ONMEAS®

Rev.A1

# AT9600

## Earth Resistance Meter




# User's Guide

Scan QR code for operation video

# Safety Notice

**Warning** **Danger**:If any of the following abnormal conditions occurs, stop operation immediately and disconnect the power cord. Contact the Onmeas sales department immediately for repair. Otherwise, a fire may occur or the operator may be exposed to a potential electric shock hazard.

- The instrument operates abnormally.
- The instrument produces abnormal noise, odor, smoke, or flashes during operation.
- The instrument generates high temperature or electric shock during operation.
- The power cord, power switch, or power socket is damaged.
- Foreign matter or liquid has entered the instrument.

# Safety Information

**Warning** **Danger:**To avoid possible electric shock and ensure personal safety, follow the guidelines below during operation.

| | |
|---|---|
| *Disclaimer* | Please read the following safety information carefully before using the instrument. Onmeas assumes no liability for any personal injury or property damage caused by the user's failure to comply with the following provisions. |
| **Instrument Grounding** | To prevent electric shock hazard, connect the power ground wire properly. |
| **Do Not** Use the Instrument in Explosive Gas Atmospheres | Do not use the instrument in an environment containing flammable or explosive gases, vapors, or excessive dust. Using any electronic equipment in such an environment poses a risk to personal safety. |
| **Do Not** Open the Instrument Case | Non-professional maintenance personnel must not open the instrument enclosure in an attempt to repair the instrument. Charge that has not been fully discharged may remain inside the instrument for some time after it is switched off, which may cause an electric shock hazard to persons. |
| **Do Not** Use the instrument in a strong magnetic field environment | Do not use this instrument in places with strong magnetic or electric fields; electromagnetic pulses can cause instrument malfunction and fire. |
| **Do not** use this instrument near sensitive test equipment and equipment under test.Do not use this instrument near sensitive test equipment and equipment under test. | If these devices are used near this instrument, noise generated by breakdown failure of the DUT may interfere with them.For test voltages exceeding 3 kV, the electric field between test leads will ionize air and produce corona, causing substantial broadband RF interference between the test leads. To mitigate this effect, ensure sufficient separation between test leads. Additionally, keep test leads away from conductive surfaces, especially sharp metal edges. |
| **Do Not** Use a Malfunctioning Instrument | If the instrument is not operating normally, the hazards are unpredictable. Disconnect the power cord, do not use the instrument again, and do not attempt to repair it yourself. |
| **Do Not** Use the Instrument Beyond the Methods Specified in This Manual | Beyond the specified scope, the protective measures provided by the instrument will become ineffective. |

# Limited Warranty and Limitation of Liability

**Onmeas Ltd. (hereinafter referred to as Onmeas) warrants that every AT9600 you purchase is fully compliant in terms of quality and metrology.**This warranty does not cover the fuse, nor damage caused by negligence, misuse, contamination, accident, or abnormal conditions of use. This warranty applies only to the original purchaser and is not transferable.

**From the date of shipment, Onmeas provides one year of free warranty; this warranty also covers VFD or LCD.** During the one-year warranty period, damage to the instrument caused by improper operation of the user shall be repaired at the user's expense. After two years and for the lifetime of the instrument, Onmeas provides repair services on a charged basis. For the replacement of VFD or LCD, the fee is charged at the current cost price.

If product damage is found, please contact Onmeas to obtain the information required for an approved return or replacement. Afterwards, please send this product to the dealer for return or replacement. Be sure to state the reason for the product damage, and prepay the postage and the insurance to the destination. For the repair or replacement of products within the warranty period, Onmeas will cover the return shipping cost. For the repair of non-warranty products, Onmeas will make an estimate of the repair cost and will only carry out the repair with your consent; all costs arising from the repair shall be borne by the user, including the return shipping cost.

This warranty is the only warranty provided by Onmeas and is your sole and exclusive remedy. Apart from this, there are no other express or implied warranties (including the implied warranty of fitness for a particular purpose), and all other warranties are expressly disclaimed. Neither Onmeas nor its other agents have made any oral or written representation to establish a warranty or to expand the scope of this warranty in any way. In no event shall Onmeas be liable for any special, indirect, incidental or consequential damages or losses (including loss of data) arising from any cause beyond the specifications. If any of the terms hereof conflicts with local regulations, or because certain jurisdictions do not allow the exclusion or limitation of implied warranties, local regulations shall prevail; therefore such a term may not apply to you. However, the ruling of such a term does not affect the validity and enforceability of the other terms.

People's Republic of China
Jiangsu Province
Onmeas Ltd.
October 2009
Rev.A3

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# 1. Installation and Setup Guide

& Thank you for purchasing our company's product! Please read this chapter carefully before use.
In this chapter you will learn the following:

- Main Functions Packing List
- Power Requirements
- Operating Environment
- Cleaning
- Fuse Replacement
- Instrument Handle

## 1.1 Packing List

Before formally using the instrument, please first:
1. Inspect the appearance of the product for defects such as damage or scratches;
2. Check the instrument accessories against the packing list for any missing items.

Table1- 1Instrument Accessories

| Name | Quantity |
|---|---|
| Test current clamp | 1 piece |
| 3A (220-240V) slow-blow fuse | 2 pieces |
| Power cord | 1 piece |
| AT9600 User's Guide | 1 copy |
| RS232 interface cable | 1 set |

If there is damage or missing accessories, contact the Onmeas instrument sales department or your dealer immediately.

## 1.2 Power Requirements

The AT9600 can only be used under the following power conditions:
Voltage: 198VAC~242VAC
Frequency: 50Hz/60Hz



Warning: To prevent electric shock hazard, connect the power ground wire properly
If the user replaces the power cord, ensure that the ground of the power cord is reliably connected.

## 1.3 Operating Environment

The AT9600 must be used under the following environmental conditions:
Temperature: 0C~55C,
Humidity: below 70%RH at 23C

## 1.4 Cleaning

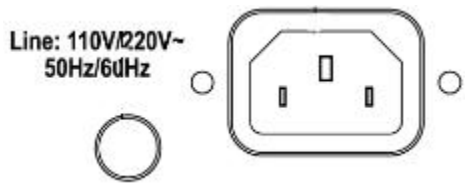
To prevent electric shock hazard, disconnect the power cord before cleaning.
Use a clean cloth moistened with a small amount of clean water to clean the enclosure and panel.

Do not clean the interior of the instrument.

Note: Do not use solvents (such as alcohol or gasoline) to clean the instrument.

## 1.5 Fuse Replacement

Figure1- 1 Fuse Holder on the Rear Panel




To prevent electric shock, before checking or replacing a fuse, make sure the power switch is turned off and the AC power cord is unplugged. Make sure
the fuse used is consistent with that specified in the equipment manual, including shape, rating and characteristics. If a fuse of a different type
or a shorted fuse is used, the equipment may be damaged.

Table1- 1 Fuse Selection

| Input voltage range | Frequency range | Fuse (slow-blow) | Rated power |
|---|---|---|---|
| 220V | 47-63Hz | 3A | 300VA |

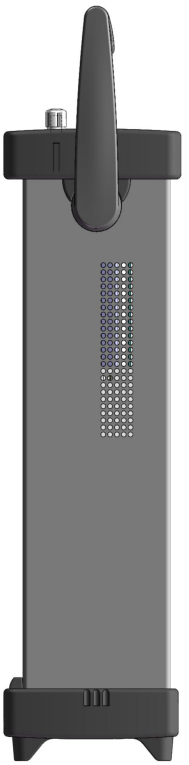
## 1.6 Instrument Handle

The instrument handle is adjustable. Hold both sides of the handle with both hands, pull it gently outward, and then rotate the handle. The handle can be adjusted to four positions, as shown in the figure below:

Figure1- 2Instrument Handle (Schematic; the panel drawing differs from the actual unit)



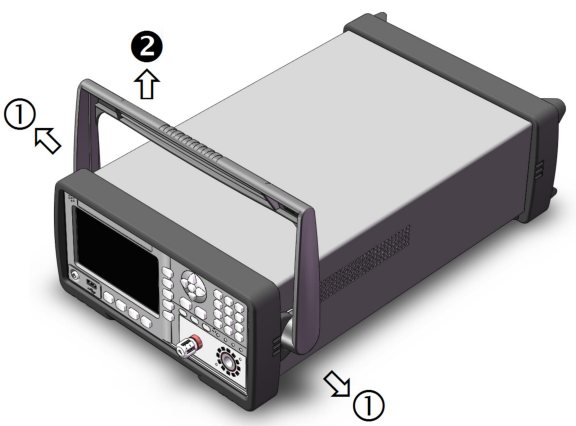
Viewing position 1 [Hold both sides of the handle with both hands and pull it gently outward until it can rotate freely, then switch to viewing position 2]



Carrying position



Viewing position 2 [Hold both sides of the handle with both hands and pull it gently outward until it can rotate freely, then switch to the carrying position]




Position for removing the handle. (Pull at both sides ① until the handle is removed.)

# 2. Overview

In this chapter you will learn the following:

& 
- Safety Rules
- Product Performance

## 2.1 Safety Rules



This instrument can generate an AC current of up to 40A during operation. When operating the instrument, be very careful and follow the
cautions, warnings, and other instructions given in this chapter.

**Workstation Arrangement**

➢ Work location

The workstation must be located in an open area not routinely passed by other personnel, keeping non-workers away from the workstation. The workstation must be separated from other facilities and specially marked "**Ground Test Workstation**". During testing, the following sign must be posted: "**DANGER! TEST IN PROGRESS. NO UNAUTHORIZED PERSONNEL!**".

➢ Input power

Make sure the **instrument is connected to electrical ground (earth)** to ensure safety. The workstation power supply must have its own switch, installed in a conspicuous place at the workstation entrance and specially marked so that everyone can identify it as the workstation power switch. In an emergency, switch off the power immediately before entering to deal with the situation.

