# Operator's Manual

## 701 Test Kit for Static Control Surfaces (Megohmmeter)



### INTENDED USE

The 3M Model 701 Megohmmeter is designed to measure the resistance of static control work surfaces and flooring. This is to be done in a manner as described in this operator's manual. Measurements described in this manual refer to the ESD Association Standards S4.1 (Worksurfaces-Resistive Characterization) and S7.1 (Floor Materials-Resistive Characterization of Materials). These standards are available from the ESD Association (315-339-6937). Refer to the operator's manual for complete use of this instrument. Use of other components may cause improper performance and or an unsafe condition.

## SAFETY SYMBOLS



This marking adjacent to another marking or a terminal or operating device indicates that the operator must refer to an explanation in the Operating Instructions to avoid damage to the equipment and/or personal injury.

**WARNING**

**WARNING:** Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

**CAUTION**

**CAUTION:** Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It also may be used to alert against unsafe practices that may cause property damage.

### SAFETY INFORMATION

The Operator's Manual contains cautions and warnings alerting the user to hazardous operating and servicing conditions. This information is flagged by CAUTION or WARNING headings throughout this publication, where applicable, and is defined in this manual under SAFETY SYMBOLS. To ensure the safety of operating and servicing personnel and to retain the operating integrity of this Instrument, these instructions must be adhered to.

**WARNING**

- Turn off the Instrument before connecting or disconnecting test leads, or before moving test weights.
- Do not use this Instrument with any accessories not specifically designed to be used with this product.
- Do not use this Instrument to measure live circuits.
- The circuitry enclosed in the Model 701 produces high voltages. Make sure that the main selector switch is in the OFF position before removing the back cover.

**CAUTION**

- Product intended for indoor use only.
- The test weights included in this kit are heavy. Exercise care in handling.
- Improper battery installation will damage this instrument.

## INTRODUCTION

### DESCRIPTION

The Model 701 Test Kit for Static Control Surfaces includes a hand-held megohmmeter (here-in after referred to as the "Instrument" or "Model 701") and accessories. The kit has been specifically designed for evaluating the resistive characteristics of static control surface materials and testing installed surfaces as specified in ESD Association Standards.

The Instrument has four test functions which allow the user to measure the resistance of a static control surface at either of two test voltages, verify proper Instrument performance, and check the electrical continuity of the test set-up.

### ACCESSORIES

All accessories required for operating the Model 701 are included in the test kit. Available replacement parts are listed on page 6.

### UNPACKING AND INSPECTION

Examine the shipping carton for obvious signs of damage. If damage is suspected, open the carton and inspect the Instrument for possible damage. If damage is noted, notify the carrier and supplier immediately. If the Instrument appears to be in good condition, read this Operator's Manual in its entirety. Check that all items are included with the Kit, then run a series of familiarity tests as instructed in this manual.

## CONTROLS, CONNECTORS, AND INDICATORS

### GENERAL

Before attempting any operation of the Instrument, become familiar with each control. A thorough understanding of how the Instrument operates will avoid undue mistakes and prolong its useful life.

## Figure 3-1. Controls, Connectors, and Indicators

**1. Main Selector Switch:**

Main function selector switch allows selection of desired test function.

**2. TEST Button:**

This button engages the Instrument and activates the test function selected.

**3. OHMS Scale:**

This scale is used in conjunction with the SURFACE TEST functions to indicate the amount of resistance measured.

**4. CONTINUITY Scale:**

This scale indicates the total resistance of the test set-up (meter, leads, weights, and calibration plate) in the CONTINUITY TEST function.

**5. BATTERY Scale:**

This scale indicates the charge level of the main battery of the Instrument in the BATTERY TEST function by verifying the open circuit output test voltage.

**6. Test Jacks:**

These jacks are used to connect the Instrument to the test leads.

**7. Mechanical Zero Adjust:**

This control is used to zero the pointer.

