ONMEAS®

Rev.A1

AT51X8

Multi-Channel Resistance Meter



User's Guide

Scan QR code for operation video

Safety Precautions

⚠ 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 Using the Instrument in an Explosive Gas Environment	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 Opening the Instrument Enclosure	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 Using a Damaged Instrument	If the instrument has been damaged, the hazards are unpredictable. Disconnect the power cord, do not use the instrument again, and do not attempt to repair it yourself.
Do Not Using an Instrument Operating Abnormally	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 Using 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 AT51X8 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 years 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 one year 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

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

1.2 Power Requirements

The AT51X8 can only be used under the following power conditions:
Voltage: 220VAC (1±10%)
Frequency: 50Hz (1±10%)



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

1.3 Operating Environment

The AT51X8 must be used under the following environmental conditions:
Temperature: 0°C~55°C,
Humidity: below 70%RH at 23°C

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.

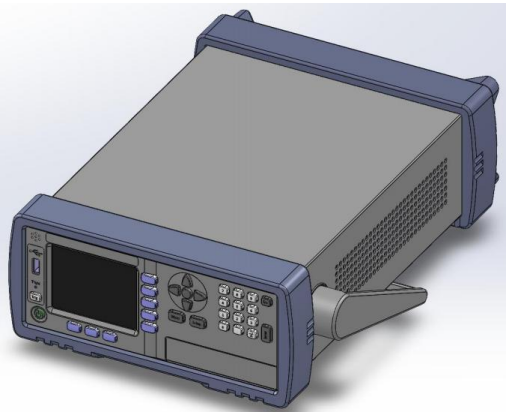


Note: Do not use solvents (such as alcohol or gasoline) to clean the instrument.

1.5 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:

Figure 1- 1 Instrument 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]

⇩

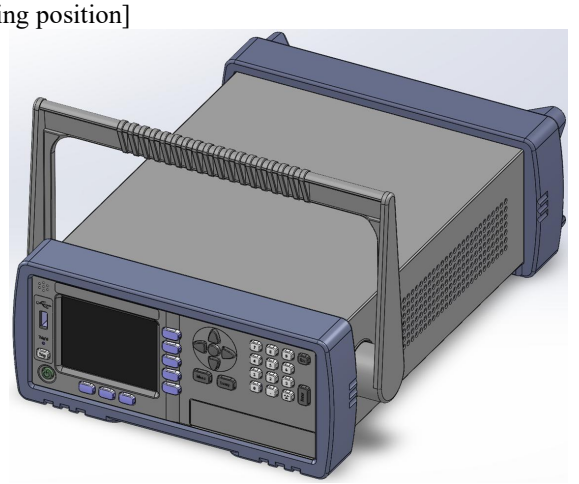


Viewing position 2 [Hold both sides of the handle with both hands and pull it gently outward until it can rotate freely, then switch to the carrying position]

⇨



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:

- Introduction
- Main Features

2.1 Introduction

Thank you for purchasing the AT51X8 multi-channel resistance meter.

The AT51X8 multi-channel resistance tester is a micro bench-top instrument for fully automatic real-time testing, controlled in parallel by a high-performance ARM microprocessor and an FPGA.

It is the first to measure the resistance of 8 channels in parallel in real time and display them on the screen simultaneously. Each channel provides 0.05% basic accuracy and a measurement range of 10μΩ~30kΩ. The resistance value of each channel is displayed with 5 digits, providing 30000 counts. Thanks to FPGA control technology, testing 8 channels and displaying the measurement results takes only 50ms while maintaining accuracy.

Each channel of the instrument has an independent comparator setting, and the comparator results of the 8 channels are output separately through the Handler interface.

The instrument comes standard with an RS-232 interface, a Handler interface and a temperature compensation interface.

The computer remote control commands are compatible with SCPI (Standard Command for Programmable Instrument), efficiently accomplishing remote control and data acquisition.

Reference: For complete technical specifications, refer to the Specifications chapter.

2.2 Main Features

2.2.1 Range

Uses 6 ranges to test resistance from 10μΩ to 30kΩ.
Manual ranging.

2.2.2 Test Speed

The instrument provides four speed settings: slow, medium and fast.
All channels on, in manual ranging mode:
Slow: 333ms/8 channels
Medium: 90ms/8 channels
Fast: 50ms/8 channels

2.2.3 Trigger Mode

Internal, external, manual, and remote triggering.

2.2.4 Basic Accuracy

Slow, medium: 0.05%
Fast: 0.1%

2.2.5 Calibration Function

Short-circuit zeroing over the full range: eliminates the influence of lead resistance.

2.2.6 Comparator Function (Sorting Function)

The instrument can sort each channel independently.
Fail bins (CH1-CH8): low level output, indicating fail
NG: low level output when all channels fail.
GD: high level output when all channels pass.

Comparison mode:
The measured value is compared directly with the upper and lower limits

2.2.7 System Settings

1. Keyboard lock function
2. Administrator and user accounts, and a password can be set for the administrator

2.2.8 Interfaces

RS-232 remote control:
Supports a maximum baud rate of 115200bps, is compatible with the SCPI protocol, and supports ASCII transmission.

Handler interface
Darlington output; output port with built-in pull-up resistors.
Optocoupler-isolated input port.
Supports internal 5V and 24V external power.
Input: trigger signal,
Output: all sorting comparison result signals; measurement synchronization signal (EOC).

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 instru warm-up time.
- Starting a test — including how to connect to the test terminals

3.1 Getting to Know the Front Panel

3.1.1 Front Panel Description

Figure 3- 1 Front Panel

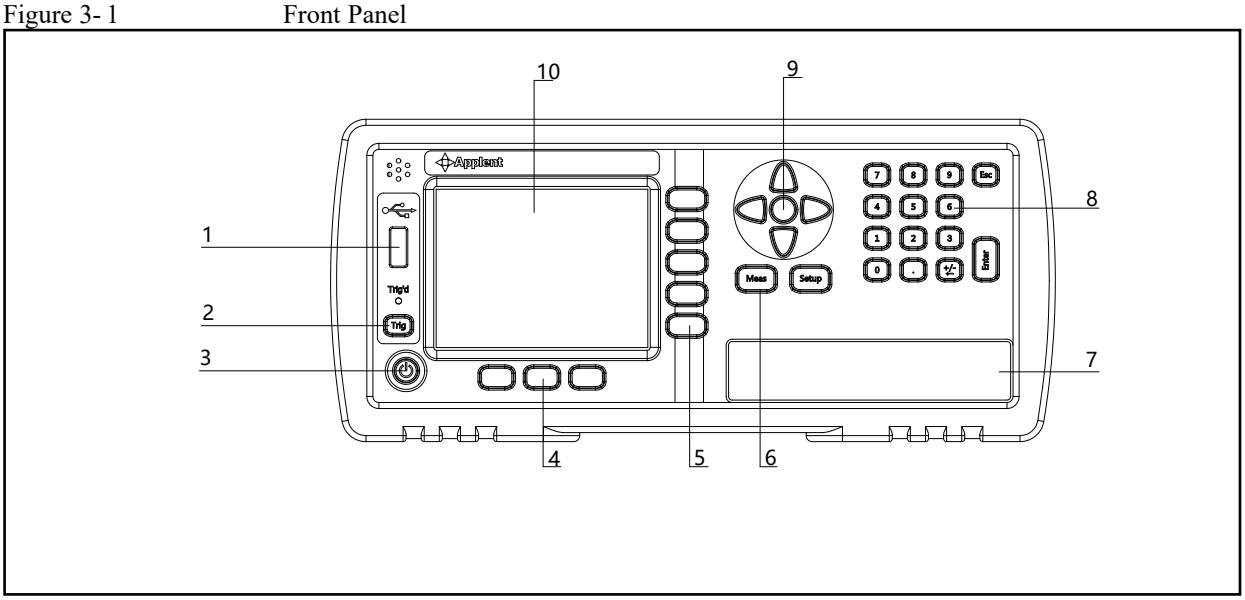
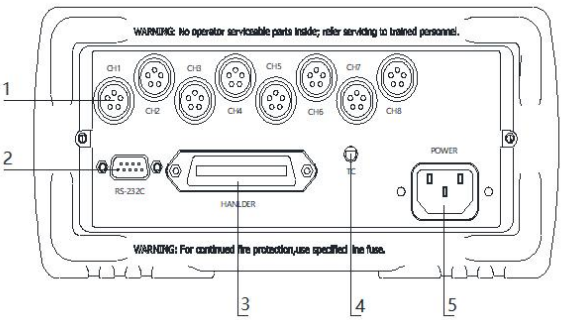


Table 3- 1 Front Panel Function Description

No.	Function
1	USB disk interface (optional)
2	Manual trigger key, and manual or remote trigger indicator lights
3	Power switch
4	System function keys, including System, keyboard lock, etc.
5	Soft key
6	Main function keys: Measure and Setup
7	Test terminals: not provided on the AT51X8; AT51X8 testing is done on the rear panel
8	Numeric keypad
9	Cursor keys
10	LCD display window

3.1.2 Getting to Know the Rear Panel

Figure 3- 2 Rear Panel



1. Test terminals.
2. RS-232C interface.
3. HANDLER interface.
4. Temperature compensation interface.
5. Power socket

3.2 Power-On Startup

3.2.1 Powering On

The key marked "+" at the lower left of the panel is the power switch. It is an illuminated tactile switch: when the indicator is orange or off, the instrument is in standby; when the green indicator lights up, the instrument is powered on.

