Digital Surface Resistance Meter Kit Installation, Operation and Maintenance

Made in the United States of America

Figure 1. Desco Digital Surface Resistance Meter Kit

Description

The Desco 19787 Digital Surface Resistance Meter Kit is an instrument designed to measure resistance point-to-point (Rtt) or surface to ground (Rtg) in accordance with ESD Association Standard ANSI/ESD S4.1.

Its test funcitions include:

- Resistance measurement accuracy of ±10% (±20% for resistance values 1 x 10^{11} and greater)
- Resistance range of <1 x 10^{3} ohms to >1 x 10^{12} ohms
- Under load voltages of 10 and 100 volts ±5%
- Electrification period of approximately 15 seconds

The Digital Surface Resistance Meter also measures ambient temperature and relative humidity.

The Digital Surface Resistance Meter Kit and its accessories are available in the following item numbers:

Item	Description
19787	Digital Surface Resistance Meter Kit
19788	Digital Surface Resistance Meter
19783	Shielded Test Leads
50003	Five Pound Electrodes, 1 Pair
50004	Replacement T-Handles for Electrodes, 1 Pair
50005	Concentric Ring Probe

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

- Compliance Verification - ESD TR53 - Resistance Measurements
- Worksurfaces - ANSI/ESD S4.1 Worksurfaces
- Floors - ANSI/ESD S7.1- Resistive Characterization of Materials Floor Materials
  - Foot Grounders - ESD SP9.2 - Foot Grounders 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

"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 section 7.3)

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.

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Packaging

19787 Digital Surface Resistance Meter Kit

1 Digital Surface Resistance Meter
2 Shielded Test Leads, 5' Length
2 Five Pound Electrodes
2 AA Alkaline Batteries
1 Gator Clip
1 Plastic Carrying Case
1 Certificate of Calibration

