ONMEAS®

Rev.B1.0

# AT688

## InsulationResistanceMeter




# User's Guide

Scan QR code for operation video

# Safety Summary

WARNING DANGER: When you notice any of the following abnormal conditions, terminate operation immediately and disconnect the power cord. Contact Applent Instruments Sales for repair. Failure to do so may result in fire or potential electrical shock to operators.

- Instrument is operating abnormally.
- Instrument produces abnormal noise, odor, smoke or flash during operation.
- Instrument generates high temperature or electric shock during operation.
- Power cord, power switch, or power outlet is damaged.
- Impurities or liquids flow into the instrument.

# Safety Information

WARNING DANGER: To avoid possible electric shock and personal safety, follow guidelines in below.

| | |
|---|---|
| **Disclaimer** | Users should read the following safety information carefully before starting to use the instrument. Applent Instruments will not be held liable for any personal safety and property damage caused by user's failure to comply with the following terms. |
| **Ground**<br>The instrument | To avoid electric shock hazard, the instrument chassis and cabinet must be connected to a safety earth ground by the supplied power cable with earth blade. |
| **DO NOT**<br>Operate in an Explosive Atmosphere | Do not use the instrument in a flammable or explosive atmosphere, steam or dusty environment. The use of any electronic device in such an environment is an adventure for personal safety. |
| **DO NOT**<br>Open instrument enclosure | Non-professional maintenance personnel should not open the instrument case in an attempt to repair the instrument. The instrument still has charge after a period of shutdown, which may pose a shock hazard to users. |
| **DO NOT**<br>Use a damaged instrument | If the instrument has been damaged, its danger will be unpredictable. Please disconnect power cord and don't use the instrument; do not attempt to repair it. |
| **DO NOT**<br>Use an instrument that works abnormally | If the instrument is not working properly, its danger is unpredictable. Please disconnect power cord and don't use the instrument; do not attempt to repair it. |
| **DO NOT**<br>Use the instrument beyond instructions specified in this manual | If out of scope, the protection provided by the instrument will be invalid. |

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This Applent instrument product is warranted against defects in material and workmanship for a period corresponding to the individual warranty periods of its component products. **The warranty period is 2 year and begins on the date of shipment.** During the warranty period, Applent will, at its option, either repair or replace products that prove to be defective. This warranty extends only to the original buyer or end-user customer of a Applent authorized reseller, and does not apply to fuses, disposable batteries or to any product which, in Applent's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling.

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Applent Instruments, Ltd.
Changzhou,
Jiangsu,
China,
Rev.A3 October, 2009
Rev.a3

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# 1. Installation and Setup Wizard



Thank you for purchasing our products. Please read this chapter carefully before use.
In this chapter you will learn the following:

- Packing List
- Power Requirements
- Operating Environment
- Cleaning
- Replace fuse
- How to Remove the Handle

## 1.1 Packing List

Before using the instrument, please:
1. Check appearance of the product whether there is damage, scratches, etc.;
2. Check the instrument packing list if there are any missing items.

Table 1- 1 Instruments accessories

| Name | Qty |
|---|---|
| AT688 User's guide | 1 |
| AC power cord | 1 |
| 250V/1A slow-blow fuse | 1 |
| ATL507 test cable | 1 |
| ATL108 communication cable | 1 |
| 1A Fuse (Slow-Blow) | 1 |
| Test report | 1 |

If there is any damage or insufficient accessories, please contact Applent Instruments Sales or distributor immediately.

## 1.2 Power Requirements

AT688 can only be used in the following power conditions:
Voltage: 198 ~ 252 VAC/110V
Frequency: 47.5~52.5Hz
Power: up to 30VA



Warning: To prevent electric shock, please connect the power ground.
If users replace power cord, make sure that the ground of the power cord is securely connected.

## 1.3 Operating Environment

AT688 must be used under the following environmental conditions:
Temperature: 0°C～55°C
Humidity: < 70%　RH at 23℃

## 1.4 Cleaning

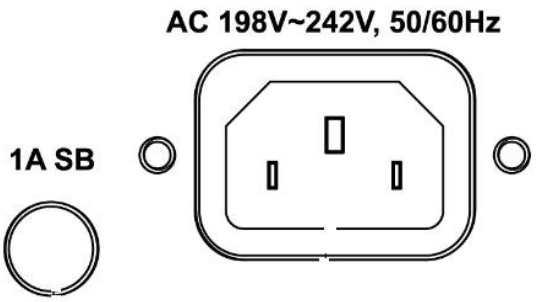
To prevent electrical shock, disconnect the AT688 power cable from the receptacle before cleaning.

