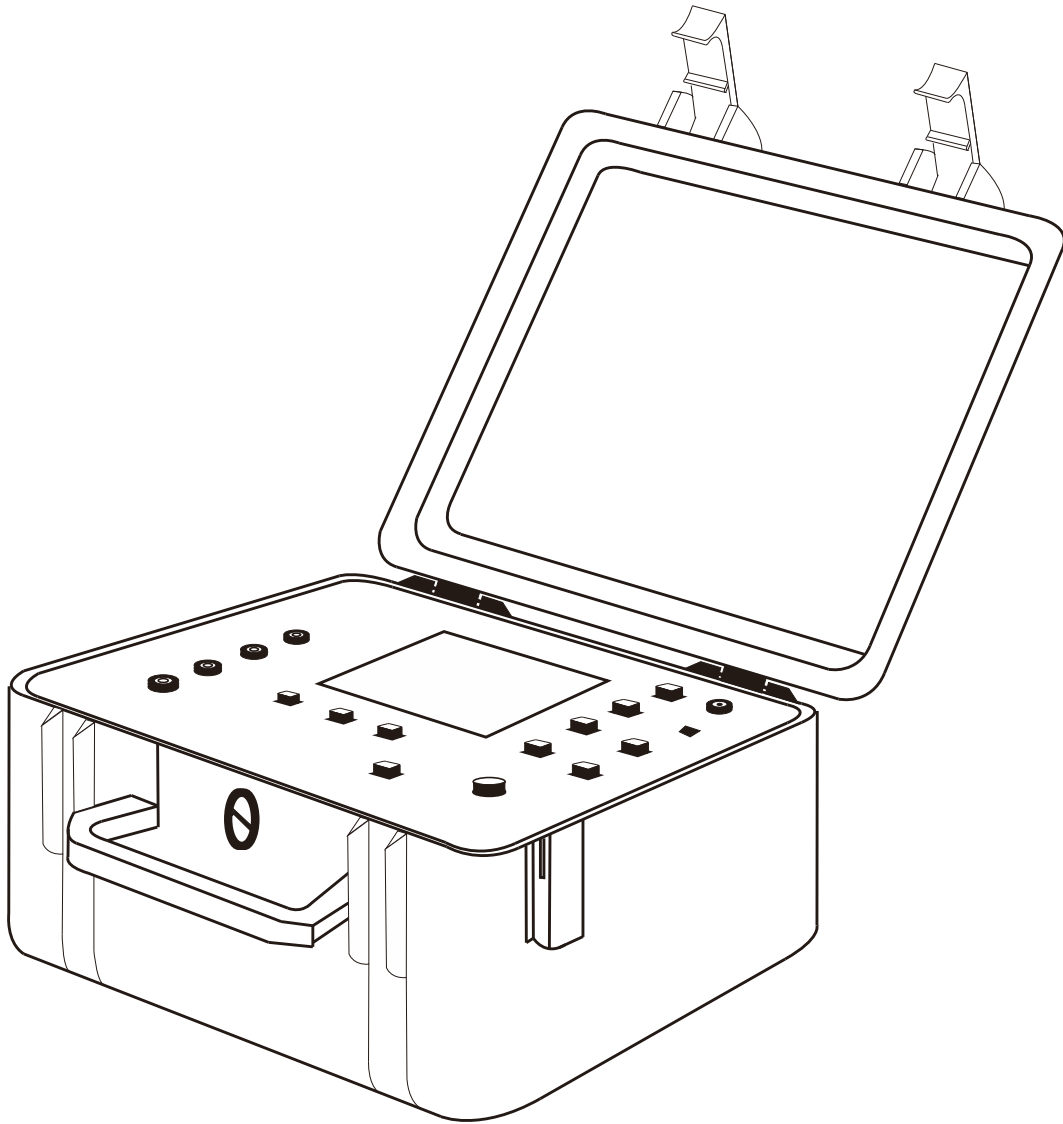


# Soil Resistivity Meter



**ES3001**

**Manual**

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Guang Zhou ZhengNeng Electronic Technology Co., Ltd.


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# I. Safety Precautions and Procedures

Thank you for purchasing our company's Soil Resistivity Tester. Before using the instrument for the first time, in order to avoid possible electric shock or personal injury, please be sure to read and strictly observe the safety rules and precautions listed in this manual.

In any case, the use of this instrument should pay special attention to safety.

- I The instrument is designed, produced and inspected according to IEC61010 safety specifications.
- I In any case, the use of this instrument should pay special attention to safety.
- I When measuring, high-frequency signal generators such as mobile phones should not be used next to the meter to avoid errors.
- I Pay attention to the text and symbols on the body of the instrument.
- I Before use, make sure that the instrument and accessories are in good condition. The insulation layer of the instrument and test wire is not damaged, exposed or broken.
- I During the measurement, it is forbidden to touch exposed conductors and the circuit being measured.
- I Make sure the connection plug of the wire is tightly inserted in the meter connector.
- I Do not apply more than 100V AC voltage or DC voltage between the test terminal and the interface, doing so may damage the meter.
- I Do not measure in flammable places, sparks may cause explosion.
- I When the instrument is in use and the enclosure or test wire is broken and the metal is exposed, please stop using it.
- I Do not place and store the instrument for a long period of time under conditions of high temperature, humidity, condensation, and direct sunlight.
- I When charging the battery, make sure the test line has been removed from the meter and the meter is off.
- I The meter displays the battery voltage low symbol “” and should be charged in time.
- I Pay attention to the measuring range and use environment specified by this instrument.
- I The use, disassembly, calibration and maintenance of this instrument must be performed by authorized personnel.
- I Because of the reason of this instrument, if it is dangerous to continue using it, it should be immediately stopped and sealed immediately, and

it should be handled by a qualified organization.

- I The "⚠" safety warning sign in the instrument and manual must be operated strictly in accordance with the contents of this manual.

