Operator's Manual

Portable Surface Resistivity/Resistance Meter

Model 272A

072811

MONROE ELECTRONICS

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Monroe Electronics, Inc., warrants to the Owners, this instrument to be free from defects in material and workmanship for a period of two years after shipment from the factory. This warranty is applicable to the original purchaser only.

Liability under this warranty is limited to service, adjustment or replacement of defective parts (other than tubes, fuses or batteries) on any instrument or sub-assembly returned to the factory for this purpose, transportation prepaid.

This warranty does not apply to instruments or sub-assemblies subjected to abuse, abnormal operating conditions, or unauthorized repair or modification.

Since Monroe Electronics, Inc. has no control over conditions of use, no warranty is made or implied as to the suitability of our product for the customer's intended use.

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RETURN POLICIES AND PROCEDURES

Return authorization is required for factory repair work. Material being returned to the factory for repair must have a *Return Material Authorization* number. To obtain an RMA number, call 585-765-2254 and ask for Customer Service.

Material returned to the factory for warranty repair should be accompanied by a copy of a dated invoice or bill of sale, which serves as a proof of purchase for the material. Serial numbers and date codes on our products also serve to determine warranty status. Removal of these labels or tags may result in voiding a product's warranty.

Repairs will be returned promptly. Repairs are normally returned to the customer by UPS within 10 to 15 working days after receipt by Monroe Electronics, Inc. Return (to the customer) UPS charges will be paid by Monroe Electronics on warranty work. Return (to the customer) UPS charges will be prepaid and added to invoice for out-of-warranty repair work.

RETURN OF REPAIRED ITEMS:

Factory repairs will be returned to the customer by the customer's choice of FedEx, DHL or UPS. Warranty repairs will be returned via UPS ground. The customer may request accelerated shipping via the previous mentioned carriers for both warranty and non-warranty repairs. **NOTE:** Accelerated transportation expenses for all factory repairs will always be at the expense of the customer despite the warranty status of the equipment.

FACTORY REPAIRS TO MODIFIED EQUIPMENT:

Material returned to the factory for repair that has been modified will not be tested unless the nature and purpose of the modification is understood by us and does not render the equipment untestable at our repair facility. We will reserve the right to deny service to any modified equipment returned to the factory for repair regardless of the warranty status of the equipment.

INTRODUCTION:

The Monroe Electronics Model 272A Portable Surface Resistivity/Resistance Meter provides fast repeatable measurements of both surface resistivity and resistance to ground in one versatile instrument. Its improved accuracy and digital readout make it ideal for checking and evaluating static control products such as static dissipative bags, mats and work surfaces and resistance of work surfaces to ground. The Model 272A's convenient size, portability and rugged construction make this meter ideally suited for applications in a manufacturing environment.

FEATURES:

- Measures both surface resistivity and resistance to ground
- Easy to use - autozero - no adjustments required
- Portable - uses rechargeable battery for 8 hours continuous use
- Improved accuracy - ±0.1 decade with digital readout
- Guarded ring electrode weighing 5 pounds conforms to standards
- Wide range of direct readings in ohms per square (Ω/■) for surface resistivity or ohms (Ω) for resistance to ground
- Switch selectable measuring voltage - 10 volts or 100 volts
- Displays value in scientific notation or 3-place log

SPECIFICATIONS:

RANGE:	From 8 x 10E3 to 2.0 x 10E13 Ω or 8 x 10E4 to 2.0 x 10E14 Ω/■
INSTRUMENT ACCURACY:	±0.1 decade thru 10E12, ±0.15 decade above 10E12 (typical); ±0.1 decade thru 10E9, ±0.15 decade thru 10E11; ±0.2 decade above 10E12 (maximum)
MEASURING VOLTAGE	10 volts for 8.0 x 10E3 to 2.0 x 10E12 Ω or 8.0 x 10E4 2.0:10E13 Ω/■ and 100 volts for 1.1 x 10E5 to 2.0 x 10E13 Ω or 1.1 x 10E6 to 2.0 x 10E14 Ω/■
DISPLAY:	16x1 LCD alpha/numeric display will show: Operation mode - Ω or Ω/■ Readings in log or scientific notation Applied voltage Low battery Also used in SETUP mode
POWER:	Rechargeable battery with 100 VAC, 120 VAC or 230 VAC adapter/charger supplied. Power requirement is 16 VAC or DC (either polarity) @ 1.25A. Connector plug is 5mm OD; 2.55mm ID. Battery operation up to 8 hours continuous use
ELECTRODE:	Guarded ring electrode recommended by ASTM D-257 weighing five pounds (2.7kg). The outer electrode is a ring having an inside diameter of 2.25 inches 5.72cm) and a width of 0.125 inches 0.32cm). The inner electrode is a disc with an outside diameter of 1.2 inches (3.05cm). The electrode assembly is separate from the meter and is connected to the meter by a cable 3 feet (91 cm) in length. A two-sided specimen support plate is included.
DIMENSIONS:	Electrode - overall height - 4.0 inches (10.2cm)outside diameter - 3.0 inches (7.6cm) Meter - height - 2.5 inches (6.4cm) width - 6.0 inches (15.2cm) depth - 6.0 inches (15.2cm)

Recommended factory calibration cycle is one year.

HOW THE MODEL 272A WORKS:

Located on the insulating base of the electrode assembly are two concentric circular electrodes of conductive elastomeric material. The dimensions of these rings are such that when the assembly is placed on the flat surface of the material to be tested, ten squares of the material lie between the electrodes. When power is switched on a voltage is impressed on the outer ring and current flow in the interposed material is detected by the inner electrode thus defining the resistivity characteristics of the material. Internal circuitry of the Model 272A interprets this signal and provides a direct readout of the surface resistivity of the material under test in ohms per square. (Re. ASTM D-257, para. 3.5) In the resistance to ground mode, the test voltage is removed from the outer electrode and is applied to ground via a test lead supplied with the instrument. Current flowing between ground and the inner sensing electrode is detected and is converted to a direct readout of the resistance of the intervening path in ohms.

CAUTION
DO NOT TOUCH ELECTRODES

1. Electrodes will become contaminated with skin oils.
2. When in operation, electrodes may be operating at a potential of 100 volts and are capable of delivering an annoying shock to the person touching them. Although the current capability is limited, a distinct hazard exists in the person's reaction to the shock.

BATTERY OPERATION:

Model 272A was designed to operate continuously for up to 8 hours on its internal battery when fully charged. A battery symbol will flash in the display when the battery needs recharging. To conserve battery power, the unit was shipped from the factory with its battery shutdown timer set for five minutes. This means that after five minutes of use (or non-use) the instrument will shut itself off. The timer is reset simply by pressing the ON-OFF switch. The default value may also be changed in software in the SETUP mode (described later). Optional default values are: 5 min., 10 min., 30 min. and NONE. Model 272A may also be line operated regardless of the state of its internal battery, although errors may be introduced by noise injected through the charging supply in this mode. To determine the degree of error, check readings in both modes. Battery operation will always produce the most reliable reading as long as the battery is charged.

During charging, the charge rate is reduced to a "float" rate as battery capacity is reached. The unit may be left on charge indefinitely. The battery is charged at a much lower rate when the unit is operating. The time-out feature is disabled while the charger is plugged in.

OPERATING ENVIRONMENT:

Proper operation of this instrument requires attention to its operating environment. Its sensitive circuitry is affected by uncontrolled static charges, ESD events and AC electric fields. Any of these may produce erroneous or erratic results. Generally, an ESD controlled environment is a preferred location for measurements.

CONFIDENCE CHECK:

As shipped from the factory, the default settings for the Model 272A are to measure surface resistivity using the probe provided at an applied voltage of ten volts and to display the result in scientific notation similar to that shown below:

1.2E10 Ω/■ @10 V

To demonstrate this, connect the probe to the Model 272A by attaching the coaxial plug to the mating connector on the front panel and inserting the miniature banana plug into the jack directly above. Included with the Model 272A is a Specimen Support Surface-a metal plate with an insulative surface-and a cable with banana plugs on each end. Connect this cable between the hole on the side of the plate and the metallic jack on the side of the Model 272A. Place an ordinary sheet of common notepad paper on the insulative surface of the plate and set the probe on top of the paper. Press the ON-OFF switch. A brief announcement will appear on the screen and, if the factory settings have not been disturbed, the message shown above will be displayed within a few seconds. The value will probably be different. Common paper generally will have a resistivity within the range of the instrument under normal ambient conditions allowing some value to be displayed.