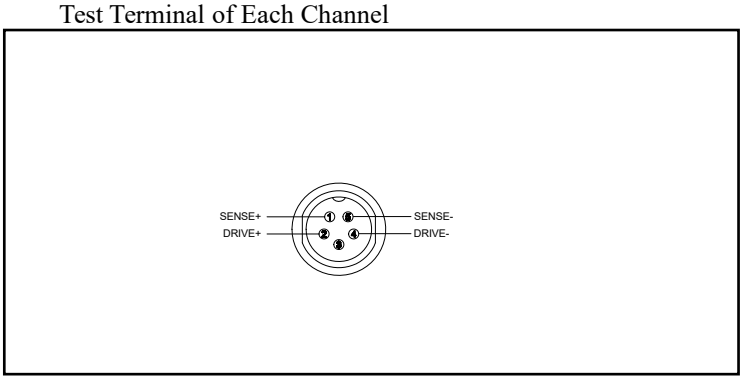
Warm-up time: to achieve the specified accuracy, the instrument needs to warm up for at least 10 minutes.

3.3 Connecting the Test Terminals

The test terminals are on the rear panel. Insert the test plug correctly into the test port in the direction of the slot.

The pin definitions of the test terminal of each channel are as follows:

Figure 3- 3 Test Terminal of Each Channel



Warning: It is strictly forbidden to connect current sources or voltage sources directly to the test terminals. Connect energy-storage components to the test terminals only after they are discharged.

4. [Meas] Page

4.1<Measure Display> Page

Press the [Meas] key to enter the [Measure Display] page.

<Measure Display>This page primarily highlights the measurement result, and also displays the current sorting result in small characters.
On this page, 6 commonly used functions can be set. They include:

- Trigger – trigger settings
- 01-08 – channel settings

Figure 4- 1 AT51X8 <Measure Display> Page



4.1.1 [Trigger] Mode

Communication command: **TRIGger:SOURce {INT,MAN,EXT,BUS}**
The instrument has 4 trigger modes:
Internal trigger, manual trigger, external trigger, and remote trigger.

Trigger Mode	Description
Internal	Also called continuous testing: the trigger signal is generated inside the instrument, and tests are performed continuously at a fixed period.
Manual	Each time the [Trig] key is pressed, the instrument performs one measurement cycle; at all other times the instrument is in a waiting state.
External	Upon receiving a rising-edge pulse from the Handler interface on the rear panel, the instrument executes one measurement cycle. At other times it is in a waiting state. Refer to the Handler interface.
Remote	After receiving an RS232 trigger command, the instrument performs one measurement cycle; at all other times it is in a waiting state.

■ **Steps for setting the trigger mode:**

Step 1 Press the [Meas] key to enter the main measurement page;
Step 2 Use the cursor keys to select the [Trigger] field;
Step 3 Use the soft keys to select the trigger mode.

Soft key	Function

Internal	Internal trigger mode
Manual	Manual trigger mode
External	External trigger mode
Remote	Remote trigger mode

4.1.2 [Channel] Settings

Each channel of the instrument can be set to on or off.

■ **Steps for setting the channel working mode:**

Step 1 Press the [Meas] key to enter the main measurement page;

Step 2 Use the cursor keys to select the channel number [01]~[08] field;

Step 3 Use the soft keys to select the channel working mode.

Channel settings	Description
Off	The current channel is turned off and ignored during measurement
On	The current channel is allowed to measure

Note! Since the instrument tests in parallel, turning off a channel does not increase the measurement speed.

5. [Setup] Page

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

- Measurement Settings
- Temperature Compensation Settings
- Short-Circuit Zeroing Operation
- Comparator Settings

At any time, press the [Setup] key and the instrument will enter the Setup main page.

5.1 Measure Settings

All settings related to measurement are performed on the <Setup> page.
On the <Setup> page, the instrument does not display test results or comparator results, but testing of the instrument is still in progress.
These settings include the following parameters:

- Trigger – trigger mode
- Range – test range
- Speed – test speed
- Temp comp – turn temperature compensation on/off
- Temp coefficient – enter the temperature coefficient
- Ref temperature – enter the compensation temperature

Figure 5- 1 <Setup> Page



5.1.1 [Trigger] Mode

Communication command: **TRIGger:SOURce {INT,MAN,EXT,BUS}**
The instrument has 4 trigger modes:
Internal trigger, manual trigger, external trigger, and remote trigger.

Trigger Mode	Description
Internal	Also called continuous testing: the trigger signal is generated inside the instrument, and tests are performed continuously at a fixed period.
Manual	Each time the [Trig] key is pressed, the instrument performs one measurement cycle; at all other times the instrument is in a waiting state.
External	When a rising-edge pulse is received from the Handler interface on the rear panel,

	the instrument performs one measurement cycle. At all other times the instrument is in a waiting state. Refer to the Handler interface
Remote	After receiving an RS232 trigger command, the instrument performs one measurement cycle; at all other times it is in a waiting state.

■ **Steps for setting the trigger mode:**

Step 1 Press the [Setup] key to enter the settings page;
Step 2 Use the cursor keys to select the [Trigger] field;
Step 3 Use the soft keys to select the trigger mode.

Soft key	Function
Internal	Internal trigger mode
Manual	Manual trigger mode
External	External trigger mode
Remote	Remote trigger mode

5.1.2 [Range]

Communication command:
FUNCtion:RANGe:NO {<Range No.>,min,max}
FUNCtion:RANGe <nominal value>

The AT51X8 has 6 ranges. The variation range of each range is as follows:

Table 5- 1 Range Variation Range

Range number	Range	Measuring range	Up range	Down range
1	100mΩ	29.000mΩ~300.00mΩ	↓ 300mΩ ↓ 3Ω ↓ 30Ω ↓ 300Ω ↓ 3kΩ ↓ 30kΩ	↑ 290mΩ ↑ 2.9Ω ↑ 29Ω ↑ 290Ω ↑ 2.9kΩ ↑ 29kΩ
2	1Ω	290.00mΩ~3.0000Ω		
3	10Ω	2.9000Ω~30.000Ω		
4	100Ω	29.000Ω~300.00Ω		
5	1kΩ	290.00Ω~3.0000kΩ		
6	10kΩ	2.9000kΩ~30.000kΩ		

Note! For high-speed sorting tests, to guarantee speed, the instrument does not provide auto ranging and only uses manual ranging.

■ **Steps for setting the range:**

Step 1 Press the [Setup] key to enter the settings page;
Step 2 Use the cursor keys to select the [Range] field;
Step 3 Use the soft keys to select auto range, manual range, or select a range

Soft key	Function
Increase +	Increases the range number, and the range is changed to lock
Decrease -	Decreases the range number, and the range is changed to lock

5.1.3 Test [Speed]

Communication command: **FUNCtion:RATE {SLOW,MED,FAST }**

The instrument provides 3 test speeds (slow, medium and fast). The slower the speed, the more accurate and stable the test results.
Sampling times with all channels on and in manual ranging mode:
Slow: 330ms/8 channels
Medium: 90ms/8 channels
Fast: 50ms/8 channels

■ **Steps for setting the test speed:**

Step 1 Press [Setup] to enter the Setup page;
Step 2 Use the cursor keys to select the [Speed] field;
Step 3 Use the soft keys to select

Soft key	Function
Slow	
Medium	
Fast	

5.1.4 [Temperature Compensation] Switch

Communication command: **FUNCtion:TC {ON,OFF,1,0}**
The instrument has a built-in temperature compensation circuit that compensates for measured-value drift caused by temperature.
The compensation formula of the instrument is as follows:

$$F2 = \frac{100 + \alpha \times (T - To)}{100} \times F1$$

T0 - Reference temperature

T - Current measured temperature

A - Temperature coefficient at the reference temperature (%)

F1 - Uncompensated value

F2 - Temperature-compensated value

■ **Steps for turning on temperature compensation:**
Step 1 Press [Setup] to enter the Setup page;
Step 2 Use the cursor keys to select the [Temperature Compensation] field;
Step 3 Use the soft keys to select

Soft key	Function
Off	
On	The measurement result is the value compensated to the reference temperature

5.1.5 [Temperature Coefficient]α

Communication command: **FUNCtion:TC:RATIo <float>**
Temperature compensation requires setting the temperature coefficient of the material.

■ **Steps for entering the temperature coefficient:**
Step 1 Press [Setup] to enter the Setup page;
Step 2 Use the cursor keys to select the [Temperature Coefficient] field;
Step 3 Enter the required temperature coefficient with the numeric keypad; the unit of the temperature coefficient is percent.
For example, the temperature coefficient of copper is 0.393%; enter 0.393 here.