## II. Introduction

Soil Resistivity Tester also Known as Ground Resistance • Soil Resistivity Tester, Precision Ground Resistance Tester, etc., is a commonly used meter for measuring grounding resistance. It adopts a large LCD gray-white screen backlight display and microprocessor technology to meet the requirements of two-wire, three-wire and four-wire test resistance and soil resistivity. Suitable for telecommunications, electricity, meteorology, computer rooms, oil fields, power distribution lines, iron tower transmission lines, gas stations, factory grounding networks, lightning rods and so on. Instrument testing is precise, fast, simple, stable and reliable.

The Soil Resistivity Tester is controlled by the microprocessor and can automatically detect the connection status of each interface and the interference voltage and interference frequency of the ground network, and has the function of testing the auxiliary grounding resistance value. At the same time store 500 sets of data, resistance measurement range:  $0.01\ \Omega \sim 30.00k\ \Omega$ , grounding voltage range:  $0.01 \sim 100.0V$ . Online monitoring data through monitoring software, USB data uploaded to PC and unique features such as intelligent alarm alert

The Soil Resistivity Tester consists of host, monitoring software, test line, USB cable, and grounding rod. It has the functions of reading, checking, saving, reporting and printing of historical data.

## III. Rang and Accuracy

Test Function	Range	Accuracy	Resolution
Grounding Resistance (R)	$0.00\ \Omega \sim 30.00\ \Omega$	$\pm 2\%rdg \pm 5dgt$ (remark 1)	$0.01\ \Omega$
	$30.0\ \Omega \sim 300.0\ \Omega$	$\pm 2\%rdg \pm 3dgt$	$0.1\ \Omega$
	$300\ \Omega \sim 3000\ \Omega$	$\pm 2\%rdg \pm 3dgt$	$1\ \Omega$
	$3.00k\ \Omega \sim 30.00k\ \Omega$	$\pm 2\%rdg \pm 3dgt$	$10\ \Omega$
Soil Resistivity ( $\rho$ )	$0.00\ \Omega m \sim 99.99\ \Omega m$	$\rho = 2\ \pi aR$ (remark 2)	$0.01\ \Omega m$
	$100.0\ \Omega m \sim 999.9\ \Omega m$		$0.1\ \Omega m$
	$1000\ \Omega m \sim 9999\ \Omega m$		$1\ \Omega m$
	$10.00k\ \Omega m \sim 99.99k\ \Omega m$		$10\ \Omega m$
	$100.0k\ \Omega m \sim 999.9k\ \Omega m$		$100\ \Omega m$
	$1000k\ \Omega m \sim 9999k\ \Omega m$		$1k\ \Omega m$

Grounding Voltage	AC 0.00~100.0V	$\pm 2\%rdg \pm 3dgt$	0.01V
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Remark:

1. Reference conditions: accuracy with  $R_h R_s < 100 \Omega$  .

Working conditions:  $R_h \max = 3k \Omega + 100R < 50k \Omega$  ;  $R_s \max = 3k \Omega + 100R < 50k \Omega$

2. Depends on the measurement accuracy of R,  $\pi = 3.14$ , a: 1 m~100m;

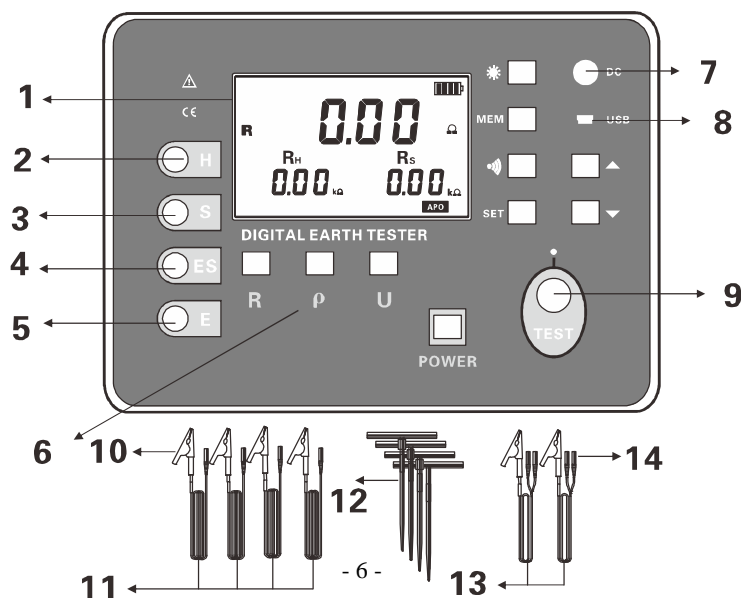
#### IV. Technical Specifications

Function	Two three four-wire measure grounding resistance, soil resistivity; Ground voltage, AC voltage measurement
Ambient temperature and humidity	23°C $\pm$ 5°C, below 75%rh
Power	DC 6V 4.5Ah lead-acid battery lasts more than 100 hours standby
Interference voltage	<20V (should be avoided)
Interference current	<2A (should be avoided)
Measure R electrode spacing	a > 5d
Measured electrode spacing	a > 20h
Auxiliary ground resistance	Reference condition <100 $\Omega$ , working condition <5k $\Omega$
Range	Grounding resistance: 0.00 $\Omega$ ~ 30.00k $\Omega$
	Soil resistivity: 0.00 $\Omega m$ ~ 9999k $\Omega m$
	Grounding voltage: 0.00V~100.0V
measurement mode	Precise four-wire、three-wire measurement, simple two-wire measurement
Measurement methods	Grounding resistance: rated current change pole method Soil resistivity: four-pole method Ground Voltage: Average Rectification(between S-ES interface)
Test frequency	128Hz
Short circuit test current	> 20mA (Sine Wave)