Figure 2. Desco 19787 Digital Surface Resistance Meter Kit

19788 Digital Surface Resistance Meter

1 Digital Surface Resistance Meter
2 AA Alkaline Batteries
1 Certificate of Calibration

Figure 3. Desco 19788 Digital Surface Resistance Meter

Features and Components

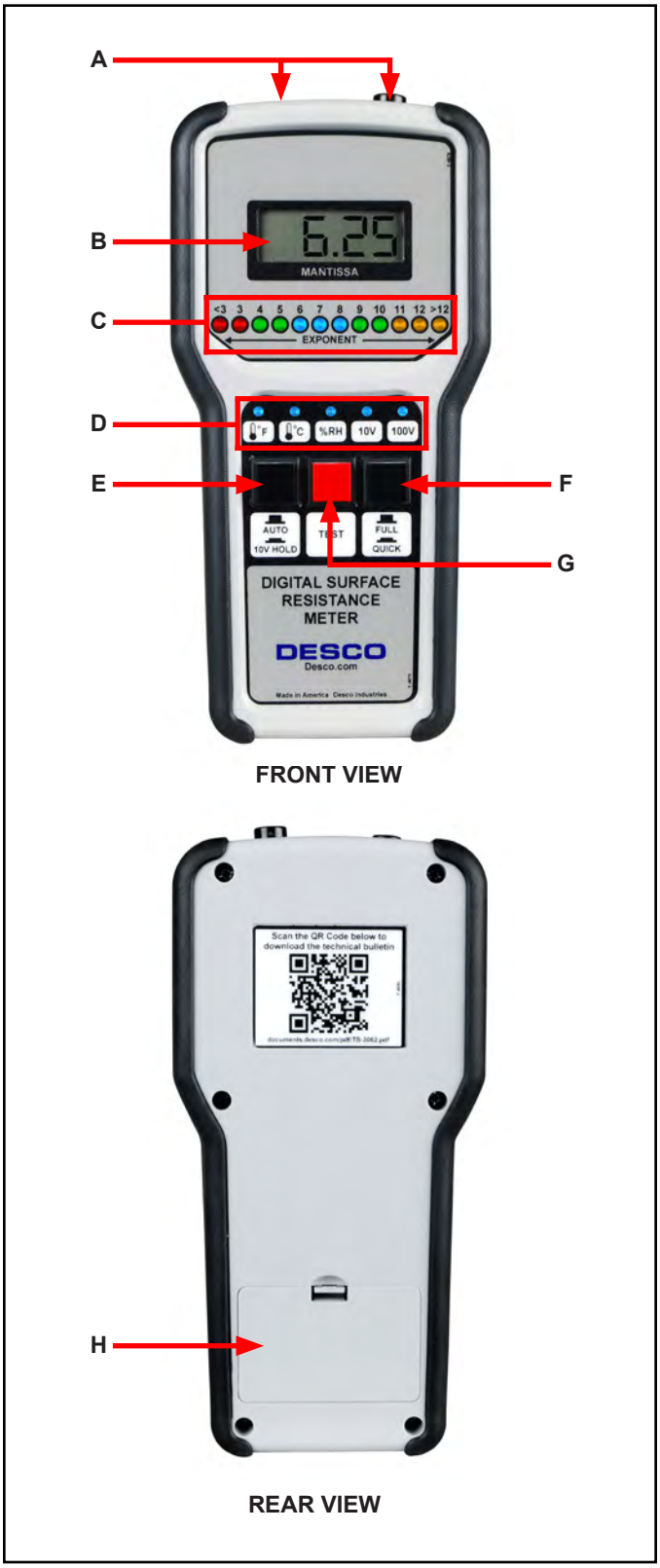

Figure 4. Digital Surface Resistance Meter features and components

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A. Test Jacks: The shielded test leads connect here. The black test lead's 3.5mm plug connects into the stereo jack, and the white test lead's banana plug connects into the banana jack.

B. Display: Temperature, Relative Humidity and Surface Resistance Mantissa values appear on this display.

When the test button is depressed and the meter is set to FULL test mode, the following information will display in sequence:

- Temperature in degrees Fahrenheit (±10%)
- Temperature in degrees Celsius (±10%)
- Relative Humidity as a percentage (±10 integers)
- Surface Resistance Mantissa (with exponent displayed via LED, measurement in ohms)

Surface resistance ohm values are expressed with a mantissa and exponent (power) of the number. For example, if the #8 exponent LED illuminates and the meter displays "7.14", the measurement is 7.14 x 10^8 ohms or 714,000,000 ohms.

If the measured surface resistance is over 10^{12} ohms, "1___" will appear on the display.

C. Exponent LEDs: These LEDs indicate the surface resistance exponent value. They are color coded for quick checks.

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

Quick Checks
The surface resistance exponent number illuminates immediately (i.e. 8 = 10^8 ohms or 100,000,000 ohms).

D. Function LEDs: These LEDs indicate the measurement type indicated on the display. The surface resistance mantissa is displayed when either the "10V" or "100V" LED is illuminated.

These LEDs will flash when the battery voltage drops to approximately 2 volts. Replace the batteries when this occurs.

E. Test Voltage Button: When set to AUTO, the meter will automatically switch to the appropriate test voltage for the measured resistance range. The Function LEDs will indicate the applied test voltage. Material that is 9 x 10^5 ohms or less should be measured at 10 volts. Material that is 1 x 10^6 ohms or greater should be tested at 100 volts. When the switch is set to 10V HOLD, the test voltage will be fixed at 10 volts regardless of the measured resistance value.

F. Quick Check Button: When set to FULL, the meter will cycle through the 15 second period that displays the temperature and relative humidity before the surface resistance mantissa is displayed. When set to QUICK, the meter will skip the 15 second period and immediately display the measured surface resistance mantissa.

G. Test Button: Push and hold this button to make a measurement with the meter. Testing in accordance with ANSI/ESD S4.1 requires 15 seconds of electrification. These 15 seconds are included when the meter is set to FULL test mode. The surface resistance mantissa will display on the meter after temperature and relative humidity measurements are displayed.

