ONMEAS®

Rev.A1

AT2513

Resistance Meter



User's Guide

Scan QR code for operation video

Safety Precautions



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, fire or a potential electric shock hazard to the operator may result.

- 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



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 instrument you purchase is fully compliant in terms of quality and metrology. This warranty does not cover the fuse, nor damage caused by negligence, misuse, contamination, accident, or abnormal conditions of use. This warranty applies only to the original purchaser and is not transferable.

From the date of shipment, Onmeas provides one year of free warranty; this warranty also covers VFD or LCD. During the 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 the product is found to be damaged, please contact Onmeas to obtain approval and information for return or replacement. Then send the product to the dealer for return or replacement. Be sure to state the cause of the damage, and prepay the postage and the insurance to the destination. For the repair or replacement of a product within the warranty period, Onmeas will be responsible for the return shipping costs. For the repair of a product not covered by the warranty, Onmeas will provide an estimate of the repair costs, and the repair will be performed only after your consent has been obtained; all costs arising from the repair shall be borne by the user, including the return shipping costs.

This warranty is the sole warranty provided by Onmeas and constitutes your sole and exclusive remedy; apart from this, there are no other warranties, express or implied (including fitness for a particular purpose), and all other warranties are expressly disclaimed. Neither Onmeas nor any other dealer has made any oral or written representation to establish a warranty or to expand the scope of this warranty in any way. Onmeas shall not be liable for any special, indirect, incidental, or consequential damage or loss (including loss of data) arising from any cause outside the specifications. If any provision of this warranty conflicts with local laws and regulations, the local laws and regulations shall prevail, and therefore that provision may not apply to you; however, the determination of that provision shall not affect the validity and enforceability of the other provisions.

People's Republic of China
Jiangsu Province
Onmeas Ltd.
May 2014
Rev.C0

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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 AT2513 can only be used under the following power conditions:
Voltage: 100-240VAC
Frequency: 50Hz/60Hz

! 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 AT2513 must be used under the following environmental conditions:
Temperature: 0°C~40°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 dampened with a little clean water to clean the enclosure and panel.
Do not clean the inside 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)



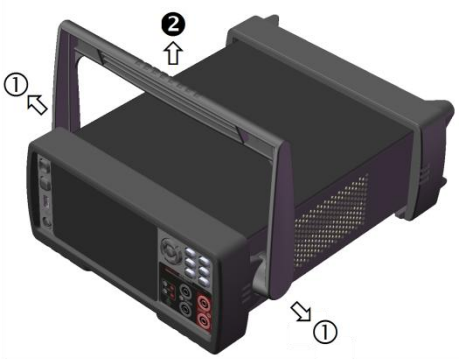
Viewing position 1 [Hold both sides of the handle with both hands and pull it gently outward until it can rotate freely, then switch to viewing position 2]



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



Handle removal position. (Pull outward at ① on both sides until the handle can be removed, then pull it out upward at ②.)

2. Overview

In this chapter you will learn the following:

- Introduction
- Main Features

2.1 Introduction

Thank you for purchasing the AT2513 resistance tester.

The AT2513 series resistance tester is a micro bench-top instrument for fully automatic real-time testing, controlled by a high-performance ARM microprocessor.
The instrument provides up to 0.02% basic accuracy and a measurement range of 0.01μΩ~300Ω. The resistance value is displayed with 6 digits, providing 300,000 counts, and the measurement speed reaches 10 readings/second.

The instrument has a built-in comparator, and the comparator results can be output through the Handler interface.

The instrument comes standard with an RS-232 interface and communicates with computers, PLCs or WINCE devices using SCPI (Standard Command for Programmable Instrument) and the Modbus RTU protocol, efficiently accomplishing remote control and data acquisition.

The instrument comes standard with a LAN interface, which can simplify communication between the computer and the instrument.

The instrument comes standard with an RS-485 interface supporting the Modbus RTU protocol, making communication with PLCs very convenient.

For complete technical specifications, refer to the Specifications chapter.

2.2 Main Features

2.2.1 Range

The AT2513 uses 6 ranges for testing
Auto, manual and nominal ranging.
Nominal range (a new term defined by Onmeas): the instrument automatically selects the optimal range according to the nominal value.

2.2.2 Test Speed

The instrument provides two speed settings: slow and fast.
In manual ranging mode:
Slow: 1 reading/second
Fast: 10 readings/second

2.2.3 Trigger Mode

Internal trigger,
External trigger

2.2.4 Basic Accuracy

Slow: 0.02%
Fast: 0.05%

2.2.5 Comparator Function (Sorting Function)

The AT2513 has 1 group of comparator functions

Comparison mode:

Absolute tolerance ±TOL sorting: the absolute deviation of the measured value from the nominal value is compared with the limits of each bin.

Percentage tolerance ±TOL sorting: the percentage deviation of the measured value from the nominal value is compared with the bin limits.

Sequential comparison sorting: the measured value is compared directly with the upper and lower limits

2.2.6 System Settings

Keyboard lock function

2.2.7 Interfaces

RS-232/RS-485 remote control:

Supports a maximum baud rate of 115200bps, is compatible with the SCPI protocol, and supports ASCII transmission.

LAN remote control

100M Ethernet port.

Handler interface

Input/output ports with full optocoupler isolation and built-in pull-up resistors.

Supports internal 5V and 24V external power.

Input: trigger signal,

Output: HI/LO, OK/NG outputs; 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 instrument 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- 1Front Panel

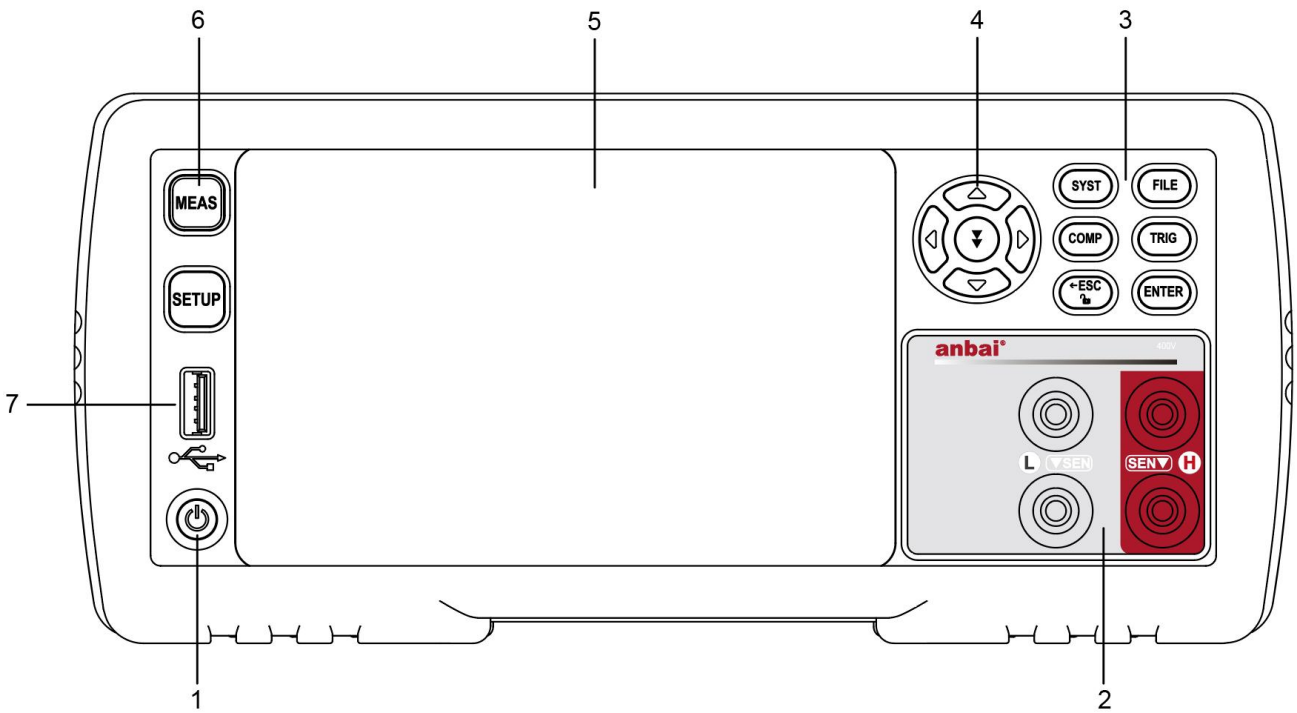
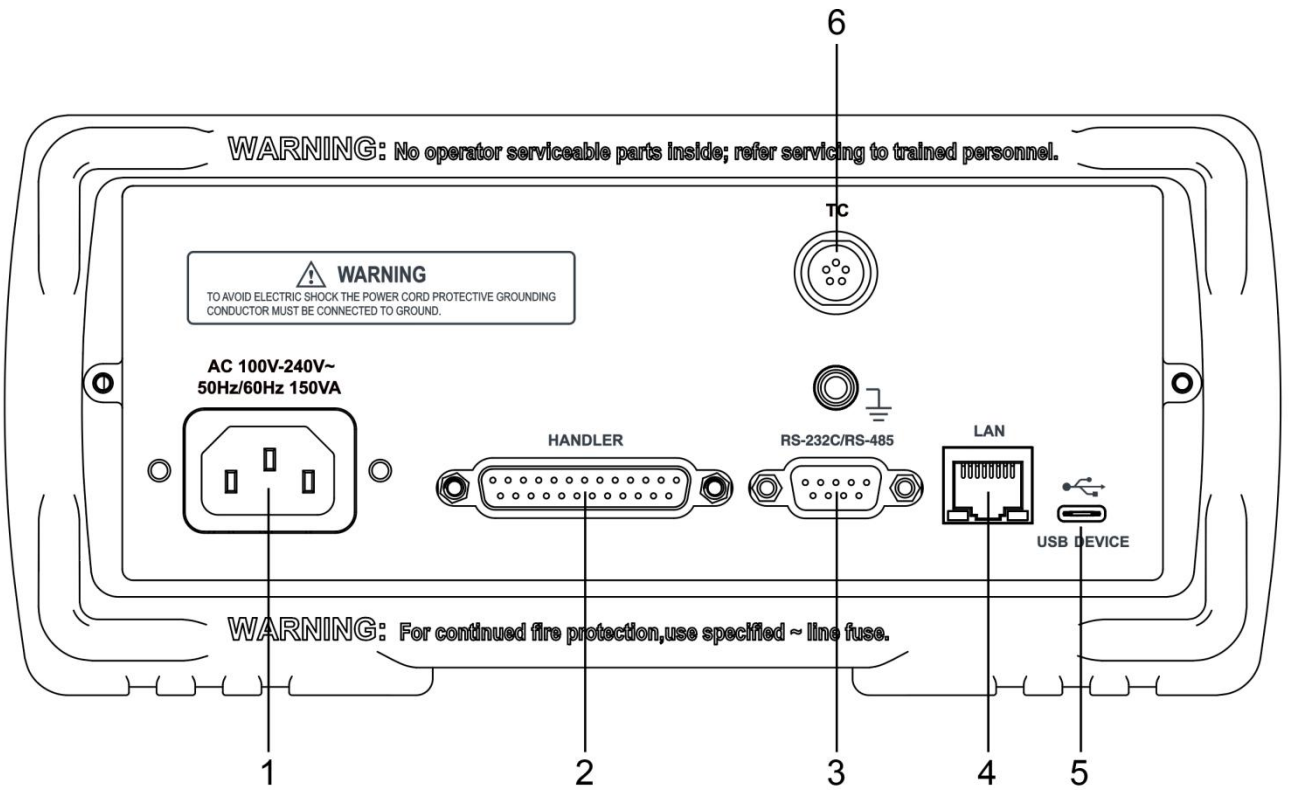


Table 3- 1 Front Panel Function Description

No.	Function
1	Power switch (tact switch; orange for standby, green for operating)
2	Test terminals
3	Page shortcut keys, including SYST (System), FILE (File), COMP (Comparator), keyboard lock, etc.
4	Cursor keys
5	5-inch TFT-LCD with capacitive touch screen
6	Main page shortcut keys: MEAS (Measure) and SETUP (Setup)
7	USB drive interface

3.1.2 Getting to Know the Rear Panel

Figure 3- 2Rear Panel



1. Power socket (fuse not included; the fuse is inside the instrument).
2. HANDLER interface
3. RS-232C/RS-485 interface
4. LAN interface
5. USB-VCOM (TYPE-C) interface (for internal debugging; generally not used as a communication interface; please specify in advance if needed)
6. TC temperature sensor interface

3.2 Power-On Startup

3.2.1 Powering On

The key marked “+” at the lower left of the panel is the power switch.
Orange indicator: powered off
Green indicator: powered on

3.2.2 Warm-up

Warm-up time: to achieve the specified accuracy, the instrument needs to warm up for at least 15 minutes.

3.3 Connecting the Test Terminals

If you use the supplied “Kelvin” test clips for testing, connect them to the instrument test terminals as follows.

Insert the test cable marked *red* into the + terminal; make sure the Drive and Sense marks correspond one to one;
Insert the test cable marked *black* into the - terminal; make sure the Drive and Sense marks

correspond one to one.
The red cable is the high terminal of the test.
The black cable is the low terminal of the test.



! To ensure the accuracy the instrument can achieve, use the supplied “Kelvin” test clips for testing. 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 [Measurement Display] page.

<Measure Display>This page primarily highlights the measurement result, and also displays the current sorting result in small characters.
The following 4 frequently used functions can be set on this page:

- Trigger – trigger mode
- Range – test range
- Speed – test speed
- Current mode – pulse or forward/reverse

Figure 4- 1 <Measure Display> Page



4.1.1 [Trigger] Mode

Communication command: TRIGger:SOURce {INT,EXT}
The instrument has 2 trigger modes:
Internal trigger and external 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.
External	External triggering includes 3 trigger methods: 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. Upon receiving a trigger command via RS232 or another communication interface, the instrument executes one measurement cycle; at other times it is in a waiting state. The TRIG key on the panel: each press executes one measurement cycle.

