# Surface Resistance Test Kit Operation and Maintenance

Made in the United States ofAmerica


*Figure 1. Desco 19780 Surface Resistance Test Kit*

## Description

The Surface Resistance Test Kit is a portable, accurate, and versatile instrument designed to measure resistance point-to-point (Rtt), surface to ground (Rtg), and surface resistivity in accordance with ESD Association Standard ANSI/ESD S4.1 including:

- Resistance measuring accuracy ± 10% (E11 & greater ±20%)
- Resistance range <1.0 x 10E3 ohms to >10E12 ohms
- Under load voltages of 10 and 100 volts ± 5%
- Electrification period of 15 seconds
- Electrodes (two) 5 pounds ± 2 oz with 50-70 durometer conductive pads

In addition, the Meter measures ambient temperature and relative humidity.

The Surface Resistance Test Kit (or its Meter) is referenced and designed to be used to make measurements in accordance with the test methods in:

- Worksurfaces - ANSI/ESD S4.1 Worksurfaces Compliance Verification - ESD TR53 - Resistance Measurements
- Floors - ANSI/ESD S7.1- Resistive Characterization of Materials Floor Materials
- Footwear - ESD S9.2 - Footwear - Resistive Characterization
- Garments - ANSI/ESD STM2.1 Garments
- Seating - ANSI/ESD STM12.1- Seating - Resistive Measurement
- Floor/Footwear - ANSI/ESD STM97.1 - Floor Materials and Footwear- Resistance Measurement in Combination with a Person
- Workstations - ESD-ADV53.1 - ESD Protective Workstations

## Versatility:

Measures Rtt, Rtg or Resistivity (requires optional Resistivity Attachment, EMIT item 50560)

- **Quick Checks** - Surface resistance exponent number illuminates immediately i.e. 8 = 10E8 ohms or 100,000,000 ohms
- **Compliance Verification** - Surface resistance exponent number illuminates immediately and displays Temperature and Relative Humidity during 15 second electrification period making numerous measurements and calculations to then display mantissa i.e. if LED displays 8 and LCD displaying 7.14 as mantissa = 7.14 x 10E8 ohms or 714,000,000 ohms
- **Test Lab Evaluation of Product** - Display same as Compliance Verification above

The Surface Resistance Test Kit is NIST calibrated and items available are:

| Model | Description | Power |
|---|---|---|
| 19780 | Surface Resistance Test Kit | 2 x AA Batteries |
| 19781 | Meter & Attachment | 2 x AA Batteries |
| 50560 | Resistivity Attachment | N/A |

Desco 19780 includes two 5 pound electrodes (item 50003) and Test Leads (item 19783) which also can be bought separately.

## Inspection

Remove the meter from the carton and inspect for damage. Each Surface Resistance Test Kit should include the following:

1 Protective carrying case
1 Meter
2 Test leads
2 5 pound electrodes
2 AA alkaline batteries
1 Gator clip
1 Certificate of Calibration

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## ESD control items should be tested:

A. Prior to installation to qualify for listing in user's ESD control plan approved ESD control items
B. During initial installation
C. For periodic checks of installed products as part of ESD control plan compliance verification plan

"A Compliance Verification Plan shall be established to ensure the Organization's fulfillment of the technical requirements of the ESD Control Program Plan. Process monitoring (measurements) shall be conducted in accordance with a Compliance Verification Plan that identifies the technical requirements to be verified, the measurement limits and the frequency at which those verifications shall occur. The Compliance Verification Plan shall document the test methods and equipment used for process monitoring and measurements. If the test methods used by the Organization differ from any of the standards referenced in this document, then there must be a tailoring statement that is documented as part of the ESD Control Program Plan. Compliance verification records shall be established and maintained to provide evidence of conformity to the technical requirements.

The test equipment selected shall be capable of making the measurements defined in the Compliance Verification Plan." (ANSI/ESD S20.20-2007 section 7.3)

## Electrification Period

The Surface Resistance Test Kit provides the proper electrification period of 15 seconds per ANSI/ESD S4.1, after numerous readings and calculations are executed, then displays surface resistance mantissa measurement (Note: most analog type meters display measurements instantaneously).

