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- Specialist Drummond Testers
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CE

E1610 EARTH / GROUND TESTER

INSTRUCTION MANUAL

Metrohm

SAFETY INFORMATION: Always read before proceeding.

WARNING

These instructions contain both information and warnings that are necessary for the safe operation and maintenance of the earth tester. It is recommended that you read the instructions carefully and ensure that the contents are fully understood. Failure to understand and to comply with the warnings and instructions can result in serious injury, damage or even death.

In order to avoid the danger of electrical shock, it is important that proper safety measures are taken when working with voltages exceeding 30V AC rms, 42 V AC peak or 60 V DC.

This tester must only be used under the conditions and for the purposes for which it has been constructed. Particular attention should be paid to these warnings, the precautions, the technical specifications and the use of the E1610 in dry surroundings.

Always inspect your meter and accessories for any sign of damage before use. If any abnormal conditions exist (e.g: cracked case, display not reading, etc.), do not attempt to use it. Do not expose it to direct sunlight, excessive temperature or moisture.

Keep these instructions for future reference. Updated instructions and product information are available at: www.martindale-electric.co.uk

SYMBOLS:

Equipment complies with relevant EU Directives

AC (Alternating Current)

Ground **Direct Current**

Equipment protected by Double Insulation (Class II)

Caution - refer to accompanying documents

Caution - risk of electric shock

End of life disposal of this equipment should be in accordance with relevant EU Directives

B) MECHANICAL

Size: 190 X 90 X 54mm
Material: Polycarbonate/ABS
Weight (less carrying case): 0.5 kg
Display: Custom Liquid Crystal

C) ENVIRONMENTAL

Operating Temperature Range: -15°C to +55°C
Storage Temperature: -20°C to +70°C

General

Safety Class: II EMC: Meets BS EN 50081-1
BS EN 50082-1 LVD: Meets BS EN 61010-1

Battery: 6 off 1.5V, AA / IEC LR6 / MN1500 Manganese-Alkaline

Fuses: 2 X 100mA, 5 X 20mm, HBC, 250V Fast Blow

SPARES AND ACCESSORIES

Field Test Kit 1: MARER2KIT
Field Test Kit 2: MARER4KIT
Carrying Case: MARTC57

CONTENTS

1. DESCRIPTION

The E1610 is a hand held digital earth tester designed to measure earth resistance, earth continuity and can be used to determine soil resistivity. The tester is supplied in a carrying case that has been designed to allow the tester to be operated from within it. An adjustable strap is included so the unit can be suspended from the user's neck.

The E1610 uses the four terminal measurement method in which the resistance of the current circuit test leads does not affect the reading. The resistance of the potential circuit test leads can also be ignored because the measuring circuit has an input buffer stage to prevent loading of the earth resistance under test.

NOTE: The E1610 can also be used for the three terminal measurement method with reduced accuracy.

The earth resistance is displayed directly on the large liquid crystal display.

There are two optional earth testing field accessory kits available from Martindale Electric Ltd.

MARER2KIT contains 1x 50m test lead, 1x 30m test lead, 1x 3m test lead, 2x test spikes, a mallet and carry bag.

MARER4KIT contains 1x 50m test lead, 1x 30m test lead, 2x 3m test lead, 4x test spikes, a mallet and carry bag.

Interference:	Interference voltages of 5V rms nominal 50/60Hz in the potential circuit will not affect the reading by more than ±0.5%
Maximum Current Spike Resistance	2kΩ typical on 20Ω range 5kΩ typical on 200Ω range 50kΩ typical on 2000Ω range
Maximum Potential Spike Resistance	2.2kΩ typical on 20Ω range 22kΩ typical on 200Ω range 52kΩ typical on 2000Ω range
Maximum Output Voltage:	30V rms
Response Time:	3secs nominal
Voltage Withstand:	240V AC between any two terminals
Temperature Coefficient:	±0.05%/°C
Battery Low Indication point:	6.5V nominal
Current Consumption:	120mA nominal on 20Ω range 90mA nominal on 200Ω range 90mA nominal on 2000Ω range

Metrohm Specification
E1610 Earth / Ground Tester

A) ELECTRICAL

Earth Resistance Ranges

Range: 0 to 20Ω in steps of 0.01Ω
0 to 200Ω in steps of 0.1Ω
0 to 2000Ω in steps of 1Ω

Accuracy: 2% of reading ±2 digit
Total service error ±5% of reading ±2 digit

Test Current: 10mA a.c. rms nominal on 20Ω range
1mA a.c. rms nominal on 200Ω range
0.1mA a.c. rms nominal on 2000Ω range

