

Hantek

HBT4000 series

Internal resistance tester

User Manual

2023.12

Warranties and Declarations

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The Hantek certified HBT4000 series internal resistance tester meets Chinese national and industry standards, and has passed CE certification and UKCA certification.

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1 Safety requirement

1.1 Summary of general security issues

Read the following safety precautions carefully to avoid injury and to prevent damage to this product or any product connected. To avoid possible dangers, please use this product in accordance with the regulations.

- **Only professionally authorized personnel can perform repairs.**
- **Use the correct power cord.**

Only use the dedicated power cord recognized by the country where the product is located.

- **Ground the product.**

To avoid electric shocks, the product is grounded through a grounding conductor of the power cable. The grounding conductor must be connected to the ground before connecting the input or output terminals of the product.

Ensure that the product is properly grounded.

- **View all terminal rating values.**

To avoid fire or excessive current, please check all rating values and signs on the product. Please consult the product manual for details of the rating values before connecting the product.

- **Do not operate with the cover open.**

Do not run the product with the cover or panel open.

- **Avoid circuit exposure.**

Do not touch exposed connectors and components after power is switched on.

- **Do not operate if the product is suspected to be faulty.**

If you suspect that the product has been damaged, please ask qualified maintenance personnel to check it.

- **Maintain proper ventilation.**
- **Do not operate in a humid environment.**
- **Do not operate in inflammable or explosive environment.**
- **Please keep the product surface clean and dry.**



Warning:

Equipment that meets Class A requirements may not provide adequate protection for broadcast services in residential environments.

1.2 Security terms and signs

Security terms in this manual:



Warning:

Indicates that the operation may not cause immediate damage to you.



Warning:

Indicates that if you perform this operation, it may not immediately cause damage to you.



Note:

Indicates that the operation may cause damage to the product or other property.

Safety terms on products:

Warning:

Indicates a potential hazard may be caused to you if you do not perform this operation.

Safety signs on the product:

Warning

Shell grounding
terminalEnvironmental protection usage
period identification

1.3 Measurement category

Measurement category

This instrument can be used for measurement under class I.

**Warning:**

This instrument is only allowed to be used in the specified measurement class.

Measurement class definition

- **Class I** refers to measurements taken on a circuit not directly connected to the main power supply. For example, measurements made on circuits that are not exported from a main power supply, especially from a protected (internal) main power supply. In the latter case, the instantaneous stress will change. Therefore, the user should understand the instantaneous capacity of the instrument.

- **Class II** refers to measurements taken on a circuit directly connected to low-voltage instruments. For example, measurements made on household appliances, portable tools, and similar equipment.
- **Class III** refers to measurements taken on construction equipment. For example, measurements made on switchboards, circuit breakers, circuits (including cables, busbars, junction boxes, switches, sockets) in fixed equipment, as well as equipment for industrial use and certain other equipment (for example, fixed motors permanently connected to fixed instruments).
- **Class IV** refers to measurements taken at the source of low-voltage equipment. For example, measurements made on electricity meters, primary overcurrent protection equipment, and pulse control units.

1.4 Ventilation Requirement

To ensure sufficient ventilation, when using the instrument in a workbench or rack, please ensure that there is a gap of at least 10 centimeters on both sides, above, and behind it.



Note:

Poor ventilation can cause an increase in instrument temperature, leading to instrument damage. Good ventilation should be maintained during use, and ventilation openings should be regularly checked.

1.5 Work Environment

Operating temperature and humidity range

0 °C -40 °C, below 80% RH (without condensation)

Storage temperature and humidity range

-10 °C -50 °C, below 80% RH (without condensation)

Accuracy assurance temperature and humidity range

23 °C ± 5 °C, below 80% RH (without condensation)



Warning:

To avoid the risk of short circuits or electric shock inside the instrument, do not operate the instrument in a damp environment.

Altitude

Operating and Non-operating: 2,000m.

This product is powered by mains conforming to installation (overvoltage) category II.



Warning:

Ensure that no overvoltage (e.g. from lightning) reaches the product.

Otherwise, the operator may be in danger of receiving electric shock.

Installation (Overvoltage) Category Definitions.

Installation (overvoltage) category I refers to the signal level, which is suitable for measuring terminals connected to equipment in the source circuit, where measures have been taken to limit instantaneous voltage to the corresponding

1.6 Care and Cleaning

Care:

When storing or placing the internal resistance tester, do not expose the LCD display to direct sunlight for a long time.

Cleaning:

According to the requirements of operating conditions, regularly check the internal resistance tester and test line. Please clean the outer surface of the instrument according to the following steps:

- 1) Use a lint free cloth to remove floating dust from the outside of the internal resistance tester and test line. Please be extremely careful to avoid scratching the smooth display filter material.
- 2) Clean the internal resistance tester with a soft cloth soaked in water. To clean more thoroughly, a water solvent of 75% isopropanol can be used.



Note:

To avoid damaging the surface of the internal resistance tester or test line, do not use any corrosive or chemical cleaning agents.



Warning:

Before re powering on, please confirm that the instrument has dried thoroughly to avoid electrical short circuits or even personal injury caused by moisture.

1.7 Environmental precautions

The following symbols indicate that this product complies with the requirements established by WEEE Directive 2002/96/EC.



Equipment recycling:

The production of this equipment requires the extraction and utilization of natural resources. If the scrapping of this product is not handled properly, certain substances contained in the equipment may be harmful to the environment or human health. To avoid the release of harmful substances into the environment and reduce the use of natural resources, it is recommended to use appropriate methods to recycle this product to ensure that most materials can be correctly reused.

2 Product features

Product features

- The full range of voltage measurement covers:160 V/260 V/410V/1300V/1700V/2100V
- Internal impedance measurement range:3 m Ω /30 m Ω /300 m Ω /3 Ω /30 Ω /300 Ω /3.9 k Ω
- Using the AC 4-terminal method, impedance measurement is not affected by the impedance of the test line
- Resistance minimum resolution 0.1 $\mu\Omega$, minimum voltage resolution 1 μ V
- It has independent comparison functions for resistance and voltage, while displaying the internal resistance and voltage of the battery
- Short circuit zeroing function to remove bias voltage of the instrument or errors caused by measurement environment
- Supports USB data storage and screenshot saving functions, and can upgrade instrument programs through USB drives
- Calculate various statistical indicators, including but not limited to mean, maximum, minimum, standard deviation, etc., and easily draw a normal distribution map
- Standard RS232/485, LAN, EXT I/O, USB Host, ANALOG OUTPUT, USB Device interface, optional GPIB interface
- Sampling rate: Slow/Horotelic/Fast, capable of high-speed measurement up to approximately 40 ms
- Voltage calibration and resistance calibration, used to compensate for bias voltage or gain drift in the internal circuit of the instrument

The HBT4000 series internal resistance tester is a battery internal resistance tester with high precision, high resolution, and fast measurement characteristics. Using the AC four terminal testing method to more accurately test the internal resistance and voltage of the battery; 0.1 $\mu\Omega$ Resistance resolution, minimum voltage resolution 1 μ V. Ensure the credibility of the measurement; Built in comparator function to automatically determine whether battery parameters meet standards; Built in multiple high-speed communication interfaces, suitable for more testing scenarios; Easy to operate, precise and fast, stable and reliable, this battery internal resistance tester will be your best choice.

3 Overview

This document is used to guide users to quickly understand the front and rear panels, user interface, and basic operating methods of the HBT4000 series internal resistance tester.



Tip:

The latest version of this manual can be downloaded at

(<https://www.hantek.com>).

Document number: 202312

Software version:

Software upgrade may change or increase product functionalities, please pay attention to Hantek website for the latest version.

Document format conventions:

1 button

Use "square brackets+text (bold)" to represent the front panel buttons, for example, **[Utility]** represents the "Utility" button.

2 menus

Use "menu text (bold)+blue" to represent a menu option, such as "**other**" to click on the "other" option on the current operating interface of the instrument and enter the "other" function configuration menu.

3 Operation steps

Use "->" to represent the next step. For example, **[Utility]** -> **Other** means click

Utility label before clicking Other menu.

4 Button icon





Icon	Button	Icon	Button
	Direction keys		Screenshot key
	Confirm key		Menu softkeys

Table 3-1 Button

Document content agreement:

The HBT4000 series internal resistance tester includes the following models.

Unless otherwise specified, this manual uses HBT4563H as an example to explain the HBT4000 series and its basic operations.

Model	Resistance resolution	Voltage resolution	Measuring range	Interface
HBT4561A	0.1 $\mu\Omega$	1 μV	0~3.9k Ω / 0~160V	RS232/485,USB,LAN,I O,ANALOG OUTPUT
HBT4561H	0.1 $\mu\Omega$	1 μV	0~3.9k Ω / 0~160V	RS232/485,USB,LAN,I O,ANALOG OUTPUT,GPIB
HBT4562A	0.1 $\mu\Omega$	1 μV	0~3.9k Ω / 0~260V	RS232/485,USB,LAN,I O,ANALOG OUTPUT
HBT4562H	0.1 $\mu\Omega$	1 μV	0~3.9k Ω / 0~260V	RS232/485,USB,LAN,I O,ANALOG OUTPUT

Model	Resistance resolution	Voltage resolution	Measuring range	Interface
			0~260V	O,ANALOG OUTPUT,GPIB
HBT4563A	0.1 $\mu\Omega$	1 μV	0~3.9k Ω / 0~410V	RS232/485,USB,LAN,I O,ANALOG OUTPUT
HBT4563H	0.1 $\mu\Omega$	1 μV	0~3.9k Ω / 0~410V	RS232/485,USB,LAN,I O,ANALOG OUTPUT,GPIB
HBT4564A	0.1 $\mu\Omega$	10 μV	0~3.9k Ω / 0~1300V	RS232/485,USB,LAN,I O,ANALOG OUTPUT
HBT4564H	0.1 $\mu\Omega$	10 μV	0~3.9k Ω / 0~1300V	RS232/485,USB,LAN,I O,ANALOG OUTPUT,GPIB
HBT4565A	0.1 $\mu\Omega$	10 μV	0~3.9k Ω / 0~1700V	RS232/485,USB,LAN,I O,ANALOG OUTPUT
HBT4565H	0.1 $\mu\Omega$	10 μV	0~3.9k Ω / 0~1700V	RS232/485,USB,LAN,I O,ANALOG OUTPUT,GPIB
HBT4566A	0.1 $\mu\Omega$	10 μV	0~3.9k Ω / 0~2100V	RS232/485,USB,LAN,I O,ANALOG OUTPUT

Model	Resistance resolution	Voltage resolution	Measuring range	Interface
HBT4566H	0.1 $\mu\Omega$	10 μV	0~3.9k Ω / 0~2100V	RS232/485,USB,LAN,I O,ANALOG OUTPUT,GPIB

Table 3-2 Model Table

4 Quick Start

4.1 General inspection

Check transportation packaging

After receiving the internal resistance tester, the user should check the equipment according to the following steps: check whether there is any damage caused by transportation: if the packaging carton or foam plastic protective pad is seriously damaged, please keep it until the whole machine and accessories pass the electrical and mechanical tests.

Check attachments

The details of the provided attachments are explained in Appendix A: Models and Accessories at the end of this manual. If missing or damaged attachments are found, please contact the dealer responsible for this business.

Inspect the entire machine

If you find that the appearance of the instrument is damaged, the instrument is not working properly, or it fails the performance test, please contact the dealer responsible for this business.