When the Test Button is depressed, the liquid crystal display (LCD) will indicate:

- Temperature in degrees Fahrenheit (tolerance ±5°F, typical)
- Temperature in degrees Celsius (tolerance ±3°C, typical)
- Humidity as percentage (from 5% - 95% tolerance, ±10 digits)
- Surface resistance mantissa (with exponent displayed via LED, measurement in ohms)

Measurement being displayed is identified by the illuminated function LED. The surface resistance exponent (or power of number) is immediately illuminated and remains illuminated measuring the range the surface resistance in ohms.

## Reference Literature

In addition to those noted above:
ANSI/ESD S20.20 - Development of ESD Control Program
ESD ADV1.0 - Glossary of Terms
ANSI/ESD S6.1 Grounding

These documents can be obtained directly from the ESD Association, 7902 Turin Rd., Suite 4, Rome, NY 13440-2069, (315) 339-6937 or www.esda.org.

Other standards are available from the agencies who produce them. MIL-HDBK 263A, EIA-IS-5-A, ASTM-F-150, EN 100015, and EIA-625. If you need help in obtaining these documents, please contact our customer service department.

## Features

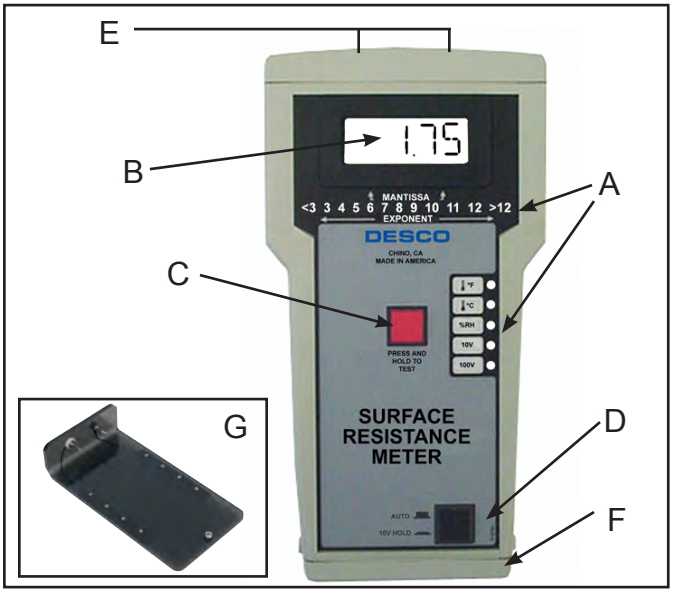


*Figure 2. Features of the Surface Resistance Meter*

**A. LED Displays:** Surface resistance exponent is displayed via light emitting diodes illuminating 1/8" high number. There are 12 LEDs displaying surface resistance exponent measurement. They are color coded for quick checks:

| Exponent | Color |
|---|---|
| <3, 3 | Red |
| 4, 5 | Green |
| 6, 7, 8 | Blue |
| 9, 10, 11 | Green |
| 12, >12 | Yellow |

Five Function LED's identify the measurement being displayed (see B below).

- When battery voltage drops to approximately 2 volts, the Function LED's to the right of the red test button will begin to flash, indicating the need to replace batteries.

**B. Display:** Mantissa is displayed via 9/16" high liquid crystal display and provides easy to read resistance (or resistivity) measurements.

When the Test Button is depressed, the LCD will indicate:

- Temperature in degrees Fahrenheit
- Temperature in degrees Celsius
- Relative Humidity as percentage
- Surface resistance mantissa (with exponent displayed via LED, measurement in ohms)

Surface resistance ohm values are expressed with a mantissa and exponent or power of the number. For example, if "8" is illuminated by its LED and the LCD displays a mantissa of "7.14", the measurement is 7.14 x 10E8 ohms or 714,000,000 ohms

If surface is over 10E12 ohms, the following will appear:
- "1____" on the LCD display indicate Overrange or that the reading exceeds the display capabilities

**C. Test Button:** This red button activates electrical power to the Meter. The exponent or power of the measurement is displayed immediately with LED illuminating number. If "8" is illuminated, the measurement is in the $10^8$ or 10E8 ohm range. To make a measurement in accordance with ANSI/ESD S4.1, the button is to be depressed for 10-20 seconds for the unit to make numerous readings and calculations. (Testing in accordance with ANSI/ESD S4.1-1997 requires 15 seconds of electrification; in contrast, most analog type meters display measurements instantaneously.) The LCD will display temperature (F), then temperature (C), then relative humidity, and then the surface resistance mantissa.