Test Frequency: 128Hz nominal

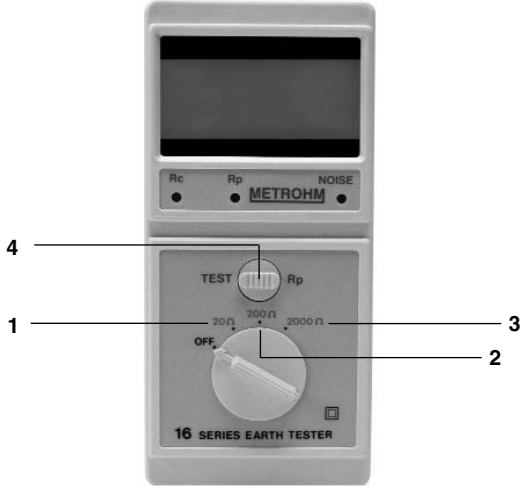

Fig 1. illustrates the front layout of the E1610 tester. The function switch selects OFF, 20 Ohms, 200 Ohms and 2000 Ohms.

1. Resistance 0-20Ω
With the function switch in the 20Ω position, earth resistance in the range 0-20Ω can be measured and the value is displayed on the L.C.D.

2. Resistance 0-200Ω
With the function switch in the 200Ω position, earth resistance in the range 0-200Ω can be measured and the value is displayed on the L.C.D.

3. Resistance 0-2000Ω
With the function switch in the 2000Ω position, earth resistance in the range 0-2000Ω can be measured and the value is displayed on the L.C.D.

4. Test RP button
Checking the potential spike resistance. Rp LED should not light.

5. High Current Spike Resistance
To indicate that the test spike resistance of the current circuit is too high the LED marked Rc (resistance current) will illuminate and the display will indicate an overrange condition. This will prevent the operator taking an invalid reading should he/she not react to the Rc lamp. This circuit is activated when the tester is switched on and will automatically display an Rc fault even during a test. An Rc fault may be caused by an open circuit or poor connection in the test lead, high resistance in the ground in the vicinity of the current test spike or poor contact with the spike.

6. High Potential Spike Resistance
To indicate that the resistance of the potential circuit is too high the LED marked Rp (resistance potential) will illuminate. This test is not automatic, but should be a preliminary test carried out by the operator by pressing the button marked "TEST Rp". An Rp fault may be caused by an open circuit or poor connection to the test lead, high resistance in the ground in the vicinity of the potential test spike or poor electrical contact with the spike.

NOTE: Operating the "TEST Rp" button will cause the L.C.D. to read overrange during this test.

7. Interference Noise
The LED Marked "NOISE" will automatically illuminate when

4.4 Storage Conditions
The earth tester should be kept in warm dry conditions away from direct sources of heat or sunlight, and in such a manner as to preserve the working life of the unit. It is strongly advised that the unit is not kept in a tool box where other tools may damage it.

5. WARRANTY
The E1610 is guaranteed against faults in manufacture and materials for 24 months from date of invoice and will be rectified by us free of charge, provided the unit has not been tampered with and is returned to us with its housing unopened. Damage due to dropping, abuse or misuse is not covered by this guarantee. Batteries and fuses are not covered by this guarantee.

References

I.E.E. 16th EDITION WIRING REGULATIONS (BS7671) GUIDANCE NOTE 3 INSPECTION & TESTING

IEEE Std. 81.2 - 1991
IEEE Std. 81 - 1983

4. MAINTENANCE

Maintenance consists of periodic cleaning and battery replacement. The exterior of the instrument can be cleaned with a dry clean cloth to remove any oil, grease or grime. Never use liquid solvents or detergents which may be conductive.

4.1 Fuses

The fuse located in the battery compartment is used to protect the tester if the current circuit test leads are connected to a "live circuit". To replace this fuse disconnect the test leads, remove the battery cover and the blown fuse then replace with a fuse of the correct type and rating. There is also a fuse located on the pcb which is used to protect the potential circuit. Fuse type 5 X 20mm 250V 100mA HBC, refer to the spares and accessories section.

4.2 Cleaning

The E1610 may be cleaned using a soft damp cloth. Do not use abrasives, solvents, or detergents, which can be conductive. Allow to dry completely before using.

4.3 Repair & Service

Repairs or servicing not covered in this manual should only be performed by qualified personnel. There are no user serviceable parts in this unit. Return to Martindale Electric Company Ltd if faulty. Our service department will quote promptly to repair any fault that occurs outside the guarantee period.

