9460-GR40

AC Ground Resistance Tester User Manual

PLEASE SCAN QR CODE TO WATCH THE OPERATION VIDEO OF PRODUCTS.

VIDEO

Contents

1. The install and setup wizard

Thank you for buying our company's products! Please read this chapter carefully before use. You will learn the following in this chapter:

- Power requirement
- Operational environment
- Clean
- The replacement of the fuse
- Instrument handle

1.1 Power requirement

9460-GR40 can only be used in the following power supply

Conditions: Voltage: 110V/220V AC

Frequency: 50Hz/60Hz

Warning: To prevent electric shock danger, connect the power grid

If the user replaces the power cord, ensure the reliable connection of the power cord.

1.2 Operational environment

9460-GR40 must be used in the following environmental conditions:

Temperature: 10°C~40°C

Humidity: At 23°C was less than 70%RH

1.3 Clean

To prevent electric shock hazards, unplug the power cord before cleaning.

Please clean the shell and panel with a little clean water.

Do not clean the instrument interior.

Note: Instruments should not be cleaned with solvents (alcohol or gasoline, etc.).

1.4 Change the fuse

Figure 1-1 Fuse box in the rear panel
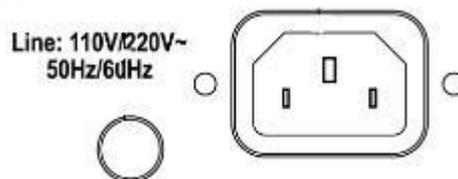
To prevent electric shock, make sure the power switch is turned off and the AC power cord is removed before checking or replacing the fuse. Ensure the fuse used is consistent with the equipment instructions, including shape, grade, characteristics, etc. If a different type of fuse is used or a short circuit, which could damage the equipment.

Table 1-1 Select the fuse specifications

Input voltage range	Frequency range	Fuses (slow-melt)	Power rating
110V/220V	47Hz~63Hz	5A	300VA

1.5 Instrument handle

The instrument handle can be adjusted, hold both hands at the same time, pull gently to the sides, and then rotate the handle. The handle can be adjusted to four positions, as shown in the figure below:

Figure 1-2 Instrument handle (schematic diagram, panel drawing inconsistent with actual condition)

Visual position 1 [Hold both sides of the handle at the same time, pull gently
to both sides until it can rotate freely, and then switch to the visible position 2]
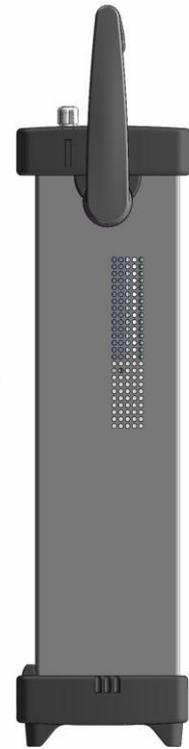
Visual position 2 [Hold both sides with both hands, pull gently to the sides
until the position can rotate freely, and then switch to the handle position]
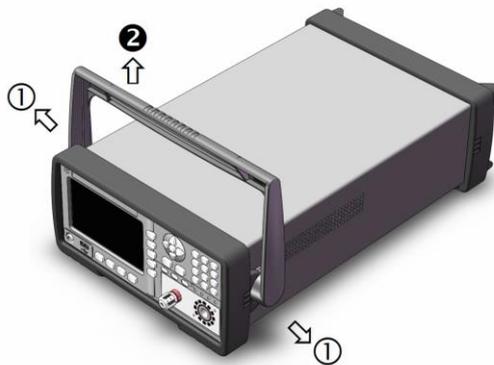
Hand position

Remove the handle position (Pull ① until handle is removed)

2. Overview

You will learn the following in this chapter:
- safety regulations
- product property

2.1 Safety regulations

The instrument produces a maximum AC current of 40A, and must be very careful and compliant when operating the instrument attention, warnings, and other instructions given in the chapter.

Workstation arrangement

➢ Operating position

The location of the workstation must be arranged in the open place where general personnel are not necessary, so that the non-staff away from the workstation. The workstation must be separated from other facilities and specially marked "ground test station". The test must be marked with the words "Hazard! During test execution!".

➢ Enter the power supply

Ensure that the instrument is connected to the electrical ground (earth) to ensure safety. The power supply of the workstation must have a separate switch, which should be installed at the entrance of the workstation and given special identification, so that everyone can distinguish that it is the power supply switch of the workstation. Once an emergency occurs, you can immediately turn off the power, and then enter the accident.

➢ Work place

An insulated table or table must be used, and no metal shall be used between the operator and the tested body. In the design of the workplace, the operators are not allowed to operate the test instrument across the objects to be tested. The workplace must be kept neat and clean. Put the unused instruments and test lines in a fixed position, so that all personnel can immediately distinguish the tested items, to be tested items and tested items. The test station and its surrounding shall not contain combustible gases and corrosive gases, and shall not be used next to flammable substances.

Operator regulations

➢ Personnel qualification

The maximum output of 40A AC current of the tester cannot be disconnected during testing, so the user should be trained first and strictly follow the user manual.

➢ Safety regulations

Operators must be given safety education and training at any time, so that they understand the importance of various safe operations, and according to safety rules for operating the tester.

➢ Clothing regulations

Operators should not wear metal-decorated clothes, metal hand ornaments and watches, which can easily cause accidental electric shock.

Prohibited operations

➢ Do not continuously switch on the power supply

After cutting off the power switch, ensure a few seconds or more interval before turning on the power switch again. Do not repeat the frequent on / off the power switch, if you do so, the instrument protection facilities may not be able to fully perform the protection function. Do not turn off the power switch when the instrument is being tested, except in special or emergency situations.

➢ Do not open the output terminal during testing

Be careful of the test line of the instrument and not short circuit to nearby AC power lines already connected to the ground or other nearby equipment (such as transmission equipment).

➢ Do not connect the external voltage to the test end

Do not connect any external voltage to the output end of the instrument., The output end connected to the external voltage may damage the instrument.

Precautions in the testing

➢ Discontinue and (suspend) the test precautions

To change the test conditions, first press [Stop] once to exit the test readiness state. If you need a break or will leave the test site, turn off the power switch to prevent accidentally touching the start switch from causing a safety hazard.

➢ Ensure fault-free use for a long time

Due to the volume, weight, and actual use of the instrument, the heat dissipation design of the current generating module of the instrument is too small. Therefore, the instrument is recommended to be used in the following areas. If the fan works continuously for 30 minutes, the use of the instrument must be suspended, otherwise the power amplifier output module may be burned due to overheating.

2.2 Major function

Product profile

9460-GR40 the AC grounding resistance tester uses a 5-inch full-touch color LCD screen, and is equipped with a mainstream high-performance 32-bit ARM processor, which is small in size, light in weight, high-cost performance and easy to operate.

9460-GR40 AC grounding resistance tester can be widely used in household electrical appliances, transformers, electrical equipment, etc. The instrument is equipped with Handler interface (PLC interface) RS232C, which can easily conduct data communication and remote control with PC to meet the automatic testing and improve production efficiency.