During the entire period, if the measurement is stable, the surface resistance exponent will be displayed by LED illuminating number.

**D. Override Test Range Voltage Button:** When in the "up" position, the Meter will automatically switch to the correct voltage for the resistance range. LED will illuminate noting selected voltage. Material 10E5 ohms or less should be measured at 10 volts. Material 10E6 or greater ohms should be tested at 100 volts. The button is a switch, which if depressed will override the automatic voltage selection and test will be performed at 10 volts regardless of resistance level.

**E. Jacks:** One end of Test Leads has 3.5mm plug (fits Meter left jack). The 3.5mm plug is shielded (identified by insulated tip and barrel black lead) - see Rtg test procedure: Per ANSI/ESD S4.1 "The sensing lead of the resistance meter shall be connected to groundable point." One end of Test Lead has a standard banana plug (fits 5# Electrode jack).

**F. AA Battery Compartment.**

**G. Resistivity Parallel Attachment with Electrodes.** (optional Item number 50560)

## Cleaning

Per ANSI/ESD S4.1 "Clean the electrodes with a minimum 70% isopropanol-water solution." Make sure the 5 pound electrodes' conductive pads are dry prior to use.

See specific product test standard for test lab specimen cleaning instructions. Per ANSI/ESD S4.1 Worksurfaces "The test specimens and electrodes shall be cleaned twice with a minimum 70% isopropanol-water solution using a clean, low-linting cloth each time." (Note: then conditioned for 72 hours, minimum).

For compliance verification testing, do not clean surfaces. However, if any measurements lie outside acceptable range, then clean the material's surface and re-test.

NOTE: For worksurfaces, use Desco Item# 10435 Reztore™ Antistatic Surface and Mat Cleaner or other silicone-free ESD cleaner. Be sure the surface is dry before testing.

**Periodic maintenance** - The area surrounding the cable jacks at the top end of the meter should be wiped with a clean cloth moistened with alcohol to remove skin oils that will accumulate and affect the accuracy at high resistances. The frequency of cleaning will depend on usage; once a month would be a good starting point. Other items that should also be cleaned in this fashion are the cable jackets and the resistivity attachment.

## Power Requirements

The Meter is powered by two replaceable alkaline AA batteries.

## Battery Replacement

Depress buttons on both sides of bottom end cap of meter housing. Remove exterior cap. The batteries are located under the raised, black, rectangular cap. Insert small probe or screwdriver into slot and pry cap up. Carefully replace batteries with alkaline Type AA. Polarity must be correct or damage may occur. Close battery door and re-install bottom end cap on meter housing.

## Test Procedure
## General Guidelines:

- Use both 5 pound electrodes for Rtt
- Use one 5 pound electrode and one lead to groundable point for Rtg (note: groundable points are usually snaps installed on the material or workstation common point ground)
- Use optional Resistivity Attachment (removing leads & electrodes) for Resistivity measurements
- Ensure that item being measured is electrically isolated (i.e. placed on an insulative surface) as Meter will measure lowest resistance path
- Ensure that test leads are separated as a best practice
- When using 5 pound electrodes:
  - Place no closer than 2" from edge of surface being measured
  - Place no closer than 3" to any groundable point
  - Place 5 pound electrodes about 10" apart for Rtt of worksurface and 3' for floor
  - Preferred placements include: most commonly used surface portion, most worn, center, and furthest from groundable point.
  - For Rtg, connect the sensing lead with shielded plug to groundable point
- If surface has sections (like floor tiles or garment panels), for Rtt place a 5 pound electrodes on different sections
- Clean material's surface for Test Lab, but do not initially clean surface for installed products (clean and retest if failure occurs).

