HIOKI

INSTRUCTION MANUAL

3150

EARTH HiTESTER

HIOKI E.E. CORPORATION
81 Koizumi, Ueda, Nagano 386-11, Japan
TEL 0268-28-0562 FAX 0268-28-0568
TLX:3327508 HIOKI J CABLE:HEWLOV, Ueda

3150A981-06 94-04-004T 783200226

⚠ WARNING

THIS INSTRUMENT IS DESIGNED TO PREVENT ACCIDENTAI SCHOCK TO THE OPERATOR WHEN PROPERLY USED. HOWEVER, NO ENGINEERING DESIGN CAN RENDER SAFE AN INSTRUMENT WHICH IS USED CARELESSLY. THEREFORE, THIS MANUAL MUST BE READ CAREFULLY AND COMPLETELY BEFORE MAKING ANY MEASUREMENT. FAILURE TO FOLLOW DIRECTIONS CAN RESULT IN A SERIOUS OR FATAL ACCIDENT.

CONTENTS

SAFETY NOTICE

Please carefully read the following information before using the 3150 Earth Tester.

⚠ WARNING This notation indicates a condition that can result in hazard to the operator.

⚠ CAUTION This notation indicates a condition or practice that can result in damage to the test equipment.

Always observe the following safety precautions when using this test equipment.

* Verify that the leads are in good condition. If the insulation on any leads is damaged and/or the lead wire is exposed, please replace the leads before using the tester.
* Before starting measurement, verify that the proper function and range are selected.

⚠ WARNING

To avoid electrical shock, exercise extreme caution when using the tester with voltages in excess of 60V DC or 25V AC RMS.

Safety Notations

⚠	Indicates information in this manual that must be read by the operator.
⧈	Protection Class II (per IEC 348)

● Preface

Thank you for your purchasing Hioki's 3150 Earth Tester. To get the most from this tester, carefully read this manual before before making any measurement.

● Inspection

Upon taking delivery of the tester, carefully inspect it for transportation damage. If the tester appears to be damaged, or if it does not work properly, please contact the dealer from whom the tester was purchased.

OUTLINE

The earthing of electrical equipment is of the utmost importance in maintaining safety and protecting lives and earthing procedures are detailed in technical standards for electrical equipment and are based on the relative laws.

Because this tester employs an AC phase differential meter system, the effect of earthing voltage and auxiliary earthing resistance is minimized and very accurate measurement is possible.

1. FEATURES

● Performance surpasses *JIS C-1304 requirements

All performance figures are at JIS standard levels or better.

* Japanese Industrial Standards
* Complying with protection class II (per IEC 348)

● Scarcely affected by external disturbance elements

Accurate readings are possible because the effect of earth voltage, auxiliary earthing restance and air temperature is minimized.

● Easy measuring capability

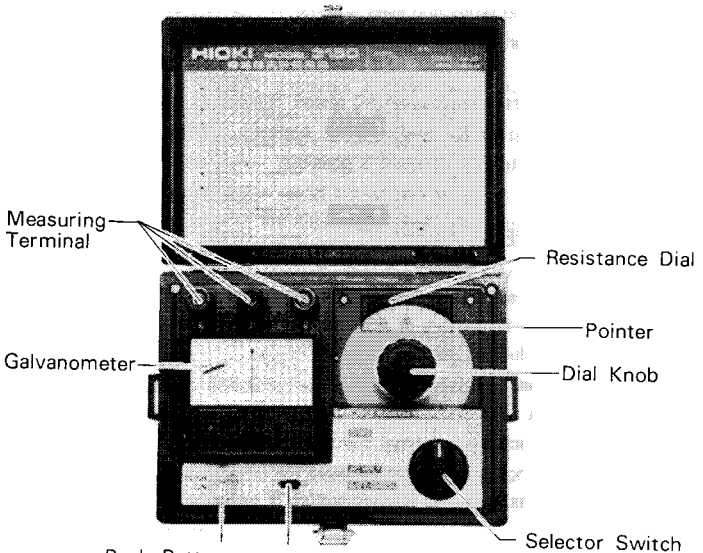
In measuring earthing resistance in tall buildings or where ground rods cannot be inserted, existing low earthing resistors are used to obtain earthing resistance readings.

When using a common earth wire on existing earth fixtures, the instrument is so designed that leak circuit breakers will not operate.