Product characteristics

A maximum grounding test current of 40A;

D / A converter produces 50Hz / 60Hz test sine wave;

Current closed-loop control, the output current is more accurate;

Four Terminal test method to eliminate lead interference;

High-precision A / D converter, the test results are more accurate.

3. Start

You will learn the following in this chapter:

- The front panel: includes an introduction to the keys and test terminals.
- The rear panel: describes the power supply and interface information.
- Start: includes power self-test process, instrument default value and instrument preheating time.
- Starting the test: includes how to connect to the test end

3.1 Know the front panel

Figure 3-1 The 9460-GR40 front panel
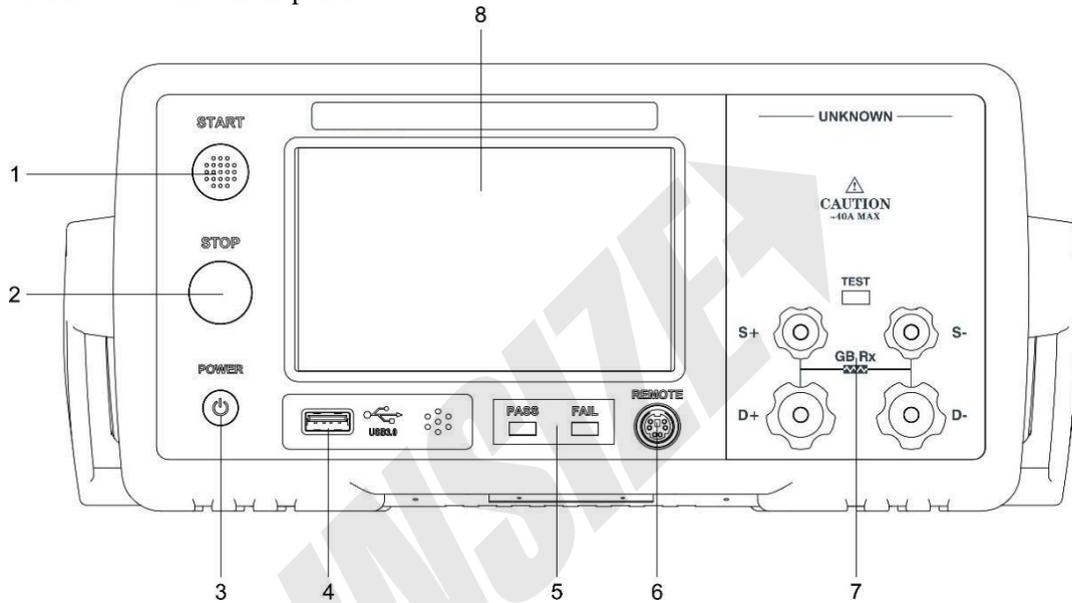
Table 3-1 9460-GR40 functional description of the front panel

No.	Function
1	start test key
2	stop test key
3	power switch
4	USB disk interface
5	PASS, FAIL indicator light
6	remote control (this machine is currently unused)
7	test port
8	5-inch TFT-LCD LCD display window

3.2 Know the rear panel

9460-GR40 rear panel function description
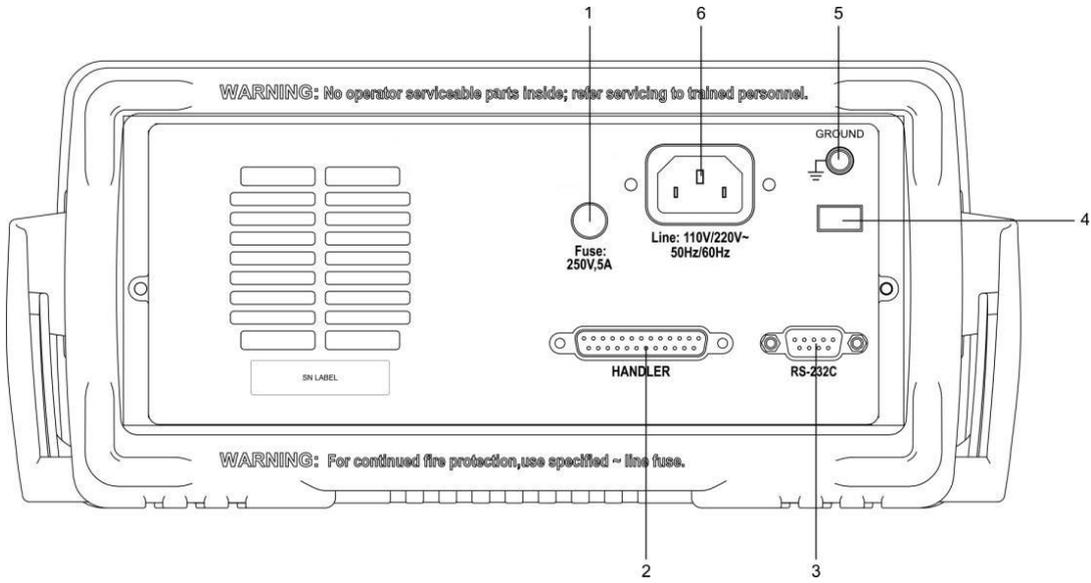
Table 3-2 9460-GR40 rear panel description

No.	Function
1	fuse box
2	handler (PLC) interface
3	RS-232C interface
4	Line voltage mode (110V, 220V) switch
5	Protect the ground terminal
6	electric outlet

3.3 On the electric start

Starting up

The key marked " $\odot$ " at the bottom left of the panel is the power switch. 9460-GR40 adopt the soft-start mode:

Power on: Press the Power key. When the POWERLED light is on, release the Power key.

Shutdown: Press the Power key. Release the Power key when the POWERLED light is off.

3.4 The connection of the test end

Connect D + S + of the test fixture and D + S + of the front panel of the instrument;

Connect D - S - of the test fixture and D - S - of the front panel of the instrument.

Figure 3-3 Instrument test end
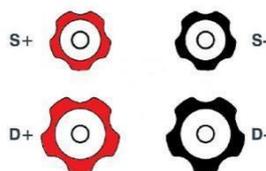
4. [MeaSetup] measurement setup page

In this chapter, you will learn about all of the setup features:

- Test parameter settings
- Comparator result settings

In the stop state, you just press the [Measurement Settings] button on the touch screen, and the instrument will enter the measurement settings home page.

4.1 Measurement settings

All measurement-related settings are operated in the <Measurement Settings> page.

Figure 4-1 <Measurement Settings> Page

Table 4-1 Scope and meaning of each option

Parameter	Range
Current	Set the current value 5A~40A, 0.1A step, unit A
Time	The test time value 0s ~999.9s, 0s or OFF indicates the continuous output
Frequency	Test frequency values of 50 or 60Hz are optional
Upper	0mΩ ~ 600mΩ, and the OFF indicates a non-comparative upper limit
Lower	0mΩ ~ 600mΩ, and the OFF indicates a non-comparison lower limit
User correction	Close: does not use the user correction Open: enable the short circuit reset function

Close: Does not use the user correction;

Open: Enable the short circuit reset function when the user correction is on, it will be short-circuited and cleared with the current setting current and frequency values, which is used to eliminate the impedance value of the measurement tooling and fixtures, and needs to be short-circuited and cleared again when changing the value of the test current, and it is recommended to turn on this option when the test result is small.