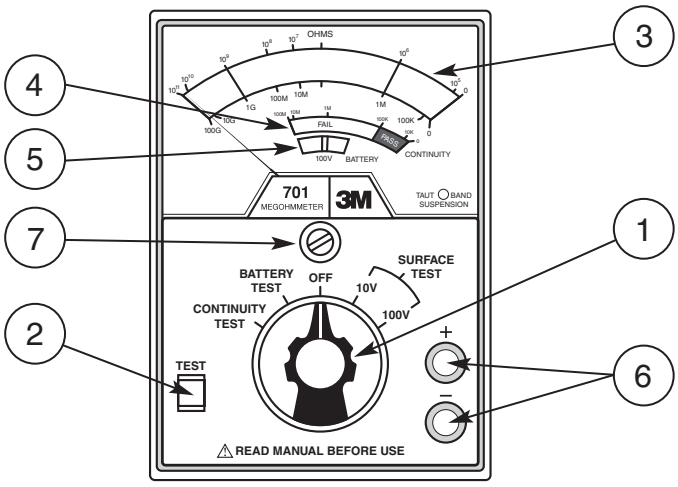


Figure 3-1: Front Panel

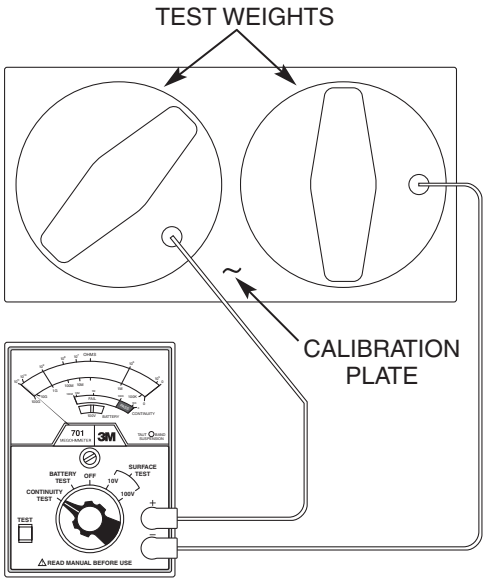


Figure 4-1: Continuity Test

# OPERATING INSTRUCTIONS

**WARNING**

- Turn off the Instrument before connecting or disconnecting test leads, or before moving test weights.
- Do not use this Instrument with any accessories not specifically designed to be used with this product.
- Do not use this Instrument to measure live circuits.

**CAUTION**

- The test weights included in this kit are heavy. Exercise care in handling.

**NOTE: The following procedures should be followed each time the Model 701 is used.**

### BATTERY TEST

Place the Instrument on a table top or other stable surface. Set the main selector switch to BATTERY TEST. Press TEST and hold for 15 seconds. The pointer should come to rest in the green area of the BATTERY scale. If the pointer is in the red area to the left of 100V, replace the battery and retest. If the pointer is in the red area to the right of 100V, the Instrument may need recalibration.

### CONTINUITY TEST

Place the Instrument on a table top or other stable surface and attach the leads as shown in Figure 4-1. Place the test weights on the calibration plate or other bare metal surface and plug in the test leads. Set the main selector switch to CONTINUITY TEST. Press TEST. The pointer should come to rest in the green section of the CONTINUITY scale. If not, the test leads may be defective or the weights may require maintenance or cleaning.

### SURFACE TEST (Resistance Measurement)

Refer to the immediate two following sections to determine which measurement(s) should be used for your application. Place the Instrument on a table top or other stable surface and attach the leads as shown in the appropriate sketch figures 5-1 through 5-5. Set the Main Selector Switch to the desired SURFACE TEST voltage. Place the test weight(s) on the surface to be tested and connect the test leads. Press TEST for 15 seconds and then read the resistance from the OHMS scale. After all readings have been completed, return the Main Selector Switch to the OFF position.

# RESISTIVE CHARACTERIZATION OF STATIC CONTROL WORK SURFACES

### GENERAL

This section provides a summary of the types of surface measurements specified and described by ESD-S4.1. Measurements are performed for three reasons:

1. Periodic performance testing of installed static control work surfaces.
2. Qualification of installed static control work surfaces.
3. Evaluation of static control work surface materials.