4.2 Appearance dimensions

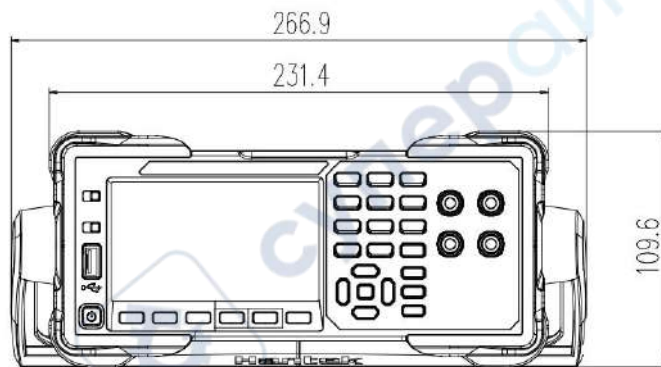


Figure 4-1 Front view

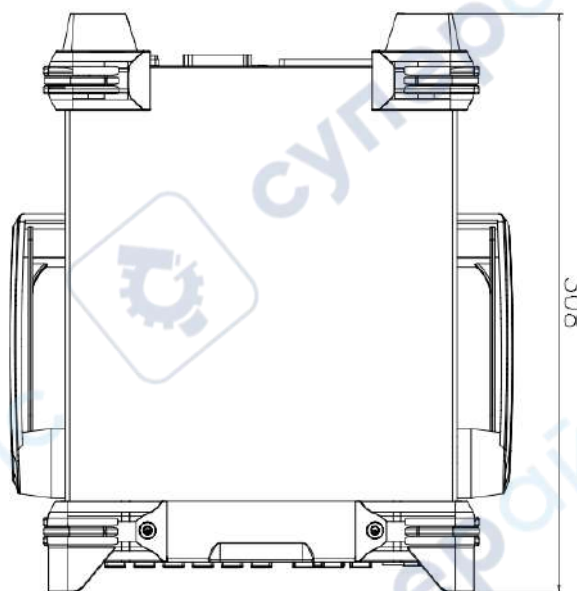


Figure 4-2 vertical view

4.3 Preparation before use

4.3.1 Connecting the power supply

This series of internal resistance testers can input AC power with specifications of

90-240 VAC, 47/63Hz, and 30VA. Please connect the internal resistance tester to the power supply using the power cord provided in the attachment. Press the power switch in the lower left corner of the front panel to turn on the instrument. If the instrument is not turned on, please confirm that the power cord is securely connected and ensure that the instrument is connected to a powered power source.



Warning:

To avoid electric shock, please ensure that the instrument is properly grounded.

4.3.2 Adjusting the handle

To adjust the handle of the instrument, hold the handles on both sides of the instrument and pull them outward, then rotate the handles.

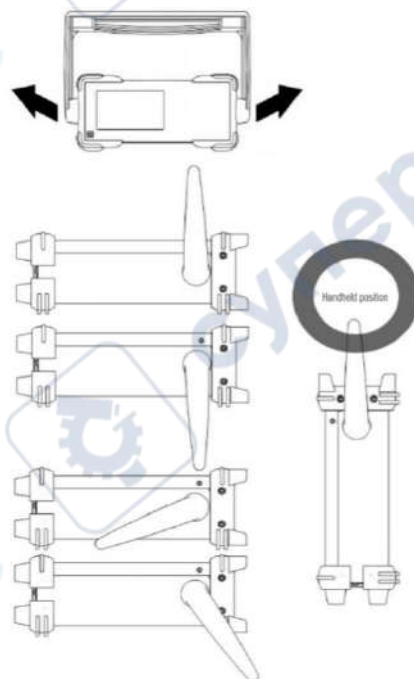


Figure 4-3 Handheld position

4.3.3 Setting System Language

The internal resistance tester supports both Chinese and English menus, and provides corresponding help information, prompt information, and interface display.

Press [**Utility**] -> **Other** -> **English** to select the desired language. When selecting "Chinese" or "English", the menu, help information, prompt messages, and interface are displayed in Chinese or English, respectively.

4.4 Product Introduction

This chapter introduces the front and rear panels and user interface of the internal resistance tester.

4.4.1 Introduction to Front Panel



Figure 4-4 Front Panel

1 Key switch

2 Menu soft keys

Corresponding to the menu above it one by one, press any soft key to activate the corresponding menu.

3 Directional keys (up/down/left/right), confirm key


Direction keys: used to select keyboard numbers or modify parameters; Confirm key: Confirm the selected parameter.

4 Plus keys, range keys, and minus keys

5 Input ports

6 Function keys

- [COMP]: Comparator function menu.
- [STAT]: Statistics function menu.
- [Local]: Lock/unlock the keyboard; Local remote control key.

- [MEA]: Measurement function menu.
- [VIEW]: System information menu.
- [0 ADJ]: Zero adjustment key.
- [SAVE]: Save key.
- [LOAD]: Load key.
- [ESC]: Escape key.
- [Utility]: Auxiliary function keys.
- [TRIG]: Trigger key.
- : Screenshot key.

7 LCD display screen

4.3-inch color TFT LCD display screen, displaying the menu and parameter settings of current functions, system status, and prompt messages.

8 Restore default settings

Used to restore the instrument status to the factory default values.

9 Help

To obtain contextual help information for any front panel buttons or menu soft keys, press the key and then press the button that you need help for.

10 USB HOST interface

Can be connected to external storage devices (USB drives) for saving or loading settings files, etc.

4.4.2 Introduction to Rear Panel



Figure 4-5 Rear Panel

- 1 AC power socket
- 2 Shell grounding terminal
- 3 Fuse holder
- 4 Safety lock holes
- 5 USB DEVICE interface
- 6 LAN interface

- 7 EXT I/O interface
- 8 ANALOG OUTPUT interface
- 9 RS-232/485 interface
- 10 GPIB interface

4.4.3 User Interface Introduction

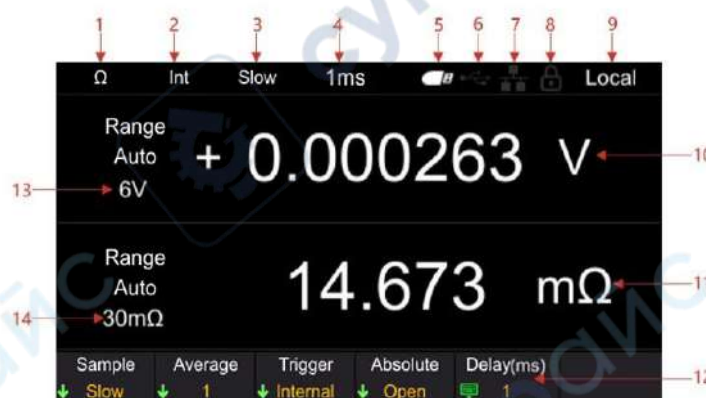


Figure 4-6 User Interface

- 1 Range Quick Identification
- 2 Trigger sources
- 3 Sampling rates
- 4 Delay
- 5 USB icon display
- 6 USB device icon display
- 7 Network icon display
- 8 lock screen icons
- 9 Local/Remote Display
- 10 Voltage measurement values
- 11 Resistance measurement value
- 12 Auxiliary menu bar
- 13 Resistance range
- 14 Voltage range

4.5 Set parameter values


The parameter settings of this series of internal resistance testers support numeric keyboard input. Parameter settings can be completed by left clicking, right clicking, and confirmation keys. Move the cursor position by clicking the left and right buttons, and click the confirm button **[OK]** to input. Move the cursor to the enter key , then click **[OK]** to save and exit.



Figure 4-7 Keypad

Note: If no settings are made on the numeric keyboard interface for more than 30 seconds, the instrument will automatically jump to the measurement display interface.

4.6 Using the built-in help system

To obtain help information for any front panel buttons or menu soft keys, on the measurement display interface, press the [?] button on the front panel, and then press the button you need help with to obtain the operation prompt for that button. Press the [?] button again to exit the help system.

5 Start using

- To prevent electric shock accidents, please do not short circuit the top of the test line and the line with voltage.
- Do not measure AC voltage, AC current, or DC current. Otherwise, it may cause instrument damage or personal injury accidents.
- To prevent electric shock, please confirm the rated value of the test wire before measurement, and do not measure voltage higher than the rated value.

5.1 Measurement Settings

Click the [Range] button to enter the measurement display interface.



Figure 5-1 Measurement display interface

Note: If no settings are made in other interfaces (except the calibration interface) for more than 30 seconds, the instrument will automatically jump to the measurement display interface.

5.1.1 Setting Type

Click the **Type** menu soft key to select categories such as V&R, Voltage, and Resistance.

V&R: Simultaneously measure and display voltage and resistance, as shown in Figure 5-1.

Voltage: Measure and display the voltage value, as shown in the following figure.



Figure 5-2 Measurement voltage interface

Resistance: Measure and display the resistance value, as shown in the following figure.

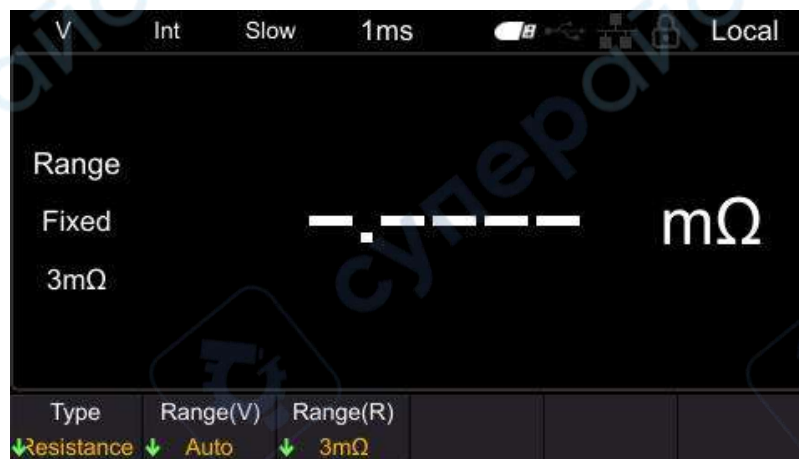


Figure 5-3 Measurement resistance interface

Note: When measuring resistance or voltage separately, if the measurement type is set to resistance function or voltage function, faster measurements can be made.

5.1.2 Set voltage range

This instrument (HBT4563H) has selectable voltage ranges of 6V, 60V, 410V, and Auto. Automatic refers to the instrument automatically selecting the appropriate voltage range.

- 1 Press the [**Range**] key to enter the measurement page;
- 2 Click on the **Range (V)** menu soft key;
- 3 Use the menu soft key to select the range and complete the voltage range setting.

In addition, the range can be switched using the plus minus keys, and automatic cannot be selected when switching ranges using the plus minus keys.

Note: The automatic range may become unstable due to the measured value of the object being at the critical range value. At this point, please manually specify the range or extend the delay time.

If the plus and minus keys are pressed in automatic range mode, the automatic range will be released in the current range and changed to manual range. The automatic displayed on the screen will become fixed.

5.1.3 Setting the Resistance Range

The resistance ranges available for this series of internal resistance testers include 3m Ω , 30 m Ω , 300 m Ω , 3 Ω , 30 Ω , 300 Ω , 3900 Ω , and Auto. Automatic refers to the instrument automatically selecting the appropriate resistance range.

- 1 Press the **[Range]** key to enter the measurement page;
- 2 Click on the **Range (R)** menu soft key;
- 3 Use the menu soft key to select the range and complete the setting of the resistance range.