➢ Workplace

Must**a work desk or bench made of insulating material**; no metal is allowed between the operator and the DUT. When designing the workplace, **it must be avoided that the operator has to reach across the DUT to operate the tester**. The workplace must be kept tidy and clean. Store unused instruments and test leads in a fixed place, and make sure all personnel can immediately distinguish the item under test, items awaiting test, and items already tested. The test station and its surroundings must be free of flammable and corrosive gases; do not use the tester near flammable materials.

**Operator Requirements**

➢ Personnel qualifications

This series of testers outputs an AC current of up to 40A during operation; the test circuit must not be disconnected at will during testing. Therefore, users should be trained first and strictly follow the user manual.

➢ Safety rules

Operators must be given continuous safety education and training so that they understand the importance of safe operation and follow the safety
rules when operating the tester.

➢ Dress code

Operators must not wear clothing with metal decorations, metal jewelry or watches; such metal ornaments can easily cause accidental electric shock.

**Prohibited Operations**

✓ Do Not Switch the Power On and Off Continuously

After turning off the power switch, wait several seconds or longer before turning it on again. Do not switch the power on/off frequently and repeatedly; otherwise the instrument's protective measures may not fully perform their protective function. Do not turn off the power switch while the instrument is testing, except in special or emergency situations.

✓ Do not leave the output terminals open-circuit during testing

Be careful with the instrument test leads; do not short them to a nearby grounded AC power line or other nearby equipment (such as conveying equipment).

✓ Do Not Connect External Voltage to the Test Terminals

Do not connect any external voltage to the output terminals of the instrument; connecting the output terminals to an external voltage may damage the instrument.

**Precautions During Testing**

- Precautions for aborting (pausing) a test

To change the test conditions, first press the [**Stop**] key to exit the test-ready state. If you need to rest or will leave the test area, turn off the power switch to prevent accidental activation of the start switch, which could cause a safety hazard.

- Conditions for long-term trouble-free use

Due to the size, weight and actual use of the instrument, the heat dissipation design of the current generation module is relatively small. Therefore, the instrument is recommended to be used within the following ranges. If the fan has been working continuously for thirty minutes, use of the instrument must be paused; otherwise the power amplifier output module may burn out due to overheating.

## 2.2 Main Features

**Product Introduction**

The AT9600 AC ground resistance tester uses a 5-inch **full-touch** color LCD display, together with a mainstream high-performance 32-bit ARM processor. It is small, light, highly cost-effective and easy to operate.

The AT9600 AC ground resistance tester can be widely used for checking the grounding performance of household appliances, transformers, electrical equipment and so on. Equipped with a Handler interface (PLC interface) and RS232C, the instrument can easily perform data communication and remote control with a PC, meeting automated testing and improving production efficiency.

**Product Features**

Provides a ground test AC current of up to 40A;
A D/A converter generates the 50Hz/60Hz test sine wave;
Closed-loop current control for more accurate output current;
4-terminal test method eliminates lead interference;
High-precision A/D converter for more accurate test results

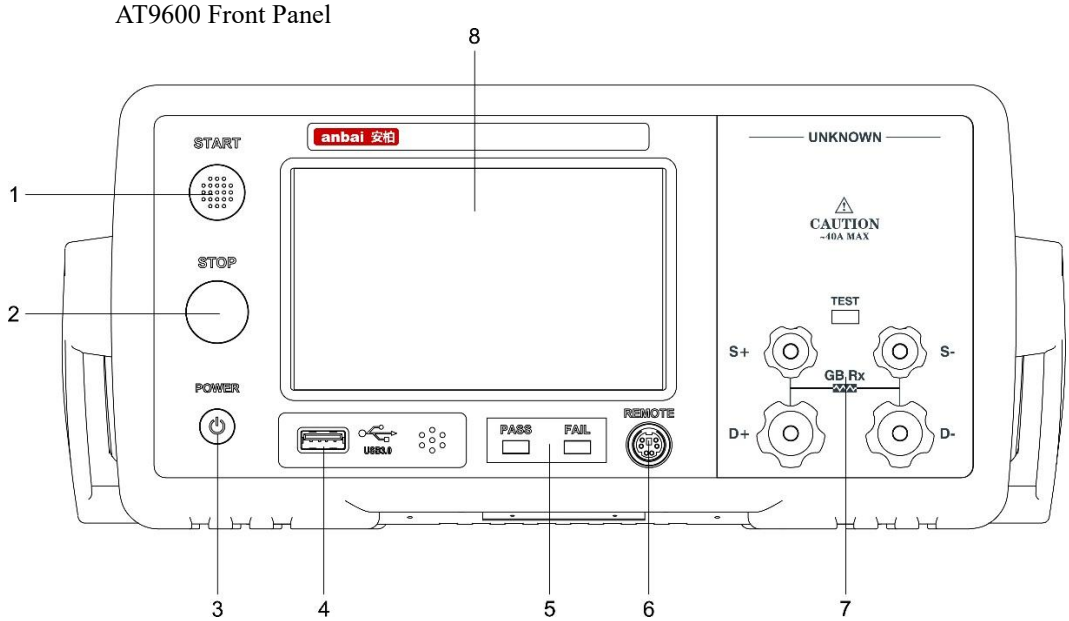
# 3. Getting Started

& In this chapter you will learn the following:

- Getting to know the front panel — includes an introduction to the keys and test terminals.
- Rear panel — introduces the power supply and interface information.
- Power-on startup — includes the power-on self-test process, instrument defaults, and instrument warm-up time.
- Starting a test — including how to connect to the test terminals

## 3.1 Getting to Know the Front Panel

Figure3- 1 AT9600 Front Panel

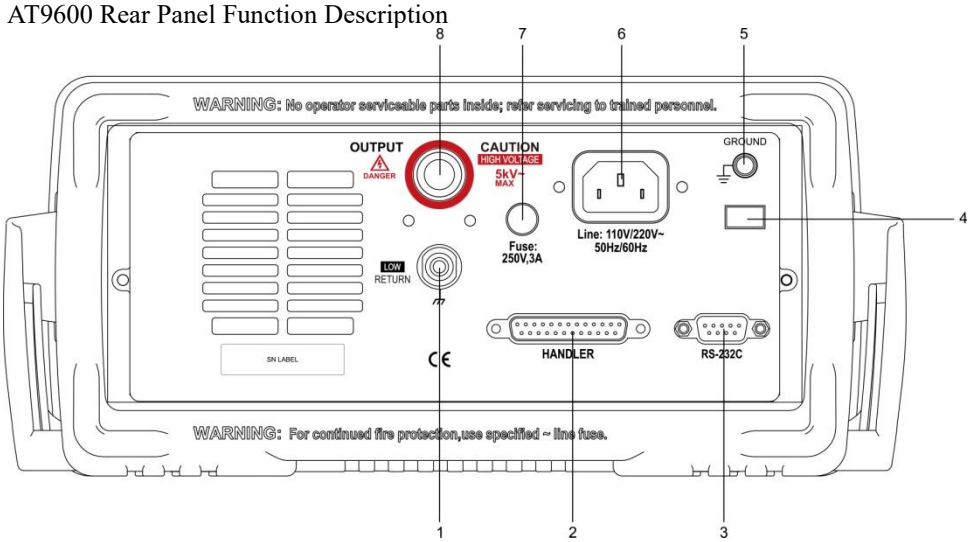



AT9600 Front Panel Function Description

| No. | Function |
|---|---|
| 1 | Start test key |
| 2 | Stop test key |
| 3 | Power switch |
| 4 | USB disk interface |
| 5 | PASS/FAIL indicators |
| 6 | Remote control (not used on this unit) |
| 7 | Test terminals |
| 8 | 5-inch TFT-LCD display window |

## 3.2 Getting to Know the Rear Panel

AT9600 Rear Panel Function Description




Tablen-n AT9600 Rear Panel Description

| No. | Function |
|---|---|
| 1 | Not used |
| 2 | HANDLER (PLC) interface |
| 3 | RS-232C interface |
| 4 | Line voltage mode (110V/220V) switch |
| 5 | Protective earth terminal |
| 6 | Power socket |
| 7 | Fuse holder |
| 8 | Not used |

## 3.3 Power-On Startup

**Powering On**

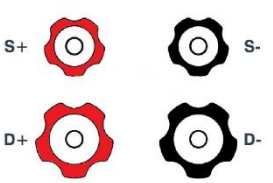
The key marked "+" at the lower left of the panel is the power switch. The AT9600 uses a soft-start method:

- Power on: press the Power key; release the Power key when the POWER LED lights up.
- Power off: press the Power key; release the Power key when the POWER LED turns off.

## 3.4 Connecting the Test Terminals

- Connect the D+ S+ of the test fixture to the D+ S+ on the instrument front panel;
- Connect the D- S- of the test fixture to the D- S- on the instrument front panel.

Figuren-n Instrument Test Terminals



# 4. [MeaSetup] Page

& In this chapter, you will learn about all of the setting functions:

- Test parameter settings
- Comparator result settings

In the stopped state, just tap the [Measurement Settings] key on the touch screen and the instrument enters the measurement settings main page.

## 4.1 Measurement Settings

All measurement-related settings are made on the <Measurement Settings> page.

Figure4- 1 <Measurement Settings> Page

1.