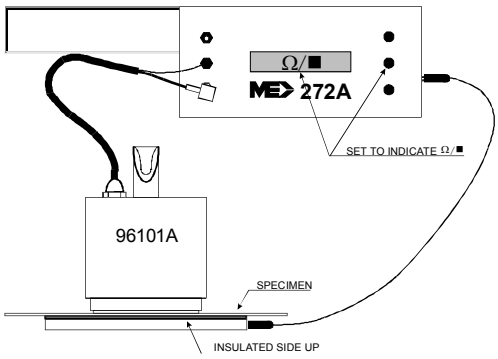

Figure 1
Setup for Surface Resistivity Measurement

The above illustrates how the display reacts to a resistivity measurement wherein the applied voltage is impressed across the material (or lack of material) between the circular electrodes of the probe and the Model 272A interprets a factor specific to the probe to produce a correct value readout in ohms per square. Now, lift the probe by its handle. Within a few seconds, an error message should be displayed (see *ERROR MESSAGES*):

VALUE TOO HIGH

OPERATING CONTROLS:

In addition to the ON-OFF push-button switch, there are two other operator controls-push-button switches labeled OHMS-OHMS/SQ and 10V-100V. These may be used to temporarily toggle the function or the applied voltage. Once the instrument is shut off or powered down automatically, the power-up default settings are restored.

SURFACE RESISTIVITY MEASUREMENTS:

The method for measurement of surface resistivity of sheet materials using the probe provided is given in “CONFIDENCE CHECK” (above).

Custom miniature probes in point-to-point and guard ring configurations are available for measuring irregularly shaped objects such as DIP tubes and thermo-formed plastic carriers.

RESISTANCE MEASUREMENTS:

Included with each Model 272A is a Model 96121-1 Surface-to-Ground Measuring Adapter. This adapter used with the probe and Model 272A meets requirements of the following standards for measurement of resistance to ground of flooring and work surface materials:

ASTM F-150
Standard Test Method for ELECTRICAL RESISTANCE OF CONDUCTIVE RESILIENT FLOORING

ESD ASSOCIATION STANDARD NO. 4.1
Worksurfaces - Resistive characterization

ESD ASSOCIATION STANDARD NO. 7.1
Floor Materials - Resistive characterization of materials

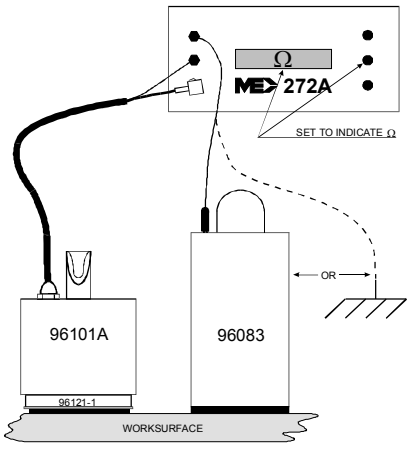

Figure 2
Setup for Surface-to-Ground and Surface-to-Surface
Resistance Measurements

NOTE: The adapter serves as a protective cap for the probe during storage and must be removed to expose the concentric ring electrodes for resistivity measurements.

ASTM standards are available from:

American Society for Testing and Materials
1000 Barr Harbor Drive
West Conshohocken, PA 19428-2959
Phone (610) 832-9500
Fax (610) 832-9555

ESD Association standards are available from:

ESD Association, Inc.
7902 Turin Road
Suite 4
Rome, NY 13440-2069
Phone (315) 339-6937
Fax (315) 339-6793

Monroe Electronics, Inc. does not supply copies of standards.

To make a measurement of resistance from a surface to a ground point, connect the jack labeled “OHMS” to the ground point, set the electrode on the surface and switch to the “OHMS” mode (see Figure 2).