**NOTE: The following paragraphs are offered as a condensed summary of the test methods and procedures outlined in the EOS/ESD standard. For complete details, refer to the standard.**

### TEST DESCRIPTION

**1. PERIODIC PERFORMANCE TESTING OF INSTALLED STATIC CONTROL SURFACES**

(Measurement of resistance from the top of an installed surface to ESD GROUND ($R_{TS\text{-}ESDG}$) at ambient temperature and humidity): Note: ESD GROUND is the point at which the ground cord or other grounding conductor from the static control surface is connected to. The ground point may be an electrical ground, building ground, or other suitable ground. If you have questions concerning the correct ground, refer to EOS/ESD STANDARD S6.0 and/or contact a qualified electrician.

This Resistance-to-Ground test is the most important test that can be done on a static control surface because it verifies that the surface is working correctly and will

drain a static charge in a reasonable time. This test involves measurement of the total resistance from the static control surface through the conductor or ground cord to the ESD GROUND (ESDG), verifying that the entire static control system is functioning correctly.

**NOTE: ESD-S4. 1 suggests that a static control surface that measures in the range of $1x10^6$ ohms to $1x10^{10}$ ohms RTS-ESDG is acceptable. HOWEVER, 3M RECOMMENDS THAT A MORE CONSERVATIVE VALUE OF $1X10^9$ OHMS BE USED AS THE HIGHEST ACCEPTABLE RESISTANCE TO ESD GROUND.**

The following procedures should be followed when testing installed static control surfaces.

A. Complete BATTERY TEST and CONTINUITY TEST.

B. Set the Instrument on a table top or other stable surface and place a test weight at the desired test point as shown in Figure 5-1. Connect the test leads to the meter using the right angle banana plugs at the meter. Then connect one of the test leads to the test weight and the other to the ESD GROUND using one of the supplied clips.

C. Test the static control surface using the 100 volts SURFACE TEST. Depress the TEST button for 15 seconds, allowing the pointer to stabilize; record the readings for each test point. If the reading is below $1x10^6$ ohms, check the static control surface for an alternate path to ground; correct and retest. If some or all the readings are above $1x10^9$ ohms, the static control surface may be dirty. Clean the surface using the manufacturer's recommended cleaning procedure followed by two clear water rinses and a rinse with 70% Isopropyl alcohol. Allow the surface to dry overnight and retest. If the resistance reading is "infinite," there is an interruption (open) in the ground connection; repair and retest.

## 2. QUALIFICATION OF INSTALLED STATIC CONTROL SURFACES

[Measurement of resistance of the top surface to the groundable point of the static control surface ($R_{TS-GP}$)]. GROUNDABLE POINT is the point at which the grounding conductor is connected to the static control surface; the GROUNDABLE POINT is most commonly a snap (mats), a bolt (laminate), or a strip of conductive foil tape (flooring). This QUALIFICATION measurement is similar to those described in the test description section and is used to verify the correct installation of the GROUNDABLE POINT by the manufacturer or by the user. While the test procedure is the same, the test setup is slightly different; see Figure 5-2.

## 3. EVALUATION OF STATIC CONTROL MATERIALS

[Measurement of the resistance between two points on top of a static control surface ($R_{TS-TS}$), and the resistance between a point on the surface and the groundable point ($R_{TS-GP}$)]: Material measurements are done to determine the intrinsic electrical properties of static control work surface materials.

**NOTE: Values obtained by these tests may not reflect how a material will perform when installed as a static control surface.**

Material evaluations are typically done at two humidities (12% RH and 50% RH) to determine whether the electrical properties of the material are humidity-dependent. If the low humidity test results are borderline or not within the expected ranges, caution should be exercised when using such materials in winter months or in dry conditions. To assure test accuracy, a minimum of six samples should be tested. The test procedure is as follows:

A. Prepare a minimum of six samples of each material to be tested as shown in Figure 5-3.

B. Clean samples to be tested with a 70% Isopropyl alcohol solution and condition at 73°F (23°C) and 50% RH for 48-72 hours.

