ONMEAS®

Rev.A5

AT2617

LCR Meter



User's Guide

Scan QR code for operation video

Safety Precautions

Warning Danger:If any of the following abnormal conditions occurs, stop operation immediately and disconnect the power cord. Contact the Onmeas sales department immediately for repair. Otherwise, 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

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

Disclaimer	Please read the following safety information carefully before using the instrument. Onmeas assumes no liability for any personal injury or property damage caused by the user's failure to comply with the following provisions.
Instrument Grounding	To prevent electric shock hazard, connect the power ground wire properly.
Do Not Using the Instrument in an Explosive Gas Environment	Do not use the instrument in an environment containing flammable or explosive gases, vapors, or excessive dust. Using any electronic equipment in such an environment poses a risk to personal safety.
Do Not Opening the Instrument Enclosure	Non-professional maintenance personnel must not open the instrument enclosure in an attempt to repair the instrument. Charge that has not been fully discharged may remain inside the instrument for some time after it is switched off, which may cause an electric shock hazard to persons.
Do Not Using a Damaged Instrument	If the instrument has been damaged, the hazards are unpredictable. Disconnect the power cord, do not use the instrument again, and do not attempt to repair it yourself.
Do Not Using an Instrument Operating Abnormally	If the instrument is not operating normally, the hazards are unpredictable. Disconnect the power cord, do not use the instrument again, and do not attempt to repair it yourself.
Do Not Using the Instrument Beyond the Methods Specified in This Manual	Beyond the specified scope, the protective measures provided by the instrument will become ineffective.

Limited Warranty and Limitation of Liability

Onmeas Ltd. (hereinafter referred to as Onmeas) warrants that every AT261X 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. Damage caused by improper operation of the user during the ninety-day replacement period terminates the replacement terms. During the one-year warranty period, damage to the instrument caused by improper operation of the user shall be repaired at the user's expense. After one year and for the lifetime of the instrument, Onmeas provides repair services on a charged basis. For the replacement of VFD or LCD, the fee is charged at the current cost price.

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

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

People's Republic of China
Jiangsu Province
Onmeas Ltd.
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1. Installation and Setup Guide

Thank you for purchasing our product! Please read this chapter carefully before use.
In this chapter, you will learn about 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 AT261X can only be used under the following power conditions:
Voltage: 90V-260VAC
Power: maximum 30VA



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 AT261X must be used under the following environmental conditions:
Temperature: 0°C~55°C,
Humidity: below 70%RH at 23°C

1.4 Cleaning

To prevent electric shock hazard, disconnect the power cord before cleaning.
Use a clean cloth dampened with a little clean water to clean the enclosure and panel. Do not clean the interior of the instrument.

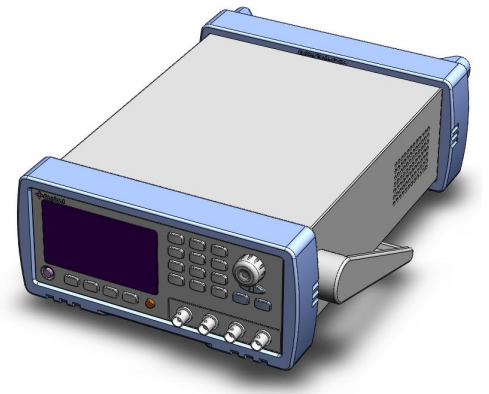


Note: Do not use solvents (such as alcohol or gasoline) to clean the instrument.

1.5 Instrument Handle

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

Figure 1- 1 Instrument Handle (Schematic; the panel drawing differs from the actual unit)



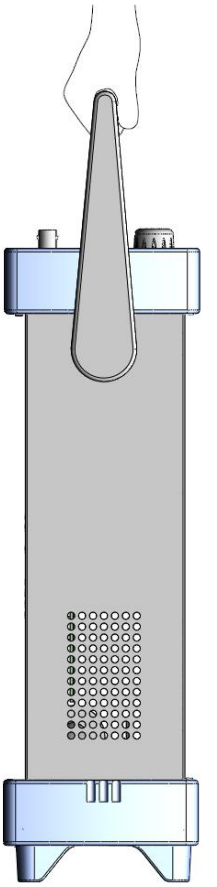
Viewing position 1 [Hold both sides of the handle with both hands and pull it gently outward until it can rotate freely, then switch to viewing position 2]

↓

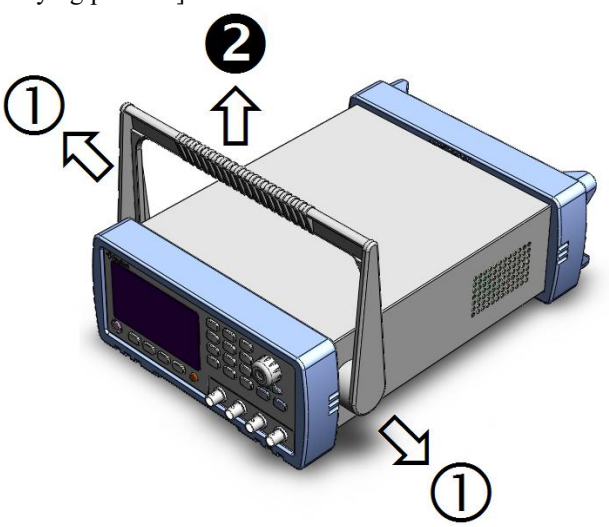


Viewing position 2 [Hold both sides of the handle with both hands and pull it gently outward until it can rotate freely, then switch to the carrying position]

→



Carrying position



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

2. Overview

In this chapter you will learn the following:

- Introduction
- Measurement Functions
- Signal Source
- Main Features

2.1 Introduction

Thank you for purchasing the AT261X series capacitance tester.

The AT261X is a capacitance tester, a micro bench-top instrument for fully automatic real-time testing controlled by a high-performance 32-bit ARM microprocessor. The instrument offers test frequencies up to 200kHz (AT2616) and selectable test signal levels of 0.1V, 0.3V, 0.5V and 1.0Vrms.

Primary and secondary parameters are displayed with 6 digits each, and one of Z, R, Δ, Δ% can be displayed at the same time. With accuracy up to 0.1%, the instrument meets the requirements of automation equipment manufacturers, component producers and users, schools, research institutes and metrology/quality inspection departments for accurate testing and mass production.

The instrument has a professional sorting function with 10 storage files, 3 programmable pass bins, 1 auxiliary bin (secondary parameter fail), 1 fail bin and primary-parameter HI/IN/LO bins. Percentage sorting or absolute-value sorting can be set. Equipped with a USB interface, a Handler interface and an RS-232C interface, it is applied in automatic sorting systems for fully automatic assembly-line testing. The improved design of the AT261X strengthens the anti-interference and protection circuits, meeting the complex operating environment of automation equipment (sorters, aging machines, etc.).

The instrument supports 2 communication protocols: the computer remote control commands are compatible with SCPI (Standard Command for Programmable Instrument, the standard command set for programmable instruments) and the Modbus communication protocol, efficiently accomplishing remote control and data acquisition functions.

For complete technical specifications, see 11. Specifications.

2.2 Measurement Functions

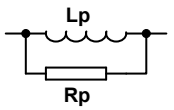
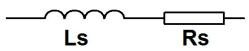
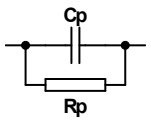
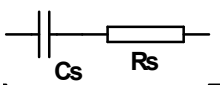
2.2.1 Measurement Parameters

Measurement parameters: Cs-Rs, Cs-D, Cp-Rp, Cp-D, Rs-Q, Rp-Q, Z-D, Z-Q.
Where:
C: capacitance R: resistance Z: impedance D: dissipation Q: quality factor
The subscript s indicates the series equivalent, and p indicates the parallel equivalent

2.2.2 Equivalent Circuit

Series, parallel.
Actual capacitors, inductors, and resistors are not ideal purely reactive or purely resistive components; they usually contain both resistive and reactive components. Any actual impedance component can be modeled by an ideal resistor and an ideal reactor (inductor or capacitor) in series or parallel form.
The two forms can be converted mathematically by formulas, but the two forms are different, and their discrepancy depends on the quality factor Q (or dissipation factor D).

Table 2- 1 Series/Parallel Equivalent Circuits

Circuit Form		Dissipation factor D	Equivalent circuit conversion
L		D=2πFLp/Rp=1/Q	Ls=Lp/(1+D²) Rs=RpD²/(1+D²)
		D=Rs/2πFLs=1/Q	Lp=(1+D²)Ls Rp=(1+D²)Rs/D²
C		D=1/2πFCpRp=1/Q	Cs=(1+D²)Cp Rs=RpD²/(1+D²)
		D=2πFCsRs=1/Q	Cp=Cs/(1+D²) Rp=Rs(1+D²)/D²

The definitions of Q, D, and Xs are: Q=Xs/Rs, D=Rs/Xs, Xs=1/2πFCs=2πFLs

Recommendations:

In general, the series equivalent circuit is used for components with a low impedance value Z (for example, high-value capacitors and low-value inductors); conversely, the parallel equivalent circuit is used for components with a large impedance value Z (low-value capacitors and high-value inductors).
Meanwhile, the equivalent circuit must also be determined according to the actual application of the component. For example, for a capacitor, the series equivalent circuit is used for power supply filtering, while the parallel equivalent circuit is used in an LC oscillation circuit.

2.2.3 Range

Measurement uses 9 ranges. Auto, lock, and nominal ranges.
Nominal range (a new term defined by Onmeas): the instrument automatically selects the optimal range according to the nominal value.

2.2.4 Test Speed

The instrument provides three speed settings: slow, medium and fast.
Fast: 30 readings/second
Medium: 10 measurements/second
Slow: 3 measurements/second
In addition, a programmable averaging count of 1-256 is available to improve reading stability.

2.2.5 Trigger Mode

Internal, external, manual, and remote triggering.

2.2.6 Basic Accuracy

0.1%

2.2.7 Measurement Display Range

Table 2-2 AT261X Display Range

Parameters	Measurement Display Range
C	0.0001pF ~ 9.9999mF
R, Z	0.0001Ω ~ 99.999MΩ
D	0.0001 ~ 9.9999
Q	0.0001 ~ 9999.9
%	-999.999% ~ 999.999%

2.3 Signal Source

2.3.1 Test Frequency

AT2610: 100, 120, 1kHz, 10kHz
AT2617: 100, 120, 1kHz, 10kHz, 100kHz
AT2616: 100, 120, 1kHz, 10kHz, 100kHz, 200kHz
Frequency accuracy: 0.01%

2.3.2 Test Signal Level

ACV: 0.1V, 0.3V, 0.5V, 1.0Vrms, accuracy: 10%

2.3.3 Constant Voltage Source Resistance

Can be set to 30Ω or 100Ω

2.4 Main Features

2.4.1 Calibration Function

Open zeroing: eliminates the influence of stray impedance at the test terminals and inside the instrument.
Sweep open zeroing.
Short zeroing: eliminates the influence of the series resistance and inductance of the test leads.
Sweep short zeroing.

2.4.2 Comparator Function (Sorting Function)

The instrument can perform multi-bin sorting. The sorting compares measured values and is independent of the deviation mode.
Pass bins (BIN1-BIN3): both the primary and secondary parameters pass;
AUX bin: when the AUX bin is enabled, indicates that the primary parameter passes but the secondary parameter fails;
OUT bin: the primary parameter fails, or, when the AUX bin is disabled, the primary parameter passes but the secondary parameter fails.
HI/IN/LO: more detailed comparison results of the primary parameter, HI: the primary parameter is high, LO: the primary parameter is low, IN: the primary parameter passes

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 ΔTOL 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
All comparator results have corresponding IO port outputs on the Handler interface.

2.4.3 File Function

The internal Flash memory of the instrument has 10 files for you to save instrument data. These data include:

1. All parameters on the <Setup> page
2. Setup data on the <Comparator Settings> page

2.4.4 System Settings

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

2.4.5 Interfaces

USB host interface:
Used to save screen images, setup parameters, and measurement data to a USB flash drive.
USB communication interface:
Supports a baud rate of up to 115200bps, compatible with the SCPI protocol and the Modbus RTU protocol.

RS-232 remote control:
Supports a baud rate of up to 115200bps, compatible with the SCPI protocol and the Modbus RTU protocol.
Handler interface
Input/output ports with full optocoupler isolation and built-in pull-up resistors.
Supports an external power supply of up to 30V.
Input: trigger signal,
Output: all sorting comparison result signals and list sweep comparison result signals; measurement synchronization signals (IDX, EOM).
GPIB Interface
Optional.

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.
- Display information — prompt messages encountered during instrument startup and use.
- 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- 2 Front Panel

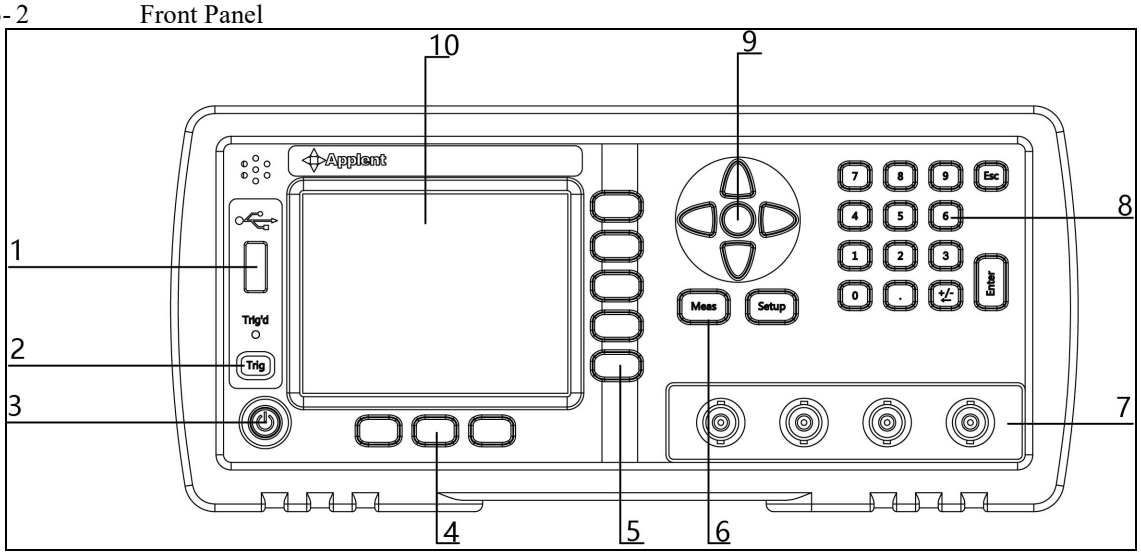
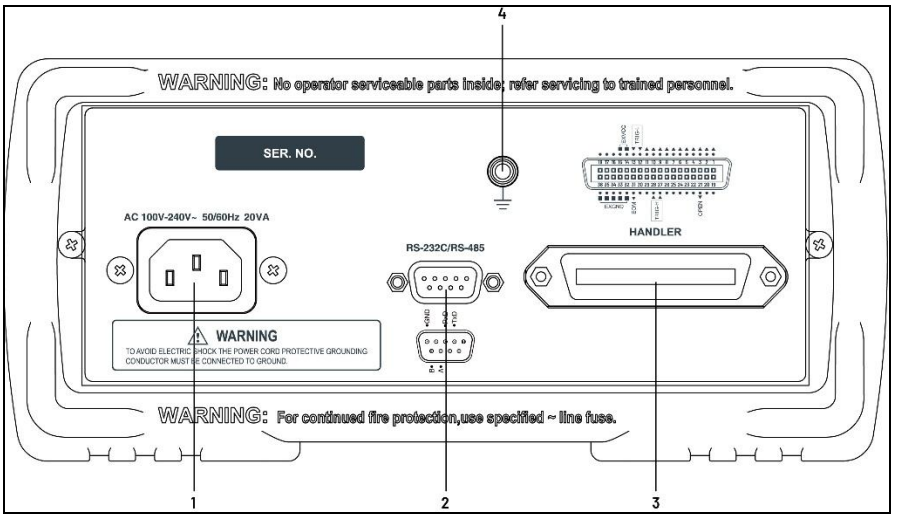


Table 3- 3 Front Panel Function Description

No.	Function
1	USB drive interface
2	Manual trigger key, and manual or remote trigger indicator lights
3	Power switch. Tact switch ⚠ Warning: To ensure the safety of the internal power supply, the instrument must wait 2 seconds after being switched off before it can be started again.
4	System function keys, including File, System, keyboard lock, etc.
5	Soft keys
6	Main function keys: Measure and Setup
7	Test terminals: the input terminals are used to connect a 4-terminal test fixture or Kelvin test clips. Hcur High terminal - current terminal Hpothigh terminal - voltage terminal Lpot Low terminal - voltage terminal Lcur Low terminal - current terminal
8	Numeric keypad
9	Cursor keys
10	LCD display window

3.1.2 Getting to Know the Rear Panel

Figure 3- 3 Rear Panel



1. Power socket.
2. RS-232/RS485 interface.
3. HANDLER interface.
4. Grounding post (earth).

3.2 Power-On Startup

3.2.1 Powering On

Power switch at the lower left of the panel. The key is a momentary switch; press the power switch key for 1s, and the instrument will start up or shut down.

To ensure the safety of the internal power supply, wait 2 seconds after the instrument is turned off before starting it.

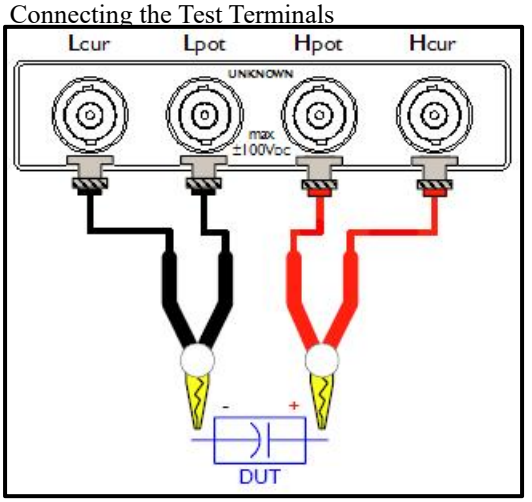
3.2.2 Warm-up Time

To achieve the specified accuracy, the instrument requires a warm-up of at least 30 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.

Figure 3- 4 Connecting the Test Terminals



Warning: Do not apply DC voltage or current to the test terminals, otherwise the instrument will be damaged.
Warning: For charged devices, make sure the charge is fully discharged before measurement.

Test fixtures and cables:

We recommend that you use our company's test fixtures or test cables; self-made test fixtures or test cables, or those from other companies, may lead to incorrect measurement results.

The contact spring plates of our test fixtures are silver-plated or gold-plated; long-term operation (for example, 1~2 years) will wear the plated surfaces. We recommend that you promptly replace the fixture with a new one when you find obvious deviations in several tests.

Connect the test fixture or test cable to the four test terminals Hcur, Hpot, Lcur, and Lpot on the front panel of the instrument.

Note	If no test fixture or test cable is installed, the instrument will display an unstable measurement result.

4. [Meas] Main Measurement Page

In this chapter you will learn about all of the measurement display functions:

- Measurement display page
- Bin No. Display page
- Bin Count page
- List Sweep page

4.1 <Measurement Display> Page

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

<Measurement Display>This page primarily highlights the measurement result, and also displays the current sorting result in small characters.
The primary and secondary test results are displayed in large characters in this area, and the monitor area is displayed in small characters.
In the lower half of the screen, some settings related to measurement are displayed in this area, and the comparator result of the current test is also displayed here.

Figure 4- 5 <Measurement Display> Page



4.1.1 Measurement [Function]

The instrument can test multiple parameters in one measurement cycle, including the primary/secondary parameters and 1 monitor parameter.

Note

Monitor parameters need to be set on the [Setup] page; initially, the monitor parameters are set to off.

Measurement parameters:

Table 4- 4 All Measurement Parameters

Cs-Rs	Cs-D	Cp-Rp	Cp-D
Rs-Q	Rp-Q	Z-D	Z-Q

- Monitor parameters:

Table 4- 5 All Monitor Parameters

Z	R	Δ	Δ%

- Parameter descriptions:

Table 4- 6 Parameter Description

Parameters	Description
Cs	Capacitance value measured using the series equivalent circuit model
Cp	Capacitance value measured using the parallel equivalent circuit model
Rs	Series equivalent resistance
Rp	Parallel equivalent resistance
Z	Absolute value of impedance

R	Resistance (=Rs)
D	Dissipation factor (also called loss factor, =tanθ)
Q	Quality factor (=1/D)
Δ	Absolute deviation value
Δ%	Relative deviation value

■ Steps for setting the measurement function

Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Measurement Display] key to switch to the <Measurement Display> page;
Step 3 Use the cursor keys to select the [Function] field;
Step 4 Use the soft keys to select the combination of primary and secondary parameters

4.1.2 Test [Range]

Table 4- 7 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, especially at low frequencies.
Lock	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	The instrument automatically selects the optimum range for testing according to the nominal value.	The best mode for sorting tests. The speed is the fastest.	Only suitable for sorting tests.

■ Parameter descriptions:

The instrument has 9 ranges: 10Ω, 30Ω, 100Ω, 300Ω, 1kΩ, 3kΩ, 10kΩ, 30kΩ, 100kΩ.
During testing, the instrument selects a suitable range according to the impedance of the DUT.

Table 4- 8 Ranges and the Corresponding Test Ranges

Range number	Range definition	Impedance measurement range
8	10Ω	0 ~ 10Ω
7	30Ω	10Ω ~ 100Ω
6	100Ω	100Ω ~ 316Ω
5	300Ω	316Ω ~ 1kΩ
4	1kΩ	1kΩ ~ 3.16kΩ
3	3kΩ	3.16kΩ ~ 10kΩ
2	10kΩ	10kΩ ~ 31.6kΩ
1	30kΩ	31.6kΩ ~ 100kΩ
0	100kΩ	100kΩ ~

■ Steps for setting the test range:

Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Measurement Display] key to switch to the <Measurement Display> page;
Step 3 Use the cursor keys to select the [Range] field;
Step 4 Use the soft keys to select auto range, manual range, or select a range

Soft key	Function
Auto range	The instrument will select the range automatically
Lock range	The instrument is locked on the current range
Nominal range	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

Note

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 [Frequency]

AT2610: 100, 120, 1kHz, 10kHz
AT2617: 100, 120, 1kHz, 10kHz, 100kHz
AT2616: 100, 120, 1kHz, 10kHz, 100kHz, 200kHz
Frequency accuracy: 0.01%

■ Steps for setting the test frequency:

Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Measurement Display] key to switch to the <Measurement Display> page;
Step 3 Use the cursor keys to select the [Frequency] field;
Step 4 You can:
Use the soft keys to increase or decrease the frequency;
Enter the data directly, and use the soft keys to enter the unit.