## Test Lab Test Procedure Guideline

For test lab use of ESD Worksurfaces, Floor Materials, Footwear, Garments, or Seating, best advice is to follow test methods in applicable ESD Association documents (see above) which include details such as:

- Cleaning (For example per S4.1, “The test specimens and electrodes shall be cleaned twice with a minimum 70% isopropanol-water solution using a clean, low-linting cloth each time). Allow to dry.
- Environmental chamber (For example per S4.1, control relative humidity to 12 ±3% RH and 50 ±5% RH and temperature to 23 ±1 degrees C)
- Specimen support surface (For example per S4.1, greater than 1.0 x 10E12 ohms such as PMMA, PTFE or polycarbonate)
- Specimen Pre-Conditioning (For example per S4.1, at 23 ±1 degrees C; 3 specimens at 12 ±3% relative humidity for up to 72 hours minimum, and 3 specimens at 50 ±5% relative humidity for up to 72 hours minimum)
- Reporting Test Results, for example per S4.1 Reporting Test Results, Report:
- Minimum, median and maximum readings for both resistance-to-groundable point and point-to-point resistance in ohms at low relative humidity
- Minimum, median and maximum readings for both resistance-to-groundable point and point-to-point resistance in ohms at moderate relative humidity
- Temperature
- Relative humidity
- Actual duration of conditioning
- Test equipment used

## Compliance Verification Test Procedure Guideline

The ESD Association lists test procedures and troubleshooting tips in Compliance Verification ESD TR53.

## Measure Rtg Resistance to Ground

Test Procedure in accordance with ANSI/ESD S4.1 section 6.4 Periodic Worksurface Testing:

- Do not clean the surface
- Remove from the surface only those items that might interfere with the test.
- ESD sensitive devices shall also be removed
- Clip the sensing test lead with shielded plug to groundable point connected to ground
- Use one 5# Electrode on other test lead and place Electrode the farthest convenient point on the surface
- Press button and hold Test Button until measurement is displayed
- Perform additional measurements placing Electrode on the most commonly used or most worn area

If measurement is outside acceptable limits, clean surface and retest to determine if cause of failure is insulative dirt layer or the ESD worksurface material. Note: Use an ESD cleaner containing no insulative silicone (i.e. Reztore™ Antistatic Surface and Mat Cleaner).

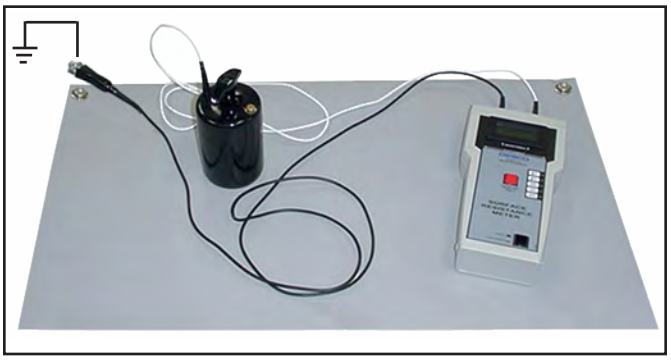

*Figure 3. Setting up for RTG testing.*

## Measure Resistance Point-to-Point (Rtt) on the Surface

- Do not clean the surface
- Remove from the surface only those items that might interfere with the test.
- ESD sensitive devices shall also be removed
- Use two 5 opund electrodes, place in the most commonly used portion of the surface about 10” apart (2” from any edge, 3" from any groundable point)
- Press button and hold Test Button until measurement is displayed
- If the most used portion is not obvious, use two points near the center of the surface

If measurement is outside acceptable limits, clean surface & retest to determine if cause of failure is insulative dirt layer or the ESD protective product. Note: Use an ESD cleaner containing no insulative silicone (i.e. Reztore™ Antistatic Surface and Mat Cleaner)