5.1.6 [Reference Temperature] T0

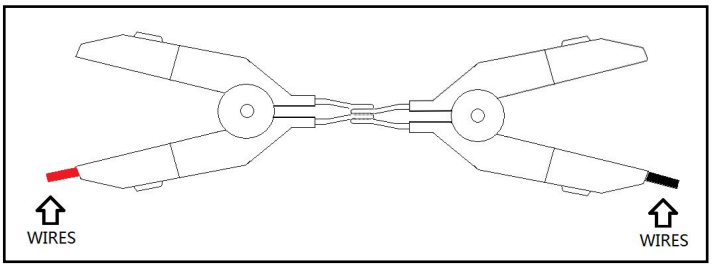
Communication command: **FUNCtion:TC:REFEr <float>**
The reference temperature for temperature compensation. The measurement result reflects the value at this temperature.

■ **Steps for entering the reference temperature:**
Step 1 Press [Setup] to enter the Setup page;
Step 2 Use the cursor keys to select the [Reference Temperature] field;
Step 3 Enter the temperature to be compensated to with the numeric keypad.

5.2 Short-Circuit Zeroing

Communication command: **CORRect:SHORt**
For high-accuracy measurement, zeroing calibration is essential. Short-circuit zeroing effectively cancels the stray resistance of the test leads.
Before zeroing, first short the test clips as follows
The instrument allows short-circuit zeroing of all channels simultaneously or of a single channel.

Figure 5- 2 Correct Short-Circuit Method



- **Short-Circuit Zeroing** Method
  - **Step 1** Press the [Setup] key to enter the settings page
  - **Step 2** Short the test clips
  - **Step 3** Use the soft keys to select the [Short-Circuit Zeroing] key
  - **Step 4** After [OK] is pressed, the instrument starts zeroing
  - **Step 5** After zeroing is completed, a message shows which channels were zeroed successfully.

6. <Comparator> Settings

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

- Comparator Setting Mode
- Upper/Lower Limit Settings

Press the [Setup] key, then press the [Comparator Settings] soft key to open the <Comparator> page. The comparator allows setting the upper/lower limits of all channels.

To make full use of the comparator, the instrument has a built-in Handler interface for outputting the bin comparison results to relays, PLCs or industrial computers.
The instrument allows all channels to use the same settings, or each channel to have its own resistance values set independently.

Figure 6- 1 <Comparator Settings> Page

Unified settings



Separate settings



6.1.1 Setting the [Mode]

Communication command: **COMParator:MODE {UNIfied,SEParated}**

The instrument comparator has 2 setting modes:

- Unified settings: all channels use the comparator upper/lower limits of channel 1.
- Separate settings: each channel uses its own comparator upper/lower limits.

■ **Steps for setting the mode:**

Step 1 Enter the <Comparator Settings> page

Step 2 Use the cursor keys to select the [Mode] field;
Step 3 Use the soft keys to select

Soft key	Function
Unified	All channels use the comparator upper/lower limits of channel 1.
Separate	Each channel uses its own comparator upper/lower limits.

6.1.2 [Beep] Settings

Communication command: **COMParator:BEEP {OFF,OK,NG}**
The beeper setting allows a PASS beep, a FAIL beep, or turning off the beeper.

■ Set the beep

Step 1 Enter the <System Configuration> page
Step 2 Use the cursor keys to select the [Beep] field;
Step 3 Use the soft keys to select

Soft key	Function
Off	The beeper is turned off
PASS beep	The beeper sounds when the sorting result is pass (OK).
FAIL beep	The beeper sounds when the sorting result is fail (NG).

6.1.3 [Lower Limit] and [Upper Limit] Settings

Command format: **COMParator:LMT <channel No. 1~8>,<float lower limit>,<float upper limit>**
The instrument uses direct-reading comparison: the measured value is compared directly with the upper/lower limits, in ohms (Ω).

■ Enter the limit values

Step 1 Enter the <Comparator> page
Step 2 Use the cursor keys to select the [1] [Lower Limit] field;
Step 3 Enter the data
Select the unit with the soft keys.
Step 4 Use the cursor keys to select the [1] [Upper Limit] field;
Step 5 Enter the data
Step 6 Repeat 2~5 to complete data entry for the other bins.

6.1.4 Comparison Formula

Lower limit ≤ measured Rx ≤ upper limit	Judged as pass
Measured Rx < lower limit	Judged as fail
Measured Rx > lower limit	Judged as fail

7. System Configuration

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

- System Configuration Page
- System Information Page
- System Service Page

At any time, as long as you press the [Meas] or [Setup] key, the [System] key appears at the very bottom of the main page.

7.1 System Configuration Page

On the [Meas] or [Setup] main page, press [System] to enter the <System Configuration> page.
The System Configuration page includes the following settings:

- LANGUAGE language setting
- Date/Time settings
- Account Settings
- Beeper settings
- Baud rate settings
- Communication [Command Handshake] Switch
- Communication [Result Send] mode

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

Figure 7- 4 <System Configuration> Page



7.1.1 Changing the System Language [LANGUAGE]

Communication command: **SYSTem:LANGuage {ENGLISH,CHINESE,EN,CN}**

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]	
ENGLISH	English

7.1.2 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
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

7.1.3 Account Settings

The instrument provides two user modes for selection:

- Administrator – all functions are open to the administrator except the [System Service] page, and the parameters set by the administrator are saved to the system memory after a 5-second delay for loading at the next power-on.
- User – except for the [System Service] and [File] pages, users can operate the other functions; the data modified by the user is restored to the values set by the administrator at the next power-on.

■ **Changing the account**:

Step 1 Enter the <System Configuration> page

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

Step 3 Use the soft keys to change:

Soft key	Function
Administrator	All functions are open except the [System Service] page If the password is forgotten, please call the sales department of our company.
User	Functions other than those on the [System Service] page and [File] page can be operated, and the set data is not allowed to be saved.

■ Administrator password setting:

Step 1 Enter the <System Configuration> page

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

Step 3 Use the soft keys to select:

Soft key	Function
Change Password	Enter a numeric password of up to 9 digits; the password contains only digits and symbols.
Delete Password	The administrator will not be password-protected

7.1.4 [Baud Rate] Settings

The instrument has a built-in RS-232 interface. When the instrument senses a signal change on the RS-232 interface, it immediately communicates with the host computer at the set baud rate, and the keyboard is locked at the same time.

To ensure correct communication, confirm that the baud rate is set correctly; the host computer and the instrument cannot communicate correctly if their baud rates are different.

The RS-232 interface of the instrument 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 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	
19200	
38400	
57600	
115200	For communication with the host computer, it is recommended that you use this high baud rate.

7.1.5 Communication [Command Handshake] Switch

The instrument supports the RS232 command handshake.
When the Command Handshake is turned on, all commands sent by the host computer to the instrument are returned to the host computer unchanged, and data is returned only afterwards.
When the Command Handshake is turned off, commands sent by the host computer to the instrument are processed immediately.

Steps for setting the Command Handshake:

Step 1 Enter the <System Configuration> page
Step 2 Use the cursor keys to select the [Command Handshake] field;
Step 3 Use the soft keys to select

Soft key	Function
Off	The Command Handshake is not used. Unless there are special requirements, set the Command Handshake to Off.
On	

7.1.6 Communication [Result Send] Mode

Communication command: **SYSTem:SENDmode {FETCH,AUTO}**
The instrument supports automatically sending data to the host.
After each test is completed, the data will be sent to the host automatically, **without** the host having to send the FETCH? command.
For example: the AT51X8 returns the test results and comparator results of the 8 channels all at once
+9.9651e+01,NG,+9.9481e-01,GD,+9.9726e+00,NG,+9.9481e-01,GD,+7.6770e-04,NG,+9.9726e+00,NG,**+1.0000e+20**,GD,+1.0040e+04,NG
Here +1.0000e+20 indicates overflow or open circuit, and xx as the sorting result indicates the comparator is invalid.

Steps for setting [Result Sending]:

Step 1 Enter the <System Configuration> page
Step 2 Use the cursor keys to select the [Result Sending] field;
Step 3 Use the soft keys to select

Soft key	Function
FETCH	Use the FETCH? command to acquire the data of all channels
Auto	Automatically sent to the host computer after each test is completed

7.2 System Information Page

Press [Meas] or [Setup] to enter the main page, press the [System] key in the task bar at the very bottom to enter the <System Configuration> page, and press the soft keys to select [System Information].
The System Information page has no user-configurable options.
Figure 7- 5 <System Information> Page


〈系统信息〉
型号
AT51X8 Multi-Channel Resistance Meter
序列号
0000000
ATOS 版本
V6.0
软件版本
@REVISION$AT51X8|A1.0
USB磁盘就绪。
系统
配置
键盘锁
00:17

8. Handler Interface

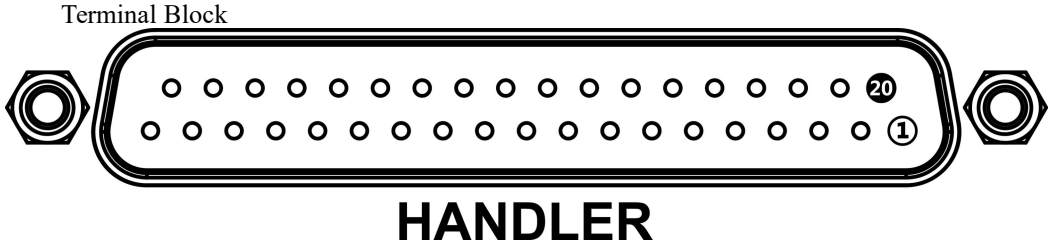
You will learn about the following:

- Terminals
- How to Connect and Interface Schematics

The instrument provides a full-featured Handler interface, which includes 10-channel sorting outputs, EOC (end-of-test signal), TRIG (external trigger start) input and other signals. Through this interface, the instrument can easily implement automatic control together with the user's system control components.