Soft key	Function
100Hz	
120Hz	
1kHz	
10kHz	AT2610
100kHz	AT2617
200kHz	AT2616

4.1.4 [Trigger] Settings

The instrument has 4 trigger modes:
Internal trigger, manual trigger, external trigger, and remote trigger.

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

■ Steps for setting the trigger mode:

Step 1 Press the [Meas] key to enter the main measurement page;
Step 2 Press the [Measurement Display] key to switch to the <Measurement Display> page;
Step 3 Use the cursor keys to select the [Trigger] field;
Step 4 Use the soft keys to select the trigger mode.

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

4.1.5 Test [Level]

The test level of the instrument is set as the true RMS value of the sine-wave signal. The frequency of the sine-wave signal is the test frequency, and it is generated by the internal oscillator of the instrument.
The instrument provides 4 test levels for selection: 0.1V, 0.3V, 0.5V and 1.0V
The output impedance of the signal source can be set to 30Ω or 100Ω. Usually 30Ω output impedance is more suitable.
If you have no specific level requirement, specify a level of 1V for testing.

■ Steps for setting the test level:

Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Measurement Display] key to switch to the <Measurement Display> page;
Step 3 Use the cursor keys to select the [Level] field;
Step 4 You can use the soft keys to select

Soft key	Function
0.1V	
0.3V	
0.5V	
1.0V	

4.1.6 Test [Speed]

The instrument provides 3 test speeds (slow, medium and fast). The slower the speed, the more accurate and stable the test results.

■ Steps for setting the test speed:
Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Measurement Display] key to switch to the <Measurement Display> page;
Step 3 Use the cursor keys to select the [Speed] field;
Step 4 Use the soft keys to select

Soft key	Function
Slow	Longest measurement cycle, about 3 readings/second at 1kHz
Medium	Moderate, about 10 readings/second at 1kHz
Fast	Fastest measurement, about 30 readings/second at 1kHz

Note:

1. The measurement speed refers to the time from the Handler interface trigger to the end of the measurement (EOM) output.
Page: <Bin No. Display>
Range: lock range or nominal range
Averaging: 1
Monitor: off

Speed (ms)	100Hz	1kHz	10kHz~200kHz
SLOW	470	340	329
MED	150	92	90
FAST	90	30	22

4.1.7 Information Bar of the <Measurement Display> Page

Below the test results, the instrument provides some information related to measurement; this information is modified on the main [Setup] page and is shown here for reference.
In addition, the comparator result is also displayed in the information bar.
Calibration information is also displayed in the information bar.
The status information bar also includes a line of help information; when selecting with the cursor keys, the help information provides relevant hints.

4.2 <Bin No. Display> Page

Press the [Meas] key, and use the soft keys to enter the [Bin No. Display] page.

Figure 4- 6 <Bin No. Display> Page



Settings bar: the settings area of the Bin No. Display page is roughly the same as that of the [Measurement Display] page. These settings include:

- Function
- Range
- Freq
- Trigger
- Level
- Speed
- Comparator
- AUX bin

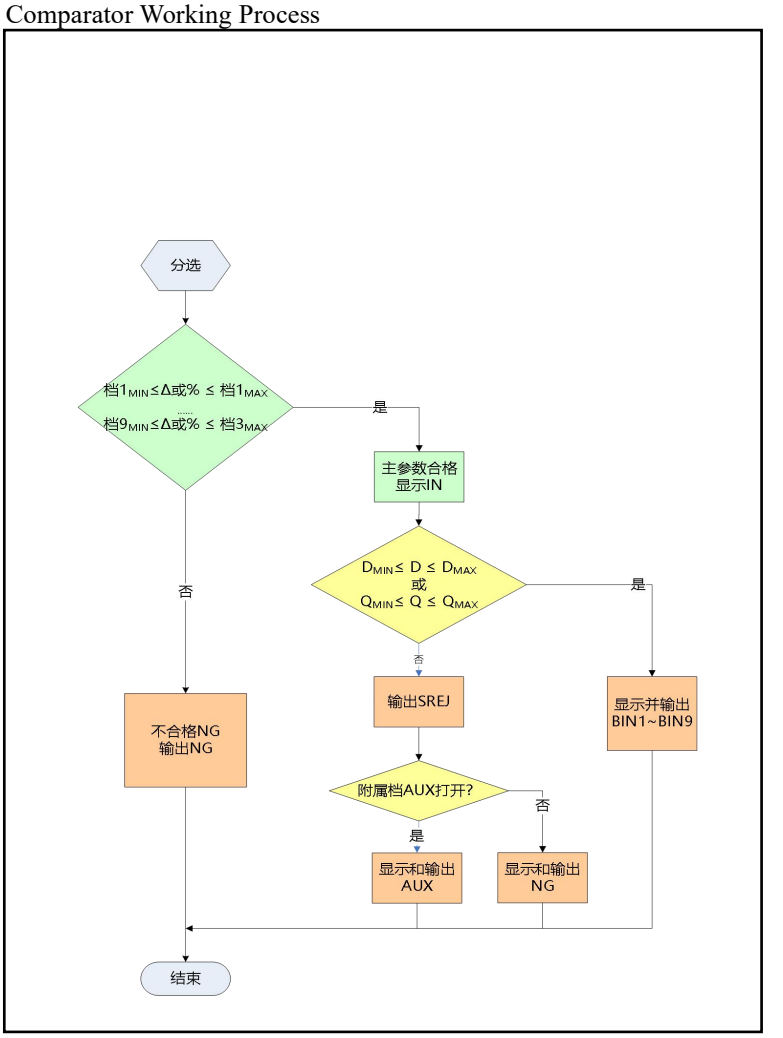
8 items in total.
The comparator result is displayed here in large characters, and the primary and secondary test results are displayed in small characters in this area.
In the lower half of the screen, some settings related to the comparator are displayed in this area.

4.2.1 [Comparator] Switch

The built-in comparator can sort 3 groups of primary parameters and 1 group of secondary parameters, classifying them into up to 5 bins (BIN 1~BIN 3, AUX and OUT). Devices whose primary parameter passes but secondary parameter fails can also be classified into the auxiliary bin (AUX).
The comparator can be turned off.

■ Comparator workflow:

Figure 4- 7 Comparator Working Process



■ Steps for turning the comparator on or off:

Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Bin No. Display] key to switch to the <Bin No. Display> page;
Step 3 Use the cursor keys to select the [Comparator] field;
Step 4 Use the soft keys to select

Soft key	Function
Off	The comparator is turned off; the measurement bar displays OFF
On	The comparator is turned on; the measurement bar displays the sorting result of the current measurement.

4.2.2 [Auxiliary] Bin Switch

If the user does not need to sort the secondary parameter, the AUX bin (AUX) can be turned off. After it is turned off, the secondary parameter limits will not be judged during measurement.

■ Steps for turning the AUX bin on or off:

Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Bin No. Display] key to switch to the <Bin No. Display> page;
Step 3 Use the cursor keys to select the [AUX bin] field;
Step 4 Use the soft keys to select

Soft key	Function
Off	The AUX bin is turned off
On	The AUX bin is turned on

4.2.3 Information Bar of the <Bin No. Display> Page

The information bar displays the settings related to the comparator, including the nominal value, comparison mode, secondary parameter limit values, and the limit range of bin 1.
At the same time, calibration information is also displayed in the information bar.

4.3 <Bin Count> Page

Press the [Meas] key, and use the soft keys to enter the [Bin Count Display] page.

Figure 4- 8 <Bin Count Display> Page



The <Bin Count Display> page will display the counting results of the comparator.
Settings bar:

- Bin count

Information bar:
The information bar monitors the following counts:

- Count values of Bin1~Bin9
- 2nd failed secondary parameter count [AUX]
- Failure count [OUT]

To set the conditions, they need to be modified in the <Comparator Settings> page of the main [Setup] page.

4.3.1 [Counter] Function

The instrument counts the pass or fail of each bin; the maximum count value is 999999. When this value is exceeded, the counter stops and displays ------.

■ Counter settings:

Step 1 Press [Meas] to enter the main measurement page;
Step 2 Press the [Bin Count] key to switch to the <Bin Count Display> page;
Step 3 Use the cursor keys to select the [Counter] field;
Step 4 Use the soft keys to select

Soft key	Function
Bin count on	
Bin count off	
-	
-	
Reset bin counts	All counts are reset to 0

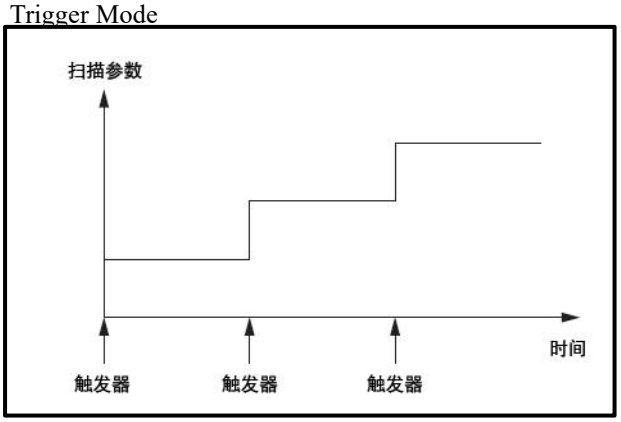
4.3.2 [Trigger] Mode

The instrument performs the sweep according to the trigger mode. Manual triggering is usually used; therefore, when entering the page, the trigger mode is set to manual by default, and one sweep is performed automatically.

Table 4- 9 Trigger Mode Description

Soft key	Function
Internal	Internal trigger: the instrument continuously sweeps the set sweep points in a cycle.
Manual	Manual trigger: the instrument sweeps one point each time the [Trig] key is pressed.
External	External trigger: the instrument sweeps one test point each time it receives a trigger pulse from the Handler interface.
Remote	Remote trigger: the instrument sweeps one test point when it receives a trigger command from the RS232 interface.

Figure 4- 9 Trigger Mode



4.3.3 Scan [Mode] Settings

The <List Sweep Display> page performs swept-frequency or level value tests on up to 10 list points.

When the test [Mode] is set to sequential and [Trigger] is set to manual, the sweep function automatically executes each test step in the list in order until the last step. It will then wait for the trigger button to be pressed.

When the test [Mode] is set to single-step and [Trigger] is set to manual, the sweep function automatically executes the first test step, then stops and waits for the trigger button to be pressed before executing the next step.

The instrument performs the sweep according to the trigger mode. Manual triggering is usually used; therefore, when entering the page, the trigger mode is set to manual by default, and one sweep is performed automatically.

Table 4- 10 Scan Mode

Soft key	Function
Sequential	One trigger sweeps all test points
Manual	One trigger sweeps only one test point.

5. [Setup] Page

In this chapter, you will learn about all of the setting functions:
Measurement Settings
User calibration
Comparator Settings
List setup

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

5.1 Measurement Settings

All settings related to measurement are performed on the <Setup> page.
On the <Setup> page, the instrument does not display test results or comparator results, but testing of the instrument is still in progress.
Some of these settings can also be set by the user on the <Measurement Display> page and the <Bin No. Display> page.
For the setting method, refer to 4.1<Measurement Display> page.

Figure 5- 10 <Settings> Page



5.1.1 Source Resistance

The source resistance is also called the output impedance.
The instrument has 2 built-in source resistances: 30Ω and 100Ω.
After the test level Vs is set, the test current Is flowing through the DUT is determined jointly by the impedance of the DUT, Zx=Rx+jXx, and the source resistance Rs, that is:

$$Is=\frac{Vs}{|Rs+Rx+jXx|}$$

Since the measured value of some devices under test, such as high-permeability core inductors, varies with the magnitude of the test current (i.e. they are current-sensitive), at the same test level different source resistances inevitably lead to different measurement results. The selectable source resistance makes it easy for current-sensitive devices to obtain relatively consistent measurement results. This instrument offers two source output resistances; the default is 100Ω.
KEYSIGHT LCR meters (e.g. E4980A) have a 100Ω source resistance; users who need to compare data with such instruments should change the source resistance of this instrument accordingly.
For non-current-sensitive, especially low-impedance, devices under test, we recommend the 30Ω source resistance.

■ Steps for setting the source resistance:

Step 1 Press the [Setup] key to enter the Setup main page;
Step 2 Use the cursor keys to select the [Source Resistance] field;
Step 3 Use the soft keys to select

Soft key	Function
30Ω	30Ω source resistance; if you have no requirement on the source resistance, 30Ω is recommended.
100Ω	100Ω source resistance

5.1.2 [Averaging] Count

Averaging is the most commonly used form of digital filtering; the "count" is the depth of the filter. Its purpose is to take multiple measurements and use the averaged result as the final displayed value, which improves the stability and reliability of the measurement results. The averaging count ranges from the positive integers 1 to 256.

■ Steps for setting the averaging count:

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

Soft key	Function
Increase +	Increases the averaging count in steps of 1, 2, 4, 8, 16, 32, 64, 128, and 256.
Decrease -	Decreases the averaging count in steps of 1, 2, 4, 8, 16, 32, 64, 128, and 256.

5.1.3 [Monitor] Parameter Selection

The instrument can monitor two other parameters while measuring the primary and secondary parameters.

Note
The additionally added monitor parameters do not increase the processing time of the instrument.
The default value of the instrument is “Off”.
Monitor parameters are displayed only on the [Measurement Display] page.
For the explanation of the monitor parameter terms, refer to Table 4-6.

■ Steps for setting the monitor parameter:

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

Soft key	Function
Off	Monitor parameter is off
Z	Absolute value of impedance
R	Resistance
Δ	Absolute deviation
Δ%	Relative deviation

5.1.4 Measurement [Delay]

The delay time before each test can be set with the test [Delay] timer of the instrument, which is used to wait for the station to be ready before testing.
The maximum delay time is 60s, and the minimum delay time is 1ms.

5.1.5 [Nominal Value] Setting

For convenience, when the [Monitor 1] function is set to Δ or Δ%, the nominal value field is shown on the <Settings> page.
This nominal value is synchronized with the nominal value on the <Comparator Settings> page.

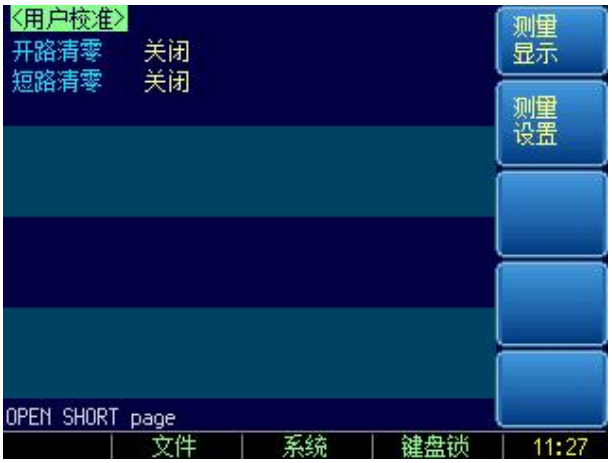
5.2 User Calibration

Press the [Setup] key, then press the [User Calibration] soft key to enter the <User Calibration> page.
On this page, the user can perform open/short/load calibration to compensate for any errors caused by external interference factors, such as stray admittance and residual impedance.

Note
Open zeroing and short zeroing are required to achieve the accuracy specified in the technical specifications.
Load calibration refers to linear correction of the instrument using a known standard; usually users do not need to use this function.
After replacing the test fixture or test cable, perform open and short zeroing again.
When the temperature changes greatly, perform open and short zeroing promptly.
Small ranges depend heavily on open zeroing, and large ranges depend heavily on short zeroing.

Calibration based on all frequency points. This calibration performs full open and short zeroing at all frequency points in the entire frequency range.

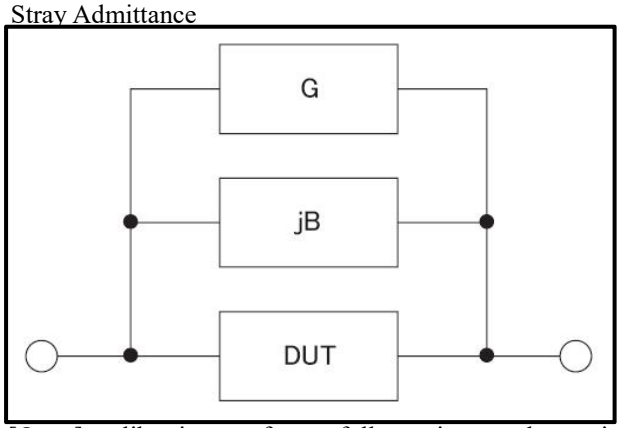
Figure 5- 11 User Calibration Page



5.2.1 [Open] Calibration

The open calibration function of the instrument compensates for any stray admittance (G,B) that may exist between the calibration plane, determined by the length of the test cable, and the DUT connection point.

Figure 5- 12 Stray Admittance



[Open] calibration performs full zeroing at the typical frequencies of the instrument. These frequency points vary with the instrument version:

For these typical frequencies, refer to the “frequently used frequency list” under test frequency.

■ Open calibration method

Step 1 Press the [Setup] key to enter the Setup main page, then press the [User Calibration] key to enter the <User Calibration> page;

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

Step 3 Use the soft keys to select

Soft key	Function
On	Turns on the open calibration function
Off	Turns off the open calibration function; the zeroing value does not participate in the measurement calculation.
Open full zeroing	Performs full-frequency open zeroing.

Step 4 Press the [Open full zeroing] key, and the instrument prompts you to open the test fixture.

Step 5 Keep the test fixture or test cable open; do not place any DUT, and do not allow contact with any object.

Step 6 After [OK] is pressed, the instrument starts zeroing

During calibration, a progress bar is displayed at the bottom of the page, and the “Trig’d” indicator blinks.

After calibration is complete, the progress bar disappears, and “Calibration complete.” is displayed in the help prompt line.

During calibration, the user can press the [Abort] key at any time to cancel the calibration.

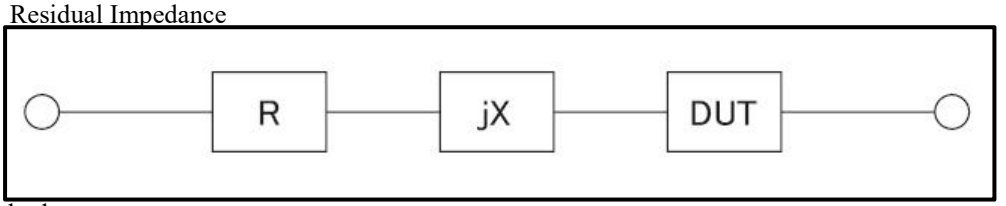
Step 7 Press [On] to enable open zeroing.

5.2.2 [Short] Calibration

The short calibration function of the instrument compensates for any residual impedance (R,X) that

may exist between the calibration plane, determined by the length of the test cable, and the DUT connection point (see the figure below).

Figure 5- 13 Residual Impedance



■ Short calibration method

Step 1 Press the [Setup] key to enter the Setup main page, then press the [User Calibration] key to enter the <User Calibration> page;

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

Step 3 Use the soft keys to select

Soft key	Function
On	Turns on the short calibration function
Off	Turns off the short calibration function; the zeroing value does not participate in the measurement calculation.
Short full zeroing	Performs full-frequency short zeroing.

Step 4 Press the [Short full zeroing] key, and the instrument prompts you to short the test fixture.

Step 5 Short the test fixture with the shorting plate, or clamp the test cable leads together; do not place any DUT, and do not allow contact with any object.

Step 6 After [OK] is pressed, the instrument starts zeroing

During calibration, a progress bar is displayed at the bottom of the page, and the “Trig’d” indicator blinks.

After calibration is complete, the progress bar disappears, and “Calibration complete.” is displayed in the help prompt line.

During calibration, the user can press the [Abort] key at any time to cancel the calibration.

Step 7 Press [On] to enable short zeroing.

5.3 Comparator Settings

Press the [Setup] key, then press the [Comparator Settings] soft key to open the <Comparator Settings> page.

The <Comparator Settings> page helps the user configure the built-in comparator of the instrument. The comparator can use 3 groups of primary parameter limits and 1 group of secondary parameter limits. The sorting comparator classifies the devices under test into 11 bins (BIN1 to BIN3, AUX and OUT).

The comparator also has a bin count function and can count up to 999999 DUTs.

To make full use of the comparator, the instrument has a built-in Handler interface for outputting these bin comparison results to a PLC or an industrial computer.

Figure 5- 14 <Comparator Settings> Page



5.3.1 [Function] Setting

The instrument can make independent settings for all test functions and saves them in separate

internal storage spaces.
Before setting the comparator parameters, select a test [Function] consistent with the parameters set on the measurement page.

5.3.2 [Comparator] Switch

The built-in comparator can sort 3 groups of primary parameters and 1 group of secondary parameters, classifying them into up to 5 bins (BIN 1~BIN 3, AUX and OUT OF BIN). Devices whose primary parameter passes but secondary parameter fails can also be classified into the auxiliary bin (AUX).
The comparator can be turned off.

■ Steps for turning the comparator on or off:

Step 1 Press [Setup] to enter the Setup page;
Step 2 Press the [Comparator Settings] key to switch to 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	The comparator is turned off; the measurement bar displays OFF
On	The comparator is turned on; the measurement bar displays the sorting result of the current measurement.

Note: The comparator is turned off, and bin counting also stops, regardless of whether bin counting is turned on.

