ACL 395 Resistivity Meter

OPERATION MANUAL

Meter is warranted for one year from the date of purchase on parts and labor.
Calibration is recommended every 12 months.

ACL 395 Resistivity Meter

The ACL 395 is a lightweight, pocket-sized, auto-ranging surface resistivity meter. It is designed to test conductive, dissipative, and insulative surfaces for electrical resistivity according to the ESDA's parallel resistivity probe method DIN EN 100 015/1 & ASTM D257.

If the meter is used with the 5-lb probes available in the accessory kit, it will comply to IEC 61340-4-1, ANSI/ESDA S4.1 and ANSI/ESDA S7.1.

ACL 395 Resistivity Meter includes:
* Tester
* Two accordion cables (stereo to banana)
* 9-volt battery
* Certificate of calibration

ACL 396 Accessory Kit includes:
* Two 5-lb probes
* Foam-lined carrying case

Limits
* Resistivity: 10^{3}-10^{12} ohms/square
* Resistance: 10^{3}-10^{12} ohms
* Measuring voltage: 10v and 100v

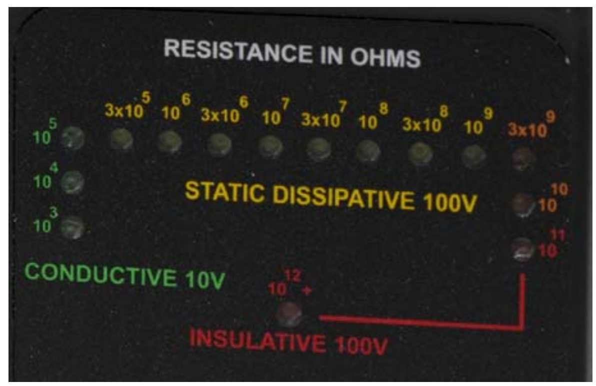
INTRODUCTION

The ACL 395 Resistivity Meter is an easy-to-use tester for measuring surface resistivity. When used with the ACL 396 Accessory Kit, the ACL 395 Resistivity Meter is a dependable audit kit for conductive and dissipative surfaces. This meter is designed for use in all facets of material production including engineering, maintenance, quality control, incoming inspection, manufacturing and research, or in sales departments for the testing of anti-static mats, floor finishes, paints, wrist straps, smocks, footwear, bags and containers.

When using the built-in probes, the meter's test values for surface resistivity are in ohms per square (although they are displayed in ohms). When using the external 5-lb probes, the meter's test values for resistance are in ohms.

DECADE SCALE

10^3	=	1 kilohm
10^4	=	10 kilohms
10^5	=	100 kilohms
3×10^5	=	300 kilohms
10^6	=	1 meg ohm
3×10^6	=	3 meg ohm
10^7	=	10 meg ohms
3×10^7	=	30 meg ohms
10^8	=	100 meg ohms
3×10^8	=	300 meg ohms
10^9	=	1000 meg ohms
3×10^9	=	3000 meg ohms
10^{10}	=	10,000 meg ohms
10^{11}	=	100,000 meg ohms
10^{12}	=	1,000,000 meg ohms



The test value is indicated on the LED display. Half decades provide greater accuracy by giving a closer approximation to the measurement value. An LED will brighten to the according test result. Colors signify the test value's function.

COLOR	INDICATING FUNCTION	Ω
Green	Conductive	10^3 - 10^5
Yellow	Dissipative: ideal test measurement	3×10^5 - 10^9
Orange	Dissipative, but close to going out of spec	3×10^9 – 10^{10}
Red	Near-insulative to insulative	10^{11} - 10^{12}

TEST VOLTAGE

The test voltages are 10v and 100v. According to ESD Association (ESDA) standards S4.1 and S7.1, 10v should be applied to surfaces with resistivity of less than 10^6 and 100v should be applied to surfaces with resistivity of 10^6 or greater. The ACL 395 will automatically simulate the proper voltage according to the test measurement.