In addition, the range can be switched using the plus minus keys, and automatic cannot be selected when switching ranges using the plus minus keys.

Note: The automatic range may become unstable due to the measured value of the object being at the critical range value. At this point, please manually specify the range or extend the delay time.

If the plus and minus keys are pressed in automatic range mode, the automatic range will be released in the current range and changed to manual range. The automatic displayed on the screen will become fixed.

5.1.4 Setting the sampling rate

Click the **[MEA]** button to enter the measurement display interface, as shown in the following figure. Click on the **Sample** again, and the selectable gears are: Slow, Horotelic and Fast. Use the menu soft key to select the desired rate gear to complete the sampling rate setting.

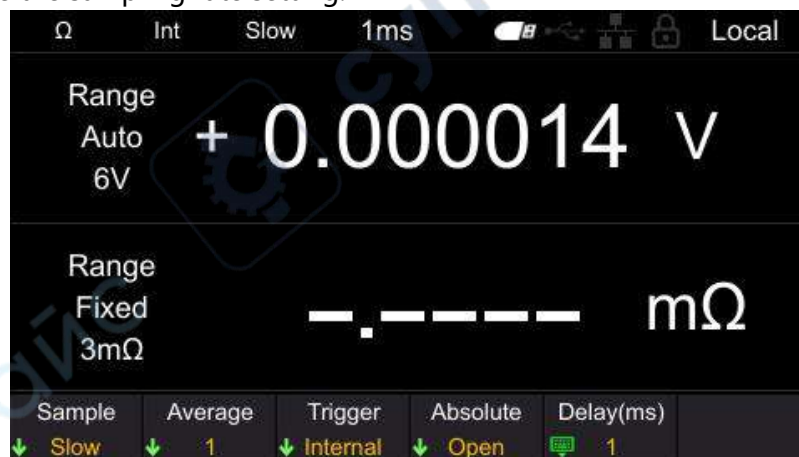


Figure 5-4 Measurement display interface

5.2 Zeroing

To eliminate errors caused by the bias voltage of the instrument itself or the measurement environment, please perform zero adjustment before measurement. The measurement accuracy is specified after zeroing. Zero adjustment can also be performed on the 0ADJ terminal of EXT I/O.

Click on the **[0 ADJ]** key, or click on **[Utility]** -> **Cal** in sequence. After entering the password, click on the **[0 ADJ]** soft key to execute zero adjustment. After successful zero adjustment, the interface will pop up as shown in the following figure. If zero adjustment fails, please check if the short circuit is correct, and then perform zero adjustment until successful.

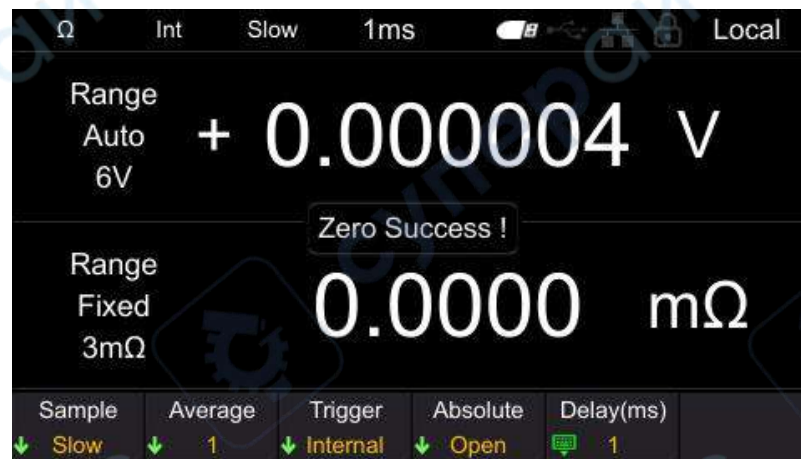


Figure 5-5 Zeroing

5.3 Test abnormal output

- When the test line is not connected to the test object, [-----] is displayed on the screen, as shown in the following figure. In addition, an abnormal test signal (ERR) will be output from the EXTI/O terminal.



Figure 5-6 Test exception

- When the resistance of the test object is greater than the range, [OverLoad] is displayed on the screen, as shown in the following figure. In addition, an abnormal test signal (ERR) will be output from the EXT/I/O terminal.

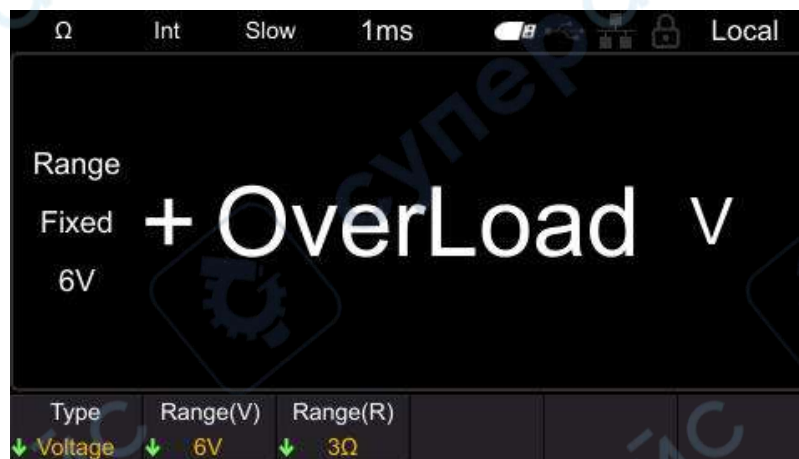


Figure 5-7 Measure overflow

In addition, the following situations can also cause testing anomalies.

- When the probe is disconnected
- When the circuit protection fuse is disconnected
- When the contact resistance is high or the wiring resistance is high due to probe wear, dirt, etc

Note: If the contact resistance or wiring resistance is large, the measurement error will increase.

6 Application measurement

6.1 Measurement Configuration

The measurement page has 5 test configurations: [Sample], [Average], [Trigger], [Absolute] and [Delay]. Below are the functions and setting methods of these measurement configurations.

6.1.1 Setting the sampling rate

The sampling rate can be changed in three stages (Slow/Horotelic/Fast). The lower the sampling rate, the higher the testing accuracy.

Steps for switching sampling rate:

Click on the **[MEA]** button, and the display will be as follows:



Figure 6-1 Measurement display interface

Click on the **Sample** and it will display as follows. Press the corresponding soft key again to complete setting the sampling rate.



Figure 6-2 Set sampling rate

6.1.2 Setting the average value

The average function refers to the function of outputting the average measured value. By using this function, the deviation of the displayed value can be reduced. Click on [MEA] -> **Average** to set the average value. The average number of choices is 1, 2, 4, and 8, as shown in the figure. The default setting is 1. Press the corresponding soft key again to complete setting the average value.



Figure 6-3 Set average value

6.1.3 Trigger function

The trigger source function is used to set the trigger mode of the instrument. Trigger sources include [Int], [Ext], and [Man].

Internal trigger: Automatically triggered internally (measured automatically).

External triggering: Measurement is carried out through external input triggering signals. Set to external trigger, connect the TRIG terminal of the EXT I/O connector on the rear panel to ISO_COM short circuit, perform one measurement.


Manual triggering: Measurement is carried out by manually inputting triggering signals. Set to manual trigger, press the TRIG key to perform one measurement.

Click on [MEA] -> **Trigger** in sequence to set the trigger source, as shown in the figure. Press the corresponding soft key again to complete the setting of the trigger source. The default setting is Int.



Figure 6-4 Set trigger source

6.1.4 Delay function

Set the delay time from the input trigger signal to the start of measurement. If a trigger signal is input immediately after connecting the test object, the instrument will start measuring after the measurement value stabilizes by setting a delay time. The adjustable delay range is 1ms~9999ms, with a default of 1ms. Click on [MEA] -> **Delay (ms)** in sequence to set the delay time, as shown in the figure. Move the cursor position by left and right clicking, and click [OK] to input. Move the cursor to the key , then click [OK] to save and exit.

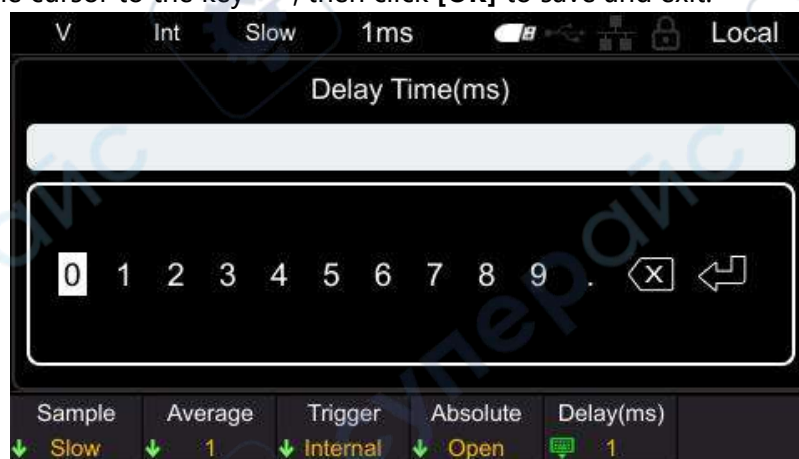


Figure 6-5 Setting Delay

6.1.5 Absolute value function

The absolute value determination includes [Open] and [Close], and the absolute value determination defaults to Open. After enabling this function, even if the battery polarity is reversed, it can still be displayed as a positive value; If this

function is turned off, there is a possibility of negative measurement values, which can affect the judgment of comparison results.

Click on [MEA] -> **Absolute** in sequence to set the absolute value, as shown in the figure. Press the corresponding soft key again to complete the function of setting absolute values.



Figure 6-6 Set absolute value function

6.2 Comparator function

The comparator function refers to the function of comparing pre-set critical values with measured values, determining whether the measured values meet the judgment criteria, and displaying and outputting them. The comparison methods for thresholds include two methods: setting upper and lower limits, and setting baseline values and percentages. As a comparator result, in addition to displaying Hi, In, Lo pages and sounding the buzzer, it can also be output through the EXT I/O terminal.

There are two comparison modes: Auto and Manual, with the default being Auto mode.

Automatic mode: After setting to automatic mode and enabling the comparator function, always output the comparison results of the comparator.

Manual mode: After setting to manual mode and enabling the comparator function, the comparison result is only output when the MANU input of EXT I/O is on.

Note: When the comparator is turned on, automatic range cannot be used.

6.2.1 Comparator function settings

Click the [Comp] button to jump to the comparator settings page, as shown in the figure.



Figure 6-7 Set comparator function

After entering the comparator interface, there are two methods to modify the corresponding settings:

Method 1: Use the up/down keys of the arrow keys to move the white box to the corresponding setting. After confirming the setting to be modified, click the left/right keys of the arrow keys to modify the corresponding parameters.

Method 2: Click on the menu soft key to set it.

1. Switch

Press the soft key to select whether to turn the comparator function on or off.

2. Comp Mode

Press the soft key to select automatic or manual mode.

3. Buzzer

Press this soft key to set the buzzer to sound. The available types are closed, HL, IN, BT1, and BT2.

Off: The buzzer is in the off state.

HL: When the comparison result is Hi or Lo, the buzzer emits a "beep..." sound.

In: When the comparison between voltage and resistance is In, the buzzer emits a continuous beep sound.

BT1: When the comparison result is In, the buzzer emits a "beep" sound (continuous sound), and when Hi and Lo, the buzzer emits a "beep..." sound.