■ 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
External	External trigger mode

4.1.2 [Range]

Communication command:
FUNCtion:RANGe {<Range No.>,min,max}
FUNCtion:RANGe:MODE {AUTO,HOLD,NOMinal}
The AT2513 has 6 ranges. The variation range of each range is as follows:

Table 4- 1 AT2513 Range Variation Range

Range number	Range	Test current	Measuring range	Up range	Down range
0	3mΩ	10A	0.00000mΩ~3.20000mΩ	min range 3mΩ ↓ 30mΩ ↓ 300mΩ ↓ 3Ω ↓ 30Ω ↓ max range	min range 2.8mΩ ↑ 28mΩ ↑ 280mΩ ↑ 2.8Ω ↑ 28Ω ↑ max range
1	30mΩ	1A	3.0000mΩ~32.0000mΩ		
2	300mΩ	100mA	30.000mΩ~320.000mΩ		
3	3Ω	100mA	0.30000Ω~3.20000Ω		
4	30Ω	10mA	3.0000Ω~32.0000Ω		
5	300Ω	1mA	30.000Ω~320.000Ω		

There are 3 ranging modes:

Table 4- 2 Test Range Description

Range mode	Description	Advantage	Disadvantage
Auto	The instrument automatically selects the optimum test range according to the impedance value, and the range number in the range field is set automatically.	No user intervention is required	Auto ranging needs to predict the range, so the test speed is lower than in manual ranging mode.
Manual	The instrument always uses the range specified by the user for testing	The test speed is the fastest.	The user needs to participate in range selection
Nominal	Nominal ranging mode has 2 ways of selecting the range: 1. In SEQ comparison, the instrument selects the best range according to the**maximum upper limit** of all enabled bin comparators. 2. In Δ and Δ% comparison, the instrument selects the best range according to the**Nominal value** automatically for testing.	The best mode for sorting tests. The speed is the fastest.	Only suitable for sorting tests.

■ Steps for setting the range:

Step 1 Press the [Meas] key to enter the measurement page or 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
Auto	The instrument will select the range automatically
Manual	The instrument is locked on the current range
Nominal	The instrument will select the optimum range according to the nominal value
Increase +	Increases the range number, and the range is changed to lock
Decrease -	Decreases the range number, and the range is changed to lock

i In auto range, the instrument performs range prediction in every measurement cycle, so the test speed is slightly slower than with lock range. Moreover, during automatic measurement, frequent range changes slow down the response. Usually, when the instrument is used for sorting measurement, the auto range mode is not suitable.

Users performing sorting should select the nominal range mode.

4.1.3 Test [Speed]

Communication command: FUNCtion:RATE {SLOW,FAST}

The instrument provides 2 test speeds (slow and fast). The slower the speed, the more accurate and stable the test results.

Sampling times in manual ranging mode are as follows:

Slow: 1 reading/second

Fast: 10 readings/second

■ Steps for setting the test speed:

Step 1 Press the [Meas] key to enter the measurement page or [Setup] to enter the settings page;

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

Step 3 Use the soft keys to select

Soft key	Function
Slow	
Fast	

4.1.4 [Current Mode]

Current modes are the pulse mode and the forward/reverse mode.

When different metals contact each other, a thermoelectromotive force forms on the contact surface and grows as the temperature of the contact increases. Enabling pulse testing or the forward/reverse mode can effectively remove the thermoelectromotive force formed on the contact surface.

Only suitable for resistance testing of components with almost no inductance! For inductive devices, use the AT517 series.

Pulse testing is suitable for continuous observation of high-accuracy, low-resistance targets; its heat generation is far lower than forward/reverse testing and conventional continuous-current testing.

■ Steps for selecting the current mode:

Step 1 Press the [Meas] key to enter the measurement page or [Setup] to enter the settings page;

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

Step 3 Use the soft keys to select

Soft key	Function
Pulse	Current flows from the positive test lead to the negative test lead for about 50ms, then drops to zero for about 950ms (slow)
Forward/Reverse	In one test cycle, current first flows from the positive test lead to the negative test lead, and then from the negative test lead back to the positive test lead

i In fast pulse mode, current flows forward for about 50ms and drops to zero for about 50ms; the heat generation is only half of that of forward/reverse testing.
Neither the pulse mode nor the forward/reverse mode requires short-circuit zeroing.

5. [RES] Resistivity Page

5.1 <Resistivity> Page

On the Meas screen, press the Resistivity key to enter the [Resistivity] page.

<Resistivity>page mainly highlights the calculated results: the resistance measurement data is acquired and then converted into resistivity.
The following 4 frequently used functions can be set on this page:

- Upper limit – upper limit of the measured resistance
- Lower limit – lower limit of the measured resistance
- Cross-section area – set by the user according to the device under test
- Length – set by the user according to the device under test

Figure 5- 1 <Resistivity> Page



6. [Setup] Page

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

- Measurement Settings
- Temperature Compensation Settings
- Comparator Settings

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

6.1 Measurement Settings

All settings related to measurement are performed on the <Setup> page.
On the <Settings> page, the instrument does not perform testing.
These settings include the following parameters:

- Trigger – trigger mode
- Comparator – turn the comparator on/off
- Beeper settings
- 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

The [Trigger], [Range] and [Speed] settings can also be made on the <Measurement Display> page.
For setting these parameters, refer to the [Meas] Measurement Main Page chapter.

Figure 6- 1 <Settings> Page



6.1.1 [Temperature Compensation]

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:

$$R0 = R1 \cdot [1 + \alpha \cdot (T0 - T1)]$$

T0 - Reference temperature

T1 - Current measured room temperature

α - Temperature coefficient at reference temperature T0

R1 - Uncompensated value (measured value)

R0 - Temperature-compensated value (displayed value)

Example:
Given: at 30℃ the measured value R1=104Ω and the temperature coefficient α=3930ppm, then the resistance value at 20℃ is:

$$R0 = R1 \cdot [1 + \alpha \cdot (T0 - T1)] = 104 \cdot [1 + 3930 \cdot 1e^{-6} \cdot (20 - 30)] = 99.9128\Omega$$

■ Steps for turning on temperature compensation:

Step 1 Press the [Setup] key;
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

6.1.2 [Temperature Coefficient]

Temperature compensation requires setting the temperature coefficient of the material.

■ Steps for entering the temperature coefficient:

Step 1 Press the [Setup] key;
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 ppm.
For example, the temperature coefficient of copper is 3930ppm; enter 3930 here.

6.1.3 [Reference Temperature]

The reference temperature for temperature compensation. The measurement result reflects the value at this temperature.

■ Steps for entering the reference temperature:

Step 1 Press the [Setup] key;
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.

6.2 Comparator Settings

Press the [Setup] key, then press the [Comparator Settings] soft key to open the <Comparator Settings> page.
The AT2513 has a 1-bin comparator (a multi-bin comparator can be customized if required)

To make full use of the comparator, a Handler interface is built in to output the bin comparison results to a PLC or an industrial computer.
On the <Comparator> page, you can set the following:

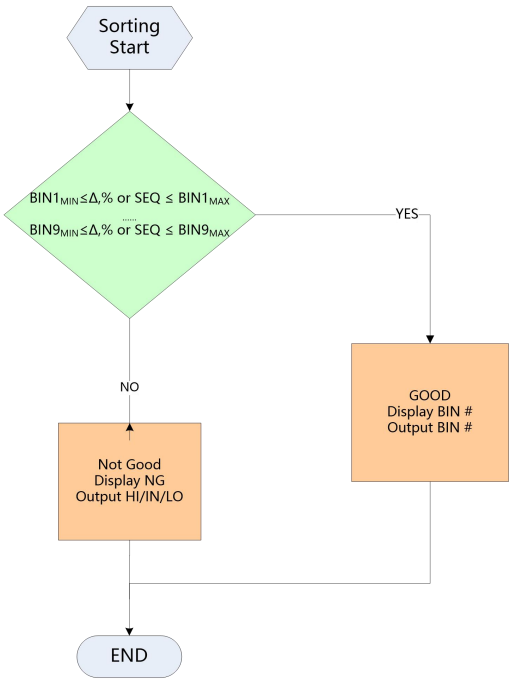
- [Comparator] Switch
- [Comparison] mode setting
- [Nominal Value] Setting
- Enter the [Upper Limit] and [Lower Limit] data for each bin

Figure 6- 2 <Comparator Settings> Page



6.2.1 Sorting Process

Figure 6- 3 Sorting Process



6.2.2 [Comparator] Switch

Communication command: COMParator[:STATe] {OFF,#-BIN}

■ Steps for turning the comparator on or off:

Step 1 Press the [Meas] or [Setup] key to enter the corresponding page;

Step 2 Press the [Comparator Settings] key to enter the <Comparator Settings> page;

Step 3 Use the cursor keys to select the [Comparator] field;

Step 4 Use the soft keys to select

Soft key	Function
Off	Turns off the comparator
On	Turns on the comparator

6.2.3 Comparison [Mode]

Communication command: COMParator:MODE {ABS,PER,SEQ}

The built-in comparator of the instrument has three comparison modes:

- Absolute value Δ
- Relative value Δ%
- Direct reading SEQ

Absolute value Δ = measured value – nominal value

Percentage Δ% = (measured value - nominal value) / nominal value × 100%

Direct-reading SEQ comparison compares the direct-reading measured value with the bin upper/lower limit range, so the nominal value does not participate in the calculation.

■ Steps for setting the comparison 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
Absolute value Δ	Switches the comparator to the absolute comparison mode
Relative value Δ%	Switches the comparator to the percent comparison mode
Direct reading SEQ	Switches the comparator to the direct reading comparison mode

6.2.4 [Nominal Value] Entry

Communication command: COMParator:NOMinal <float>

The nominal value must be entered for the absolute-value and relative-value comparison modes. In direct-reading comparison mode, the nominal value does not participate in the calculation.

In [Nominal] ranging mode, absolute value comparison and relative value comparison modes: the nominal value participates in range selection, so in [Nominal] ranging the correct nominal value must be entered.

■ Enter the nominal value:

Step 1 Enter the <Comparator Settings> page
Step 2 Use the cursor keys to select the [Nominal Value] field;
Step 3 Enter data with the numeric keys, and select the unit with the soft keys.

6.2.5 [Beeper] Settings

Communication command: COMParator:BEEP {OFF,PASS(OK),FAIL(NG)}

The instrument can be set to a PASS beep or a FAIL beep.

■ Setting the beeper:

Step 1 Enter the <Comparator Settings> page
Step 2 Use the cursor keys to select the [Beeper] field;
Step 3 Use the soft keys to select

Soft key	Function
Off	Beeper off
PASS	PASS beep
FAIL	FAIL option

i WHEN THE INSTRUMENT OVERRANGES OR THE CIRCUIT IS OPEN, THE BEEPER WILL NOT WORK.

6.2.6 [Lower Limit] and [Upper Limit] Settings

Command format: COMParator:BIN <bin No. 1~6>,<float lower limit>,<float upper limit> (customized version)

Command format: COMParator:BIN <float lower limit>,<float upper limit> (AT2513)

Each comparison mode has independent upper/lower limit values without mutual interference.
For the “absolute value Δ” comparison mode, enter the absolute value of the main parameter, in ohms (Ω).
For the “relative value Δ%” comparison mode, enter the relative value of the main parameter, in %.
For the “direct-reading SEQ” comparison mode, enter the direct-reading value of the main parameter, 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
Relative value Δ% mode requires no unit multiplier selection; enter the percentage value.
Absolute value Δ and direct-reading SEQ modes: 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 (For the multi-bin version, repeat steps 2~5 to complete the data entry for the other bins.)

i The instrument provides independent storage space for the three comparison modes, so the comparator data under each comparison mode is independent of the others.

7. File Management

Press the [File] soft key at the bottom to enter the <File Management> page.
File Management allows the user to save settings into 10 files, convenient for loading at power-on or when changing the device under test.

On the <File Management> page, you can set the following:

- [Power-On File] – specifies the file loaded at power-on
- [Auto Save] – modified parameters are saved to the current file in real time
- [File] – save, load or delete files.

Figure 7- 1 <File Management> Page



7.1.1 [Power-On File]

The Power-On File option specifies the file loaded at power-on.

■ Steps for setting the power-on file:

Step 1 Enter the <File Management> page
Step 2 Use the cursor keys to select the [Power-on Recall] field;
Step 3 Use the soft keys to select

Soft key	Function
File 0	Loads the settings of File 0 at power-on
Current File	Loads the settings of the current file number at power-on

7.1.2 [Auto Save]

When Auto Save is allowed, the parameters set by the user are saved to the current file automatically.

■ Steps for setting Auto Save:

Step 1 Enter the <File Management> page
Step 2 Use the cursor keys to select the [Auto Save] field;
Step 3 Use the soft keys to select

Soft key	Function
Allow	The parameters set by the user are saved to the current file automatically
Forbid	The parameters set by the user can only be saved to the file manually; otherwise they will be lost at the next power-on.

7.1.3 [File 0]~[File 9]

The user can specify 10 files (0~9) for saving, loading and deleting.

■ Steps for setting the files:

Step 1 Enter the <File Management> page
Step 2 Use the cursor keys to select the [File 0]~[File 9] field;
Step 3 Use the soft keys to select

Soft key	Function
Save	Saves all settings to the current file
Read	Reads the file parameters into the system

Delete	The file data will be deleted

7.2 USB Disk Storage

Press the [Setup] key, then press the [USB Disk Storage] soft key to enter the <USB Disk Storage> page.