8.1 Terminal Blocks and Signals

Figure 8- 1 Terminal Block



■ Output terminals (all signals are active low)

Table 8- 1 Output Pin Definitions

Pin	Name	Description
1	CH1	1: OK, 0: NG
2	CH2	1: OK, 0: NG
3	CH3	1: OK, 0: NG
4	CH4	1: OK, 0: NG
5	CH5	1: OK, 0: NG
6	CH6	1: OK, 0: NG
7	CH7	1: OK, 0: NG
8	CH8	1: OK, 0: NG
31	NG	0: NG, 1: OK (all-channel fail output)
32	OK	0: OK, 1: NG (all-channel pass output)
33	EOC	1: measuring, 0: measurement completed

■ Input terminals

Table 8- 2 Input Pin Definitions

Pin	Name	Description
37	Trigger input	Trigger input terminal; internally built-in 0.25W, 499 Ω current-limiting resistor.

■ Power terminals

Table 8- 3 Power Pin Definitions

Pin	Name	Description
34	GND	External power input GND
35	External VCC	External power input positive terminal

8.2 Connection Methods

■ Using the External Power Supply

Connect the external power supply to the following pins at the same time:
VCC: pin 35
GND: pin 34

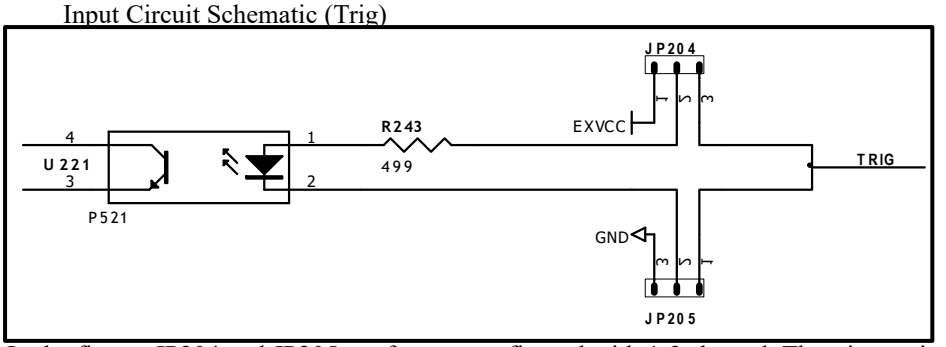
■ Electrical specifications

Power requirements: +3.3V~35VDC
Output signal: Collector output with built-in pull-up resistors. Darlington driven. Active low.
Max. voltage: Power supply voltage.
Input signal: Optocoupler isolated. Active low.
Max. current: 50mA

Note: To avoid damaging the interface, do not allow the power supply voltage to exceed the power requirements.
To avoid damaging the interface, wire the connections after the instrument is turned off.
The output signals can control signals and low-power relays (a reverse energy-release diode is already integrated inside the instrument). Do not use the internal power supply for high-power relays.

■ Input terminal schematic diagram

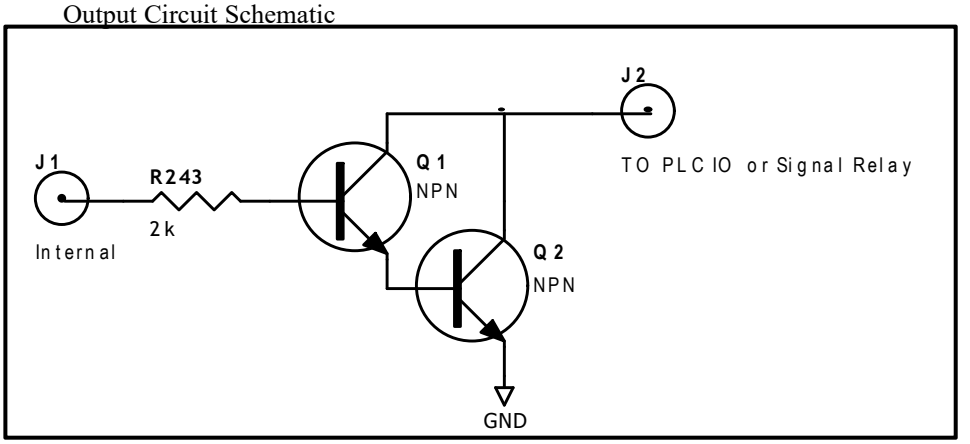
Figure 8- 2 Input Circuit Schematic (Trig)



In the figure: JP204 and JP205 are factory-configured with 1-2 shorted. The trigger signal is rising-edge triggered.
If the trigger signal uses falling-edge triggering, set both JP204 and JP205 to 2-3 shorted; the external VCC can then be left floating.

■ Output Circuit Schematic

Figure 8- 3 Output Circuit Schematic



9. 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 the RS-232 interface (standard configuration) to communicate with a computer and perform all instrument functions. With standard SCPI commands, users can also conveniently develop various data acquisition systems of their own.

9.1 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:

Table 9- 1 Common 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 used by the instrument.

Table 9- 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

9.1.1 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.

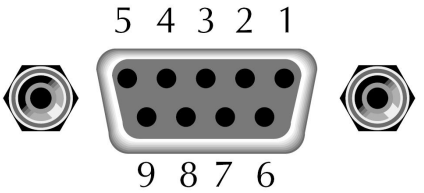


You can make it yourself, or purchase a 9-core**straight-through** cable yourself, or purchase one from Onmeas.

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

Figure 9- 1 RS-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

9.1.2 RS485 Connection

Figure 9- 2 RS-485 Interface on the Rear Panel

Signal	Symbol	9-pin connector pin number
A	A	8
B	B	9

9.2 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>

9.3 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.

Reference: ℘

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.

10. 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.

10.1 Command String Parsing and Terminator

The host can send a command string to the instrument; the instrument command parser starts parsing when it captures the terminator (\n) or when the input buffer overflows.

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.

10.1.1 Command Parsing Rules

1. The command parser only parses and responds to ASCII code data.
2. **The SCPI command string must end with a line feed (ASCII 0x0A)**, 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.

10.1.2 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.

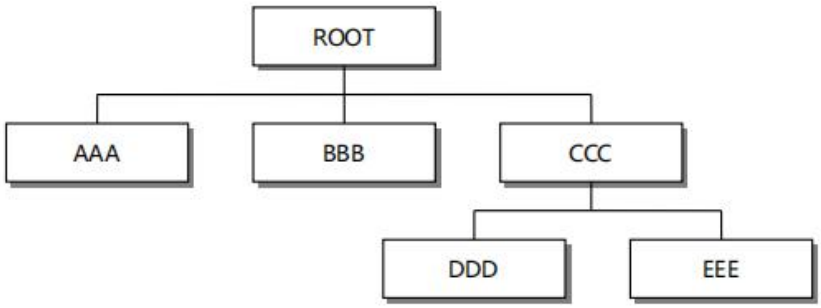
( ) The abbreviated form of a parameter is placed in parentheses.

Uppercase letters The abbreviated form of a command.

10.1.3 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.

Figure 10- 1 Command Tree Structure



Example: ROOT:CCC:DDD PPP
ROOT Subsystem command
CCC Second level
DDD Third level
PPP Parameter

10.2 Commands and Parameters

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

Example: AAA:BBB 1.234
Command [Parameters]

10.2.1 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.

10.2.2 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 CCC
- The parameter can be in numeric form
  - <*integer*> Integer 123, +123, -123
  - <*float*> Floating-point number
    1. <fixfloat>: fixed-point floating-point number: 1.23, -1.23
    2. <Sciloat>: 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

Table 10- 1 Multiplier Abbreviations

Numeric 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.

10.2.3 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

10.3 Command Summary

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

- DISPlay Display subsystem
- FUNCtion Function subsystem
- CORRection Correction subsystem
- COMParator Comparator subsystem
- SYSTem System subsystem
- TRIGger Trigger subsystem
- FETCh? Result acquisition subsystem
- ERRor Error information subsystem

Common commands:

- IDN? Instrument information query subsystem
- TRG Trigger and acquire data

10.4 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.

Figure 10- 2 DISPlay Subsystem Tree

DISPlay	**:PAGE**	**{MEASurement, SETUp,COMParator,SYSTem,SYSTEMINFO(SINF)}**
	:LINE	**<string>**

10.4.1 DISPlay:PAGE

DISP:PAGE switches to the specified page.