BT2: When the state changes from Hi and Lo to In, the buzzer only emits a "beep" (short sound) once, and when Hi and Lo, the buzzer emits a "beep..." sound.

4. Res

Press this soft key to set the Limits and Percent of the resistance.

Select the Limits, set the Max(mΩ) and Min(mΩ).

Select the Percent, set the Datum(mΩ) and Percent (%).

5. Vol

Press this soft key to set the Limits and Percent of the voltage.

Select the Limits, set the Max(V) and Min(V).

Select the Percent, set the Datum(V) and Percent (%).

Note: if there is no command setting in the comparator interface for more than 30 seconds, the instrument will automatically jump to the measurement display interface.

After the comparator function is turned on, the comparator interface parameters cannot be modified.

After the comparator function is turned on, operations that affect measurement will be prohibited. Prohibited operations include the following: All settings in the MEA interface are invalid, and clicking the SAVE, LOAD, and OADJ buttons is invalid.

6.2.2 Setting the Limits and Percent

Click on the **Res** on the comparator page to set the parameters of the resistor comparator; Click on the **Vol** on the comparator page to set the voltage comparator parameters. There are two modes for parameter settings: Limits and Percent, with the default being the Limits mode.



Figure 6-8 Set the upper and lower limits of resistance

Press this soft key to set the Limits and Percent.

Select the Limits, set the Max and Min.

Select the Percent, set the Datum and Percent.

The steps for setting Max, Min, Datum, and Percent are the same, using setting Datum as an example for explanation.

On the resistance ratio interface, click on the **Datum (mΩ)** and a numeric keypad will pop up, as shown in the following figure.

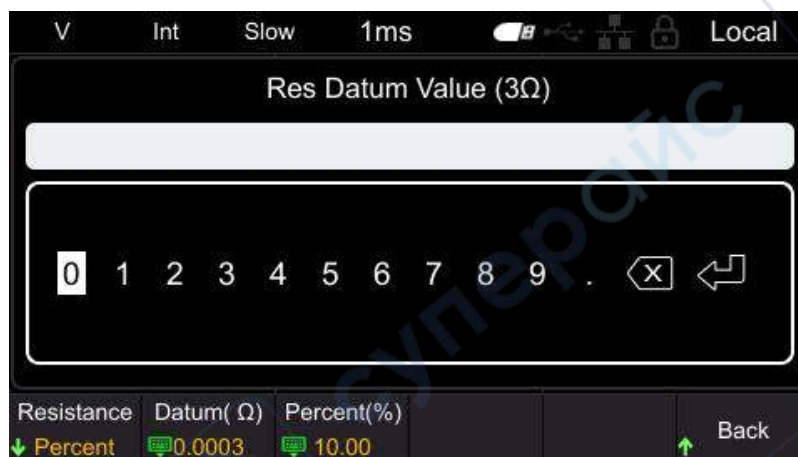


Figure 6-9 Keypad

Move the cursor position by clicking the left and right buttons, and click the confirm button **[OK]** to input. Move the cursor to the enter key **[OK]**, then click **[OK]** to save and exit.

The parentheses in the keyboard title contain the current measurement gear of the instrument, as shown in the above figure, which is the 300mΩ gear. The values set using the keyboard are also in mΩ units. For example, entering 15 on the keyboard represents the set resistance reference value of 15mΩ.

Note: The comparison value set will change with the switching of the instrument's measurement gear. For example, if the current gear is 3.9kΩ, set the upper limit value of the comparator to 3kΩ. When switching to the 300Ω gear, the upper limit value of the comparator will automatically change to 300Ω.

6.2.3 Page display of comparator

After the comparator is turned on, the instrument will compare it with the measured value based on the set upper and lower limits or ratio, and display the comparison results Hi, In, and Lo on the page. As shown in the figure.

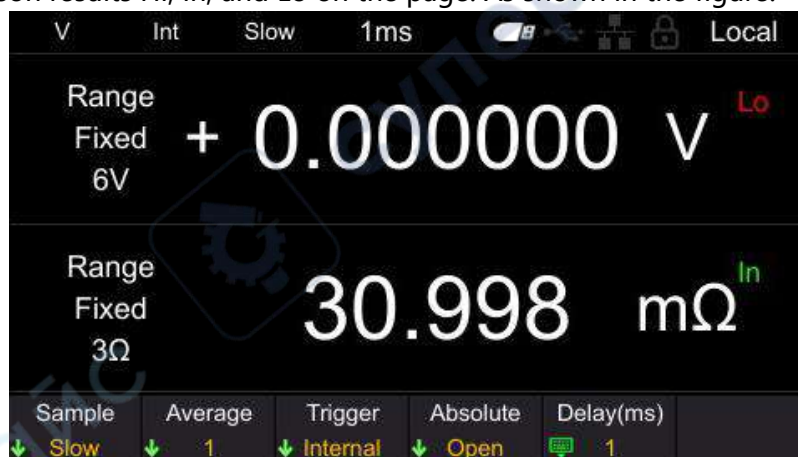


Figure 6-10 page display

Hi: The measured value exceeds the upper and lower limits or proportional range.
 In: The measured value is within the upper and lower limits or proportional range.
 Lo: The measured value is below the upper and lower limits or proportional range.

6.3 Statistical operation function

Click the **[STAT]** button to enter the statistical calculation function interface, as shown in the figure. The following will introduce the statistical function switch, statistical results, normal distribution map, save/load, data temp, and clear data functions.



Figure 6-11 Statistical operation function

6.3.1 Switch of statistical function

Click on the **[STAT]** -> **Switch** in sequence to set the switch for the statistics function. Press the corresponding soft key to turn on or off the statistics function. After turning on the statistics function, the current count will be displayed in real-time on the screen.

After turning off the statistics function, if data clearing is not performed and the statistics function is turned on again, the instrument will accumulate on the basis of the original count.

6.3.2 Statistical Results

The viewing methods for statistical results are divided into [Index] and [List]. Click on **[STAT]** -> **StatResult** -> **Index** in sequence, and the statistical indicators will be displayed as follows:

Indicate	Resistance	Voltage
Average	00.000mΩ	000.017mV
Max	00.000mΩ	000.025mV
Min	00.000mΩ	000.012mV
Parent Standard Deviation	00.000mΩ	000.003mV
Sample Standard Deviation	00.000mΩ	000.003mV
Procedure Ability Index(Deviati...	99.99	0
Procedure Ability Index(Shift)	99.99	0
Switch OFF	StatResult	NorDistrib
S / L	DataTemp 1000	Clear Data

Figure 6-12 statistical indicators

Calculate and display the Average, Max, Min, Parent Standard Deviation, Sample Standard Deviation, and Procedure Ability Index for up to 1000 measurement data. The calculation formula is as follows:

Mean

$$\bar{x} = \frac{\sum x}{n}$$

Standard deviation of population

$$\sigma = \sqrt{\frac{\sum x^2 - n\bar{x}^2}{n}} \quad (= \sigma_n)$$

Standard deviation of sample

$$s = \sqrt{\frac{\sum x^2 - n\bar{x}^2}{n-1}} \quad (= \sigma_{n-1})$$

Process capability index (dispersion)

$$Cp = \frac{|Hi - Lo|}{6\sigma_{n-1}}$$

Process capability index (bias)

$$CpK = \frac{|Hi - Lo| - |Hi + Lo - 2\bar{x}|}{6\sigma_{n-1}}$$

- The n in the formula represents the number of valid data.
- Hi and Lo use the upper and lower limits of the comparator.
- The process capability index refers to the ability to achieve process quality, which can be understood as the degree of quality deviation and deviation that a process has.

Generally, the values of Cp and Cpk can be used to evaluate process capability (as shown below):

Cp, Cpk > 1.33..... Sufficient process capability

1.33 ≥ Cp, Cpk > 1.00... Appropriate process capability

1.00 ZCp, Cpk, etc. Insufficient process capability

Note:

- When the number of valid data (excluding test anomalies) is 1, the sampling

standard deviation and process capability index are not displayed.

- When σ_{n-1} is 0, Cp and CpK are 99.99.
- The upper limit of Cp and CpK is 99.99. When Cp and CpK > 99.99, it is displayed as 99.99.
- When CpK is negative, CpK=0.

Click on [STAT] -> **Statistical Results** -> **Statistical List**, and the statistical list will be displayed as follows:

Num	Resistance	Voltage	Compare Result
1	010.9538Ω	000.000258V	PASS
2	010.9538Ω	000.000256V	PASS
3	010.9532Ω	000.000255V	PASS
4	010.9545Ω	000.000257V	PASS
5	010.9538Ω	000.000258V	PASS
6	010.9532Ω	000.000255V	PASS
7	010.9532Ω	000.000259V	PASS

Switch: OFF StatResult: ↓ NorDistribut: ↓ S / L: ↓ DataTemp: 1000 Clear Data

Figure 6-13 Statistical List

Num	Resistance	Voltage	Compare Result
1	000.0310Ω	-00.000003V	UNPASS
2	000.0310Ω	-00.000006V	UNPASS
3	000.0310Ω	-00.000004V	UNPASS
4	000.0310Ω	-00.000012V	UNPASS
5	000.0310Ω	-00.000008V	UNPASS
6	000.0310Ω	-00.000005V	UNPASS
7	000.0310Ω	-00.000001V	UNPASS

Switch: OFF StatResult: ↓ NorDistribut: ↓ S / L: ↓ DataTemp: 1000 Clear Data

Figure 6-14 Statistical List

Compare the maximum and minimum values of voltage and resistance set in the comparator function with the statistical data. If the statistical data is within the comparison range, the corresponding voltage or resistance will be displayed in white; If it is not within the comparison range, the corresponding voltage or resistance will be displayed in red; If the voltage and resistance values are both within the comparison range, the comparison result shows PASS; On the contrary, display UNPASS. The judgment results PASS and UNPASS (Hi, In, Lo of resistance and voltage respectively) can be output to EXT I/O.

6.3.3 Normal distribution diagram

The HBT4000 series internal resistance tester can generate a normal distribution map of statistical resistance and voltage measurement data. In the statistics main interface, click on the **Nor Distribut** to enter the normal distribution map interface. X represents the waveform display multiple.

When the instrument has statistical data, it displays as follows:

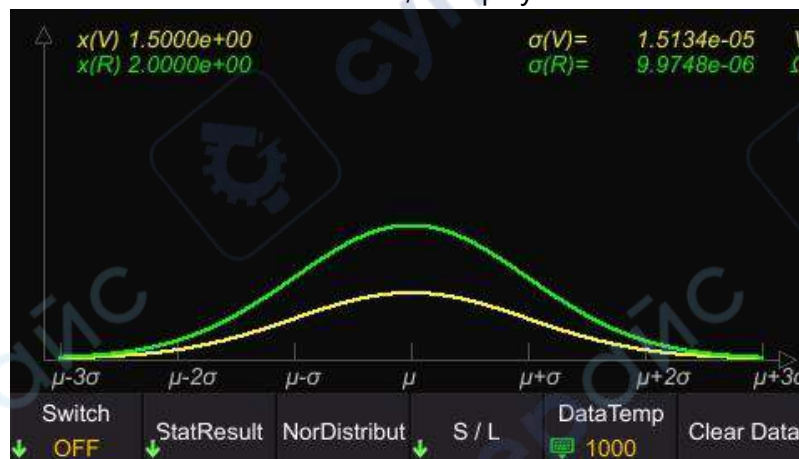


Figure 6-15 Normal distribution diagram

When there is no statistical data, it is displayed as follows:

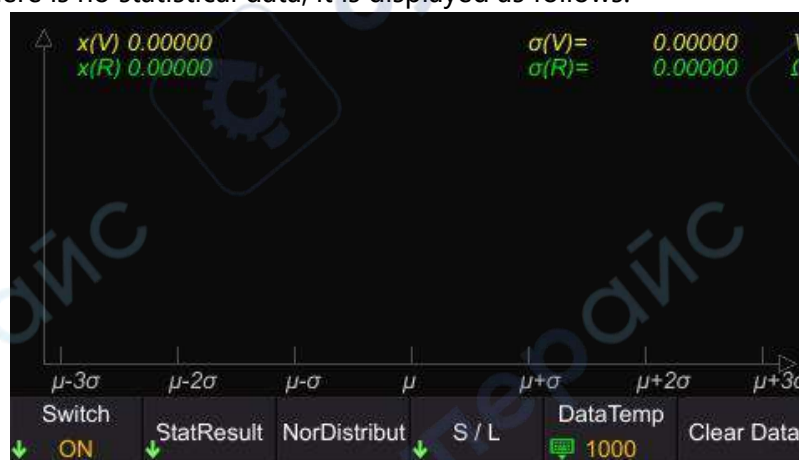


Figure 6-16 Normal distribution diagram

6.3.4 SAVE/LOAD

Users can store statistical data in the form of .csv files to external USB drives.