Use a dry cloth or a cloth slightly dipped in water to clean the casing.
Do not attempt to clean the AT688 internally.

WARNING: Don't Use Organic Solvents (such as alcohol or gasoline) to clean the instrument.

## 1.5 Replace Fuse

Figure 1- 1 Fuse holder on the rear panel




To prevent electric shock, be sure to turn off the power switch and unplug the AC power cord before checking or replacing the fuse.
Make sure the fuse used is identical to the equipment instructions, including shape, grade, characteristics, etc. If different types of fuses are used or short circuit, then the device may be damaged.

Note: Please use a 250V, 1A slow blow fuse.

## 1.6 How to Remove the Handle

Instrument handle can be adjusted. Hold both sides of the handle with both hands, gently pull it to the sides, then rotate the handle. The handle can be adjusted to four positions as shown below:

Figure 1- 2 Instrument handle (schematic, panel graphics do not match the actual)

Handheld position

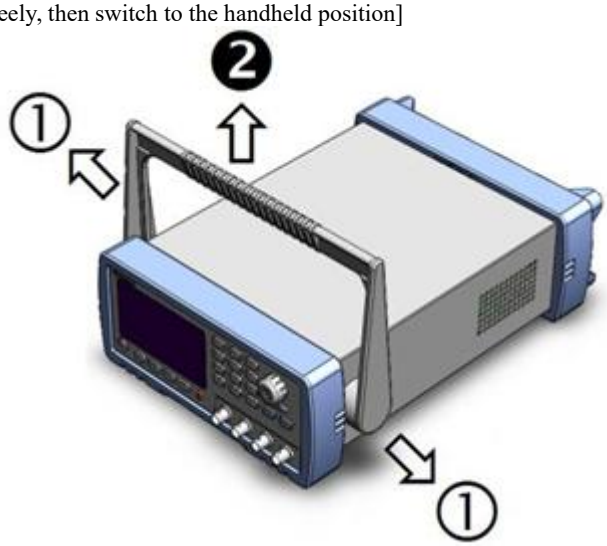


Visible position 1 [Hands hold both sides of the handle at the same time, gently pull it to the sides until it can rotate freely, then switch to the visible position 2]

⇩



Visible position 2 [hold both sides of the handle at the same time, gently pull it to the sides until it can rotate freely, then switch to the handheld position]




Remove handle position. (Pull to both sides until the handle is removed.)

# 2. Overview



This chapter contains general information about AT688. The information is organized as follows

- Introduction
- Main Specifications
- Main Functions

## 2.1 Introduction

Thank you for purchasing the AT688 Insulation Resistance Meter.

The AT688 is an insulation resistance meter controlled by a high performance ARM processor. Unique insulation resistance and leakage current test and

Display, six-range test, the insulation resistance measurement range can reach 100kΩ~10TΩ, and the maximum display digit is 9999. With a test speed of up to 55 times per second, ultra-high speed testing provides the best solution for automated production.

The instrument has a sorting function, sorting the sound setting, and optional Handler interface, which is applied to the automatic sorting system to complete the automatic

Pipeline testing. It can be equipped with an RS232C interface for remote control and data acquisition and analysis.

The computer remote control command is compatible with SCPI (Standard Command for Programmable Instrument), which can efficiently perform remote control and data acquisition functions.

The AT688 measures the insulation resistance of various electronic components, devices, dielectric materials, and wire and cable.

## 2.2 Main Specifications

AT688 technical specification contains the basic technical specifications of the instrument and the range allowed by the instrument test. These specifications are all achievable when the instrument is shipped from the factory.

Reference: 

Full AT688 specifications are included in Appendix A.

- Freely set the test voltage:
  Output negative voltage: 1.0VDC~1000VDC, basic accuracy: 1%
  Voltage step 0.1V, display 4 digits

- **Insulation resistance range accuracy:**
  <1M: 5% ≥1M: 1% ≥1G: 3% ≥10G: 5% ≥1T: 10%
- **Maximum charging current:** 30mA ± 5mA

- Provide 3 speed options: Slow: 3 times/sec; Medium speed: 25 times/sec; Fast: 55 times / sec

- **Built-in timer, custom charging time:**
  Timing time: 0 ~ 999.9S.

