodically clean the electrodes and the instrument case area between them with a soft, non-abrasive cloth, and a solution of 70% alcohol and water.

2. Wipe the surface with a soft cloth moistened with clean alcohol and allow to dry thoroughly.

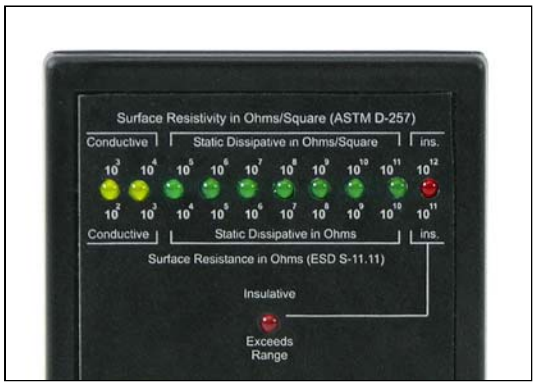
3. Dust off any lint.

VI. Reading the ESI-870 Scale

The ESI-870 resistance measurement function features automatic ranging. It is designed to provide four (4) kinds of measurements that may be read on two different resistance/resistivity scales.

A. UPPER Scale Resistance Measurement Functions

The UPPER scale is used in three (3) measurement applications: Surface Resistivity in Ohms/Square per ASTM D-257, Resistance to Ground (Rtg)



using the front panel Auxiliary Connection, and Resistance Point to Point (Rtt) when using the two Resistance Reference Auxiliary Connections located on the top end of the instrument.

1. When the ESI-870 is used to measure Surface Resistivity of a Packaging Material in Ohms/Square per ASTM D-257, the bottom two brass electrodes are firmly placed against the material, and ESI-870 actuated.

    a. The resistance between the two electrodes is displayed on the LED's and approximate surface resistivity in Ohms/Square is read from the UPPER scale, above the LED's.

    b. The color indication and scale notes describe the material's approximate Static Control Classification in accordance with Electronic Industries Association Packaging Standard, EIA-541, as follows:

        (1) The Yellow LED lights indicate the material is in the "Conductive" range, i.e., less than $1.0x10^5$ Ohms/square.

        (2) The Green LED lights indicate the material is in the "Static Dissipative" range, i.e., greater than $1.0x10^5$ to less than $1.0x10^{12}$ Ohms/square.

        (3) The Red LED lights indicate the material is "Insulative", or greater than $1.0x10^{12}$ Ohms/square, and possibly greater than the range of the ESI-870.

    c. Note that when the instrument is used for Packaging Material Surface Resistivity in Ohms/square as described above, the *equivalent* Surface Resistance in accordance with ANSI/ESD STM11.11 Standard is described on the LOWER Scale. See "Surface Resistance in Ohms per ANSI/ESD STM11.11: The LOWER Scale Resistance Measurement Function" below, for further information.

2. When the ESI-870 is used to measure Resistance of a Surface to Ground (Rtg) Ohms, the front panel "Auxiliary Connection -- Resistance to Ground" connection is used with the provided six foot lead/phone plug accessory.

    a. The ESI-870 is placed on the surface to be measured to ground.

b. The phono plug of the six foot lead is inserted in the front panel "Auxiliary Connection".

c. The opposite end of the lead is connected to an ESD Ground reference, and the ESI-870 is then actuated.

d. The resistance **in Ohms** between one electrode on the test material's surface and the ground point is displayed on the UPPER scale, above the LED's.

Note: The UPPER Scale unit of measure in this Rtg measurement mode is **Ohms**, *not Ohms/square.*

e. The color indication and scale notes may, *or may not* describe the material's Static Control Classification, depending on the material being measured and the standard reference being used.

3. When the ESI-870 is used to measure Resistance between two points, i.e., Resistance Point to Point (Rtt) in Ohms, the two "Resistance Reference Inputs & Auxiliary Connections" located at the top end of the unit are used with additional test leads.

a. The additional test leads are inserted in the Auxiliary Connection receptacles that are designed for standard banana plugs.

b. The opposite ends of the test leads are connected to the object to be measured, i.e., equipment points, test fixture, electrodes, etc.

c. The electrode switch is moved to the “ELECTRODES OFF” position.

d. The ESI-870 is hand held, be careful not to touch the brass electrodes, then the unit is actuated.

Important Note: If the brass electrodes are active when these two Auxiliary Connections are used and body or material contact is made with the brass electrodes during this measurement mode, the indicated reading may be affected.

e. The resistance **in Ohms** between the two lead connection points is displayed on the UPPER scale, above the LED's.