5.3.3 Comparison [Mode]

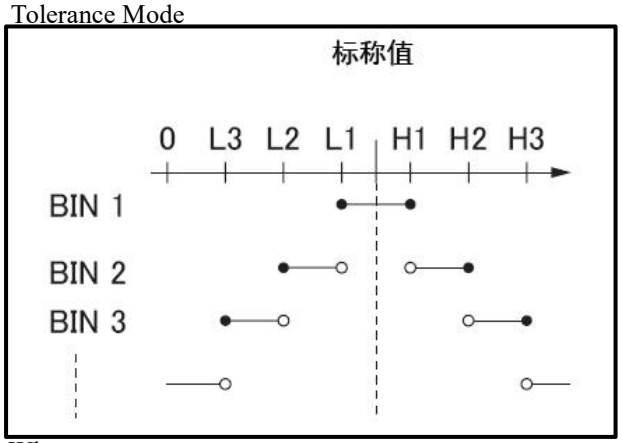
The comparison mode applies only to the primary parameter.
The built-in comparator of the instrument has three comparison modes:

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

■ Absolute value Δ and relative value Δ% modes:

The absolute value Δ and relative value Δ% modes are together called the tolerance mode; its principle is as follows:

Figure 5- 15 Tolerance Mode

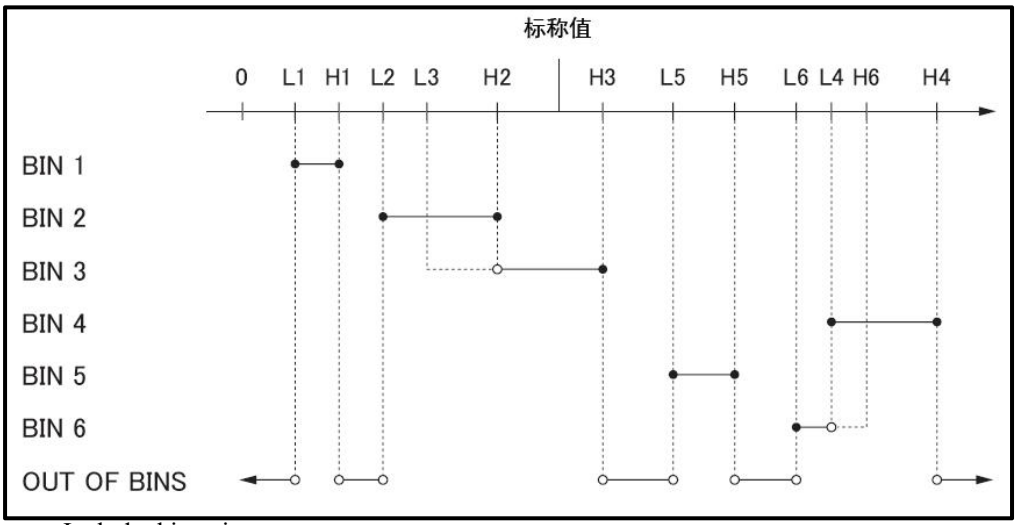


Where:
Nominal value: the tolerance modes require entering a nominal value.

- ● Include this point
- ○ Exclude this point

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

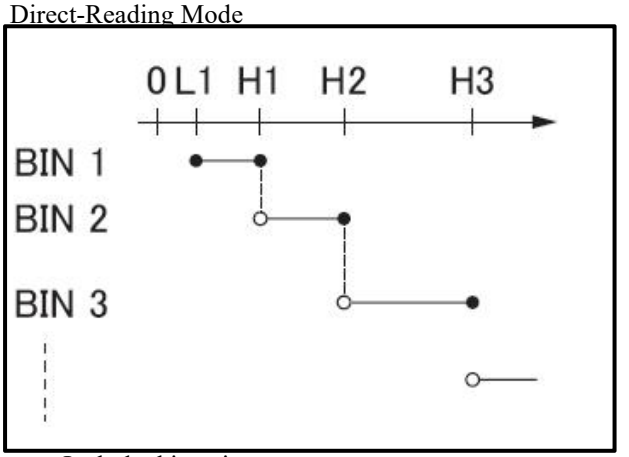
Figure 5- 16 Example Illustrating the Sorting Mechanism of the Tolerance Mode



● Include this point
○ Exclude this point

■ Direct reading SEQ mode:

Figure 5- 17 Direct-Reading Mode



● Include this point
○ Exclude this point

The direct reading SEQ comparison compares the directly read measured value with the upper and lower limit range of the bin, so no nominal value is involved.

■ 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

5.3.4 [Nominal] Value Entry

The absolute and percent comparison modes require entering a nominal value. In the direct reading comparison mode the nominal value is not considered; it does not matter whether it is set.

Note

When using a negative nominal value, be sure to set the lower limit to a value higher than the upper limit, because when converted to absolute values the lower limit value becomes greater than the upper limit value

The entered nominal value corresponds to the primary parameter of the test [Function].

■ Enter the nominal value:

Step 1 Enter the <Comparator Settings> page

Step 2 Use the cursor keys to select the [Mode] field;
Step 3 Enter data with the numeric keys, and select the unit with the soft keys.

5.3.5 [Auxiliary] Bin Switch

If the user does not need to sort the secondary parameter, the AUX bin (AUX) can be turned off. After it is turned off, the secondary parameter limits will not be judged during measurement.

■ Steps for turning the AUX bin on or off:

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

Soft key	Function
Off	The AUX bin is turned off
On	The AUX bin is turned on

5.3.6 [Beeper] Settings

The beeper setting allows a PASS beep, a FAIL beep, or turning off the beeper.

■ Set 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	The beeper is turned off
PASS beep	The beeper sounds when the sorting result is pass (OK).
FAIL beep	The beeper sounds when the sorting result is fail (NG).

5.3.7 Comparison Bin Number Setting

The instrument provides 3 pass bins (Bin1~Bin3). Set the number of comparison bins as required and turn off the extra bins.

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

Soft key	Function
Total 1 bin	Only 1 pass bin
……	
Total 3 bins	Turns on all 3 pass bins

5.3.8 [Lower Limit] and [Upper Limit] Settings

Regardless of the comparison mode, both the primary and secondary parameters have upper/lower limit settings: 3 groups for the primary parameter and 1 group for the secondary parameter.
For the “absolute value Δ” comparison mode, enter the absolute value of the primary parameter, in the primary parameter unit.
For the “relative value Δ%” comparison mode, enter the relative value of the primary parameter, in %.
For the “Direct reading SEQ” comparison mode, enter the direct reading value of the primary parameter, in the unit of the primary parameter.
The lower and upper limits of the secondary parameter are always direct reading values, regardless of the comparison mode.

■ Enter the limit values

Step 1 Enter the <Comparator Settings> 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 Repeat 2~5 to complete data entry for the other bins.

Note	The instrument provides independent storage for the three comparison modes, so the comparator data of each mode is independent. For reasonable sorting, set the Bin1 to Bin3 intervals of the tolerance mode in increasing order, and the Bin1 to Bin3 data ranges of the sequential mode in increasing order. After everything is set, for long-term use, go to the [File] page to save the data in a file.

6. System Configuration

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

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

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

6.1 System Configuration Page

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

- LANGUAGE
- Date/Time settings
- Account and password settings
- Key beep settings
- Beeper volume settings
- Remote interface
- Data buffer – sets the maximum buffer value for the data recording function

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

Figure 6- 18 <System Configuration> Page



6.1.1 Changing the System Language [LANGUAGE]

The instrument supports two languages: Chinese and English.

■ Steps for changing the language

Step 1 Enter the <System Configuration> page
Step 2 Use the cursor keys to select [LANGUAGE].
Step 3 Use the soft keys to select the language:

Soft key	Function
Chinese (CHS)	
ENGLISH	English

6.1.2 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
Day+	+1 day
Day-	-1 day

■ To change the clock:

Step 1 Enter the <System Configuration> page
Step 2 Use the cursor keys to select the [Clock] field.
Step 3 Use the soft keys to set the clock:

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

6.1.3 Account Settings

The instrument provides two user modes for selection:

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

■ To change the account:

Step 1 Enter the <System Configuration> page
Step 2 Use the cursor keys to select the [Account] field.
Step 3 Use the soft keys to change:

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

■ Administrator password setting:

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

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

6.1.4 [Key Tone] Switch

The key beep setting allows the key beep to be turned on or off.

■ Set the key beep switch

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	The key beep is turned off
On	The key beep is turned on

6.1.5 [Volume] Switch

The alarm beeper can be set to two volume levels, high and low.

■ Setting the volume

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

Soft key	Function
Volume high	The beeper volume is high
Volume low	The beeper volume is low

6.1.6 [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 interface of the instrument is programmed using the SCPI language.
The RS-232 configuration is as follows:

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

Set the baud rate:

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

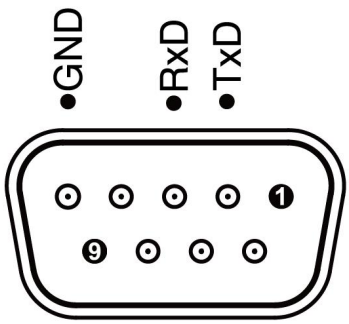
Soft key	Function
9600	
19200	
38400	
57600	
115200	For communication with the host computer, it is recommended that you use this high baud rate.

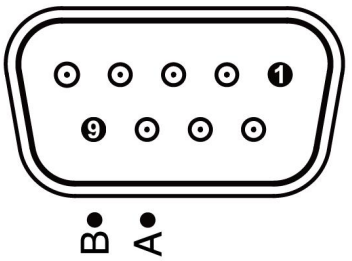
6.1.7 [Remote Communication] Setting

The instrument supports 4 communication interface protocols: RS232, USB, RS485 and GPIB. The GPIB interface is an optional interface.

■ Set 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
RS232	RS232 communicates via the DB9 interface on the rear panel, using 3 of its pins: P2: TxD P3: RxD P5: GND  Supports SCPI and Modbus protocols
USB	USB-232 interface; communicates via the USB interface on the rear panel Supports SCPI and Modbus protocols
RS485	RS485 communicates via the DB9 interface on the rear panel, using 2 of its pins: P8: A(+) P9: B(-)

	 Supports SCPI and Modbus protocols
GPIB	GPIB interface, optional. Supports the SCPI protocol only.

6.1.8 [Communication Protocol] Setting

The instrument supports 2 communication protocols: SCPI and Modbus (RTU).
SCPI: standard instrument communication protocol, ASCII transmission, suitable for hosts that are advanced devices such as computers and industrial computers.
Modbus: an industrial field bus protocol, binary transmission, suitable for hosts that are devices such as PLCs and touch screens.

■ Set 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	ASCII transmission
MODBUS	Binary (BIN) transmission

6.1.9 [Terminator] Setting

The instrument supports multiple terminators: LF (ASCII: 0x0A), CR (ASCII: 0x0D), CR+LF (ASCII: 0x0D 0x0A).
Data received by the instrument from the host may come without a terminator, while data sent by the instrument to the host always ends with the specified terminator.

Note

The instrument allows commands sent by the host to come without a terminator, but it is recommended to add a terminator at the end of the command; otherwise an extra timeout wait is added after each command reception (depending on the baud rate, the command timeout is 10ms~50ms).
This setting is only valid under the SCPI protocol.

The GPIB interface supports the LF terminator only.

■ Set 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	ASCII: 0x0A
CR	ASCII: 0x0D
CR+LF	ASCII: 0x0D 0x0A

6.1.10 [Command Handshake] Switch

When the command handshake is turned on, the instrument returns all received data to the host unchanged.

■ Set the command handshake switch:

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	
On	

Note This setting is only valid under the SCPI protocol.

6.1.11 [Error Code] Switch

When the error code function is turned on, the instrument returns the execution result of each command to the host.
When the command is a query command, the query result is returned if execution succeeds, and an error code is returned if execution fails.
When a command requires no return value, *E00 is returned if execution succeeds, and an error code is returned if execution fails.

Table 6- 11 SCPI Error Codes

Error Codes	Description	Explanation
*E00	NO ERROR	No error
*E01	BAD COMMAND	Command error
*E02	PARAMETER ERROR	Parameter error
*E03	MISSING PARAMETER	Missing parameter, a command that takes parameters was issued without providing parameters
*E04	INPUT BUFFER OVERRUN	Receive buffer overflow, the maximum buffer of the instrument is 1000 bytes
*E05	SYNTAX ERROR	Syntax error
*E06	INVALID SEPARATOR	Invalid separator
*E07	INVALID MULTIPLIER	Invalid multiplier unit
*E08	BAD NUMERIC DATA	Numeric value error
*E09	VALUE TOO LONG	Number too long, numeric parameter exceeds 20 bytes
*E10	INVALID COMMAND	Invalid command, the command is invalid under specific conditions
*E11	UNKNOWN ERROR	Other unknown errors besides the above errors

■ Set the error code switch

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

Soft key	Function
Off	Error codes are not returned
On	Error codes are returned

Note This setting and function are only valid under the SCPI protocol.

6.1.12 [Result Send] Setting

When the result sending function is set to Auto, the data of each measurement is automatically sent to the host.

■ Set 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
Off	
On	

Note This setting and function are only valid under the SCPI protocol.

6.1.13 [Factory Reset]

The factory settings option allows the user settings to be restored to the factory settings.

6.2 System Information Page

Press [Meas] or [Setup] to enter the main page, press the [System] key in the task bar at the very bottom to enter the <System Configuration> page, and press the soft keys to select [System Information].

The System Information page has no user-configurable options.

Figure 6- 19 <System Information> Page



7. File Operations

In this chapter you will learn about the file operations of the instrument.

The instrument has built-in non-volatile memory in which users can save system configuration data and user data. The built-in memory can store 10 configuration files.
If you have installed the USB memory interface option, data can also be saved in external USB memory. Using USB memory, you can save 10 configuration files and also 999 measurement result files.

7.1 File Management

On the [Meas] or [Setup] main page, press the [File] key at the bottom to enter the <File Management> page.

Figure 7- 20 <File Management> Page



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

- [Memory] selection – internal memory or external USB memory
- [Power-on Recall] mode – recall File 0 or the last used file at power-on
- [Auto Save] switch – saves the modified data to the current file after 1 minute.
- Perform file operations
- Soft key [Quick Save] - immediately saves the current setting data to the current file
- Soft key [Quick Recall] - immediately loads the current file data into the system
- Soft key [Load File 0] - immediately loads File 0 data into the system
- Soft key [Load File 1] - immediately loads File 1 data into the system

7.1.1 [Memory] Selection

Select internal memory or external USB memory.
If the USB memory interface is not installed, the USB memory function cannot be enabled.

■ Steps for selecting [Memory]:

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

Soft key	Function
Internal	Internal Memory
External	USB memory

7.1.2 [Power-On File] Mode

At power-on the instrument can recall File 0 or the current file. This is set via the [Power-on Recall] field.

■ Steps for setting [Power-on Recall]:

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	The data of File 0 is always loaded at power-on.
Current File	The current file will be loaded at power-on

7.1.3 [Auto Save] Switch

The instrument allows users to automatically save the modified setting data to the current file at power-off. [Auto Save] is disabled by default.

■ 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	Allows auto save at power-off
Forbid	Disables auto save at power-off

7.1.4 File Operations

■ Select a file number and perform operations

Step 1 Enter the <File Management> page

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

Step 3 Use the soft keys to select

Soft key	Function
Save	Saves the setting data to the current file
Read	Loads the current file data into the system
Delete	Deletes all data of the current file, and the file is also cleared at the same time.

Note

If a deleted file is recalled automatically at power-on, the system will create the file with default values.

8. Handler Interface

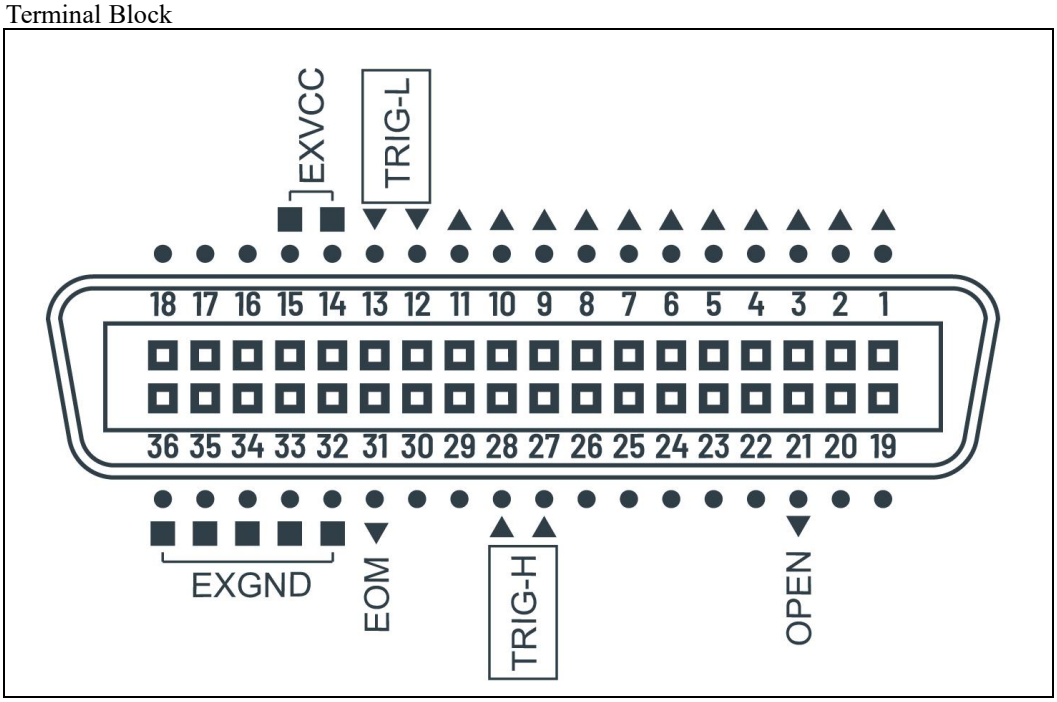
You will learn about the following:

- Terminals
- How to Connect and Interface Schematics
- Timing Table

The instrument provides users with a fully functional Handler interface. This interface includes 14-bin sorting outputs, IDX (AD conversion end signal), EOM (test completion signal), the TRIG (external trigger start) input, the comparator record number input, and other signals. Through this interface, the instrument can easily perform automatic control functions with the user's system control components.

8.1 Terminal Blocks and Signals

Figure 8- 21 Terminal Block



- Output terminals (all signals are active low)

Table 8- 12 Output Pin Definitions

Pin	Pin Name	Signal Description	Level State
1	O_BIN_1	Pass bin BIN1 output	Active low.
2	O_BIN_2	Pass bin BIN2 output	Active low.
3	O_BIN_3	Pass bin BIN3 output	Active low.
10	O_NG	Total fail output	Active low
21	O_OPEN	Device under test open	Active low
31	O_EOM	Measurement conversion in progress	Active high

- Input terminals

Table 8- 13 Input Pin Definitions

Pin	Name	Description
12-13	I_TRIG-L	External input, rising-edge active, low level maintained for

		10ms~100ms
27-28	I_TRIG-H	External input, falling-edge active, low level maintained for 10ms~100ms

Note:

The external trigger pins can be configured for 2 trigger edges:

1. When 27-28 is connected to EXVCC(24V) and 12-13 to the PLC IO, it is rising-edge triggered;
2. When 27-28 is connected to the PLC IO and 12-13 to EXGND(0V), it is falling-edge triggered.

■ Power terminals

Table 8- 14 Power Pin Definitions

Pin	Name	Description
32-36	EXGND(0V)	Common ground; must not be left floating. All pins must be shorted together and reliably connected to the COM terminal of the external controller (e.g. PLC) power supply.

8.2 Connection Methods

■ Power

When falling-edge triggering is used:

leave pins 14-15 floating,**does not**connect the external VCC (24V)

connect pins 12-13 and 32-36 to EXGND(0V) at the same time

When rising-edge triggering is used:

connect pins 27-28 to the external EXVCC (24V)

connect pins 32-36 to EXGND(0V) at the same time

■ Electrical specifications

Output signal: optocoupler-isolated open-collector output. Active low.

Max. voltage: 3V~30V, 24V recommended.

Input signal: Optocoupler isolated. Active low.

Max. current: 50mA



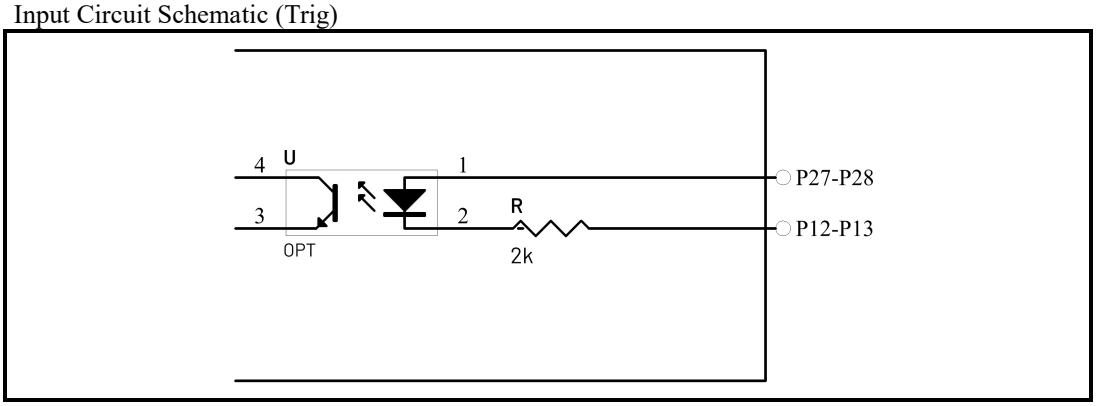
Note: To avoid damaging the interface, do not allow the power supply voltage to exceed the power requirements.

To avoid damaging the interface, wire the connections after the instrument is turned off.

If the output signal is used to control a relay, the output optocoupler can only drive a small-signal relay; the relay must use a reverse energy-release diode. To drive a high-power relay, add a transistor driver stage.