Instrument

- [Auto Enable] – when a USB disk is inserted, the file opens automatically and storage starts
- [File] – create a new file
- [Resistance Unit] – unit of the measurement data stored in the file

Figure 7- 2 <USB Disk Storage> Page



7.2.1 [Auto Enable]

When [Auto Enable] is on, each time a USB disk is inserted the instrument checks whether the most recently used file exists on the disk; if so, the file opens automatically and is used for logging.

■ Steps for enabling [Auto Enable]:

Step 1 Enter the <USB Disk Storage> page

Step 2 Use the cursor keys to select the [Auto Enable] field

Step 3 Use the soft keys to select

Soft key	Function
On	
Off	

7.2.2 Creating a [New File]

The [New File] field creates a new file on the USB disk; the file name is defined by the user. The file format is fixed as CSV.

■ Steps for creating a [New File]:

Step 1 Enter the <USB Disk Storage> page

Step 2 Use the cursor keys to select the [File] field

Step 3 Use the soft keys to select

Soft key	Function
Create file	A character keyboard will pop up; enter a custom file name. After entering, press the [OK] soft key to create a new file; the file name will appear in the list.

7.2.3 [Resistance Unit] Selection

Since the measurement value units span a wide range, the storage data unit can be preset for the user's convenience in later data processing.

■ Steps for setting the [Resistance Unit]:

Step 1 Enter the <USB Disk Storage> page

Step 2 Use the cursor keys to select the [Resistance Unit] field

Step 3 Use the soft keys to select

Soft key	Function
Auto	The unit of the measurement data is the same as the measurement result on the measurement page.

mΩ	The unit of the measurement data is fixed as mΩ
Ω	The unit of the measurement data is fixed as Ω
Scientific notation	The measurement data is in scientific notation (mantissa + exponent), in Ω

7.2.4 [File] Selection

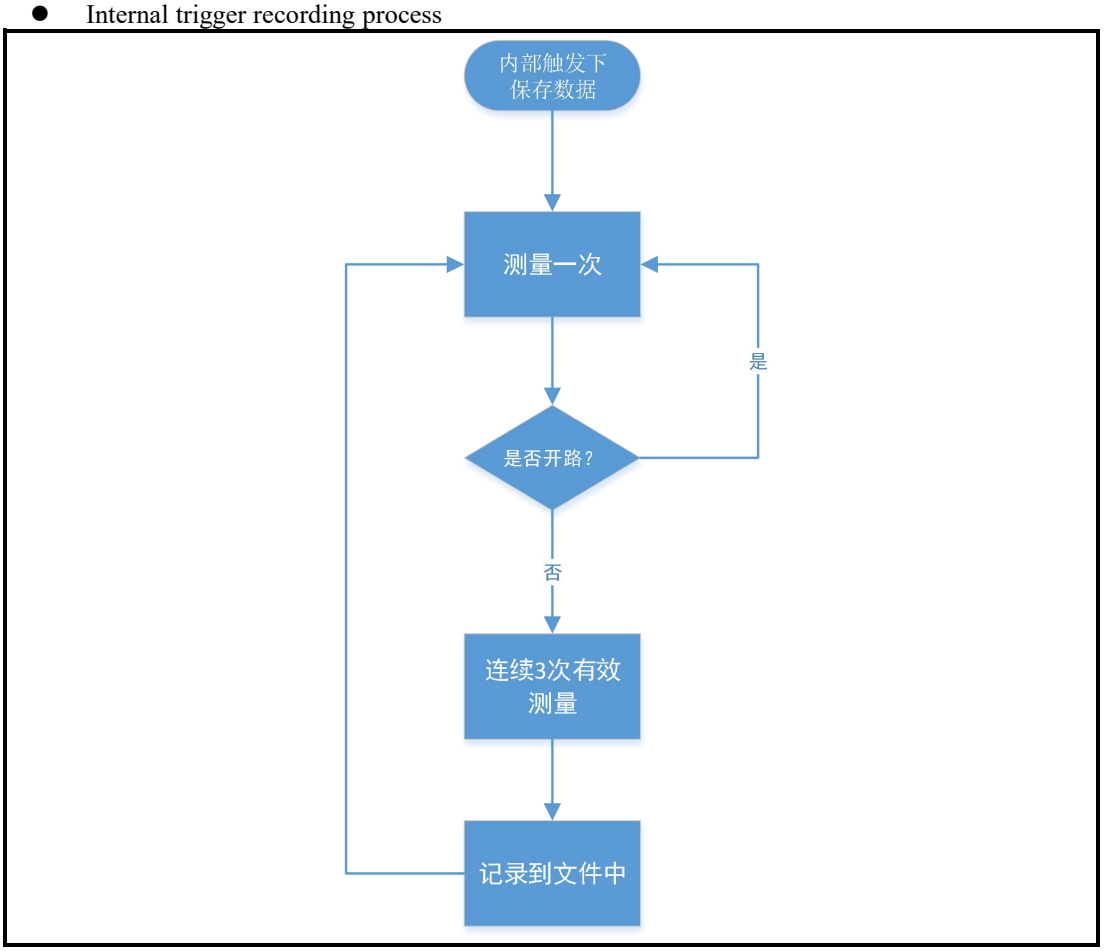
Step 1 Enter the <USB Disk Storage> page
Step 2 Use the soft keys to select the [File 0]~[File 9] page
Step 3 Use the cursor keys to select the [File 0]~[File 9] field;
Step 4 Use the soft keys to select

Soft key	Function
On	Opens this file for data storage
Off	Closes this file
Delete	Deletes this file; the stored data is cleared as well and cannot be recovered after deletion.

7.2.5 USB Disk Data Storage Mechanism

Data storage file under internal triggering.

- Internal trigger recording process



8. 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, just press the [Setup] key and the [System] key will appear at the very bottom of the main page.

8.1 System Configuration Page

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

- LANGUAGE
- Date/Time settings
- Key beep settings
- [Communication Protocol] Selection
- [Baud Rate] Settings
- RS485 Station No. selection
- Communication [Command Handshake] Switch
- Communication [Result Send] Mode
- SCPI [Terminator] setting

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

Figure 8- 1 <System Configuration> Page



8.1.1 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

8.1.2 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 [Time] 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

8.1.3 [Key Tone] Settings

The key tone of the instrument can be turned off.

■ Setting the key tone

Step 1 Enter the <System Configuration> page

Step 2 Use the cursor keys to select the [Key Beep] field;

Step 3 Use the soft keys to select

Soft key	Function
Off	
On	

8.1.4 [Communication Protocol] Selection

The instrument supports 2 communication protocols: SCPI and Modbus (RTU). SCPI is usually more convenient for communication with computers, while the Modbus protocol is easier to use for communication with industrial control equipment such as PLCs.

Selecting the communication protocol:

Step 1 Enter the <System Configuration> page

Step 2 Use the cursor keys to select the [Communication Protocol] field;

Step 3 Use the soft keys to select

Soft key	Function
SCPI	
Modbus	

8.1.5 RS485 [Station No.] Selection

If the Modbus (RTU) protocol is used, be sure to set the station address of this instrument.

This station number can also be used for multi-instrument communication under the SCPI protocol.

i Tip: Multi-instrument communication is also possible using the SCPI protocol extended by Onmeas Instruments. Add “addr #;:” at the beginning of each command line to select a slave. For example: addr 02;:fetch?Δ fetches data from the slave with station number 2.

Selecting the RS485 station number:

Step 1 Enter the <System Configuration> page

Step 2 Use the cursor keys to select the [Station No.] field;

Step 3 Use the soft keys to select

Soft key	Function
00 Broadcast	
01	
02	

03	
04	
05	
06	
07	
08	
09	
10	
11	
12	
13	
14	
15	

Under the Modbus protocol, to facilitate operating multiple identical instruments simultaneously, the instrument allows station number 00 for broadcast communication. When communicating via station number 00, the instrument only receives commands and does not return a response code.

8.1.6 [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/USB/RS-485 configuration of the instrument 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	For communication with a host via Modbus, this baud rate is recommended
38400	
57600	
115200	For communication with a computer host via SCPI, this high baud rate is recommended.

8.1.7 Communication [Command Handshake] Switch

This function is valid for the SCPI protocol only.
The instrument supports the SCPI 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	

8.1.8 Measurement Result [Upload] Mode

Communication command: SYSTem:UPLOAD {FETCH,AUTO}
This function is valid for the SCPI protocol only.

The instrument supports automatically sending data to the host. After each test is completed, the data is sent to the host automatically, without the host having to send the FETCH? command.
After each test, the instrument sends the test result and the comparator result to the host in the following format:
+9.9651e+01,BIN1
+1.0000e+20,BIN0
Here +1.0000e+20 indicates overflow or open circuit
BIN0 indicates fail or comparator off.
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 command FETCH? to obtain all measurement data
Auto	Automatically sent to the host computer after each test is completed

8.1.9 SCPI [Terminator] Switch

This function is valid for the SCPI protocol only.
The instrument supports the SCPI command terminator setting.
The host may send commands with or without a terminator; the instrument can receive and parse both.
When sending response results to the host, the instrument always appends the set terminator at the end.

Steps for setting the terminator:

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

Soft key	Function
LF(0x0A)	LF: line feed, ASCII 0x0A
CR(0x0D)	CR: carriage return, ASCII 0x0D
CR+LF	
NUL(0x00)	NUL: null character, ASCII 0x00

8.2 System Information Page

Press [Setup] to enter the main page, press the [System] key on the taskbar 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 8- 2 <System Information> Page



9. Handler Interface <AT2513>

You will learn about the following:

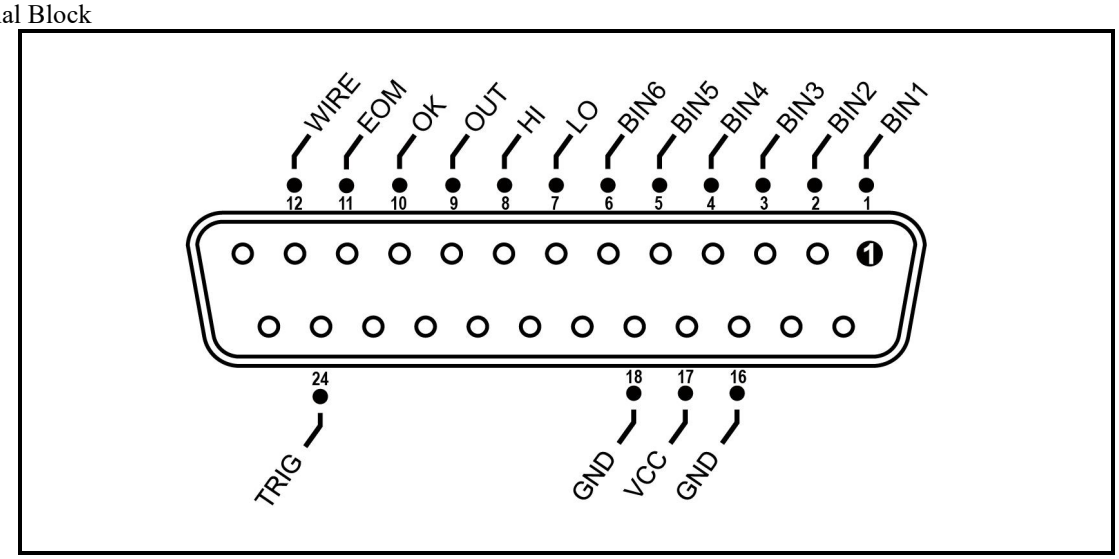
- Terminals
- How to Connect and Interface Schematics

Handler interface.

The instrument provides a full-featured Handler interface, including 6-bin pass sorting outputs (reserved), HI/LO, PASS/FAIL and other 10-bin outputs, the EOM end-of-test signal output, and the TRIG (external trigger start) input. Through this interface, the instrument can easily implement automatic control together with the user's system control components.

9.1 Terminal Blocks and Signals

Figure 9- 1Terminal Block



- Output terminals (all signals are active low)

Table 9- 1Output Pin Definitions

Pin	Name	Description
1	BIN1	0: OK
2	BIN2	0: OK
3	BIN3	0: OK
4	BIN4	0: OK
5	BIN5	0: OK
6	BIN6	0: OK
7	LO	0: LOW
8	HI	0: HIGH
11	OUT	0: NG
12	OK	0: OK
13	EOM	0: READY 1: MEAS

- Input terminals

Table 9- 2Input Pin Definitions

Pin	Name	Description
24	Trigger	Trigger input terminal; internally built-in 0.25W, 499 Ω

	input	current-limiting resistor. Rising edge.

■ Power terminals

Table 9- 3Power Pin Definitions

Pin	Name	Description
16,18	GND	Common ground
17	Internal VCC	Internal VCC positive terminal; internal isolated power supply: 5V, 0.5A, 2.5W max If the internal power supply is not needed, leave this terminal floating.

9.2 Connection Methods

■ Using external power (recommended)

Connect the external power supply GND to the following pins:
GND: pin 16 or 18
Internal power 17: floating.

■ Using the internal power supply

When the load power is unknown or uncertain, do not use the internal power supply;**Do Not**otherwise the instrument will not work properly.
For known low-power applications, you can use the internal power supply, but it may degrade the interference immunity of the instrument.