Open circuit test voltage	AC 28V max
Electrode spacing range	Can be set 1m ~ 100m
Change gear	fully automatic shifting 0.00 $\Omega$ ~ 30.00k $\Omega$
	fully automatic shifting 0.00 $\Omega$ m~9000k $\Omega$ m
Backlight	Controllable gray screen backlight, suitable for use in dim places
Display mode	4-bit large LCD display, gray screen backlight
Measurement instructions	LED flashing indicator during measurement
LCD size	111mm×68mm
LCD display field	108mm×65mm
Instrument size	L/W/H: 277.2mm×227.5mm×153mm
Standard test line length	4 strips: red 15m, black 15m, yellow 10m, green 10m each one
Simple test line	2strips: yellow 1.6m, green 1.6m each one
Auxiliary Grounding rod	4PCS: $\phi$ 10mm×200mm
Measure time	Ground voltage: about 3 times/sec;
	grounding resistance、soil resistivity: about 7 seconds/time
Line voltage	Measurement below AC100V (ground voltage measurement function cannot be used to measure commercial power)
USB interface	With USB interface, software monitoring, storage data can be uploaded to the computer, save and print
Communication Line	One USB communication line, 1.5m long
Data storage	500 groups, "MEM" storage indicates, flashing "FULL" symbol indicates that the memory is full
Data review	Data review function: "MR" symbol display
Overflow display	Over-range overflow function: "OL" symbol display
Interference test	Automatic identification of interference signals, "NOISE" symbol indication when the interference voltage is higher than 5V
Auxiliary grounding test	With auxiliary ground resistance test function, 0.00K $\Omega$ ~ 30k $\Omega$ (Rh max = 3k $\Omega$ +100R <50k $\Omega$ ; Rs max = 3k $\Omega$ +100R <50k $\Omega$ )
Alarm function	Alarm when the measured value exceeds the alarm setting value
Battery voltage	Real-time display of battery power, reminding timely

	charging when battery voltage is low
Automatic Shutdown	“APO” Indicates, automatic Shutdown After 15 Minutes
Power consumption	Standby: 40mA Max(Backlight off)
	Turn on backlight: about 43mA
	measuring: 75mA Max(Backlight off)
Weight	Instrument: 2450(including battery)
	Test lines: 1300g
	Auxiliary grounding rod: 850g(4PCS)
Working temperature and humidity	-10°C~40°C; below 80%rh
Storage temperature and humidity	-20°C~60°C; below 70%rh
Overload protection	Grounding resistance: AC 280V/3 seconds between H-E and S-ES ports
Insulation resistance	20MΩ 以上(500V between circuit and housing)
Pressure resistance	AC 3700V/rms(between circuit and housing)
Electromagnetic properties	IEC61326(EMC)
Suitable for safety regulations	IEC61010-1(CAT III 300V、CAT IV 150V、pollution level 2); IEC61010-031; IEC61557-1(grounding resistance); IEC61557-5(soil resistivity); JJG 366-2004.

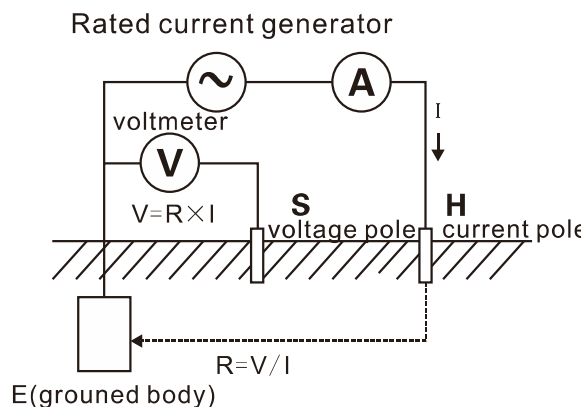
## V. Structure



- |                                     |                                      |                   |
|-------------------------------------|--------------------------------------|-------------------|
| 1. LCD                              | 2. H interface: current pole         |                   |
| 3. S interface: voltage pole        | 4. E interface: grounding pole       |                   |
| 5. E interface: grounding electrode | 6. Function button                   |                   |
| 7. DC charging                      | 8. USB interface                     | 9. Test button    |
| 10. Safety Alligator Clip           | 11. Test line                        | 12. Grounding rod |
| 13. Easy test line                  | 14. Simple test line short connector |                   |

## VI. Measuring Principle

1. Ground voltage measurement using average rectification.
2. The grounding resistance value is measured using the rated current change method, that is, the AC rated current  $I$  flows between the ground electrode of the measuring object  $E$  and the  $H$  current electrode to obtain the potential difference  $V$  between the  $E$  ground electrode and the  $S$  voltage electrode, and calculate the grounding resistance  $R$  according to the formula  $R=V/I$ . In order to ensure the accuracy of the test, a four-wire method was designed to increase the  $ES$  auxiliary ground. During the actual test,  $ES$  and  $E$  were clamped at the same point of the grounding body. The four-wire test can eliminate the influence of the contact resistance (usually dirt or rust) on the measured grounding body, auxiliary grounding rod, test clip, and the input interface of the instrument to the measurement, and can eliminate the influence of the wire resistance on the measurement, more precise.





3. The working error (B) is the error within the rated operating conditions, which is calculated from the inherent error (A) and variation error (Ei) of the existing instrument. .

$$B = \pm ( |A| + 1.15 \times \sqrt{E_2^2 + E_3^2 + E_4^2 + E_5^2} )$$

A: inherent error

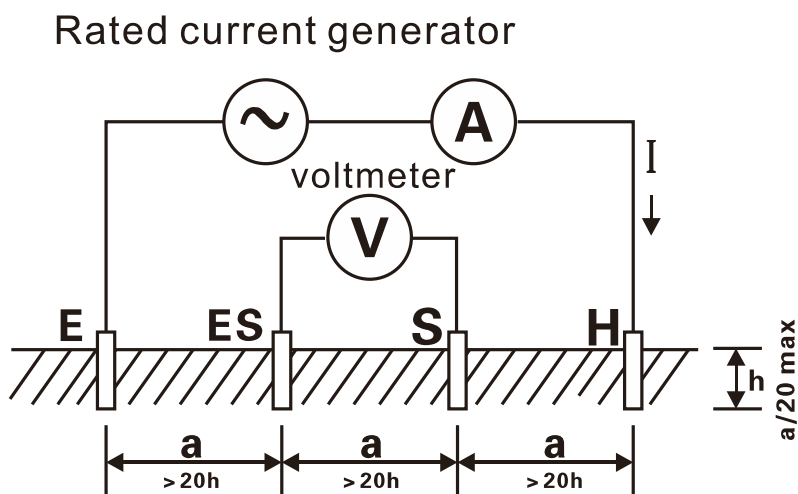
E2: Changes due to power supply voltage changes