● Small, lightweight and sturdy

The case is made of very strong, shock-resistant plastic.

2. NAME OF PARTS



3. SPECIFICATIONS

- **Applicable Standard: JIS C-1304**
  (Applies in the case of the two-terminal method, 100Ω and 1000Ω range only)
- **Measuring Range and Accuracy Earth Resistance**
  10/100/1000Ω±2.5% of f.s.
- **Earth Voltage**
  30V AC. ±3% of f.s.
- **Operating System**
  AC potentiometer
- **Effect of Power Voltage**
  To accuracies given above, at 4~6.5V
- **Effect of Temperature**
  Not more than ±1% at 0~40°C
- **Effect of Auxiliary Earth Resistance**
  Not more than ±5% when fluctuation is 0~5kΩ
- **Effect of Earth Voltage**
  Not more than ±2% at 0~5V and not more than ±5% at 5~10V
- **Power Source** DC 6V SUM-2×4("C" SIZE)
- **Battery Life** Approx. 6hours
- **Environmental Conditions(operating)**
  0~40℃ < 80%RH (No condensation)
- **Insulation Resistance**
  At least 20MΩ at 500V DC between circuit and case
- **Dielectric Strength**
  3000V for1 min.
- **Safety Rating Protection Class II (per IEC 348)**
- **Dimensions. Weight**
  Approx. 125H×170W×110D mm. 1.1kg
- **Accessories**
  9049 Auxiliary earth probes 2pcs. 9040 Earth resistance measuring leads (One 5m black, one 10m yellow, one 20m red)
  Storage bag for accessories

4. EXPLANATION

4-1 Earth Resistance

Earth resistance differs from ordinary resistance and has the following characteristics.

a) Polarization

Because of Polarization between the earthing body and the earth, it is impossible to use DC in taking measurements.

b) Special Condition

Since the earth resistance terminal is implanted into the earth the terminal cannot be taken out. Because the earth resistance is a kind of spreading resistance from the earthing body, it is necessary to use the electrode method in taking measurements, with a considerable distance between the measuring elect rodes.

c) Existence of External Noise

The measurement of earth current is influenced by the existence of external noise factors due to the effect of the leakage current from the earthed electrical appliance or equipment and earth voltage due to earth current. In view of these special qualities of earth resistance, because this tester employs an AC potentionetric system, the unique circuit building technology that the makers have developed has almost entirely eliminated the effect of earth voltage so that accurate measurement is possible with this tester under even the most adverse conditions.

4-2 Basic Principle of Measurement

a) Ordinary Measurements (3-pole method)

Fig. 1 shows the basic principle of measurement of earth resistance.

The measuring current I, driven by the oscillating voltage of the oscillator, flows through a loop formed in the following way: oscillator → Rc → Rx → C.T..

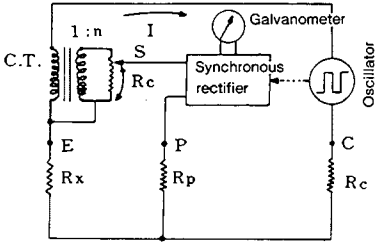


Fig. 1 Basic Principle of Measurement (3-pole method)

Now, if a balance is obtained on the galvanometer and if the voltage produced between measuring terminals E and P be Ex, the resistance between the measuring terminal E and the slider S of the sliding resistor be Rs and the voltage drop be Es, then

From $Ex = IRx, Es = IRs/n$ (n : CT winding ratio)

and $Ex = Es$, $Rx = Rs/n$, so that if 1/n graduations for Rs are inscribed on the dial directly connected to the sliding resistor, the readings obtained on this dial are those for earth resistance Rx.

b) Simple Measuring Method (2-pole method)

Fig. 2 shows the simple 2-pole measuring method employed where there is an existing earthing body. If the earth resistance of the body be Ro and the earth resistance being measured be Rx then, as in 4-2, a), $Rx + Ro = Rs/n$, so that earthing resistance can be found as the sum of resistance Ro of the existing earthing body and Rx which is the resistance being measured.

Again, in the case where common earth line, including a lead breaker is used as the existing earthing body, the measuring current is set low so that the leak breaker will not be tripped.