Actual value = measured value-short circuit zero value.

5. [Meas] measurements show

The measurement main page includes the following:

- <Measurement Display> page
- Test the functional principle and instructions for use

5.1 <Measurement Display> page

Start the instrument and enter the [measurement display] page, and other pages [press the measurement display] or [display] to enter the measurement display page.

Figure 5-1 <Measurement Display> Page
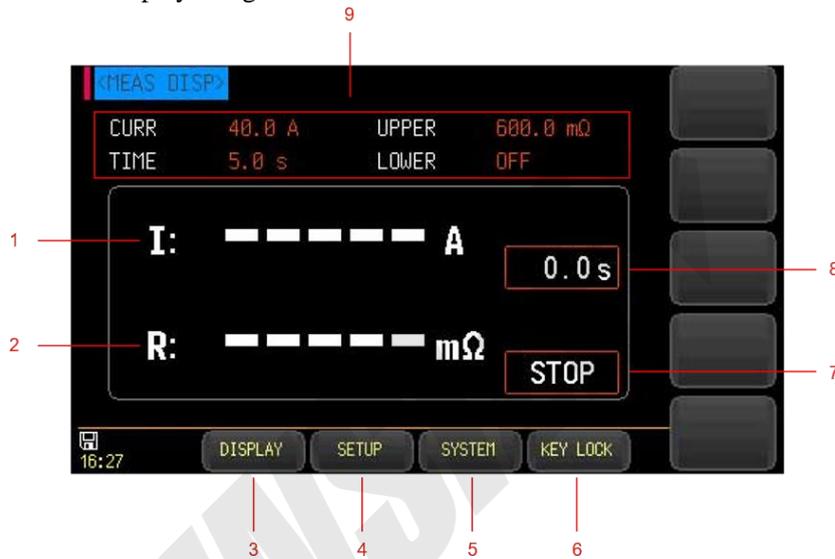
Table 5-1

No.	Function
1	Test current value, and "------" is displayed without test or open circuit
2	Ground resistance value, display "------" when not tested or blocked
3	Measure Display button, click back to the <Measure Display> page
4	Measurement Settings button, click to enter the <Measurement Settings> page
5	The System Configuration button, click to enter the <System Configuration> page
6	Keyboard lock, click lock the device, unlock
7	Test status indication, remember to see the table below
8	Test time display, display the remaining time during the countdown test; the test time OFF is the display duration

Table 5-2 Implications of the test status

test mode	Meaning
STOP	Stop testing or do not test
TEST	Is testing
PASS	Test qualified
FAIL	The test failed

5.2 Start the test

In the test mode, after checking the test conditions and the test part is connected correctly, press the [Start] key to start the test.

5.3 Stop testing

When the test time is up, the instrument will automatically stop the test, and display the measurement results in real time, press the [STOP] key, and the instrument will clear the measurement results;

Before the test time ends, press the [STOP] key, the instrument will stop the test and display the measurement result. Press the [STOP] key again will clear the measurement result

5.4 Disqualified judgment

If the resistance value is judged unqualified, the display (FAIL) ground resistance value will be displayed in red font, and the FAIL indicator light will light up.

5.5 Qualified judgment

If the test result is qualified after the test time. Display (PASS), the qualified indicator light will light up, and the resistance value is displayed in green.

6. System configuration

In this chapter, you will learn about the system configuration of this instrument:

- System configuration page
- System information page

6.1 System configuration page

The System Configuration page includes the following settings:

- LANGUAGE
- Date / time setting
- protocol
- Porter rate setting
- Results Send
- Instructions shake hands

All settings of the system configuration page will be automatically saved in the system and loaded automatically at the next boot time.

Figure 6-1 <System Configuration> page

Change the system language [LANGUAGE]

The instrument supports both Chinese and English languages.

■ To change the language

Step 1   Enter the <System Configuration> page

Step 2   Use the cursor key to select [LANGUAGE]

Step 3   Use the function keys to select a language:

Function key	Function
中文[CHN]	Chinese
ENGLISH	English

Modify the date and time

The instrument uses a 24-hour clock.

■ Change date:

Step 1   Enter the <System Configuration> page

Step 2   Use the cursor key to select the [Date] field

Step 3   Set the date by using the function key:

Function key	Function
year +	+1 Year
year -	-1 Year
moon +	+1 January
sun +	+1 Day
sun -	-1 Day

■ Change the clock:

Step 1   Enter the <System Configuration> page

Step 2   Use the cursor key to select the [Clock] field

Step 3   Use the function key to set the clock:

Function key	Function
time +	+1 Hour
time -	-1 Hour
component +	+1 Minutes
component -	-1 Minutes
second +	+1 Seconds
second -	-1 Seconds

[Communication Protocol] setting

Instrument communication has two communication protocols: SCPI and MODBUS, which are connected through the RS-232 interface behind the instrument. Please see the following chapter for the specific communication protocol.

[Baud rate] setting

The instrument has built-in RS-232 interface. After the instrument senses the signal transformation at the RS-232 interface, and the keyboard will be locked. In order to communicate correctly, please make sure that the baud rate is set correctly, and the instrument is programmed in SCPI language for RS-232.

The RS-232 is configured as follows:

● Data bit: 8 bits

● Stop bit: 1 bit

● Parity: no

● Paud rate: configurable

➢ Set the Baud rate:

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

Step 2　　Use the cursor key to select the [BAUD rate] field

Step 3　　Use the function keys to select

Function key	Function
9600	If you use a communication converter with optical coupling isolation, use this baud rate
38400	
57600	
115200	Communicate with the computer host and recommend that you use this high-speed port

[Results send] switch

How the test results are sent.

➢ Steps for setting up an audible signal:

Step 1　　Enter the <System Configuration> page

Step 2　　Use the cursor key to select the [Sound] field

Step 3　　Use the function key to select

Function key	Function
Auto	Return the test results automatically during the test
FETCH?	Upper computer to send "FETCH?" The instruction only returns the test results

[Handshake command] switch

Opening means that every time the instruction is received, the instrument returns the instruction as is and then returns the result of the instruction query. Closing means that the instruction is not returned, and only the instruction result is returned.

6.2 System information page

Press the [System Information] function key in the <System Settings> interface to enter the <System Information> page.

Figure 6-2 <System Information> Page

6.3 System service page

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

7. Handler (PLC) interface

You will learn about the following:
- terminal
- A Schematic of how to connect and interface

The instrument provides the user with a fully functional processor interface. Through
this interface, the instrument can easily complete the automatic control function with the user
system control components.

7.1 The wiring terminals and the signals

The Handler of this instrument adopts the DB25 master head interface, and the pin is defined as
follows.