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

Parameters: <page name> includes:

MEASurement	Measurement display page
SETUp	Setup page
COMParator	Comparator page
SYSTem	System Configuration Page
SYSTEMINFO(SINF)	System Information Page

Example: Send> **disp:page setup** //Switch to the setup page

Query syntax: **DISP:PAGE?**

Query response:

<page name> abbreviation
meas
setu
syst
sinf

comp

Example: Send> **disp:page?**
Return> **meas**

10.4.2 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 "This is a Comment.**"

10.5FUNCtion Subsystem

Figure 10- 3 FUNCtion Subsystem Tree

FUNCtion	**:RANGe**	**{float}**	
		:NO	**{Range No.,max,min}**
	:RATE	**{SLOW,MED,FAST}**	
	:TC	**:RATIO**	**<float>**
		:REFEr	**<float>**
	:CHannel	**<No.>,{ON,OFF,1,0}**	

Parameters set via the FUNCtion subsystem are not saved in the instrument; they must be set again at the next power-on.

10.5.1 FUNCtion:RANGe

FUNC:RANG sets the range according to the parameter

Command syntax: **FUNCtion:RANGe <float>**
Parameters: where <float> is the nominal value
The instrument automatically selects the best range according to the nominal value
Example: Send> **FUNC:RANG 1k** //Switch to the 3kΩ range
Query syntax: **FUNC:RANG?**
Query response: Ranges:
"300.00E-03"
"3.0000E+00"
"30.000E+00"
"300.00E+00"
"3.0000E+03"
"30.000E+03"
Example: Send> **FUNC:RANG?**
Return> **3.0000E+03**

10.5.1 FUNCtion:RANGe:NO

FUNC:RANG:NO sets the ranging mode and range number

Command syntax: **FUNCtion:RANGe:NO {<Range No.>,min,max}**
Parameters: where <Range No.> includes 1~**6**
min min range=**1**
max max range=**6**
Example: Send> **FUNC:RANG:NO 5** //Switch to range 5 (1kΩ)
Query syntax: **FUNC:RANG:NO?**
Query response: **Range No. 1~6**
Example: Send> **FUNC:RANG:NO?**
Return> **5**

10.5.2 FUNCtion:RATE

FUNC:RATE sets the test speed.

Command syntax: **FUNCtion:RATE {SLOW,MED,FAST,ULTRa }**
Example: Send> **FUNC:RATE FAST** //Set to fast testing
Query syntax: **FUNC:RATE?**
Query response: **{SLOW,MED,FAST,ULTRA}**

10.5.3 FUNCtion:TC

FUNC:TC turns temperature compensation on or off.

Command syntax: **FUNCtion:TC {ON,OFF,1,0}**

Example: Send> **FUNC:TC ON** //Turn on the temperature compensation function

Query syntax: **FUNC:TC?**

Query response: **{ON,OFF}**

10.5.4 FUNCtion:TC:COEFicient

FUNC:TC:RATI sets the temperature coefficient.

Command syntax: **FUNCtion:TC:COEFicient <float>**

Example: Send> **FUNC:Tc:COEF 0.394** //Set the temperature coefficient to 0.394%

Query syntax: **FUNC:TC:COEF?**

Query response: **<fixfloat>**

Example: Send> **FUNC:Tc:COEF?**
Response> **+0.3940**

10.5.5 FUNCtion:TC:REFErence

FUNC:TC:REFE sets the reference temperature

Command syntax: **FUNCtion:TC:REFErence <float>**

Example: Send> **FUNC:Tc:REFE 25** //Set the reference temperature to 25 degrees

Query syntax: **FUNC:TC:REFE?**

Query response: **<fixfloat>**

Example: Send> **FUNC:Tc:REFE?**
Response> **+25.00**

10.5.6 FUNCtion:CHannel

FUNC:CHannel shows or hides the specified channel.

Command syntax: **FUNCtion:CHannel <1~8>,{ON,OFF,1,0}**

Example: Send> **FUNC:CH 1,ON**
Send> **FUNC:CH 8,ON**

Query syntax: **FUNC:Channel? <1~8>**

Query response: **{ON,OFF}**

Example: Send> **FUNC:CH? 1**
Response> **ON**

10.6 COMParator Subsystem

Comparator parameters set via the COMParator subsystem are saved in the system for use at power-on.

The COMP subsystem sets the comparator parameters.

Figure 10- 4 COMParator Subsystem Tree

COMParator	**[:STATe]**	**{OFF,ON,0,1}**
	:BEEP	**{OFF,OK,NG}**
	:MODE	**{UNIfied, SEParated}**
	:LiMiT	**<1~8>, <float Lower Limit>,<float Upper Limit>**

10.6.1 COMParator:BEEP

COMP:BEEP enables the beeper.

Command syntax: **COMParator:BEEP {OFF,OK,NG}**

Example: Send> **COMP:BEEP OK** //PASS beep

Query syntax: **COMP:BEEP?**

Query response: **{OFF,OK,NG}**

10.6.2 COMParator:MODE

COMP:MODE sets the comparator setting mode.

Command syntax: **COMParator:MODE {UNIfied, SEParated }**
Example: Send> **COMP:MODE UNI** //Switch to unified setting mode
Query syntax: **COMP:MODE?**
Query response: **{ UNI, SEP }**

10.6.3 COMParator:LiMiT

COMP:LiMiT sets the upper/lower limits of the specified channel.
If the current setting mode is unified, just set the limits of channel 1.

Command syntax: **COMParator:LiMiT <channel No. 1~8>,<float lower limit>,<float upper limit>**
Example: Send> **COMP:LMT 1,1.2345m,12.345m** //Set the upper/lower limits of channel 1. 1.2345m~12.345mΩ
//Negative numbers are forced to 0
Query syntax: **COMP:LiMiT? <channel No. 1~8>**
Query response: <scifloat lower limit>,<scifloat upper limit>
Uses fixed-exponent rather than fixed-point scientific notation.
Exponent format:
E-03 Corresponds to unit m
E+00
E+03 Corresponds to unit k
E+06 Corresponds to unit M
Example: Send> **COMP:LMT? 1**
Return> **+1.0000E+00,+2.0000E+00**

10.7TRIGger Subsystem

Figure 10- 5 TRIGger Subsystem Tree

TRIGger	**[:IMMediate]**	
	:SOURce	**{INT,MAN,EXT,BUS}**
TRG		

TRIGger sets the trigger source and generates a trigger.

10.7.1 TRIGger[:IMMediate]

TRIG[:IMM] generates one trigger when the trigger source is set to BUS, but does not return the triggered test data. To return data, use the TRG command.

Command syntax: **TRIGger[IMMediate]**
Example: Send> **TRIG** //The instrument tests once and stops

10.7.2 TRIGger:SOURce

TRIG:SOUR sets the trigger source.

Command syntax: **TRIGger:SOURce {INT,MAN,EXT,BUS}**
Example: Send> **TRIG:SOUR BUS** //Set to bus trigger mode.
Query syntax: **TRIG:SOUR?**
Query response: **<INT,MAN,EXT,BUS>**

10.7.3 TRG

TRG generates one trigger when the trigger source is set to BUS, and returns the triggered test data.
Uses fixed-exponent rather than fixed-point scientific notation.
Exponent format:
E-03 Corresponds to unit m
E+00
E+03 Corresponds to unit k
E+06 Corresponds to unit M

Command syntax: **TRG**
Example: Send> **TRG** //The instrument tests once and returns the test data
Return>
100.05E-03,NG;
1.0000E-20,--;
1.0000E+20,NG;

1.0000E+20,NG;
1.0000E+20,NG;
1.0000E+20,NG;
1.0000E+20,NG;
1.0000E+20,NG

Note!
1.0000E-20 indicates invalid data; this value is output when a channel is turned off.
1.0000E+20 indicates open circuit or range overflow.
The actually returned data contains no line breaks; line breaks are used here for readability.

10.8FETCh? Subsystem

FETCh? acquires the test data. Before using this command, set the [Result Send] field on the <System Configuration> page to [FETCH].
The FETCh? command returns the test data of all channels.

Figure 10- 6 FETCh? Subsystem Tree

FETCh?	

Uses fixed-exponent rather than fixed-point scientific notation.
Exponent format:
E-03 Corresponds to unit m
E+00
E+03 Corresponds to unit k
E+06 Corresponds to unit M

Query syntax: **FETCh?**
Query response: **<scifloat>,{OK,NG,--};**
<scifloat>,{OK,NG,--};
<scifloat>,{OK,NG,--};
<scifloat>,{OK,NG,--};
<scifloat>,{OK,NG,--};
<scifloat>,{OK,NG,--};
<scifloat>,{OK,NG,--};
<scifloat>,{OK,NG,--}

Example: Send> **FETC?**
Return>
100.05E-03,NG;
1.0000E-20,--;
1.0000E+20,NG;
1.0000E+20,NG;
1.0000E+20,NG;
1.0000E+20,NG;
1.0000E+20,NG;
1.0000E+20,NG

Note!
1.0000E-20 indicates invalid data; this value is output when a channel is turned off.
1.0000E+20 indicates open circuit or range overflow.
The actually returned data contains no line breaks; line breaks are used here for readability.

10.9SYSTem Subsystem

The SYSTem subsystem is used to set system-related parameters.
Data set with the SYSTem subsystem will not be saved inside the instrument.