8.2.1 Input Circuit Schematic

Figure 8- 22 Input Circuit Schematic (Trig)



8.2.2 Input Circuit Connection Methods

Figure 8- 23 Rising-Edge Trigger

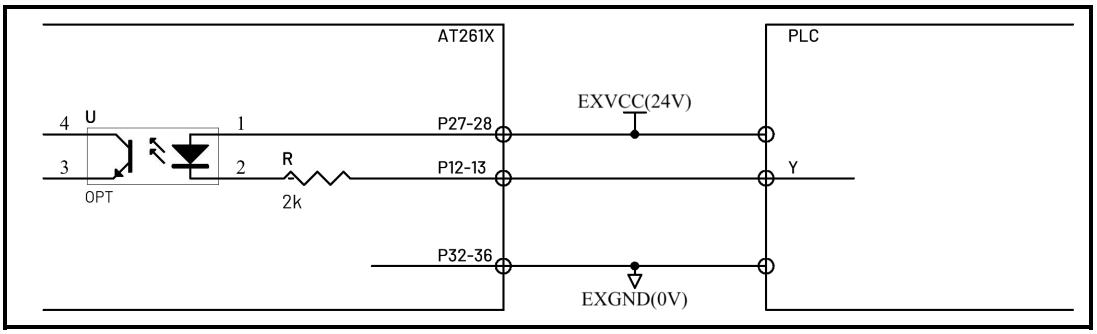
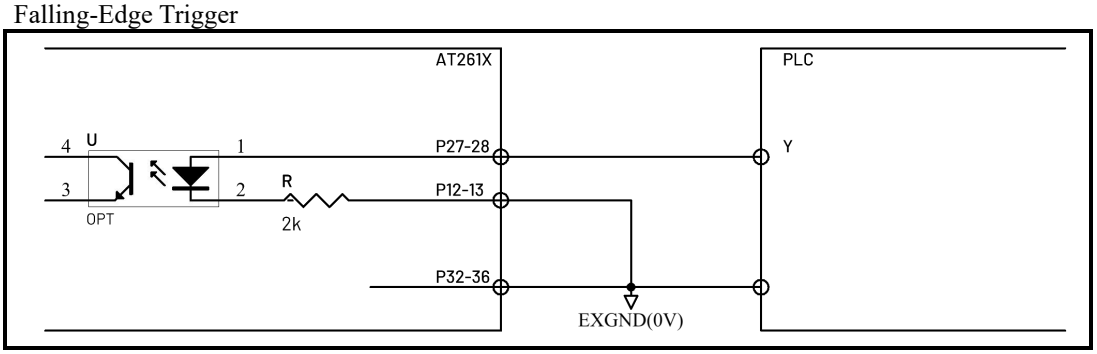
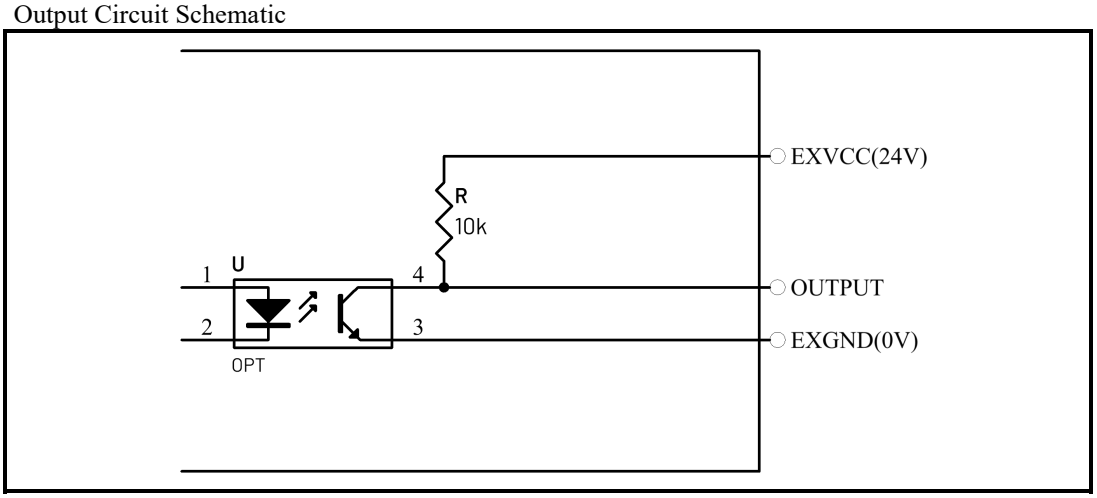


Figure 8- 24 Falling-Edge Trigger



8.2.3 Output Circuit Schematic

Figure 8- 25 Output Circuit Schematic



8.2.4 Output Circuit Connection Methods

Figure 8- 26 Output Circuit

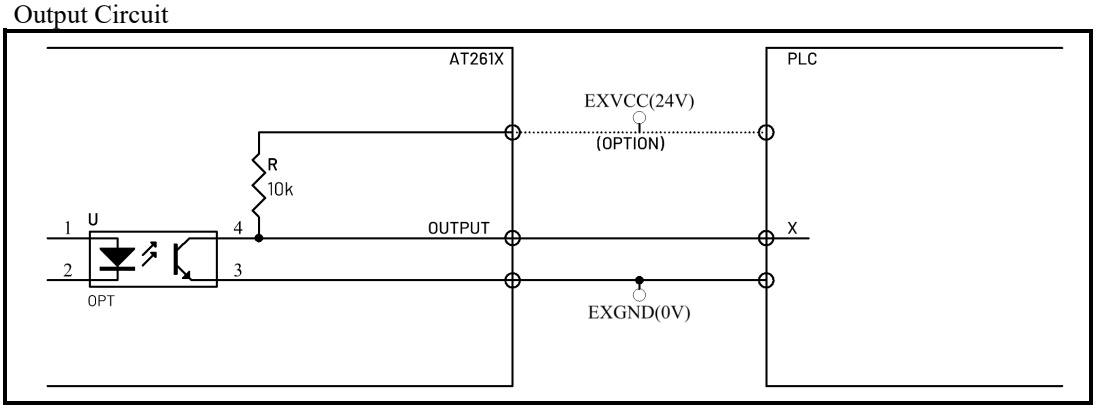


Figure 8- 27 Timing Table

- **Recommended signal input/output cycle table**

The completion of one sampling by the instrument is entirely controlled by an external device (PLC, etc.).

Figure 8- 28 Signal Timing Table

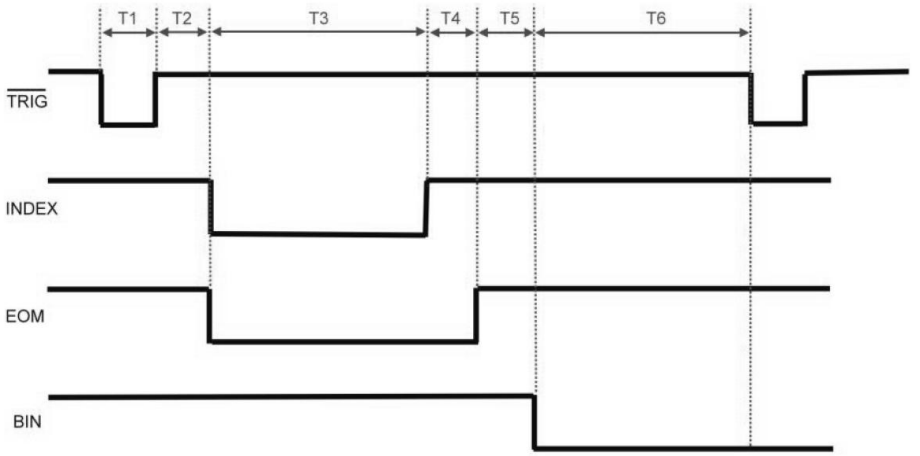


Table 8- 15 Timing Table

Time	Description		Minimum
T1	Trigger pulse width		1ms
T2	Measurement cycle	Trigger delay time	<10μs
T3		ADC time	(related to test speed)
T4		Calculation time	1ms
T5		Comparator result delay time	200μs
T6	Wait for next trigger		0μs

9. Remote Communication

You will learn about the following:

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

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

9.1 RS-232C

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

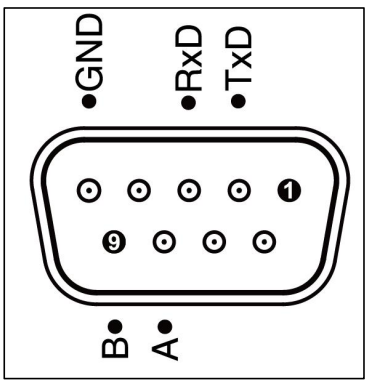
Most serial port configurations are usually not strictly based on the RS-232 standard: a 25-pin connector is used on each port (today's computers mostly use a 9-pin connector). The most commonly used RS-232 signals are shown in the following table:

Table 9- 16 Minimum Subset of the RS-232 Standard

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

9.1.1 RS232C Interface

Figure 9- 29 RS-232 Interface on the Rear Panel [Male]



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

■ Default communication settings of the instrument:

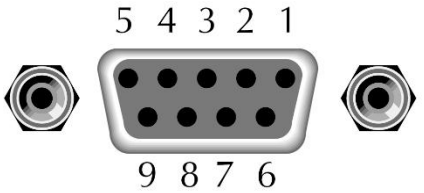
Transmission mode: Full-duplex asynchronous communication with start and stop bits
Data bits: 8 bits
Stop bits: 1 bit
Parity: None

Before communication, set the remote communication to RS232 on the [System Configuration]

page of the instrument.

9.1.2 Connection Methods

Figure 9- 30 RS-232 Interface on the Rear Panel [Male]



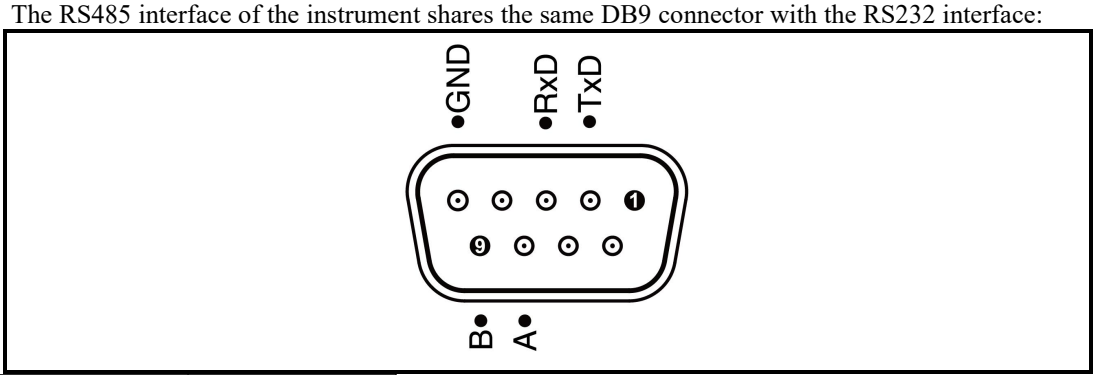
Note: The instrument cannot use a null modem cable.
You can make it yourself, or purchase a 9-core straight-through cable from Onmeas Instruments.
Note the following for a user-made 3-wire cable:
·When using the DB9 port built into the PC, pins 4-6 and 7-8 of the DB-9 connector (male) on the computer side may need to be shorted

9.2 RS485 Interface

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

The RS485 interface supports the SCPI and MODBUS communication protocols.

Before communication, set the remote communication to RS485 on the [System Configuration] page of the instrument.

9.3 USB Interface

The built-in USB communication interface of the instrument virtualizes an RS232C serial port on the computer for communication.
To use this USB, a driver must be installed on the computer; the driver can be downloaded from the product page of the company website.
Once the driver is installed, the instrument can be communicated with like an ordinary RS232 interface.
The USB interface can still use the SCPI or MODBUS protocol for communication.
Before communication, set the remote communication to USB on the [System Configuration] page

of the instrument.

9.4 GPIB Interface

GPIB is the abbreviation of General-Purpose Interface Bus.
Via the GPIB interface, one computer can control up to 31 instruments; bus transfer sampling with parallel bus communication is more efficient.
For instruments with the optional GPIB interface, plug the cable directly into the GPIB interface on the rear panel.
Before communication, set the remote communication to GPIB on the system configuration page of the instrument.

9.5 Communication Protocol

The instrument supports 2 communication protocols: SCPI and Modbus (RTU).

9.5.1 SCPI Protocol

It is the abbreviation of the English Standard Commands for Programmable Instruments: SCPI. The SCPI protocol defines a set of standard syntax and commands for controlling programmable test and measurement instruments. SCPI commands are transmitted as ASCII strings and enter the instrument through the physical transport layer. A command consists of a series of keywords, and some commands also need to include parameters. In the protocol, a command is specified in the following form: CONFigure. In use, either the full name or an abbreviation containing only the uppercase letters may be written. The feedback of the instrument to a query command is also ASCII code. In fact, for simple applications (such as a PLC), it is only necessary to translate the commands into HEX bytes and transmit them byte by byte.
RS232, RS485, USB and GPIB all support the SCPI protocol.
The GPIB interface supports the SCPI protocol only.

9.5.2 Modbus (RTU) Protocol

The Modbus protocol is a general language applied to electronic controllers, and is a bus protocol mainly used in industrial fields. It is the communication standard for industrial control devices such as PLCs and touch screens.
RS232, RS485 and USB all support the MODBUS protocol.
The GPIB interface does not support the MODBUS protocol.

10. SCPI Command Reference

& This chapter includes the following topics:

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

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

10.1 Handshake Protocol

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

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

Tip

If the host 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 parsing the previous command, the host computer cannot receive a response from the instrument either; please wait and try again.

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

10.2 Terminator

The instrument supports 4 terminators:
LF (hexadecimal: 0x0A)
CR(hexadecimal: 0x0D)
CR+LF (hexadecimal: 0x0D 0x0A)
NUL (hexadecimal: 0x00)

The terminator can be selected on the <System Configuration> page; the factory default of the instrument is LF.

Note:
The instrument allows commands sent by the host to come without a terminator, but it is recommended to add a terminator at the end of the command; otherwise an extra timeout wait is added after each command reception (depending on the baud rate, the command timeout is 10ms~50ms).

10.3 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.

10.3.1 Command Parsing Rules

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

10.3.2 Symbol Conventions and Definitions

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

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

10.3.3 Command Tree Structure

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

Figure 10- 31 Command Tree Structure

Example:

ROOT:CCC:DDD ppp

ROOT	Subsystem command
CCC	Second level
DDD	Third level
ppp	Parameter

10.4 Commands and Parameter

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

Example: AAA:BBB 1.234

Command [Parameters]

10.4.1 Commands

Command words can be in long form or abbreviated form. The long form makes it easier for

engineers to understand the meaning of the command string; the abbreviated form is convenient for writing.

10.4.2 Parameters

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

Table 10- 17 Multiplier Abbreviations

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

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

10.4.3 Separators

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

; Semicolon, used to separate two commands.
Example: AAA:BBB 100.0[;]CCC:DDD

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

? Question mark, used for queries.
Example: AAA[?]

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

10.4.4 Error Codes

The instrument temporarily stores the processing result of each received command in the buffer; before the next command is sent, the status can be obtained with the ERR? command. If the Error Code function is enabled in [System Configuration], the instrument automatically returns the processing result after executing the command.

Table 10- 18 SCPI Error Codes

Error Codes	Description	Explanation
*E00	NO ERROR	No error
*E01	BAD COMMAND	Command error
*E02	PARAMETER ERROR	Parameter error
*E03	MISSING PARAMETER	Missing parameter,

		a command that takes parameters was issued without providing parameters
*E04	INPUT BUFFER OVERRUN	Receive buffer overflow, the maximum buffer of the instrument is 1000 bytes
*E05	SYNTAX ERROR	Syntax error
*E06	INVALID SEPARATOR	Invalid separator
*E07	INVALID MULTIPLIER	Invalid multiplier unit
*E08	BAD NUMERIC DATA	Numeric value error
*E09	VALUE TOO LONG	Number too long, numeric parameter exceeds 20 bytes
*E10	INVALID COMMAND	Invalid command, the command is invalid under specific conditions
*E11	UNKNOWN ERROR	Other unknown errors besides the above errors

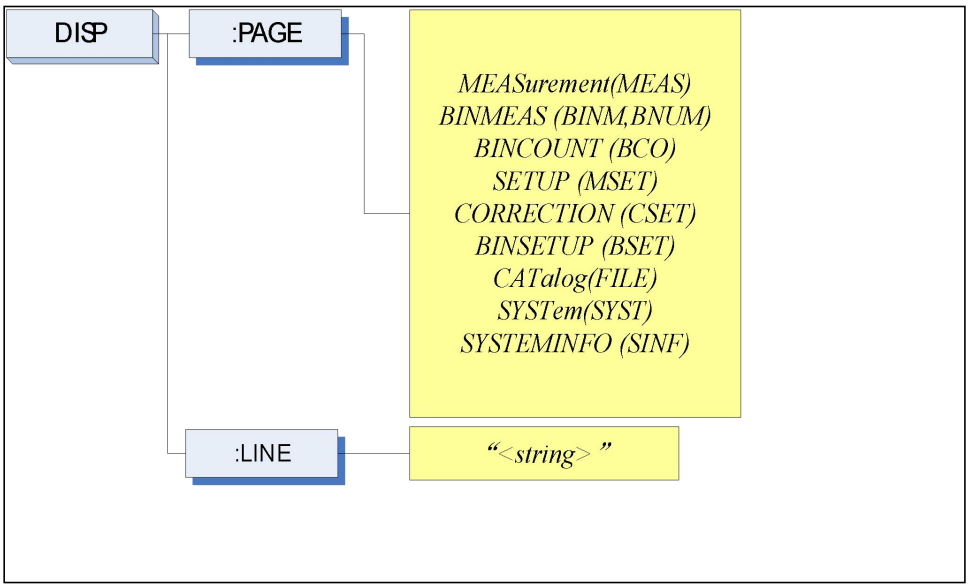
10.5 Command Summary

DISPlay subsystem
FUNCtion subsystem
FREQuency subsystem
VOLTage subsystem
APERture subsystem
FETCh subsystem
COMParator subsystem
LIST subsystem
CORRection subsystem
TRIGger subsystem
BIAS subsystem
FILE subsystem
ERRor subsystem
Common commands
*TRG
*IDN?
*SAV
*RCL
Multi-instrument communication commands
addr #;:

10.6 DISPlay Subsystem

The DISP Subsystem command group sets the display page.

Figure 10- 1 DISP Command Tree



10.6.1 DISP:PAGE

The :PAGE command sets the display page.

The :PAGE? Query returns the abbreviated page name currently displayed on the LCD screen.

Command Syntax	**DISP:PAGE *<page name>***
Parameter	**Where, <page name> is:** MEASurement [or MEAS] Sets display page to MEAS DISPLAY BINMEAS [or BINM] Sets display page to BIN MEAS BINCOUNT [or BCO] Sets display page to BIN COUNT SETUP [or MSET] Sets display page to MEAS SETUP CORRECTION [or CSET] Sets display page to CORRECTION BINSETUP [or BSET] Sets display page to BIN SETUP CATalog [or CAT] Sets display page to CATALOG SYSTem [or SYST] Sets display page to SYSTEM CONFIG SYSTEMINFO [or SINF] Sets display page to SYSTEM INFORMATION
Example	**SEND> DISP:PAGE SYST //Set to the SYSTEM CONFIG**
Query Syntax	**DISP:PAGE?**
Query Response	***<page name>***
Example	**SEND> DISP:PAGE?** **RET> SYST**

10.6.2 DISP:LINE

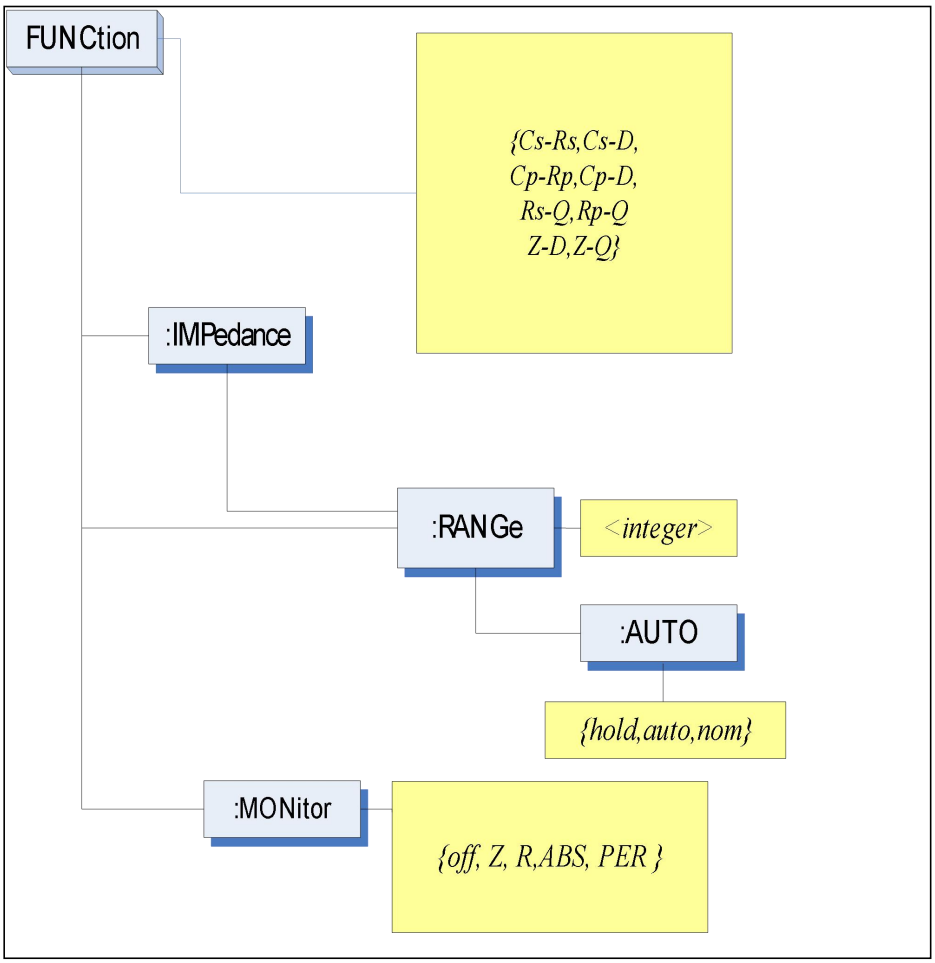
The :LINE command enters an arbitrary comment line of up to 30 ASCII characters in the comment field.

