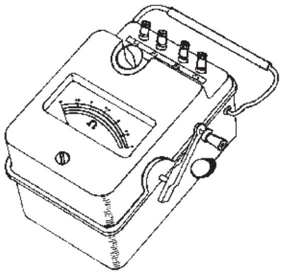
OPERATING INSTRUCTIONS
EARTH TESTER
Direct Indicating Type



Applications

The installation of good earthing system is an essential part of electrical supply, wiring safety and installation economics.

It is necessary for an earth electrode to have a total low resistance to perform satisfactorily. The value is influenced by a specific resistance of the surrounding soil. This in turn depends on the nature of the soil and its moisture contents .Before sinking an electrode, it is advantageous to survey the surrounding area before choosing the final site for electrodes.

One of the major applications of EARTH TESTER is to measure resistivity of soil at different levels underground from ground level. This indicates the advisability of sinking electrodes to a greater depth, rather than increasing cost by adding more electrodes and connecting cables, in order to Reach, a specified total earth system resistance.

For archaeological and geological surveys, an investigation of soil structure and building remains can be carried out at varying measured depths.

Detailed methods of obtaining soil resistivity reading are given in later page.In all the cases, accuracy of the instrument readings may be taken to be higher than the natural variables in soil characteristics.

General Description

SHANTI Earth Tester is a completely self contained instrument designed to give accurate measurement of earth electrode resistance, soil resistivity,earth continuity and Neutral Earth loop tests for IEEE wiring regulations.

An AC brushless generator is used to provide alternating current which is passed through the soil to to overcome interference from stray currents. An electronic converter is used to convert AC to DC for measurements.

The basic system employed in this instrument incorporates a hand driven AC generator to pass a test current between earth electrode under test and a current electrode. The potential drop across the test electrode and a separate intermediate electrode i.e. P1 & P2 is rectified and passed to a moving coil microammeter.

To make test

1. Connect the instrument for the particular test required as described later.
2. Set the RANGE SELECTOR to Highest range, if any.
3. Rotate the generator handle at 160 RPM and observe the ohmmeter deflection.
4. If the ohmmeter deflection is very low, change the RANGE SELECTOR to the next lower range.

WARNING : As a precaution, when working near high tension systems where accidental high potentials on the structure and in the ground are possible, it is recommended to wear rubber gloves.

Installing Test Electrodes

Recommended test spikes for making temporary connections are available as part of optional accessory kit. Solid mild Steel spikes, 13mm dia. and 45cm long, should be driven to the depth of 30 cm with rapid blows from a 1 kg. hammer.

Testing Earth Electrodes

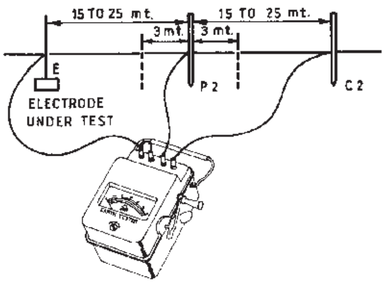


Fig.1 CONNECTIONS FOR TESTING RESISTANCE TO EARTH OF AN EARTH ELECTRODE

[a] Normal Method of Test

Join together terminals C1 & P1 and connect a lead from them to the Earth electrode under test E as shown in Figure 1. Keep this lead as short as possible,since its resistance will be included in the test. This lead resistance can be eliminated by connecting separate leads to the electrode E from C1 & P1 instead of shorting them together [Fig.2].

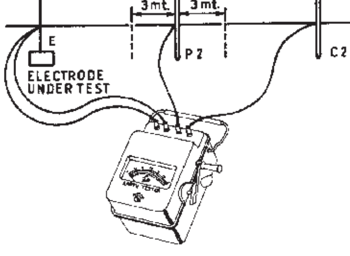


Fig. 2 ALTERNATIVE CONNECTIONS FOR TESTING RESISTANCE TO EARTH OF AN EARTH ELECTRODE COMPENSATING FOR CABLE RESISTANCE WHERE LONG LEADS REQUIRED

Alternatively the lead resistance can be determined and deducted from the total resistance. This is carried out by removing the lead from electrode E after the test and connecting it to P2 & C2 joined together. Its true resistance is then measured by the EARTH TESTER. The earth electrode resistance is measured as described previously.