Steps to save data settings:

- 1 Firstly, turn off the statistics function and insert the USB drive into the USB port on the front panel of the instrument. After successful connection, the screen will display "USB Device Connect".


- 2 In the statistical calculation interface, click on **S/L->Save Data**. The screen will display "File saved successfully", and the instrument will automatically generate a file name and save it to the USB drive. The file is named based on the current system time.

Steps for calling up data settings:

- 1 Firstly, turn off the statistics function and insert the USB drive into the USB port on the front panel of the instrument. After successful connection, the screen will display "USB Device Connect".
- 2 In the statistical calculation interface, click on **S/L->Load Data**, use up/down keys to move the cursor to select a file, click **[OK]** to retrieve the file, and the screen will display "File loaded successfully".
- 3 Click **Stat Result -> List** to view the file data currently called out.

6.3.5 Data Temp

The HBT4000 series internal resistance tester can record up to 1000 sets of statistical data. Through the data caching function, the size of the data cache area can be set, that is, the number of recorded values for each statistical test. For example, if the data cache is set to 10, the instrument will automatically stop recording when the recorded value reaches 10.

Click **[STAT]** -> **Data Storage**, left and right click to move the cursor position, and click **[OK]** for input. Move the cursor to the key , then click **[OK]** to save and exit.

6.3.6 Data Clearing

Click **[STAT]** -> **Clear data**, click **[OK]** to confirm clearing, and click **[ESC]** to cancel clearing. If the statistics function is not turned off, click **Clear Data**, and the instrument will clear the current count and automatically perform the next statistics.

6.4 System Settings

Click **[Utility]** to enter the system settings interface. The system settings include Sys info, Cal, IO, and Other.

Click on **[Utility]** -> **Sys info** in sequence to view device information (such as model, serial number, software version, hardware version, etc.). In addition, system information can also be viewed by clicking on **[VIEW]**. After the system information menu pops up, if no action is taken on the interface for more than 30 seconds, the system information will automatically close.



Figure 6-17 System settings

6.5 Calibration

Click on **[Utility]** -> **Cal** in sequence, enter the password, and you can set [Zero], [Calib Vol], and [Calib Res].

The specific steps are as follows:

Click **Cal** to pop up the numeric keypad for the password.


After entering the correct password, enter the calibration submenu; If the password is incorrect, a prompt message "Password Error" will pop up on the interface.

Zero

Details reference [Appendix C: Performing Zero Adjustment](#)

Voltage calibration setting steps

- 1 Connect the DC power supply to the input port of the internal resistance tester and set the power output
- 2 Input actual voltage

Click on **Calib Vol** -> **Real Vol** in sequence, and the page will display Voltage Calibration (P). Use the left/right keys to move the cursor, click **[OK]** to enter the actual voltage value, position the cursor to the key , and then click **[OK]** to save the value.

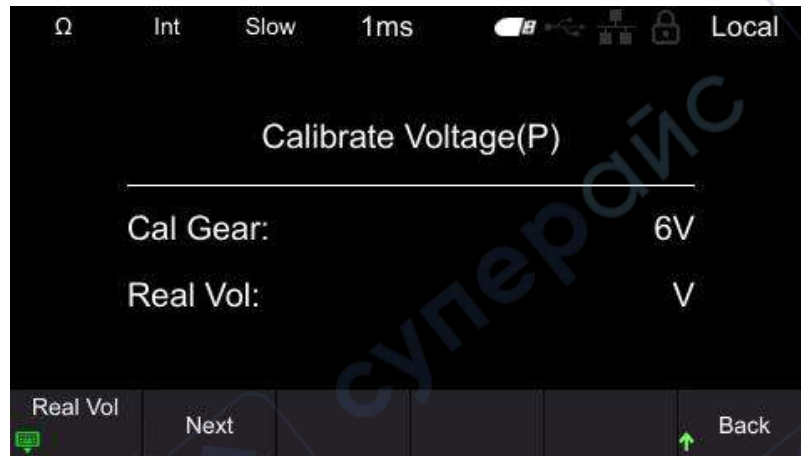


Figure 6-18 Voltage Calibration

3 Set the next gear

Click **Next** to correct the next gear. Repeat steps 1 and 2.

When the page displays voltage calibration (N), the red and black probes should be reversed and calibration should continue. After all gear calibration is completed, the return menu in the bottom right corner switches to complete.

Click **Done** to complete the voltage calibration..

Steps for setting up resistance calibration

1 Connect the four wire resistor to the input port of the internal resistance tester

2 Input actual resistance value

Click on **Calib Res** -> **Real Res** in sequence, and the page will display Resistance Calibration. Use the left/right keys to move the cursor, click **[OK]** to enter the actual resistance value, position the cursor to the key **[↩]**, and then click **[OK]** to save the value.

3 Set the next gear

Click **Next** to correct the next gear. Repeat steps 1 and 2. After all gear calibration is completed, the return menu in the bottom right corner switches to complete. Click **Done** to complete the resistance calibration.

Note:

Before calibration, please preheat the machine for 30 minutes.

Before calibration, please confirm the rated values of the instrument and test lines, otherwise it may cause damage to the instrument or personal injury accidents.

6.6 IO

Communication settings include: LAN, Serial, GPIB

6.6.1 LAN

Click on **[Utility]** ->**IO** ->**LAN** in sequence to enter the LAN settings menu.

LAN parameter settings include: IP mode, IP address, subnet mask, and gateway.



Figure 6-19 LAN parameter settings

Switch input boxes by left/right clicking, click **[OK]** to select the input box, click up/down to modify the value, click left/right to move the cursor position, and click **[OK]** again to exit the current input box. After setting the LAN parameters, use the arrow keys to position the cursor to confirm, click **[OK]** to save and exit.

Note: In the LAN parameter setting interface, if no operation is performed for more than 30 seconds, the instrument will automatically close the LAN parameter setting interface.

6.6.2 Serial

Click on **[Utility]** ->**IO** ->**Serial** Port to enter the Serial Port Settings menu.

The serial port parameter settings include Baud, Data, Check, and Stop.

Set the baud rate, click on the corresponding soft key to select the appropriate baud rate.

Set the data bit and click the corresponding soft key to select the appropriate data bit.

Set the checksum, which can be selected from no checksum, odd checksum, and even checksum.

Set the stop position and click the corresponding soft key to select the desired stop position.

6.6.3 GPIB

Click on **[Utility]** ->**IO** ->**GPIB** in sequence to enter the GPIB settings menu.

Click **[OK]** to display the position of the cursor. Use up/down to modify values

and move the cursor position left/right. Click **[OK]** again to exit the input box, use the arrow keys to position the cursor to confirm, click **[OK]** to save and exit.

6.7 Other settings

Other settings include: Sys Time, Brightness, Keytone, Language, and Upgrade.

6.7.1 System time

Click on **[Utility]** -> **Other** -> **Sys Time** to enter the clock setting interface. Switch input boxes by left/right clicking, click **[OK]** to select the input box, click up/down to modify the value, click left/right to move the cursor position, click **[OK]** again to save and exit the current input box. Click **[ESC]** to exit the system time setting. The system time is mainly used for naming instruments when saving files and screenshots.

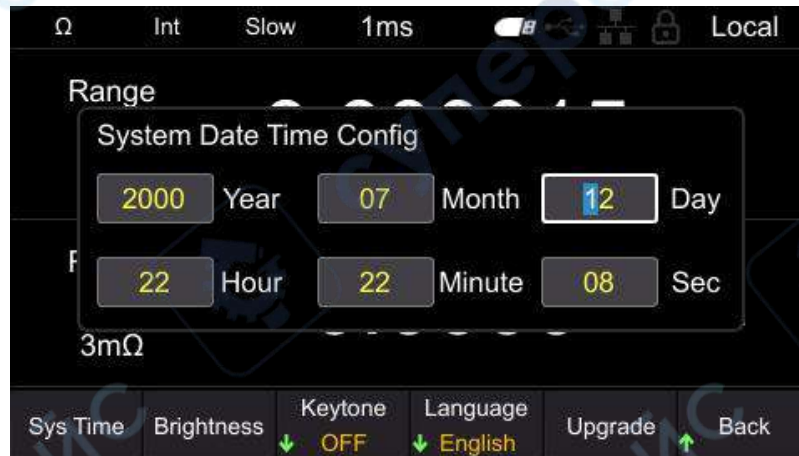


Figure 6-20 Set system time

Note: If no action is taken after 30 seconds in the system time setting interface, the instrument will automatically close the system time setting interface.

6.7.2 Brightness

Click on **[Utility]** -> **Other** -> **Brightness** to enter the screen brightness setting interface. Click the left/right button to decrease or increase screen brightness in steps of 5. The adjustable range is 10-100. The default value is 50.

6.7.3 Keytone

Click on [Utility] -> **Other** -> **Keytone** to turn on or off button sounds.

6.7.4 Language

Click on [Utility] -> **Other** -> **Language**, and switch to Chinese or English.

6.7.5 Upgrade

Copy the firmware to a USB drive and insert it into the USB port on the front panel of the instrument. Click on [Utility] -> **Other** -> **Upgrade** in sequence, and the screen will pop up "Do you want to upgrade the system?". Move the cursor to confirm and click [OK] to complete the upgrade settings. When the progress bar reaches 100%, the instrument will automatically restart, and the application upgrade is completed.

6.8 SAVE

The storage function can store the configuration used by the instrument for the next power on to the internal memory or USB drive of the machine. Click the [SAVE] button to pop up the storage function menu, which includes [Save Path], [Inter/Exter Save], and [Boot Set] options. When the storage function is enabled, the storage settings cannot be modified.

Note: The configuration saved here is the one used for the next power on of the instrument, that is, the startup settings.

6.8.1 Save Path

The save path is divided into [Inter] and [Exter]. The default path is [Inter], which can be set to [Exter] when connecting to USB.

Click on [SAVE] -> **Save Path** in sequence, and when selecting Internal, the instrument will save the configuration used for the next power on to the machine's internal system; When selecting an external device, the instrument saves the configuration used for the next power on to the USB drive.