The surface resistance exponent number illuminates immediately, and the meter first displays the temperature and relative humidity during a 15 second electrification period. The mantissa is then displayed at the end of the test sequence. For example, if the #8 exponent LED illuminates and the meter displays "7.14", the measurement is 7.14 x 10^8 ohms or 714,000,000 ohms.

H. Battery Compartment: Open this compartment to install the two AA alkaline batteries needed to power the meter. Replace the batteries once the Function LEDs begin flash.

Operation

General Guidelines

- Use both 5 pound electrodes for Rtt measurements.
- Use one 5 pound electrode and connect the black test lead to ground for Rtg measurements.
- Ensure that the item being measured is electrically isolated (placed on an insulative surface). The meter will measure the lowest resistance path.
- Ensure that the test leads are separated and uncrossed as a best practice.
- When using 5 pound electrodes:
  - Place them no closer than 2" from the edge of the surface being measured
  - Place them no closer than 3" to any groundable point
  - Place them about 10" apart from each other for Rtt measurements of a worksurface
  - Place them about 3' apart from each other for Rtt measurement of a floor
- Preferable electrode placements include:
  - Most commonly used area of a surface
  - Most worn area
  - Center of surface
  - Furthest area from a grounded point
- If the surface to be measured has sections (i.e. floor tiles, garment panels), place the 5 pound electrodes on different sections for Rtt measurements.
- Clean the material's surface for Test Lab measurements, but do not clean the surface for materials that are already installed. Only clean and re-test the installed material if failure occurs.

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- Push and hold the Test Button until the surface resistance mantissa is displayed.

Measure Resistance to Ground (Rtg)
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 black test lead to a grounded point.
- Use one 5 pound electrode on the other test lead and place the electrode on the furthest convenient point on the surface.
- Push and hold the Test Button until the surface resistance mantissa is displayed.
- Perform additional measurements by placing the electrode on the most commonly used or worn area. Set the meter to QUICK test mode to skip the 15 second period if preferred.

If the measurement is outside acceptable limits, clean the surface with an ESD cleaner containing no insulative silicone such as Reztore™ Antistatic Surface & Mat Cleaner, and re-test to determine if the cause of failure is an insulative dirt layer or the ESD worksurface material.

Figure 5. Rtg test setup

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 pound electrodes and place them on the most commonly used area of the surface. Ensure that the electrodes are about 10" apart from each other and 2" away from any edge and 3" away from any grounded point.
- Push and hold the Test Button until the surface resistance mantissa is displayed.
- If the most used area is not obvious, use two points near the center of the surface.
- Perform additional measurements by placing the electrode on the most commonly used or worn area. Set the meter to QUICK test mode to skip the 15 second period if preferred.

If the measurement is outside acceptable limits, clean the surface with an ESD cleaner containing no insulative silicone such as Reztore™ Antistatic Surface & Mat Cleaner, and re-test to determine if the cause of failure is an insulative dirt layer or the ESD worksurface material.

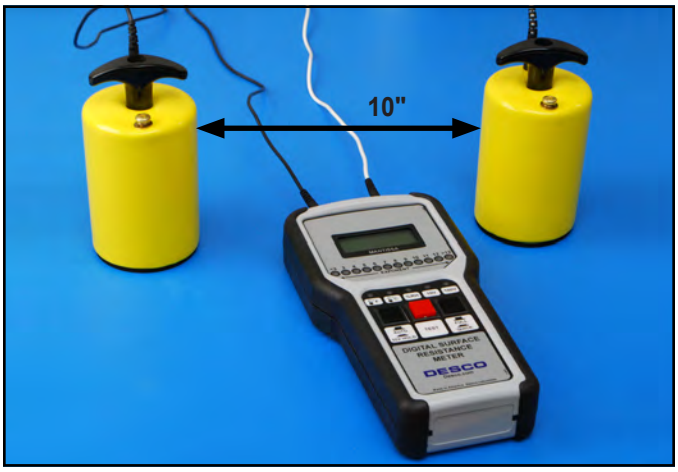

Figure 6. Rtt test setup - set the electrodes about 10" apart for worksurfaces and about 36" apart for flooring