- **Double display of insulation resistance and leakage current**

- **Multiple trigger modes:**
  Internal trigger, manual trigger, external trigger, and bus trigger.

## 2.3 Main Functions

- **3.5-inch color LCD display**
  Multiple parameters are displayed at the same time, which is straightforward

- **Correction function:**
  Open circuit clear zero for each range

- **Comparator (sorting) function:**
  PASS/UPPER/LOWER judgment can be made on the DUT.
  Comparator function display: Display directly on the LCD screen.
  Comparator output: The result can be sorted by the optional Handler interface and RS232C output.
  Alarm: Can set alarm switch.

- **Contact inspection function (to avoid misjudgment of contact failure)**
  When the inspection is turned on, if the contact is poor, OPEN is displayed on the LCD screen.

- **Interface:**

  1. Built-in Handler interface: sorting result output, trigger signal input, EOC signal output.

  2. Built-in RS232C interface: Use a three-wire simple serial interface. Compatible with SCPI command set, ASCII transmission, complete all instrument functions.

- **Rapid discharge of residual voltage**

# 3. Startup

In this chapter you will learn the following:

- Front panel – including the introduction of buttons and test terminals.
- Rear panel – describes the power and interface information.
- Power on—including power on self-test process, instrument defaults, and instrument warm-up time.
- Start testing - including how to connect to the test side

## 3.1 Front Panel

### 3.1.1 Front Panel Description

Figure 3- 1 Front panel

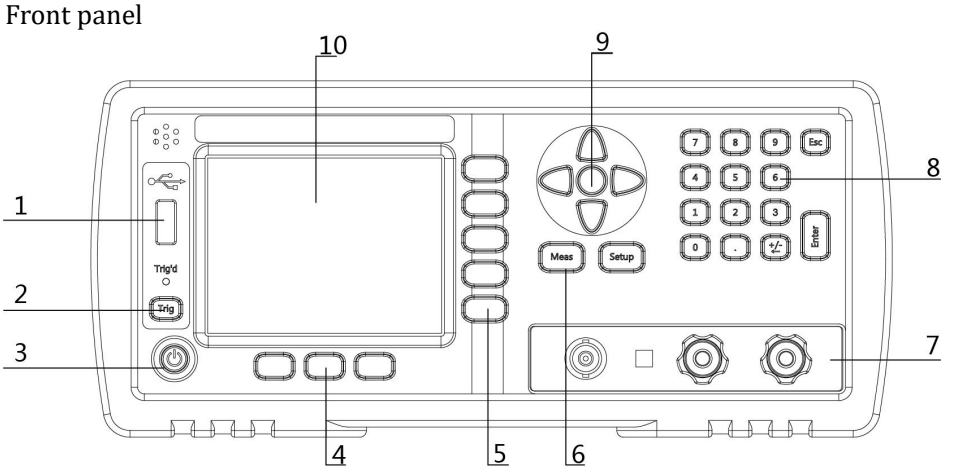



Table 3- 1 Front Panel Description

| No. | Description |
|---|---|
| 1 | USB Disk Port (USB-Host) |
| 2 | Manual trigger key |
| 3 | Power switch. Touch button |
| 4 | System soft keys, including test, discharge, keyboard locks, etc. |
| 5 | Function softkey |
| 6 | Main soft keys: Meas and Setup |
| 7 | Input terminal. The input is used to connect the test cable for testing.<br><br>(+) positive terminal (current sampling terminal)<br><br>(-) Negative terminal (voltage output, high voltage danger!)<br><br>GND Ground (used to shield the device under test. If the device under test is a cable or capacitor, this terminal is not connected.)<br>Warning: Do not connect the negative terminal to the ground terminal. |
| 8 | Numeric keypad |
| 9 | Cursor key |
| 10 | 3.5-inch LCD Display |