As defined by the ESDA, values indicate the following:

Voltage	Range	Definition
10 volt	< 10^6 ohms per square	Conductive
100 volt	10^6 – 10^{11} ohms per square	Dissipative
100 volt	> 10^{11} ohms per square	Insulative

A NOTE ABOUT VOLTAGE

In previous years, those desiring to measure resistivity or resistance followed the ASTM D264, ASTM 991, NFPA 56A or NFPA 99 test standards. These procedures required one to test at either 500 or 1000 volts. This caused concern regarding safety of the person performing the tests. The ESDA standardized the test procedures so that lower volts could be used within specific ranges.

The ACL 395 meter uses a 9-volt battery. Some meters with 9-volt batteries do not give the accuracy needed to perform the tests, especially at values higher than 10^7. The ACL 395 is built with a transformer that converts the 9-volt charge from the battery to 10 volts or 100 volts. The meter applies a constant charge over the complete voltage range. Accuracy depends on applied voltage, temperature, and humidity.

TEMPERATURE AND HUMIDITY

Ambient humidity and temperature affect the electrical properties of the material being tested. The combination of low humidity and low temperature will give the highest electrical resistance results and slowest dissipation times. At high humidity, a thin layer of water is condensed on or absorbed into the material being tested. This is true of hydroscopic additives that are incorporated into a material in order to increase the electrical conductivity. These additives will allow moisture to be absorbed into the materials to which they are added.

At elevated temperatures, the mobility of free electrons increases, thereby also increasing a material's conductivity. This is especially true for carbon black, metallic oxides, metals, and other substances. When the material is at a lower temperature, built-in stresses occur which may increase resistance due to increased distance between the conductive additives. Thus, humidity and temperature must be known.

Recording Data

ANSI/ESDA and European CECC recognize the effect environmental conditions have on test measurements and specify in their standards that they measured and recorded. It is possible to test or manufacture a material at high humidity and pass all the test specifications, but when the customer receives the material and uses it at a lower humidity or temperature the material fails to pass the specifications. This can cause rejections and loss of product.

Both ESD S4.1 ESD Protective Worksurface sections 6.2.4 and ESD S7.1-1994 Resistive Characterization of Materials Floor Materials sections 5.2.4 and 5.3.3 require reporting of temperature and humidity at the time of testing.

Calibration

Calibration is recommended annually. The ACL 395 meter comes with a certificate of calibration which verifies the calibration of the instrument using equipment that is traceable to National Standards and CAD-generated techniques. Meters can be sent back to ACL Inc. for calibration for a lab fee or they can be sent to a certified calibration lab. (See page 12 for calibration instructions.) The meters also come with a CE mark approval.

Measuring with Internal Probes

The parallel resistivity probe method complies with ASTM D257. It is used to give fast electrical resistivity measurements on flat homogeneous materials. It may be used on multilayered materials, but this should be noted along with the temperature and humidity values on the data report.

The rails on the ACL 395 are made of conductive rubber. Soft rubber rails provide the highest level of surface contact for greater accuracy.

When the measurement is taken between the meter’s two rubber rails, the meter will indicate the surface resistivity of the material being tested.

A. Prior to testing, make certain that surfaces to be tested are clean and free of contaminants.

B. Allow the meter to acclimate to the atmosphere in which it will be used. Adjustment to new environmental conditions may take as long as a half hour.

C. Place the meter on the desired surface to be tested.

D. Press and hold the red integrated test button with approximately five pounds of applied force. The meter will display the surface resistivity.

E. When using the built-in probes, the meter’s test values for surface resistivity are in ohms per square (although they are displayed in ohms).

F. The test value is indicated on the LED display. A decade will brighten to the according test value. Colors signify the test value’s function (see page 3).