Command Syntax	**DISP:LINE “*<string>*”**
Parameter	Where, <string> is ASCII character string (30 ASCII characters)
Example	**SEND> DISP:LINE “This is a comment.”**

10.7 FUNCtion Subsystem

The FUNCtion subsystem command group sets the measurement function, the measurement range, monitors parameter control.

Figure 10- 2 FUNCtion Subsystem Tree



10.7.1 FUNCtion

The FUNCtion command sets the measurement function.

Command Syntax	**FUNC <*function*>**
Parameter	**Where, <function> is:** **Cs-Rs, Cs-D, Cp-Rp, Cp-D,** **Rs-Q, Rp-Q, Z-D,Z-Q**
Example	**SEND> FUNC Cp-D //Set measurement function to Cp-D**
Query Syntax	**FUNC?**
Query Response	**<*function*>**
Example	**SEND> FUNC?** **RET> Cp-D**

10.7.2 FUNCtion[:IMPedance]:RANGe

The FUNCtion[:IMPedance]:RANGe command sets the impedance's measurement range.

Command Syntax	**FUNC:IMPedance:RANGe <*0-8,MIN,MAX*>** **FUNC:RANGe <*0-8,MIN,MAX*>**
Parameter	**Where, <0-8,MIN, MAX> is:** **0-8, The range number** **MIN, =Range 0** **MAX, =Range 8**
Example	**SEND> FUNC:IMP:RANG 2//Set measurement range to [2] 10kΩ**
Query Syntax	**FUNC:IMPedance:RANGe?**
Query Response	**<*0-8*>**
Example	**SEND> FUNC:IMP:RANG?** **RET> 0**

10.7.3 FUNCtion:RANGe:AUTO

The FUNCtion:RANGe:AUTO command sets the auto range to ON or OFF.

Command Syntax	**FUNC:RANGe:AUTO *{off(hold),on(auto),NOMinal}***
Parameter	**Where, *{off(hold),on(auto),NOMinal}* is:** **off(or hold): Sets the auto range to off.** **on(or auto): Sets the auto range to on.** **NOMinal: Nominal range.**
Example	**SEND> FUNC:RANG:AUTO AUTO //Sets to auto range.** **SEND> FUNC:RANG:AUTO on //Sets to auto range.** **SEND> FUNC:RANG:AUTO off //Sets auto range to off.**
Query Syntax	**FUNC:RANGe:AUTO?**
Query Response	***{HOLD,AUTO,NOM}***
Example	**SEND> FUNC:RANG:AUTO?** **RET> auto**

10.7.4 FUNCtion:MONitor

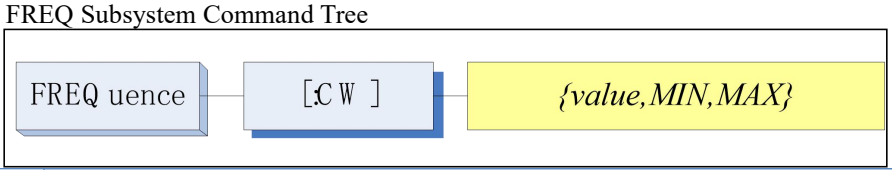
The FUNCtion:MONitor1 and FUNCtion:MONitor2 commands set the two monitor parameter.

Command Syntax	**FUNC:MONitor *{off, Z, R,ABS, PER}***
Parameter	***{off, Z, R,ABS, PER}***
Example	**SEND> FUNC:MON Z**
Query Syntax	**FUNC:MON?**
Query Response	***{off, Z, R,ABS, PER}***
Example	**SEND> FUNC:MON?** **RET> off**

10.8 FREQuency Subsystem

The FREQuency command sets the oscillator frequency. The FREQuency? Query returns the current test frequency setting.

Figure 10- 3 FREQ Subsystem Command Tree

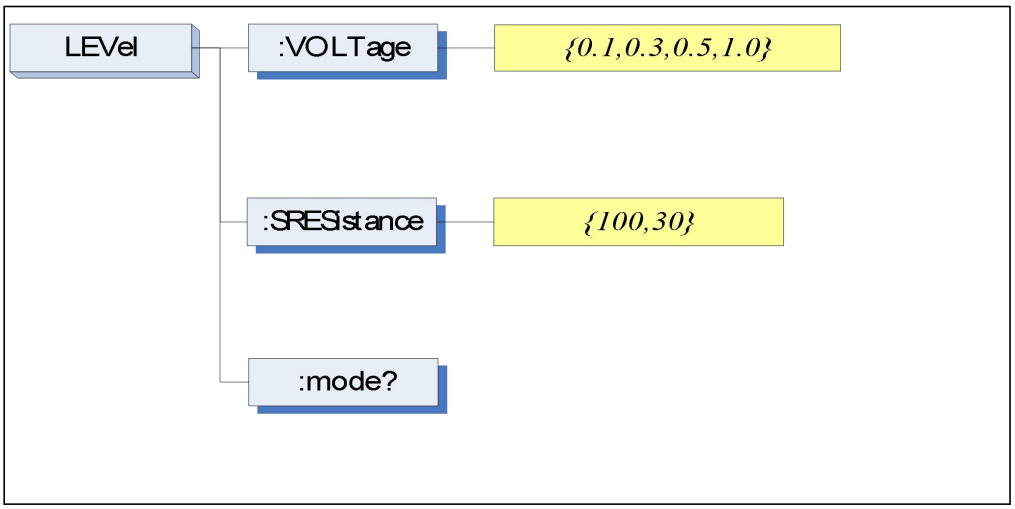


Command Syntax	**FREQ[:CW] <value>**
Parameter	**Where,** <value> is the numeric data (NR1 integer, NR2 fix float or NR3 floating point). MIN Sets to the minimum value MAX Sets to the maximum value
Example	**SEND> FREQ 1K //Set to 1kHz,the Hz cannot be added.**
Query Syntax	**FREQ[:CW]?**
Query Response	**<NR3>** NR3 floating point
Example	**SEND> FREQ?** **RET> 1.000000E+03**
Note	A suffix multiplier (k) can be used with this command. But the suffix unit Hz can't be used. This command CANNOT be used in LIST SWEEP DISPLAY page and CORRECTION page.

10.9 LEVel Subsystem

The Level subsystem sets the oscillator's output voltage/current level and source output Impedance

Figure 10- 4 LEVel Subsystem Command Tree



10.9.1 LEVel[:VOLTage] (=VOLTage[:LEVel])

The LEVel[:VOLTage] or VOLTage[:LEVel] command sets the oscillator's output voltage level.

Command Syntax	**LEVel[:VOLTage] {0.1,0.3,0.5,1.0}** **or VOLTage[:LEVel] {0.1,0.3,0.5,1.0}**
Parameter	**Where,** <value> is the numeric data (NR1, NR2 or NR3).
Example	**SEND> LEV:VOLT 0.3 //Set to 0.3V,the unit V can be ignored.**
Query Syntax	**LEVel[:VOLTage]?** **VOLTage[:LEVel]?**
Query Response	**<NR3>** NR3 floating point
Example	**SEND> VOLT?** **RET> 1.0**
Note	This command CANNOT be used in CORRECTION page.

10.9.2 LEVel:SRESistance (= VOLTage:SRESistance)

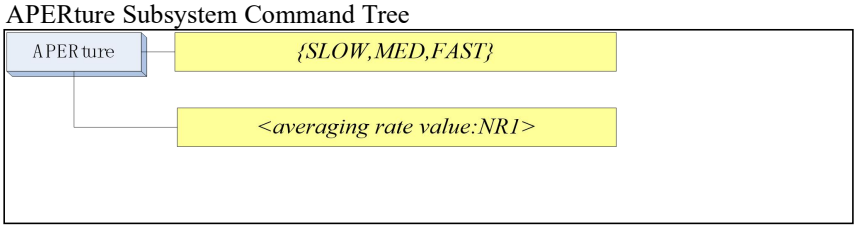
The LEVel:SRESistance or VOLTage:SRESistance command sets the source output Impedance.

Command Syntax	**LEVel:SRESistance {30,100}** **VOLTage:SRESistance {30,100}**
Parameter	**{30,100}** **Where,** 30 Sets the output impedance to 30Ω 100 Sets the output impedance to 100Ω
Example	**SEND> LEV:SRES 30** //Set to 30Ω, the unit Ω cannot be added.
Query Syntax	**VOLTage:SRES?** **or LEVel:SRES?**
Query Response	**<NR1>** NR1 integer
Example	**SEND> LEV:SRES?** **RET> 30**
Note	This command CANNOT be used in CORRECTION page.

10.10 APERture Subsystem

The **APERture** subsystem command sets the integration time of the ADC and the averaging rate.

Figure 10- 5 APERture Subsystem Command Tree



Command Syntax	**APERture {SLOW,MED,FAST}** **APERture <*value*>** **SPEED(spd) {SLOW,MED,FAST}** **SPEED(spd) <*value*>**
Parameter	Where, SLOW Set test speed to slow MED Set test speed to medium FAST Set test speed to fast <value> NR1(1 to 256): Averaging rate
Example	**SEND> APER FAST** **SEND> APER 10**
Query Syntax	**APER?**
Query Response	**{SLOW,MED,FAST},<avg value>**
Example	**SEND> APER?** **RET> slow,0**

10.10.1 APERture:RATE?

The **APERture:RATE?** query returns the current integration time.

Query Syntax	**APER:RATE?**
Query Response	**SLOW**
Example	**SEND> APER:RATE?** **RET> slow**

10.10.2 APERture:AVG?

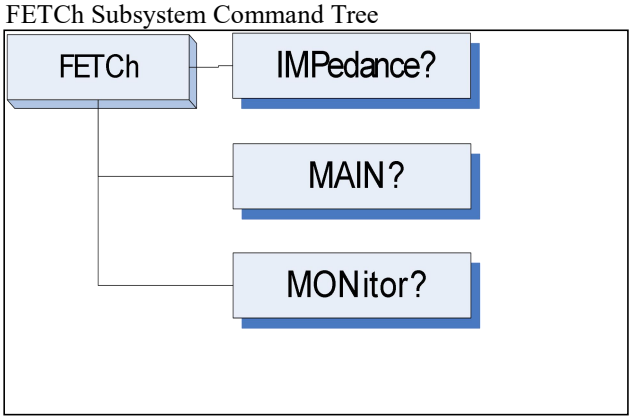
The **APERture:AVG?** query returns the averaging rate settings.

Query Syntax	**APER:AVG?**
Query Response	**<NR1>** Integer (0 to 256)
Example	**SEND> APER:AVG?** **RET> 0**

10.11 FETCh Subsystem

The FETCh subsystem command group is a sensor-only command which retrieves the measurement data taken by measurement(s) initiated by a trigger, and places the data into the output buffer.

Figure 10- 6 FETCh Subsystem Command Tree



10.11.1 FETCh?

The FETCh? query sets the latest measurement data of the primary , secondary parameters and comparator result into the output buffer.

Query Syntax	**FETCh?**
Query Response	<NR3:primary value>,<NR3:secondary value>,<BIN#>,<AUX>,<ALL OK/NG>
Example	**SEND> FETC?** **RET> +2.617886e-11,+5.454426e-01,BIN1,AUX-OK,OK** **RET> +1.23434e+05,OUT ,NG** //AUX OFF

10.11.2 FETCh:IMPedance?

The FETCh:IMPedance? query sets the latest measurement data of the primary , secondary parameters monitor result into the output buffer.

Query Syntax	**FETCh?**
Query Response	<NR3:primary>,<NR3:secondary>,<NR3: monitor>,<BIN#>,<AUX>,<ALL OK/NG>
Example	**SEND> FETC:IMP?** **RET> +2.617886e-11,+5.454426e-01, +2.14211e+04,BIN1,AUX-OK,OK**

10.11.3 FETCh:MAIN?

The FETCh:MAIN? query sets the latest measurement data of the primary and secondary parameters

Query Syntax	**FETCh:MAIN?**
Query Response	<NR3:primary value>,<NR3:secondary value>
Example	**SEND> FETC:MAIN?** **RET> +2.021009e-11,+1.644222e-01 //Primary ,Secondary** **RET> +1.23434e+05**//DCR

10.11.4 FETCh:MONitor?

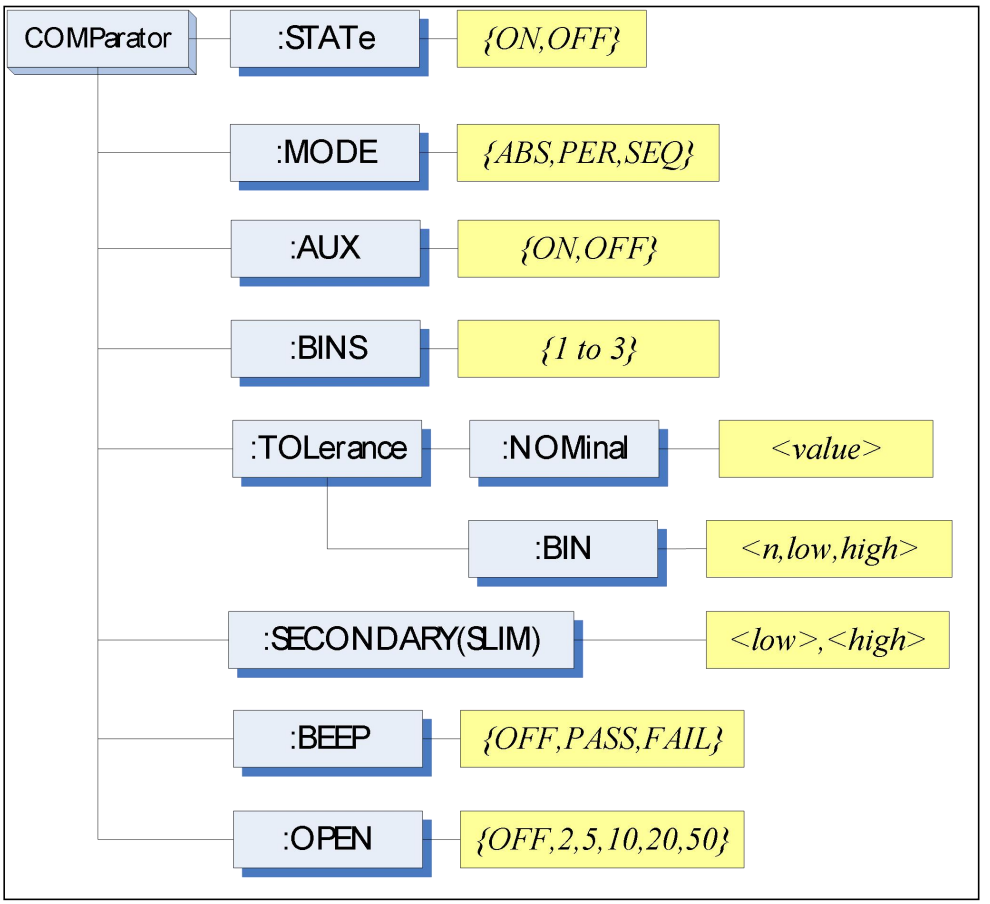
The FETCh:MONitor? or FETCh:MONitor1 set the latest measurement data of the monitor parameter into the output buffer.

Query Syntax	**FETCh:MONitor1? and FETCh:MONitor?**
Query Response	<NR3: monitor value>
Example	**SEND> FETC:MON?** **RET> +3.886517e+05** **RET> +0.000000e+00 //0: The monitor 1 is OFF**

10.12 COMParator Subsystem

The COMParator subsystem command group sets the comparator function, including its ON/OFF setting, limit mode, and limit values.

Figure 10- 7 COMParator Subsystem Command Tree



10.12.1 COMParator:STATe

The COMParator:STATe command sets the comparator function to ON or OFF.

Command Syntax	**COMParator:STATe {ON,OFF,1,0}**
Parameter	**Where,** ON or 1 Sets the comparator to ON OFF or 0 Sets the comparator to OFF
Example	**SEND> COMP:STAT OFF**
Query Syntax	**COMParator:STATe?**
Query Response	**{on,off}**
Example	**SEND> COMP:STAT?** **RET> on**

10.12.2 COMParator:MODE

The :COMParator:MODE command sets the limit mode of the comparator function.

Command Syntax	**COMParator:MODE {ABS,PER,SEQ}**
Parameter	**Where,{ABS,PER,SEQ} is:** ABS Absolute tolerance mode PER Percent tolerance mode SEQ Sequential mode
Example	**SEND> COMP:MODE PER**
Query Syntax	**COMParator:MODE?**
Query Response	**{abs,per,seq}**
Example	**SEND> COMP:MODE?** **RET> abs**

10.12.3 COMParator:AUX

The COMParator:AUX command sets the auxiliary BIN counting function of the comparator to ON or OFF.

Command Syntax	**COMParator:AUX {ON,OFF,1,0}**
Parameter	**Where,{ON,OFF,1,0} is:**

	ON or 1 Set the AUX BIN to ON OFF or 0 Set the AUX BIN to OFF
Example	**SEND> COMP:AUX OFF**
Query Syntax	**COMParator:AUX?**
Query Response	**{on,off}**
Example	**SEND> COMP:AUX?** **RET> on**

10.12.4 COMParator:BINS

The COMParator:BINS command sets the total number of bins.

Command Syntax	**COMParator:BINS <*value*>**
Parameter	**Where,{value} is:** NR1 (1 to 3)
Example	**SEND> COMP:BINS 3**
Query Syntax	**COMParator:BINS?**
Query Response	**<NR1> (1 to 3)**
Example	**SEND> COMP:BINS?** **RET> 3**

10.12.5 COMParator:TOLerance:NOMinal

The COMParator:TOLerance:NOMinal command sets the nominal value for the tolerance mode of the comparator function.

Command Syntax	**COMParator:TOLerance:NOMinal <*value*>**
Parameter	**Where,<value> is:** NR1, NR2 or NR3 A suffix multiplier can be used with this command. But the suffix unit F/Ω/H can't be used.
Example	**SEND> COMP:TOL:NOM 100N** **SEND> COMP:TOL:NOM 1E-6**
Query Syntax	**COMParator:TOLerance:NOMinal?**
Query Response	**<NR3>**
Example	**SEND> COMP:TOL:NOM?** **RET> 1.000000e-06**

10.12.6 COMParator:TOLerance:BIN

The COMParator:TOLerance:BIN command sets the low/high limit values of each BIN for the comparator function tolerance mode.

Command Syntax	**COMParator:TOLerance:BIN <*n*>,<*low limit*>,<*high limit*>**
Parameter	**Where,<*n*>,<*low limit*>,<*high limit*> is:** n NR1 (1 to 3): Bin number low limit NR1,NR2 or NR3: low limit value high limit NR1,NR2 or NR3: high limit value
Example	**SEND> COMP:TOL:BIN 1,100P,200P** **SEND> COMP:TOL:BIN 2,200E-6,300E-6**
Query Syntax	**COMParator:TOLerance:BIN? <n>**
Parameter	**Where,<*n*> is:** NR1 (1 to 3): Bin number
Query Response	**<NR3:low limit>,<NR3:high limit>**
Example	**SEND> COMP:TOL:BIN? 2 //Note: must add blank space before bin#** **RET> 1.000000e-06,2.000000E-6**

10.12.7 COMParator:SLIM

The COMParator:SLIM or COMParator:secondary command sets the LOW/HIGH limit values for the secondary parameter.

Command Syntax	**COMParator:SLIM <low *value*>,<*high value*>** **COMParator:secondary <low *value*>,<*high value*>**
Parameter	**Where, <low *value*>,<*high value*> is:** <low value> NR1,NR2 or NR3: low limit value <high value> NR1,NR2 or NR3: high limit value A suffix multiplier can be used with this command.

Example	**SEND> COMP:SLIM 0.0001,0.0010**
Query Syntax	**COMParator:SLIM?** **COMParator:secondary?**
Query Response	**<NR3:low limit>,<NR3:high limit>**
Example	**SEND> COMP:SLIM?** **RET> 1.000000e-04,1.000000e-03**

10.12.8 COMParator:BEEP

The :COMParator:BEEP command sets beep mode of the comparator function.

Command Syntax	**COMParator:BEEP {OFF,PASS,FAIL}**
Parameter	**Where,** OFF Turns the beeper off. PASS Sounds a beep when the test is passed (BIN1~BIN3). FAIL Sounds a beep while the test was failed (OUT).
Example	**SEND> COMP:BEEP PASS**
Query Syntax	**COMParator:BEEP?**
Query Response	**{OFF,PASS,FAIL}**
Example	**SEND> COMP:BEEP?** **RET> OFF**

10.12.9 COMParator:OPEN

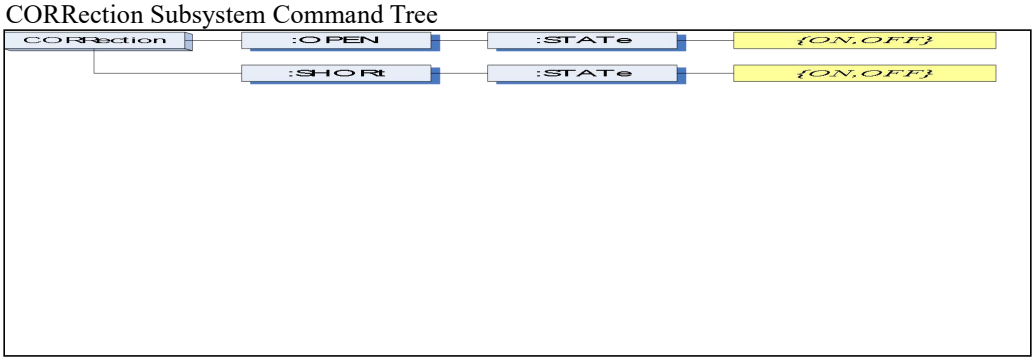
The :COMParator:OPEN command selects the open condition for main parameter.

Command Syntax	**COMParator:OPEN {OFF,2,5,10,20}**
Parameter	**Where,** OFF Turns the beeper off. 2,5,10,20 The percent range value
Example	**SEND> COMP:OPEN 2**
Query Syntax	**COMParator:OPEN?**
Query Response	**{OFF,2,5,10,20 }**
Example	**SEND> COMP:OPEN?** **RET> OFF**

10.13 CORRection Subsystem

The CORRection subsystem command group sets the correction function, including the OPEN and SHORT correction settings.