Before the unit is returned, please ensure that you have checked the unit and associated leads thoroughly for flat batteries (check & replace), blown fuses (check & replace) and other poor connections.

the interference voltage in the earth being measured exceeds the level which can be rejected by the tester. A valid measurement cannot be made in this condition. The solution may be to wait until the interference, if transient in nature, has subsided or to change the position of the test spikes.

Battery Low

If the battery voltage is too low, the "BAT LOW" symbol will appear on the L.C.D.

Reverse Polarity

If the potential test leads have been reversed with respect to the current test leads, a minus sign (-) will be displayed on the L.C.D. The reading is still valid but the potential leads should be reversed to remove the minus (-) sign.

1.2 Unpacking and Inspection
Before unpacking the Earth Tester, examine the shipping carton for any sign of damage. Unpack and inspect the Earth Tester and if there is any damage then consult your distributor immediately.

After removing your new Earth Tester from its packaging, you should have the following items:

1. E1610 Earth Tester
2. Instruction manual
3. Quantity of 6 AA / LR6 / MN1500 batteries
4. Carrying case

If any of the above items are missing or are received damaged, please contact the distributor from whom you purchased the unit.

1.3 Battery Check
Select the 20 Ohms range and if the "BAT" symbol appears on the L.C.D., replace the batteries. Note that the condition of the batteries is constantly monitored and the "BAT" symbol could appear during operation.

Battery Replacement
Disconnect the test leads and slacken the captive screws on the battery cover. Lift off the battery cover, remove the spent batteries and replace with new ones:

The instrument is powered by six 1.5V manganese-alkaline batteries size AA / LR6 / MN1500.

NOTE: When changing the batteries or the fuse, always disconnect the test leads from the instrument.

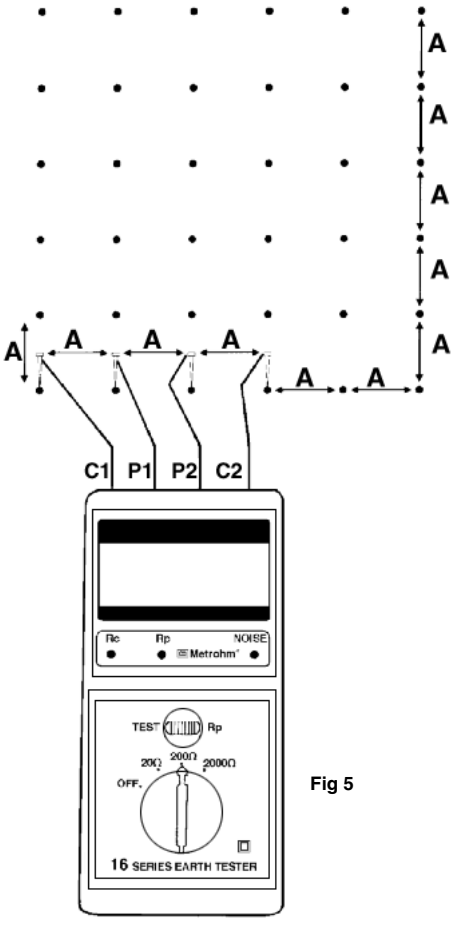

Fig 5

"Finding the region of lowest resistivity"

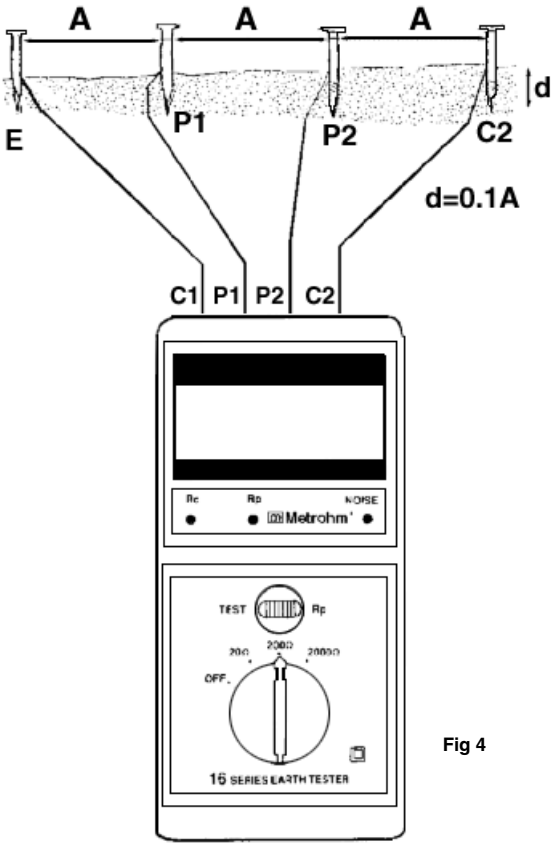

Fig 4

"Wenner arrangement"

2. SAFETY RULES

CAUTION RISK OF ELECTRIC SHOCK

This tester has been designed with your safety in mind. However, no design can completely protect against incorrect use. Electrical circuits can be dangerous and/or lethal when lack of caution or poor safety practices are used.