MEASURING WITH EXTERNAL PROBES

When the measurement is taken using the 5-lb external probes from the ACL 396 accessory kit, the tester will indicate the resistance of the material in ohms.

The external probes are used to give fast electrical resistivity measurements on flat homogeneous materials. They may be used on multilayered materials, but this should be noted along with the temperature and humidity value on the data report.

When the cables have been plugged into the appropriate sockets, the parallel probes under the meter disengage.

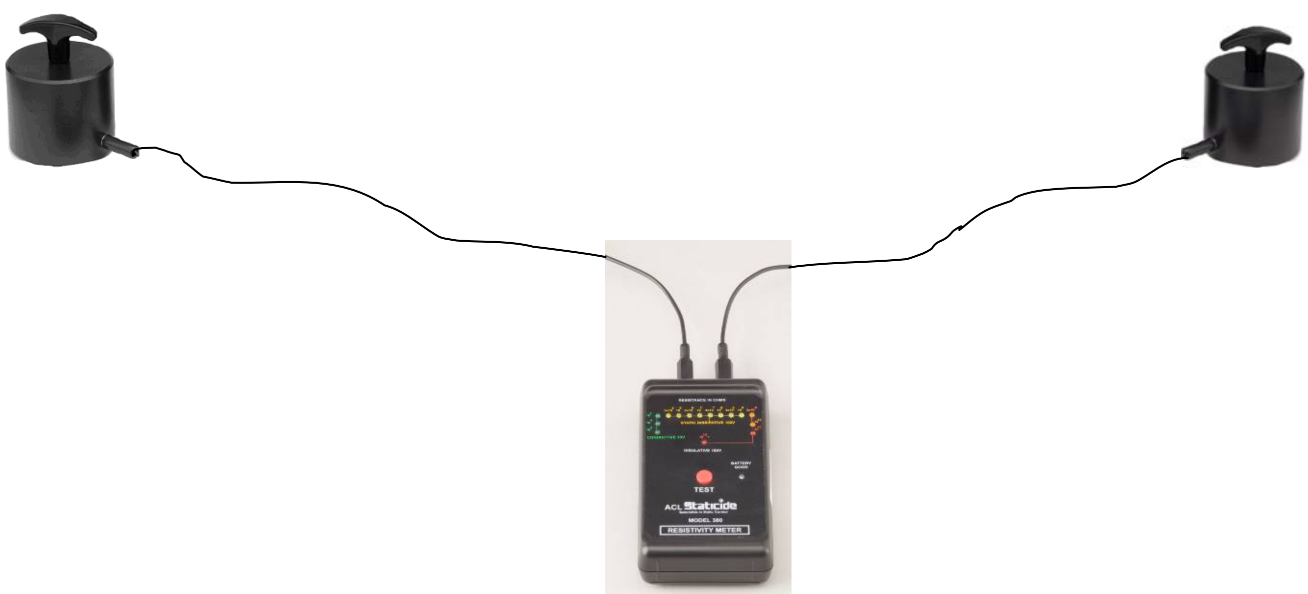
By connecting the 5-lb probes to the ACL 395's sockets, it is possible to measure Resistance Point to Point (RTT), Resistance to Ground (RTG), and Volume Resistance. Using these external probes will allow compliance with various standards including ANSI/ESDA S4.1 for Worksurface – Resistance Measurements, ANSI/ESDA S7.1 Resistive Characterization of Materials – Floor Materials.

When auditing is finished, unplug the cables and store probes in the protective case.

Resistance Point to Point (RTT)

RTT measurements can be used for the evaluation of floors, chairs, carts, work surfaces and other ESD-controlled materials and products. Procedures vary regarding sample preparation, probe preparation and spacing of the 5-lb probes. Select and read the correct test procedure or standard for the desired measurement. Test procedures can be purchased from www.esda.org.

A. Connect one end of each banana test lead into the sockets of the meter. Connect the other end of the test coil cords into the 5-lb probes.