Figure 10- 7 SYSTem Subsystem Tree

SYSTem	**:LANGuage**	**{ENGLISH,CHINESE,EN,CN}**
	:SENDmode	**{FETCH,AUTO}**

10.9.1 SYSTem:LANGuage

Sets the instrument language.

Command syntax: **SYSTem:LANGuage {ENGLISH,CHINESE,EN,CN}**

Example: Send> **SYST:LANG EN** //Set to English display

Query syntax: **SYST:LANG?**

Query response: **{ENGLISH,CHINESE}**

10.9.2 SYSTem:SENDmode

SYST:SEND sets the data sending mode: automatic or the FETCH command.

Command syntax: **SYSTem:SENDmode {FETCH,AUTO}**

Example: Send> **SYST:SEND AUTO** //Set to automatic sending

Query syntax: **SYST:SEND?**

Query response: **{FETCH,AUTO}**

10.10 CORRect Subsystem

The CORR subsystem performs a short-circuit calibration.

Figure 10- 8 CORRect Subsystem Tree

CORRect	**:SHORt**	

10.10.1 CORRect:SHORt

CORR:SHOR performs a short-circuit calibration; the test terminals must be shorted before sending the command.

Command syntax: **CORRect:SHORt**

Example: Send> **CORRect:SHORt**

Return> **Short Clear Zero Start.** //Indicates zeroing has started; after about 5s, it returns when zeroing is completed

Return> ALL OK //Indicates: zeroing passed (failure: ALL FAIL)

Return> CH 1 OK. Ohters Fail //Indicates: CH 1 zeroing passed, other channels failed

10.11 IDN? Subsystem

Figure 10- 9 IDN? Subsystem Tree

IND?	

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

Query syntax: **IDN?**

Query response: **<model>,<version>,<serial no.>,<manufacturer>**

Example: Send> **IDN?**

Return> **AT51X8,REV A1.0,0000000,Applent Instruments**

11. Modbus (RTU) Communication Protocol

This chapter includes the following topics:

- Data Format — understand the Modbus communication format.
- Function
- Variable area
- Function Codes

11.1 Data Format

We comply with the Modbus (RTU) communication protocol; the instrument will respond to the commands of the host computer and return a standard response frame.

See: You can contact the sales department of our company to obtain the Onmeas communication test tool, which contains Modbus communication debugging methods. It includes a CRC-16 calculator and conversion of floating-point numbers to the Modbus floating-point format.

11.1.1 Command Frame

Figure 11- 1 Modbus Command Frame



Table 11- 1 Command Frame Description

	At least 3.5 character times of silence required
Slave address	1 byte Modbus can support 00~0x63 slaves Specified as 00 for broadcast In instruments not fitted with the RS485 option, the default slave address is 0x01
Function Codes	1 byte 0x03: Read multiple registers 0x04: =03H, not used 0x06: Write single register, can be replaced by 10H 0x08: Echo Test (used only for debugging) 0x10: Write multiple registers
Data	Specifies the register address, quantity, and content
CRC-16	2 bytes, low byte first Cyclic Redundancy Check All data from the slave address to the end of the data is calculated to obtain the CRC16 check code
	At least 3.5 character times of silence required

11.1.2 CRC-16 Calculation Method

1. Set the initial value of the CRC-16 register to 0xFFFF.
2. Perform an XOR operation on the CRC-16 register and the first byte of the message, and return the calculation 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 from the LSB is "0", repeat step (3) (process the next shift). If the bit shifted out from the LSB is "1", perform an XOR operation on the CRC register and 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 has not been fully processed, perform an XOR operation on the CRC register and the next byte of the message, return the result to the CRC register, and repeat from step (3).
7. Append the calculated result (the value of the CRC register) to the message starting from the low-order byte.

The following is a CRC calculation function written in VB:

```
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
  CH = &HA0
  For i = 0 To UBound(data)
    CRC16Lo = CRC16Lo Xor data(i) 'Each data byte is XORed with the CRC register
    For flag = 0 To 7
      SaveHi = CRC16Hi
      SaveLo = CRC16Lo
      CRC16Hi = CRC16Hi \ 2      'The high byte is shifted right by 1 bit
      CRC16Lo = CRC16Lo \ 2      'The low byte is shifted right by 1 bit
      If ((SaveHi And &H1) = &H1) Then 'If the last bit of the high byte is 1
        CRC16Lo = CRC16Lo Or &H80   'Then 1 is filled in at the front after the low byte is shifted right
      End If          'Otherwise 0 is filled in automatically
      If ((SaveLo And &H1) = &H1) Then 'If the LSB is 1, it is XORed 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      'CRC high byte
  ReturnData(1) = CRC16Lo      'CRC low byte
  CRC16 = ReturnData
End Function
```

See: Our company's "Onmeas communication test tool"" contains Modbus communication debugging methods. It includes a CRC-16 calculator.

The calculated CRC-16 data must be appended to the end of the command frame, for example: 1234H:

Figure 11-2 Modbus Appended CRC-16 Value



11.1.3 Response Frame

Unless it is a command broadcast with the slave address 00H, the instrument will return a response frame for any other slave address.

Figure 11-3 Normal Response Frame

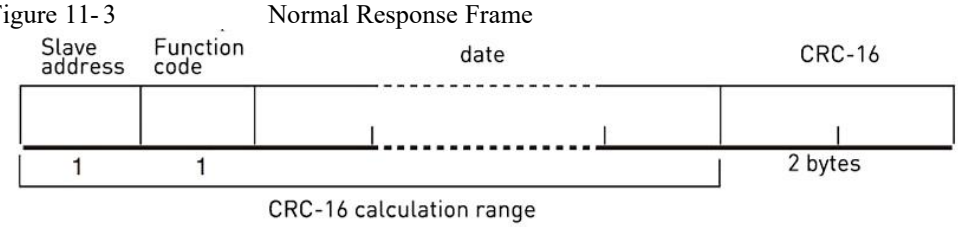


Figure 11- 4 Exception Response Frame

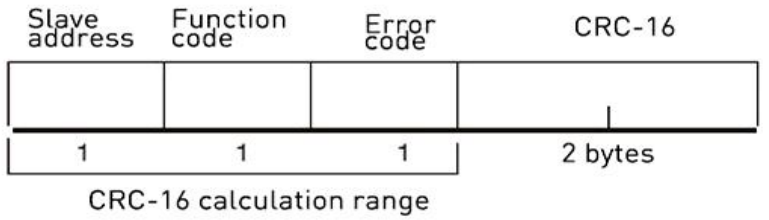


Table 11- 2 Exception Response Frame Description

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

11.1.4 No Response

In the following cases, the instrument will not perform any processing and will not respond, resulting in a communication timeout.

1. Slave address error
2. Transmission error
3. CRC-16 error
4. Digit count error, for example: the total digit count for function code 0x03 must be 8, while the received count is less than 8 or greater than 8 bytes.
5. When the slave address is 0x00, it represents the broadcast address and the instrument does not respond.

11.1.5 Error Codes

Table 11- 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

11.2 Function Codes

The instrument supports only the following function codes; for other function codes, an error frame will be returned.

Table 11- 4 Function Codes

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

11.3 Registers

The register size of the instrument is in 2-byte mode; that is, 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

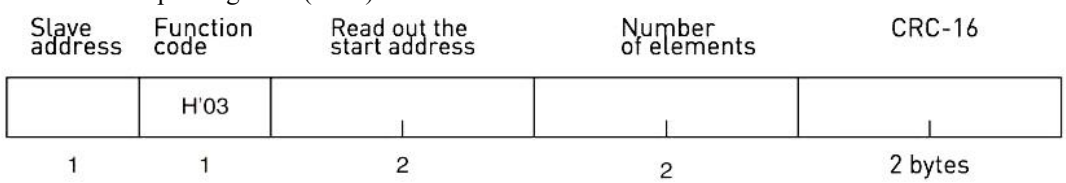
Data:
The instrument supports the following types of values:

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

Reference: Our company's "Onmeas communication test tool"" contains Modbus communication debugging methods. It includes a floating-point converter.

11.4 Read Multiple Registers

Figure 11- 5 Read Multiple Registers (0x03)

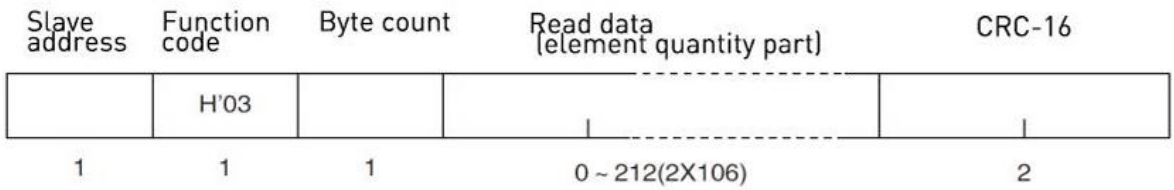


The function code for reading multiple registers is 0x03.