Note: The UPPER Scale unit of measure in this Rtt measurement mode is **Ohms**, *not Ohms/square.*

f. The color indication and scale notes may, *or may not* describe the material's Static Control Classification, depending on the material or equipment being measured and the standard reference being used.

B. Surface Resistance in Ohms per ANSI/ESD STM11.11: The LOWER Scale Resistance Measurement Function

The LOWER scale is used in one (1) measurement application: Surface Resistance of Packaging Materials in Ohms per ANSI/ESD STM11.11 Standard test method. Note that the ESI-870 **does not duplicate the** ANSI/ESD STM11.11 **measurement** procedure. However, the measurement results correlate closely with the S-11.11 data when compared under typical laboratory conditions.

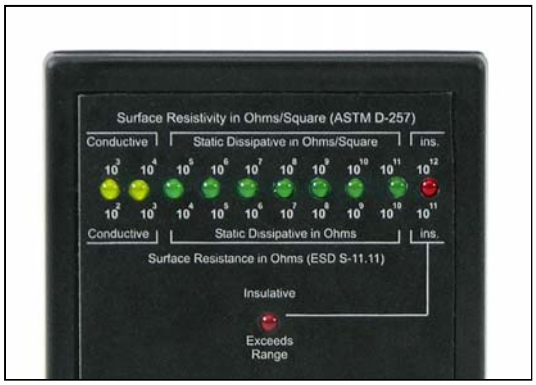
1. When the ESI-870 is used to measure Surface Resistance of a Packaging Material in Ohms per ANSI/ESD STM11.11, the bottom two brass electrodes are firmly placed against the material, and ESI-870 actuated.

2. The resistance between the two electrodes are displayed on the LED's and approximate surface resistance in Ohms per ANSI/ESD STM11.11 is read from the LOWER scale, below the LED's.

3. The color indication and scale notes describe the material's approximate Static Control Classification in accordance with Electronic Industries Association Packaging Standard, EIA-541, as modified for ANSI/ESD STM11.11 measurements.

a. The Yellow LED lights indicate the material is in the "Conductive" range, i.e., less than $1.0x10^4$ Ohms.

b. The Green LED lights indicate the material is in the "Static Dissipative" range, i.e., greater than $1.0x10^4$ to less than $1.0x10^{11}$ Ohms.



c. The Red LED lights indicate the material is "Insulative", or greater than $1.0x10^{11}$ Ohms, and possibly greater than the range of the ESI-870.

4. Note that when the instrument is used for Packaging Material Surface in Ohms as described above, the *equivalent* Surface Resistivity in accordance with ASTM D-257 in Ohms/Square is described on the UPPER Scale.

VII. ESI-870 Operation Procedures

Before each use, the ESI-870 should be tested using the Initial Operational Check, previously described and reviewed below. However, one should practice the "Basic Procedure for Making Surface Resistance/Resistivity Measurements" to become familiar -- and comfortable -- with the instrument before testing and use.

A. Basic Procedure for Making Surface Resistance/Resistivity Measurements

1. Place the material to be measured on an "insulative" surface, such as the PTB-915 Test Bed. This test configuration offers the best accuracy.

   a. This prevents incorporating a conductive test bed in the measurement circuit.

   b. If a conductive test bed is used, you may obtain a measurement indication that is *lower* than the actual material resistance.

2. Place the ESI-870 on the surface to be measured, electrodes down against the test material. Make sure the electrode switch is in the “ELECTRODES ON” position.

   Be careful not to place the instrument on blemished, bent or wrinkled areas as this will affect the quality of your measurements.

3. Place your index finger at the top edge of the instrument, above the UPPER scale notes.

4. Place your thumb directly on the Green "Press to Test" button.

5. Balance the weight of your hand between the thumb and index finger and press down slightly on the unit while pushing the "Press to Test" button.

a. Do not apply excessive pressure

b. Positioning your fingers in this manner will allow you to steady the instrument and insure that the electrodes make full contact with the material.

c. A measurement error of up to one order of magnitude may occur if full contact **is not made** between the brass electrodes and the material under test.

The ESI-870 will measure "high" in this situation because full parallel resistance between the brass electrodes will not exist.

d. You will notice the LED's will light as they automatically range to a final measurement

6. Continue applying steady pressure until one (1) LED remains on, indicating a stable measurement. (Approximately 5 seconds)

7. Read the LED indication from either the UPPER or LOWER scale.

a. If using Surface Resistivity in Ohms/square per ASTM D-257 as your measurement criteria, read the UPPER scale.

b. If using Surface Resistance in Ohms per ESD Association ANSI/ESD STM11.11 as your measurement criteria, read the LOWER scale.