B. Place both probes on the material according to test procedures or standard being used.

C. Press the "TEST" button and the value will be displayed on the LEDs. The meter will apply the correct voltage (10v or 100v) according to the value of what is measured.

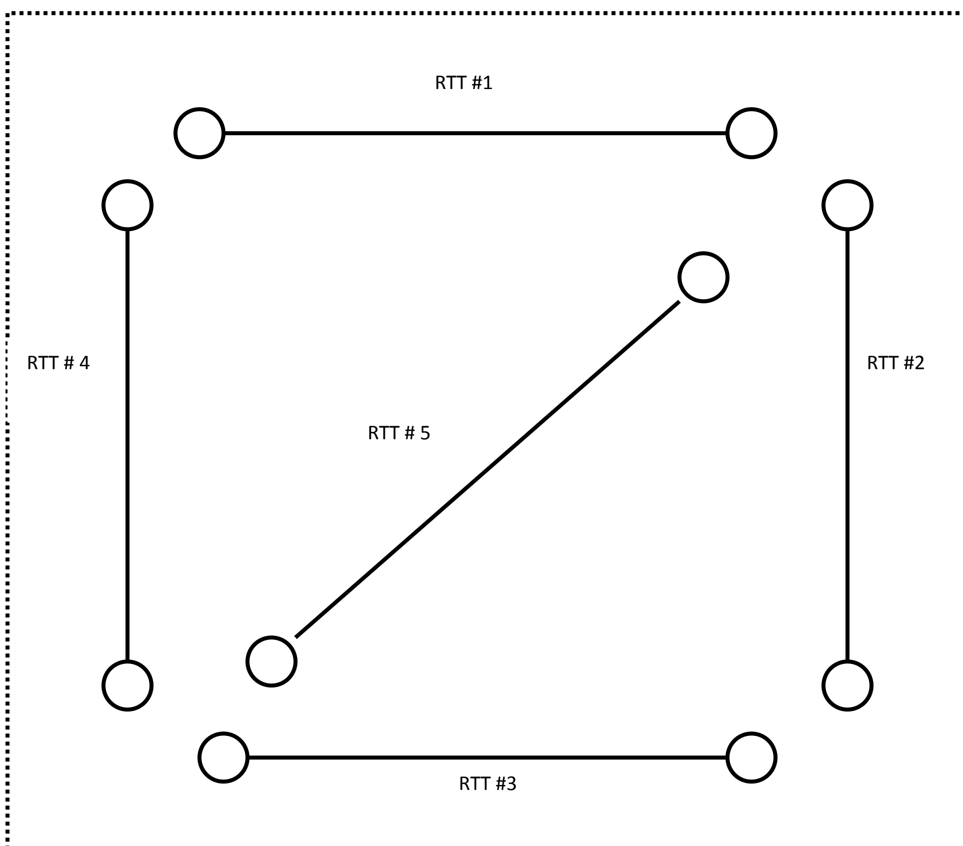
D. When performing test, do not touch lead wires or probes. Avoid overlapping of lead wires. This will ensure accurate readings.

AN EXAMPLE OF MEASURING RTT ON DISSIPATIVE FLOORING:

Taking routine measurements of tiles coated with dissipative floor finish is a key component of proper floor maintenance. Any problems that arise with the floor will be easily detected. Keeping a record of temperature, humidity and electrical properties will provide a reference, and will point toward a blueprint of traffic patterns on the floor. Good record keeping will ensure success when developing and maintaining a maintenance program.

To obtain an average measurement of a floor, map out a 4’ x 4’ section and conduct five tests (one at a time) within the square. Conduct a test for each side of the square and a final test diagonally through the center as shown in the drawing below.

In each RTT test, the 5-lb probes are placed three feet apart (36 inches). Connect the test leads to the meter. Attach a 5-lb probe to the end of each lead and place three feet apart as indicated below. Press and hold the “TEST” button on the ACL 395 meter until a value is displayed.