Reporting and Using Test Results
Different standards have different requirements; however, follow the 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 and latest calibration date

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

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Frequency of Compliance Verification Testing
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)

Per ANNEX A of Compliance Verification ESD TR53 "Test Frequency, The objective of the periodic test procedures listed in this document is to identify if significant changes in ESD equipment and materials performance have occurred over time. Test frequency limits are not listed in this document, as each user will need to develop their own set of test frequencies based on the critical nature of those ESD sensitive items handled and the risk of failure for the ESD protective equipment and materials."

Addition information includes:

- **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 10^9 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.

For example, a material that measures 10^7 ohms in surface resistance should measure 10^8 ohms/square in surface resistivity.*

Ref: ANSI/ESD STM11.11 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."

*Note: Although STM11.11 uses ohms/square, per ESD TR20.20, the correct unit of measure for resistivity is just ohms.

Product Qualification Test Lab Test Procedure Guideline
For test lab use of ESD Worksurfaces, Floor Materials, Footwear, Garments or Seating, the best advice is to follow the test methods in applicable ESD Association documents 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 the material to dry.
- Environmental chamber (For example per S4.1, control relative humidity to 12 ±3% relative humidity and 50 ±5% relative humidity and temperature to 23 ±1°C)
- Specimen support surface (For example per S4.1, greater than 1 x 10^{12} ohms such as PMMA, PTFE or polycarbonate)
- Specimen Pre-Conditioning (For example per S4.1, at 23 ±1°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 and latest calibration date

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Desco 50005 Concentric Ring Probe

Figure 7. Desco 50005 Concentric Ring Probe

The Desco 50005 Concentric Ring Probe is an instrument to be used in conjunction with a resistance meter, such as the Desco 19787 Digital Surface Resistance Meter, to measure surface resistance per ANSI/ESD STM11.11 the test method listed in Packaging standard ANSI/ESD S541 for surface resistance of planar materials.

The Concentric Ring Probe (Ref: ANSI/ESD STM11.12) can measure the volume resistance of planar materials using a flat conductive metal plate (not included).

The Concentric Ring Probe may be used for the resistance measurements of ESD packaging including static shielding and other bags.

See TB-3063 for more information.

Maintenance

The Digital Surface Resistance Meter requires little maintenance. 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 when the meter is powered. This is perfectly normal and is not considered a flaw or defect.

Battery Replacement
The Function LEDs located above the push buttons will flash when the battery voltage drops to approximately 2 volts. This indicates that the meter's batteries should be replaced. Open the compartment located on the back of the meter to replace the batteries. The meter uses two AA alkaline batteries. Ensure that the batteries' polarities are oriented in the correct fashion to avoid any possible circuit damage.

Cleaning the Digital Surface Resistance Meter
The area surrounding the cable jacks at the top end of the meter should be wiped with a clean, isopropanol-alcohol moistened cloth to remove skin oils that will accumulate and affect the meter's accuracy at high resistances. The frequency of cleaning will depend on usage. Desco recommends cleaning this area once a month. Cable jackets should also be cleaned in this fashion.

Cleaning the Five Pound Electrodes
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 standards 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: The item should then be conditioned for 72 hours minimum)

Calibration

The Digital Surface Resistance Meter is calibrated to NIST traceable standards. Most users require calibration annually which is our recomendation. Please e-mail Service@Desco.com 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 record the meter's display. Keep the test leads uncrossed and separated from one another. Should adjustment be necessary, Desco recommends to return the unit to the factory. Special equipment is required to adjust the meter.