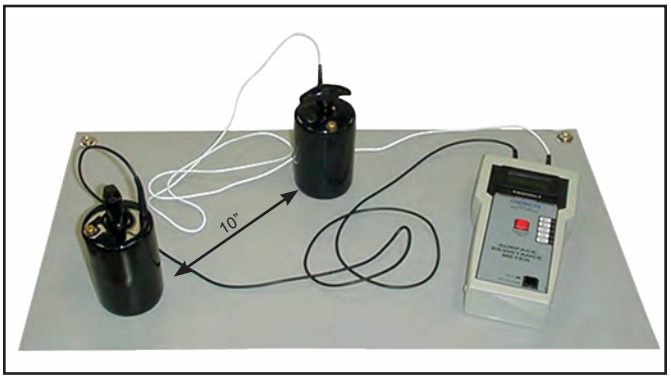


*Figure 4. Setting up for Rtt testing.*

## Reporting and Using Test Results

Different standards have different requirements; follow requirements as specified in the user’s ESD control plan. Examples are:

**Per ANSI/ESD 4.1 (worksurfaces), Report:**

- Rtg maximum and minimum values measured for resistance-to-ground in ohms
- Rtt maximum and minimum values measured for point-to-point resistance in ohms

**Per ANSI/ESD 7.1 (Floors) Report:**
- Rtg all values in ohms for resistance-to-ground
- Rtt all values in ohms for point-to-point resistance
- Voltage level
- Test date
- Temperature
- Relative humidity
- Test equipment used

Summarize test data by reporting minimum, maximum, median, and mean values obtained. Include a diagram showing approximate electrode positions and ground connections used.

## Recommended Frequency of Periodic Checks of Installed Products

Note: "The frequency of periodic testing is normally specified in corporate operating procedures. …The frequency of testing is driven by the amount of risk exposure that can occur between tests. For, example, what is the quantity of product handled between test periods?" (See ESD Handbook ESD TR20.20) However, a common guide would be:

- **Worksurface** - at least quarterly (see ESD TR20.20 section 5.3.1.13 Periodic Tests)
- **Footwear** - "Incoming inspection on a lot sampling basis should be performed for all static control footwear." (see ESD TR20.20 section 5.3.3.4 Testing)
- **Floor** - "The types of monitoring and type of equipment are considerations. In some cases, a simple electrical resistance test with a megohmmeter may suffice. In others, a static charge generation test may be required." (see ESD TR20.20 section 5.3.4.13 Performance Monitoring)
- **Seating** - "The recommended electrical resistance range for seating is less than 1 x 10E9 ohms as tested in accordance with ANSI/ESD STM 12.1. This value should be during acceptance testing, installation and periodically thereafter." (see ESD TR20.20 section 5.3.5.3 Testing)
- **Garments** - "To maintain process control, it is imperative that the garment be tested per ANSI/ESD STM 2.1. The point-to-point and sleeve-to-sleeve resistance test should be made." (see ESD TR20.20 section 5.3.13.3.1.8 Periodic Testing)

## Surface Resistivity

Theoretically Resistivity is 10 times greater than Resistance, i.e. a material that measures 10E7 ohms surface resistance, Surface Resistivity should measure 10E8 ohms/square.*

Ref: ANSI/ESD S11.11 section 12.0 Conversion to Resistivity states, "When it is appropriate to convert a resistance obtained by this test method to an equivalent resistivity in ohms per square, multiply the resistance measurements obtained by this method by 10. The conversion factor of 10 is derived from the geometry of the electrode assembly."

No conversion is required with the Surface Resistance Test Kit. The Meter incorporates provision to install an optional Resistivity Attachment which has parallel electrodes on bottom of the unit to make direct surface resistivity measurements. These parallel electrodes allow for measurement of resistivity or when quick checks without the use of 5 pound electrodes is desired.

*Note: Although S11.11-1993 uses ohms/square, per ESD TR20.20, the correct unit of measure for resistivity is just ohms.

**Battery Life:** Approximately 1,500 measurements

Resistivity Electrodes: Two parallel conductive silicone rubber electrodes (optional item)

**External Electrodes:** Two 5 pound (±2 oz) weighted electrodes, 2.5" in diameter, complies with ANSI/ESD S4.1

**Display:** One 3.5 digit .500" Liquid Crystal Display (LCD) Display and seventeen Light Emitting Diodes (LED's) illuminate exponent numbers function being performed.