Surface-to-surface measurements, also directed in these standards, require the use of a second electrode (Monroe Electronics Model 96083) as shown in Figure 2. Model 96083 electrodes are included in Models 96085-1 and 96085-2 electrode sets or they may be ordered separately.

PROGRAMMING:

Power-up default settings may be re-programmed in the SETUP MODE. Options are as shown below where the factory default is the first shown in the lists:

OBJECTIVE	OPTION
DISPLAY	SCI LOG
FUNCTION	Ω/■ OHMS
V SOURCE	10V 100V
AUTO OFF	5 MIN 10 MIN 30 MIN NONE
PROBE GAIN	* (see below)
RESET ALL	NO YES

To invoke the SETUP MODE, start with the instrument OFF. Press and hold the OHMS-OHMS/SQ push-button while switching power ON. The message "SETUP MODE" will be displayed very briefly and then the message "DISPLAY SCI" will appear. To alter the option, press the OHMS-OHMS/SQ push-button. To scroll the objectives, press the 10V-100V push-button. The PROBE GAIN options are 0.1 through 25.5 in increments of 0.1. Gain is factory preset to 10 for the probe which accompanies the Model 272A. PROBE GAIN SHOULD NOT BE CHANGED INDISCRIMINATELY IN THE FIELD.

Please note that the time-out feature is disabled in the setup mode and that if the battery voltage falls to a low value during programming, any newly selected options will be lost. At the RESET ALL objective, a NO response will accept any new power-up options and return to the operational mode using the new options. A YES response will reset any changes and return to the top of the list (DISPLAY SCI).A LOG display, the equivalent of the SCI display shown on Page 3 would be:

10.079 Ω/■ @10 V

where 10.079 is the common log value of the 12 gigaohm per square (1.2E10 Ω/■) input, not literally 10.079 ohms per square.

ERROR MESSAGES:

In addition to the flashing battery symbol that indicates the need for battery charging, any of several other error messages may appear on the screen:

MESSAGES	MEANING
ERROR MESSAGE 1: **VALUE TOO LOW** or *ERROR MESSAGE 2:* **VALUE TOO HIGH**	Measured value beyond specified range of instrument, probe disconnected or incorrect measurement mode. If VALUE TOO HIGH is not displayed when probe is lifted in *CONFIDENCE CHECK*, check operating environment.
ERROR MESSAGE 3: **CANNOT AUTOZERO**	Analog circuit malfunction or calibration problems.
ERROR MESSAGE 4: **PROBE SUPPLY LOW**	Measuring voltage supply out of regulation due to overload or instrument failure.

MAINTENANCE TIPS:

The case of the Model 272A and the painted surfaces of its probe may be cleaned using a soft cloth saturated with a solution of warm water and a small amount of mild detergent and wrung out. Care should be taken not to get detergent solution inside of or on any part of the base of the probe. The contact electrodes should be cleaned whenever any accumulation of contaminants is noted as foreign materials on the faces may cause higher than normal indications. These parts should be cleaned by spraying or wiping gently with clean technical grade isopropyl alcohol.

APPLICATION NOTE APNE-0002

PRACTICAL VOLUME RESISTIVITY MEASUREMENTS
with
Monroe Model 272A

Included with Model 272A is a P/N 96117-1/22A specimen support plate. This support plate provides a durable finish on the insulated side and also provides a smooth metallic surface on the opposite side for volume resistivity or bulk resistance measurements of materials.

The combination of this plate, the P/N 96101A-1 probe and the Model 272A instrument meets the guidelines set forth in ASTM D-257 and IEC 93 Standards for guarded-ring testing of volume resistivity of solid, homogeneous electrical insulating materials, generally in sheet form. Connections for guarded measurements are shown in Figures 3 and 4.