6.8.2 Inter/Exter Save

When the save path is selected internally, the menu bar displays Inter Save; When selecting an external save path, the menu bar displays Exter Save.

Internal save setting steps: After setting the required storage options, click on **Inter Save**. In the pop-up menu, there are a total of 6 states from 0 to 5 to choose from. Click the corresponding soft key to save to the corresponding status location. If you want to save the startup settings to 0 state, you need to click the **0** soft key, and the screen will pop up "Save Stat0. bin successful!", indicating that the settings are successful. If the entered state already exists, clicking the corresponding soft key will overwrite the original state configuration.

External save setting steps: After setting the required storage options, click on **Exter Save**, and the instrument will automatically generate a file name and save the status to the USB drive.

6.8.3 Boot Set

The startup settings include: default, previous, 0, 1, 2, 3, 4, and 5. The instrument is set to default by default.

- Default: The signal generator automatically calls up the default settings when turned on.
- Last Off: The internal resistance tester automatically saved the settings before shutdown, and after restarting, the internal resistance tester will automatically call up the settings before the previous shutdown. Including all system parameters, except for clock sources.
- 0, 1, 2, 3, 4, and 5: refer to the boot configuration stored inside the machine. Press the **[SAVE]** -> **Boot Set** soft key and select the desired configuration type.

6.9 Load

The loading function can load the configuration used when the instrument is powered on from internal memory or USB drive. Click the **[LOAD]** button to pop up a loading function menu, which includes storage functions such as [Load Path], [Inter/Exter Load], and [Boot Set] options.

Note: The configuration loaded here is the one used when the instrument is powered on, that is, the startup settings.

6.9.1 Load Path

The loading path is divided into [Inter] and [Exter].

Click **[LOAD]** -> **Load Path** in sequence, and click the corresponding soft key to select internal or external.

6.9.2 Inter/Exter Save

When selecting internal loading path, the menu bar displays Intern; When the loading path is selected as external, the menu bar displays Extern.

Internal loading setting steps: Set the loading path to internal, click on **Inter Load**, and in the pop-up menu, there are a total of 6 states to choose from, ranging from 0 to 5. Click the corresponding soft key to load it into the corresponding startup settings. If there are saved startup settings in the current state, the screen will display "StatX.bin Load Success!"; If there are no saved startup settings in the current state, the screen will display "Load Failed StatX.bin Does Not Exist!".

External loading setting steps: Insert the USB flash drive into the USB HOST interface on the front panel, set the loading path to external, click on **Exter Load**, use up/down keys to select the .csv file, and click **[OK]** to load the file.

6.9.3 Boot Set

The startup settings include: Default, Last Off, 0, 1, 2, 3, 4, and 5. The default selection for the instrument is default.

Press the **[LOAD]** -> **Boot Set** soft key, select the desired configuration type, and complete the power on settings.

6.10 0 ADJ

To eliminate errors caused by the bias voltage of the instrument itself or the measurement environment, perform zero adjustment before measurement. Before conducting the test, the instrument needs to be zeroed first. Before zeroing, short-circuit the test line using the correct method, and then press the **[0ADJ]** button to perform zeroing. The interface will display "Zero adjustment Failed/Success" and disappear after 2 seconds.

Note:

- Perform zero adjustment on all ranges.
- Even if the power is cut off, the compensation value after zero adjustment will continue to be maintained.
- Zero adjustment can be performed on the 0ADJ terminal of EXTI/O.
- After successful zeroing, continue zeroing. If zeroing fails, retain the previous zeroing result.

6.11 Local key

Click [**Local**], the lock screen icon on the screen will light up, and clicking any button other than this button is an invalid operation. Click the button again, and the lock screen icon on the screen will turn gray.

In remote control mode, click [**Local**] to switch remote control to local control.

6.12 TRIG key

When manually triggered, press this button to trigger one measurement at a time.

6.13 Plus/Minus keys

Quickly adjust the voltage and resistance range. By default, the resistance range is adjusted and displayed as Ω in the upper left corner of the screen. Press [**Range**] to switch to adjusting the voltage range, and switch the range shortcut label to V.

Note: Using the plus/minus keys to adjust the range, it is not possible to adjust the range to automatic.

6.14 Range key

Press [**Range**] to set the range of voltage and resistance.

6.15 ESC key

Use the [**ESC**] button to return or cancel the current operation. The functions of the [**ESC**] button include canceling input/canceling pop-up boxes/canceling submenus.

6.16 P key

Used to restore the instrument status to the factory default values.

Function	Default value
Range	

Function	Default value
Measurement type	V&R
Voltage range	Auto
Resistance range	Auto
MEA	
Sample	Slow
Average	1
Trigger	Internal
Absolute	Open
Delay(ms)	1
SAVE/LOAD	
Boot Set	Default
STAT	
Switch	OFF
Data Temp	1000
COMP	
Switch	Close
Comp Mode	Auto
Buzzer	Close
Resistance	Limit
Voltage	Limit

Function	Default value
Utility	
Brightness	50%
GPIB Address	2
Key tone	OFF
Language	Chinese
IP	192.168.1.127
MASK	255.255.255.0
IP MODE	Manual
Serial-Baud	9600
Serial-Data	7
Serial-Check	None
Serial-Stop	1

Table 6-1 Factory Default

7 EXT I/O

The EXT I/O interface provides external output and external control functions. Please read the precautions before connecting.



Warning:

To prevent electric shock accidents and instrument malfunctions, please follow the following instructions when connecting the wiring of the EXT I/O connector.

- Please cut off the power supply of this instrument and connect it before connecting it.
- If the wiring detaches during operation, it may come into contact with other conductive components, which is very dangerous.
- Please securely secure the external connector with screws.
- Please insulate the instruments and devices connected to the EXT I/O connector appropriately.



Note:

- Do not input voltage or current above the rated value to the EXT I/O connector.
- When using a relay, be sure to install a freewheeling diode.
- Do not use ISO_5V and ISO_COM forms a short circuit.

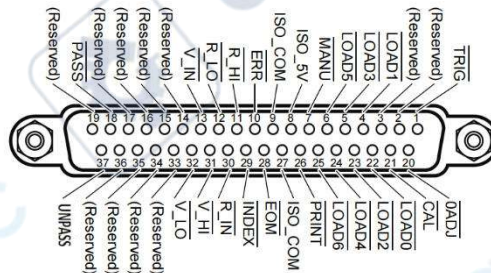


Figure 7-1 EXT I/O connector

Needle number	Signal name	I/O	Function	Logic	
1	\overline{TRIG}	IN	external trigger	negative	edge
2	(Reserved)	IN	-	-	-
3	(Reserved)	IN	-	-	-

Needle number	Signal name	I/O	Function	Logic
4	$\overline{LOAD1}$	IN	Read Number Bit1	negative edge
5	$\overline{LOAD3}$	IN	Read Number Bit3	negative edge
6	$\overline{LOAD5}$	IN	Read Number Bit5	negative edge
7	\overline{MANU}	IN	Manual control of comparator	negative edge
8	ISO_5V	-	Insulated power supply 5V output	-
9	ISO_COM	-	Insulated power supply common terminal	-
10	\overline{ERR}	OUT	Test exception	negative edge
11	$\overline{R_HI}$	OUT	Resistance determination	negative edge

Needle number	Signal name	I/O	Function	Logic	
			result HI		
12	$\overline{R_LO}$	OUT	Resistance determination	negative	level
			result Lo		
13	$\overline{V_IN}$	OUT	Resistance determination	negative	level
			result IN		
14	(Reserved)	OUT	-	-	-
15	(Reserved)	OUT	-	-	-
16	(Reserved)	OUT	-	-	-
17	(Reserved)	OUT	-	-	-
18	\overline{PASS}	OUT	Judgment	negative	level
			result PASS		
19	(Reserved)	OUT	-	-	-
20	$\overline{0ADJ}$	IN	Zero	negative	edge
21	\overline{CAL}	IN	Perform self calibration	negative	edge
22	$\overline{LOAD0}$	IN	Read the Number Bit0	negative	level

Needle number	Signal name	I/O	Function	Logic	
23	$\overline{LOAD2}$	IN	Read the number Bit2	negative	level
24	$\overline{LOAD4}$	IN	Read the number Bit4	negative	level
25	$\overline{LOAD6}$	IN	Read the number Bit6	negative	level
26	\overline{PRINT}	IN	Measurement value printing	negative	edge
27	ISO_COM	-	Insulated power supply common terminal	-	-
28	\overline{EOM}	OUT	End Of Measurement	negative	edge
29	\overline{INDEX}	OUT	Measurement reference signal	negative	level
30	$\overline{R_IN}$	OUT	Resistance determination	negative	level

Needle number	Signal name	I/O	Function	Logic	
				result IN	
31	$\overline{V_{HI}}$	OUT	Voltage judgment result Hi	negative	level
				result Lo	
32	$\overline{V_{LO}}$	OUT	Voltage judgment result Lo	negative	level
33	(Reserved)	OUT	-	-	-
34	(Reserved)	OUT	-	-	-
35	(Reserved)	OUT	-	-	-
36	(Reserved)	OUT	-	-	-
37	\overline{UNPASS}	OUT	Judgment result UNPASS	negative	level

Table 7-1 EXT I/O output terminal

Note: The outer shell of the connector is connected to the metal part of the instrument, and also connected (conductive) to the protective grounding terminal of the power socket.

7.1 Input terminal function

- \overline{TRIG}

External trigger input, when the trigger source is set to external, it will change

from a high-level signal to a low-level signal and trigger a measurement at the edge of the jump. When triggered internally, trigger measurement cannot be performed.

- $\overline{LOAD0} \sim \overline{LOAD6}$

The panel display number used for external input selection calls. When the number is selected, a signal is input, and the device reads the configuration corresponding to the selected panel display number for measurement. If the number value does not change when input, perform a measurement when triggered externally.

- \overline{OAJ}

External input control zeroing function, when the signal changes from high level to low level, it triggers the application program to perform a zeroing function in the form of an interrupt.

- \overline{PRINT}

External input control screenshot function, when the signal changes from high level to low level, it triggers the application program to execute a screenshot function in the form of an interrupt.

- \overline{CAL}

External input control correction function, when the signal changes from a high level to a low level signal, it triggers the application program to perform a correction function in the form of an interrupt.

- \overline{MANU}

External input control comparator function, default to high level. When the level changes (such as high to low or low to high), it triggers the application program to read the current level status in the form of an interrupt. If an interrupt is generated and the level is low, the comparator function is turned on. If it is high, the comparator function is turned off.

7.2 Output terminal function

- \overline{EOM}

The measurement end signal is divided into HOLD mode and PULSE mode. In the external trigger mode, after the measurement is completed, the HOLD mode keeps the EOM at a low level and continues until the next measurement begins (when the external trigger is generated) to recover to a high level. The PULSE mode outputs a configurable width of low-level pulses and then returns to a high level state; In the internal triggering mode, after the measurement is completed, the HOLD mode outputs a fixed width of low-level pulses according to the measurement mode and restores the high-level state, while the PULSE mode outputs a configurable width of low-level pulses and restores the high-level state.

- \overline{INDEX}

The measurement process indicator signal outputs an INDEX signal at a low level

when waiting for triggering, delay, self correction, and operation states. The output signal is at a high level when in range configuration, data acquisition, data transmission, and operation states. The signal can be removed from the test object from high to low.

- \overline{ERR}

The measurement of abnormal output signals can be divided into two modes: synchronous output and asynchronous output. In synchronous output mode, the ERR state is synchronized with the EOM output, and it is determined that the ERR state is valid when the EOM output is low. In asynchronous output mode, the ERR state is updated in real-time and has no synchronous timing relationship with the EOM.