***Accuracy:** Resistance measurements within ±10% (E11 & greater ±20%), complies with ANSI/ESD-S4.1. Under load voltages of 10 volts ± 5% and 100 volts ± 5% exceeds requirements of ANSI/ESD-S4.1

**Meter Weight:** 15.5 oz.

**Dimensions:** 8"L x 4.3"W x 1.6"H

Test Button: Press the red test button for 15-20 second electrification period. Meter will immediately display surface resistance exponent via LED. LCD will display temperature (both Fahrenheit & Celsius), then humidity, and after taking numerous readings and making numerous calculations display surface resistance mantissa.

Note: Reporting test results, you may want to record the resistance, humidity, temperature, and test voltage.

## Maintenance

Your Surface Resistance Test Kit will require little maintenance, and there are no user serviceable parts. If your Meter requires service beyond cleaning the Electrodes or replacing the batteries, please contact the factory.

This product utilizes a high frequency switching circuit to step up the 3 volts from the batteries to the 100 volt test level. Some users are able to discern a slight hum or buzzing. This is perfectly normal and is not considered a flaw or defect.

## *Testing / Verification

The Surface Resistance Test Kit is calibrated to NIST traceable standards. Most users require calibration annually. Please call our Customer Service Department at 909-627-8178 (Chino, CA) or 781-821-8370 (Canton, MA) for details. In-house calibration can be performed by using 1% resistors in each of the meter ranges. Simply attach the resistors to the test leads using clips and recording the meter display. Keep the test leads separated. Should adjustment be necessary, it is recommended that the unit be returned to the factory as access to internal adjustments requires special equipment.

## Testing / Verification (cont.)

### EQUIPMENT:

- Digital Multimeter - accurate to 1.25% @ 10VDC and 100VDC
- Fixed Decade Box value 10E3 - 10E12 - accurate to ±2.5%, except at 10E11 and 10E12 (±5%)
- Thermometer - accurate to ±1°F
- Humidity meter - accurate to 2%
- Test leads
- 99% Isopropyl alcohol and cleaning wipes

### SET UP:

**A .Test Area** - Area needs to be free of any high voltage transformer or power supply. Not under any type of fluorescent lighting or high power lighting.

**B. Worksurface** - needs to be covered with conductive mat at 1.0 x 10E3 or less, connected to equipment ground.

**C. Technician** - needs to be grounded with zero ohms resistor to equipment ground.

**D. Decade Box** - needs to be grounded to earth ground.

*Accuracy is measured after normalizing the instrument at 70-80 °F and 30-50% RH for a minimum of 4 hours.

### NORMALIZATION OF METER

Temperature inside testing area needs to be 75°F @ ±6.6% 40% to 60% RH. Meters need to stay at constant temperature 75°F @ ±6.6% for about 2 hours for proper reading. Meters cannot be inside objects, enclosed boxes, containers or cases unit is supplied with (temperature inside case will differ from outside temperature, cases will act like an insulator to the Meters), Meters will have to be stationary in testing area for about 2 hours with no significant temperature changes.

### TESTING OF SURFACE RESISTANCE METER

- When testing use only the leads supplied with the Meter. DO NOT TEST WITH RESISITIVITY ATTACHMENT, Resitivity Attachment will give a much higher reading and is only designed for periodic checks.
- With 10V/AUTO switch down, press Test Button - voltage between the two leads should be 10V ±5%
- With 10V/AUTO switch up, press Test Button - voltage between the two leads should be 100V ±5%
- Using the cleaning wipes and 99% isopropyl, clean around banana jack and mono jack where leads connects to, oil from human fingers can alter accuracy.
- Make sure 10V/AUTO switch is set to AUTO (switch up). Testing each decade starting from 1.0 x 10E12 and down, never start from 1.0 x 10E3.

| | | |
|---|---|---|
| Temperature | Fahrenheit | = 75°F ±6.6% |
| | Celsius | = 23.8°C ±10.2% |

Relativity Humidity ±10 Digits

**A. 1.0 x 10E12**

| | | |
|---|---|---|
| + 20% | LED = 12 Yellow | Mantissa 1.20 |
| 0% | LED = 12 Yellow | Mantissa 1.00 |
| - 20% | LED = 11 Yellow | Mantissa 8.00 |

**B. 1.0 x 10E11**

| | | |
|---|---|---|
| +20% | LED = 11 Yellow | Mantissa 1.20 |
| 0% | LED = 11 Yellow | Mantissa 1.00 |
| -20% | LED = 10 Green | Mantissa 8.00 |