Do not carry out field measurements on either the power system grounding, during periods of forecast lightning activity, in areas that encompass the station being measured or of the power network connected to the station being measured. In the event that lightning occurs, stop all testing and isolate any temporarily installed test spikes.

Preparations for testing of power system grounding can leave personnel vulnerable to exposure caused by faults at or fed from the system under test, transferred potentials from remote test grounds and inadvertent line electrification.

While the probability of the occurrence of one of these events is low, personnel safety will, nevertheless, be enhanced by the following:

When working near high tension systems rubber gloves and shoes should be worn.

Work on an approved insulating material such as an insulating blanket.

Avoid bare hand to hand contact between the tester and extended test leads.

Safety can be further enhanced by the use of a disconnecter or switch to isolate the current source (C2) and the voltage probe (P1) circuit when measurements are being made.

Disconnect the tester from any external circuit when changing the batteries.

Follow the instructions in this manual for every measurement. Read and understand the instructions before attempting to use this tester.

2.1 SAFETY CHECK

Before using the tester check the condition of the batteries.

This is readily accomplished by switching the tester to the 20Ω range. If the “BAT LOW” symbol appears the batteries need replacing.

When changing the battery, fuse, or removing the cover to access the internal circuitry, always disconnect the test leads.

When replacing the fuse use only the type specified: 5 X 20mm, 100mA, 250V HBC fuse. Be sure to insert correctly in the fuse holder.

Double check the switch setting and lead connections before taking measurements.

Don't touch exposed wiring, connections or other "Live" parts of an electrical circuit. Always check circuits first for voltage before working on them.

Do not use cracked or broken test leads.

THIS INSTRUMENT SHOULD ONLY BE USED BY A COMPETENT, SUITABLY TRAINED PERSON.

Soil Resistivity

The techniques for measuring soil resistivity are essentially the same whatever the purpose of the measurement, i.e. finding the best site to sink an electrode, geophysical prospecting or archaeological surveys. However the interpretation of the recorded data can vary considerably, especially where soils with non uniform resistivities are encountered. The added complexity caused by non uniform soils is common, and in only a few cases are soil resistivities constant with increasing depth. Earth resistivity not only varies with the type of soil but also with temperature, moisture content, salt content and compactness. Therefore it is essential that the soil resistivity is checked prior to siting an electrode and periodically thereafter.

The most common method of measuring earth resistivity is the equally spaced or Wenner Arrangement. With this method the electrodes are arranged, as shown in Fig. 4, in a straight line, equally spaced at intervals ‘A’ and driven to a depth not exceeding 0.1A. The tester is operated and a resistance measurement taken. The soil resistivity ρ *can be calculated from the formula* $\rho = 2\pi AR$ *where 'A' is the distance between the test spikes and R is the resistance reading.*

This gives approximately the average soil resistivity to the depth 'A'. If the spacing and depth of the test spikes are maintained and further readings are taken as shown in Fig. 5 the region of lowest resistivity can be found over a given area. Extra sets of readings taken with different test spike spacings give a set of resistivities which, when plotted against spacing, indicate whether there are distinct layers of soil or rock and give an idea of their respective resistivities and depth.

This rule only applies when the earth electrode and both the current and potential spikes are in a straight line, the soil is homogeneous and the earth electrode has a small resistance area. Bearing in mind these limitations this method can be used on small earth systems consisting of single rod or plate and on medium systems using several rods. The connections and layout for the 62% rule are shown in Fig. 3. For most purposes the current spike should be placed 30 to 50m from the earth electrode under test. The potential spike should be inserted in the ground at 62% of this distance, measured from the earth electrode and in a straight line with the earth electrode and current spike. For greater accuracy an average reading can be calculated by moving the current spike C2 10m either side of its original position, also moving the potential spike P2 relative to the earth electrode to maintain 62% of the distance between the earth and current electrodes, and making further measurements.