Figure 7-1 Connecting terminal

DB25 (Female)
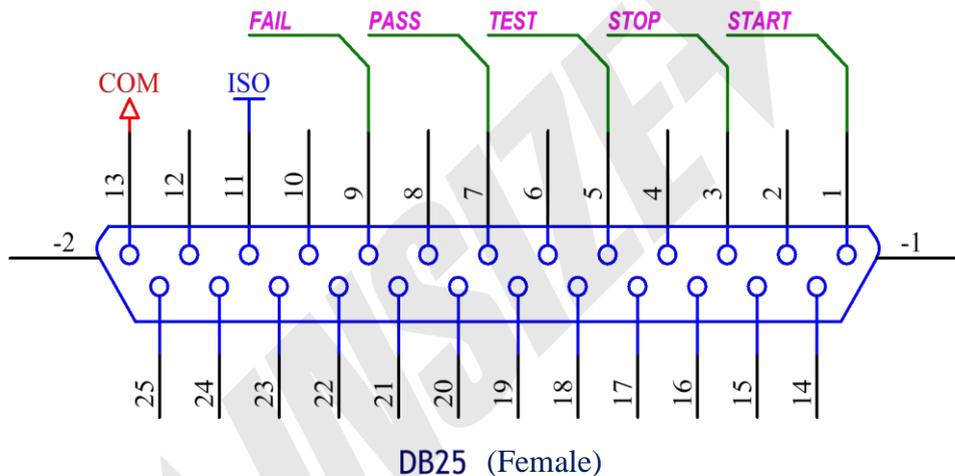
- **START**，External start signal, the low pulse is effective;
- **STOP**，External stop signal, low pulse effective.
- **TEST**，The instrument is testing the signal, the pin is low, not the test is high level;
- **PASS**，Comparator qualified output signal, qualified output low level;
- **FAIL**，Comparator unqualified output signal, unqualified output low level;
- **COM**，The foot is the public end, that is, the ground of the external power supply;
- **ISO**，It is the external power supply foot. The Handler of this instrument is powered by an external power supply.

7.2 Attended mode

Handler adopt optical coupling isolation open collector working mode, when using the external
power supply (voltage range +5V~30VDC).

Figure 7-2 Internal circuit structure of the instrument Handler interface
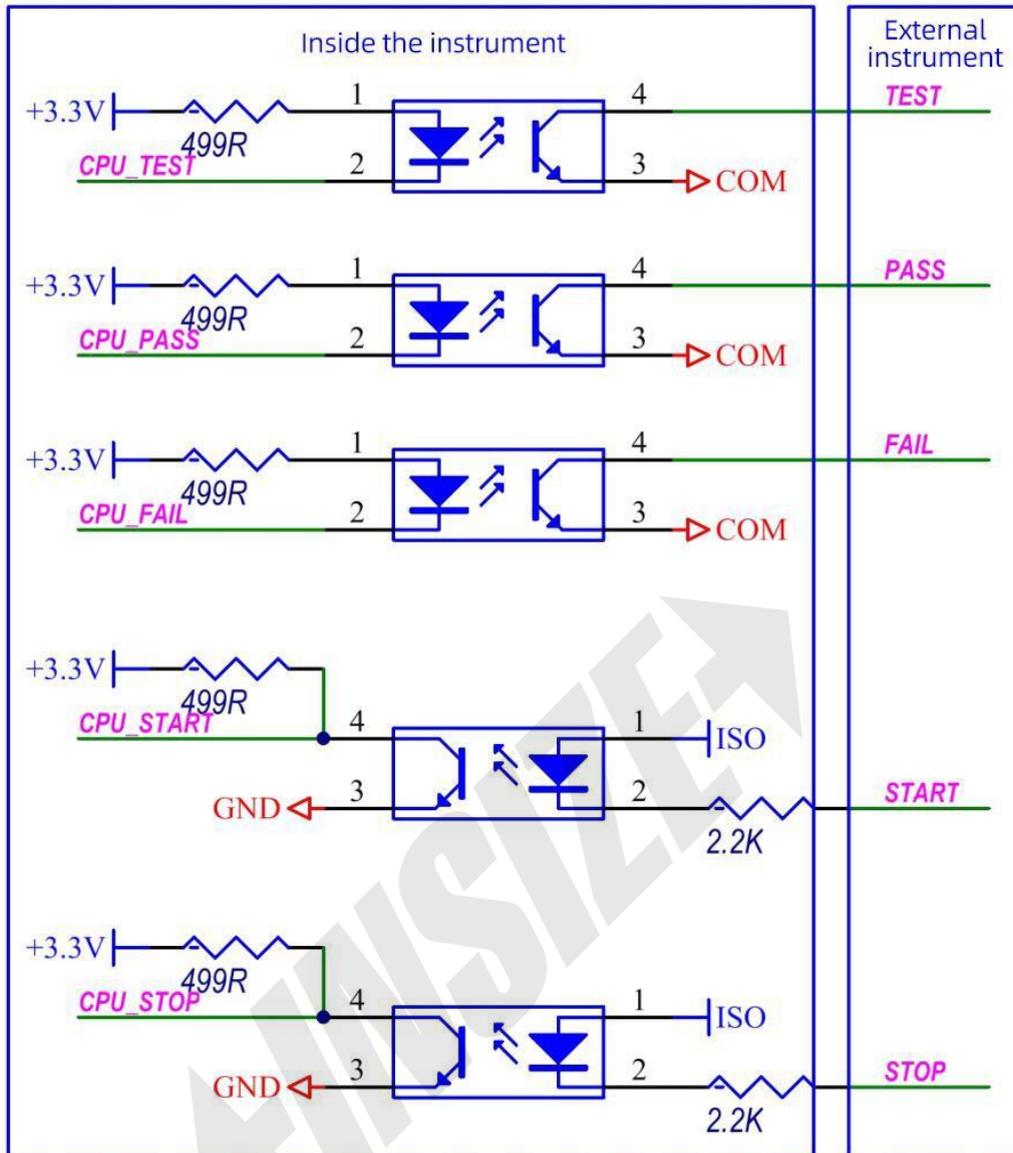
8. Remote communication

You will learn about the following:
- Introducing the RS-232 interface
- RS-232 linkage.
- Choose the Porter rate.
- Software protocol.

The instrument communicates with the computer using the RS-232 interface (standard configuration) to complete all instrument functions. Through the standard SCPI and MUDbus communication protocols, users can also easily compile various acquisition systems suitable for themselves.

8.1 RS-232C

RS-232 is a widely used serial communication standard, also known as asynchronous serial communication standard, used to achieve data communication between computers and computers, computers and peripherals. RS for the 'Recommended Standard' acronym, 232 is the standard number, the standard is the U.S. Electronic Industries Association (EIA) in 1969 officially announced the standard, which provides for one bit at a time by a data line transmission.

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

Table 8-1 Commonly used RS-232 signals

Signal	Symbol	The 25-core connector pin number	The 9-core connector pin number
Request to send	RTS	4	7
Clear-to-send	CTS	5	8
Data setting preparation	DSR	6	6
Data carrier detection	DCD	8	1
Data terminal preparation	DTR	20	4
Send data	TXD	2	3
Receive data	RXD	3	2
Grounding	GND	7	5
Request to send	RTS	4	7

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

Table 8-2 The smallest subset of the RS-232 criteria

Signal	Symbol	The 9-core connector pin number
Send data	TXD	2
Receive data	RXD	3
Landing	GND	5

8.2 RS232C connect

The RS-232 serial interface can connect with the serial interface of the controller (e. g. PC or PC) through a DB-9 cable.