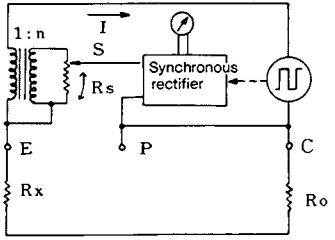


Fig. 2 Basic Principle of Measurement (2-pole method)

5. USUAL MEASURING METHOD (3-pole method)

5-1 Connecting Method

As shown in Fig. 3 drive accessory earthing rod C into the ground at a distance of about 10 to 20 meters from the earthing body E for which measurements are being made and then drive in accessory earthing rod P about halfway between E and C and in such a way that all three are in a straigh line and connect the cords from E, P and C to the respective terminals on the Earth Tester.

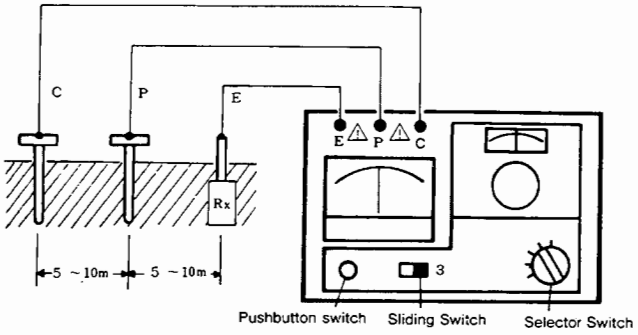


Fig. 3 Connecting 3-pole Method

Note: ∗From body E a 5m black cord is connected to terminal E.
∗From aux. earthing rod P a 10m yellow cord is connected to terminal P.
∗From auxiliary earthing rod C a 20m red cord is connected to terminal C.

※Earthing net method

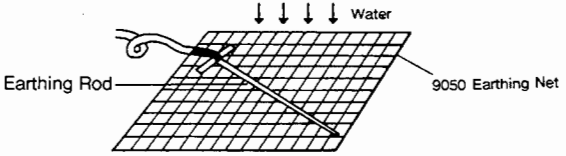


Fig. 4

Where there are concrete surfaces or if ground bars cannot be inserted, use an earthing net. Spread the nets as on the ground, wet them thoroughly and take readings. Either connect a test cord directly to each net with a clip or place a connected ground rod on top of each net and take measurements.

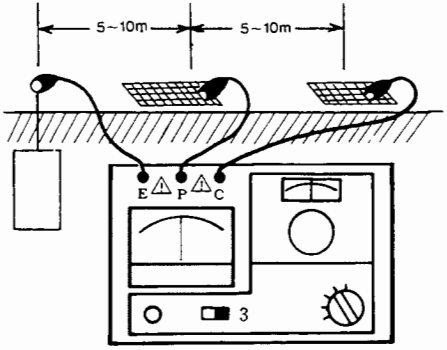


Fig. 5 Using earthing nets measuring method

5-2 Battery Check

Turn the selector switch to the BATT. CHECK position depress the pushbutton to turn it on and check to see that the galvanometer needle is

in the green band. This condition should obtain when the connecting terminal are ready for the taking of readings.

Note: If the galvanometer needle is not pointing to the green band, change the batteries. For battery changing instructions, see Section 8.

5-3 Checking Earth Voltage

Turn the selector switch to the [AC VOLT] position and find out if there is earth voltage or not. Do not depress the pushbutton switch.

⚠ CAUTION

When the earth voltage is higher than 10V, disconnect the electrical equipment from earth or turn off its power switch so that measurement is taken at lower earth potential.

5-4 Earth Resistance

Push the sliding switch to the position for the 3-pole method and according to the type of earthing that has been carried out, turn the selector switch to a suitable [OHMS] range, and, while maintaining pressure on the pushbutton switch, turn the dial knob and balance the galvanometer. The figure required is obtained by multiplying the reading on the dial by the multiplying factor for the range used.

⚠ WARNING

During measurement of the earth-resistance there is a dangerous voltage present on the measuring contacts.
Avoid to touch the contacts while pressing the orange pushbutton switch.

⚠ CAUTION

*** Always make sure to set the sliding switch to the 3-pole position.**
*** As a rule, the 100Ω range is selected first and then a lower range after that if it is found necessary.**

6. SIMPLE MEASURING METHOD (2-pole method)

If there is already an earthing body having a known earth in resistance close to the earthing body being tested or a water supply pipe or other object with an earthing resistance sufficiently smaller than that being tested, it is possible to use such objects in finding the required resistance. However, this simple method should be used only when the earth resistance is relatively high (several tens ohms or higher). Be sure to use the normal method when the earth resistance is 10Ω or less.