Table4- 1Ranges and Meanings of the Options

| Parameters | English | Range |
|---|---|---|
| Current | CUR | Sets the current value, 5~40A, 0.1A step, in A |
| Time | TIME | Sets the test time value, 0~999.9s; 0s or OFF means continuous output |
| Frequency | FREQ | Sets the test frequency, 50 or 60Hz selectable |
| Upper limit | UPPER | 0~600mR; OFF means no upper-limit comparison |
| Lower limit | LOWER | 0~600mR; OFF means no lower-limit comparison |
| User correction | USER CORRECTION | Off: user correction not used<br>On: short-circuit zeroing enabled |

When both the upper and lower limits are set to 0 or OFF, the instrument does not compare;

when user correction is on, short-circuit zeroing is performed with the current current and frequency settings to eliminate the impedance of the measurement fixture and

clamp; re-zero when the test current changes. Enabling this option is recommended when test results are small.

Actual value = measured value - short-circuit zeroing value.

# 5. [Meas] Display

& The measurement main page includes the following:
- <Measurement Display> Page
- Test function principle and usage instructions

## 5.1 <Measure Display> Page

At power-on the instrument enters the [MeasureDisplay] page; from other pages, tap [Measure Display] or [Display] to enter the measurement display page

Figure5- 1 <Measure Display> Page

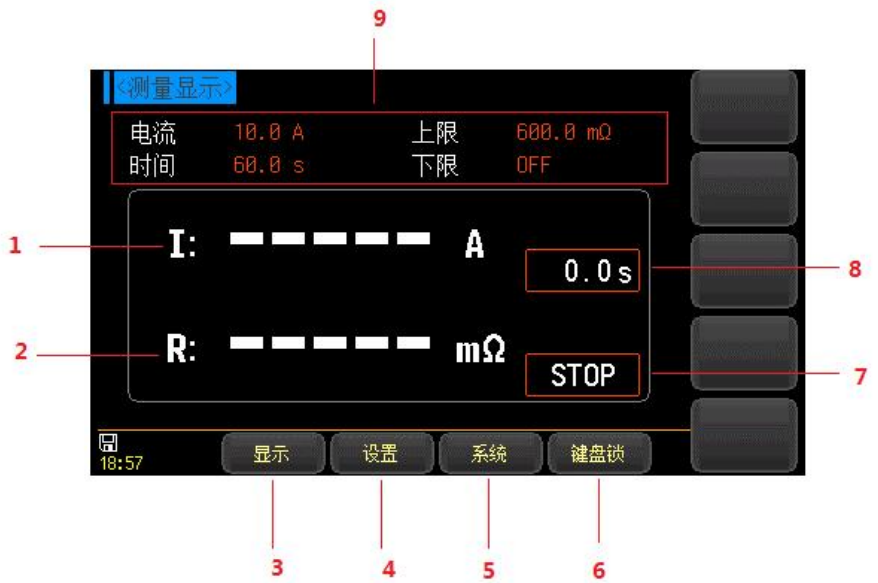



Table 5-1

| No. | Function |
|---|---|
| 1 | Test current value; shows "------" when not testing or open-circuit |
| 2 | Ground resistance value; shows "------" when not testing or out of range |
| 3 | Measurement display button; tap to return to the <Measurement Display> page |
| 4 | Measurement settings button; tap to enter the <Measurement Settings> page |
| 5 | System configuration button; tap to enter the <System Configuration> page |
| 6 | Keyboard lock; tap to lock the device, tap again to unlock |
| 7 | Test status indicator; see the table below |
| 8 | Test time display; shows the remaining time in countdown testing; shows the elapsed time when the test time is OFF |

Table 5-2 Meaning of Test Status

| Test status | Meaning |
|---|---|
| STOP | Test stopped or not started |
| TEST | Testing in progress |
| PASS | Test Passed |
| FAIL | Test FAIL |

## 5.2 Starting a Test

In test mode, after verifying the test conditions and that the device under test is connected correctly, press the [**Start**] key to start the test.

## 5.3 Stopping a Test

When the test time expires, the instrument stops testing automatically and displays the measurement result in real time. Press the STOP key once and the instrument clears the measurement result;
if the test time has not expired, pressing the STOP key stops the test and displays the measurement result; pressing the STOP key again clears the measurement result

## 5.4 FAIL Judgment

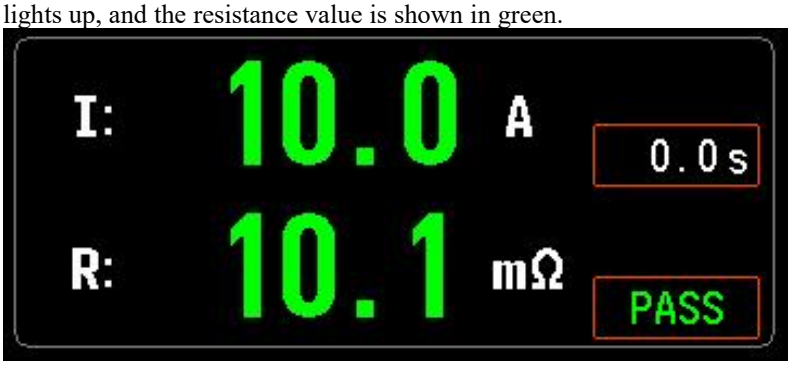
If the resistance judgment fails during testing, (FAIL) is displayed; the ground resistance value is shown in red and the FAIL indicator lights up.

Figure 5-2 FAIL Display




## 5.5 PASS Judgment

If the test result is judged PASS after the test time ends, (PASS) is displayed, the PASS indicator lights up, and the resistance value is shown in green.



# 6. System Configuration

& In this chapter you will learn about the system configuration of the instrument:
- System Configuration Page
- System Information Page

## 6.1 System Configuration Page

The System Configuration page includes the following settings:
- LANGUAGE
- Date/Time settings
- Communication Protocol
- Baud rate settings
- Result Sending
- Command Handshake

All settings on the <System Configuration> page are automatically saved in the system and automatically loaded at the next power-on.

Figure 6- 1 <System Configuration> Page




**Changing the System Language [LANGUAGE]**

The instrument supports two languages: Chinese and English.

■ **Steps for changing the language**

**Step 1** Enter the <System Configuration> page

**Step 2** Use the cursor keys to select [LANGUAGE].

**Step 3** Use the soft keys to select the language:

| Soft key | Function |
|---|---|
| Chinese [CHN] | Chinese |
| ENGLISH | English |

**Setting the Date and Time**

The instrument uses a 24-hour clock.

■ **To change the date:**

**Step 1** Enter the <System Configuration> page

**Step 2** Use the cursor keys to select the [Date] field.

**Step 3** Use the soft keys to set the date:

| Soft key | Function |
|---|---|
| Year + | +1 year |
| Year - | -1 year |
| Month + | +1 month |
| Day + | +1 day |
| Day - | -1 day |

■ **To change the clock:**

**Step 1** Enter the <System Configuration> page

**Step 2** Use the cursor keys to select the [Clock] field.

**Step 3** Use the soft keys to set the clock:

| Soft key | Function |
|---|---|
| Hour + | +1 hour |
| Hour - | -1 hour |
| Minute + | +1 minute |
| Minute - | -1 minute |
| Second + | +1 second |
| Second - | -1 second |

**[Communication Protocol] Setting**

The instrument supports two communication protocols, SCPI and MODBUS, both connected externally via the RS-232 interface on the rear of the instrument. See later chapters for the specific communication protocols.

**[Baud Rate] Setting**

The instrument has a built-in RS-232 interface. Once the instrument senses a signal change on the RS-232 interface, it immediately communicates with the host at the set baud rate and the keyboard is locked. For correct communication, make sure the baud rate is set correctly; if the baud rates of the host and the instrument differ, correct communication is impossible. The instrument RS-232 is programmed using the SCPI language.

The RS-232 configuration is as follows:

- Data bits: 8 bits
- Stop bits: 1 bit
- Parity: none
- Baud rate: configurable

**Set the baud rate:**

**Step 1** Press the <System> touch key at the bottom of the display to enter the <System Configuration> page

**Step 2** Use the cursor keys to select the [Baud Rate] field;

**Step 3** Use the soft keys to select

| Soft key | Function |
|---|---|
| 9600 | If you use an optocoupler-isolated communication converter, use this baud rate |
| 38400 | |
| 57600 | |
| 115200 | For communication with the host computer, it is recommended that you use this high baud rate. |

**[Result Send] Switch**

The sending mode of the test result,

**Steps for setting the beeper:**

**Step 1** Enter the <System Configuration> page

**Step 2** Use the cursor keys to select the [Beeper] field;

**Step 3** Use the soft keys to select

| Soft key | Function |
|---|---|
| Auto | Automatically returns the test result after each test |
| FETCH? | The test result is returned only when the host sends the FETCH? command |

**[Command Handshake] Switch**

When on, each time a command is received the instrument first echoes the command as-is and then returns the result of the command query; when off, the command is not echoed, only the command result is returned.

## 6.2 System Information Page

On the <System Settings> screen, press the [System Information] soft key to enter the <System Information> page.

Figure 6- 2 <System Information> Page




## 6.3 System Service Page

This page is the factory calibration interface and is not open to users.