### 3.1.2 Rear Panel

Figure 3- 2 Rear Panel

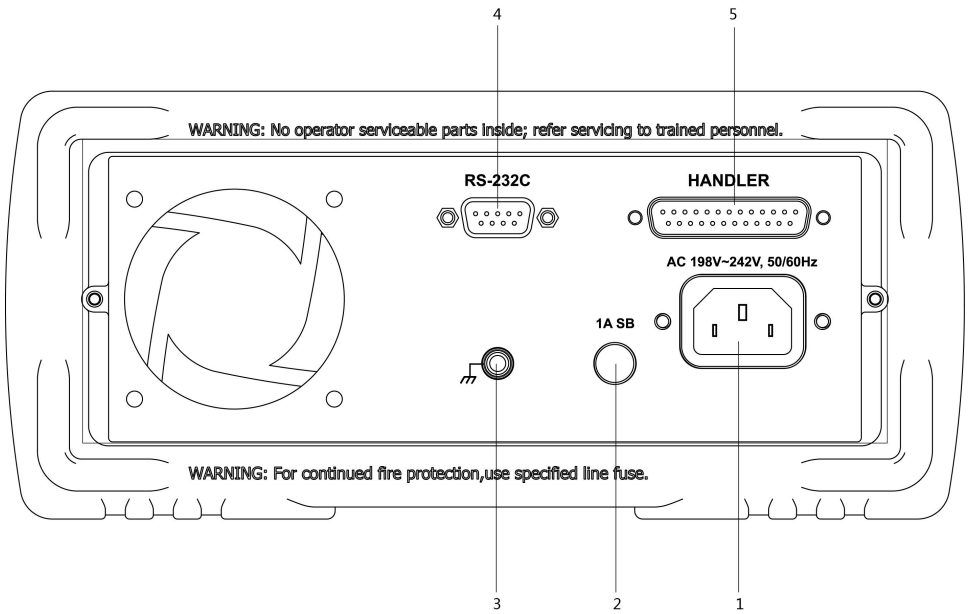



Table 3- 2 Rear Panel Description

| No. | Description |
|---|---|
| 1 | Power Cable Receptacle (Outlet) |
| 2 | Fuse holder |
| 3 | GND |
| 4 | RS-232C interface |
| 5 | HANDLER（PLC）interface |

## 3.2 Power On

### 3.2.1 Power On

The button labeled "⏻" at the bottom left of the panel is the power switch. AT688 uses soft start mode:
Power on: Press the Power button. When the POWERLED light is on (green), release the Power button.
Power off: Press the Power button. When the POWERLED light is on (orange), release the Power button.

### 3.2.2 Warm-up Time

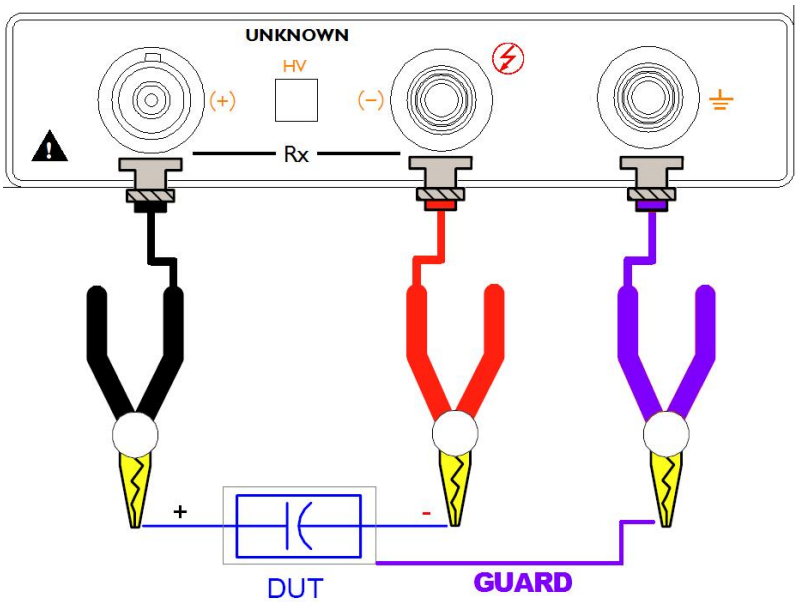
In order to achieve the accuracy rating, warm up the instrument for at least **30 minutes**.

## 3.3 Preparing for Testing

### 3.3.1 Connect to Device under Test (DUT)

For devices with shielded terminals, devices with shielded enclosures such as standard high-resistance boxes please test as follows:

Figure 3- 3 Measurement of the device under test with a shield terminal

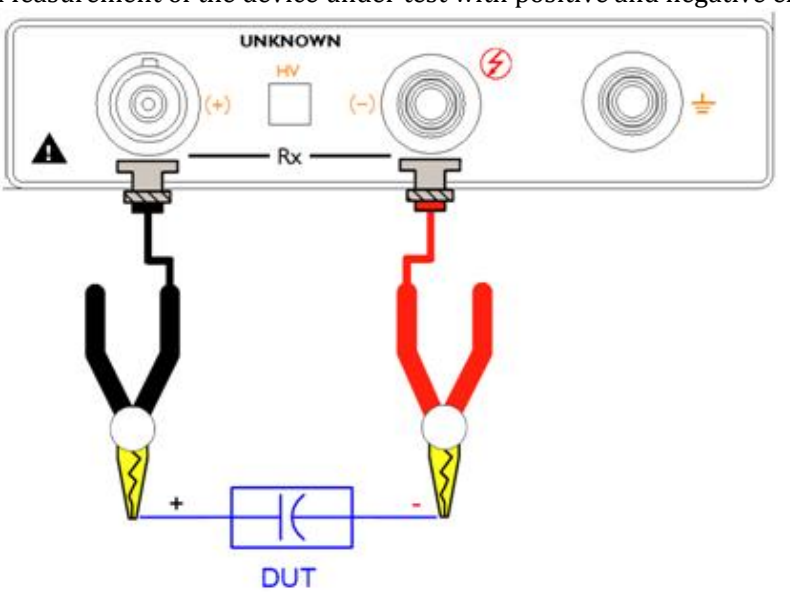



Note: If your device under test has a shielded enclosure, it cannot be connected to the positive and negative poles.

### 3.3.2 Connecting a DUT with Polarity

The device under test with polarity, such as capacitors, has positive and negative electrodes, it must be tested as follows, pay attention to the positive and negative electrodes.

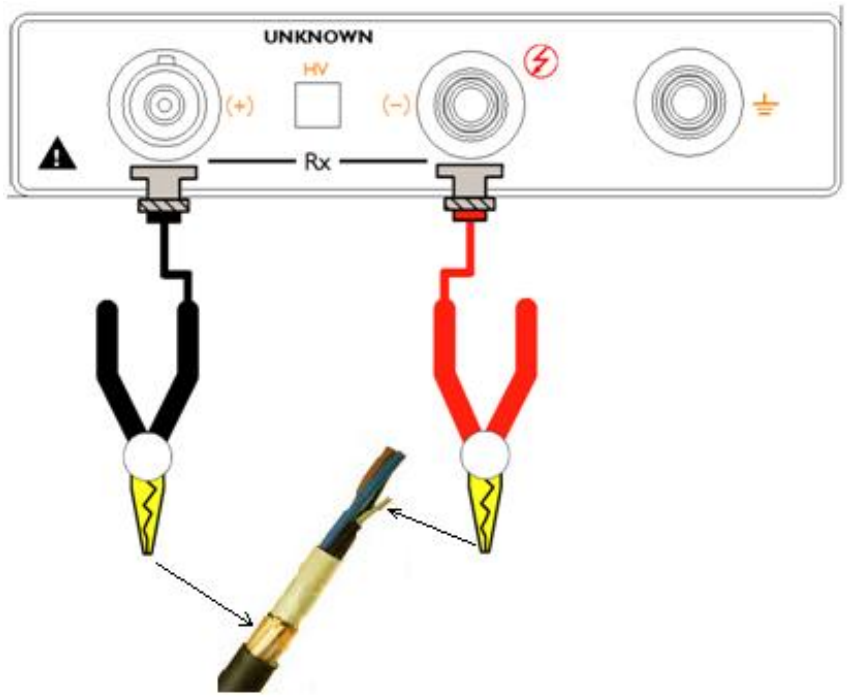
Figure 3- 4 Measurement of the device under test with positive and negative electrodes




### 3.3.3 Connecting the device under test without polarity and without shielding

Non-polar non-shielded devices and materials, such as wire and cable, please measure as follows, there are no special test requirements.

Figure 3- 5 Non positive and negative & shield terminal measurement




1. Warning: There is high voltage at the negative terminal of the test. It is recommended to connect the device under test in the discharge state to prevent electric shock.
2. Warning: If there are polar devices (electrolytic capacitors, etc.), please connect them with positive and negative poles, otherwise it will pose a threat to personal safety. And after a few seconds of discharge, remove it to prevent clicks.
3. Recommendation: The device uses an internal discharge.
4. The instrument does not allow short-circuiting for a long time, otherwise it will damage the instrument.
5. In order to ensure the accuracy and stability of the measurement, please ensure that the temperature and humidity of the environment meet the requirements of the instrument.