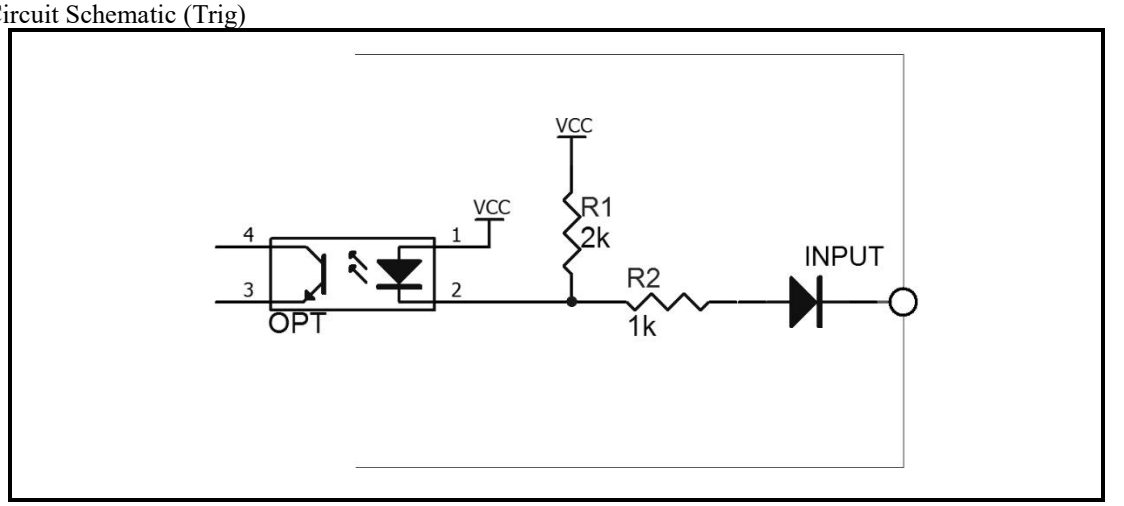
Internal power supply: 5V, max. 0.5A.
When using the internal power supply, connect the following pins at the same time:
VCC (5V): pin 17
GND: pin 16 or 18

■ Electrical specifications

Output signal: Collector output with built-in pull-up resistors. Optocoupler isolated. Active low.
Max. voltage: External power supply voltage.
Input signal: Optocoupler isolated. Active low.
Max. current: 50mA

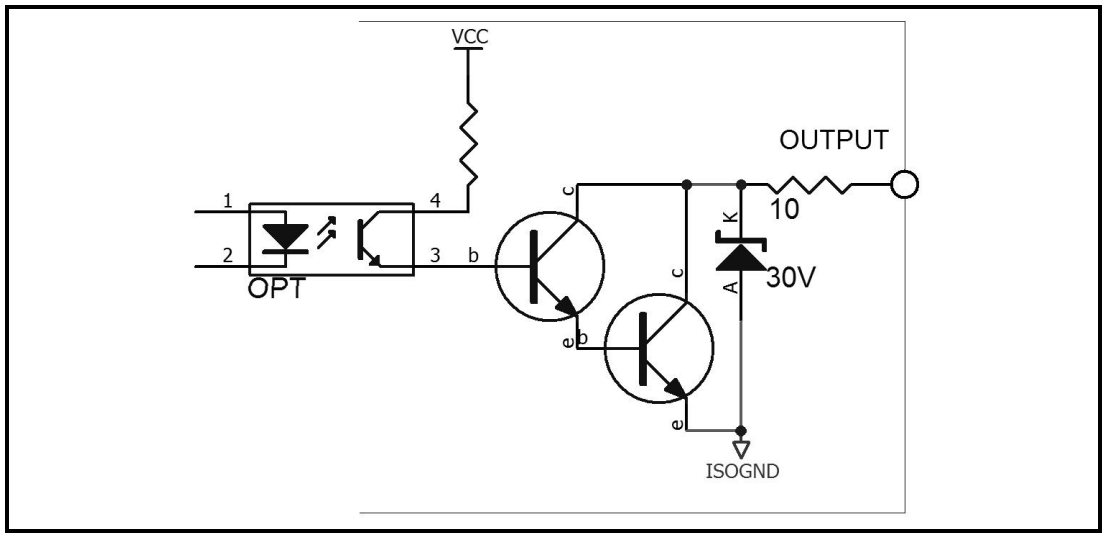
9.2.1 Input terminal schematic diagram

Figure 9- 2 Input Circuit Schematic (Trig)



9.2.2 Output Circuit Schematic

Figure 9- 3 Output Circuit Schematic



9.2.3 Input Circuit Connection Methods

Figure 9- 4 Connection to a Switch

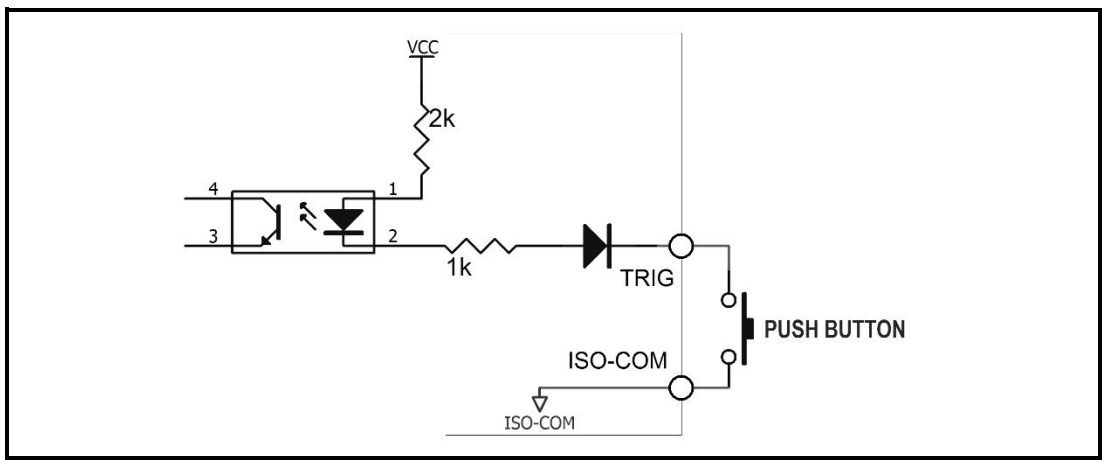


Figure 9- 5 Control Using a Relay

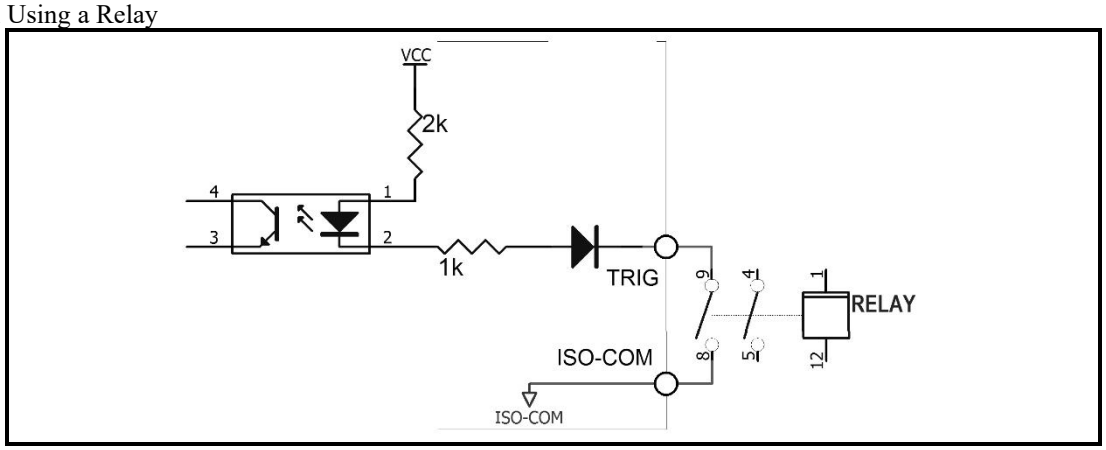


Figure 9- 6 Control Using a PLC Negative Common Terminal

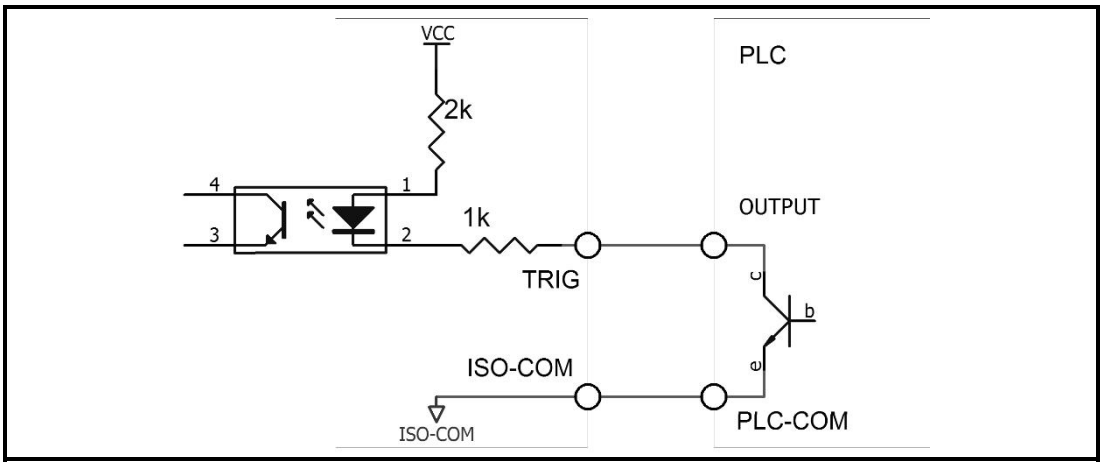
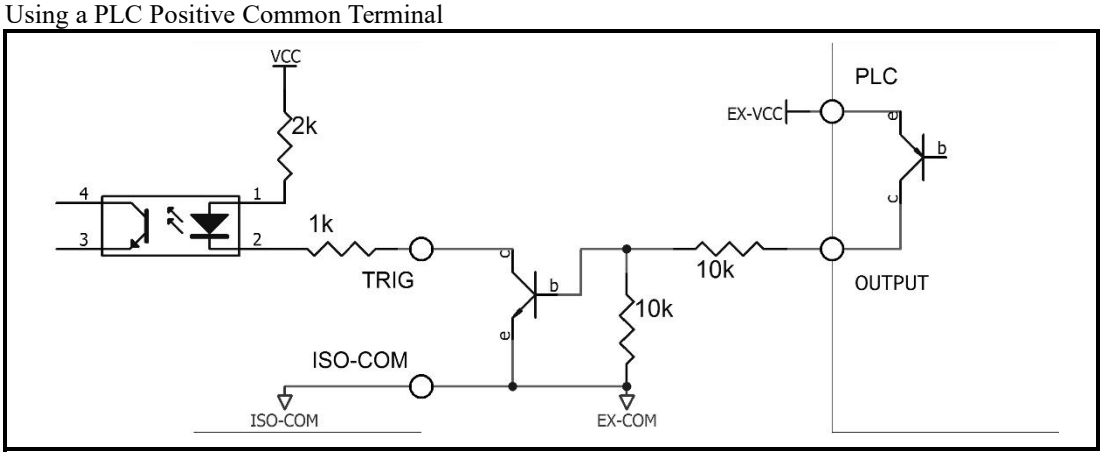