E3: Changes due to temperature changes

E4: Changes due to disturbance voltage variations

E5: Changes due to contact electrode resistance

4. Soil resistivity ( $\rho$ ) is measured using the 4-pole method (Wenner method): AC current I between ground electrode E and current electrode H, calculate the potential difference V between the voltage pole S and the auxiliary ground pole ES, the potential difference V is divided by the alternating current I to obtain the ground resistance value R, the electrode spacing distance is a(m), according to the formula  $\rho = 2\pi aR(\Omega m)$ , the soil resistivity value is obtained, when the distance between H-S and S-ES is equal (both a), it is the Wenner method. For ease of calculation, please make the electrode spacing a much larger than the buried depth h, generally should meet  $a > 20h$ , see the figure below.




## VII. Operation


### 1. Switch on/off

Press the POWER button to switch on and off. After turning on the machine, the lower corner shows "APO" and it will automatically shut down after 15 minutes when it is not operating.

### 2. Battery Voltage Check

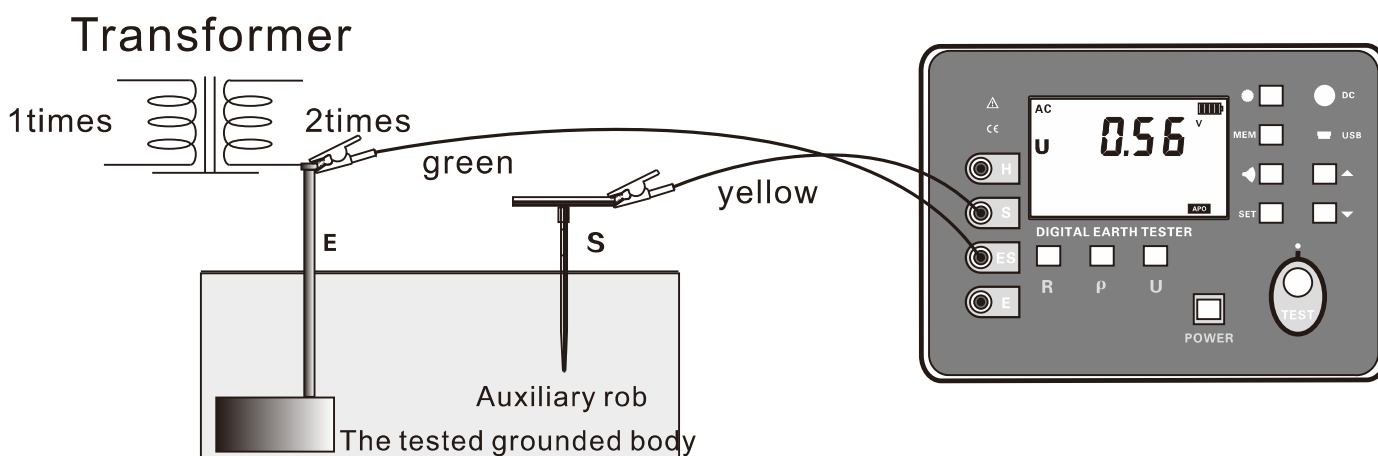
After powering on, if the LCD shows a low battery voltage symbol “”, it indicates that the battery is running low. Please charge it in time. The battery power is sufficient to ensure the accuracy of the measurement. When the battery power decreases, the power indicator bar decreases.

### 3. Ground Voltage Measurement

	One auxiliary grounding rod is required for the ground voltage test.
	As long as the instrument is connected to the ground through the test wire and the auxiliary grounding rod, the other test wires of the instrument interface cannot be connected to the L and N wires of the commercial power supply. Otherwise, the leakage may occur, and the circuit breaker may start up and be dangerous.
	Ground voltage test cannot exceed 100V.

Grounding voltage: when the ground fault of the electrical equipment occurs, the potential difference between the grounding device casing, the grounding wire, the grounding body and the zero potential point, the grounding voltage is the earth's reference point, potential difference with the earth, the earth is zero potential point.

An auxiliary grounding rod is required for the ground voltage test. Note the difference from the commercial AC voltage test. See the following figure: After the meter, auxiliary grounding rod and test line are all connected, after power on, press function button U, and the LCD shows the test result.



Commercial grounding body to ground voltage test

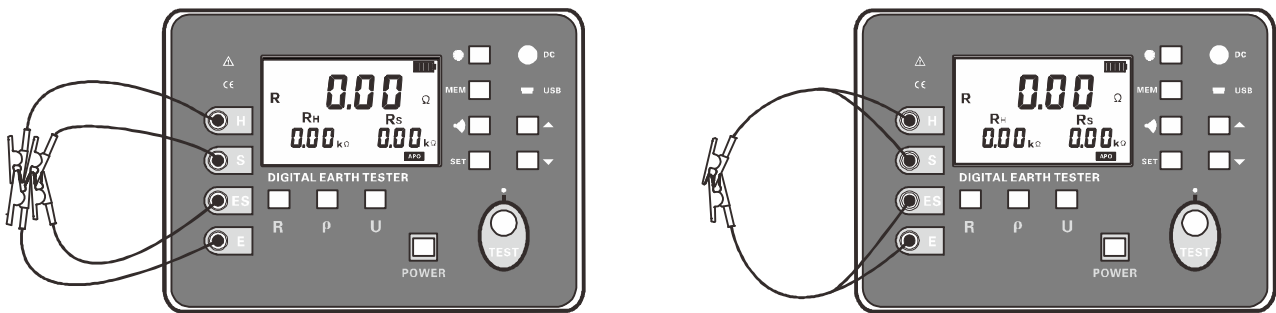
### 4. Wire resistance check

In order to improve the precision and stability of the grounding resistance measured in the field, the error caused by the change of the wire resistance due to the test line being used for a long time is avoided; To avoid the error caused by the test line not completely inserted into the


instrument interface or poor contact; to avoid the error caused by the user to replace or lengthen the test line, the line resistance check function is specially designed to measure the low-value resistance more accurately.