B. Initial Operational Check: A Review

Prior to using the ESI-870 for test measurements always perform the Initial Operational Check, as follows. This procedure assumes that a fresh battery of good quality has been properly installed in the instrument.

1. Place the instrument, with electrodes down, on a clean metal surface such as the PFP-861 Foot Plate and measure its resistance as described above.

a. The Yellow LED located at left end of the scale should light, indicating a very "conductive" material measurement.

b. Proceed to Step 2, below.

c. If the lowest decade LED (10^3 UPPER Scale and 10^2 LOWER Scale) does not light, the unit is not functioning properly, or the battery is dead.

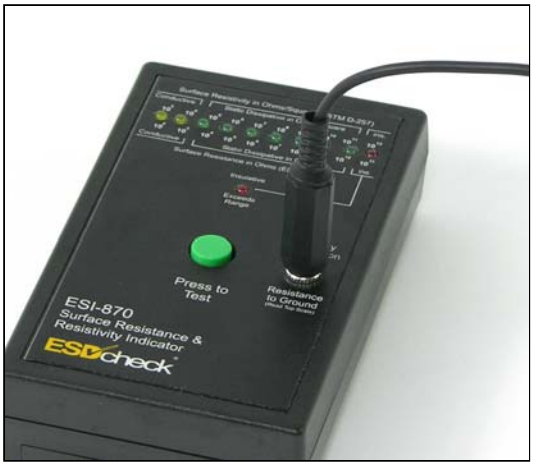
2. Place the instrument, with electrodes down, on a clean plastic insulating surface such as the white BOTTOM surface of the PFP-861 Foot Plate, and measure its resistance as described above.

a. The Red LED located at right end of the scale should light briefly, then the Red center panel "Insulative -- Exceeds ESI-870 Range" LED should light. This indicates a very high resistance "Insulative" material measurement.

b. This completes the "Initial Operational Check"

c. If the highest decade LED "Insulative -- Exceeds ESI-870 Range" does not light, the unit isn't functioning properly, the battery is dead.

C. Resistance to Ground (Rtg) Measurement Procedure



1. Insert the black lead 3.5mm phone jack into the front panel "Auxiliary Connection -- Resistance to Ground"

   Note: By inserting the lead into the auxiliary connection, you have disabled one of the ESI-870's brass electrodes

2. Connect the opposite end of the black lead to a defined ESD Ground point. Use the accessory alligator clip if necessary.

3. Place the ESI-870 on the material to be measured

4. Place your index finger at the top edge of the instrument, above the UPPER scale notes.

5. Place your thumb directly on the Green "Press to Test" button.

6. Balance the weight of your hand between the thumb and index finger and press down slightly on the unit while pushing the "Press to Test" button.

   a. Do not apply excessive pressure

   b. Positioning your fingers in this manner will allow you to steady the instrument while insuring that the operational electrode is making full contact with the material being measured.

   c. You will notice the LED's will light as they automatically range to a final measurement

7. Continue applying steady pressure until one (1) LED remains on, indicating a stable measurement. (Approximately 5 seconds)

8. Read the LED indication in Ohms from the UPPER scale.

D. Resistance Point to Point (Rtt) Measurement Procedure

When the ESI-870 is used to measure Resistance between two points, i.e., Resistance Point to Point (Rtt) in Ohms, the two "Resistance Reference Inputs &

Auxiliary Connections" located at the top end of the unit are used with additional test leads.

1. Insert two banana plug equipped leads into the "Resistance Reference Inputs & Auxiliary Connections" and place the electrode switch to the “ELECTRODES OFF” position.

2. The opposite ends of the test leads are connected to the object to be measured, i.e., equipment points, test fixture, electrodes, etc.

3. The ESI-870 is hand held, being careful not to touch the brass electrodes, then push the "Press to Test" button.

    a. **Important Note:** If you do not enable the “ELECTRODES OFF” switch, the brass electrodes are active when these two Auxiliary Connections are used. If body or material contact is made with the brass electrodes during this measurement mode, the indicated reading may be affected.

    b. You will notice the LED's will light as they automatically range to a final measurement

    c. Continue pushing the "Press to Test" button until one (1) LED remains on, indicating a stable measurement. (about 5 seconds)

4. The resistance **in Ohms** between the two lead connection points is read from the UPPER scale, above the LED's.

    Note: The UPPER Scale unit of measure in this Rtt measurement mode is **Ohms**, *<u>not</u> Ohms/square.*