Figure 10- 8 CORRection Subsystem Command Tree



10.13.1 CORRection:OPEN

The CORRection:OPEN command execute all presetted OPEN correction data measurement points.

Command Syntax	**CORRection:OPEN**
Example	**SEND> CORRection:OPEN**

10.13.1.1 CORRection:OPEN:STATe

The CORRection:OPEN:STATe command sets the OPEN correction function to ON or OFF.

Command Syntax	**CORRection:OPEN:STATe *{ON,OFF,1,0}***

Parameter	**Where, {ON,OFF,1,0} is:** ON, 1 When the function is ON OFF,0 When the function is OFF
Example	**SEND> CORR:OPEN:STATe ON** **RET> open**
Query Syntax	**CORRection:OPEN:STATe?**
Query Response	**{on,off}**
Example	**SEND> CORR:OPEN:STATe?** **RET> on**

10.13.2 CORRection:SHORt

The CORRection:SHORt command execute all presetted SHORT correction data measurement points.

Command Syntax	**CORRection:SHORt**
Example	**SEND> CORRection:SHOR** **RET> short**

10.13.2.1 CORRection:SHORt:STATe

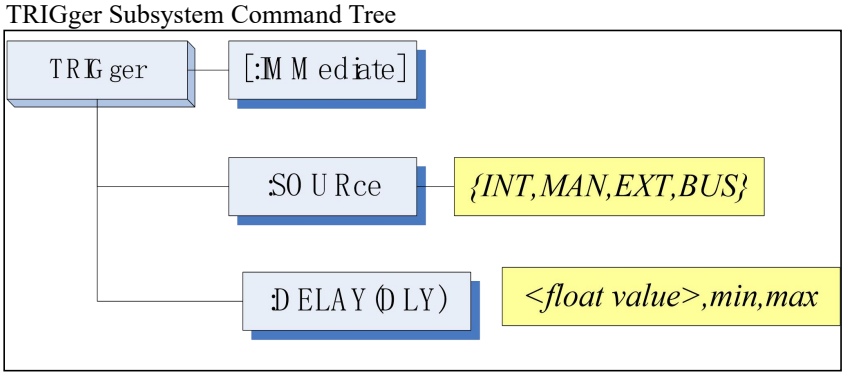
The CORRection:SHORt:STATe command sets the SHORT correction function to ON or OFF.

Command Syntax	**CORRection:SHORt:STATe *{ON,OFF,1,0}***
Parameter	**Where, {ON,OFF,1,0} is:** ON, 1 When the function is ON OFF,0 When the function is OFF
Example	**SEND> CORR:SHOR:STATe ON**
Query Syntax	**CORRection:SHOR:STATe?**
Query Response	**{on,off}**
Example	**SEND> CORR:SHOR:STATe?** **RET> on**

10.14 TRIGger Subsystem

The TRIGger subsystem command group is used to enable a measurement or a sweep measurement, and to set the trigger mode.

Figure 10- 9 TRIGger Subsystem Command Tree



10.14.1 TRIGger[:IMMediate]

The TRIGger:IMMediate command causes the trigger to execute a measurement or a sweep measurement, regardless of the trigger state.

Command Syntax	**TRIGger[:IMMediate]**
Example	**SEND> TRIG**
Note	**This command can be ONLY used in BUS trigger mode.**

10.14.2 TRIGger:SOURce

The TRIGger:SOURce command sets the trigger mode.

Command Syntax	**TRIGger:SOURce {INT,MAN,EXT,BUS}**
Parameter	Where, {INT,MAN,EXT,BUS} is

	INT Internal Trigger Mode MAN Manual Trigger Mode EXT External Trigger Mode BUS BUS Trigger Mode
Example	**SEND> TRIG:SOUR BUS**
Query Syntax	**TRIGger:SOURce?**
Query Response	**{INT,MAN,EXT,BUS}**
Example	**SEND> TRIG:SOUR?** **RET> INT**

10.14.3 TRIGger:DELAY

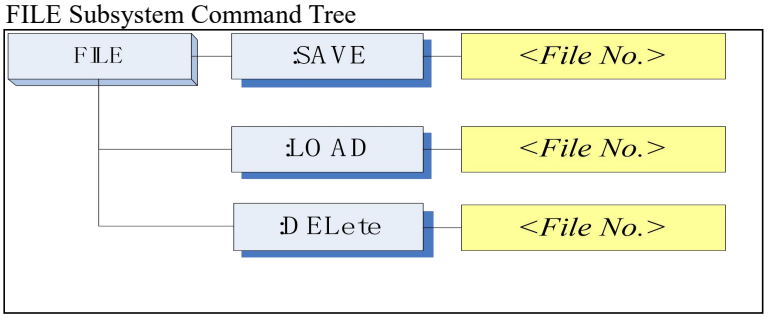
The TRIGger:DELAY command sets the trigger delay time.

Command Syntax	**TRIGger:DELAY {<float>,min,max}** **TRIGger:DLY {<float>,min,max}**
Parameter	Where, is float value: from 1ms to 60.00s min: =0ms max: =60.000s
Example	**SEND> TRIG:DLY 1** //1.000s
Query Syntax	**TRIGger:DELAY?** **TRIGger:DLY?**
Query Response	**{0.000s~60.00s}**
Example	**SEND> TRIG:DLY?** **RET> 1.000s**

10.15 FILE Subsystem

The FILE subsystem command group executes the file operation.

Figure 10- 10 FILE Subsystem Command Tree



10.15.1 FILE?

The FILE? query returns the file number used by system.

Query Syntax	**FILE?**
Query Response	**<NR1(0 TO 9):File number>**
Example	**SEND> FILE?** **RET> 0**

10.15.2 FILE:SAVE

The FILE:SAVE command saves all user settings into current used file.

Command Syntax	**FILE:SAVE**
Example	**SEND> FILE:SAVE**

The FILE:SAVE <n> command saves all user settings into specified file.

Command Syntax	**FILE:SAVE <*File No.*>**
Parameter	**Where, <File No.> is:** NR1 (0 to 9)
Example	**SEND> FILE:SAVE 0**

10.15.3 FILE:LOAD

The FILE:LOAD command recalls all user settings from current used file.

Command Syntax	**FILE:LOAD**
Example	**SEND> FILE:LOAD**

The FILE:LOAD <n> command recalls all user settings from specified file.

Command Syntax	**FILE:LOAD <*File No.*>**
Parameter	**Where, <File No.> is:** NR1 (0 to 9)
Example	**SEND> FILE:LOAD 0**

10.15.4 FILE:DELete

Command Syntax	**FILE:DELete <*File No.*>**
Parameter	**Where, <File No.> is:** NR1 (0 to 9)
Example	**SEND> FILE:DELete**

10.16 ERRor Subsystem

10.16.1 ERRor?

The ERRor? retrieves last error information.

Query Syntax	**ERRor?**
Query Response	**Error string**
Example	**SEND> ERR?** **RET> no error.**

10.17 SYSTEM Subsystem

10.17.1 SYSTem:SHAKehand

The SYSTem:SHAKehand command feeds back the sent commands.

Command Syntax	**SYSTem:SHAKehand {on,off}**
Example	**SEND> SYST:SHAK ON**
Query Syntax	**SYSTem:SHAKehand?**
Query Response	**{on,off}**
Example	**SEND> SYST:SHAK?** **RET> OFF**

10.17.2 SYSTem:CODE

The SYSTem:CODE command feeds back error code for each sent command.

Command Syntax	**SYSTem:CODE {on,off}**
Example	**SEND> SYST:CODE ON**
Query Syntax	**SYSTem:CODE?**
Query Response	**{on,off}**
Example	**SEND> SYST:CODE?** **RET> OFF**

10.17.3 SYSTem:KEYLock

SYSTem:KEYLock command unlocks the keypad.

Command Syntax	**SYST:KEYLOCK OFF** **or UNLOCK(UNLK)**
Example	**SEND> UNLOCK**

10.17.4 SYSTem:RESult

SYSTem:RESult command selects the test results send mode.

Command Syntax	**SYSTem:RESult {fetch,auto}**
Example	**SEND> SYST:RES fetch**
Parameter	**Where,** **fetch** The test results will be sent back by command “fetch?” **auto** The results will be sent back by one trig.
Query Syntax	**SYSTem:RESult?**
Query Response	**{FETCH,AUTO}**
Example	**SEND> SYST:RES?** **RET> fetch**

10.18 Common Commands

10.18.1 *IDN?

The *IDN? query returns the instrument ID.

Query Syntax	**IDN? Or *IDN?**
Query Response	**<manufacturer>,<model>,<serial no.>,<firmware>**

10.18.2 *TRG

The *TRG command (trigger command) performs the same function as the Group Execute Trigger command.

Command Syntax	***TRG**
Query Response	**<primary value>,<secondary value>,<comparator result>**
Example	**SEND> *TRG** **RET> +5.566785e-11,+7.253470e-01,OUT**
Note	This command can be used in BUS trigger mode. *TRG = TRIG;:FETC?

10.18.3 *SAV

*SAV = FILE:SAVE
The *SAV command saves all user settings into current used file.

Command Syntax	***SAV**
Example	**SEND> *SAV**

10.18.4 *RCL

*RCL = FILE:LOAD
The *RCL command recalls all user settings from current used file.

Command Syntax	***RCL**
Example	**SEND> *RCL**

10.19 SCPI Multi-Instrument Communication

The SCPI protocol extended by Onmeas Instruments also supports multi-instrument communication, so the SCPI protocol can be used to communicate with the host via the RS485 interface.
Add the address command before the communication command:**ADDR#;:**

Command Syntax	**ADDR <address>;:**
Example	**SEND> ADDR 1;:IDN? //Get the version information of instrument 1** **SEND> ADDR 2;:FETCH? //Get the measurement result of instrument 2**

11. Modbus (RTU) Communication Protocol

This chapter includes the following topics:

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

11.1 Data Format

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

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

11.1.1 Command Frame

Figure 11- 1 Modbus Command Frame



Table 11- 1 Command Frame Description

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

11.1.2 CRC-16 Calculation Method

1. Set the initial value of the CRC-16 register to 0xFFFF.
2. Perform an XOR operation on the CRC-16 register and the first byte of the message, and return the calculation result to the CRC register.
3. Fill the MSB with 0 and shift the CRC register right by 1 bit.
4. If the bit shifted out from the LSB is “0”, repeat step (3) (process the next shift). If the bit shifted out from the LSB is “1”, perform an XOR operation on the CRC register and 0xA001, and return the result to the CRC register.
5. Repeat steps (3) and (4) until 8 bits have been shifted.

6. If the message has not been fully processed, perform an XOR operation on the CRC register and the next byte of the message, return the result to the CRC register, and repeat from step (3).
7. Append the calculated result (the value of the CRC register) to the message starting from the low-order byte.

The following is a CRC calculation function written in VB:

```
Function CRC16(data() As Byte) As Byte()
  Dim CRC16Lo As Byte, CRC16Hi As Byte   'CRC register
  Dim CL As Byte, CH As Byte       'Polynomial code &HA001
  Dim SaveHi As Byte, SaveLo As Byte
  Dim i As Integer
  Dim flag As Integer
  CRC16Lo = &HFF
  CRC16Hi = &HFF
  CL = &H1
  CH = &HA0
  For i = 0 To UBound(data)
    CRC16Lo = CRC16Lo Xor data(i) 'Each data byte is XORed with the CRC register
    For flag = 0 To 7
      SaveHi = CRC16Hi
      SaveLo = CRC16Lo
      CRC16Hi = CRC16Hi \ 2      'The high byte is shifted right by 1 bit
      CRC16Lo = CRC16Lo \ 2      'The low byte is shifted right by 1 bit
      If ((SaveHi And &H1) = &H1) Then 'If the last bit of the high byte is 1
        CRC16Lo = CRC16Lo Or &H80   'Then 1 is filled in at the front after the low byte is shifted right
      End If           'Otherwise 0 is filled in automatically
      If ((SaveLo And &H1) = &H1) Then 'If the LSB is 1, it is XORed with the polynomial code
        CRC16Hi = CRC16Hi Xor CH
        CRC16Lo = CRC16Lo Xor CL
      End If
    Next flag
  Next i
  Dim ReturnData(1) As Byte
  ReturnData(0) = CRC16Hi      'CRC high byte
  ReturnData(1) = CRC16Lo      'CRC low byte
  CRC16 = ReturnData
End Function
```

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

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

Figure 11-2 Modbus Appended CRC-16 Value



11.1.3 Response Frame

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

Figure 11-3 Normal Response Frame

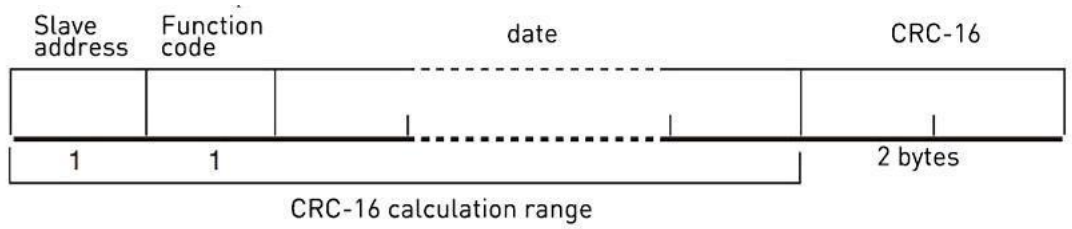


Figure 11-4 Exception Response Frame

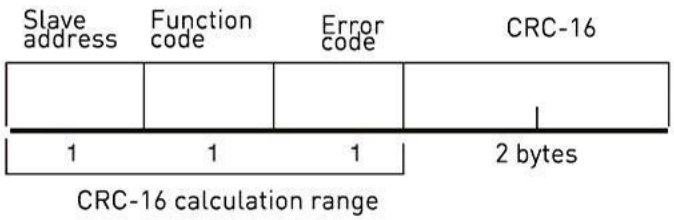


Table 11-2 Exception Response Frame Description

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

11.1.4 No Response

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

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

11.1.5 Error Codes

Table 11-3 Error Code Description

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

11.2 Function Codes

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

Table 11-4 Function Codes

Function Codes	Name	Description

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

11.3 Registers

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

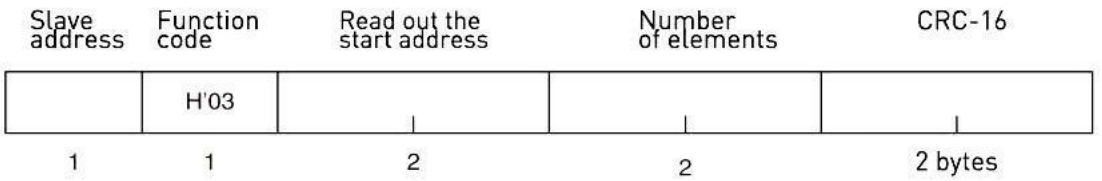
Data:
The instrument supports the following types of values:

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

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

11.4 Read Multiple Registers

Figure 11- 5 Read Multiple Registers (0x03)

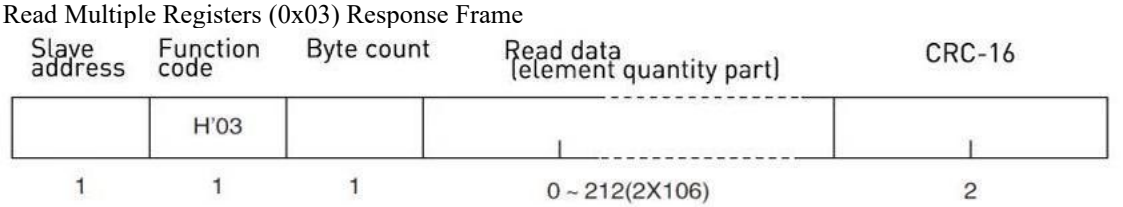


The function code for reading multiple registers is 0x03.

Table 11-5 Read Multiple Registers

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

Figure 11- 7 Read Multiple Registers (0x03) Response Frame



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

	Data	Data read
CRC-16	Check Code	

11.5 Write Multiple Registers

Figure 11- 8 Write Multiple Registers (0x10)

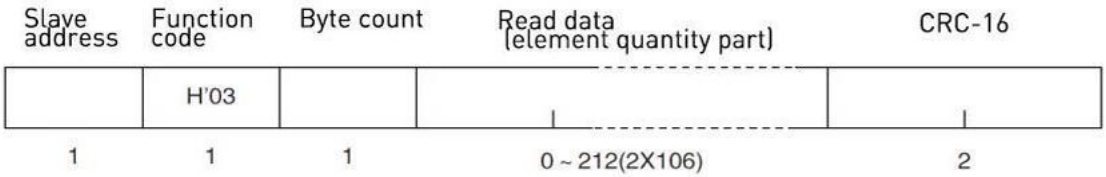
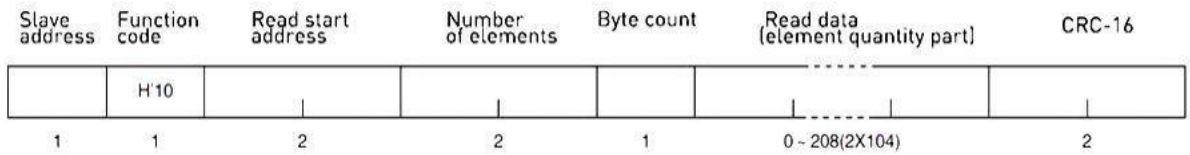


Table 11- 19 Write Multiple Registers

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

Figure 11- 9 Write Multiple Registers (0x03) Response Frame



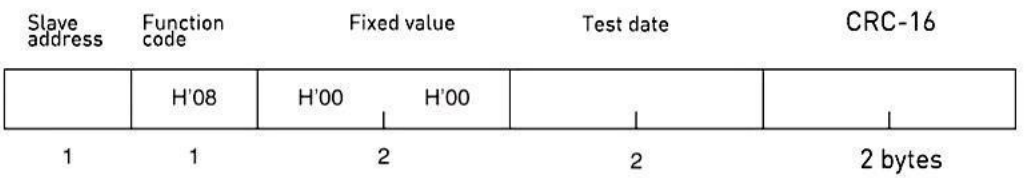
Name	Name	Description
	Slave address	Returned as is
0x10 or 0x90	Function Codes	No exception: 0x10 Error code: 0x90
	Starting address	
	No. of Registers	
	CRC-16 Check Code	

11.6 Echo Test

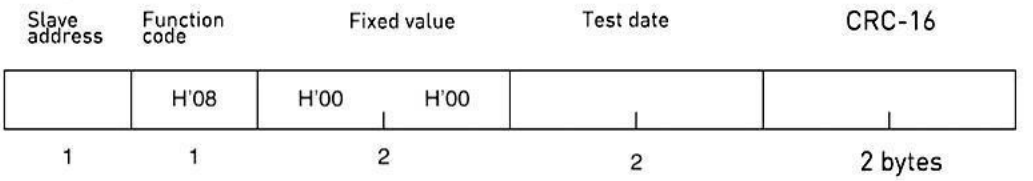
The function code of the Echo Test is 0x08, which is used for debugging Modbus.

Figure 11- 10 Echo Test (0x08)

Instruction frame

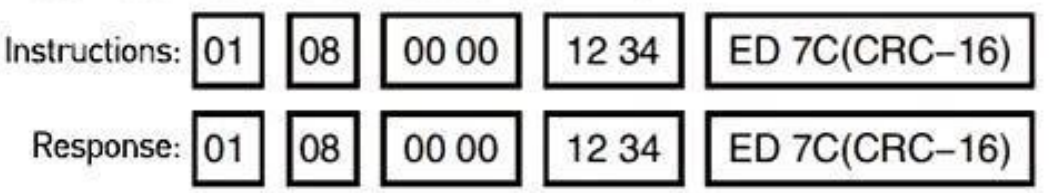


Response frame



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

Example:
Assume the test data is 0x1234:



12. Modbus (RTU) Command Set

This chapter includes the following topics:
Register Overview
Detailed operation

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

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

12.1 Register Overview

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

Table 12- 20 Register Overview

Register Address	Name	Numeric value	Description
2000-2001	Read the primary parameter measurement result	4-byte floating-point number	Read-only register, data occupies 2 registers
2002-2003	Read the secondary parameter measurement result	4-byte floating-point number	Read-only register, data occupies 2 registers
2004	Get the comparator result	2-byte integer	Read-only register, data occupies 1 register
0000	Read the instrument version number	4-byte ASCII	Read-only register, data occupies 2 registers
3000	Function register	Data Function 0000 Cs-Rs 0001 Cs-D 0002 Cp-Rp 0003 Cp-D 0008 Rs-Q 0009 Rp-Q 000E Z-D 000F Z-Q	Read/write register 1 register 2-byte integer
3001	Range number	0000~0008	Read/Write register, 2-byte integer
3002	Range mode	0000: Manual range 0001: Auto range 0002: Nominal range	Read/Write register, 2-byte integer
3003	Test Speed	0000: Slow 0001: Medium 0002: Fast	Read/Write register, 2-byte integer
3004	Averaging count	0000: Invalid 0001~0x0100 (1~256)	Read/Write register, 2-byte integer
3005	Trigger Mode	0000: Internal 0001: Manual 0002: External 0003: Remote	Read/Write register, 2-byte integer
3006-3007	Test Frequency	4-byte floating-point	Read/Write register, data occupies 2

		number	registers
3008-3009	Test level	4-byte floating-point number	Read/Write register, data occupies 2 registers
300C	File power-on recall	0000: File 0 0001: Current file	Read/Write register, 2-byte integer
300D	Auto save	0000: Forbid 0001: Allow	Read/Write register, 2-byte integer
300E	System Language	0000: English 0001: Simplified Chinese	Read/Write register, 2-byte integer
3100	Comparator status	0000: Comparator off 0001: Comparator on	Read/Write register, 2-byte integer
3101	Comparator mode	0000: ABS 0001: PER 0002: SEQ	Read/Write register, 2-byte integer
3102	Secondary parameter comparison switch	0000: Disable secondary parameter comparison 0001: Enable secondary parameter comparison	Read/Write register, 2-byte integer
3103	Number of bins	0001~0003 Number of bins 1~3	Read/Write register, 2-byte integer
3104	Beeper	0000: Off 0001: PASS beep 0002: FAIL beep	Read/Write register, 2-byte integer
310A	Primary parameter nominal value	4-byte floating-point number	Read/Write register, data occupies 2 registers
310C	Secondary parameter lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
310E	Secondary parameter upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3110	Primary parameter BIN1 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3112	Primary parameter BIN1 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3114	Primary parameter BIN2 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3116	Primary parameter BIN2 upper limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
3118	Primary parameter BIN3 lower limit	4-byte floating-point number	Read/Write register, data occupies 2 registers
311A	Primary parameter BIN3 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
4008	Read the current file data	Fixed value: 0001	Write-only register, data 2 bytes
4010	Save settings to the specified file	0000~0009	Write-only register, data 2 bytes
4018	Read the specified file data	0000~0009	Write-only register, data 2 bytes
5000	Full-frequency open zeroing register Read the zeroing status	Write fixed value: 0001 Read: 0001 Zeroing in progress 0000 Zeroing succeeded	Read/Write register, data occupies 1 register Once the zeroing function has been executed, Modbus will disable the execution of write commands and only allow reading registers.