4’ x 4’ Section
(not to scale)

MEASURING RESISTANCE TO GROUND (RTG)

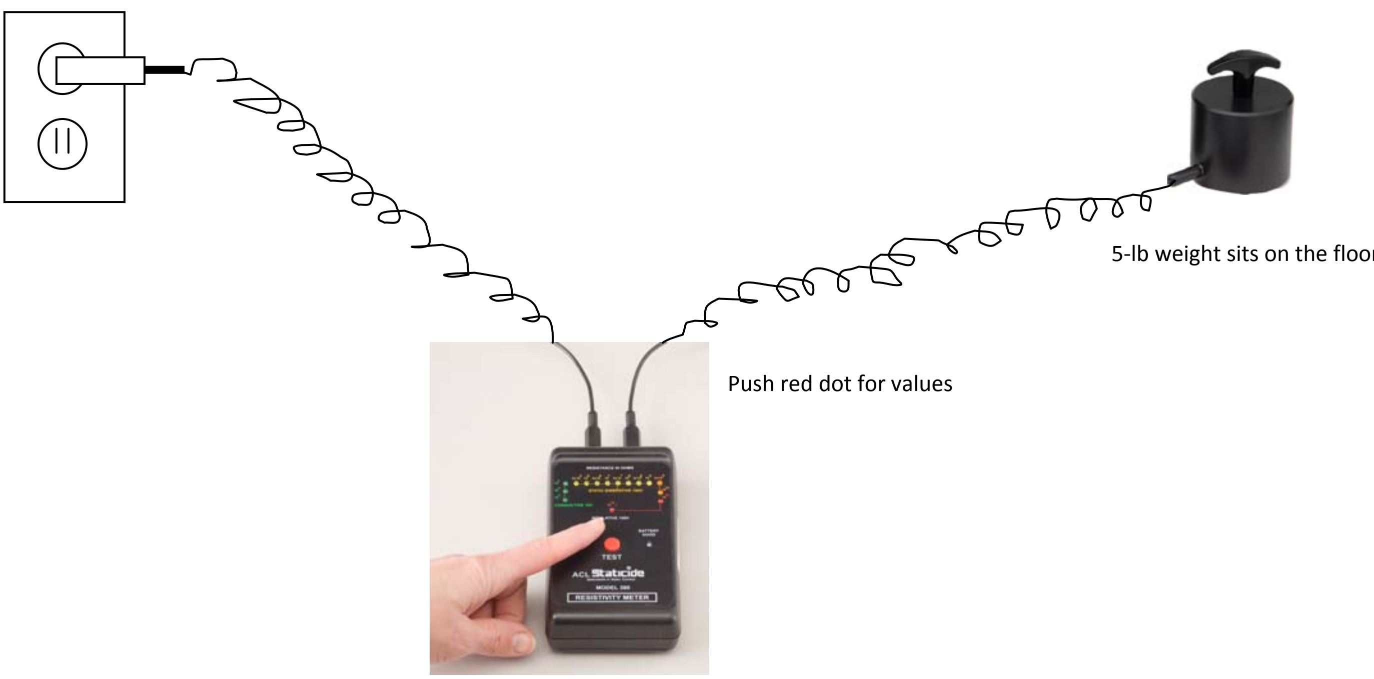
RTG measurements can be used for the evaluation of floors, chairs, carts, work surfaces and other ESD-controlled materials and products. Keeping a record of test results for temperature, humidity and electrical properties will provide a reference.

AN EXAMPLE OF MEASURING RTG ON DISSIPATIVE FLOORING:

For Testing Resistance on Floors, S7.1 requires a minimum of five RTG tests per 5,000 sq. ft. Connect the leads for the external probes to the meter.

When the cables have been plugged into the appropriate socket, the parallel probes under the meter disengage.