**C. 1.0 x 10E10**

| | | |
|---|---|---|
| +10% | LED = 10 Green | Mantissa 1.10 |
| 0% | LED = 10 Green | Mantissa 1.00 |
| -10% | LED = 9 Green | Mantissa 9.00 |

**D. 1.0 x 10E9**

| | | |
|---|---|---|
| +10% | LED = 9 Green | Mantissa 1.10 |
| 0% | LED = 9 Green | Mantissa 1.00 |
| -10% | LED = 8 Blue | Mantissa 9.00 |

**E. 1.0 x 10E8**

| | | |
|---|---|---|
| +10% | LED = 8 Blue | Mantissa 1.10 |
| 0% | LED = 8 Blue | Mantissa 1.00 |
| -10% | LED = 7 Blue | Mantissa 9.00 |

**F. 1.0 x 10E7**

| | | |
|---|---|---|
| +10% | LED = 7 Blue | Mantissa 1.10 |
| 0% | LED = 7 Blue | Mantissa 1.00 |
| -10% | LED = 6 Blue | Mantissa 9.00 |

**G. 1.0 x 10E6**

| | | |
|---|---|---|
| +10% | LED = 6 Blue | Mantissa 1.10 |
| 0% | LED = 6 Blue | Mantissa 1.00 |
| -10% | LED = 5 Green | Mantissa 9.00 |

**H. 1.0 x 10E5**

| | | |
|---|---|---|
| +10% | LED = 5 Green | Mantissa 1.10 |
| 0% | LED = 5 Green | Mantissa 1.00 |
| -10% | LED = 4 Green | Mantissa 9.00 |

**I. 1.0 x 10E4**

| | | |
|---|---|---|
| +10% | LED = 4 Green | Mantissa 1.10 |
| 0% | LED = 4 Green | Mantissa 1.00 |
| -10% | LED = 3 Red | Mantissa 9.00 |

**J. 1.0 x 10E3**

| | | |
|---|---|---|
| +10% | LED = 3 Red | Mantissa 1.10 |
| 0% | LED = 3 Red | Mantissa 1.00 |
| -10% | LED = <3 Red | Mantissa <0.90 |

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## Specifications

**Ranges:** 1 x 10E3 - 1 x 10E12 ohms @ 10 Volts complies with ANSI/ESD S4.1.

1 x 10E6 - 1 x 10E12 ohms @ 100 Volts complies with ANSI/ESD S4.1.

**Power Supply:** Two AA alkaline batteries

**Limited Warranty**
Desco expressly warrants that for a period of one (1) year from the date of purchase, Desco Surface Resistance Test Kits will be free of defects in material (parts) and workmanship (labor). Within the warranty period, the product will be tested, repaired, or replaced at Desco's option, free of charge. Call our Customer Service Department at 909-627-8178 (Chino, CA) or 781- 821-8370 (Canton, MA) for a Return Material Authorization (RMA) and proper shipping instructions and address. Include a copy of your original packing slip, invoice, or other proof of purchase date. Any unit under warranty should be shipped prepaid to the Desco factory. Warranty repairs will take approximately two weeks.

If your unit is out of warranty call Customer Service at 909-627-8178 (Chino, CA) or 781-821-8370 (Canton, MA) for a Return Material Authorization (RMA) and proper shipping instructions and address. Desco will quote repair charges necessary to bring your unit up to factory standards.

**Warranty Exclusions**
THE FOREGOING EXPRESS WARRANTY IS MADE IN LIEU OF ALL OTHER PRODUCT WARRANTIES, EXPRESSED AND IMPLIED, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH ARE SPECIFICALLY DISCLAIMED. The express warranty will not apply to defects or damage due to accidents, neglect, misuse, alterations, operator error, or failure to properly maintain, clean or repair products.

**Limit of Liability**
In no event will Desco or any seller be responsible or liable for any injury, loss or damage, direct or consequential, arising out of the use of or the inability to use the product. Before using, users shall determine the suitability of the product for their intended use, and users assume all risk and liability whatsoever in connection therewith.

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