Figure 9- 7 Control Using a PLC Positive Common Terminal



9.2.4 Output Circuit Connection Methods

Figure 9- 8 Controlling a Relay

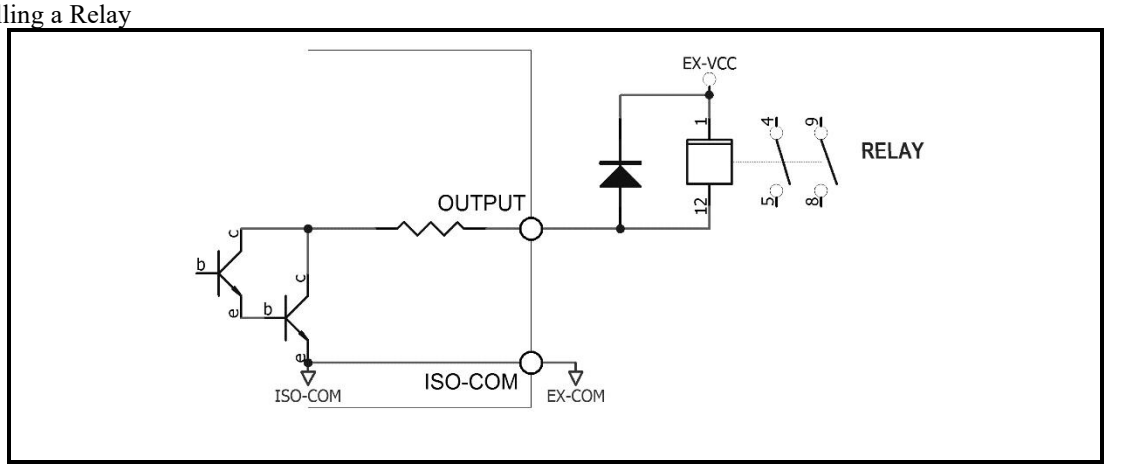


Figure 9- 9 Controlling an LED or an Optocoupler

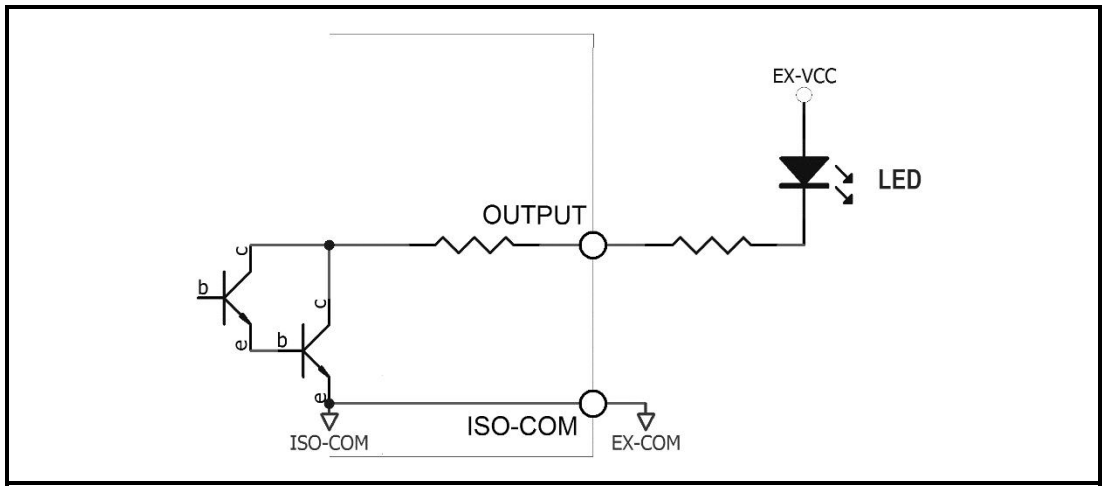


Figure 9- 10 Negative-Logic Output

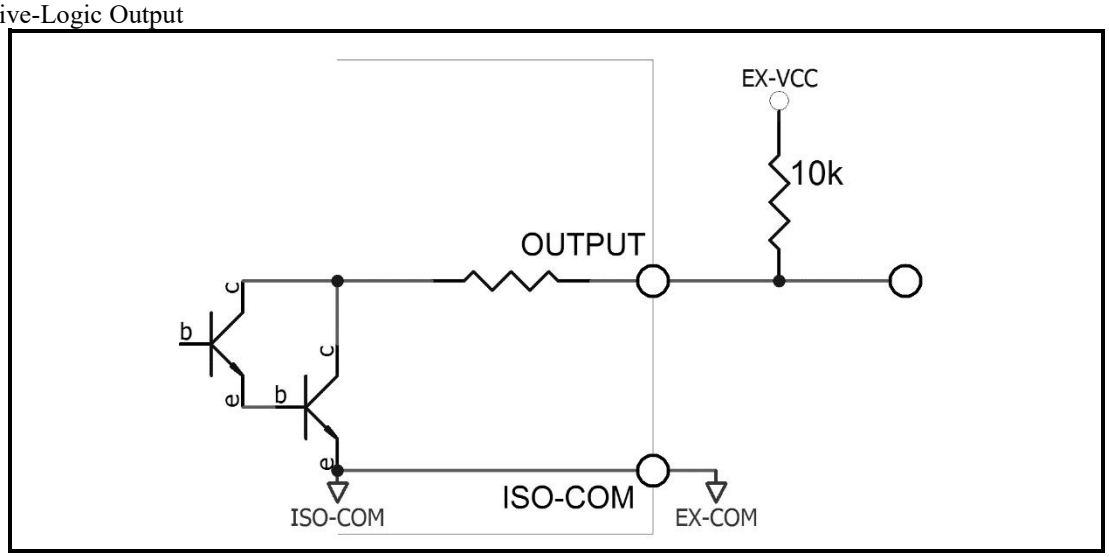


Figure 9- 11 Two-Port Output Forming a Logic-OR Circuit

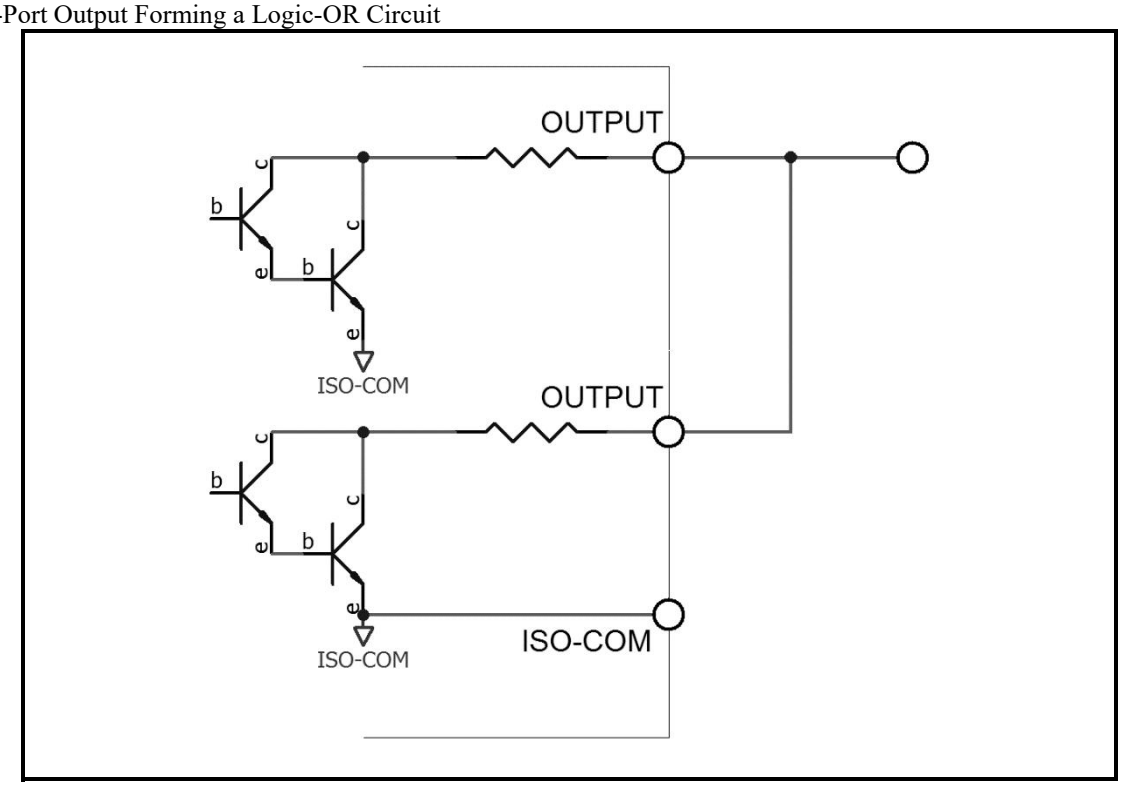


Figure 9- 12 Output to a PLC Negative Common Terminal

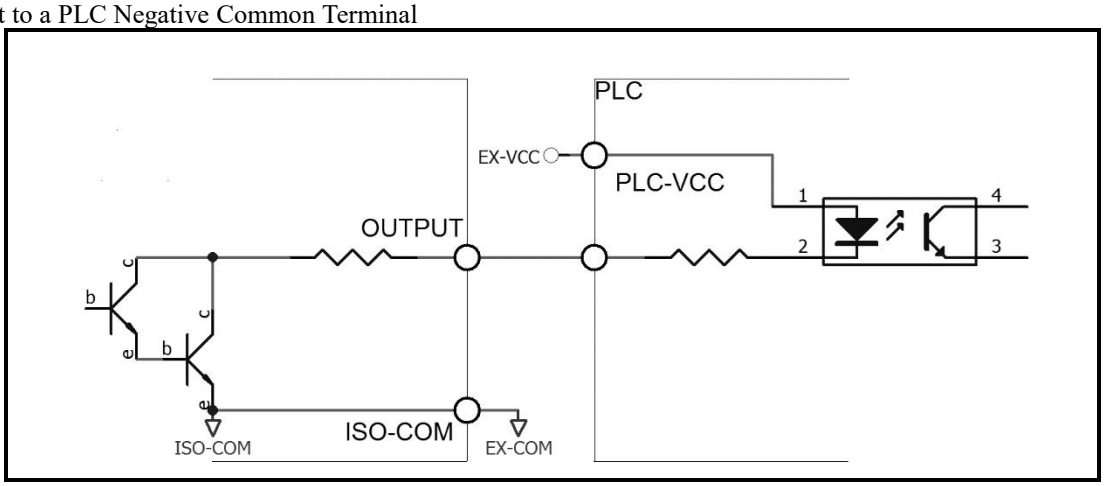
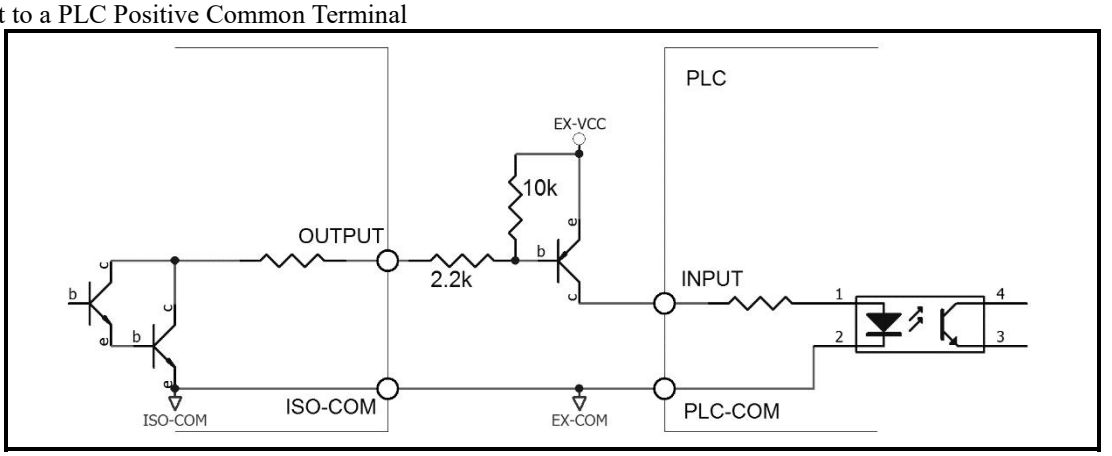


Figure 9- 13 Output to a PLC Positive Common Terminal



9.3 Timing Table

Figure 9- 14 Timing Table

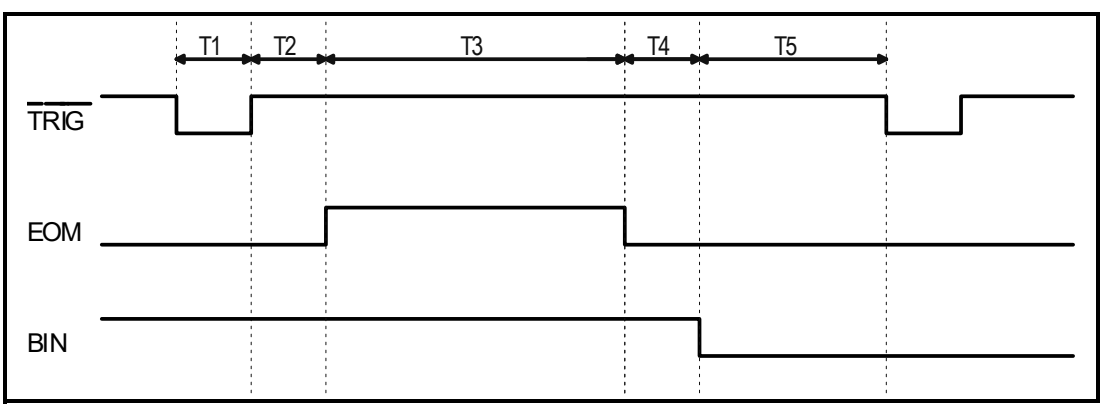


Table 9- 4 Time Table

Description			Minimum
T1	Trigger pulse width		1ms
T2	Measurement cycle	Trigger delay	<10μs
T3		Measurement time	Depends on settings
T4		BIN output delay	200μs
T5	Waiting time after trigger		0s

10. 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.

10.1 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 10- 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 10- 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

10.1.1 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.

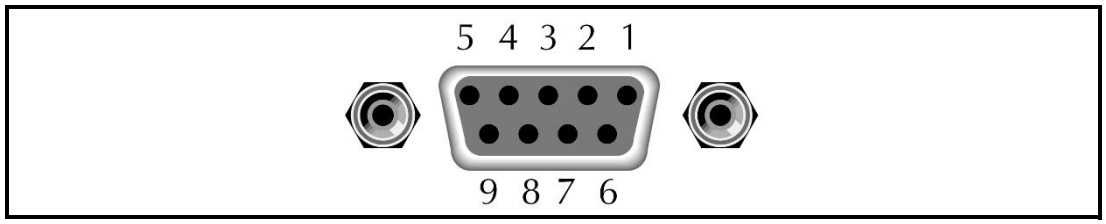
Note: The instrument cannot use a null modem cable.

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 10- 1 RS-232 Interface on the Rear Panel



! To avoid electrical shock, turn off the instrument power when plugging/unplugging connectors.

- Default communication settings of the instrument:

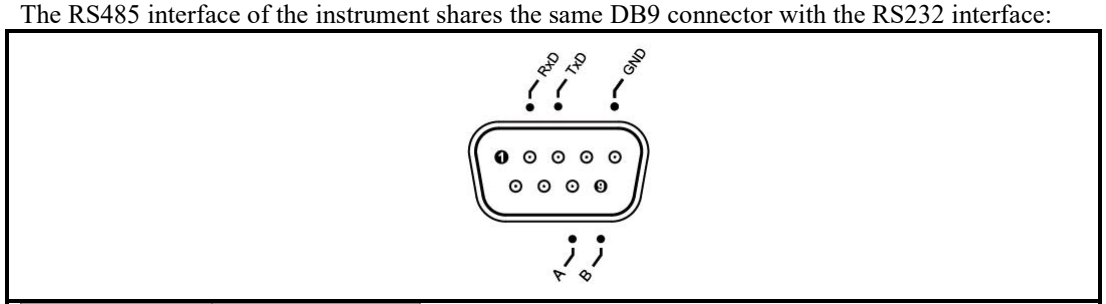
Transmission mode: Full-duplex asynchronous communication with start and stop bits
Data bits: 8 bits
Stop bits: 1 bit
Parity: None

10.2 RS485 Connection

The instrument comes standard with an RS485 interface and also supports the Modbus RTU protocol.