After connecting the test line and the meter, short the other end of all the test lines. As shown in the figure below, press the function button R to switch to the corresponding ground resistance measurement position. Press “▲” key to start calibration, LED indicator flashes during calibration, LCD countdown display, LCD display after calibration.

Shutdown does not save the verification line resistance. The next time it is turned on, it needs to be recalibrated.




### 5. Four-wire precision test grounding resistance

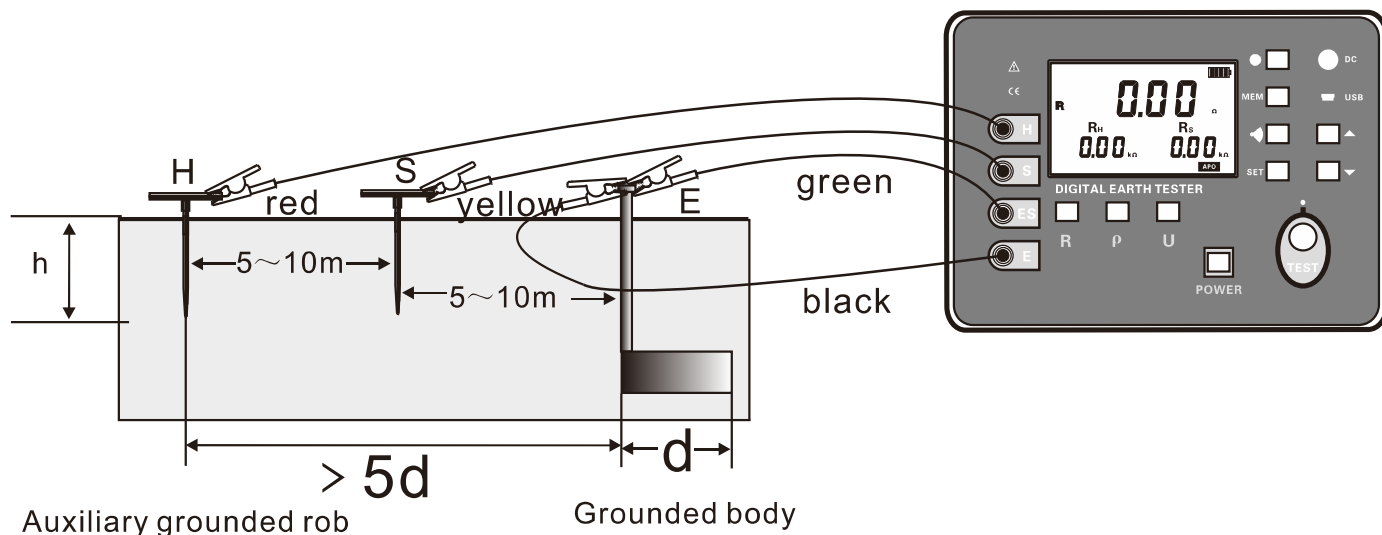
	<p>When testing the grounding resistance, first confirm the grounding voltage of the grounding wire, that is, the voltages of H and E or S and ES must be less than 20V. If the grounding voltage is above 5V, the meter displays the NOISE symbol, then, the measurement value of the grounding resistance may be inaccurate. At this time, the measured grounding device is first de-energized so that the grounding voltage is lowered and then the grounding resistance test is performed.</p>
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Four-wire test: The four-wire test eliminates the influence of the contact resistance (usually dirt or rust) on the measured grounding body, auxiliary grounding bar, test clip, and the input interface of the instrument to the measurement, can eliminate the impact of wire resistance on the measurement, better than the three-wire test.

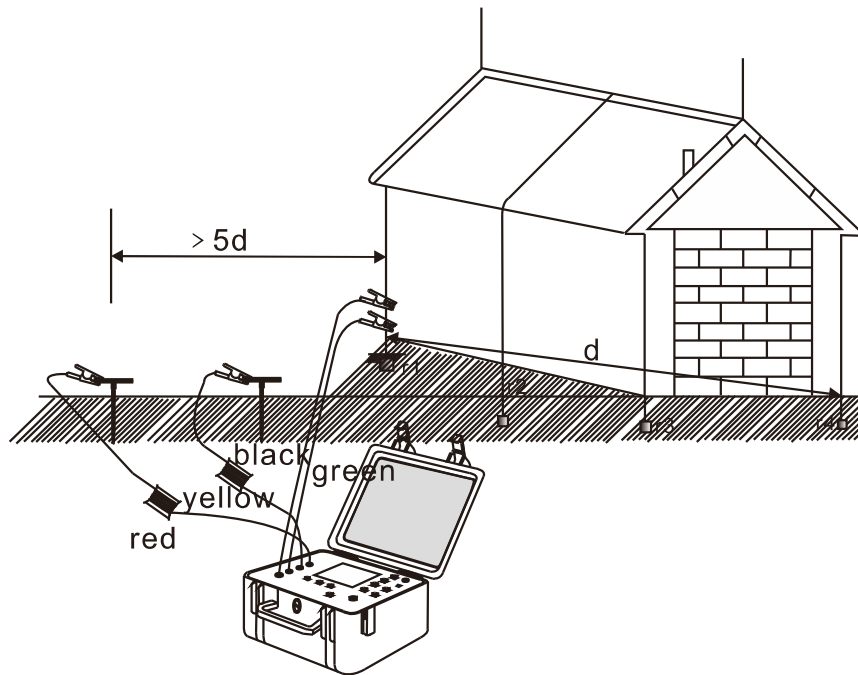
See the following figure: Beginning with the measured object, generally

spaced 5m ~ 20m, respectively, the S, H auxiliary grounding rod is buried deep into the ground in a straight line, connect the grounding test lines (black, green, yellow, and red) from the E, ES, S, and H interfaces of the meter to the ground electrode E under test, the auxiliary voltage electrode S, and the auxiliary current electrode H.