# 4. [Meas] Page

This section includes the following information:
- Related setting for MEAS DISPLAY page

## 4.1 <MEAS DISPLAY> Page

Under the discharge state (DSCH), press [Meas] key to enter the [Meas Display] page.

The <Meas Display> page is mainly used to display measurement results, test status, and sorting results. The shortcut function keys can perform the following functions:

- Measurement Setup – Enter the Measurement Setup page
- System Setup – Enter the System Setup page
- Open circuit clear zero – used for instrument open clear zero operation
- Keyboard lock – used to lock the keys on the keyboard

At the same time, five common functions can be set on this page, including:
- Voltage – set the voltage at the output of the instrument
- Speed – test speed
- Range – select test range
- Charging – set the charging time
- Timekeeping – set the charging timer timing mode

Figure 4- 1 <MEAS DISPLAY> Page




### 4.1.1 Voltage

Used to set the voltage at the output of the instrument.
AT688 test voltage ranges from 1.0V to 1000VDC, 4 digits, and with voltage step of 0.1V.

■ **Procedure for setting voltage:**

Step 1 Press [Meas] to enter the Meas page or press [Setup] to enter Setup page;
Step 2 Use cursor keys to select the [Voltage] field;
Step 3 Output voltage setting operation method 1:
Use the function key to directly select the commonly used 5 voltages, which are 50V, 100V, 250V, 500V, 1000V;

Output voltage setting operation method 2:
Input the required voltage value directly through the numeric keypad;

### 4.1.2 Test Speed

Used to set test speed (sampling rate) of the instrument.
Completing a sample is generated from the test - analog to digital conversion - operation until the measurement result and the sort result are displayed. This period of time is called sampling
The sampling rate is the number of samples that can be completed per second.
Usually, when users manually test the device, use slow speed; if it is used for online testing of automation equipment such as PLC, please use medium speed or fast.
AT688 provides three rates for users to choose from, either in the discharge state or in the test state.

■ **Procedure for setting test speed:**

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

| Soft key | Function |
|---|---|
| Slow | 3 t/s |
| Medium | 25 t/s |
| Fast | 55 t/s |

### 4.1.3 Range

Reference: ” Please refer to the section "Insulation Resistance Measurement Range" of the technical specifications for the range of resistance for different voltages and different ranges.

The correct range is related to the test accuracy, and the wrong range will make the measurement result unable to achieve the specified accuracy.

There are 3 ranges:

Table 4- 1 Test range description

| Mode | Function overview | Advantage | Disadvantage |
|---|---|---|---|
| Auto range | The instrument automatically selects the best test range based on impedance value. The range number in range field is automatically set. | Users do not need any participation | Auto range requires predictive range and test speed will be lower than the manual range mode, which is especially noticeable at low frequencies (below 1 kHz). |
| Hold range | Measurement is performed with a fixed impedance range | Test speed is the fastest. | Users need to participate in the range selection |
| Nominal Range | AT688 sets the optimum range depending on the nominal value. | The best way for sort test. Speed is the fastest. | Valid only in the sorting mode. |

*Warning*

- Under auto range, some devices (such as CBB capacitors) will not be able to select the range correctly. This is normal phenomenon. Switching to the hold range test will avoid such situations.
- When measuring leakage current, it is recommended to use the hold range.
- The nominal range here is automatically selected according to the set lower limit. Only works when the comparator is turned on. When the comparator is off, the nominal range is auto range.

■ **Procedure for setting range:**

**Step 1** Press [Meas] to enter the Meas page or press [Setup] to enter Setup page;
**Step 2** Use cursor keys to select the [Range] field;
**Step 3** Use soft keys to select Auto, Hold, or Nominal

| Soft key | Function |
|---|---|
| Auto range | The instrument will automatically select the range |
| Hold range | The instrument is locked on the current range |
| Nominal range | The instrument will select the best range based on the nominal value. |
| Increase+ | Increase the range number while the range is changed to locked |
| Decrease- | Decrease the range number while the range is changed to locked |

### 4.1.4 Charging

Used to set the charging time of the instrument. AT688 has a 999.9S built in charge timer.

■ **Procedure for setting charging time:**

**Step 1** Press [Meas] to enter the Meas page or press [Setup] to enter Setup page;

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

**Step 3** Charging time setting operation method 1:

Use the function key to directly select to close or select the commonly used 4 times, respectively 10s, 30s, 60s, 120s;

Charging time setting operation method 2:

Enter the required charging time directly through the numeric keypad;

### 4.1.5 Timer

Used to set the timing of the charging time.