RS485 is a communication interface supporting multi-instrument communication: one host can be connected in parallel with multiple slaves.
The detailed RS485 specification is not the focus of this user manual; refer to
https://en.wikipedia.org/wiki/RS-485

The RS485 interface of the instrument shares the same DB9 connector with the RS232 interface:



Pin	Function
8	A
9	B

10.3 Handshake Protocol

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

- The instrument command parser only accepts ASCII format, and command responses also return ASCII codes.
- The command string sent by the host must end with NL (‘\n’); the instrument command parser starts executing the command string only after receiving the terminator.
- The instrument can enable the Command Handshake: after receiving each character, the instrument immediately sends that character back to the host computer, and the host computer can send the next character only after receiving this returned character.

! If the host cannot receive the data returned by the instrument, you can try the following methods to resolve it:
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 still parsing the previous command, the host cannot receive the instrument’s response either; please wait and try again.

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

10.4 SCPI Language

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

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.

11. 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.

11.1 Command String Parsing

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

Example: Valid command string:

AAA:BBB CCC;DDD EEE;:FFF

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

11.1.1 Command Parsing Rules

1. The command parser only parses and responds to ASCII code data.
2. The SCPI command string must end with NL (‘\n’ ASCII 0x0A); the command parser starts executing the command string only after receiving the terminator or when the buffer overflows.
3. If the command handshake is on, each time the parser receives a character it immediately echoes the character back to the host; the host may continue sending the next character only after receiving this echo 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.

11.1.2 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.

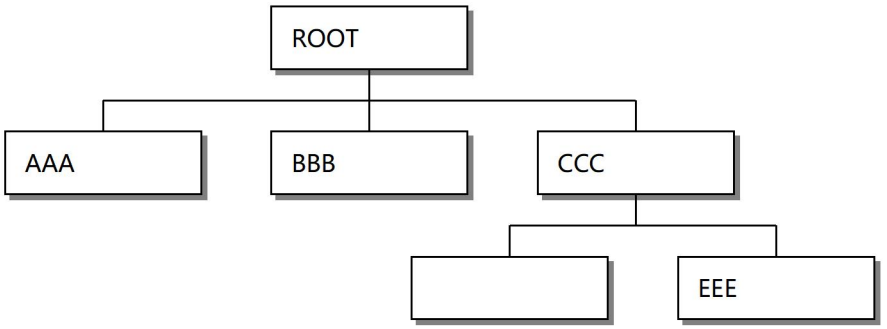
( ) The abbreviated form of a parameter is placed in parentheses.

Uppercase letters The abbreviated form of a command.

11.1.3 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 11- 1Command Tree Structure



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

11.2 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]

11.2.1 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.

11.2.2 Parameters

1. A command with a single command word and no parameters.
   Example: AAA:BBB
2. The parameter can be in the form of a string, and its abbreviation rules still follow the “command abbreviation rules” in the previous section.

E.g.: AAA:BBB 1.23

3. The parameter can be in numeric form

<*integer*>Integer 123, +123, -123
<float> Floating point
<fixfloat>: fixed-point floating point: 1.23, -1.23
<Sciloat>: scientific notation floating point: 1.23E+4, +1.23e-4
<mpfloat>: floating point with multiplier: 1.23k, 1.23M, 1.23G, 1.23u

Table 11- 1Multiplier 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

i The multiplier is not case-sensitive; its spelling differs from the standard names.

11.2.3 Separators

The instrument command parser only accepts the allowed separators; for any other separator the parser generates the “Invalid 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

11.2.4 Error Codes

The corresponding error codes are as follows:

Error Codes	Description	
*E00	No error	No error
*E01	Bad command	Command error
*E02	Parameter error	Parameter error
*E03	Missing parameter	Missing parameter
*E04	buffer overrun	Buffer overflow
*E05	Syntax error	Syntax error
*E06	Invalid separator	Invalid separator
*E07	Invalid multiplier	Invalid multiplier unit
*E08	Numeric data error	Numeric value error
*E09	Value too long	Number too long
*E10	Invalid command	Invalid command
*E11	Unknow error	Unknown error

11.3 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

11.4 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 11-2 DISPlay Subsystem Tree

DISPlay	:PAGE	{TEST,SETUP(MSET),COMParator,CORRECTION(CSET),FILE,SYSTem,SYSTEMINFO(SINF)}
	:LINE	<string>

11.4.1 DISPlay:PAGE

DISP:PAGE switches to the specified page.

Command syntax: DISPlay:PAGE <page name>

Parameters: <page name> includes:

TEST	Measurement display page
SETUP(MSET)	Settings page
COMParator	Comparator page
CORRection	Calibration page
FILE	File Management Page
SYSTem	System Configuration Page
SYSTEMINFO(SINF)	System information page

Example: Send> disp:page setup<NL> //Switch to the setup page

Query syntax: DISP:PAGE?

Query response: <page name> abbreviation

test
mset
comp
cset
file
syst
sinf

Example: Send> disp:page? <NL>
Return> test<NL>

11.4.2 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.” <NL>

11.5 FUNCtion Subsystem

Figure 11-3 FUNCtion Subsystem Tree

FUNCtion	:RANGe	{Range No., max, min}	
		:MODE	{AUTO,HOLD,NOMinal}
	:RATE	{SLOW,MED,FAST }	
	:TC	:COEFficient :a	<float>
		:REFEr :t0	<float>
		:rt	{OFF,<float>}
		:rou :p	{OFF,ON}
		:SECTion	{RECTangle,ROUNd,AREA,CIRCle} ROUNd=CIRCle
		:Width	<float>
		:Height	<float>
		:DIAMeter	<float>
		:AREA	<float>
		:RADius	<float>
		:Length	<float>

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

11.5.1 FUNCtion:RANGe

FUNC:RANG sets the ranging mode and range number

Command syntax: FUNCtion:RANGe {<Range No.>,min,max}

Parameters:	where <Range No.> 1~6 (AT2513) **min** min range **max** max range
Example:	Send> **FUNC:RANG 6**<NL> //Switch to range 6 (300Ω)
Query syntax:	FUNC:RANG?
Query response:	Range No. 0~5
Example:	Send> FUNC:RANGE? <NL> Return> 6<NL>

11.5.2 FUNCtion:RANGe:MODE

FUNC:RANG:MODE switches the ranging mode

Command syntax:	FUNCtion:RANGe:MODE {AUTO,HOLD(MANual),NOMinal}
Example:	Send> FUNC:RANG:MODE NOM<NL> //Switch to nominal ranging mode
Query syntax:	FUNC:RANG:MODE?
Query response:	{AUTO,HOLD,NOM}

11.5.3 FUNCtion:RATE

FUNC:RATE or FUNC:SPEED sets the test speed.

Command syntax:	FUNCtion:RATE {SLOW, FAST}
Example:	Send> FUNC:RATE SLOW <NL> //Set to slow testing
Query syntax:	FUNC:RATE?
Query response:	{SLOW ,FAST}

11.5.4 FUNCtion:TC

FUNC:TC turns temperature compensation on or off.

Command syntax:	FUNCtion:TC {ON,OFF,1,0}
Example:	Send> FUNC:TC ON <NL> //Turn on the temperature compensation function
Query syntax:	FUNC:TC?
Query response:	{ON,OFF}

11.5.5 FUNCtion:TC: COEFficient or FUNC:TC:A

FUNC:TC:COEFficient sets the temperature coefficient.

Command syntax:	FUNCtion:TC: COEFficient <float> FUNCtion:TC: A <float> Note: the unit of temperature coefficient A is ppm; for example, the temperature coefficient of silver-copper at 20℃ is 3930 ppm
Example:	Send> FUNC:TC:COEF 3930<NL> //Set the temperature coefficient to 3930ppm Send> FUNC:TC:COEF 3930<NL> //Set the temperature coefficient to 3930ppm
Query syntax:	FUNC:TC:COEF? FUNC:TC:A?
Query response:	<fixfloat>
Example:	Send> FUNC:TC:A? <NL> Response> +3930.0<NL>

11.5.6 FUNCtion:TC:REFErence

FUNC:TC:REFE sets the reference temperature

Command syntax:	FUNCtion:TC:REFErence <float> FUNCtion:TC:T0 <float> Note: the temperature unit is ℃
Example:	Send> FUNC:TC:T0 25 //Set the reference temperature to 25℃
Query syntax:	FUNC:TC:REFE? FUNC:TC:T0?
Query response:	<fixfloat>
Example:	Send> FUNC:TC:REFE? Response> +20.00

11.5.7 FUNCtion:resUpper

FUNC:resUpper sets the upper limit of the measured resistance on the Resistivity page

Command syntax:	FUNCtion:resUpper {float}
Example:	Send> FUNC:resUpper 3 //The upper limit is now 3Ω
Query syntax:	FUNC:resUpper?
Query response:	Upper limit <float>
Example:	Send> FUNC:resUpper? Response> +3.00000

11.5.8 FUNCtion:resLow

FUNC:resLow sets the lower limit of the measured resistance on the Resistivity page

Command syntax:	FUNCtion:resLow {float}
Example:	Send> FUNC:resLow 0.2 //The upper limit is now 200mΩ
Query syntax:	FUNC:resLow?
Query response:	Upper limit <float>
Example:	Send> FUNC:resLow? Response> +0.20000

11.5.9 FUNCtion:resSquare

FUNC:resSquare sets the cross-section area

Command syntax:	FUNCtion: resSquare {float}
Example:	Send> FUNC:resSquare 4 //The cross-section area is now 4mm2
Query syntax:	FUNC:resSquare?
Query response:	Cross-section area value <float>
Example:	Send> FUNC:resSquare? Response> +4.00000

11.5.10 FUNCtion:resLength

FUNC:resLength sets the rectangle length, in mm

Command syntax:	FUNCtion:resLength {float} Floating point, unit defaults to mm
Example:	Send> FUNC:resLength 1 //The length is now 1mm
Query syntax:	FUNC:resLength?
Query response:	Length value <float>
Example:	Send> FUNC:resLength? Response> +1.00000

COMParator Subsystem

The COMP subsystem sets the comparator parameters.

Figure 11-4 COMParator Subsystem Tree

COMParator	[:STATe]	{OFF,#-BIN} (customized version) {OFF,ON} (AT2513)
	:BEEP	{OFF,PASS(OK),FAIL(NG)}
	:MODE	{ABS,PER,SEQ}
	:NOMinal	<float>
	:BIN	<bin No. 1~10>, <float lower limit>, <float upper limit>

11.5.11 COMParator[:STATe]

COMP[:STATe] turns off the comparator or sets the number of bins.

Command syntax:	COMParator[:STATe] {OFF,#-BIN} (customized version) COMParator[:STATe] {OFF,ON} (AT2513)
Parameters:	where <#-BIN> includes:**1-BIN ~ 6-BIN**
Example:	Send> COMP:STAT 6-BIN //Turn on the comparator and set 6-bin sorting Send> COMP:STAT OFF //Turn off the comparator
Query syntax:	COMP[:STAT]?
Query response:	{OFF,#-BIN}

11.5.12 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}

11.5.13 COMParator:MODE

COMP:MODE sets the comparator mode.

Command syntax:	COMParator:MODE {ABS,PER,SEQ}
Example:	Send> **COMP:MODE SEQ** //Switch to sequential comparison mode
Query syntax:	COMP:MODE?
Query response:	{ABS,PER,SEQ}

11.5.14 COMParator:NOMinal

COMP:NOM sets the nominal value.

Command syntax:	COMParator:NOMinal <float>
Example:	Send> COMP:NOM 1.0000Ω //The nominal value is set to 1Ω Send> **COMP:NOM 1** //The nominal value is set to 1Ω Send> **COMP:NOM 1** //The nominal value is set to 1Ω
Query syntax:	COMP:NOM?
Query response:	<scifloat>
Example:	Send> COMP:NOM? Return> 1.0000 //The nominal value is 1Ω

11.5.15 COMParator:BIN

COMP:BIN sets the nominal value.

Command syntax:	COMParator:BIN <bin No. 1~6>,<float lower limit>,<float upper limit> (customized version) COMParator:BIN <float lower limit>,<float upper limit> (*AT2513)
Example:	Send> **COMP:BIN 1,-10,+10** //In percentage sorting mode: BIN1 lower limit -10%, upper limit 10%
Query syntax:	COMP:BIN? <1~6>
Query response:	<scifloat>,<scifloat>
Example:	Send> COMP:BIN? 1 Return> -10.000E+00,+10.000E+00 //-10,+10

11.6 TRIGger Subsystem

Figure 11-5 TRIGger Subsystem Tree

TRIGger	[:IMMediate]	
	:SOURce	{INT,EXT}
	:DELAy	<float>
TRG		

TRIGger sets the trigger source and generates a trigger.

11.6.1 TRIGger[:IMMediate]

TRIG[:IMM] generates one trigger when the trigger source is set to EXT, 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

11.6.2 TRIGger:SOURce

TRIG:SOUR sets the trigger source.

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

11.6.3 TRG

TRG generates one trigger when the trigger source is set to EXT, and returns the triggered test data.

Command syntax:	TRG
Example:	Send> **TRG** //The instrument tests once and returns the test data Return> +9.9651e+01,BIN00

11.7 FETCh? 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.

Figure 11- 6 FETCh? Subsystem Tree

FETCh?	<NONE>
	:RT?
	:T2?