Attach one lead to a 5-lb probe and place probe onto the floor to be tested. Attach the other lead to an alligator clip and connect to a groundable point (RTGP). If using a ground adapter plug, plug the banana lead into the adaptor after the adapter is plugged into the receptacle.



AN EXAMPLE OF MEASURING RTG ON DISSIPATIVE TABLE MATS:

A. To test RTG on a workstation, connect the first lead to the meter and to a 5-lb probe. Place the probe on the work surface. Connect the second lead to the meter and to a groundable point (RTGP).

B. To attach lead to RTGP, slip the alligator clip to the lead and connect it to the ground snap or connect the banana plug to a common point ground plug:

b. Press the “TEST” button and the value will be displayed on the LED. While performing test, do not touch lead wires or probe. Avoid overlapping of lead wires. This will ensure accurate readings.

c. Resistance values are in ohms. When recording test values also make note of the temperature and humidity, as the environment can affect test results.

Volume Resistance Measurement

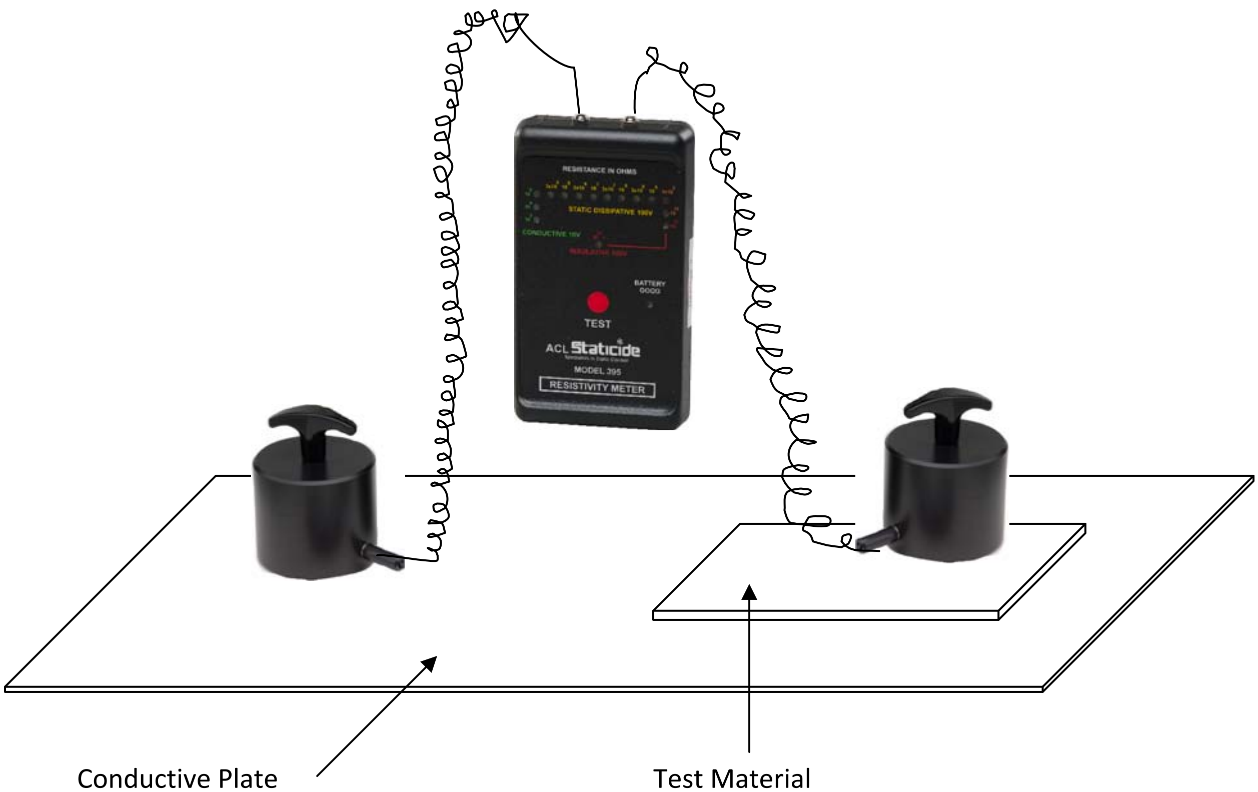
Volume Resistance measures the electrical path through a material.