# 7. Handler (PLC) Interface

&

You will learn about the following:

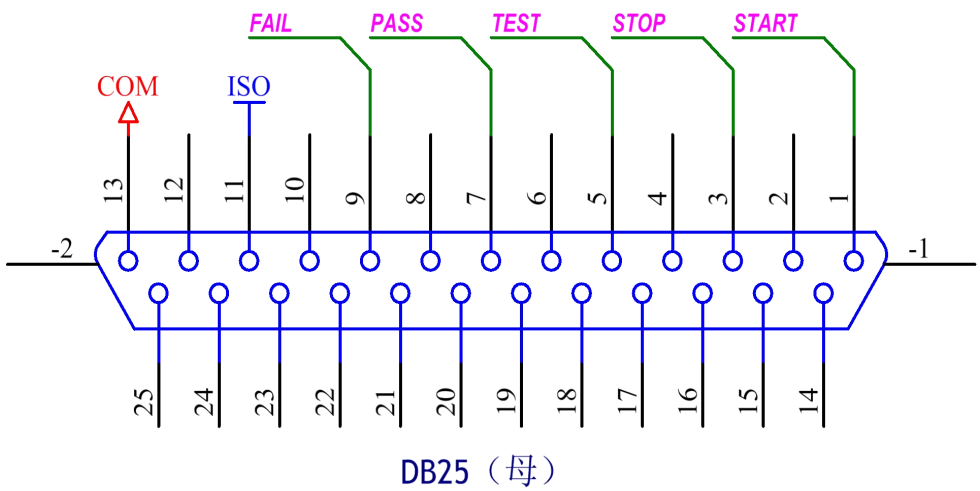
- Wiring terminals
- How to connect and the interface schematic diagrams

The instrument provides a full-featured Handler interface. Through this interface, the instrument can easily implement automatic control together with the user's system control components.

## 7.1 Terminal Blocks and Signals

The Handler of this instrument uses a DB25 female connector; the pin definitions are as follows.

Figure7-1Terminal Block

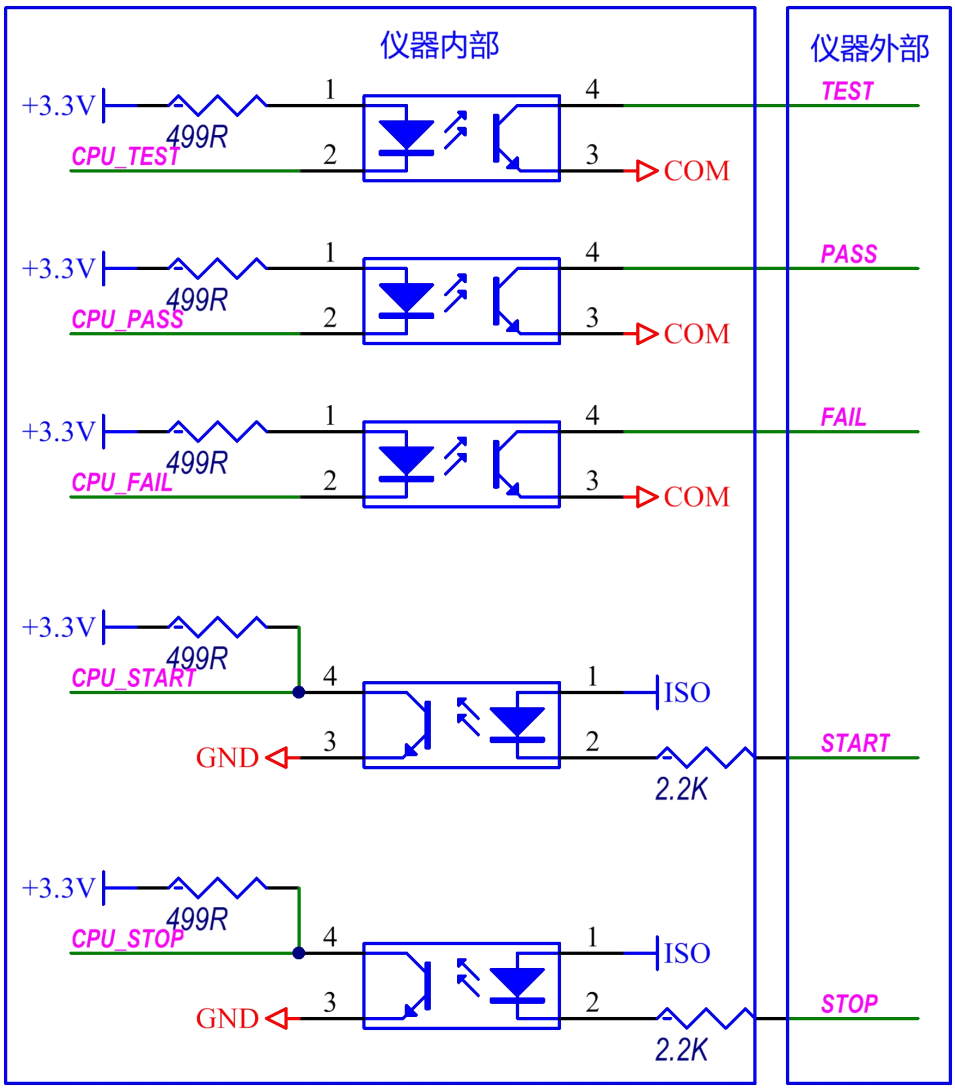



- START, external start signal, active-low pulse;
- STOP, external stop signal, active-low pulse.
- TEST, instrument-testing signal; this pin is low during testing and high when not testing;
- PASS, comparator pass output signal; low level for pass;
- FAIL, comparator fail output signal; low level for fail;
- COM is the common terminal, i.e. the ground end of the external power supply;
- ISO is the external power supply pin. The Handler of this instrument is powered by an external power supply.

## 7.2 Connection Methods

The Handler uses an optocoupler-isolated open-collector working mode; an external power supply (voltage range +5V~30VDC) is required during use.

Figure7-2Internal Circuit Structure of the Instrument Handler Interface



# 8. Remote Communication

& You will learn about the following:

- Introduction to the RS-232 interface
- RS-232 connection.
- Selecting the baud rate.
- Software protocol.

The instrument uses an RS-232 interface (standard configuration) to communicate with a computer, completing all instrument functions. With the standard SCPI and MODBus communication protocols, the user can also conveniently develop various acquisition systems suited to their needs.

## 8.1 RS-232C

RS-232 is a serial communication standard widely used today, also called the asynchronous serial communication standard, used for data communication between computers and between computers and peripherals. RS is the English abbreviation of "Recommended Standard" (recommended standard), and 232 is the standard number. This standard was officially published in 1969 by the Electronic Industries Association (EIA) of the United States; it specifies that data is transmitted one bit at a time over a single data line.

Most serial port configurations are usually not strictly based on the RS-232 standard: a 25-pin connector is used on each port (today's computers mostly use a 9-pin connector). The most commonly used RS-232 signals are shown in the following table:

Table8- 1Common RS-232 Signals

| Signal | Symbol | 25-pin connector pin number | 9-pin connector pin number |
|---|---|---|---|
| Request to send | RTS | 4 | 7 |
| Clear to send | CTS | 5 | 8 |
| Data set ready | DSR | 6 | 6 |
| Data carrier detect | DCD | 8 | 1 |
| Data terminal ready | DTR | 20 | 4 |
| Transmitted data | TXD | 2 | 3 |
| Received data | RXD | 3 | 2 |
| Ground | GND | 7 | 5 |
| Request to send | RTS | 4 | 7 |

In addition, RS232 also has a minimum subset, which is the connection method adopted by the instrument.

Table8- 2 Minimum Subset of the RS-232 Standard

| Signal | Symbol | 9-pin connector pin number |
|---|---|---|
| Transmitted data | TXD | 2 |
| Received data | RXD | 3 |
| Ground | GND | 5 |

## 8.2 RS232C Connection

The RS-232 serial interface can be interconnected with the serial interface of a controller (for example, a personal computer or an industrial computer) through a straight-through DB-9 cable.

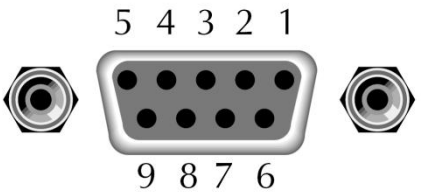
Note: The instrument cannot use a null modem cable.

You can make it yourself, or purchase a 9-core**straight-through** cable yourself, or purchase one from Onmeas.

Note the following for a user-made 3-wire cable:

·When using the DB9 port built into the PC, pins 4-6 and 7-8 of the DB-9 connector (male) on the computer side may need to be shorted

Figure8-1RS-232 Interface on the Rear Panel




Recommendation: To avoid electric shock, turn off the power of the instrument when plugging or unplugging connectors.

■ Default communication settings of the instrument:

Transmission mode: Full-duplex asynchronous communication with start and stop bits

Data bits: 8 bits

Stop bits: 1 bit

Parity: None

## 8.3 Handshake Protocol

Since the instrument uses the minimum subset of the RS-232 standard and does not use hardware handshake signals, the instrument can enable software handshake to reduce possible data loss or data errors during communication. High-level language software engineers should develop the computer communication software strictly according to the following handshake protocol:

- **The command parser of the instrument accepts only ASCII format, and command responses are also returned as ASCII codes.**
- **The command string sent by the host computer must end with NL(' \n' ), and the command parser of the instrument starts executing the command string only after receiving the terminator**.
- The instrument can enable command handshake: after receiving each character, the instrument immediately sends that character back to the host computer, and the host computer can continue to send the next character only after receiving this echoed character.

Tip: If the host computer cannot receive the data returned by the instrument, you can try the following methods to resolve the problem:

1. The software handshake is turned off; refer to the <System Settings> page of the instrument to turn it on.
2. Serial port connection fault; check the cable connections.
3. The communication format of the high-level language program on the computer side is incorrect. Try checking whether the serial port number and the communication format are correct, and whether the baud rate is the same as that set on the instrument.
4. If the instrument is parsing the previous command, the host computer cannot receive a response from the instrument either; please wait and try again.

<If the problem still cannot be solved, immediately consult the Onmeas technical engineers>

## 8.4 SCPI Language

SCPI (Standard Commands for Programmable Instruments) is a universal command set for test instruments adopted by Onmeas. SCPI, also known as TMSL (Test and Measurement System Language), was developed by Agilent Technologies as an extension of IEEE488.2 and has been widely adopted by test equipment manufacturers to date.