Required Equipment
- Digital Multimeter: accurate to 1.25% @ 10VDC and 100VDC
- Fixed Decade Box with values from 10^3 - 10^{12}: accurate to ±2%, except at 10^{11} and 10^{12} (±5%)
- Thermometer: accurate to ±1°F
- Relative Humidity Meter: accurate to 2%
- Test Leads
- 99% Isopropyl Alcohol and Cleaning Wipes

Setup
- **Test Area** - needs to be free of any high voltage transformers or power supplies and away from any type of fluorescent lighting or high power lighting.
- **Worksurface** - needs to be covered with a grounded conductive mat at 1.0 x 10^3 or less.
- **Technician** - needs to be connected to equipment ground with a 0 ohm resistor in the ground cord.
- **Decade Box** - needs to be connected to equipment ground.

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Normalization of the Meter

The temperature inside the testing area needs to be 75°F ±3°F at 40% to 60% relative humidity. The meter needs to stay at a temperature of 75°F ±3°F for approximately 2 hours for proper readings. The meter cannot be normalized inside objects, enclosed boxes, containers or cases. The temperature inside an enclosed case will differ from the outside temperature. These cases will act as insulators to the meter. The meter must remain stationary in the testing area for about 2 hours without any significant changes to the temperature.

NOTE: Accuracy is measured after normalizing the meter for a minimum of 2 hours.

Calibration Test Procedure

- Use only the test leads that were supplied with the meter.
- Clean around the banana jack and stereo jack located at the top of the meter with 99% isopropyl alcohol. Oil from human fingers can affect the accuracy of the meter.
- Set the Test Voltage Button to 10V HOLD. Press and hold the Test Button. The measured voltage between the two test leads should be 10V ±5%.
- Set the Test Voltage Button to AUTO. Press and hold the Test Button. The measured voltage between the two test leads should be 100V ±5%.
- Ensure that the Test Voltage Button is set to AUTO when performing the following measurements. Always measure from 1.0 x 10^{12} ohms and work your way down to 1.0 x 10^{3}. Never start your measurements from 1.0 x 10^{3}.

Temperature: 75°F ±3°F (23.9°C ±1.7°C)

Relative Humidity: ±10 digits

A. 1.0 x 10^{12}

+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 10^{11}

+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 10^{10}

+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 10^{9}

+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 10^{8}

+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 10^{7}

+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 10^{6}

+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 10^{5}

+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 10^{4}

+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 10^{3}

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

Specifications

Resistance Ranges	1 x 10^{3} - 1 x 10^{12} ohms @ 10 Volts, complies with ANSI/ESD S4.1 1 x 10^{6} - 1 x 10^{12} ohms @ 100 Volts, complies with ANSI/ESD S4.1
Accuracy	Resistance measurements within ±10% (±20% for resistance values 1 x 10^{11} and greater), complies with ANSI/ESD-S4.1. Under load voltages of 10 Volts ± 5% and 100 Volts ± 5% exceeds requirements of ANSI/ESD S4.1
Power Supply	2 AA alkaline batteries
Battery Life	Approx. 1,500 measurements
Operating Temperature	32°F - 104°F (0 - 40°C)
Meter Dimensions	8.1" x 4.1" x 1.5" (20.6cm x 10.4cm x 3.8cm)
Meter Weight	0.7 lbs (0.3 kg)
Kit Dimensions	13.5" x 10.8" x 4.0" (34.3cm x 27.4cm x 10.2cm)
Kit Weight	13.0 lbs (5.9 kg)
External Electrode	5 lbs (±2 oz), 2.5" in diameter, complies with ANSI/ESD S4.1

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Limited Warranty

Desco expressly warrants that for a period of one (1) year from the date of purchase Desco Surface Resistance Meters will be free of defects in material (parts) and workmanship (labor). Within the warranty period, a credit for purchase of replacement Desco Surface Resistance Meters, or, at Desco's option, the Surface Resistance Meter will be repaired or replaced free of charge. If product credit is issued, the amount will be calculated by multiplying the unused portion of the expected one year life times the original unit purchase price. 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. Please include a copy of your original packing slip, invoice, or other proof of date of purchase. Any unit under warranty should be shipped prepaid to the Desco factory. Warranty replacements will take approximately two weeks.

If your unit is out of warranty, 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. 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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