11.7.1 FETCh? Acquiring Measurement Results

Query syntax:	FETCh?
Query response:	<scifloat>,{BIN0~BIN6 } Here BIN0 indicates fail
Example:	Send> FETC? Return>+9.9651e+01,BIN0

11.8 SYSTem 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 11- 7 SYSTem Subsystem Tree

SYSTem	:LANGuage	{ENGLISH,CHINESE,EN,CN}
	:TIME	<YEAR>,<MONTH>,<DAY>,<HOUR>,<MINUTE>,<SECOND>
	:KEYLock(KLOC)	{ON(1),OFF(0)}
	:BEEP	{ON(1),OFF(0)}
	:SHAKEHAND(SHAK)	{ON(1),OFF(0)}
	:UPLOAD(UPLD)	{FETCh,AUTO}

11.8.1 SYSTem:LANGuage 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}

11.8.2 SYSTem:TIME System Time Setting

Command syntax:	SYSTem:TIME <YEAR>,<MONTH>,<DAY>,<HOUR>,<MINUTE>,<SECOND>
Example:	Send> SYST:TIME 2016,12,30,11,18,31 //2016-12-30 11:18:31
Query syntax:	SYSTem:TIME?
Query response:	<YEAR>-<MONTH>-<DAY> <HOUR>:<MINUTE>:<SECOND>
Example:	Send> SYST:TIME? Receive> 2016-12-30 11:18:31

11.8.3 SYSTem:KEYLock or SYSTem:KLOCk Keyboard Lock Setting

Command syntax:	SYSTem:KEYLock {ON,OFF,0,1} SYSTem:KLOCk {ON,OFF,0,1}
Example:	Send> SYST:KEYL OFF //Unlock the keyboard
Query syntax:	SYSTem:KEYLock? SYSTem:KLOCk?

Query response:	{on,off}

11.8.4 SYSTem:BEEPer Key Tone

This command **does not** affect the comparator beeper.

Command syntax:	SYSTem:BEEPer {OFF,ON,0,1}
Parameters:	{OFF,ON,0,1} OFF/0: key tone off ON/1: key tone off
Example:	Send> SYST:BEEP OFF
Query syntax:	SYSTem:BEEPer?
Query response:	{OFF,ON}

11.8.5 SYSTem:SHAKhand Communication Handshake Command (Header Return)

With the communication handshake on, the instrument echoes the received command back to the host as-is before returning the data.

Command syntax:	SYSTem:SHAKhand {ON,OFF,0,1} SYSTem:HEADer {ON,OFF,0,1}
Example:	Send> SYST:SHAK ON Send> SYST:HEAD ON
Query syntax:	SYSTem:SHAKhand? SYSTem:HEADer?
Query response:	{on,off}

11.8.6 SYSTem:UPLOAD(UPLD) Test Result Sending

SYSTem:UPLOAD(UPLD) sets the data sending mode: automatic or the FETCH command.

Command syntax:	SYSTem:UPLOAD {FETCH,AUTO}
Parameters:	{FETCH,AUTO} FETCH: the data is returned to the host only via the fetch? command; the instrument sends passively. AUTO: after each test, the test result is sent to the host automatically; the instrument sends actively.
Example:	Send> SYST:UPLD AUTO //Set to automatic sending
Query syntax:	SYST:UPLD?
Query response:	{FETCH,AUTO}

11.9 FILE(MMEM) Subsystem

The FILE(MMEM) subsystem manages files: it can save user parameters to the internal flash, or read flash files into the system.

Figure 11-8 FILE(MMEM) Subsystem Tree

FILE MMEM	:SAVE	<no parameter> or <file No. 0-9>
	:LOAD	<no parameter> or <file No. 0-9>
	:DELete	<file No. 0-9>

11.9.1 FILE:SAVE Saving Files

FILE:SAVE saves the current settings to the current file or a specified file.

Command syntax:	FILE:SAVE FILE:SAVE <File No. 0-9>
Example:	Send> **FILE:SAVE** //Save to the current file Send> **FILE:SAVE 1** //Save to File 1

11.9.2 FILE:LOAD Loading Files

FILE:LOAD reads file data into the system.

Command syntax:	FILE:LOAD FILE:LOAD <File No. 0-9>
Example:	Send> **FILE:LOAD** //Read the current file data into the system Send> **FILE:LOAD 1** //Read the data of File 1 into the system

11.9.3 FILE:DELete Deleting a Specified File

FILE:DELete deletes the data of a specified file.

Command syntax:	FILE:DELete <File No. 0-9>
Example:	Send> **FILE:DEL 1** //Delete the specified file
Note:	Deleting the current file does not affect the system parameters

11.9.4 SAV

SAV saves the current settings to the current file.

Command syntax:	SAV = FILE:SAVE
Example:	Send> **SAV** //Save to the current file

11.9.5 RCL

RCL reads the current file data into the system.

Command syntax:	RCL = FILE:LOAD
Example:	Send> **FILE:LOAD** //Read the current file data into the system

11.10 IDN? Subsystem

Figure 11- 9 IDN? Subsystem Tree

IDN?	

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

Query syntax:	IDN?
Query response:	<MODEL>,<Revision>,<SN>,< Manufacturer>
Example:	Send> IDN? Return> AT2513,REV A1.0,0000000,Onmeas Instruments

12. Modbus (RTU) Communication Protocol

This chapter includes the following topics:

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

12.1 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.