**NOTE: Samples must be maintained at the appropriate humidity level throughout the test procedures.**

C. Complete BATTERY TEST and CONTINUITY TEST

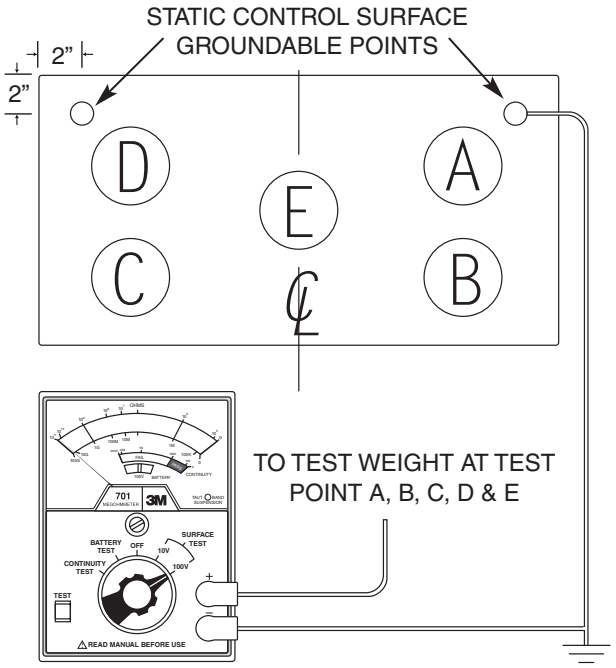


Figure 5-1: Periodic Performance Tests of Installed Surfaces

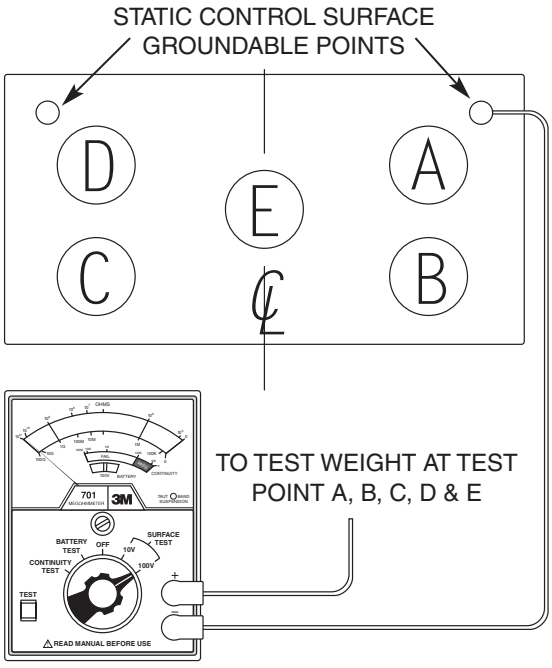


Figure 5-2: Qualification Tests of Installed Surfaces

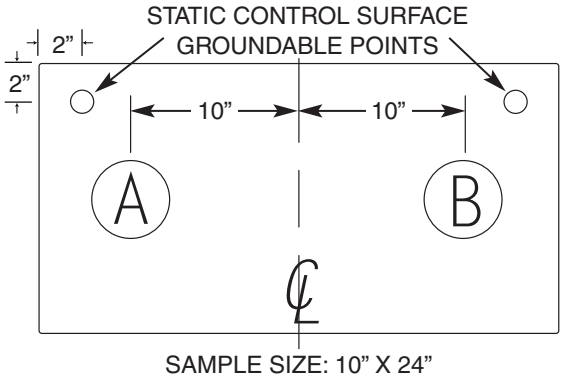


Figure 5-3: Material Evaluation Sample Configuration

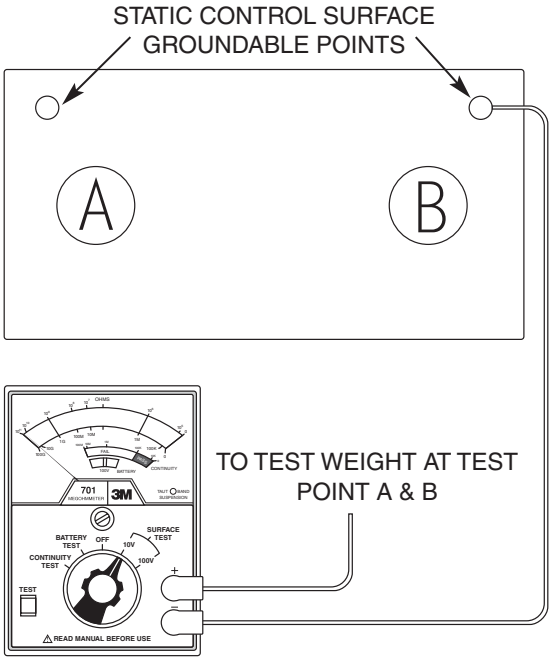


Figure 5-4: Material Evaluation Surface to Groundable Point Test

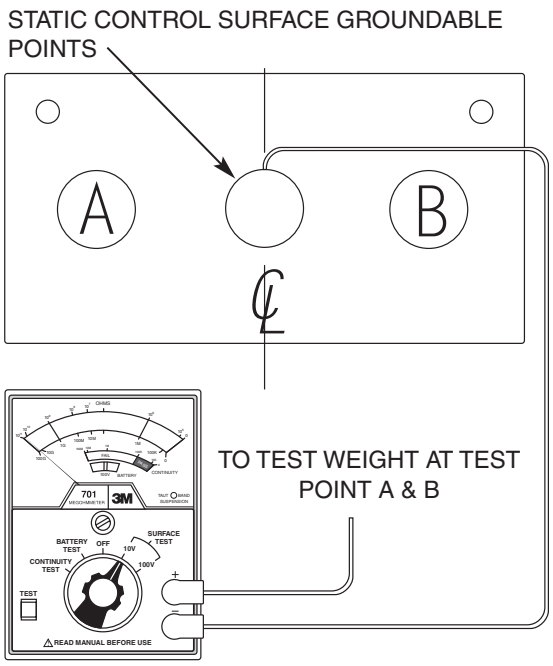


Figure 5-5: Material Evaluation Surface to Surface Test

D. Surface-to-Groundable Point Test: Test samples per Figure 5-4, using both the 100 volts and 10 volts SURFACE TEST ranges at 50% RH and record the values as ($R_{TS\text{-}GP}$).

**Procedure:** Place the Instrument on a table top or other stable surface. Connect the test leads to the Instrument by means of the right angle banana plugs. Connect the other end of one of the leads to one of the test weights and place the weight on the surface to be tested. Use one of the supplied clips to connect the other lead to the groundable point on the static control surface. Depress TEST button for 15 seconds and then record the reading.

E. Surface-to-surface Test: Test samples as shown in Figure 5-5; use both test weights and repeat the same test procedure used to determine ($R_{TS\text{-}GP}$).

F. Repeat A through E after conditioning samples at 73°F (23°C) and 12% RH. Use the same test points and record the values.

# RESISTIVE CHARACTERIZATION OF STATIC CONTROL FLOORING

## GENERAL

This section provides a summary of installed or applied floor material measurements specified and described by ESD-S7.1.