■ **Procedure for setting charging timer:**

**Step 1** Press [Meas] to enter the Meas page or press [Setup] to enter Setup page;

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

**Step 3** Use soft keys to select

| Soft key | Function |
|---|---|
| Positive timing | Time is gradually increasing |
| Countdown | Time is gradually decreasing |

### 4.1.6 Open Circuit Clear Zero

Used to perform an open circuit clear zero operation on the instrument. In order to achieve high precision measurements, zero calibration is essential.

■ **Procedure for open-circuit clear zero:**

**Step 1** Press [Meas] to enter the Meas page or press [Setup] to enter Setup page;

**Step 2** Use the sidebar function key to select the [Open Clear] field;

**Step 3** Use soft keys to select

| Soft key | Function |
|---|---|
| Enter | The instrument open circuit clear zero all ranges. If the clear zero is successful, the data will be saved in memory. |
| Cancel | Abandon the zero and the instrument returns to the discharge state. |

# 5. [Setup] Page

In this chapter users will learn about all the setup features:

Under the discharge state (DSCH), press the [Setup] key to enter the [Meas Setup] page.

## 5.1 <MEAS SETUP> Page

- All measurement related settings are operated in the <Meas Setup> page.
- These settings include the following parameters:
- Voltage – set the voltage at the output of the instrument
- Speed – test speed
- Range – select test range
- Charging – set the charging time
- Timekeeping – set the charging timer timing mode
- Contact inspection – setting up the contact inspection of the instrument
- Trigger – select the trigger mode of the instrument
- Trigger edge – select the edge mode of the external trigger
- Delay – only for external trigger delays
- Comparator – Sorting status
- Upper limit – comparator upper limit
- Lower limit – comparator lower limit
- Beep – beep working status
- Automatic discharge

The [Voltage], [Speed], [Range], [Charge] and [Timer] settings can also be set on the <Meas Display> page. For the setting of these parameters, please refer to the [Meas] measurement main page section.

Figure 5- 1 <MEAS SETUP> Page




### 5.1.1 Contact Inspection

Used to set up the contact check of the instrument.
For capacitive materials such as capacitors and cables (greater than 100 PF), the contact check function can well interpret whether the device is in good contact, thus reducing the occurrence of erroneous testing, and the contact inspection does not increase any test time.
After the contact inspection function is turned on, if the instrument is in the test state and the presence of capacitive material is not checked, the instrument will display OPEN.
After the contact check function is turned off, the instrument will not judge the capacitive material and directly test the value.

- **Procedure for setting contact inspection:**

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

| Soft key | Function |
|---|---|
| OFF | Used to turn off the contact inspection of the instrument. |
| ON | Used to turn on the contact inspection of the instrument. |

### 5.1.2 Trigger

The instrument provides 4 trigger modes:
Internal trigger, manual trigger, bus trigger and external trigger.

| Trig Mode | Function |
|---|---|
| INT | Internal Trigger. All ten sweep points are swept continuous. |
| MAN | Manual Trigger. Each time the instrument is triggered by [Trig] key, the sweep points are swept one by one. |
| EXT | External Trigger. An edge pulse is received from the Handler interface of the rear panel (see the trigger edge setting for details), and the instrument performs a measurement cycle. Other time instruments are waiting. Please refer to the Handler interface. |
| BUS | BUS Trigger. After the instrument receives the RS232 trigger instruction, it will perform a measurement cycle, and wait for other times. |

■ **Procedure for setting trigger mode:**

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

| Soft key | Function |
|---|---|
| INT | Internal trigger |
| MAN | Manual trigger |
| EXT | External trigger |
| BUS | Bus trigger (only valid if the comparator is turned on) |

### 5.1.3 Trigger Edge

The edge mode of the external trigger. (only valid under external trigger)

■ **Procedure for setting trigger edge:**

**Step 1** Press [Setup] to enter Setup page;
**Step 2** Use cursor keys to select the [Trigger] field and select [EXT] trigger
**Step 3** Use cursor keys to select the [Trigger Edge] field;

| Soft key | Function |
|---|---|
| Rising edge | External trigger edge selection is triggered by rising edge |
| Falling edge | External trigger edge selection is triggered by falling edge |

### 5.1.4 Delay

In the trigger mode, after the trigger signal is captured, the high-voltage output is started after a certain time delay.
The instrument can set the delay time before each test by triggering the [delay] timer, and wait for the station to be ready before the test.
The maximum delay time is 60s and the minimum delay time is 1ms.