A. Connect one end of each of the banana test leads into the sockets of the meter. Connect the other end of the test coil cords into the 5-lb probes.

B. Place sample material on a conductive metal plate (such as stainless steel). Place one of the 5-lb probes onto the material so that the material is sandwiched between the probe and metal plate. (See below)

C. Place the second 5-lb probe on the conductive metal plate.

D. Press the "TEST" button and the value will be displayed on the LED. Volume Resistance is measured in ohms-cm.



ACL 395 Calibration Instructions

This meter should be calibrated every twelve months. To verify if the tester is within specification, a test resistance can be applied across the parallel bars using a resistance decade box. Calibration can be obtained by contacting ACL Incorporated.

Specifications

Dimensions:	70mm x 130mm x 35mm (approximate)	
Weight:	103 grams (approximate)	
Power:	Battery-operated PP3 9-volt	
Connections:	2 x 3.5mm jack plug for earth connection	
Test Range:	10^3 to 10^{12+}	
Dissipative Range:	3×10^5 to 3×10^9 (½ decade between each decade on a logarithmic scale)	
Unit of Measurement:	Surface resistivity	Ohms per square
	Resistance point to point	Ohms
Accuracy:	+/- 0.5 decade in conductive range	
	+/- 0.25 decade in dissipative range	

Decade range	Change over point	value	value
10E3 to 4	3x10E3	3,000	3 K ohm
10E4 to 5	3x10E4	30,000	30 K ohm
10E5 to 3x10E5	1.7x10E5	170,000	170 K ohm
3x10E5 to 10E6	6x10E5	600,000	600 K ohm
10E6 to 3x10E6	1.7x10E6	1,700,000	1.7 M ohm
3x10E6 to 10E7	6x10E6	6,000,000	6 M ohm
10E7 to 3x10E7	1.7x10E7	17,000,000	17 M ohm
3x10E7 to 10E8	6x10E7	60,000,000	60 M ohm
10E8 to 3x10E8	1.7x10E8	170,000,000	170 M ohm
3x10E8 to 10E9	6x10E8	600,000,000	600 M ohm
10E9 to 3x10E9	1.7x10E9	1,700,000,000	1.7 G ohm
3x10E9 to 10E10	6x10E9	6,000,000,000	6 G ohm
10E10 to 11	3x10E10	30,000,000,000	30 G ohm

TEST EQUIPMENT USED

* Resistance Decade Box
* Test Leads

The resistance decade box required will need a range of from 1 kilohm (10^3) to 999 meg ohms (10^9). Measurements greater than 10^9 are calculated using CAD-generated techniques, as high resistances greater than 10^9 are difficult to verify with a test voltage of 9 volts.

Connect the test leads from the resistance decade box to the test probes of the meter, set the decade box to the desired resistance i.e. 10^3 = 1 K, then press and hold the meter's test button. The 10^3 LED should light, 10 K 10^4 LED should light and so on. To measure the changeover point between decades, increase the resistance of the decade box while pressing the meter's test button. Record the resistance when the next LED lights permanently (this is the changeover resistance).

Example: The first green LED is illuminated 10^3 = 1 kilohm. At 3 or 4 kilohms, 10^4 LED is illuminated. The changeover point is 3 or 4 kilohms. 10^4 = 10 kilohms so between 3 or 4 kilohms and 30 or 40 kilohms will be the changeover points from 10^4 to 10^5.

Please note that the meter has no internal parts to adjust, so verification of calibration can be achieved by using the above process. If verification cannot be achieved the unit should be returned to the supplier.