	<p>The distance between the measured grounding body E and the current pole H should be at least 5 times the buried ground depth (h) of the measured grounding body, or 5 times the buried ground electrode length (d).</p>
	<p>Measure the total grounding resistance of a complex grounding system. The distance d is the distance of the largest diagonal of the grounding system.</p>
	<p>During the test, the test leads cannot be intertwined with each other. Otherwise, the test accuracy may be affected.</p>



For a multi-point independent grounding system or a geodetic grounding system, the user can choose a longer test line, and the electrode spacing is greater than 5 times the maximum diagonal length of the tested network. As shown below:



$R=r_1 // r_2 // r_3 // r_4 // r_5 // r_6 // \dots // r_n$  ( $r_1 \dots r_n$  are all independent grounding points)

$R$ —meter readings, total grounding resistance of the entire grounding system;

$r_1 \dots r_n$ —are all independent grounding points, and grounding bodies are not connected together under the ground;

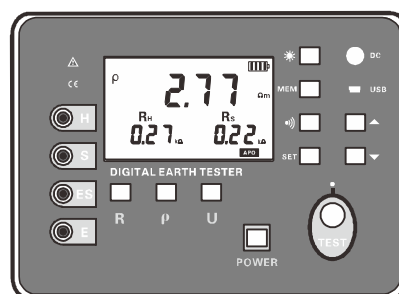
$R_H$ —ground resistance of auxiliary current pole H;

$R_S$ —ground resistance of auxiliary voltage pole S;

$n$ —the number of independent grounding points, the more points, the smaller the  $R$  value.

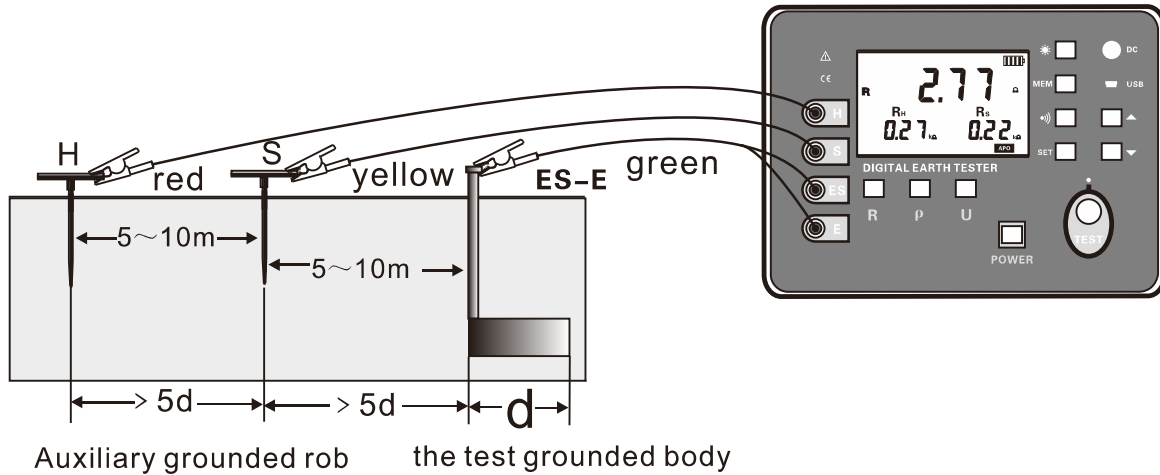
After connecting the test line, press the function button  $R$  to enter the ground resistance test mode, and press the “TEST” key to start the test. There is a countdown indication during the test and stable data is displayed after the test is completed. That is, the grounding resistance value  $R_H$  of the grounding resistance value and the auxiliary current pole H, the grounding resistance value  $R_S$  of grounding resistance value  $R$  and auxiliary voltage pole S.

As shown in the following figure, the tested grounding resistance is  $2.77 \Omega$ , the grounding resistance of the auxiliary current  $R_H$  is  $0.27K \Omega$ , and the grounding resistance of the auxiliary voltage electrode  $R_S$  is  $0.22K \Omega$ .