> *Note: The instrument cannot use the null modem cable.*
>
> *User-made 3-wire cable shall note that: Using the DB9 port of the PC, you may have to short connect 4-6,7-8 of the DB-9 connector (pin) on the computer side*

Figure 8-1 The RS-232 interface on the rear panel
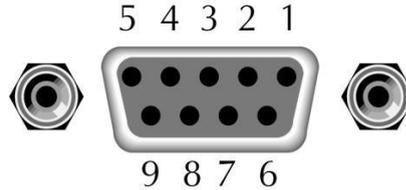
> *Suggestion: To avoid electrical impact, turn off the power when plugging the connector.*

Instrument-default communication settings:

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

Data bit: 8 bits

Stop bit: 1 bit

Check position: no

8.3 Handshake agreement

Since the instrument uses the minimum subset of RS-232 standard without hardware handshake signal, in order to reduce the possible data loss or data error in communication, the instrument can enable software handshake. Senior language software engineers should strictly follow the following handshake protocol when developing computer communication software:

The instrument command parser only accepts the ASCII format, and the command response also returns the ASCII code.

The command string sent by the host must end with an NL ('\ n'), and the instrument command parser does not execute the command string until after receiving the end character.

The instrument can be set up for command handshaking: The instrument immediately sends a character back to the host after each character is received, and the host can continue to send the next character only after it receives this returned character.

Tip: If the host cannot accept the data returned by the instrument, you can try to solve it with the following method:

1．The software handshake is turned off, please refer to the Instrument <System Settings> page to turn it on.

2．Serial port connection failure, please check the cable connection。

3．Senior language program communication format error on computer. Try checking that the serial port number, that the communication format is correct, and that the port rate is the same as the instrument settings.

4．If the instrument is parsing the last command and the host cannot accept the instrument response, please try again later.

9. SCPI Command reference

This chapter covers the following aspects:

- Command parser: Know some rules of the command parser.
- Command syntax: Writing of a rule on the command line
- Query syntax: Writing rule of the query command
- Query response: Format of the query response
- Command reference

This section provides all the SCPI commands used by the instrument, through which all instrument functions can be fully controlled.

9.1 Command string parsing

The host can send a string of commands to the instrument, and the instrument command parser starts resolving after capturing the end character (\ n) or the input buffer overflows.

Example: Legal command string: AAA:BBB CCC;DDD EEE;:FFF

The instrument command parser is responsible for all commands resolution and execution, and you must first learn about its resolution rules before writing a program.

Command parsing rules

1．The command parser parses and responds to ASCII code data.

2．The SCPI command string must end with the NL ('\ n' ASCII 0x0A) before the command parser starts executing the command string after receiving the end character or the buffer overflow.

3．If the command handshake opens, the command parser immediately returns the character to the host after each character received, and the host can only continue to send the next character sent after receiving the character.

4．The command parser stops the resolution, and the current instruction is invalid.

5．The command parser stops the command string parsing, and then the string is ignored.

6．The command parser is not case-sensitive to the command string.

7．The command parser supports command abbreviations.

Symbol conventions and definitions

This chapter uses symbols that are not part of the command tree, just to get a better understanding of the command string.

< >   The text in angle brackets indicates the parameters of the command.

[ ]   The text in square brackets indicates optional commands.

{ }   When the curly braces contain several parameter items, it means that only one item can be selected from them.

( )   The abbreviated form of the parameters is placed in parentheses.

Capital letter   Abbreviated form of the command.

Command tree structure

For the SCPI command using the tree structure, it can go down three levels (note: the command parser of this instrument can parse down to any layer), here the highest level is called the subsystem command. The subordinate command is valid only if the subsystem command is selected, and the SCPI uses a colon (:) to separate high-level and low-level commands.

Figure 9-1 Command tree structure
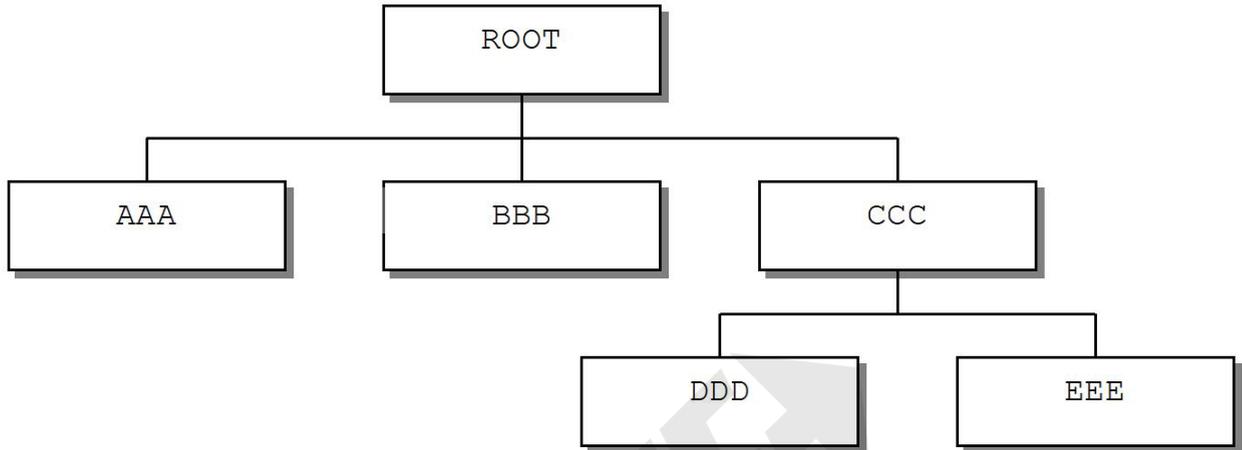
Example: ROOT:CCC:DDD ppp

ROOT   subsystem command

CCC   second stage

DDD   third stage

ppp   parameter

Commands and Parameters

A command tree consists of commands and [parameters], separated by a space (ASCII: 20H).

Example: AAA:BBB 1.234

Command [Parameter]

Command

Command words can be a long command format or short form, which allows engineers to better understand the meaning of the command string; the short form is suitable for writing.

Parameter

■ Single command word command, with no parameters.

e.g.: AAA:BBB

■ The parameter can be a string, and its short rules still follow the command short rules in the previous section.

e.g.: AAA:BBB 1.23

■ The parameter can be in a numerical form

<integer>   integer 123, +123, -123

<float>   floating number

  <fixfloat>: Number of fixed floating points: 1.23, -1.23

<Sciloat>: Scientific counting method of floating point number: 1.23E+4, 1.23E-4

<mpfloat>: Floating-point number, as represented by the multiplier: 1.23k, 1.23M, 1.23G, 1.23u

Table 9-1 Rate abbreviations

numerical value	Multiplying power
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 rate is not case-sensitive, which is different from the standard name.

Separator

The instrument command parser accepts only the allowed delimiters, otherwise the delimited command parser produces the Invalid separator (illegal split) error.

These delimiters include：

; Semicolon to separate two commands.

  e.g.: AAA:BBB 100.0 ; CCC:DDD

: Colon, which separates the command tree, or command tree restart.

  e.g.: AAA : BBB : CCC 123.4; : DDD : EEE 567.8

? Question mark, used for the query.

  e.g.: AAA ?