Table 11- 5 Read Multiple Registers

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

Figure 11- 6 Read Multiple Registers (0x03) Response Frame



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

11.5 Write Multiple Registers

Figure 11- 7 Write Multiple Registers (0x10)

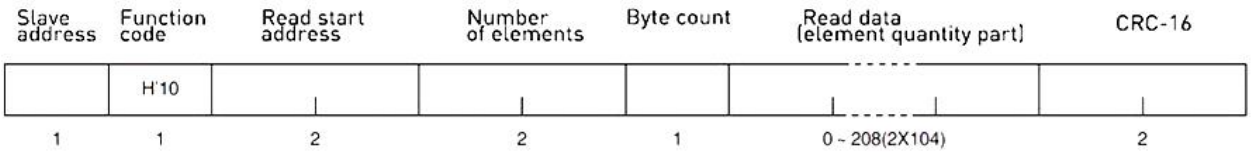
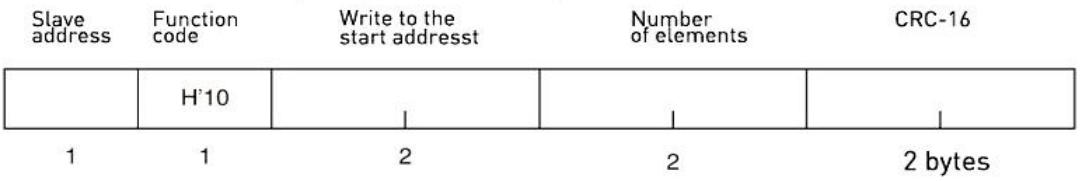


Table 11- 6 Write Multiple Registers

Name	Name	Description
	Slave address	When no RS485 address is specified, the default is 01
0x10	Function Codes	
	Starting address	Starting register address, refer to the Modbus command set
	Number of registers to write 0001~0068 (104)	Number of registers to read consecutively. Refer to the Modbus command set to ensure that all these register addresses exist; otherwise, an error frame will be returned.
	Number of bytes	= number of registers x 2
CRC-16	Check Code	

Figure 11- 10 Write Multiple Registers (0x03) Response Frame

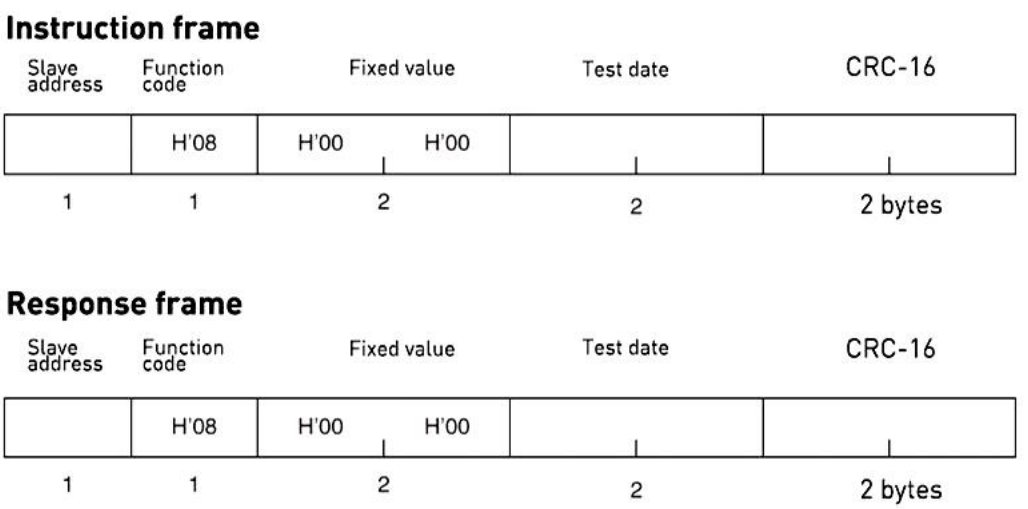


Name	Name	Description
	Slave address	Returned as is
0x10 or 0x90	Function Codes	No exception: 0x10 Error code: 0x90
	Starting address	
	No. of Registers	
	CRC-16 Check Code	

11.6Echo Test

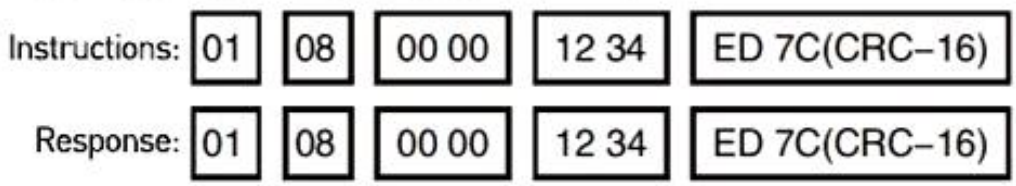
The function code of the Echo Test is 0x08, which is used for debugging Modbus.

Figure 11- 9 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:



12. Modbus (RTU) Command Set

This chapter includes the following topics:

- Register Address

Reference: Be sure to contact the sales department of our company to obtain the Onmeas instrument communication test tool, which contains Modbus communication debugging methods. It includes a CRC-16 calculator and conversion of floating-point numbers to the Modbus floating-point format.

Note: Unless otherwise specified, the values in the command and response frames below are hexadecimal.

12.1 Register Overview

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

Table 12- 1 Register Overview

Register Address	Name	Numeric value	Description
2000	Read channel 1 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
2002	Read channel 2 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
2004	Read channel 3 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
2006	Read channel 4 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
2008	Read channel 5 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
200A	Read channel 6 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
200C	Read channel 7 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
200E	Read channel 8 measurement result	4-byte floating-point number	Read-only, data occupies 2 registers
2100	Comparator result	4-byte integer	Read-only, data occupies 2 registers
2200	Read channel 1 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register
2201	Read channel 2 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register
2202	Read channel 3 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register
2203	Read channel 4 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register
2004	Read channel 5 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register

2005	Read channel 6 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register
2006	Read channel 7 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register
2007	Read channel 8 measurement result, integer value	2-byte integer	Read-only, data occupies 1 register
0000	Read the instrument version number	4-byte integer	Read-only, data occupies 2 registers
3000	Range number	0000~0007	Read/Write register, 2-byte integer
3002	Test Speed	0000: Slow 0001: Medium 0002: Fast	Read/Write register, 2-byte integer
3005	System Language	0000: English 0001: Simplified Chinese	Read/Write register, 2-byte integer
3006	Beeper	0000: Off 0001: PASS beep 0002: FAIL beep	Read/Write register, 2-byte integer
3101	Comparator mode	0000: ABS 0001: PER 0002: SEQ	Read/Write register, 2-byte integer
3102	Nominal value	4-byte floating-point number	Read/Write register, data occupies 2 registers
3110	CH1 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3112	CH1 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3114	CH2 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3116	CH2 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3118	CH3 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
311A	CH3 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
311C	CH4 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
311E	CH4 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3120	CH5 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3122	CH5 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3124	CH6 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3126	CH6 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3128	CH7 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
312A	CH7 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
312C	CH8 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
312E	CH8 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3130	CH9 lower limit	4-byte floating-point number	Read/Write register, data occupies 2

			registers
3132	CH9 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3134	CH10 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3136	CH10 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3138	CH11 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
313A	CH11 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
313C	CH12 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
313E	CH12 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3140	CH13 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3142	CH13 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3144	CH14 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3146	CH14 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3148	CH15 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
314A	CH15 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
314C	CH16 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
314E	CH16 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3150	CH17 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3152	CH17 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3154	CH18 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3156	CH18 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3158	CH19 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
315A	CH19 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
315C	CH20 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
315E	CH20 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3201	CH1 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3202	CH2 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3203	CH3 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3204	CH4 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3205	CH5 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3206	CH6 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3207	CH7 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3208	CH8 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
3209	CH9 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes
320A	CH10 switch, 0: off, 1: on	2-byte integer	Write-only register, data 2 bytes

4000	Save settings to the current file	Fixed value: 0001	Write-only register, data 2 bytes
4001	Read the current file data	Fixed value: 0001	Write-only register, data 2 bytes
4002	Save settings to the specified file	0000~0009	Write-only register, data 2 bytes
4003	Read the specified file data	0000~0009	Write-only register, data 2 bytes
5000	Execute zeroing register Read the zeroing status	Write fixed value: 0001 Read: 0001 Zeroing in progress 0000 Zeroing succeeded FFFF Zeroing failed	Read/Write register, data occupies 1 register Once the zeroing function has been executed, Modbus will disable the execution of write commands and only allow reading registers.
5020	Trigger once in remote mode	Write value: 0000	Valid only under remote trigger

12.2 Acquiring Measurement Data

12.2.1 Acquiring Measurement Results

Registers 2000~2026 are used to acquire the instrument measurement data.
Example: acquire the measurement data of channel 1
Command:

1	2	3	4	5	6	7	8
01	03	2000		0002		CRC-16	
Slave	Read	Registers		No. of Registers		Check Code	

Response

1	2	3	4	5	6	7	8	9
01	03	Bytes	Single-precision floating-point number				CRC-16	

- **Acquiring the measurement data of channel 1:**

Send:

1	2	3	4	5	6	7	8
01	03	20	00	00	02	CF	CB

Response:

1	2	3	4	5	6	7	8	9
01	03	04	**78**	**EC**	**60**	**AD**	CA	DB

To make it easy for a PLC to convert directly to the actual value, the returned floating-point format is CDAB; manual conversion requires reordering to ABCD:
For example: 78 EC 60 AD => 60 AD 78 EC
IEEE754 single-precision floating-point format: 60AD78EC = decimal 1E20

12.2.2 Acquiring the Comparator Result [2100]

The register stores the OK/NG status of each channel bit by bit: 1=NG, 0=OK
For example: 000FFFFE
32-bit storage field:
0000 0000 0000 0000 0000 0000 0000
Here: BIT0 = 0 means channel 1 is OK
Send:

1	2	3	4	5	6	7	8
01	03	21	00	00	02	CE	37

Response:

1	2	3	4	5	6	7	8	9
01	03	04	00	00	00	FF	BA	73

B0~B7 correspond to the comparator results of CH1~CH8

12.2.3 Acquiring Measurement Results (16-bit Integer Values)

Registers 2200~2207 acquire the instrument measurement data; the data format is a 16-bit integer.
Example: acquire the measurement data of channel 1
Command:

1	2	3	4	5	6	7	8
01	03	2200		0001		CRC-16	
Slave	Read	Registers		No. of Registers		Check Code	

Response

1	2	3	4	5	8	9
01	03	Bytes	Integer		CRC-16	

- **Acquiring the measurement data of channel 1:**

Send:

1	2	3	4	5	6	7	8
01	03	22	00	00	01	8E	72

Response:

1	2	3	4	5	6	7
01	03	04	**27**	**10**		

Return value: 0x2710 =>10000

Range	Decimal position	Unit	e.g. 0x2710 (10000)
30mΩ	3	mΩ	=10.000mΩ
300mΩ	2	mΩ	=100.00mΩ
3Ω	4	Ω	=1.0000Ω
30Ω	3	Ω	=10.000Ω
300Ω	2	Ω	=100.00Ω
3kΩ	4	kΩ	=1.0000kΩ
30kΩ	3	kΩ	=10.000kΩ

12.3 Parameter Settings

12.3.1 Speed [3002]

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	30	02	00	01	02	00	01	56	71
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	10	30	02	00	01	AF	09
		Registers		No. of Registers		CRC	

Read

1	2	3	4	5	6	7	8
01	03	30	02	00	01	2A	CA
	Read	Registers		No. of Registers		CRC	

Response:

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

where
0000 Slow
0001 Medium
0002 Fast

12.4Comparator Settings

The comparator parameter register addresses start from 3100.

12.4.1 Limit Values [3110]

The channel limit values start from 3110: the lower limit uses 2 registers, the upper limit uses 2 registers, 4 registers in total.
The lower limit and upper limit can be set separately or at the same time.

Write

Lower limit: 1E-3 = 3A 83 12 6F
Upper limit: 10E-3 = 3C 23 D7 0A

Send: 01 10 31 10 00 04 08 **3A 83 12 6F** **3C 23 D7 0A** F0 41
Response: 01 10 31 10 00 04 CE F3

Read

Send: 01 03 3110 0004 4B30
Response: 01 03 08 **3A 83 12 6F** **3C 23 D7 0A** 51 62

12.5 Setting Channels [3201]

Each channel can be turned on or off independently via registers.
To turn off channel 1, write 0 to register 3201
To turn on channel 1, write 1 to register 3201

Write

Channel 1 off
Send: 01 10 32 01 00 01 02 00 00 B4 42
Response: 01 10 32 01 00 01 5E B1
Channel 1 on:
Send: 01 10 32 01 00 01 02 00 01 75 82
Response: 01 10 32 01 00 01 5E B1

13. Specifications

You will learn about the following:

- Technical specifications
- General specifications
- Dimensions

13.1 Technical Specifications

The following data are measured under the following conditions:
Temperature condition: 23℃±5℃
Humidity condition: ≤65% R.H.
Zero adjustment: short-circuit zeroing before testing
Warm-up time: >60 minutes
Calibration interval: 12 months
Channel: CH1
Test speed: slow
Test current accuracy: 0.01%

Range		Max. display	Resolution	Ultra-fast	Fast	Medium/S low	Test current	Open-circuit voltage
1	**300mΩ**	300.00mΩ	10μΩ	0.5%±10 counts	0.1%±5 counts	0.05%±2 counts	100mA	<1V
2	**3Ω**	3.0000Ω	100μΩ	0.5%±10 counts	0.1%±5 counts	0.05%±2 counts	100mA	<1V
3	**30Ω**	30.000Ω	1mΩ	0.5%±10 counts	0.1%±5 counts	0.05%±2 counts	10mA	<1V
4	**300Ω**	300.00Ω	10mΩ	0.5%±10 counts	0.1%±5 counts	0.05%±2 counts	1mA	<5V
5	**3kΩ**	3.000kΩ	100mΩ	0.5%±10 counts	0.1%±5 counts	0.05%±2 counts	100μA	<5V
6	**30kΩ**	30.000kΩ	1Ω	0.5%±20 counts	0.1%±10 counts	0.05%±5 counts	10μA	<5V

13.2 General Specifications

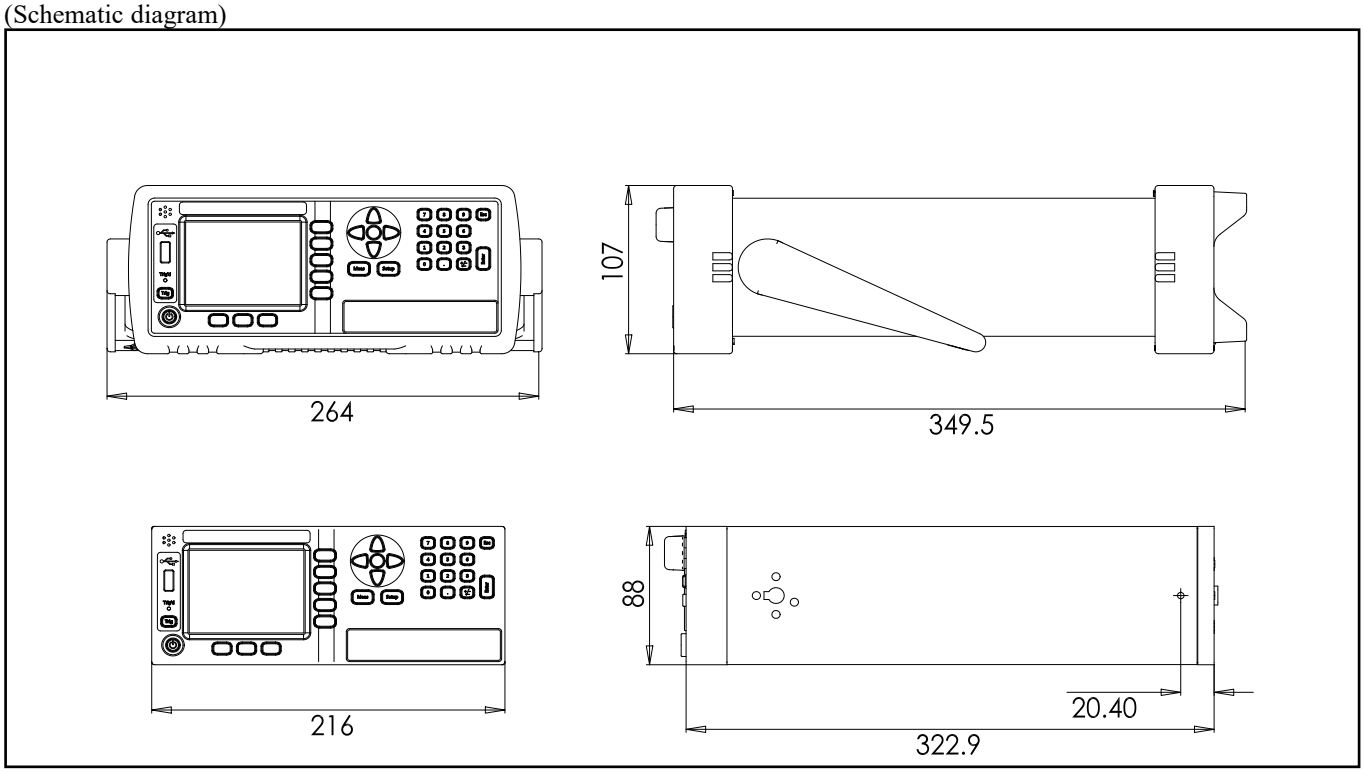
Screen: TFT-LCD true-color display, 3.5-inch screen.
Test speed: All channels on, in manual ranging mode:
Slow: 330ms/8 channels
Medium: 90ms/8 channels
Fast: 50ms/8 channels
Max. reading: 30000
Ranging mode: Manual
Calibration: Short-circuit zeroing over the full range
File: Settings saved automatically
Beeper: Off, pass, fail.
Trigger: Internal, external, manual, and remote trigger.
Interfaces: Handler interface
RS232 interface
Temperature compensation interface
Programming language: SCPI
Auxiliary function: keyboard lock

Environment: Specification: 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: 250V 1A slow-blow
Power consumption: Max. 20VA
Weight: Approx. 5 kg.

13.3 Dimensions

(Schematic diagram)



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