12.1.1 Command Frame

Figure 12- 1 Modbus Command Frame



Table 12- 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

12.1.2 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()
    IM CRC16LO AS BYTE, CRC16HI AS BYTE     'CRC REGISTER
    IM CL AS BYTE, CH AS BYTE               'POLYNOMIAL CODE &HA001
 IM SAVEHI AS BYTE, SAVELO AS BYTE
 IM I AS INTEGER
 IM FLAG AS INTEGER
 RC16LO = &HFF
 RC16HI = &HFF
 L = &H1
 H = &HA0
 OR 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
 EXT I
 IM RETURNDATA(1) AS BYTE
  ETURNDATA(0) = CRC16HI          'CRC HIGH BYTE
  ETURNDATA(1) = CRC16LO          'CRC LOW BYTE
 RC16 = RETURNDATA
END FUNCTION
```

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 12- 2 Modbus Appended CRC-16 Value



12.1.3 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 12- 3 Normal Response Frame

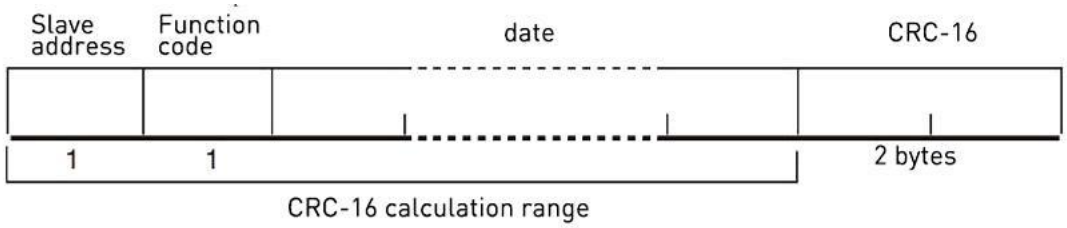


Figure 12- 4 Exception Response Frame

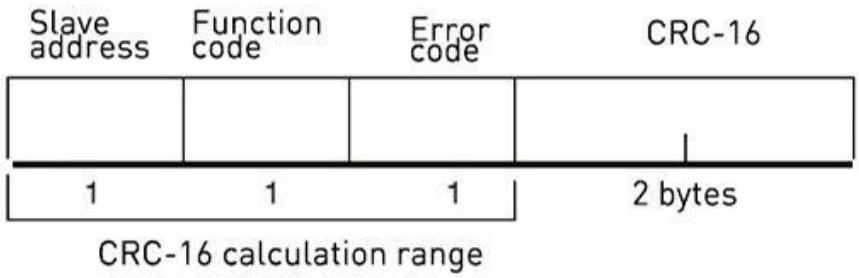


Table 12- 2 Exception Response Frame Description

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

12.1.4 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.

12.1.5 Error Codes

Table 12- 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

12.2 Function Codes

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

Table 12- 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

12.3 Registers

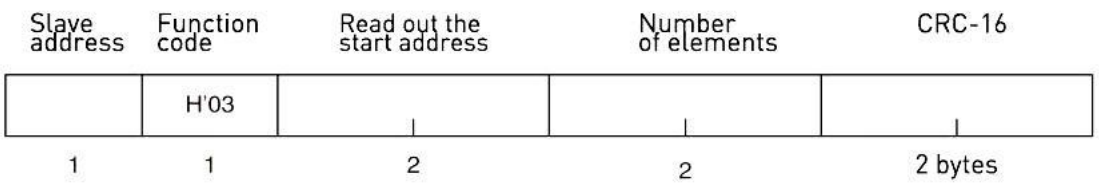
The register size of the instrument is in 2-byte mode; that is, 2 bytes must be written each time. For example: the speed register is 0x3002, the data is 2 bytes, and the value must be written as 0x0001

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

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

12.4 Read Multiple Registers

Figure 12- 5 Read Multiple Registers (0x03)

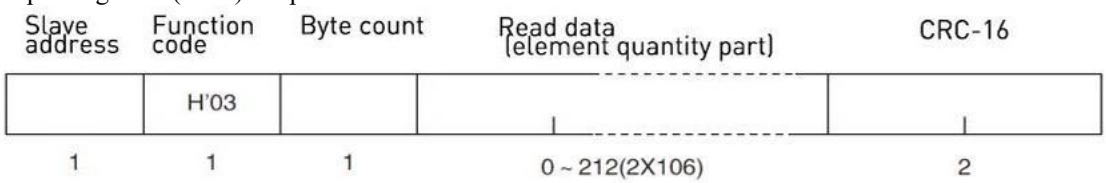


The function code for reading multiple registers is 0x03.

Table 12- 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 12- 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	

12.5 Write Multiple Registers

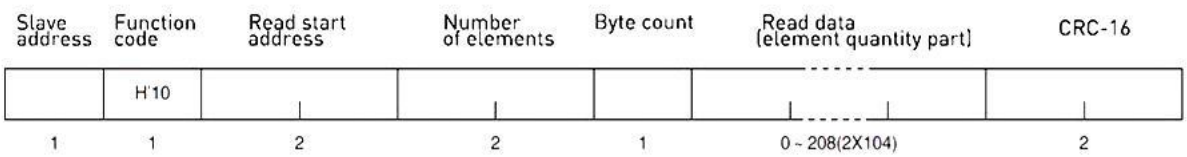
Figure 12- 7 Write Multiple Registers (0x10)



Table 12- 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 12- 8 Write Multiple Registers (0x03) Response Frame

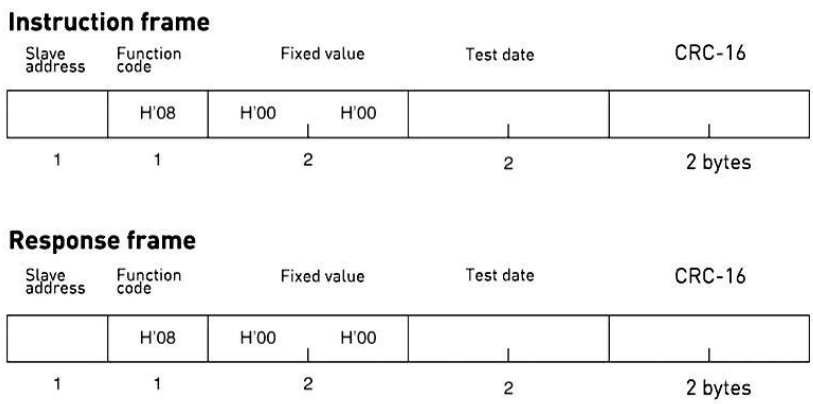


Name	Name	Description
	Slave address	Returned as is
0x10 or 0x90	Function Codes	No exception: 0x10 Error code: 0x90
	Starting address	
	No. of Registers	
	CRC-16 Check Code	

12.6 Echo Test

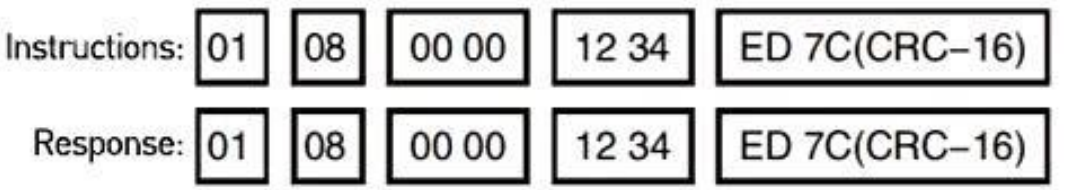
The function code of the Echo Test is 0x08, which is used for debugging Modbus.

Figure 12- 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:



13. Modbus (RTU) Command Set

This chapter includes the following topics:

- Register Address

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

! Unless otherwise specified, the values of the command and response frames in the following descriptions are hexadecimal data.

13.1 Register Overview

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

Table 13- 1 Register Overview

Register Address	Name	Numeric value	Description
2000	Read measurement result	4-byte floating-point number	Read-only, data occupies 2 registers, 4 bytes Byte order ABCD, low word first
2100	Read comparator result	4-byte integer	Read-only, data occupies 2 registers
2200	Read measurement result	4-byte floating-point number	Read-only, data occupies 2 registers, 4 bytes Byte order CDAB
3000	Range number	0001~0006	Read/Write register, 2-byte integer
3001	Range mode	0000: Auto range 0001: manual range 0002: Nominal range	Read/Write register, 2-byte integer
3002	Test Speed	0000: Slow 0001: fast	Read/Write register, 2-byte integer
3003	File power-on recall	0000: File 0 0001: Current file	Read/Write register, 2-byte integer
3004	Auto save	0000: Forbid 0001: Allow	Read/Write register, 2-byte integer
3006	Beeper	0000: Off 0001: PASS beep 0002: FAIL beep	Read/Write register, 2-byte integer
3008	Trigger setting	0000: internal trigger 0001: external trigger	Read/Write register, 2-byte integer
3100	Comparator bin number	0000: Comparator off 0001: 1-BIN	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	BIN1 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3112	BIN1 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
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	0000~0009	Write-only register, data 2 bytes

	file		
4003	Read the specified file data	0000~0009	Write-only register, data 2 bytes
5001	Key lock	0000: unlocked 0001: locked	Write-only register, 2 bytes
5002	Trigger once = Handler Trig pin	Fixed value: 0001	Write-only register, 2 bytes
6000	Resistivity upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
6002	Resistivity lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
6004	Resistivity cross-section area	4-byte floating-point number	Read/Write register, data occupies 2 registers
6006	Resistivity length	4-byte floating-point number	Read/Write register, data occupies 2 registers

13.2 Acquiring Measurement Data

13.2.1 Acquiring Measurement Results

Registers 2000~2003 are used to obtain the instrument measurement data.
Example: acquire the measurement data
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:
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	60	AD	78	EC	56	5F

Here B4~B6 are the measurement data: 60AD78EC is a single-precision floating point, low word first.
Byte order AA BB CC DD converts to decimal 1E20

13.2.2 Acquiring the Comparator Result [2100]

The returned 4-byte integer represents the comparator result:
00: fail
01: pass bin 1
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	00		

13.2.3 Acquiring Measurement Results (CCDD AABB) [2200]

Registers 2200~2203 acquire the instrument measurement data.
Example: acquire the measurement data
Command:

1	2	3	4	5	6	7	8
01	03	2200		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:

Send:

1	2	3	4	5	6	7	8
01	03	22	00	00	02	CE	73

Response:

1	2	3	4	5	6	7	8	9
01	03	04	43	8D	3F	80	6F	CC

Here B4~B6 are the measurement data: 43 8D 3F 80 is a single-precision floating point, high word first, byte order CC DD AA BB. Swapping the word order to AABBCCDD gives 3F 80 8D 43, which converts to decimal 1.0020614862442017

13.3 Parameter Settings

13.3.1 Range [3000]

Writing range 1

1	2	3	4	5	6	7	8	9	10	11
01	10	30	00	00	01	02	00	01	57	93
	Write	Registers		No. of Regs		Bytes	Data		CRC	

where data 0001~0006 changes the range

Response:

1	2	3	4	5	6	7	8
01	10	30	00	00	01	CRC	

Reading the range number

1	2	3	4	5	6	7	8
01	03	30	00	00	01	8B	0A
	Read	Registers		No. of Registers		CRC	

Response:

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

13.3.2 Range Auto [3001]

Writing the range mode

1	2	3	4	5	6	7	8	9	10	11
01	10	30	01	00	01	02	00	01	56	42
	Write	Registers		No. of Registers		Bytes	Data		CRC	

where the data:

0000: Auto range

0001: locked range

0002: Nominal range

Response:

1	2	3	4	5	6	7	8
01	10	30	01	00	01	CRC	

Reading the range mode

1	2	3	4	5	6	7	8
01	03	30	01	00	01	8B	0A
	Read	Registers		No. of Registers		CRC	

Response:

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

13.3.3 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 Registers		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 fast

13.3.4 Beeper Settings [3006]

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	30	06	00	01	02	00	01	57	F5
	Write	Registers		No. of Registers		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	10	30	06	00	01		
		Registers		No. of Registers		CRC	

Read

1	2	3	4	5	6	7	8
01	03	30	06	00	01	6B	0B
	Read	Registers		No. of Registers		CRC	

Response:

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

where
0000 beeper off
0001 PASS beep
0002 FAIL beep

13.3.5 Trigger Source Setting [3008]

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	30	08	00	01	02	00	01	56	DB
	Write	Registers		No. of Registers		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	10	30	08	00	01		
		Registers		No. of Registers		CRC	

Read

1	2	3	4	5	6	7	8
01	03	30	08	00	01	0A	C8
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7

01	03	02	00	00		
		Bytes	Data		CRC	

where
0000 internal trigger
0001 external trigger

13.4 Comparator Settings

13.4.1 Nominal Value [3102]

The nominal value uses 2 registers, 3102.
Write
100E-3 (single-precision floating point: 0x3DCCCCCD)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	10	31	02	00	02	04	3D	CC	CC	CD	72	E1
	Write	Registers		No. of Regs		Bytes	Data				CRC	

Response:

1	2	3	4	5	6	7	8
01	10	31	02	00	02	EE	F4
		Registers		No. of Regs		CRC	

Read

1	2	3	4	5	6	7	8
01	03	31	02	00	02	6B	37
	Read	Registers		No. of Regs		CRC	

Response:

1	2	3	4	5	6	7	8	9
01	03	04	3D	CC	CC	CD	A3	35
		Bytes	Data 100E-3				CRC	

13.4.2 Limit Values [3110-3112]

For the 1-bin comparator, the lower-limit register address is 3110 and the upper-limit register address is 3112; each comparator bin uses 2 registers for the lower limit and 2 registers for the upper limit, 4 registers in total. The lower and upper limits can be set separately.
Write

1	2	3	4	5	6	7	8	9	10	11	12	13
01	10	31	10	00	02	04	40	00	00	00	BE	F2
	Write	Registers		No. of Regs		Bytes	Data				CRC	

13.5 File Operations

Since the instrument settings are stored in files, if the [Auto Save] field on the <File> page is not turned on, data set via Modbus commands cannot be stored in the internal FlashRom in real time; at the next power-on the register data will revert to the values of the original file.
The user can use the file operation registers to store all setting values into the current or a specified file; at the same time, the data of a specified file can also be recalled into the setting registers.

> **i** You can also turn on the [Auto Save] field on the <File> page so that every setting is saved automatically; the file commands can then be ignored.

13.5.1 Save to Current File [4000]

Send the value 0001 to register 4000, and the instrument will perform the file write operation; all settings will be saved to the current file.
This register cannot be read.
Write

1	2	3	4	5	6	7	8	9	10	11
01	10	40	00	00	01	02	00	01	26	54

	Write	Registers		No. of Regs		Bytes	Data	CRC

Response:

1	2	3	4	5	6	7	8
01	10	40	00	00	01	14	09
		Registers		No. of Regs		CRC	

Where the data values are:

Data	Function	Description
0001	Allowed operation	Fixed value

13.5.2 Reload Current File [4001]

Send the fixed value 0001 to register 4001; the instrument will load the current file data into the system.
This register cannot be read.

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	40	01	00	01	02	00	01	27	85
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0001	Fixed value	

13.5.3 Save to Specified File [4002]

Send the file number to register 4002; the instrument will perform the file write operation, save all settings to the specified file, and use the specified file as the current system file.
This register cannot be read.

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	40	02	00	01	02	00	01	27	85
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000~0009	File 0~9	

13.5.4 Load Specified File [4003]

Send the file number to register 4003; the instrument will load the settings of the specified file into the system and use the specified file as the current system file.
This register cannot be read.

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	40	03	00	01	02	00	01	26	67
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000~0009	File 0~9	

13.6 System Functions

13.6.1 Key Lock [5001]

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	50	01	00	01	02	00	00	F7	84
	Write	Registers		No. of Regs		Bytes	Data		CRC	

13.6.2 Trigger [5002]

Write

1	2	3	4	5	6	7	8	9	10	11
01	10	50	02	00	01	02	00	01	36	77

	Write	Registers	No. of Regs	Bytes	Data	CRC

13.6.3 Resistivity Upper Limit [6000]

Write

1	2	3	4	5	6	7	8	9	10	11	12	13
01	10	60	00	00	02	04	40	00	00	00	4E	6D
	Write	Registers		No. of Regs		Bytes	Data				CRC	

13.6.4 Resistivity Lower Limit [6002]

Write

1	2	3	4	5	6	7	8	9	10	11	12	13
01	10	60	02	00	02	04	40	00	00	00	CF	B4
	Write	Registers		No. of Regs		Bytes	Data				CRC	

13.6.5 Resistivity Cross-Section Area [6004]

Write

1	2	3	4	5	6	7	8	9	10	11	12	13
01	10	60	04	00	02	04	40	00	00	00	4F	9E
	Write	Registers		No. of Regs		Bytes	Data				CRC	

13.6.6 Resistivity Length [6006]

Write

1	2	3	4	5	6	7	8	9	10	11	12	13
01	10	60	06	00	02	04	40	00	00	00	CE	47
	Write	Registers		No. of Regs		Bytes	Data				CRC	

i This command returns an error code only under internal triggering.

14. Specifications

You will learn about the following:
Technical specifications.
General specifications.
Dimensions.

14.1 Technical Specifications

The following data are measured under the following conditions:
Temperature condition: 23℃±5℃
Humidity: ≤65% R.H.
Warm-up time: >30 minutes
Calibration interval: 12 months

AT2513 test current accuracy: ranges 0~5: 10%.
AT2513:

Range		Slow, medium Max. display	Resolution	Fast	Slow	Test current	Test terminal open-circuit voltage
0	3mΩ	3.00000mΩ	0.01μΩ	0.1%±5 counts	0.02%±3 counts	10A	<3.5V
1	30mΩ	32.0000mΩ	0.1μΩ	0.05%±5 counts	0.02%±3 counts	1A	<3.5V
2	300mΩ	320.000mΩ	1μΩ	0.05%±5 counts	0.02%±3 counts	100mA	<3.5V
3	3Ω	3.20000Ω	10μΩ	0.05%±5 counts	0.02%±3 counts	100mA	<3.5V
4	30Ω	32.0000Ω	100μΩ	0.05%±5 counts	0.02%±3 counts	10mA	<3.5V
5	300Ω	320.000Ω	1mΩ	0.05%±5 counts	0.02%±3 counts	1mA	<3.5V

14.2 General Specifications

Screen: TFT-LCD true color display with capacitive touch screen; screen size 5 inches, resolution 800x480.
Test range: 0.00001mΩ~320Ω (AT2513)
Test speed: Manual ranging mode:
Slow: 1 reading/second
Fast: 10 readings/second
Max. reading: 320000
Ranging mode: Auto, manual and nominal
File: Settings saved automatically
Beeper: Off, pass, fail.
Trigger: Internal and external trigger.
Interfaces: Handler interface
RS232 interface, RS485 interface and LAN interface
Temperature compensation interface (optional)
Programming language: SCPI and Modbus (RTU)
Auxiliary function: keyboard lock

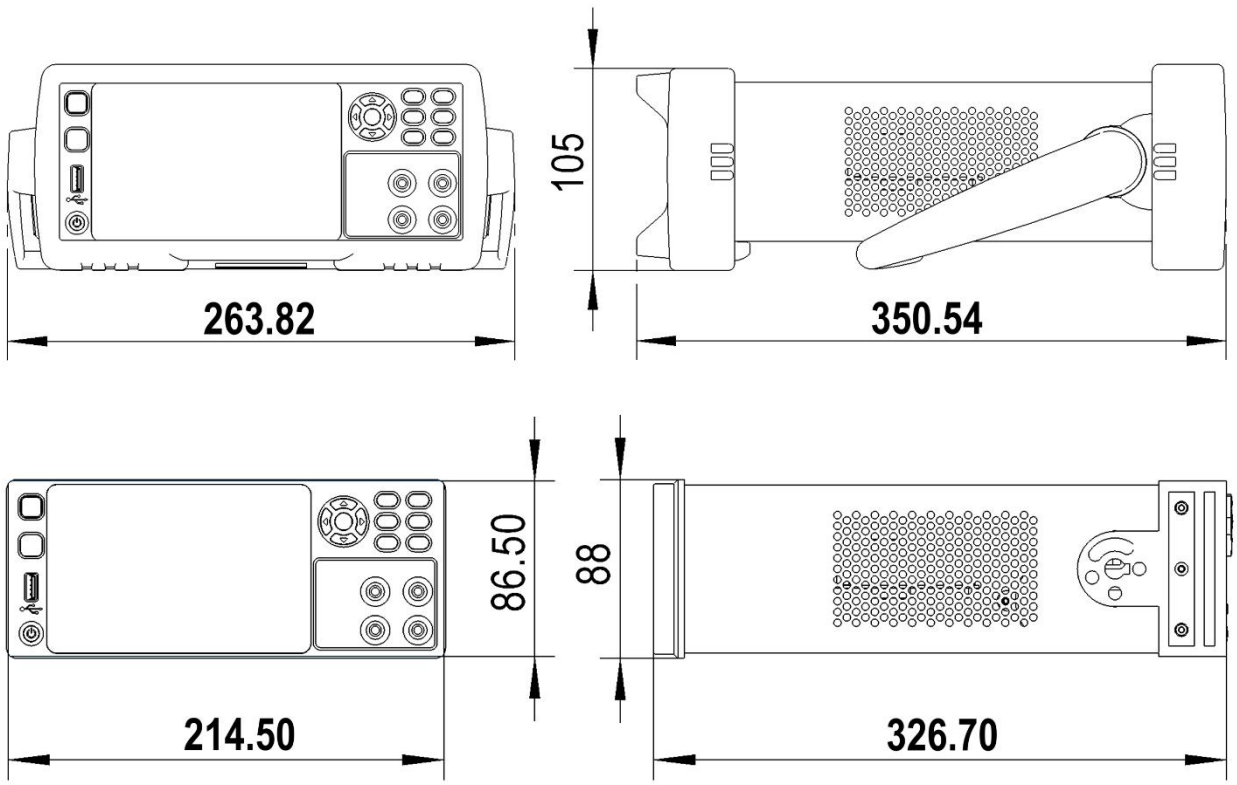
Environment: Rated: temperature 18℃~28℃ humidity ≤ 65% RH

Operation: Temperature 10℃~40℃ Humidity 10~80% RH
Storage: Temperature 0℃~50℃ Humidity 10~90% RH

Power: 100VAC~240VAC
Power consumption: Max. 150VA
Weight: Approx. 3.5 kg.

14.3 Dimensions

(Schematic diagram)



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