- $\overline{R_HI}$, $\overline{R_IN}$, $\overline{R_LO}$, $\overline{V_HI}$, $\overline{V_IN}$, $\overline{V_LO}$, \overline{PASS} , \overline{UNPASS}

The output results of the comparator function, R-HI, R-IN, R-LO, V-HI, V-IN, V-LO represent the comparison results of resistance and voltage, respectively. The PASS signal is judged under different conditions based on different measurement modes. In the resistance voltage mode, when the resistance comparison result is R-IN and the voltage is V-IN, the PASS is at a low level; In resistance mode, when the comparison result is R-IN, PASS is at a low level; In voltage mode, when the comparison result is V-IN, PASS is at a low level. The UNPASS signal is a logic inversion output of the PASS signal.

Note:

- When the measurement conditions of this instrument change, I/O signals cannot be used.
- When the power is turned on, the signal and signal are initialized to HIGH (OFF).
- When there is no need to switch measurement conditions, please fix all $\overline{LOAD0} \sim \overline{LOAD6}$ as Hi or Lo.
- To avoid erroneous judgments, please confirm the comparator's judgment through both \overline{PASS} and \overline{UNPASS} signals.

8 Analog Output

The analog output of resistance measurement values is recorded by connecting the analog output to a recorder to record the changes in resistance values.

- To avoid electric shock and instrument malfunction, please set the power supply of this instrument and the connected instrument to OFF when connecting the analog output terminal.
- To avoid damaging this instrument, please do not short circuit the output terminals or input voltage.

8.1 Connect analog output

Analog output specifications	
Output voltage	DC 0V~DC 3.1V (f.s.)
Resolution ratio	12 bit resolution (approximately 1mV)
output resistance	100Ω
Output items	Resistance measurement value (display count value) OF, fixed at 3.1V when testing abnormal, fixed at 0V when negative value
Output rate	0 count value~31000 count values 0V~3.1V
Output accuracy	Resistance testing accuracy is 0.2% f. s. (temperature coefficient is 0.02% f. s./°C)
Response time	Resistance measurement response

Analog output specifications	
	time+sampling time+1 ms

Table 8-1 Analog output specifications

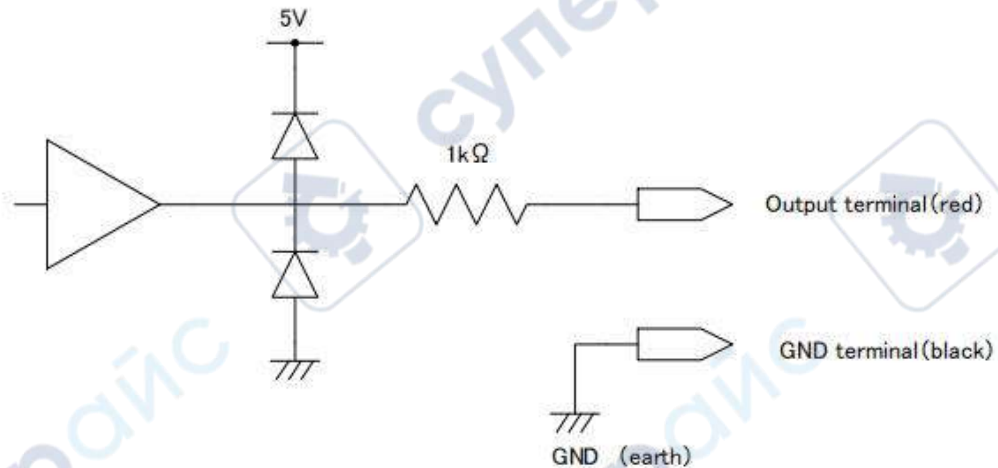


Figure 8-1 Connection diagram

Note:

- The output impedance is 100 Ω . Please use a connecting instrument with an input impedance of 5M Ω or higher.
- If cables are connected, external noise may be picked up. Please use bandpass filters, etc. on the connected instruments as needed. Connect the GND terminal of the analog output to the ground wire (metal part of the casing).
- The output voltage is updated based on the sampling timing of resistance measurement.
- The recorded waveform is in a stepped shape. (Because the response of the output circuit is very fast compared to the update cycle)
- In automatic range, due to range switching, even if the resistance value is the same, the output voltage is 1/10 (or 10 times). It is recommended to use in manual range.
- When changing settings (range switching, etc.) and when the power is turned off, the output is set to 0 V.

9 Remote control

When remote control is enabled, the Local displayed in the upper right corner of the interface switches to Remote.

9.1 USB remote control

Use a USB cable to connect the computer's USB port to the USB interface on the back panel of the internal resistance tester. At this point, the upper right corner of the measurement display interface of the internal resistance tester displays the USB connected label.

Download and install IO software from the following address:

<https://www.keysight.com/main/software.jsp?ckey=2175637&lc=chi&cc=CN&nid=-11143.0.00&id=2175637>

Open the IO software, locate the device, send a command to check if communication is normal, and after obtaining normal communication, use the SCPI command to remotely control the internal resistance tester.

For example:

Query :FETC? (Read the latest measurement values)

Response 288.02E-3 , 1.3921E+0 (Ω V function)

The measured resistance value is 288.02m Ω , and the measured voltage value is 1.3921V

9.2 LAN remote control

Connect the backend network port of the computer to the rear panel network port of the internal resistance tester using a LAN cable.

Click on **[Utility]** -> **IO** -> **LAN** in order to set the LAN parameters of the internal resistance tester.

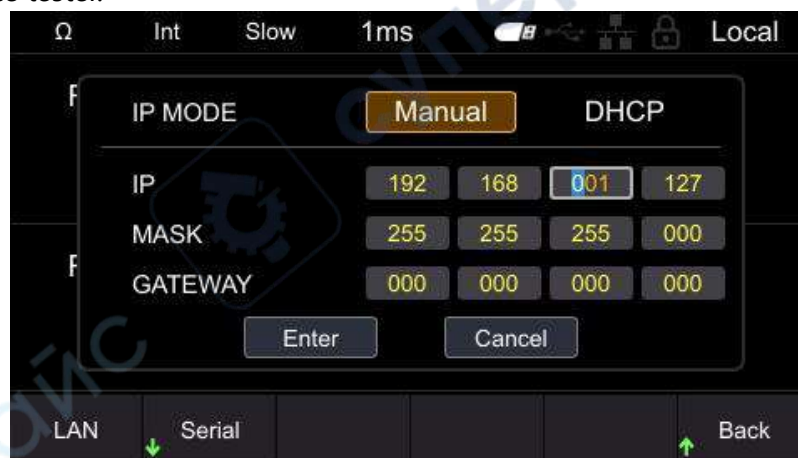


Figure 9-1 Set LAN parameters

Manually configure the IP and other information of the computer, and set the Ethernet properties of the computer:

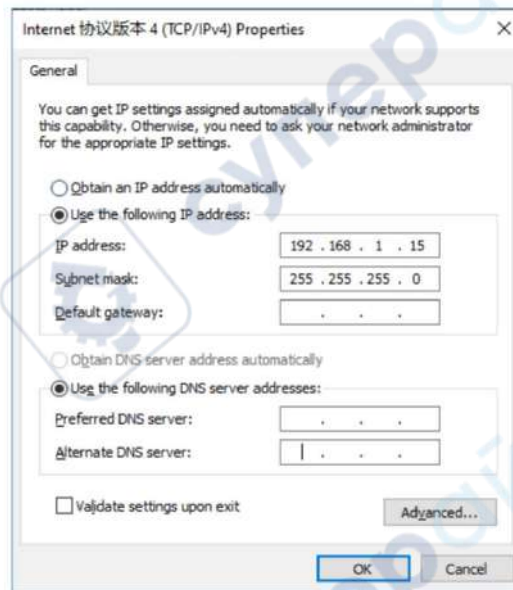


Figure 9-2 Set computer Ethernet properties

After opening the IO software and successfully connecting, the device will appear in the LAN list. If the device does not appear, you can manually add the device, enter the IP address and protocol of the device, test the VISA address, and click OK to add a new device.

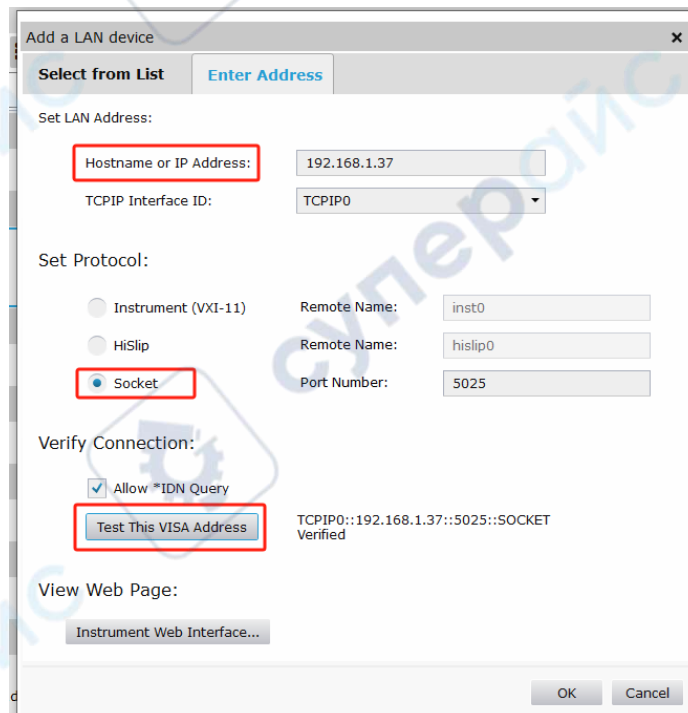


Figure 9-3 Manually adding devices

After successful connection, the network port icon in the upper right corner of the machine measurement display interface is displayed as follows:

**Figure 9-4 Network interface icon display**

Like USB remote control, after obtaining normal communication, SCPI instructions can be used to control the power output.

If there is a DHCP server in the local area network, the DHCP function can be turned on, and the instrument will automatically obtain IP and other information from the DHCP server without the need for manual settings.

Note: There is no DHCP server in the local area network, and IP and other information must be manually configured.

9.3 Serial port control

Click on **[Utility]** -> **IO** -> **Serial**, and set the serial port parameters of the internal resistance tester.

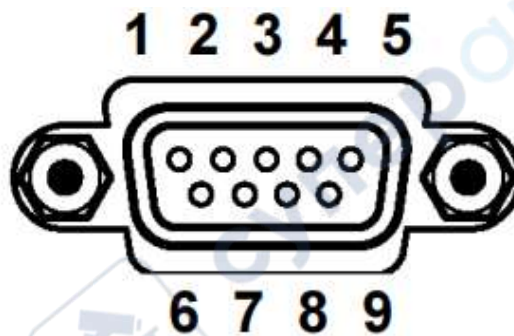
Click on the **Baud**, and the available baud rates are 9600, 19200, 38400, 57600, 115200, and 230400.

Click on the **Data**, there are 7 and 8 data bits to choose from.

Click on the **Check** to select no checksum, odd checksum, and even checksum.

Click on the **Stop**, and there are 1 and 2 stop bits to choose from.

Use an RS232/485 cable to connect the computer's RS232/485 port to the RS232/485 interface on the rear panel of the internal resistance tester.