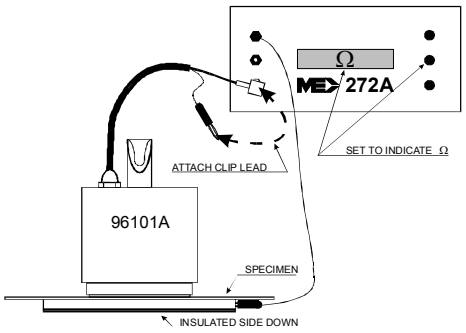

Figure 3: Setup for Guarded Measurement of Volume Resistivity

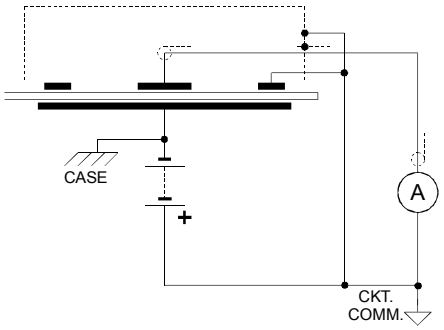

Figure 4: Schematic Representation

Volume resistivity, ρ_v, must always be calculated because the thickness of the test specimen is one of the measurement variables. The ASTM D-257 (or IEC 93) formula for ρ_v is:

$$\rho_{v=} \quad \frac{A}{t} R_m \; ohm \bullet cm$$

where: A = Effective area of measuring electrode in cm^2
t = Thickness of test specimen in cm
R_m = Measured resistance in ohms

For the 96101A-1 probe the effective area of the measuring electrode is 7.1 cm^2 thus:

$$\rho_{v=} \quad \frac{7.1}{t} R_m \; ohm \bullet cm$$

Appendix X2 in the ASTM standard further addresses the modification of the effective area of the measuring electrode in the guarded ring configuration.

The above information is presented as an overview of some of the complications involved in the use of the concentric or guarded ring type electrode. Either of the standards should be consulted for further details.

SIMPLIFIED METHOD

Most materials commonly being tested in today's world of ESD awareness are intended not to be electrically insulative. For specimens that have negligible surface leakage, an unguarded measurement based on the actual area of the (1.2" dia.) center electrode greatly simplifies the calculations. For material samples less than 0.060" thick, the errors introduced into an unguarded measurement are usually small enough to be negligible. The connections for unguarded measurements are given in Figure 5. Factors for converting meter readings (in Ω) directly to volume resistivity (unit Ω•cm) are presented in Table 1.

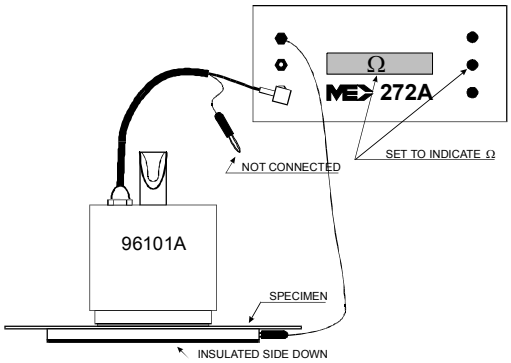

Figure 5
Connections for Un-guarded Measurement of Volume Resistivity

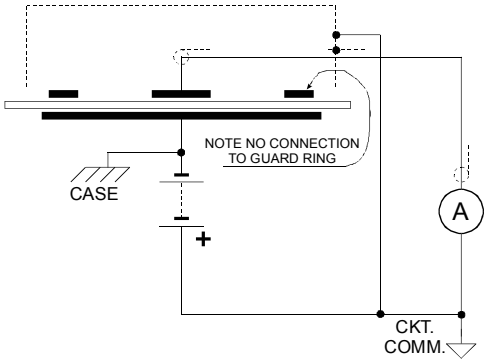

Figure 6:
Schematic Representation

Material Thickness	***Factor***	***Material Thickness***	***Factor***
0.005" (0.13mm)	575	0.035" (0.89mm)	82
0.010" (0.25mm)	287	0.040" (1.02mm)	72
0.015" (0.38mm)	192	0.045" (1.14mm)	64
0.020" (0.51mm)	144	0.050" (1.27mm)	57
0.025" (0.64mm)	115	0.055" (1.40mm)	52
0.030" (0.76mm)	96	0.060" (1.52mm)	48

Table 1

TO USE THIS TABLE-

1) Arrange test setup as in Figure 5.
2) Set Model 272A to "ON".
3) Select "OHMS". The "Ω " symbol will appear in the display.
4) Select measuring voltage (10V or 100V).
5) Record the reading and the material thickness.
6) Multiply the reading by the factor given in the table for the value of volume resistivity in Ω•cm.