See: The built-in command parser of the instrument is responsible for parsing the various command formats entered by the user. Since the command parser is based on the SCPI protocol but is not fully consistent with SCPI, read the “SCPI Command Reference” chapter carefully before starting work.

# 9. SCPI Command Reference

& This chapter includes the following topics:

- Command Parser — understand some rules of the command parser.
- Command Syntax — rules for writing command lines
- Query Syntax — rules for writing query commands
- Query Response — format of the query response
- Command Summary

This chapter provides all the SCPI commands used by the instrument. Through these SCPI commands, all functions of the instrument can be fully controlled.

## 9.1 Command String Parsing

The host computer can send a string of commands to the instrument, and the command parser of the instrument starts parsing after detecting the terminator (\n) or an input buffer overflow.

*Example:* Valid command string:

AAA:BBB CCC;DDD EEE;:FFF

The command parser of the instrument is responsible for the parsing and execution of all commands. Before writing a program, you must first understand its parsing rules.

**Command Parsing Rules**

1. The command parser only parses and responds to ASCII code data.
2. **The SCPI command string must take NL(' \n' ASCII 0x0A) as its terminator**, and the command parser starts executing the command string only after receiving the terminator or when the buffer overflows.
3. If Command Handshake is enabled, the command parser immediately sends each received character back to the host computer; the host computer can continue to send the next character only after receiving this echoed character.
4. After parsing an error, the command parser immediately terminates parsing and the current command becomes invalid.
5. After parsing a query command, the command parser terminates parsing of the current command string, and the subsequent string is ignored.
6. The command parser is not case-sensitive when parsing command strings.
7. The command parser supports abbreviated command forms; for the abbreviation specifications, refer to the following chapters.

**Symbol Conventions and Definitions**

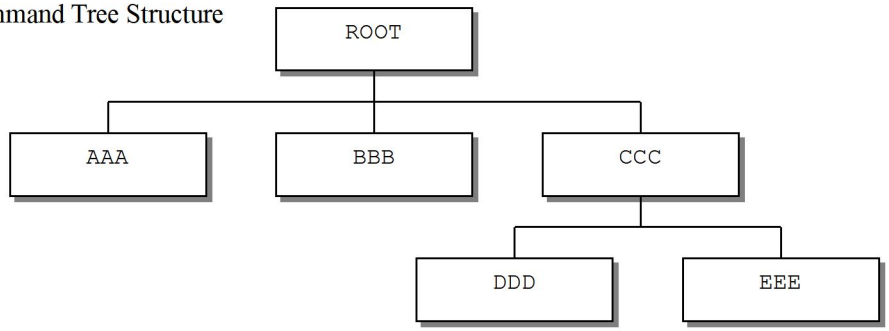
This chapter uses some symbols that are not part of the command tree; they are only intended to facilitate a better understanding of command strings.

| | |
|---|---|
| <> | The text in angle brackets indicates the parameter of the command |
| [ ] | The text in square brackets indicates an optional command |
| {} | When the braces enclose several parameter items, it indicates that only one of the items may be selected. |
| ( ) | The abbreviated form of a parameter is placed in parentheses. |
| Uppercase letters | The abbreviated form of a command. |

**Command Tree Structure**

SCPI commands adopt a tree structure and can extend down three levels (Note: the command parser of this instrument can parse down any number of levels). The highest level here is called the subsystem command. Only after a subsystem command is selected are the commands below it valid. SCPI uses the colon (:) to separate higher-level commands from lower-level commands.

Figure9-1 Command Tree Structure




*Example* ROOT:CCC:DDD ppp
ROOT Subsystem command
CCC Second level
DDD Third level
ppp Parameter

Commands and Parameters
A command tree consists of**a command and [parameters]** separated by 1 space (ASCII: 20H).

*Example* AAA:BBB 1.234
Command [Parameter]

**Commands**
Command words can be in long form or abbreviated form. The long form makes it easier for engineers to understand the meaning of the command string; the abbreviated form is convenient for writing.

**Parameters**

- A command with a single command word and no parameters.
  Example: AAA:BBB
- The parameter can be in the form of a string, and its abbreviation rules still follow the "command abbreviation rules" in the previous section.
  Example: AAA:BBB 1.23
- The parameter can be in numeric form
  - *<integer>* Integer 123, +123, -123
  - *<float>* Floating point
    1. <fixfloat>: fixed-point floating-point number: 1.23, -1.23
    2. <Scifloat>: floating-point number in scientific notation: 1.23E+4, +1.23e-4
    3. <mpfloat>: floating-point number expressed with a multiplier: 1.23k, 1.23M, 1.23G, 1.23u

Table9- 1 Multiplier Abbreviations

| Value | Multiplier |
|---|---|
| 1E18 (EXA) | EX |
| 1E15 (PETA) | PE |
| 1E12 (TERA) | T |
| 1E9 (GIGA) | G |
| 1E6 (MEGA) | MA |
| 1E3 (KILO) | K |
| 1E-3 (MILLI) | M |
| 1E-6 (MICRO) | U |
| 1E-9 (NANO) | N |
| 1E-12 (PICO) | P |
| 1E-15 (PEMTO) | F |
| 1E-18 (ATTO) | A |

Tip: The multipliers are not case-sensitive, and their notation differs from the standard names.

**Separators**
The command parser of the instrument only accepts the permitted separators; for any other separator, the command parser will generate an "Invalid separator(illegal separator)" error. These separators include:

; Semicolon, used to separate two commands.

*Example:* AAA:BBB 100.0;CCC:DDD

: Colon, used to separate command trees or to restart the command tree.
*Example:* AAA:BBB:CCC 123.4;:DDD:EEE 567.8

? Question mark, used for queries.
*Example:* AAA?

□ Space, used to separate parameters.
*Example:* AAA:BBB□1.234

## 9.2 Command Summary

All commands are interpreted in the order of subsystem commands; all subsystems are listed below

- DISPlay Display subsystem
- FUNCtion Function subsystem
- FETCh? Result acquisition subsystem

Common commands:

- IDN? Instrument information query subsystem

## 9.3 DISPlay Display Subsystem

The DISPlay subsystem can be used to switch between different display pages or to display a string of text on the page prompt bar.

Figuren-n DISPlay Subsystem Tree

| | | |
|---|---|---|
| **DISPlay** | **:PAGE** | **MEASurement(MEAS),MeasureSETup(MSET),SYSTem(SYST),SystemINFo(SINF)** |
| | **:PAGE?** | |
| | **:LINE** | **<string>** |

**DISPlay:PAGE**

DISP:PAGE switches to the specified page.

Command syntax: **DISPlay:PAGE <page name>**

Parameters: <page name> includes:

**MEASurement** Measurement display page, abbreviated as**MEAS**
**MeasureSETup** Measurement settings page, abbreviated as**MSET**
**SYSTem** System configuration page, abbreviated as**SYST**
**SystemINFo**

*Example:* Send> **disp**:**measuresetup**<NL>
The instrument switches to the measurement settings page

Query syntax: **DISP:PAGE?**
Queries the current page of the instrument

Query response: **<page name> abbreviation**
**meas**
**mset**
**syst**
**sinf**

*Example:* Send> **disp:page?** <NL>
Return>**mset**<NL>
means the current page of the instrument is the measurement settings page

**DISP:LINE**

DISP:LINE displays a string of text on the prompt bar at the bottom of the page. The text can display up to 30 characters.

Command syntax: **DISPlay:LINE <*string*>**

Parameters: **<string>**up to 30 characters

*Example:* Send> **DISP:LINE HelloWorld**<NL>
the bottom bar of the instrument displays in redHelloWorld

## 9.4 FUNCtion Subsystem

Figure9-3 FUNCtion Subsystem Tree

| | | |
|---|---|---|
| **FUNCtion** | **:STARt** | |
| | **:STOP** | |
| | **:SOURce** | **:CURRSET** |
| | | **:CURR?** |
| | | **:FREQSET** |
| | | **:FREQ?** |
| | | **:TIMESET** |
| | | **:TIME?** |
| | | **:UPPERSET** |
| | | **:UPPER?** |
| | | **:LOWERSET** |
| | | **:LOWER?** |

**Start/Stop Command Set**

Command syntax: **FUNCtion:STARt**

*Example:* Send> **FUNC:STARt**<NL> //Starts the test, functionally equivalent to the [Start] key

Command syntax: **FUNCtion:STOP**

*Example:* Send> **FUNC:STOP**<NL> //Stops the test, functionally equivalent to the [Stop] key

**Function Parameter Command Set**

Command syntax: **FUNC:SOUR:CURRSET <float>**

Parameters: **<float>**: (unit A)
Test current value. 5~40A

Example: **Send> FUNC:SOUR:CURRSET 10.2**<NL> //Set the test current to 10.2A

Query syntax: **FUNC:SOUR:CURR?** //Query the test current value

Example: Send> **FUNC:SOUR:CURR?** <NL>
Return> 10.2 <NL>
means the current test current is 10.2A

Command syntax: **FUNC:SOUR:FREQ <int>**

Parameters: **<int>**: (unit Hz)
50 means the test frequency is 50Hz
60 means the test frequency is 60Hz

*Example:* Send> **FUNC:SOUR:FREQ 50**<NL> //Set the test current frequency to 50Hz

Query syntax: **FUNC:SOUR:FREQ?** //Query the test current frequency

*Example:* Send> **FUNC:SOUR:FREQ?**<NL>
Return> 60<NL>
means the current test frequency is 60Hz

Command syntax: **FUNC:SOUR:TIMESET <float>**<NL> //Set the test time

Parameters: **<float>**(data unit: s):
Test time 0~999.9s
0 means unlimited-time testing