E. Other Resistance Measurements Using the ESI-870

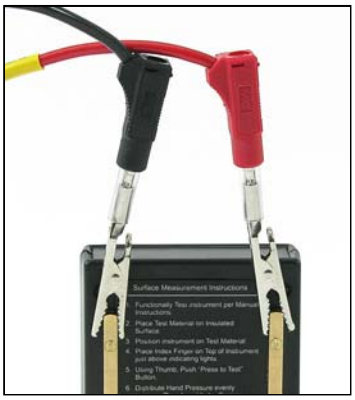
As a basic resistance instrument, the ESI-870 can be used for general resistance measurements of virtually any ESD Controlled product or material. To increase its flexibility, one may employ fixtures, NFPA electrodes, extended leads, clips or clamps for evaluating the following items.

Floors, Mats, Worksurfaces, Chairs, Carts, Body Resistance, Tapes, Conveyors, Footwear, Assembly Equipment, Garments, Tools, Raw Materials, Production Aids, Tote Boxes, Packaging Materials, and others.

VIII. Functionally Testing the ESI-870

A. The ESI-870 has no internal parts to adjust, so verification of calibration can be achievedusing the following process.

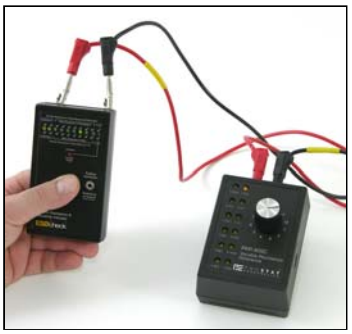
If verification cannot be achieved, the unit should be returned to the supplier.



B. Using the Resistance reference inputs & Auxiliary connections at the end of the unit, insert one lead into each input jack and place the electrode switch to the "ELECTRODES OFF" position.

C. Insert the opposite ends of the leads into a Resistance Reference such as the PRO**STAT**® PAR-809C Variable Resistance Reference

1. The range of the resistance reference required is from >1.0x10^3 to 1.0x10^{10} Ohms.



2. Measurements greater than 10^{10} are calculated using cad generated techniques, as high resistance's greater than 10^{10} are difficult to verify with a test voltage of 9 volts.

D. Once the leads are inserted, set the resistance reference to the desired resistance, i.e. 10^3

1. Press and hold the ESI-870's "Press to Test" button

Important Note: If you do not enable the "ELECTRODES OFF" switch, the brass electrodes are active when these two Auxiliary Connections are used. If body or material contact is made with the brass electrodes during this measurement mode, the indicated reading may be affected.

2. The 10^3 LED (as read on the top scale) should light

3. Repeat this process using all of the ranges possible with the resistance reference

E. To measure the changeover point between decades:

1. Gradually increase the resistance of the resistance reference while pressing the test button

2. Record the resistance when the next LED lights and holds in a stable manner. This is the changeover resistance.

   Example: The first LED (10^3) is illuminated. At 4,000 Ohms the 10^4 LED is illuminated. The changeover point is 4.0×10^3 Ohms.

ESI-870 Resistance/Resistivity Indicator

Test Voltage & Current:	Nominal 9 volts and 0.006 µA to 1.0 mA.
Power:	One (1) standard 9-volt battery, PROCELL, Eveready #216 (NEDA 1604, JIS 006P, IEC 6F22)
Electrodes:	2 each Machined Brass, One (1) Square Resistivity configuration
Overall Accuracy:	± 10%
Changeover Point:	Based on measured resistance; ± 1/2 decade on logarithmic scale (i.e., 3.16 x 10n)
Changeover Point Accuracy:	± ½ decade
LED Measurement Indications:	11 LED's with Dual scales: 10^3 to 10^{12} Ohms/square per ASTM 257 in one decade increments 10^2 to 10^{11} Ohms per S-11.11 in one decade increments Over range indicator light for "**Insulative**" surfaces, i.e., $>10^{12}$ Ohms/square or $>10^{11}$ Ohms.
Auxiliary Connections:	2 ea. Female Banana for Resistance Range Performance Verification and Direct Point to Point Resistance measurements without electrodes. 1 ea. Point to Ground Phono Receptacle for resistance measurements using one electrode
Operation Control:	One (1) PUSH to TEST Button
Operating Range:	40^oF to 120^oF (5^oC to 49^oC)
Storage Temp:	-15^oC to $+60^oC$
Relative Humidity:	0% to 90%
Battery Life:	40 hours typical
Dimensions:	115 mm x 69 mm x 26 mm
Weight:	6 oz.

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