6-1 Connecting Method

Connect the earthing body being tested to terminal E and the earthing body used to terminal C, as shown in the diagrams, Figs. 6, 7.

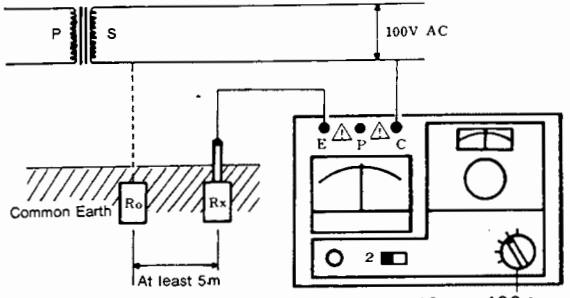


Fig. 6 Using Commercial Power Earth Side

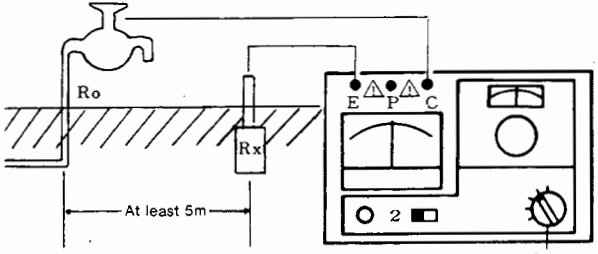


Fig 7. When Using a Water Supply Pipe

⚠ CAUTION

- **The simple method cannot be used when the distance between the two poles is less than 5m or when the water pipe is made of vinyl or some other non-conducting material.**
- **Before connecting to the earth side of a commercial power line as shown in Fig. 6, be sure to confirm the earth side. Connecting the C terminal to the hot side of the commercial power line may damage the tester, since it does not incorporate any protection circuit.**

6-2 Battery Check and Earth Voltage Check

These are carried out in the same way as for ordinary measurement. Refer to Sections 5-2 and 5-3.

6-3 Measuring Earthing Resistance

Push the sliding switch to the 2-pole position. Select the [OHMS] range most suitable for the type of earthing involved and, while maintaining pressure on the pushbutton switch, turn the dial knob and obtain galvanometer balance. The figure required is obtained by multiplying the reading on the dial by the multiplying factor for the range used. The measured value = Rx + Ro.

Note: Do not fail to push the sliding switch to the 2-pole position first.

7. CAUTIONS

7-1 Using the Accessory Auxiliary Earthing Rods (3-pole method)

The two auxiliary earthing rods are required for the 3-pole method for measuring earth resistance and if these rods are not implated in the earth correctly accurate readings cannot be obtained.

a) Distances between the earthing electrodes

As shown in Fig. 8(a), if the distance between electrodes E and C be 1

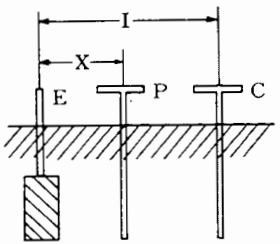


Fig. 8 (a)

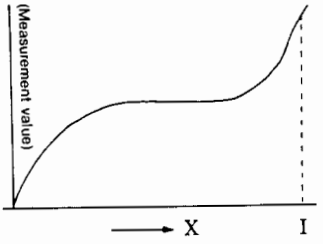


Fig. 8 (b)

meters and that from E to P be x meters, and earth resistance for E be measured, the kind of readings shown in Fig. 8(b) will be obtained so that if P is shifted closer to either E or C, error will result. Again, if the distance between E and C is short, the reading for earth resistance (Rx) being tested and that for the auxiliary rods (Rc) will no longer be able to be distinguished from one another and again measuring error will result.

b) Location of electrodes

As a rute auxiliary earthing rod P should be inserted in a straight line between earthing body E and the other auxiliary earthing rod C and halfway between them. However, although this is the ideal, if there is an object in the way which prevents insertion of P in this position, accurate readings can still be obtained if it is inserted outside of a 5m radius of either E or C. (See Fig. 9)

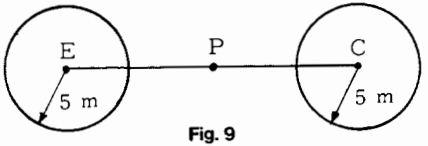


Fig. 9

c) Earth resistance of the auxiliary earthing rods

Usually quite satisfactory results can be obtained in measuring when rod earth resistance is up to about 10kΩ but if rod earth resistance is great especially when attempting to measure low earth resistance, measuring sensitivity becomes insufficient.