□ Spaces are used to separate parameters.

  e.g.: AAA:BBB 1.234

9.2 Command reference

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

DISPlay   display subsystem

FUNCtion   Functional subsystems

FETCh?   Get the result subsystem

Public order：

IDN?   Instrument information query subsystem

9.3 Display subsystem

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

Table 9-2 Display subsystem tree

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

DISPlay:PAGE

DISP:PAGE   Used to switch to the specified page.

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

parameter: <Page name> includes:

MEASurement   Measurement display page, abbreviated as **MEAS**

MeasureSETup   The Measurement Settings page, abbreviated as **MSET**

SYSTem   The System Configuration page, abbreviated as **SYST**

SystemINFo   The System Information Page, abbreviated as **SINF**

e.g.: send > **disp: measuresetup** ⟨*NL*⟩
The instrument will switch to the measurement settings page

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

Query response: **<Page name> abbreviation**

meas

mset

syst

sinf

e.g.: send > **disp: page?** ⟨*NL*⟩

return > **mset** ⟨*NL*⟩
The current page of the instrument is the measurement setting page

DISP:LINE

DISP: LINE   Used to display a string of text in the prompt bar at the bottom of the page. Text can display up to 30 characters.

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

parameter: <**string**> Up to 30 characters

e.g.: send > **DISP: LINE HelloWorld** ⟨*NL*⟩
The bottom of the measuring instrument will display a red Hello World

9.4 FUNCtion subsystem

Table 9-3 FUNCtion Subsystem tree

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

Start / stop the command set

Command syntax: **FUNCtion: STARt**

e.g.: send > **FUNC:STARt** *‹NL›*

Start the test, the function is equivalent to the [start] key

Command syntax: **FUNCtion: STOP**

e.g.: send > **FUNC: STOP** *‹NL›*

Start the test, the function is equivalent to the [stop] key

Function parameter command set

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

parameter: <**float**>: (unit A)

Test current value. 5A ~ 40A

e.g.: send > **FUNC: SOUR: CURRSET 10.2** *‹NL›*

Set the test current to be set at 10.2A

Query syntax: **FUNC: SOUR: CURR?**

Query the test current value

e.g.: send > **FUNC: SOUR: CURR?** *‹NL›*

return > 10.2 *‹NL›*

Indicates that the current test current is 10.2A

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

parameter: < **int** >: (unit Hz)

50 indicates a test current of 50Hz
60 indicates a test current of 60Hz

e.g.: send > **FUNC: SOUR: FREQ 50** *‹NL›*

Set the test current frequency at 50Hz

Query syntax: **FUNC: SOUR: FREQ?**

Query the test current frequency furnace

e.g.: send > **FUNC: SOUR: FREQ?** <NL>

return > 60 <NL>
Indicates that the current test frequency is 60Hz

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

parameter: <**float**>: (unit s)
Test time: 0~999.9s
0 represents an unlimited time test

e.g.: send > **FUNC: SOUR: TIMESET 60** <NL>
The test time was set to be 60s

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

Query response: **<float>**: (unit s)
Returning an OFF indicates that the test time is closed

e.g.: send > **FUNC: SOUR: TIME?** <NL>

return > 60.1 <NL>
Indicates that the current test time is a 60.1s

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

parameter: <**float**>: (unit mΩ)
Where 0 indicates the upper limit OFF

e.g.: send > **FUNC: SOUR: UPPERSET 100** <NL>
The lower limit was set to 100m Ω

Query syntax: **FUNC: SOUR: UPPER?**
Query the current ceiling settings value

Query response: **<float>**: (unit mΩ)
returned value 0~600
Return 0 indicates the upper limit OFF and does not participate in the comparison

e.g.: send > **FUNC: SOUR: UPPER?** <NL>

return > 22.1 <NL>
Indicates that the current upper limit is set to 22.1m Ω

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

parameter: <**float**>: (unit mΩ)
0 indicates the lower limit of the OFF

e.g.: send > **FUNC: SOUR: LOWERSET 10.5** <NL>
Set the lower limit to 10.5m Ω

Query syntax: **FUNC: SOUR: LOWER?**

Query response: **<float>**: (unit mΩ)
returned value 0~600
Return 0 indicates the lower limit OFF and does not participate in the comparison

e.g.: send > **FUNC: SOUR: LOWER?** <NL>

return > 10.5 _{\<NL\>}

Indicates that the current lower limit is 10.5m Ω

9.5 FETCh? subsystem

FETCh The subsystem command set is used to obtain the measurement results of the instrument and to set the acquisition mode.

In the page "System Settings" of the instrument [send sending], select [automatic], return the data after the end of each measurement, and select [FECTH?], Which means receiving the FETCh? Command, the instrument will return the data only once

Query syntax: **FETCh?**

Acronym for FETC?

e.g.: send > **FETCh?** _{\<NL\>}

return > 10.1,15 _{\<NL\>}

10.1 is the grounding resistance value in mΩ, and 15 is the test current in A, separated by commas

9.6 IDN? subsystem

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

Query syntax: **IDN?**

Query response: **\<Manufacturer\>**, **\<Model Number\>**, **\<Serial Number\>**, **\<Version\>**

e.g.: send > **IDN?** _{\<NL\>}

return > INSIZE, 9460-GR40, 7660001, REV A2.2 _{\<NL\>}

10. MODBus (RTU) protocol

You will learn about the following:
- Data format: Understand the Modbus communication format
- function
- variable domains
- function code

10.1 Data format

We follow the Modbus (RTU) communication protocol, and the instrument will respond to the instructions of the upper computer and return the standard response frame.

Instruction frame

Figure 10-1 MODBus instruction frame format

Table 10-1 Description of the instruction frame

	A Squelch Interval of at least 3.5 characters is required
From the station address	1 Bytes Modbus Can support 00~0x63 slave stations The uniform broadcast address is 00 In the RS485 options, the default slave address is 0x01
function code	1 Bytes 0x03: Read out the multiple registers 0x04: =03H, not used 0x06: Write to a single register and can be replaced with 10H 0x08: Echo test (used for commissioning only) 0x10: Write to multiple registers
data	Specifies the register address, quantity, and content
CRC-16	2 bytes, low in front Cyclic Redundancy Check All the data from the station address to the end of the data are calculated to obtain the CRC16 check code
	A Squelch Interval of at least 3.5 characters is required

CRC-16 method of calculation

1．Set the initial value of the CRC-16 register to 0xFFFF.

2．XOR on the 1st byte of the CRC-16 register and information and returns the calculation to the CRC register.

3．Fill in the MSB with 0 and shift the CRC register right by 1 bit.

4．If the bit moved from the LSB is 0, repeat step (3) (handle next 1 shift). If the bit moved from the LSB is "1", perform XOR to the CRC register and 0xA001 and returns the result to the CRC register.

5．Repeat steps (3) and (4) until 8 bits.

6．If the information processing is not finished, perform the XOR operation on the CRC register and the next 1 byte of the information and return the CRC register, repeating from step (3).