**NOTE: The following paragraphs are offered as a condensed summary of the test methods and procedures outlined in the EOS/ESD standard. For complete details, refer to the standard.**

## TEST DESCRIPTION

PERIODIC PERFORMANCE TESTING OF INSTALLED OR APPLIED FLOORING MATERIALS(Measurement of resistance from the surface of an installed floor to GROUNDABLE POINT at ambient temperature and humidity): Note: GROUNDABLE POINT is a point on the floor material that is intended to accommodate an electrical connection from the floor material to an appropriate electrical ground. The ground point may be an electrical ground, building ground, or other suitable ground. If you have questions concerning the correct ground, refer to EOS/ESD Standard 6.0 and/or contact a qualified electrician.

The Resistance-to-Ground test is the most important test that can be done on a static control surface because it verifies that the surface is working correctly and will drain a static charge in a reasonable time. This test involves measurement of the total resistance from the static control surface through the conductor or ground cord to the ESD to the ESD GROUND (ESDG), verifying that the entire static control system is functioning correctly.

**NOTE: ESD 7.1 is designed to measure floor materials with resistances of 2.5 x $10^4$ to 1.0 x $10^{11}$ ohms.**

The following procedures should be followed when testing installed static control floor mats or flooring surfaces.

## TEST PROCEDURE FOR RESISTANCE TO GROUND

A. Complete BATTERY TEST and CONTINUITY TEST. If required clean, electrodes as described in Test Weight Cleaning section page 5.

B. Before testing new floor mats or newly installed floors, clean mats/floors per manufacturer's recommendations. For testing of floor finishes or monitoring of existing floor materials, test in an as-is condition.