## 6. Three-wire Test Grounding Resistance

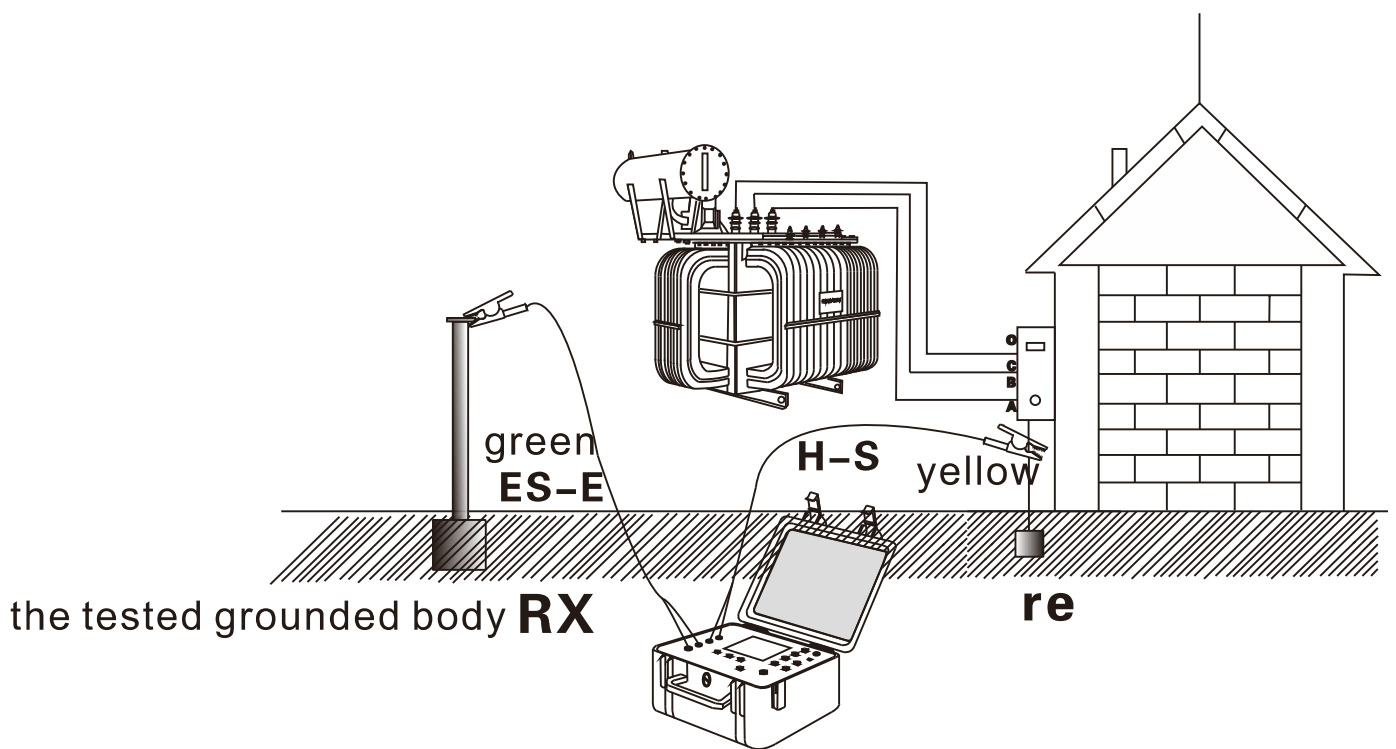
Three-wire test: As shown below, short-circuit the ES, E interface of the instrument, which is a three-wire test, instrument operation is the same as four-wire test. The three-wire test cannot eliminate the influence of the wire resistance on the measurement, nor can it eliminate the influence of the change of the contact resistance between the instrument and the test wire and the influence of the change between the test wire and the auxiliary grounding rod. When measuring, the oxide layer on the surface of the ground body to be measured must also be removed.



## 7. Two-wire Easy Test Grounding Resistance

Two-wire test: This method is a simple measurement method that does not use the auxiliary grounding rod. It uses the grounding electrode with the smallest value of the grounding resistance as the auxiliary grounding electrode, and uses two simple test lines to connect the HS interface and the E-ES interface. The auxiliary ground rods H and S may be replaced with metallic ground pipes such as metal water pipes and fire hydrants, common grounding of commercial power systems, or lightning protection grounds of buildings, etc., take care to remove the oxide layer at the connection point of the selected metal auxiliary grounding body during measurement. Wiring as shown below, the instrument operation same as the four-wire test.

	<p>When using the commercial power system grounding as an auxiliary grounding pole measurement, it must be confirmed that it is the grounding pole of a commercial power system. Otherwise, the circuit breaker may start up and be in danger.</p>
	<p>Use a simple two-wire method to measure the grounding resistance, and try to select the grounding body with a smaller value as the auxiliary grounding electrode so that the meter reading is closer to the true value. When measuring, Please take precedence to choose the metal water pipe and metal fire hydrant as the auxiliary grounding electrode.</p>



The simple two-wire method measures the grounding resistance. The instrument reading value is the sum of the grounding resistance of the measured grounding body and the grounding resistance of the commercial grounding body. That is:

$$RE = RX + re$$

And: RE is the meter reading value;

RX is the grounding resistance value of the grounding body under test;

re is the grounding resistance value of a common grounding body such as a commercial power system.

Then, the grounding resistance of the measured grounding body is:

$$RX = RE - re$$

## 8. Soil Resistivity Test

The soil resistivity  $\rho$  is an important factor that determines the grounding resistance of the grounding body. 土壤电阻率  $\rho$  是决定接地体接地电阻的重要因数。 Different types of soil, of course, have different soil resistivities, even the same kind of soil, because of different temperature and moisture content, the soil resistivity will also have a significant change. Therefore, in order to have a correct basis for the design of the grounding device, the designed grounding device can better meet the needs of the actual work, and the soil resistivity must be measured.

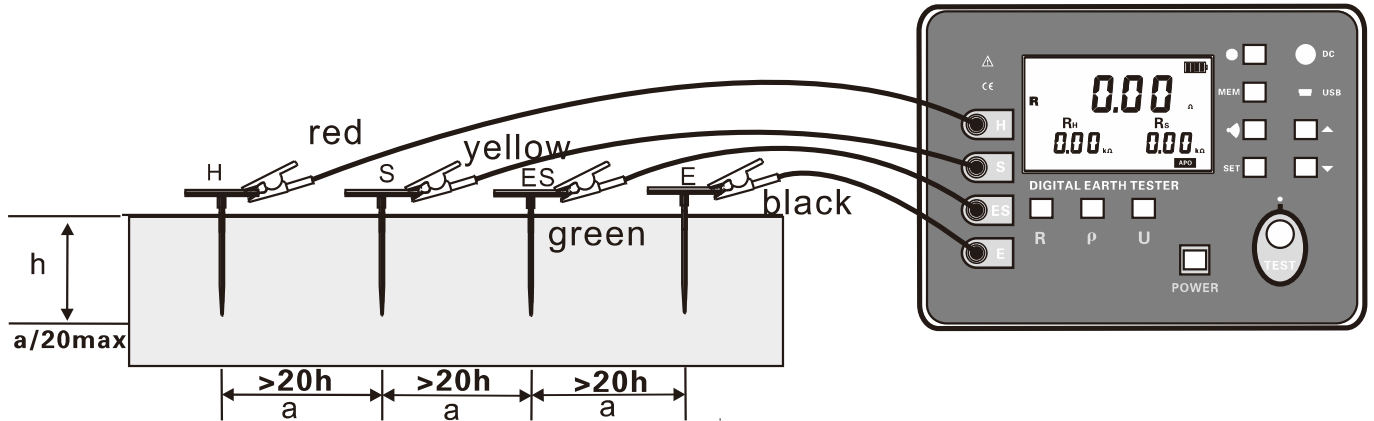
The soil resistivity was measured by the four-pole method (Winner method).