7．Attach the calculated result (the value of the CRC register) from the low-level byte to the message.

The following is a CRC calculation function for a VB language:

```
Function CRC16(data() As Byte) As Byte()
    Dim CRC16Lo As Byte, CRC16Hi As Byte        'CRC register
    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)            'Each data is XXOR to the CRC register
        For flag = 0 To 7
            SaveHi = CRC16Hi
            SaveLo = CRC16Lo
            CRC16Hi = CRC16Hi \ 2                 'Move a high right
            CRC16Lo = CRC16Lo \ 2                 'Move one position from low to right
            If ((SaveHi And &H1) = &H1) Then      'If the last digit of the high byte is 1
                CRC16Lo = CRC16Lo Or &H80         'Then the low byte moves right after the front fill 1
            End If      'Otherwise automatically fill 0
            If ((SaveLo And &H1) = &H1) Then      'If LSB is 1, 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                       'CRC high-order position
    ReturnData(1) = CRC16Lo                       'CRC low-order
    CRC16 = ReturnData
End Function
```

Figure 10-2 Modbus additional CRC-16 values

CRC−16 Calculation range

Response frame

Except for the 00H slave address command, the other slave address instrument returns the response frame.

Figure 10-3 the normal response frame

CRC−16 Calculation range
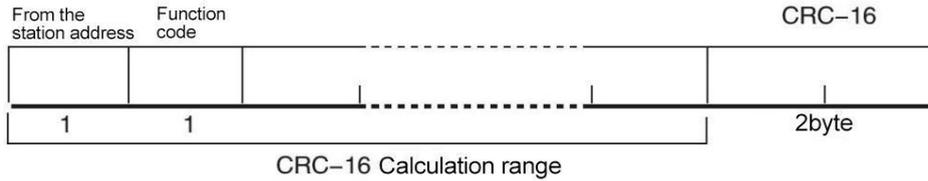
Figure 10-4 Abnormal response frames
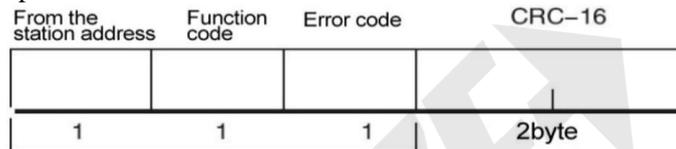
Table 10-2 Description of the abnormal response frames

From the station address	1 Bytes Return from the station address as is
function code	1 Bytes BIT 7 (0x80) on function code logic or (OR) For example: 0x03 OR 0x80 = 0x83
Error code	Exception code: 0x01 Function code error (function code is not supported) 0x02 Register error (register not present) 0x03 Data error 0x04 execution error
CRC-16	2 bytes, low in front Cyclic Redundancy Check All the data from the station address to the end of the data are calculated to obtain the CRC16 check code

No-response

In this case, the instrument will not do any processing or respond, resulting in a communication timeout

1. Error from station address

2. Error of transmission

3. CRC-16 error

4. Digit error, such as function code 0x03, total digit must be 8 and received less than 8 or more than 8 bytes

5. The slave station address is 0x00, which represents the broadcast address, and the instrument does not respond

6. Error code

Error code

Table 10-3 description of error codes

Error code	Name	Illustration	Priority level
0x01	Functional code error	The functional code does not exist	1
0x02	The register error	The register does not exist	2
0x03	Data error	Wrong number of registers or bytes	3
0x04	Execution error	Data is illegal, and the written data is not within the allowable range	4

10.2 Function code

Table 10-4 Functional codes

Function code	Name	Illustration
0x03	Read out the multiple registers	Read out multiple consecutive register data
0x04	Same as in 0x03	Please take the place with 0x03
0x08	The echo test	The received data is returned as it is
0x10	Write to multiple registers	Write to multiple consecutive registers

10.3 Register

The number of registers of the instrument is 2 byte mode, that is, 2 bytes must be written each time, for example, the register of speed is 0x3002, the data is 2 bytes, the value must be written to 0x0001.

data：

1 register, double-byte (16-bit) integer, such as 0x64→00 64

2 registers, four-byte (32-bit) integer, such as 0x12345678→12 34 56 78

2 registers, four-byte (32-bit) single precision floating point number, such as 3.14→40 48 F5 C3

10.4 Read the multiple registers

Figure 10-5 Read multiple registers (0x03)
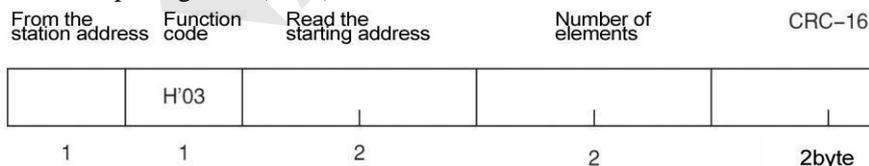
Table 10-5 The function code for reading out multiple registers is 0x03.

No.	Name	Illustration
	From the station address	The default is 01 when no RS485 address is specified
0x03	FC	
	start address	Register start address, please refer to the Modbus instruction set
	Number of read registers0001~006A (106)	Number of registers read. Refer to the Modbus instruction set to ensure that these register addresses are present, otherwise the error frame will be returned.
CRC-16	check code	

Figure 10-6 Read multiple registers (0x03)
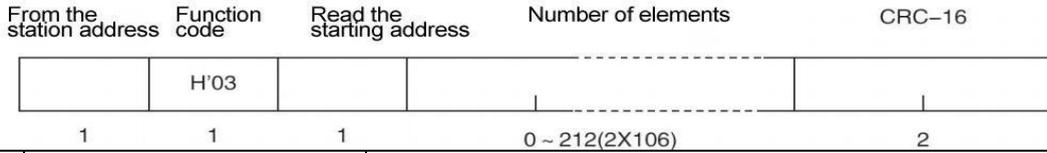
No.	Name	Explain
	From the station address	Return as is
0x03 or 0x03	function code	No exception: 0x03 Error code: 0x83
	start address	= Number of registers, x 2
		For example: 1 register returns 02
	data	Read the data
CRC-16	check code	

10.5 Write to multiple registers

Figure 10-7 writes to multiple registers (0x10)

No.	Name	Illustration
	From the station address	The default is 01 when no RS485 address is specified
0x10	FC	
	Start address	Register start address, please refer to the Modbus instruction set
	Number of written registers 0001~0068 (104)	Number of registers read. Refer to the Modbus instruction set to ensure that these register addresses are present, otherwise the error frame will be returned.
CRC-16	Byte number	

Write to multiple register response frames (0x03)
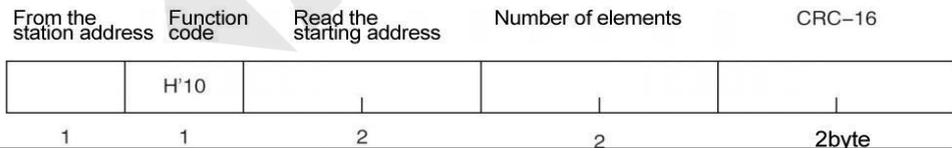
No.	Name	Illustration
	From the station address	Return as is
0x10 or 0x90	Function code	No exception: 0x10 Error code: 0x90
	Start address	
	Number of registers	
	CRC-16 check code	

10.6 The echo test

Echo test function code 0x08 for debugging the Modbus.