C. Perform tests at ambient humidity.

D. Place the Instrument and test weight at the desired test location.

E. Connect one lead of the meter to ground with supplied clip and the other lead to the test weight.

F. Set meter to 100V. Place test weight on the surface of the material being tested.

G. Push test button and record the resistance after the measurement has stabilized or after 15 seconds. Release test button.

H. Repeat the procedure placing the test weight on the surface at different locations.

I. Perform a minimum of five tests per contiguous floor surface material or a minimum of five tests per 5,000 square feet (464,5 $m^2$) of floor material, whichever is greater. A minimum of three of the five tests should be conducted in those areas that are subject to wear or have chemical or water spillage or are visibly dirty.

### TEST PROCEDURE FOR RESISTANCE POINT TO POINT

A. Complete BATTERY TEST and CONTINUITY TEST. If required clean electrodes as described in Test Weight Cleaning section below.

B. Before testing new floor mats or newly installed floors, clean mats/floors per manufacturer's recommendations. For testing of floor finishes or monitoring of existing floor materials, test in an as-is condition.

C. Perform tests at ambient humidity.

D. Place the Instrument and test weight at the desired test location.

E. Connect test leads of the meter to the test weights.

F. Set meter to 100V. Place test weights three feet apart on the surface of the material being tested.

G. Push test button and record the resistance after the measurement has stabilized or after 15 seconds. Release test button.

H. Repeat the procedure placing the test weights three feet apart on the surface at different locations.

I. Perform a minimum of five tests per contiguous floor surface material or a minimum of five tests per 5,000 square feet (464,5 $m^2$) of floor material, whichever is greater. A minimum of three of the five tests should be conducted in those areas that are subject to wear or have chemical or water spillage or are visibly dirty.

## MAINTENANCE

### GENERAL

This section details the maintenance which may be performed by the user. **Performance by the user of any maintenance not specified here will void the Instrument warranty**. If it is determined that maintenance beyond the scope of this section is required, contact your local 3M sales representative or call 3M Technical Service (Electronic Handling & Protection Division) at 512-984-3200.

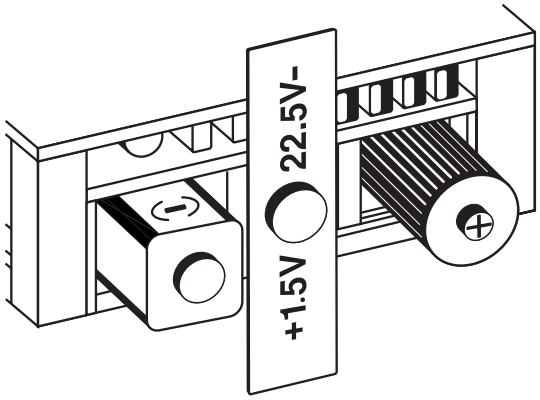


Figure 6-1: Battery Replacement

### BATTERY REPLACEMENT

Before attempting to replace either battery, place the main selector switch in the OFF position.

**⚠ WARNING**

**The circuitry enclosed in the Model 701 produces high voltages. Make sure that the main selector switch is in the OFF position before removing the back cover.**

A. To open the back cover, remove the screw located in the center of the back cover.

B. The batteries are held in place by a metal bracket at the top of the Instrument. To release this bracket, turn the screw located in the center of the bracket counter clockwise until the bracket swings free. The batteries will now slide out.

C. Install new batteries as shown in Figure 6-1.

**⚠ CAUTION**

**Improper battery installation will damage this Instrument.**

D. Replace bracket and tighten bracket screw. Replace back cover and cover screw.

### TEST WEIGHT CLEANING

**⚠ CAUTION**

**The test probes included in this kit are heavy. Exercise care in handling.**

After a period of use, the conductive rubber pads on the test weights may become soiled, causing the weight to fail the CONTINUITY TEST. To clean the surface of the conductive pad, use a 70% Isopropyl alcohol/water mixture on a clean low-linting cloth. Allow surface to “air dry” 15 minutes before use.

### ZERO ADJUSTMENT

On occasion, due to handling, vibration, or other causes, the pointer on the Model 701 may need adjustment. To zero the pointer, turn the main selector switch to the OFF position. Place the Instrument on a level stable surface and turn the mechanical zero adjust screw until the pointer is over the left-most mark on the OHMS scale.