The soil resistivity  $\rho$  is calculated according to the formula  $\rho = 2\pi aR$  ( $\Omega m$ ), and the unit is  $\Omega m$ , and:

a—Electrode spacing

$R_{S-ES}$  Resistance of soil between electrodes

Four-pole method (Winner method): Connect the test leads as shown below. Note the spacing between the auxiliary grounding bars and the depth of burial, bury H, S, ES, and E auxiliary ground rods in the ground in a straight line, connect the grounding test leads (red, yellow, green, and black) from the H, S, ES, and E connectors of the instrument to the H, S, ES, and E auxiliary grounding rods under test.



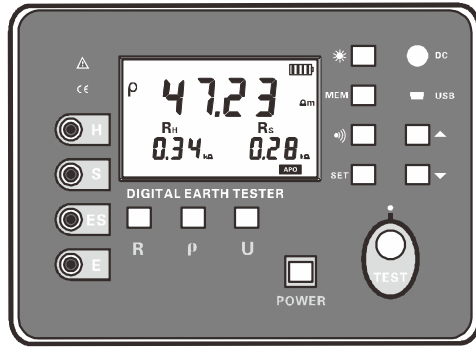
Auxiliary ground rod spacing setting: After connecting the test line, press the function button  $\rho$  to enter the soil resistivity test mode, press and hold the "SET" key (more than 3 seconds) to enter the spacing setting of the auxiliary grounding rod, short press "●))" to move the cursor, press "▲" or "▼" key to change the current value (value a range: 1m ~ 100m), long press "SET" key (more than 3 seconds) to save the set value a and return to soil resistivity test mode.



After setting value a, in soil resistivity test mode, press "TEST" key to start the test, and count down to display the test progress. After the test is completed, a stable soil resistivity value is displayed.

As shown in the following figure, the measured soil resistivity is  $47.23 \Omega m$ , the grounding resistance value  $R_H$  of the auxiliary current electrode is  $0.34K \Omega$ , and the grounding resistance value  $R_S$  of the auxiliary voltage electrode is  $0.28K \Omega$ . After this display is completed, it will automatically return back to display the tested soil resistivity  $\rho$ .





### 9. Backlight Control

After power on, press “☀” key to turn the backlight on or off, and the backlight function is suitable for dim places. The default backlight turns off every time you turn it on.

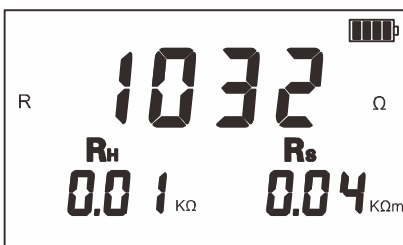
### 10. Alarm Setting

After power on, short press “🔔” to turn on and off the alarm function. Short press “**SET**” key to set the resistance alarm value, press “🔔” key to move the cursor, press “▲” or “▼” key to change the current size, and then press “**SET**” key to save and exit. When the measured value is greater than the alarm critical setting value and the alarm function is turned on, the meter displays the “🔔” symbol and issues a “beep-beep-beep--” alarm sound. The maximum value of the ground voltage alarm setting is 100V, the maximum value of the ground resistance alarm setting is 3000 Ω, and the maximum value of the soil resistivity alarm setting is 9999 Ωm. As shown below:



### 11. Data Lock/Storage

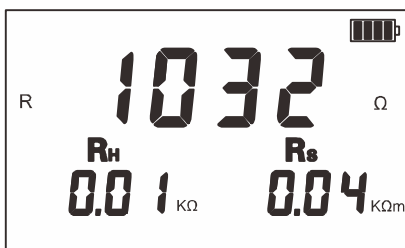
After the power-on or measurement is completed, short press “**MEM**” key to lock the current display data, and automatically numbered and storage. If the memory is full, the meter displays the “FULL” symbol. As shown below: The measurement data is 1032 Ω. Short press “**MEM**” to display the data showed that it is stored as the third group.



## 12. Data Review/Delection

After the power on or measurement is completed, press and hold the "MEM" button (more than 3 seconds) to enter the data review mode. The interface corresponding to the stored data interface and the stored data group number flash alternately. Press "▲" or "▼" key to select the corresponding data of the array number with a step by 1, hold down the "▼" or "▲" key to select the array number with a step by 5, then press "MEM" to exit. See below

In the figure below, the number 3 is the current group number, and 6 is the total group number. If no data is stored, the LCD displays "NULL". See the figure below.



Under data review status, press "SET" key to enter data deletion, press "▲" or "▼" key to select "NO" or "YES", select "NO" and then press "SET" key to not return data review status, select "YES". Press the "SET" key again to delete the stored data. After the deletion, the following figure is displayed.




## 13. Data Upload

Connect the USB communication cable of the computer and the instrument, turn on the instrument and run the monitoring software. If the USB connection is successful, the stored historical data can be read, uploaded to the computer and saved.

The monitoring software has on-line real-time monitoring and historical query functions, dynamic display, alarm value setting and alarm indication function, and functions such as reading, viewing, saving and printing of historical data.

## VIII. Battery Instructions

The instrument is powered by a 6V 4.5AH lead-acid battery. When the battery power is reduced, the power indicator bar is reduced. When the voltage drops to 5V, the battery symbol “” is displayed. Please charge in time. Low voltage affects the measurement accuracy.

## IX. Accessories

Instrument	1PC
Instrument bag	1PC
Auxiliary grounding rod	4PCS
Monitoring software CD	1PC
USB communication line	1PC
Test line	4PCS
Simple test line	2PCS
6V Battery (built-in)	1PC
charger	1PC
Manual , certificate	1SET

The contents of this user manual cannot be used as a reason to use the product for special purposes.

The company is not responsible for other losses caused by use.

The company reserves the right to modify the contents of the user manual. If there is any change, it will not be notified.



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