**Figure 9-5 RS232/485 connector**

Needle number	Signal name
1	NC
2	RS232_TX
3	RS232_RX
4	RS485_A
5	GND
6	NC
7	NC
8	NC
9	RS485_B

Table 9-1 RS232/485 connector pin number

Open the IO software, select Add Device, set the corresponding baud rate, data bits, checksum, and stop bits, test the VISA address, and click OK to add a new device. Like USB remote control, after obtaining normal communication, the SCPI command can be used to remotely control the internal resistance tester.

9.4 GPIB Remote control

Click on **[Utility]** -> **IO** -> **GPIB** to access the GPIB window.

Click **[OK]** to display the cursor position, click up/down to modify the value, click left/right to move the cursor position, click **[OK]** again to exit the current input box, click down to position the cursor to confirm, click **[OK]** to save and exit.

Connect the computer USB port to the GPIB interface on the rear panel of the internal resistance tester using a GPIB cable. Open the IO software, select Add Device, set the corresponding GPIB address, and click OK to add a new device.

Note: The GPIB address range is 02-30.

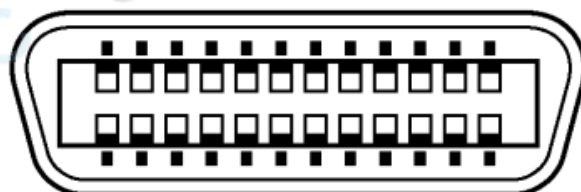


Figure 9-6 GPIB connector

10 Fault handling

Pressing the power button still causes the instrument to screen black and cannot be turned on.

- a. Check if the power connector is properly connected.
- b. Check if the power button is pressed firmly.
- c. Check if the fuse is blown. If you need to replace the fuse, please use a fuse that meets the specifications of this product.
- d. After completing the above checks, restart the instrument.
- e. If you still cannot use this product normally, please contact Hantek.

Invalid key input

- a. Check if the buttons are locked.
- b. Whether to use external remote control.
- c. If you still cannot use this product normally, please contact Hantek.

Unstable measurement values

- a. Has the four terminal connection not been made.
- b. Are there any metal parts around the probe.

Reason: If there are metal parts around the battery and probe to be measured, the measurement value may fluctuate due to the induction of eddy current.

Countermeasure: When measuring, please try to stay as far away from the metal parts as possible.

Wrap the cables together and minimize the area of the branch parts as much as possible.

- c. Is noise mixed in.

Countermeasure: Wrap the cables together and minimize the area of the branch parts as much as possible.

Shield the cable and connect it to the ground wire.

- d. Whether to use multiple instruments for simultaneous measurement.

Reason: When multiple instruments measure simultaneously, interference occurs due to the measurement signals between them, resulting in fluctuations in the measurement values.

Countermeasure: When measuring, please use the measurement current pulse output function to stagger the measurement timing.

Please try not to overlap the probes as much as possible. Do not stack this instrument when placing it.

- e. Whether the body is tightly attached to the front of this instrument for measurement

Reason: Noise may be picked up due to the induction signal in the circuit of this instrument, causing fluctuations in the measured values.

Countermeasure: When measuring, please maintain a distance of more than 20cm from this instrument.

- f. If you still cannot use this product normally, please contact Hantek.

11 Appendix

11.1 Appendix A: Models and Accessories

Ordering Information	Order ID
Host model	
160V , RS232/485,USB,LAN,IO,ANALOG	HBT4561A
OUTPUT	
160V , RS232/485,USB,LAN,IO, ANALOG	HBT4561H
OUTPUT, GPIB	
260V , RS232/485,USB,LAN,IO,ANALOG	HBT4562A
OUTPUT	
260V , RS232/485,USB,LAN,IO, ANALOG	HBT4562H
OUTPUT, GPIB	
410V , RS232/485,USB,LAN,IO,ANALOG	HBT4563A
OUTPUT	
410V , RS232/485,USB,LAN,IO,ANALOG	HBT4563H
OUTPUT, GPIB	
1300V , RS232/485,USB,LAN,IO,ANALOG	HBT4564A
OUTPUT	
1300V , RS232/485,USB,LAN,IO, ANALOG	HBT4564H
OUTPUT, GPIB	

Ordering Information	Order ID
1700V, RS232/485,USB,LAN,IO,ANALOG OUTPUT	HBT4565A
1700V, RS232/485,USB,LAN,IO,ANALOG OUTPUT, GPIB	HBT4565H
2100V, RS232/485,USB,LAN,IO,ANALOG OUTPUT	HBT4566A
2100V, RS232/485,USB,LAN,IO,ANALOG OUTPUT,GPIB	HBT4566A

Table 11-1 Internal resistance tester model

Ordering Information	Order ID
Standard accessories	
Power cord that meets the standards of the host country	— —
Square USB cable	— —
Clamp type testing line	HT2107
Needle shaped testing line	HT2100
Packing list	— —

Table 11-2 Standard accessories

11.2 Appendix B: AC Four Terminal Test Method

This series of internal resistance testers adopts the AC four terminal testing method, which deduces the wire resistance and contact electrons between the wire and the test object during the measurement process, making the measurement results more accurate.

Resistance meter circuit

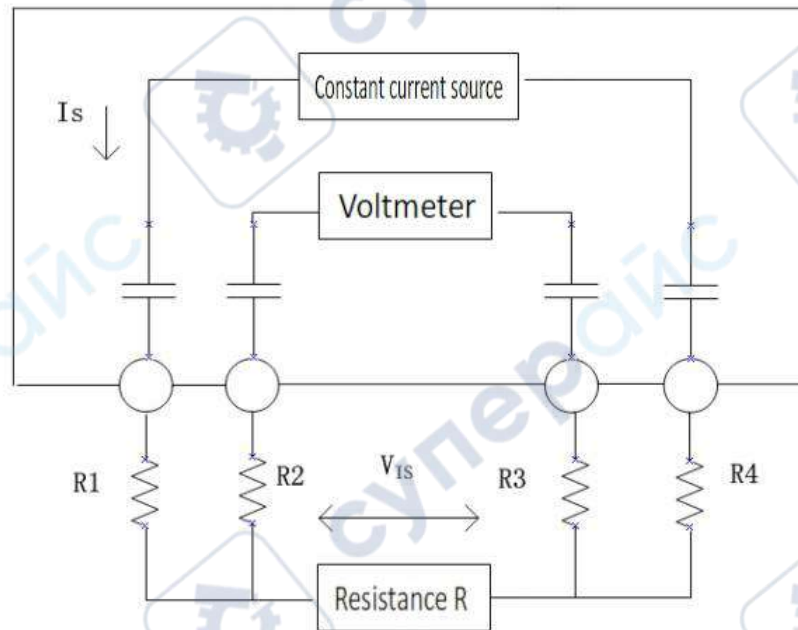


Figure 11-1 Principle diagram of measurement method

Principle of AC four terminal measurement method: As shown in the figure, the AC current I_s is input to the measured object through the current output terminal, and the voltage drop V_{is} caused by the impedance of the measured object is measured on the voltage measurement terminal. At this point, the current terminal is connected to the internal high impedance voltmeter, so there is almost no current flowing through the resistance R_2 and R_3 of the wire resistance and contact resistance, eliminating the voltage drop on R_2 and R_3 , making the measurement results more accurate.

11.3 Appendix C: Performing Zero Adjustment

To remove residual components caused by bias voltage or measurement environment of this instrument, please perform zero adjustment before measurement, and the testing accuracy will be specified after zero adjustment. Zero adjustment refers to the function of subtracting the residual value when measuring 0 to adjust the zero point, so it is necessary to perform zero adjustment when connected to 0. Considering that it is unrealistic to connect the test object without resistance in reality. So, in the actual zeroing process, zeroing is achieved by establishing a state close to 0. If zero adjustment is not performed correctly, the correct measurement value cannot be obtained.

11.3.1 Zero adjustment wiring principle

According to Ohm's law $E=I \cdot R$, in order to establish a state close to 0, it is necessary to short-circuit directly between SENSE-H (red) and SENSE-L (black). The voltage between SENSE-H and SENSE-L is approximately 0V, and the specific calculation is as follows:

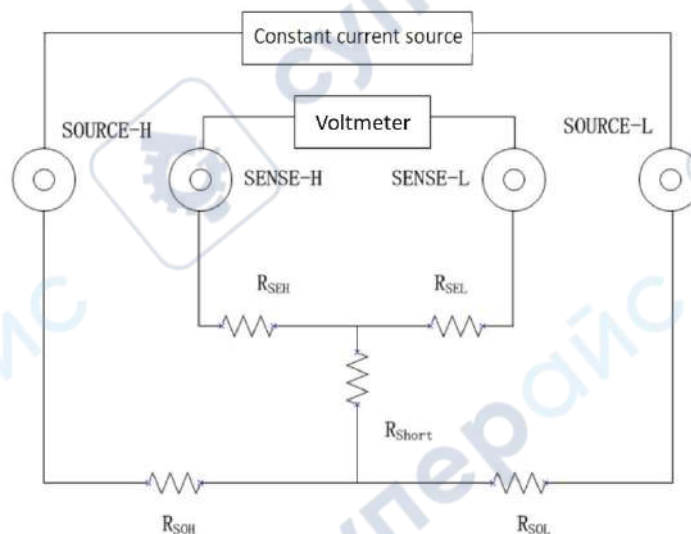


Figure 11-2 Zero adjustment schematic diagram

R_{SEH} and R_{SEL} are wiring resistors for SENSE-H and SENSE-L
 R_{SOH} and R_{SOL} are the wiring resistors for Source-H and Source-L
 R_{Short} is the short-circuit resistance
 I_0 is the current flowing from SENSE-H to SENSE-L
 I is the current flowing from Source-H to Source-L

Then:

$$E = (I_0 \times R_{SEL}) + (I_0 \times R_{SEH})$$

$$= (0 \times R_{SEL}) + (0 \times R_{SEH})$$

=0(V)

So, through the above wiring method, the voltage between SENSE-H and SENSE-L can be correctly maintained at 0V, so it can be adjusted to zero appropriately.

11.3.2 Zero adjustment using clamp type test line

To use a clamp type test wire for zero adjustment, the red and black probes need to be short circuited. Please connect the test wire as follows:

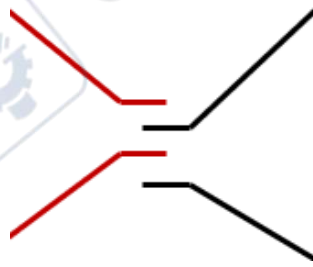


Figure 11-3 Zero adjustment of clamp type test line

11.3.3 Zero adjustment using needle shaped test lines

To use a needle type test wire to zero, short the internal pin wiring of the red and black probe. Please connect the test wire as follows:



Figure 11-4 Zero adjustment of needle shaped test line

11.4 **Appendix D: Warranty Summary**

Qingdao Hantek Electronics Co., Ltd. (hereinafter referred to as Hantek) promises that the host and accessories of its production instruments will have no material or process defects during the product warranty period.

During the warranty period, if the product is proven to be defective, Hantek will provide free repair or replacement for the user. Please refer to the official website of Hantek or the product warranty card for detailed warranty regulations. To obtain the full text of repair services or warranty instructions, please contact the Hantek repair center or local offices.

Except for the warranties provided in this summary or other applicable warranty cards, Hantek Company does not provide any other express or implied warranties, including but not limited to any implied warranties of product tradability and suitability for special purposes. Under no circumstances shall Hantek be liable for indirect, special or consequential losses.



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