Figure 10-8 Echo test (0x08)

Instruction frame

From the station address	Function code	Fixed value		Test data	CRC−16
	H'08	H'00	H'00		
1	1	2		2	2byte

Response frame
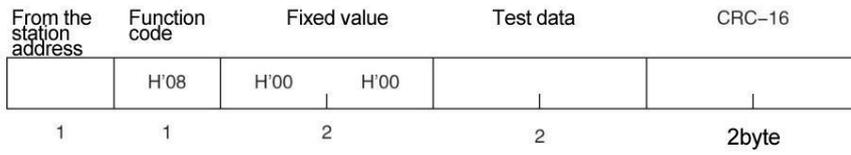
From the station address	Function code	Fixed value		Test data	CRC−16
	H'08	H'00	H'00		
1	1	2		2	2byte
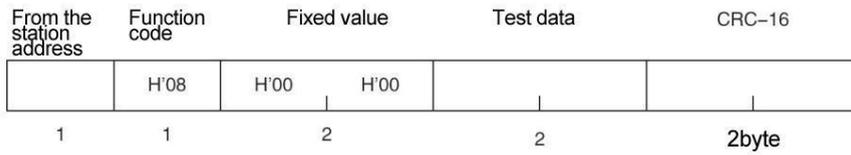
No.	Name	Illustration
	From the station address	Return as is
0x08	function code	
	fixed value	00 00
	test data	Any numerical value: for example, 12 34
	CRC-16 check code	

for example:

Assuming that the test data is 0x1234:

Instructions:	01	08	00 00	12 34	ED 7C(CRC−16)
Response:	01	08	00 00	12 34	ED 7C(CRC−16)

11. Modbus (RTU) instruction set

You will learn about the following:

- Register address

Note: Unless otherwise noted, the instructions and response frames in the following instructions are 16 decimal data

11.1 Register overview

The following lists all the register addresses used by the instrument, and any addresses not in the table will return the error code 0x02.

Table 11-1 register overview

Register address	Name	Numerical value	Illustration
2000	Test the current register	4 Byte floating point number	Read-only memory, the data occupies 2 registers
2002	Ground-resistance register	4 Byte floating point number	Read-only memory, the data occupies 2 registers
2004	Read the comparator results	2 Byte integers	Read-only memory, the data occupies 1 register
			1: PASS
			2: FAIL
3001	Set the current register	4 Byte floating point number	Read and write memory, the data occupies 2 registers
3003	Set the frequency register	2 Byte integers	Read and write memory, the data occupies 1 register
3004	Set the time register	4 Byte floating point number	Read and write memory, the data occupies 2 registers
			0: An unlimited-time test
3006	Upper limit setting register	4 Byte floating point number	Read and write memory, the data occupies 2 registers
3008	Lower limit setting register	4 Byte floating point number	Read and write memory, the data occupies 2 registers
3010	Start the test	2 Byte integers	Write to the register, and the data occupies 1 register
3011	Stop testing	2 Byte integers	Write to the register, and the data occupies 1 register

11.2 Get test data

- Read the test current value

Send

1	2	3	4	5	6	7	8
01	03	20	00	00	02	CF	CB
slave station	read	register		number of registers		check code	

Respond

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

Where 40 9F4E EF is the test current value, representing4.978385A, and the instrument is displayed as5.0A

- Read the test resistance value

Send

1	2	3	4	5	6	7	8
01	03	20	04	00	01	6E	0B
slave station	read	register		number of registers		check code	

Respond

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

Where 41 2A 21 5F is the test ground resistance value, representing 10.633147mΩ , and the instrument is displayed as 10.6mΩ

- Read the test comparator results

Send

1	2	3	4	5	6	7	8
01	03	20	02	00	02	CE	0B
slave station	read	register		number of registers		check code	

Respond

1	2	3	4	5	6	7
01	03	02	00	02	39	85
		byte	data		CRC-16	

- Set the current register (3001)

Read

1	2	3	4	5	6	7	8
01	03	30	01	00	02	9A	CB
slave station	read	register		number of registers		check code	

Respond

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

40 A0 00 00 is a single precision set current value, converted to decimal is 5.0A

Write (change 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	register	number of registers	byte	data		CRC

Respond

1	2	3	4	5	6	7	8
01	10	30	01	00	02	1F	08
	write	register		number of registers		CRC-16	

● Set Frequency register (3003)

Read (current frequency)

1	2	3	4	5	6	7	8
01	03	30	03	00	01	7B	0A
slave station	read	register		number of registers		check code	

Respond

1	2	3	4	5	6	7
01	03	02	00	00	B8	44
		byte	data		CRC-16	

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

Change the test frequency (as shown at 60Hz)

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	30	03	00	01	02	00	01	57	A0
	write	register		number of registers		byte	data		CRC	

Respond

1	2	3	4	5	6	7	8
01	10	30	03	00	01	FE	C9
	write	register address		data		CRC-16	

● Setting the upper limit register and the lower limit register operate the same as setting the current register, the upper limit and lower limit are m Ω

● Start-up Test (3010)

1	2	3	4	5	6	7	8	9	10	11
01	10	30	10	00	01	02	00	00	94	C3
	write	register		number of registers		byte	data		CRC	

● Stop Test Testing (3010)

1	2	3	4	5	6	7	8	9	10	11
01	10	30	11	00	01	02	00	00	95	12
	write	register		number of registers		byte	data		CRC	

Stop the first time of test writing, the instrument interface will retain the test results, and the data of the instrument interface will be cleared.

12. Specifications

You will learn about the following：

- Qualification
- Environmental requirements
- Outline dimension

12.1 Qualification

Essential parameter	
	9460-GR40 The AC ground resistance tester
Measurement function	4 Terminal measurement
Show	5-inch TFT color screen, grounding resistance, test current and test time are displayed on the same screen
Set the current range	AC 5A~40A, accuracy: $\pm(2\% + 5d)$, resolution of 0.1A
Frequency of occurrence	50Hz or 60Hz sine wave
Maximum output	160VA (Note: Do not operate the instrument under full load for long periods of time)
Open-way port voltage	Below the AC 6V
Range of resistance measurement	$0m\Omega \sim 600m\Omega$, accuracy: $\pm (2\% + 5d)$
The measurement time is shown	The countdown shows and the timing after the timer is off
Timer Settings	0s~999.9s Countdown, or the timer OFF
Comparer	Upper and lower limit alarm
Standard interface	RS-232 communication interface, Handler interface
Else	Chinese and English menu switch
Power supply	AC 110V/220V 50Hz/60Hz
Fuse	220V 5A slow blow fuse
Size	Outer dimension (mm): $320 \times 250 \times 120$
Weight	Approximtely 7kg

12.2 Environmental requirements

Environment: Normal: Temperature: 18℃~28℃; Humidity: ≤70% RH

                    Operation: Temperature: 10℃~40℃; Humidity: ≤80% RH

                    Store: Temperature: 0℃~50℃; Humidity: ≤90% RH