In such cases, either drive the earthing rods deep into the ground or wet the ground around the rod with water to lower the earth resistance of the rod before taking readings.

- Resistance for an auxiliary earthing rod can be measured by switching over the connections for the cords for it and earthing body E at the terminals on the main body of the tester.

7-2 Using the special Accessory Earthing Net (3-pole method)

Use this net where the surface is rock or concrete or another surface which is too hard to insert earthing rods into. Put it into as close contact with the surface as possible and wet well with water before taking readings. Especially in the case of concrete, where water may not soak in readily, wait a short time before taking readings. If the net dries out before measuring, resistance between it and the ground will be greatly increased and for this reason water should be applied a second time. To connect the cord to the net effectively, either use the clip shown in the diagram or lay the rod on top of the net.

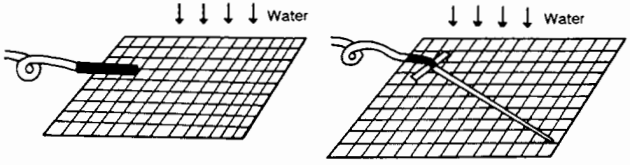


Fig. 10

7-3 Earth Voltage

Sometimes there is voltage in the earthed body due to the effects of leak age current from the electrical equipment connected to the earthing body or from earth current. In the case of commercial power frequency, a voltage of up to about 10V will not greatly affect function but if the waveform is distorted, sometimes measuring error will occur even the voltage is less than 10V.

For this reason, if the voltage is over 5V, either switch off the electrical equipment or disconnect the earthing body from it so that readings can be obtained free from the effects of earth voltage. If earth voltage is very great, this can often be attributed to deterioration of the circuit or appliance insulation. It is then necessary also to carry out insulation and leak tests. For insulation testing, use our Hioki Insulation Resistance Tester. For leaks, use our Hioki Clamp on Leakage Hi Tester.

7-4 Other

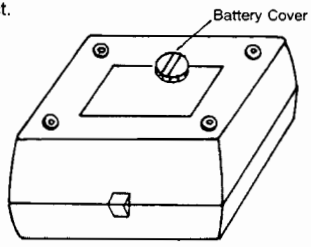
If the pushbutton switch is depressed before connecting the earthing electrodes to the measuring terminals even though the galvanometer needle will deflect in the earth resistance function, this will have absolutely no effect when actually taking readings.

⚠ WARNING

Never touch the measuring terminals when the push-button switch is pressed. When the measuring terminals are open and the switch is pressed, about 150V appears across the E–C terminals.

8. CHANGING BATTERIES

(1) Open the battery cover by removing the retainihg screw with a coin.
(2) Replace the 4 size-C batteries with new ones. Make sure that polarity is correct.

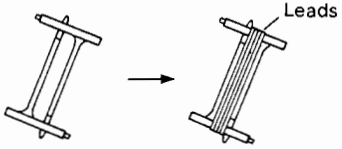


⚠ WARNING

To avoid electrical shock, always disconnect the measuring leads before replacing the batteries. After replacing the batteries, be sure to fasten the battery cover with the screw before restarting measurement.

9. EARTHING LEADS

If the earthing leads and auxiliary earthing rods are stored away in the manner shown in the sketch, they will be easy to prepare for use on the following occasion.



10. CARE OF THE EQUIPMENT

1) When using the equipment, avoid bumping or shaking it.
2) After using the accessories, clean off all dirt and wipe dry before storing away in the storage bag provided.
3) If the equipment is to be out of use for any length of time, remove the dry cell batteries from the tester.
4) Store the equipment in a fairly cool, dry place where dew is not likely to wet it.
5) If any defects are found, stop using the tester and contact the dealer that you purchased it.

Sep. 1980 Edition 1
Jul. 1990 Revised edition 5
Apr. 1994 Revised edition 6

HIOKI E.E. CORPORATION Printed in Japan