# REPLACEMENT PARTS

The following parts are user-replaceable parts:

| Description | Part Number |
|---|---|
| Model 701 Megohmmeter | 3M 701-M, 98-0798-2290-8 |
| Test Weight (each) | 3M 701-W, 98-0798-2291-6 |
| Test Leads (pair) | 3M 701-L, 98-0798-2292-4 |
| Carrying Case | 3M 701-C, 98-0798-2293-2 |
| Insulated “Bulldog” Clip | 3M 3037, 98-0798-0838-6 |
| Noninsulated Alligator Clip | 3M 3038,98-0798-0399-9 |
| Operator’s Manual | 34-7051-4709-7 |
| Batteries (2) | 1.5 volt AA Cell, 22.5 volt Eveready 505 (or equivalent*) |

*The following are equivalent replacements or alternative sources for the Eveready 505 22.5V battery: NEDA 221, Radio Shack 23-510, Newark Electronics (catalog) 49F1064.

## TECHNICAL DATA

The following electrical specifications are valid for operating temperatures of 65°F (18°C) to 82°F (28°C), at relative humidity up to 90% for altitudes up to 2000m, unless otherwise noted. Pollution degree 2, class 3 equipment.

### Resistance Ranges

| Test Function | Measurement Range* | Open Circuit Voltage** | Internal Resistance |
|---|---|---|---|
| Continuity | 0 to 10 MΩ | 10V ± .7V | 500 Ω |
| 10V Surface | $10^5$ to $10^{11}$ Ω | 10V ± .7V | 2 Ω |
| 100V Surface | $10^5$ to $10^{11}$ Ω | 100V ± .7V | 2 Ω |

*Measurement Accuracy: ±5%±2° of arc.
**Measured internally at voltage source.

### Battery Test

Internal test of 100V source – Accuracy: ± 2% ± 2° of arc

### Batteries

1–1.5V AA Cell

1–22.5v Type 505 (Eveready 505)*

*(See replacement parts above for batteries equivalent to the Eveready 505.)

### Physical Data

| Instrument | Test Weights(2) |
|---|---|
| 4.6”(H) x 3.3”(W) x 1.8”(D)<br>(11,7 x 8,4 x 4,6 cm)<br><br>Weight: 12 oz (340 gms) | Weight: 5 lbs. (2.27 Kg) each<br>Diameter: 2.5” (6,4 cm)<br>Height: 4.7” (11.9 cm)<br>(w/handle and pad) |

### Handling and Safety Precautions

Read all Health Hazard, Precautionary, and First Aid statements found in Material Safety Data Sheet (MSDS) and/or product label of chemicals prior to handling or use.

## Important Notice

Before using this product, you must evaluate it and determine if it is suitable for your intended application. You assume all risks and liability associated with such use.

## Warranty; Limited Remedy; Limited Liability.

This product will be free from defects in material and manufacture for a period of 1 year from the date of purchase. **3M MAKES NO OTHER WARRANTIES INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** If this product is defective within the warranty period stated above, your exclusive remedy shall be, at 3M's option, to replace or repair the 3M product or refund the purchase price of the 3M product. **Except where prohibited by law, 3M will not be liable for any loss or damage arising from this 3M product, whether direct, indirect, special, incidental or consequential regardless of the legal theory asserted.**

## Shipping of Warranty Returns

Pack the Instrument carefully and ship it prepaid and insured to the proper destination noted below:
DO NOT RETURN ANY ITEM WITHOUT HAVING FIRST RECEIVED RETURN AUTHORIZATION FROM 3M THROUGH YOUR 3M SALES REPRESENTATIVE.

**3M**
**Electronic and Interconnect Solutions Division**
**Quality Department**
**6801 Riverplace Boulevard**
**Austin, TX 78726-4599**

## Shipping of Nonwarranty returns

Contact 3M Service Repair Center at 800/426-8688 and select option #2 for the Service and Repair Center.

When calling, please have the following information available:

- Purchase Order Number
- Name and phone number of an individual who can be contacted for additional information
- Complete return address
- Description of the problem

You will be given complete instructions, including a RMA number for returning the instrument.

3M

**Electronic and Interconnect Solutions Division**
6801 River Place Blvd.
Austin, TX 78726-9000

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