*Example:* Send> **FUNC:SOUR:TIMESET 60**<NL> //Set the test time to 60s

Query syntax: **FUNC:SOUR:TIME?**//Query the test time

Query response: **<float>**: (unit s)
A return of OFF means the test time is off

*Example:* Send> **FUNC:SOUR:TIME?**<NL>
Return>60.1<NL>
means the current test time is 60.1s

Command syntax: **FUNC:SOUR:UPPERSET <float>**//Upper limit setting

Parameters: **<float>**(data unit: mΩ):
(where 0 means**upper limit OFF**)

*Example:* Send>**FUNC:SOUR:UPPERSET 100**<NL>//Set the lower limit to 100mΩ

Query syntax: **FUNC:SOUR:UPPER?**//Query the current upper limit setting

| | |
|---|---|
| Query response: | **<float>**: (unit mΩ)<br>Return value 0~600<br>a return of 0 means the upper limit is OFF and does not participate in comparison |
| *Example:* | **FUNC:SOUR:UPPER?**<NL><br>Return>22.1<NL><br>means the current upper limit is set to 22.1mΩ |

| | |
|---|---|
| Command syntax: | **FUNC:SOUR:LOWERSET <float>** |
| Parameters: | **<float>**(data unit: mΩ):<br>0 means the lower limit is OFF |
| *Example:* | Send>**FUNC:SOUR:LOWERSET 10.5**<NL>//Set the lower limit to 10.5mΩ |
| Query syntax: | **FUNC:SOUR:LOWER?** |
| Query response: | **<float>**(data unit: mΩ):<br>Return value 0~600<br>a return of 0 means the lower limit is OFF and does not participate in comparison |
| *Example:* | Send> **FUNC:SOUR:LOWER?**<NL><br>Return>10.5<NL><br>means the current lower limit is 10.5mΩ |

## 9.5 FETCh? Subsystem

The FETCh subsystem command set is used to obtain the measurement results of the instrument and the settings of the acquisition mode.
It can be selected via the [Result Send] option on the <System Settings> page of the instrument: with [Auto], the instrument returns data after each measurement; with [**FETCH?**], data is returned only when the**FETCh?** command is received

| | |
|---|---|
| Query syntax: | **FETCh?** //Abbreviated as FETC? |
| *Example:* | Send> **FETC?**<NL><br>Return>10.1,15<NL><br>Here 10.1 is the ground resistance value in mΩ, and 15 is the test current in A; the two are separated by a comma |

## 9.6 IDN? Subsystem

The IDN? subsystem is used to return the version number of the instrument.

| | |
|---|---|
| Query syntax: | **IDN?** |
| Query response: | **<model>,<version>,<serial number>,<manufacturer>** |
| *Example:* | Send> **IDN?**<NL><br>Return> **AT9600,REV A1,20180628,Onmeas Instruments**<NL> |

# 10. MODBus (RTU) Communication Protocol

You will learn about the following:

- Data format — learnModbus communication format.
- Functions.
- Variable area.
- Function Codes

## 10.1 Data Format

We follow the Modbus (RTU) communication protocol: the instrument responds to host commands and returns a standard response frame.

See: You can contact our sales department to obtain the Onmeas instrument communication test tool, which includesModbus communication debugging methods, including a CRC-16 calculator and a converter from floating point to the MODBus floating-point format.

**Command Frame**

Figure10-1 MODBus Command Frame Format

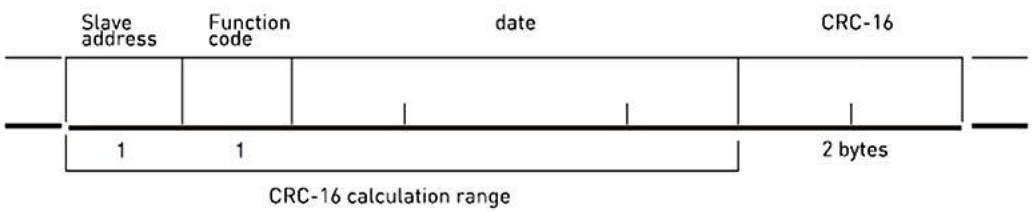



Table10-1Command Frame Description

| | |
|---|---|
| | Requires a silent interval of at least 3.5 character times |
| Slave address | 1 byte<br>Modbus supports slave addresses 00~0x63<br>The broadcast address is 00<br>On instruments without the RS485 option, the default slave address is 0x01 |
| Function Codes | 1 byte<br>0x03: Read multiple registers<br>0x04: =03H, not used<br>0x06: write single register; can be replaced by 10H<br>0x08: Echo Test (used only for debugging)<br>0x10: Write multiple registers |
| Data | Specifies the register address, quantity, and content |
| CRC-16 | 2 bytes, low byte first<br>Cyclic Redundancy Check<br>All data from the slave address to the end of the data is calculated to obtain the CRC16 check code |

| | |
|---|---|
| | Requires a silent interval of at least 3.5 character times |

**CRC-16 Calculation Method**

1. Set the initial value of the CRC-16 register to 0xFFFF.
2. XOR the CRC-16 register with the first byte of the message and return the result to the CRC register.
3. Fill the MSB with 0 and shift the CRC register right by 1 bit.
4. If the bit shifted out of the LSB is “0”, repeat step (3) (handle the next shift). If the bit shifted out of the LSB is “1”, XOR the CRC register with 0xA001 and return the result to the CRC register.
5. Repeat steps (3) and (4) until 8 bits have been shifted.
6. If the message processing is not finished, XOR the CRC register with the next byte of the message, return it to the CRC register, and repeat from step (3).
7. Append the calculated result (the value of the CRC register) to the message, low byte first.

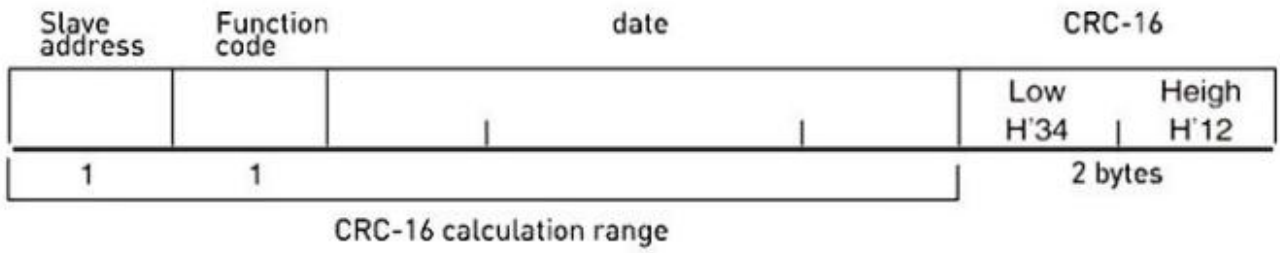
The following is a CRC calculation function in VB:

```
Function CRC16(data() As Byte) As Byte()
    Dim CRC16Lo As Byte, CRC16Hi As Byte          'CRCRegisters
    Dim CL As Byte, CH As Byte                    'Polynomial code &HA001
    Dim SaveHi As Byte, SaveLo As Byte
    Dim i As Integer
    Dim flag As Integer
    CRC16Lo = &HFF
    CRC16Hi = &HFF
    CL = &H1
    CRC16Hi = &HFF
    For i = 0 To UBound(data)
        CRC16Lo = CRC16Lo Xor data(i)             'XOR each data with the CRC register
        For flag = 0 To 7
            SaveHi = CRC16Hi
            SaveLo = CRC16Lo
            CRC16Hi = CRC16Hi \ 2                 'Shift the high byte right one bit
            CRC16Lo = CRC16Lo \ 2                     'Shift the low byte right one bit
            If ((SaveHi And &H1) = &H1) Then      'If the last bit of the high byte is 1
                CRC16Lo = CRC16Lo Or &H80             'then fill the front of the low byte after shifting with 1
            End If                                    'otherwise fill 0 automatically
            If ((SaveLo And &H1) = &H1) Then'If  LSBis  1, XOR with the polynomial code
                CRC16Hi = CRC16Hi Xor CH
                CRC16Lo = CRC16Lo Xor CL
            End If
    Next flag
Next i
Dim ReturnData(1) As Byte
ReturnData(0) = CRC16Hi                           'CRChigh
ReturnData(1) = CRC16Lo                           'CRClow
CRC16 = ReturnData
End Function
```

| | |
|---|---|
| Reference: | Our company’s “Onmeas instrument communication test tool“, which includes Modbus communication debugging methods, includingt h e CRC-16 calculator |

The calculated CRC-16 data needs to be appended to the end of the command frame, e.g. 1234H:

Figure10-2 Modbus Appended CRC-16 Value




**Response Frame**

Except for commands broadcast to slave address 00H, instruments at other slave addresses return a response frame.

Figure10-3 Normal Response Frame

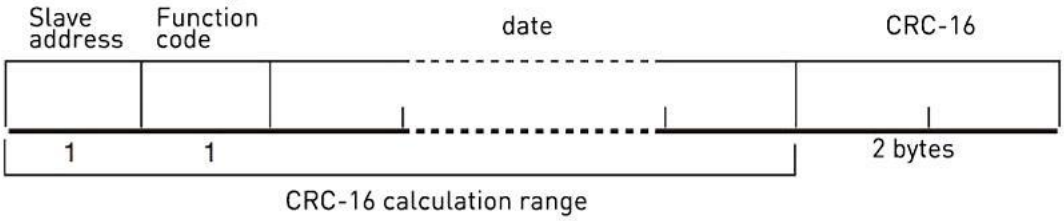



Figure10-4 Exception Response Frame

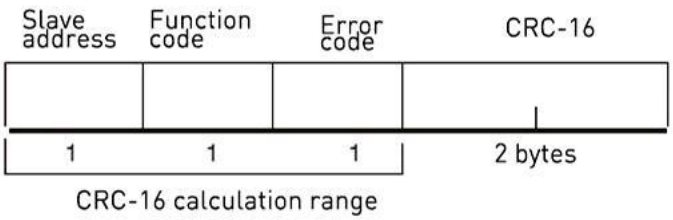



Table 10-2 Exception Response Frame Description

| | |
|---|---|
| Slave address | 1 byte<br>The slave address is returned as is |
| Function Codes | 1 byte<br>The function code of the command frame ORed with BIT7 (0x80)<br>For example: 0x03 OR 0x80 = 0x83 |
| Error Codes | Exception codes:<br>0x01 Function code error (function code not supported)<br>0x02 Register error (register does not exist)<br>0x03 Data error<br>0x04 Execution error |
| CRC-16 | 2 bytes, low byte first<br>Cyclic Redundancy Check<br>All data from the slave address to the end of the data is calculated to obtain the CRC16 check code |

**No Response**

In the following situations, the instrument does not process or respond at all, causing a communication timeout.