		FFFF Zeroing failed	
5008	Full-frequency short zeroing register Read the zeroing status	Write fixed value: 0001 Read: 0001 Zeroing in progress 0000 Zeroing succeeded FFFF Zeroing failed	Read/Write register, data occupies 1 register Once the zeroing function has been executed, Modbus will disable the execution of write commands and only allow reading registers.

12.2 Acquiring Measurement Data

12.2.1 Acquiring Measurement Results

Registers 2000~2003 are used to obtain the instrument 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	

- **Get the primary parameter measurement result:**

Send:

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

Response:

1	2	3	4	5	6	7	8	9
01	03	04	4E	6E	6B	28	A3	E8
01	03	Bytes	Single-precision floating-point number				CRC-16	

Where B4~B6 are the measurement data: 4E6E6B28 represents 1E9 (low byte first)

- **Get the secondary parameter measurement result**

Send:

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

Response:

1	2	3	4	5	6	7	8	9
01	03	04	50	15	02	F9	3B	D5
01	03	Bytes	Single-precision floating-point number				CRC-16	

Where B4~B6 are the measurement data: 501502F9 represents 1E10 (low byte first)

12.2.2 Acquiring the Comparator Result [2004]

Register 2004 records the comparator result of the voltage and resistance.
16-bit storage field:
Where:

BIT8 Secondary parameter bin 1: Fail
BIT7 Overall pass bin 1: Primary and secondary parameters pass, 0: Overall fail
BIT3~BIT0 Pass bin 1~9: Pass 0: Fail

Send:

1	2	3	4	5	6	7	8

01	03	20	04	00	01	CE	0B
Slave	Read	Registers		No. of Registers		Check Code	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**E0**	**E5**

Example:
Data 01 81
BIT8: 1=Secondary parameter fail
BIT7: 1=Overall fail
BIT3-BIT0: 1=Primary parameter pass bin BIN1
Data 00 01
BIT8: 0=Secondary parameter pass
BIT7: 0=Overall pass
BIT3-BIT0: 1=Primary parameter pass bin BIN1

12.2.3 Acquiring Primary/Secondary Measurement Values and Comparator Results [2000~2004]

Send:

1	2	3	4	5	6	7	8
01	**03**	**20**	**00**	**00**	**05**	**8E**	**09**
Slave	Read	Registers		No. of Registers		Check Code	

Response:
01 03 0A **44 79 D4 B1** **37 D6 9D C2** **00 81** C6 24

12.3 Parameter Settings

12.3.1 Function Register [3000]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**00**	**00**	**01**	**02**	**00**	**00**	**96**	**53**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

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

- Read

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**	**08**	**B9**	**82**
		Bytes	Data		CRC	

Where the data values are:

Data	Function
0000	Cs-Rs
0001	Cs-D
0002	Cp-Rp
0003	Cp-D
0008	Rs-Q
0009	Rp-Q
000E	Z-D
000F	Z-Q

12.3.2 Range Register [3001]

- Write

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 Regs	Bytes	Data	CRC

Response:

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

- Read

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

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Range 0	100kΩ
0001	Range 1	30kΩ
0002	Range 2	10kΩ
0003	Range 3	3kΩ
0004	Range 4	1kΩ
0005	Range 5	300Ω
0006	Range 6	100Ω
0007	Range 7	30Ω
0008	Range 8	10Ω

12.3.3 Ranging Mode Register [3002]

- Write

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

Response:

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

- Read

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

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Manual range	
0001	Auto range	
0002	Nominal range	Select the range according to the nominal value

12.3.4 Test Speed Register [3003]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**03**	**00**	**01**	**02**	**00**	**01**	**57**	**A0**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**03**	**00**	**01**	**FE**	**C9**
		Registers		No. of Registers		CRC	

- Read

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

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Slow	
0001	Invalid	This value is reserved
0002	Medium	
0003	Fast	

12.3.5 Averaging Count Register [3004]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**04**	**00**	**01**	**02**	**00**	**02**	**16**	**16**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**04**	**00**	**01**	**4F**	**08**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**04**	**00**	**01**	**CA**	**CB**
	Read	Registers		No. of Registers		CRC	

Response:

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

Where the data values are:

Data	Function	Description
0001~0100	Average value 0~256	Average value 0 = average value 1

12.3.6 Trigger Mode Register [3005]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**05**	**00**	**01**	**02**	**00**	**02**	**17**	**C7**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**05**	**00**	**01**	**1E**	**C8**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**05**	**00**	**01**	**9B**	**0B**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7

01	03	02	00	02	39	85
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Internal trigger	
0001	Manual trigger	Use the Trigger key
0002	External trigger	Handler trigger
0003	Remote trigger	SCPI trigger

12.3.7 Test Frequency Register [3006][3007]

- Write [1kHz: 1000 = 44 7A 00 00]

1	2	3	4	5	6	7	8~11	12	13
01	**10**	**30**	**06**	**00**	**02**	**04**	**44 7A 00 00**	**12**	**AD**
	Write	Registers		No. of Regs		Bytes	Data	CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**06**	**00**	**02**	**AE**	**C9**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**06**	**00**	**02**	**CF**	**1A**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4~7	8	9
01	**03**	**04**	**44 7A 00 00**	**CF**	**1A**
		Bytes	Data	CRC	

12.3.8 Test Voltage Register [3008][3009]

- Write [1V: 1.00 = 3F 80 00 00]

1	2	3	4	5	6	7	8~11	12	13
01	**10**	**30**	**08**	**00**	**02**	**04**	**3F 80 00 00**	**EB**	**B4**
	Write	Registers		No. of Regs		Bytes	Data	CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**08**	**00**	**02**	**FF**	**09**
		Registers		No. of Registers		CRC	

Note: In the following cases, an error will be returned

Test conditions	Description
<User Calibration> page	Operation error
<List Sweep> page	Operation error
Function: DCR	Operation error
Level value exceeds the specification value	Data error

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**07**	**00**	**02**	**7A**	**CA**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4~7	8	9
01	**03**	**04**	**3F 80 00 00**	**F7**	**CF**
		Bytes	Data	CRC	

Note: In the following cases, an error will be returned

Test conditions	Description
<User Calibration> page	Operation error
<List Sweep> page	Operation error
Level is in current state	Operation error
Function: DCR	Operation error

12.3.9 Power-On File Register [300C]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**0C**	**00**	**01**	**02**	**00**	**01**	**FA**	**C8**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**0C**	**00**	**01**	**CE**	**CA**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**0C**	**00**	**01**	**4B**	**09**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	File 0	Default setting
0001	Current File	

12.3.10 Auto Save [300D]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**0D**	**00**	**01**	**02**	**00**	**01**	**56**	**8E**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**0D**	**00**	**01**	**9F**	**0A**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**0D**	**00**	**01**	**79**	**84**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Off	Default setting
0001	On	

12.3.11 System Language Setting [300E]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**0E**	**00**	**01**	**02**	**00**	**01**	**56**	**BD**

	Write	Registers	No. of Regs	Bytes	Data	CRC

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**0E**	**00**	**01**	**6F**	**0A**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**0E**	**00**	**01**	**EA**	**C9**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	English language	
0001	Chinese language	

12.3.12 Test Current Register [3010][3011]

- Write [1mA: 0.001 = 3A 83 12 6F]

1	2	3	4	5	6	7	8~11	12	13
01	**10**	**30**	**10**	**00**	**02**	**04**	**3A 83 12 6F**	**17**	**1E**
	Write	Registers		No. of Regs		Bytes	Data (1mA)	CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**10**	**00**	**02**	**4F**	**0D**
		Registers		No. of Registers		CRC	

Note: In the following cases, an error will be returned

Test conditions	Description
<User Calibration> page	Operation error
<List Sweep> page	Operation error
Function: DCR	Operation error
Level value exceeds the specification value	Data error

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**10**	**00**	**02**	**CA**	**CE**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4~7	8	9
01	**03**	**04**	**3A 83 12 6F**	**4B**	**8F**
		Bytes	Data 1mA	CRC	

Note: In the following cases, an error will be returned

Test conditions	Description
<User Calibration> page	Operation error
<List Sweep> page	Operation error
Level is in voltage state	Operation error
Function: DCR	Operation error

Note: An operation error is returned when the present level is not in current mode or the measurement parameter is DCR.

12.3.13 DC Bias Register [3012][3013]

- Write 1V: 3F 80 00 00

1	2	3	4	5	6	7	8~11	12	13
01	**10**	**30**	**12**	**00**	**02**	**04**	**3F 80 00 00**	**2A**	**87**
	Write	Registers		No. of Regs		Bytes	Data (1V)	CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**30**	**12**	**00**	**02**	**EE**	**CD**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**30**	**12**	**00**	**02**	**6B**	**0E**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4~7	8	9
01	**03**	**04**	**00 00 00 00**	**FA**	**33**
		Bytes	Data	CRC	

12.4 Comparator Settings

The comparator parameter register addresses start from 3100.

12.4.1 Comparator Status Register [3100]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**00**	**00**	**01**	**02**	**00**	**01**	**47**	**53**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**31**	**00**	**00**	**01**	**0F**	**35**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**31**	**00**	**00**	**01**	**8A**	**F6**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Comparator off	Default setting
0001	Comparator on	

12.4.2 Comparator Mode Register [3101]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**01**	**00**	**01**	**02**	**00**	**01**	**46**	**82**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**31**	**01**	**00**	**01**	**5E**	**F5**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**31**	**01**	**00**	**01**	**DB**	**36**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	ABS comparison	Absolute deviation comparison
0001	PER comparison	Percent deviation comparison
0002	SEQ comparison	Direct reading sequential comparison

12.4.3 Secondary Parameter Comparison Switch Register [3102]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**02**	**00**	**01**	**02**	**00**	**01**	**46**	**B1**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**31**	**02**	**00**	**01**	**AE**	**F5**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**31**	**02**	**00**	**01**	**2B**	**36**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Secondary parameter comparison off	
0001	Secondary parameter comparison on	

12.4.4 Comparison Bin Number Register [3103]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**03**	**00**	**01**	**02**	**00**	**01**	**47**	**B1**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**31**	**03**	**00**	**01**	**FF**	**35**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**31**	**03**	**00**	**01**	**7A**	**F6**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7

01	03	02	00	01	79	84
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	Invalid	
0001~0009	Number of bins	

12.4.5 Beeper Register [3104]

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**04**	**00**	**01**	**02**	**00**	**01**	**46**	**D7**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**31**	**04**	**00**	**01**	**4E**	**F4**
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	**03**	**31**	**04**	**00**	**01**	**CB**	**37**
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
		Bytes	Data		CRC	

Where the data values are:

Data	Function	Description
0000	OFF	Off
0001	PASS	PASS beep
0002	FAIL	FAIL beep

12.4.6 Nominal Value Register [310A][310B]

The primary parameter nominal value uses 2 registers, 310A and 310B. Note! Reading 310B alone is invalid.

- Write

100E-9 (single-precision floating-point number: 33D6BF95)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	10	31	0A	00	02	04	33	D6	BF	95	74	A2
	Write	Registers		No. of Regs		Bytes	Data				CRC	

Response:

1	2	3	4	5	6	7	8
01	10	31	0A	00	02	6F	36
		Registers		No. of Registers		CRC	

- Read

1	2	3	4	5	6	7	8
01	03	31	0A	00	02	EA	F5
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7	8	9
01	03	04	33	D6	BF	95	A4	D0
		Bytes	Data 100E-9				CRC	

12.4.7 Secondary Parameter Limit Register [310C-310F]

The secondary parameter limit values start from 310C; the lower limit uses 2 registers and the upper limit uses 2 registers, 4 registers in total.
The lower limit and upper limit can be set separately or at the same time.

- Write

Lower limit: 0.001, upper limit: 0.01

1	2	3~4	5	6	7	8~11	12~15	16~17
01	10	310C	00	02	04	3A 83 12 6F	3C 23 D7 0A	21 AE
						Lower Limit	Upper Limit	

Response:

1	2	3	4	5	6	7	8
01	10	31	0C	00	04	0F	35

- Read

1	2	3	4	5	6	7	8
01	03	31	0C	00	04	8A	F6

Response

1	2	3~4	5~8	9~12	13~14
01	03	31 14	3A 83 12 6F	3C 23 D7 0A	51 61
			Lower Limit	Upper Limit	

12.4.8 Primary Parameter Limit Register [3110-3133]

There are 9 primary parameter bins in total; the limit values start from 3110. The lower limit of each bin uses 2 registers and the upper limit uses 2 registers, 4 registers in total.
The lower limit and upper limit can be set separately or at the same time.

- Write

BIN1
Lower limit: -10, upper limit: 10

1	2	3~4	5	6	7	8~11	12~15	16~17
01	10	3110	00	02	04	C1 20 00 00	41 20 00 00	CD5C
						Lower Limit	Upper Limit	

Response:

1	2	3	4	5	6	7	8
01	10	31	10	00	04	8F	1F

- Read

1	2	3	4	5	6	7	8
01	03	31	10	00	04	4B	30

Response

1	2	3~4	5~8	9~12	13~14
01	03	31 10	C1 20 00 00	41 20 00 00	6C7F
			Lower Limit	Upper Limit	

12.5 File Operations

Since the instrument settings are stored in files, the data set through Modbus commands cannot be stored in the internal FlashRom in real time; before 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.

12.5.1 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 Registers		CRC	

Where the data values are:

Data	Function	Description

0001	Allowed operation	Fixed value

12.5.2 Save to Specified File [4008]

Send the file number to register 4008, and the instrument will perform the file write operation; all settings will be saved to the specified file, and the specified file will be used 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**	**08**	**00**	**01**	**02**	**00**	**09**	**26**	**DA**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**40**	**00**	**00**	**01**	**95**	**CB**
		Registers		No. of Registers		CRC	

Where the data values are:

Data	Function	Description
0000~0009	File 0~9	

12.5.3 Reload Current File [4010]

Send the fixed value 0001 to register 4010, and the instrument will load the data of the current file into the system.
This register cannot be read.

- Write

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**40**	**10**	**00**	**01**	**02**	**00**	**01**	**24**	**C4**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**40**	**10**	**00**	**01**	**15**	**CC**
		Registers		No. of Registers		CRC	

Where the data values are:

Data	Function	Description
0001	Fixed value	

12.5.4 Load Specified File [4018]

Send the file number to register 4018, and the instrument will load the settings of the specified file into the system; the specified file will be used 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**	**18**	**00**	**01**	**02**	**00**	**00**	**E4**	**4C**
	Write	Registers		No. of Regs		Bytes	Data		CRC	

Response:

1	2	3	4	5	6	7	8
01	**10**	**40**	**18**	**00**	**01**	**94**	**0E**
		Registers		No. of Registers		CRC	

Error response:
If the file is empty, the instrument will respond with the error code: 04

1	2	3	4	5
01	**90**	**04**	**4D**	**C3**
		Error Codes	**CRC**	

Where the data values are:

Data	Function	Description

0000~0009	File 0~9	

12.6 Zeroing

12.6.1 All-Frequency Open Zeroing [5000]

Write 0001 to register 5000, and the instrument will start executing the full-frequency open zeroing operation.

Since the zeroing process takes several seconds, during this period any write operation will be ignored and only the read operation is available. After zeroing is completed, write commands become available as normal.

During or after the execution of zeroing, the zeroing status can be obtained by reading register 5000:
0000 Zeroing succeeded
FFFF Zeroing failed
0001 Zeroing in progress

- Write

Please write the fixed value 00 01 to register 5000
Send: 01 10 5000 0001 02 0001 3795
Response: 01 10 5000 0001 10C9

- Read

While the zeroing is being executed, it can be determined whether the zeroing is completed by reading the register data
Send: 01 03 5000 0001 950A
Response: 01 03 02 FFFF B9F4
A return of FFFF indicates that the zeroing failed



Note:
During zeroing, try not to read the zeroing status frequently; continuous interruptions can easily cause the zeroing of the instrument to fail.
Since the zeroing time is fixed, it is recommended that, after the zeroing command is sent, the host computer forcibly wait until the zeroing time has elapsed before obtaining the zeroing result.

12.6.2 All-Frequency Short Zeroing [5008]

Writing 0001 to register 5008, the instrument will start the full-frequency open zeroing operation.

Since the zeroing process takes several seconds, during this period any write operation will be ignored and only the read operation is available. After zeroing is completed, write commands become available as normal.

During zeroing execution or after zeroing is completed, the zeroing status can be obtained by reading register 5008:
0000 Zeroing succeeded
FFFF Zeroing failed
0001 Zeroing in progress

- Write

Write the fixed value to register 5008: 00 01
Send: 01 10 5008 0001 02 0001 36DD
Response: 01 10 5008 0001 910B

- Read

While the zeroing is being executed, it can be determined whether the zeroing is completed by reading the register data
Send: 01 03 5008 0001 950A
Response: 01 03 02 FFFF B9F4

A return of FFFF indicates that the zeroing failed



Note:
During zeroing, try not to read the zeroing status frequently; continuous interruptions can easily cause the zeroing of the instrument to fail.
Since the zeroing time is fixed, it is recommended that, after the zeroing command is sent, the host computer forcibly wait until the zeroing time has elapsed before obtaining the zeroing result.

12.7 System Settings

12.7.1 Instrument Version [0000]

Read-only register; registers [0000]~[0003] return the instrument version number:

- Read

1	2	3	4	5	6	7	8
01	03	00	10	00	02	4A	6D
	Read	Registers		No. of Registers		CRC	

Response:

1	2	3	4	5	6	7	8	9
01	03	04	43	37	30	30	4A	6D
		Bytes	Data ASCII: C700				CRC	

The version number is an ASCII value: for example, 43 37 30 30 = C700

13. Performance Test

In this chapter you will learn about the instrument accuracy definitions and test errors, and how to perform the performance test on the instrument. This chapter includes the following:

- Accuracy
- Accuracy factors
- Performance test

The measurement accuracy includes errors such as measurement stability, temperature coefficient, linearity, and measurement repeatability.
The measurement accuracy check of the instrument must be performed under the following conditions:
Power-on warm-up time: ≥ 20 minutes.
After warm-up, correctly perform open and short zeroing.
The instrument range is set to auto.

13.1 Accuracy

13.1.1 Accuracy of C, R, |Z|

The accuracy Ae of C, R, |Z| is expressed as follows:
$A_e = \pm[A+(K_a+K_b)\times 100]\times K_c$ [%]
A: Basic measurement accuracy
K_a: impedance scale factor
K_b: impedance scale factor)
K_c: temperature factor
Conditions for using the C accuracy: D_x(measured D value) ≤0.1
R accuracy conditions: Q_x(measured Q value) ≤0.1
When $D_x \geq 0.1$, the L, C accuracy factor A_e should be multiplied by $\sqrt{1+D_x^2}$
When $Q_x \geq 0.1$, the R accuracy factor A_e should be multiplied by $\sqrt{1+Q_x^2}$

13.1.2 Accuracy of D

The D accuracy D_e is given by the following formula:
$D_e = \pm\frac{Ae}{100}$
The above formula applies only when $D_x \leq 0.1$.
When $D_x > 0.1$, D_e should be multiplied by $(1+D_x)$

13.1.3 Accuracy of Q

The Q accuracy is given by the following formula:
$Q_e = \pm\frac{Qx\times De}{1\mp Qx\times De}$
Here, Q_x is the measured Q value.
D_e is the accuracy of D
The above formula applies when $Q_x \times D_e < 1$

13.1.4 Accuracy of θ

θ accuracy is given by the following formula:
$\theta_e = \frac{180}{\pi}\times\frac{Ae}{100}$ [deg]

13.1.5 R_pAccuracy

When D_x(measured D value) ≤0.1
$R_p$accuracy is given by the following formula:
$R_p = \pm\frac{Rpx\times De}{Dx\mp De}$ [Ω]
Here, R_{px} is the measured R_p value [S].
D_x is the measured D value [F].

D_e is the accuracy of D.