[b] Alternative Method When 'Dead Earth' is available

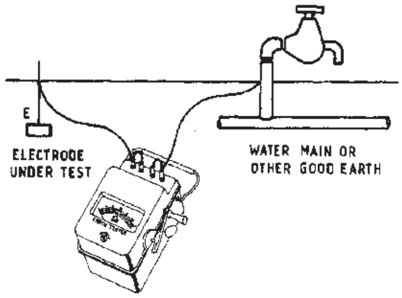


Fig. 3
ALTERNATIVE METHOD OF TEST WHEN A DEAD EARTH IS AVAILABLE

In congested areas it may not be possible to find a suitable site for testing spikes or to run the required test leads. In these cases, an alternative low resistence earth such as water main can be used. This should be of very low resistance earth and connections are as shown in fig.3 This test gives the combined resistance of the two earths in series. If resistance of the 'dead earth' is negligible then the reading may be taken as that of the electrode under test. However, care must be taken in using this method since non-metallic piping and joining is commonly found in water main installations.

The results obtained by this method are not as accurate as the two spike system (a) as above, which should be used as the standard practice wherever possible. Readings are particularly affected by the distance between the two earths which can cause serious distortions in the current flow.

Resistance of both leads are included in the test reading. It should be measured by joining further ends together. This value should be deducted from the total reading.

Rules for Test Electrode Spacing
The 61.8% Rule for Single Earth Systems

It is normal to measure earth electrode resistance by the 'fall-of potential' method. This involves positioning of current and potential spikes C & P as shown in fig.4 and connecting these by suitable cable to the Earth Tester to complete the current and voltage circuit. The tester is calibrated to read directly the resistance of earth electrode E under test. To obtain a sensible reading, the current spike must be correctly sited in relation to the electrode. Since both possess 'resistance areas' the former must be sufficiently remote to prevent these areas from overlapping. Further more the potential spike must lie between these two areas.

In practice the dimensions of the resistance areas of E & C are unknown and to allow a safety margin the distance EC must be impractically high. It is also necessary to experiment with positioning of P. However, by graphical considerations and by actual test it can be demonstrated that true resistance of the electrode to be tested is equal to the measured resistance when the potential electrode is at a distance from the earth electrode equal to 61.8% of the distance from the earth electrode to the current electrode.

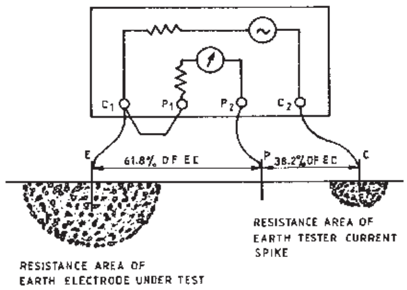


Fig. 4

Note that this rule is applicable only when all the three electrode are in a straight line and the earth is a single rod,pipe or plate etc.

Test Electrode Spacing

For most purposes the current electrode C2 (as in Fig.1) should be 30 to 50 metres from the electrode under test E. The potential electrode P2 should be inserted at 61.8% of this distance in a straight line with the other two. For ease of use in the field the following table gives a range of distance which follows this rule. In the first column 'Maximum Dimension' is defined as the maximum distance across the earth electrode system to be measured.

For maximum accuracy, the current electrode C2 should be moved say, 6.8 metres towards and away from its first position and further test readings are obtained. Remember that the potential electrode P2 must also be moved proportionately in accordance with the 61.8% rule. The average of the three readings is then taken.

Maximum Dimension M	Distance to potential electrode in Meters	Distance to current electrode in Meters
1	17	27
2	42	70
5	68	112
10	92	153
20	140	218

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OPERATING INSTRUCTIONS
EARTH TESTER
Direct Indicating Type

Continuity Testing

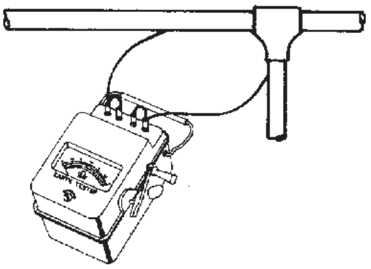

Fig. 5
INSTRUMENT IN USE FOR EARTH CONTINUITY TESTING

To test the continuity of conduit or other earth conductors, the instrument is connected as shown in Fig.5. It will measure metallic resistance of the low inductance or capacitance. Usual care should be taken where circuits may be live or of high potential.