1. Slave address error
2. Transmission error
3. CRC-16 error
4. Byte-count error, e.g. for function code 0x03 the total must be 8 bytes, but the received byte count is less or greater than 8

5. A slave address of 0x00 is the broadcast address; the instrument does not respond.
6. Error Codes

**Error Codes**

Table10-3 Error Code Description

| Error Codes | Name | Description | Priority |
|---|---|---|---|
| 0x01 | Function code error | Function code does not exist | 1 |
| 0x02 | Register error | Register does not exist | 2 |
| 0x03 | Data error | Register quantity or byte count error | 3 |
| 0x04 | Execution error | Invalid data, the written data is not within the allowed range | 4 |

## 10.2 Function Codes

Table10-4 Function Codes

| Function Codes | Name | Description |
|---|---|---|
| 0x03 | Read Multiple Registers | Read data from multiple consecutive registers |
| 0x04 | Same as 0x03 | Use 0x03 instead |
| 0x08 | Echo Test | The received data is returned as is |
| 0x10 | Write Multiple Registers | Write multiple consecutive registers |

## 10.3 Registers

The instrument registers are in 2-byte mode, i.e. 2 bytes must be written each time. For example: the speed register is 0x3002, the data is 2 bytes, and the value must be written as 0x0001.

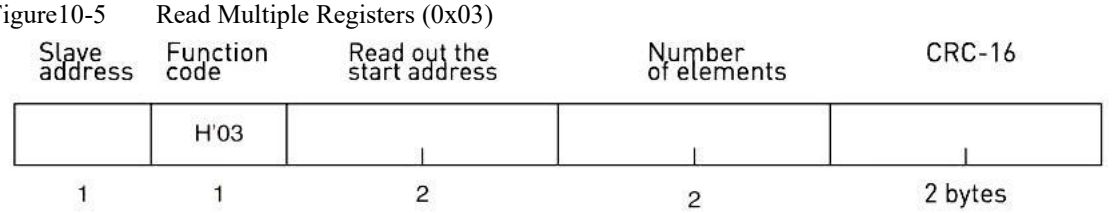
Data:

1. 1 register, double-byte (16-bit) integer, e.g. 0x64 → 00 64
2. 2 registers, four-byte (32-bit) integer, e.g. 0x12345678 → 12 34 56 78
3. 2 registers, four-byte (32-bit) single-precision floating point, 3.14 → 40 48 F5 C3

Reference: Our company's "Onmeas instrument communication test tool",which includes Modbus communication debugging methods, includingthe floating-point converter

## 10.4 Read Multiple Registers

Figure10-5 Read Multiple Registers (0x03)



The function code for reading multiple registers is 0x03.

| Name | Name | Description |
|---|---|---|
| | Slave address | When no RS485 address is specified, the default is 01 |
| 0x03 | Function Codes | |
| | Starting address | Register starting address; refer to the Modbus command set |
| | Number of registers to read<br>0001~006A (106) | Number of registers to read consecutively. Refer to the Modbus command set to ensure<br>these register addresses exist; otherwise an error frame is returned. |
| CRC-16 | Check Code | |

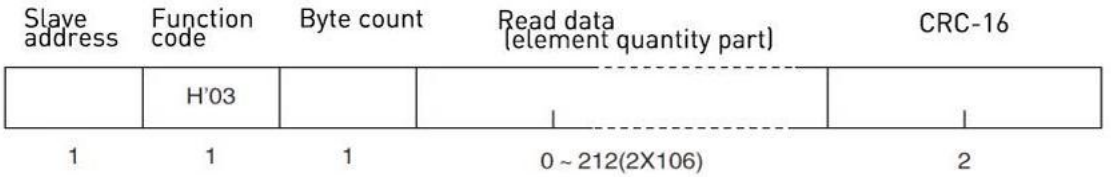
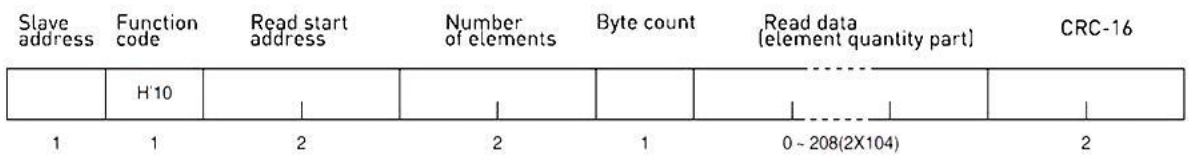



Figure n-n Read Multiple Registers (0x03) Response Frame

| Name | Name | Description |
|---|---|---|
| | Slave address | Returned as is |
| 0x03<br>or 0x83 | Function Codes | No exception: 0x03<br>Error code: 0x83 |
| | Number of bytes | = number of registers x 2 |
| | | For example: 1 register returns 02 |
| | Data | Data read |
| CRC-16 | Check Code | |

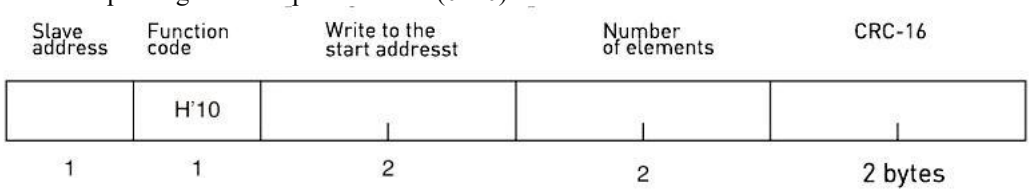
## 10.5 Write Multiple Registers

Figuren-n Write Multiple Registers (0x10)




| Name | Name | Description |
|---|---|---|
| | Slave address | When no RS485 address is specified, the default is 01 |
| 0x10 | Function Codes | |
| | Starting address | Register starting address; refer to the Modbus command set |
| | Number of registers to write<br><br>0001~0068 (104) | Number of registers to read consecutively. Refer to the Modbus command set to ensure<br>these register addresses exist; otherwise an error frame is returned. |
| | Number of bytes | =**regis**ter count x 2 |
| CRC-16 | Check Code | |

Write Multiple Registers Response Frame (0x10)



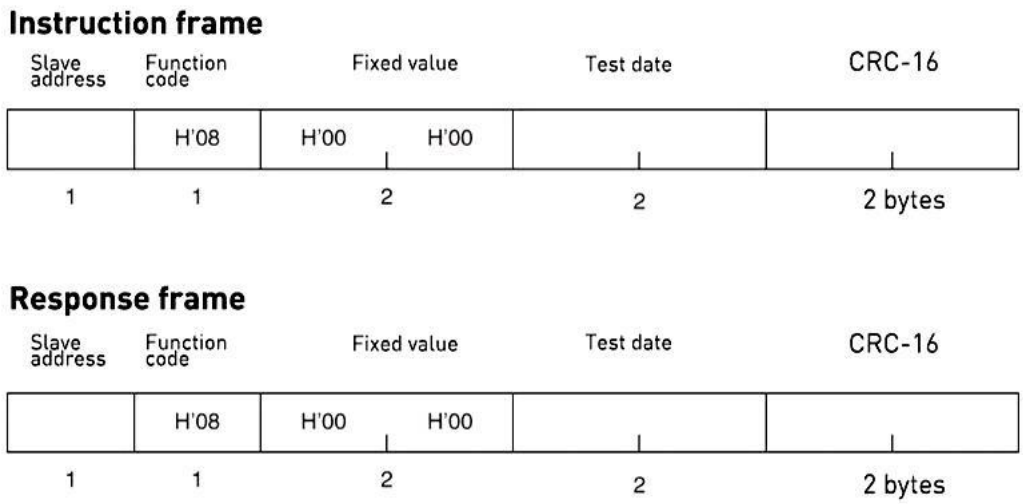

| Name | Name | Description |
|---|---|---|
| | Slave address | Returned as is |
| 0x10<br>or 0x90 | Function Codes | No exception: 0x10<br>Error code: 0x90 |
| | Starting address | |
| | No. of Registers | |

| | | |
|---|---|---|
| | CRC-16 check code | |

## 10.6 Echo Test

The echo test function code 0x08 is used to debug Modbus.

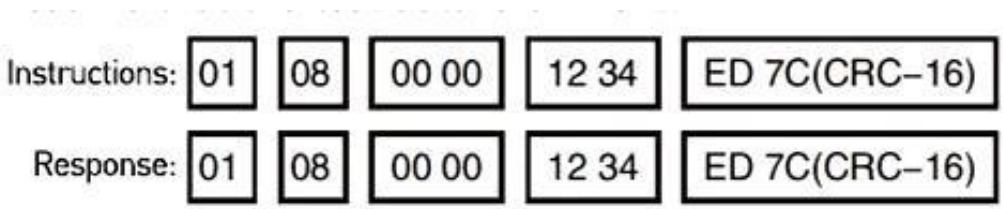
Figuren-n Echo Test (0x08)




| Name | Name | Description |
|---|---|---|
| | Slave address | Returned as is |
| 0x08 | Function Codes | |
| | Fixed value | 00 00 |
| | Test data | Any value: for example 12 34 |
| | CRC-16 check code | |

Example:

Assume the test data is 0x1234:



# 11. Modbus (RTU) Command Set

& You will learn about the following:
- Register Address

Note: unless otherwise stated, the commands and response frames in the following descriptions are hexadecimal data

## 11.1 Register Overview

The following lists all register addresses used by the instrument; any address not in the table returns error code 0x02.