13.1.6 R_sAccuracy

When D_x(measured D value) ≤0.1
$R_s$accuracy is given by the following formula:

$R_{se} = X_x \times D_e$ [Ω]

$X_x = 2\pi f L_x = \frac{1}{2\pi f C_x}$

Here,

X_x is the measured X value [S].
C_x is the measured C value [F].
L_x is the measured L value [H].
D_e is the accuracy of D
F is the test frequency

13.2 Accuracy Factors

Figure 13- 32 Basic Measurement Accuracy A

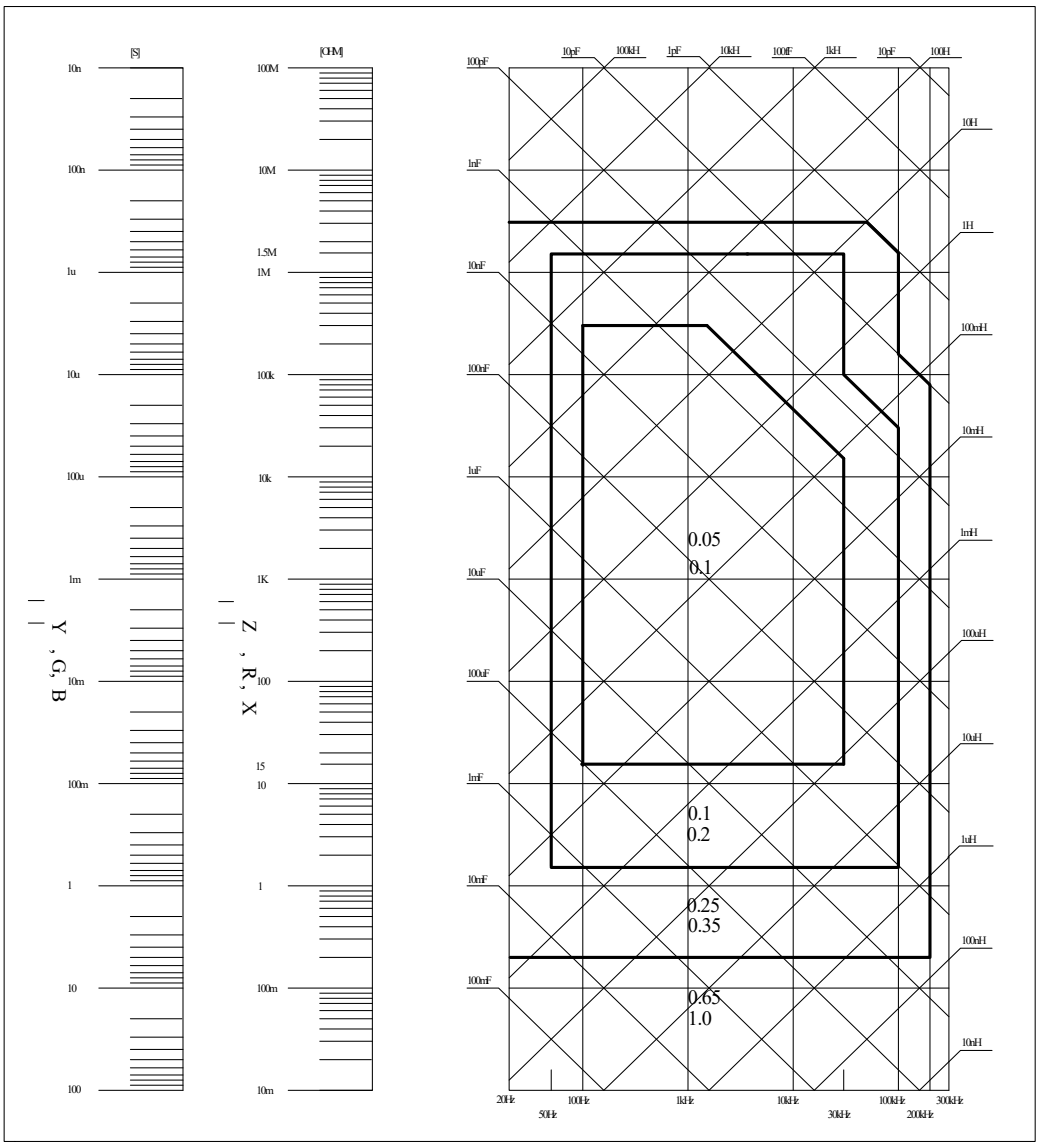


Figure 13-41 Basic Measurement Accuracy: on the boundary lines, select the smaller value
The basic accuracy A value is selected as follows:
0.05 ---- when $0.4V_{rms} \le V_s \le 1.2V_{rms}$, the A value for the medium and slow measurement speeds.
0.1 ---- when $0.4V_{rms} \le V_s \le 1.2V_{rms}$, the A value for the fast measurement speed.

When V_s<0.4V_{rms} or V_s>1.2V_{rms} , the A value is calculated as follows: select the A according to the current measurement speed, then select the accuracy correction factor A according to the current test signal voltage$_r$ (see Figure 6-2), A multiplied by A_r gives the current basic measurement accuracy A. Here, V_s is the test signal voltage.

Figure 13- 33 Basic Accuracy Correction Curve

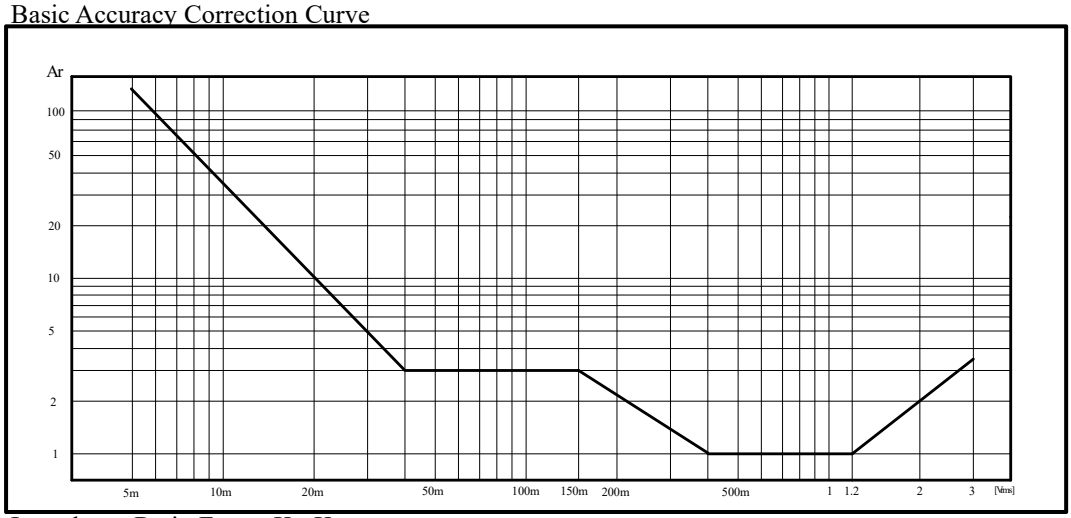


Table 13- 21 Impedance Ratio Factor K_a, K_b

Speed	Freq	K_a	K_b
medium-1 medium-2 Slow	f_m<100Hz	$(\frac{1\times10^{-3}}{\lvert Zm\rvert})(1+\frac{200}{Vs})(1+\sqrt{\frac{100}{fm}})$	$\lvert Zm\rvert(1\times10^{-9})(1+\frac{70}{Vs})(1+\sqrt{\frac{100}{fm}})$
	100Hz≤fm ≤100kHz	$(\frac{1\times10^{-3}}{\lvert Zm\rvert})(1+\frac{200}{Vs})$	$\lvert Zm\rvert(1\times10^{-9})(1+\frac{70}{Vs})$
	fm>100kHz	$(\frac{1\times10^{-3}}{\lvert Zm\rvert})(2+\frac{200}{Vs})$	$\lvert Zm\rvert(3\times10^{-9})(1+\frac{70}{Vs})$
Fast	f_m<100Hz	$(\frac{2.5\times10^{-3}}{\lvert Zm\rvert})(1+\frac{400}{Vs})(1+\sqrt{\frac{100}{fm}})$	$\lvert Zm\rvert(2\times10^{-9})(1+\frac{100}{Vs})(1+\sqrt{\frac{100}{fm}})$
	100Hz≤fm ≤100kHz	$(\frac{2.5\times10^{-3}}{\lvert Zm\rvert})(1+\frac{400}{Vs})$	$\lvert Zm\rvert(2\times10^{-9})(1+\frac{100}{Vs})$
	fm>100kHz	$(\frac{2.5\times10^{-3}}{\lvert Zm\rvert})(2+\frac{400}{Vs})$	$\lvert Zm\rvert(6\times10^{-9})(1+\frac{100}{Vs})$

In the table,
fm: test frequency [Hz]
Zm: impedance of the device under test [Ω]
Vs: test signal voltage [mV_{rms}]
When the impedance is less than 500Ω, K_a is used, K_b is invalid.
When the impedance is greater than 500Ω, K_b is used, K_a is invalid.

Table 13- 22 Temperature Factor Kc

Temperature (℃)	5	8	18	28	38
Kc	6	4	2	1	2	4

Table 13- 23 Calibration Interpolation Factor Kf

Test Frequency	Kf
Typical frequency (direct calibration)	0
Non-typical frequency (interpolation calibration)	0.0003

Table 13- 24 Cable Length Factor

Test Signal Level	Cable length		
	0m	1m	2m
≤1.5Vrms	0	$2.5x10^{-4}(1+0.05fm)$	$5x10^{-4}(1+0.05fm)$
>1.5Vrms	0	$2.5x10^{-3}(1+0.016fm)$	$5x10^{-3}(1+0.05fm)$

In the table, fm is the test signal frequency [kHz].

13.3 Performance Test

Each test shall be performed under the following operating conditions.
Power-on warm-up time: ≥ 20 minutes.
After warm-up, correctly perform open and short zeroing.
The instrument range is set to “AUTO” to select the correct measurement range.

These tests cover only the specifications of the main parts of the instrument. For parameters of other parts not listed here, the user may perform testing under the specified conditions according to the specifications given in this manual. If a test result is found to exceed the specification range, please contact our service department for repair immediately.

13.3.1 Devices and Equipment for Performance Testing

Table 13- 25 Devices and Equipment for Performance Testing

No.	Instrument and equipment name		Technical requirements
1	Standard capacitor	100pF	0.02% Loss D known
		1000pF	
		10000pF	
		10nF	
		0.1μF	
		1μF	
2	AC Standard resistor	10Ω	0.02%
		100Ω	
		1kΩ	
		10kΩ	
		100kΩ	
3	Standard inductor	100μH	0.02%
		1mH	
		10mH	
		100mH	
4	Frequency counter		(0~1000)MHz
5	Digital multimeter		0.5%

13.3.2 Function Check

All function keys, the display, the terminals, etc. of the instrument shall work normally, and all functions shall be correct and error-free.

13.3.3 Test Signal Level Accuracy Test

Set the digital multimeter to the AC voltage range; connect one test probe to the HD terminal of the instrument and the other test probe to the ground terminal. Change the level to 0.1V, 0.3V, and 1V, which shall meet the requirements in Appendix A.

13.3.4 Frequency Accuracy Test

Connect the ground terminal of the frequency counter to the ground terminal of the instrument, and the test terminal of the frequency counter to the HD terminal of the instrument test terminal. Change the frequency to 20Hz, 100Hz, 1kHz, 10kHz, and 100kHz; the reading of the frequency counter shall meet the requirements in the specifications.

13.3.5 Capacitance C and Dissipation D Accuracy Test

Parameter C_p-D
Test frequency 100Hz 1kHz 10kHz 100kHz test separately
Level 1V
Range AUTO
Speed SLOW
Short and open zeroing shall be performed before the test. Connect the standard capacitors 100pF, 1000pF, 10000pF, 10nF, 0.1uF, and 1uF and change the frequency. The capacitance C error between the instrument reading and the standard value shall be within the permissible error range specified in 6.1, and the loss D shall be within the permissible error range specified in 6.1.

13.3.6 Inductance L Accuracy Test

Parameter L_s-Q
Test frequency 100Hz 1kHz 10kHz 100kHz test separately
Level 1V
Range AUTO
Speed SLOW
Short and open zeroing shall be performed before the test. Connect the standard inductors 100μH, 1mH, 10mH, and 100mH and change the frequency; the error between the instrument reading and the standard value shall be within the permissible error range specified in 6.1.

13.3.7 Impedance Z Accuracy Test

Parameters Z-θ
Test frequency 100Hz , 1kHz, 10kHz, 100kHz test separately
Level 1V
Range AUTO
Speed SLOW
Short- and open-circuit zeroing should be performed before testing. Connect the AC standard resistors 10Ω, 100Ω, 1kΩ, 10kΩ, 100kΩ and change the frequency; the error between the instrument reading and the standard value should be within the allowable error range specified in 6.1.

14. Measurement Procedure and Examples

!

This chapter introduces the basic test procedures and basic LCR theory, and illustrates how to perform measurements with examples. This chapter mainly covers:

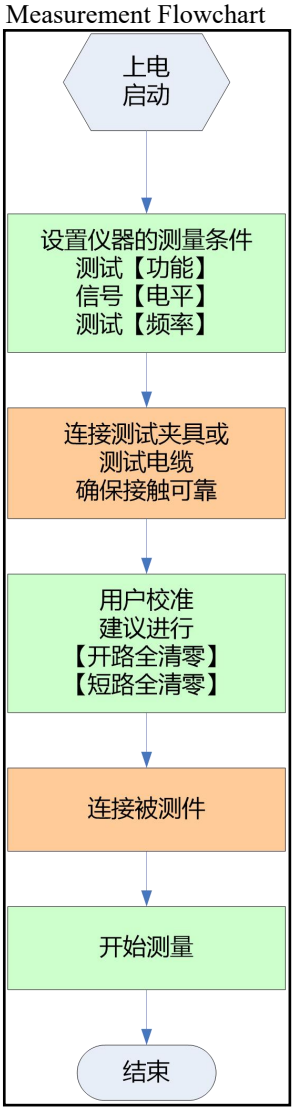
- Basic measurement procedure
- Measurement method example

14.1 Basic Measurement Procedure

The following flowchart shows the basic steps for measuring the impedance of capacitors, inductors, resistors, and other components.

Measure the impedance by following the steps, and refer to the items indicated to the right of each step.

Figure 14- 34 Measurement Flowchart



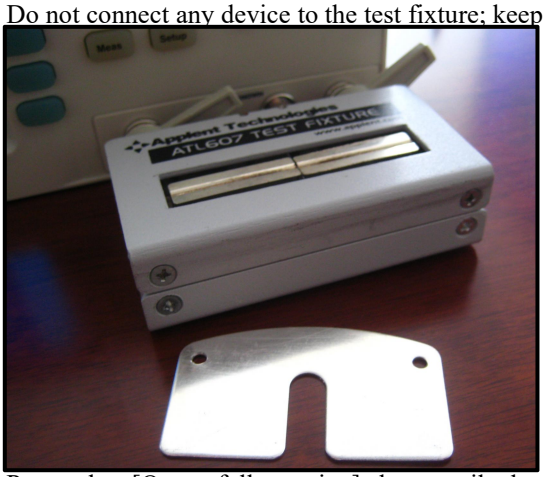
14.2 Measurement Example

This section takes the measurement of a film ceramic capacitor as an example to illustrate how to

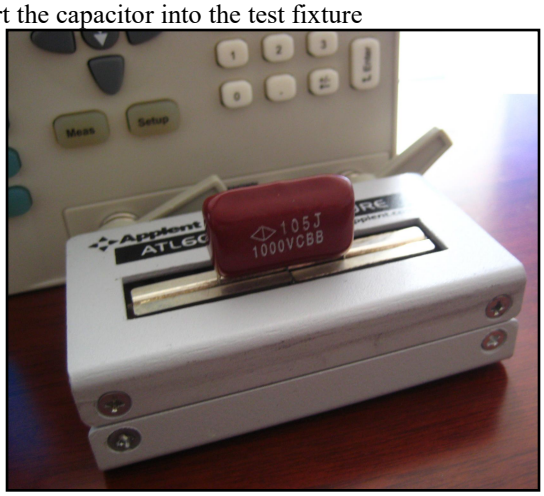
measure the capacitance value.
In this example, the ceramic capacitor is measured under the following conditions.

- DUT: film capacitor
- Measurement function: Cp-D
- Test frequency: 100kHz
- Test signal level: 1V

Step 1 Turn on the instrument power; the instrument will enter the <Measurement Display> page
Step 2 Use the cursor keys to select
[Function]: press the soft key to select Cp-D
[Frequency]: enter 100kHz
[Level]: enter 1V
Step 3 Connect the test fixture
Step 4 Perform user calibration
Press [Setup] to enter the <Setup> page
Press the soft key [User Calibration] to enter the <User Calibration> page
Use the cursor keys to select the [Open] field
Set [Open] to [On]
Do not connect any device to the test fixture; keep it open, as shown in the figure below:



Press the [Open full zeroing] key until the progress box reaches 100% and disappears automatically, and “Calibration completed” is displayed at the bottom of the screen.
Use the cursor keys to move down to the [Short] field
Set [Short] to [On]
Insert the shorting plate from the instrument accessories into the test fixture
Press the [Short full zeroing] key until the progress box reaches 100% and disappears automatically, and “Calibration completed” is displayed at the bottom of the screen.
User calibration is completed; general users do not need to perform spot-frequency calibration.
Step 5 Press the [Meas] key to return to the <Measurement Display> page
Step 6 Insert the capacitor into the test fixture



Step 7 View the test results
Figure 14- 35 Capacitor Test Results


<测量显示>
功能 Cp-D
量程 [6] 自动
频率 1.00000 kHz
触发 内部
电平 1.00 V
速度 慢速
Cp 984.614 nF
D 0.00028
R 0.04496 Ω
X -161.642 Ω
比较器 打开
附属档 打开
档号 OUT
校准 开路,短路,点频 1
USB磁盘就绪。
测量显示
档号显示
档计数
列表扫描
文件
系统
开锁
20:44

15. Specifications

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

15.1 Technical Specifications

The following data are measured under the following conditions:
Temperature condition: 23℃±5℃
Humidity: <65% R.H.
Zero adjustment: open- and short-circuit zeroing before testing
Warm-up time: >60 minutes
Calibration interval: 12 months

Test level accuracy: 10%
Test frequency accuracy: 0.01%
Basic accuracy of parameter measurement: 0.05%

15.2 General Specifications

Screen: TFT-LCD true-color display, 3.5-inch screen.
Test functions: Cs-Rs, Cs-D, Cp-Rp, Cp-D, Rs-Q, Rp-Q, Z-D, Z-Q
Monitor parameters: Z, Δ, Δ%, R
Basic accuracy: 0.1% (within the basic range)
Test frequency: 100, 120, 1kHz, 2kHz, 10kHz
Frequency accuracy: 0.01%
Test level: ACV: 10.00mV~2.00V, accuracy: 10%, CV mode accuracy: 6%
Output impedance 30Ω

Display digits: primary parameter 6 digits; secondary parameter 6 digits, auxiliary parameter: 6 digits

Display range

Parameters	Measurement Display Range
C	0.0001pF ~ 9999.9mF
R, Z	0.0001Ω ~ 99.999MΩ
D	0.0001 ~ 9.9999
Q	0.0001 ~ 9999.9
%	-99.999% ~ 999.99%

Test speed: Fast: 30 readings/second, medium: 10 readings/second, slow: 3 readings/second
Output impedance: 30Ω and 100Ω
Max. reading: 99999
Range mode: auto, lock, and nominal
Equivalent circuit: Series and parallel
Calibration: open swept-frequency zeroing, short swept-frequency zeroing

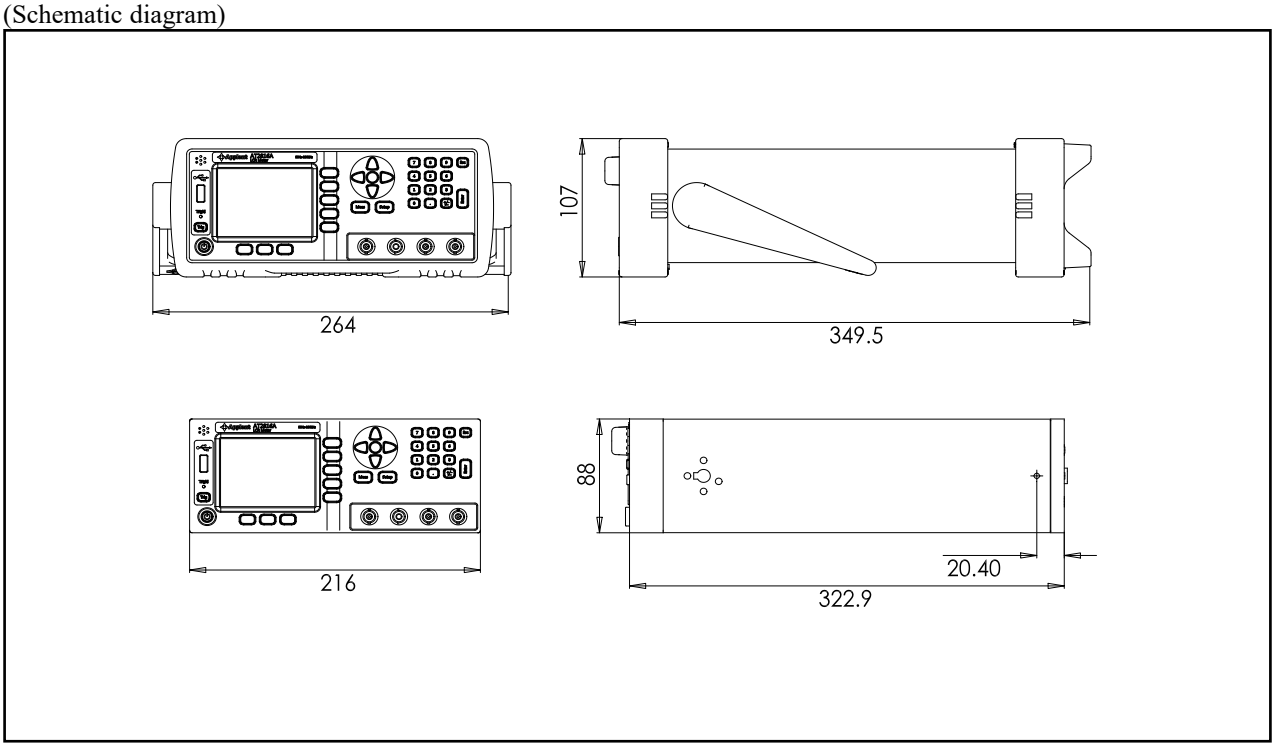
File: 10 built-in files and USB memory.
Beeper: Off, PASS, and FAIL beeps.
Trigger: Internal, external, manual, and remote trigger.
Interfaces: Handler interface/RS232 interface/RS485 interface/GPIB interface (optional)
Programming language: SCPI and Modbus (RTU)

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

Operation: Temperature 10℃~40℃ Humidity 10~80% RH
Storage: temperature -10℃~70℃ humidity 10~90% RH
Power: 90V-260VAC, 50Hz~60Hz
Fuse: 250V 3A slow-blow
Power consumption: maximum 15VA
Net weight: approx. 3 kg.

15.3 Dimensions

(Schematic diagram)



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