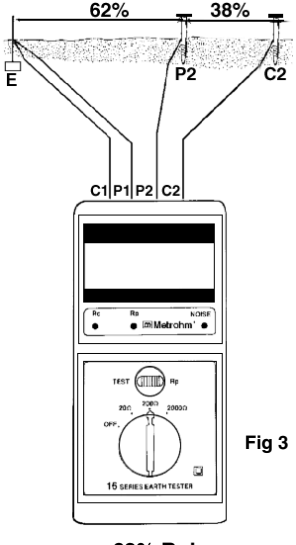

Fig 3

62% Rule

3. BASIC TEST PROCEDURE

After the test spikes have been set up and connected to the tester:

1. Select the measuring range required.
2. Check that no adverse test conditions are displayed i.e. high current circuit resistance, noise interference or battery low are not displayed.
3. Press the "TEST Rp" button to check potential spike resistance. The "Rp" LED should not be illuminated. Release the 'TEST Rp' button.
4. If all the conditions for a test are satisfactory then the reading on the display may be accepted as the earth resistance. The reading should be stable.

REQUIREMENT. (BS7671)

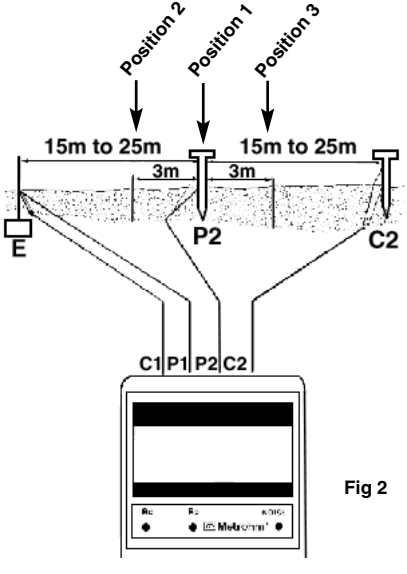

Fig 2

'Fall of potential' Method

IEE Guidance note 3 specifies the method for testing the resistance of earth electrodes.

"Before this test is undertaken, the earthing conductor to the earth electrode must be disconnected either at the electrode or the main earthing terminal to ensure that all the test current passes through the earth electrode alone. This will leave the installation unprotected against earth faults.

SWITCH OFF SUPPLY BEFORE DISCONNECTING THE EARTH.

The test requires the use of two spikes (electrodes) and is carried out in the following manner.

Connection to the earth electrode is made using terminals C1 and P1 of a four terminal earth tester. To exclude the resistance of the test leads from the resistance reading, individual leads should be taken from these terminals and connected separately to the electrode as in Fig. 2. If the test lead resistance is insignificant, the two terminals may be short-circuited at the tester and connection made with a single test lead. Connection to the temporary spikes is made as shown in Fig 2.

The distance between the test spikes is important. If they are too close together, their resistance areas will overlap. In general, reliable results may be expected if the distance between the electrode under test and the current spike is at least ten times the maximum dimension of the electrode system, e.g. 30m for a 3m long electrode.

Three readings are taken: With the potential spike initially midway between the electrode and current spike, secondly at a position 10% of the electrode-to-current spike distance back towards the electrode and finally at a position 10% of the distance towards the current spike.

By comparing the three readings, a percentage deviation can be determined. This is calculated by taking the average of the three readings, finding the maximum deviation of the readings from this average in ohms, and expressing this as a percentage of this average.

The accuracy of the measurement using this technique is typically 1.2 times the percentage deviation of the readings. It is difficult to achieve a measurement accuracy better than 2%, and inadvisable to accept readings that differ by more than 5%. To improve the accuracy of the measurement to acceptable levels, the test must be repeated with a larger separation between the electrode and the current spike.

The instrument should be capable of checking that the resistance of the temporary spikes used for testing are within the accuracy limits stated in the instrument specification. This may be achieved either by an indicator provided on the instrument, or the instrument should have a sufficiently high upper range to enable a discrete test to be performed on the spikes.

If the temporary spike resistance is too high, measures to reduce the resistance will be necessary, such as driving the spikes in deeper into the ground or watering with brine to improve contact resistance. In no circumstances should these techniques be used to temporarily reduce the resistance of the earth electrode under test.

AFTER COMPLETION OF THE TESTING ENSURE THAT THE EARTHING CONDUCTOR IS RECONNECTED"

The 62% Rule

The measurement technique stated on page 9 and 10 is essentially the fall of potential method. If the readings using the method differ beyond the required accuracy then the 62% rule can be used. The 62% rule states that the true resistance of the earth electrode is equal to the measured resistance when the potential spike is positioned 62% of the distance between the earth electrode and the current spike, away from the earth electrode.