Natural - Earth Loop Testing

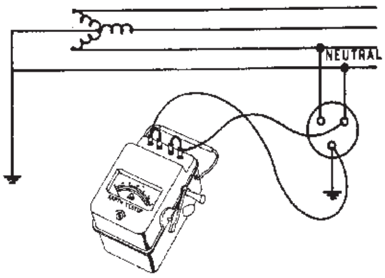

Fig. 6
TO MAKE A NEUTRAL EARTH LOOP TEST

Due to the inherently high accuracy of the instrument and the very low continuity resistance to be measured, the contact resistance between leads and conduit etc., becomes considerable and should be as low as possible.

Measuring Specific Resistivity of soil

Before sinking an electrode into the ground for a new installation it is often advantageous to make a preliminary survey of the soil resistivity of the surrounding site. This will enable decisions to be made on the best position for the earth electrode(s) and to decide whether any advantage is to be gained by driving rods to a greater depth. Such a survey may produce considerable savings in electrode and installation costs necessary to achieve a required resistance.

Calculation of Resistivity

Assuming the soil to be homogenous, the resistivity is given by the formula $\rho = 2 \Pi aR$, where 'R' is the resistance measured in ohms, 'a' is the electrode spacing in centimetres and 'p' is the resistivity in ohmscms.

For Non-homogenous ground, the formula will give an apparent resistivity which is very approximately the average Value to a depth equal to the electrode spacing 'a'.

Typical Variations in Soil Resistivity

The very wide variation in resistivity values is mainly due to moisture content. The specific resistance of any particular kind of soil cannot be forecasted with any degree of accuracy and it is therefore of the almost importance to test the resistance of any earth electrode when it is first laid down and thereafter at periodic intervals.

Material	Specific Resistance in ohms - cms.
Ashes	350
Coke	20 - 800
Peat	4,500 - 20,000
Garden earth - 50% moisture	1,400
Garden earth - 20% moisture	4,800
Clay soil - 40% moisture	770
Clay soil - 20% moisture	3,300
London Clay	400 - 2,000
Very dry clay	5,000 - 15,000
Sand - 90% moisture	13,000
Sand - Normal moisture	300,000 - 800,000
Chalk	5,000 - 15,000
Consolidated sedimentary Rocks	1,000 - 50,000

Inserting Test Electrodes

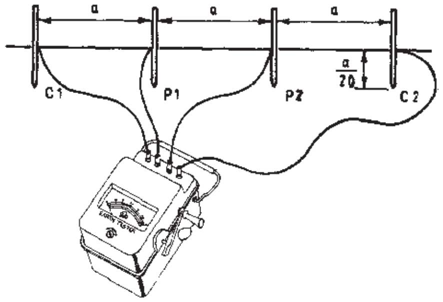

Fig. 7
CONNECTIONS FOR MEASURING EARTH RESISTIVITY

(1) Four electrodes are driven into the ground, in a straight line at equal distances 'a'.
(2) The depth of insertion must not exceed 1/20th of 'a'.
(3) The instrument is connected to four spikes as in Fig.7.
(4) The resistance is taken in the usual way.
(5) The specific resistance or resistivity is calculated.
(6) The four electrodes are repositioned for further tests. If the spacing is maintained, a direct comparative reading will be obtained each time, and areas of lowest resistivity located at constant depth 'a'.
(7) The distance 'a' is the depth to which soil resistivity is being measured. Thus a profile of different readings for depths b, c, d, etc., may be obtained by re-spacing electorodes to distances b,c,d, etc.

TEST REPORT

This is to Certify that "SHANTI" Earth Tester

Model No.__________________S. No.______________________

Range :____ ohms, was tested in our Q. C. Dept. as per Indian Standard
Specification for Earth Resistance Tester, Hand Operated (Magneto Generator Type) IS : 9223-1989 and the results are as follows :
a) Accuracy as per Clause 6.1__________________________
b) Insulation Resistance Measured by applying 500V DC as per clause 11.6 better than _____________Megohms.
c) High Voltage test for 1 minute by applying 2KV A.C. (rms)as per Clause 11.7_______________

TESTED BY : **DATED :**

WARRANTY

SHANTI Earth Tester is guaranteed for 12 months from the original date of despatch against any manufacturing defects. In case of any complaint, please return the instrument securely packed and freight prepaid to enable us to repair & return the same. No other warranty implied or otherwise is applicable.