Table 11-1 Register Overview

| Register Address | Name | Value | Description |
|---|---|---|---|
| 2000 | Test current register | 4-byte floating-point number | Read-only memory; data occupies 2 registers |
| 2002 | Ground resistance register | 4-byte floating-point number | Read-only memory; data occupies 2 registers |
| 2004 | Read comparator result | 2-byte integer | Read-only memory; data occupies 1 register |
| | | | |
| | | | 1: PASS |
| | | | 2: FAIL |
| 3001 | Current setting register | 4-byte floating-point number | Read/write memory; data occupies 2 registers |
| 3003 | Frequency setting register | 2-byte integer | Read/write memory; data occupies 1 register |
| 3004 | Time setting register | 4-byte floating-point number | Read/write memory; data occupies 2 registers |
| | | | 0: unlimited-time test |
| 3006 | Upper limit setting register | 4-byte floating-point number | Read/write memory; data occupies 2 registers |
| 3008 | Lower limit setting register | 4-byte floating-point number | Read/write memory; data occupies 2 registers |
| 3010 | Starting a Test | 2-byte integer | Write register; data occupies 1 register |
| 3011 | Stopping a Test | 2-byte integer | Write register; data occupies 1 register |

## 11.2 Acquiring Test Data

- Reading the test current value

Send

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 20 | 00 | 00 | 02 | CF | CB |
| Slave | Read | Registers | | No. of Registers | | Check Code | |

Response

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 04 | 40 | 9F | 4E | EF | AB | F1 |
| 01 | 03 | Bytes | Single-precision floating-point number | | | | CRC-16 | |

Here 40 9F 4E EF is the test current value, representing 4.978385A; the instrument displays 5.0A

- Reading the test resistance value

Send

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 20 | 04 | 00 | 01 | 6E | 0B |
| Slave | Read | Registers | | No. of Registers | | Check Code | |

Response

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 04 | 41 | 2A | 21 | 5F | 97 | AF |
| 01 | 03 | Bytes | Single-precision floating-point number | | | | CRC-16 | |

Here 41 2A 21 5F is the test ground resistance value, representing 10.633147mΩ; the instrument displays 10.6mΩ

- Read comparator result

Send

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 20 | 02 | 00 | 02 | CE | 0B |
| Slave | Read | Registers | | No. of Registers | | Check Code | |

Response

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 01 | 03 | 02 | 00 | 02 | 39 | 85 |
| | | Bytes | Data | | CRC-16 | |

- Current setting register (3001)

Read

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 30 | 01 | 00 | 02 | 9A | CB |
| Slave | Read | Registers | | No. of Registers | | Check Code | |

Response

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 04 | 40 | A0 | 00 | 00 | FF | D1 |
| 01 | 03 | Bytes | Single-precision floating-point number | | | | CRC-16 | |

Here 40 A0 00 00 is the single-precision current setting value, which converts to 5.0A in decimal

Writing (changing the test current to 20.5A)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 30 | 01 | 00 | 02 | 04 | 41 | A4 | 00 | 00 | 33 | BD |
| | Write | Registers | | No. of Registers | | Bytes | Data | | | | CRC | |

Response

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|

| 01 | 10 | 30 | 01 | 00 | 02 | 1F | 08 |
|---|---|---|---|---|---|---|---|
| | Write | Registers | | No. of Registers | | CRC-16 | |

- Frequency setting register (3003)

Reading (current frequency)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 30 | 03 | 00 | 01 | 7B | 0A |
| Slave | Read | Registers | | No. of Registers | | Check Code | |

Response

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 01 | 03 | 02 | 00 | 00 | B8 | 44 |
| | | Bytes | Data | | CRC-16 | |

Response data 00 00 means the test frequency is 50Hz; 00 01 means 60Hz

Changing the test frequency (60Hz as an example)

Write

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 30 | 03 | 00 | 01 | 02 | 00 | 01 | 57 | A0 |
| | Write | Registers | | No. of Registers | | Bytes | Data | | CRC-16 | |

Response

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 10 | 30 | 03 | 00 | 01 | FE | C9 |
| | Write | Register Address | | Data | | CRC-16 | |

- The upper limit setting register and lower limit setting register operate the same way as the current setting register; the units of the upper and lower limits are both mΩ

- Starting a test (3010)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 30 | 10 | 00 | 01 | 02 | 00 | 00 | 94 | C3 |
| | Write | Registers | | No. of Registers | | Bytes | Data | | CRC-16 | |

- Stopping a test (3010)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 10 | 30 | 11 | 00 | 01 | 02 | 00 | 00 | 95 | 12 |
| | Write | Registers | | No. of Registers | | Bytes | Data | | CRC-16 | |

On the first write of stop-test, the instrument screen keeps the test result; sending it again clears the data on the instrument screen.

# 12. Specifications

& You will learn about the following:
- Technical Specifications
- Environmental Requirements
- Dimensions

## 12.1 Technical Specifications

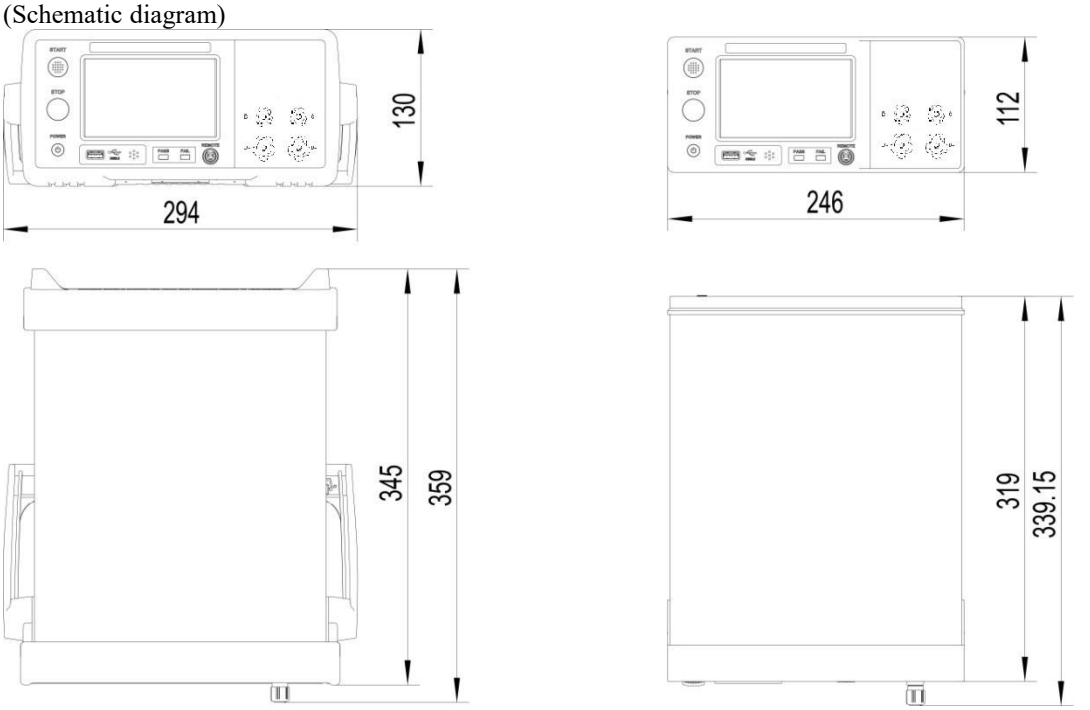
| **Basic parameters** | |
|---|---|
| | **AT9600 AC Ground Resistance Tester** |
| **Measurement function** | 4-terminal measurement method |
| **Display** | 5-inch TFT color screen; ground resistance, test current and test time displayed on the same screen |
| **Current setting range** | AC 5A~40A, accuracy ±(2%+5 counts), resolution 0.1A |
| **Generation frequency** | 50Hz or 60Hz sine wave |
| **Max. output power** | 160VA |
| **Open-circuit terminal voltage** | Below AC 6V |
| **Resistance measurement range** | 0~600mΩ, accuracy ±(2% × reading + 5 counts) |
| **Voltage measurement range** | 0~6V |
| **Measurement time display** | Countdown display; counts up when the timer is off |
| **Timer setting** | 0~999.9s countdown, or timer OFF |
| **Comparator** | Upper/lower limit alarm, |
| **Standard interfaces** | RS-232 communication interface, Handler interface |
| **Others** | Chinese/English menu switching |
| **Power supply** | 220V 50Hz AC |
| **Fuse** | 250V 3A slow-blow |
| **Dimensions and weight** | Dimensions (mm): 300×250×100, weight: approx. 7kg |

## 12.2 Environmental Requirements

| | | |
|---|---|---|
| Environment: | Rated: | temperature 18℃~28℃ humidity 65% RH |
| | Operation: | Temperature 10℃~40℃ Humidity 10~80% RH |
| | Storage: | Temperature 0℃~50℃ Humidity 10~90% RH |
| Power: | 220VAC (1±10%) | |
| Fuse: | 220V 3A slow-blow | |
| Power consumption: | Max. 300VA | |
| Weight: | Approx. 6kg | |

## 12.3 Dimensions

Figure 12-1 Outline
(Schematic diagram)





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