■ **Procedure for setting【Delay】:**

**Step 1** Press [Setup] to enter Setup page;
**Step 2** Use cursor keys to select the [Average] field;
**Step 3** Use numeric keys to input delay time

### 5.1.5 Comparator

The instrument can compare the measured resistance values.

■ **Procedures for setting comparator:**

**Step 1** Press [Setup] to enter Setup page;
**Step 2** Use cursor keys to select the [Comparator] field;

**Step 3** Use soft keys to select

| Soft key | Function |
|---|---|
| OFF | Comparator is turned off |
| ON | Comparator is turned on |

### 5.1.6 Beep

The beep function is only effective when the comparator function is turned on.
The beep setting allows for GD beep, NG beep, or turn off beep.

■ **Procedures for setting beep:**

**Step 1** Enter [Meas Setup] page;
**Step 2** Use cursor keys to select the [Beep] field;
**Step 3** Use soft keys to select

| Soft key | Function |
|---|---|
| OFF | Beep is turned off |
| GD beep | The beeper sounds when the sorting result is good. |
| NG beep | The beeper sounds when the sorting result is not good. |

### 5.1.7 【Upper Limit】 and【Lower Limit】

The reference value for sorting comparison, the upper limit can be turned off.

■ **To input limit value:**

**Step 1** Enter [Meas Setup] page;
**Step 2** Use cursor keys to select the [Upper Limit] or [Lower Limit] field;
**Step 3** Use numeric keys to input data

■ **How the comparator work**

Under the test state, the current measured value is compared with the preset limit reference value.
Comparator work flow:
Insulation Resistance:

| | | |
|---|---|---|
| 1 Lower limit < Current value < Upper limit | Product is good | Display PASS |
| 2 Current value < Lower limit | Product is not good | Display LOWER |
| 3 Current value > Upper limit | Product is not good | Display UPPER |

### 5.1.8 Automatic discharge

When the instrument is in the test state, sample the results once and automatically switch to the discharge state;

■ **To set automatic discharge:**

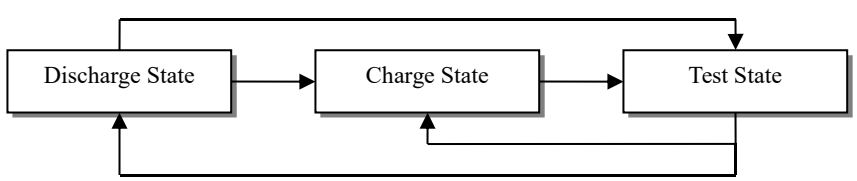
**Step 1** Press [Setup] to enter Setup page;
**Step 2** Use cursor keys to select the [Discharge] field;
**Step 3** Use soft keys to select

| Soft key | Function |
|---|---|
| OFF | **Automatic discharge** is turned off |
| ON | **Automatic discharge** is turned on |

## 5.2 Start testing

### 5.2.1 Charge – Test - Discharge

Figure 5- 2 State switching



**Charging status: (The charging time is set to 0s, there will be no charging status)**
Press the [Charge] key and the instrument will enter the charging state. Negative test output voltage, charging timer starts.
In the charging state, press the [Test] key again to enter the test state directly.

**Test status:**
Press the [Test] key to enter the test state directly.

**Discharge status:**
Press the [Discharge] key to enter the test state directly.

# 6. System Configuration

This section includes the following information:

- SYSTEM CONFIG page
- SYSTEM INFO page

Under discharge state, press the [Meas] or [Setup] key followed by [SYSTEM] bottom soft key, the <SYSTEM CONFIG> page appears.

## 6.1 <SYSTEM CONFIG> Page

Under the [Meas] or [Setup] page, press [System] to enter the <System Config> page.
Following information can be configured in the <SYSTEM CONFIG> page.

- LANGUAGE
- Date/time setting
- Account settings
- Baud rate setting
- Command handshake
- Result sending

All settings in <SYSTEM CONFIG> page will be automatically saved in the system and will be automatically loaded next time when AT688 is turned on.

Figure 6- 1 <SYSTEM CONFIG> Page




### 6.1.1 Change System Language【LANGUAGE】

`Communication commands: SYSTem:LANGuage {ENGLISH,CHINESE,EN,CN}`

Two languages (ENGLISH and CHINESE) were supported by AT688.

■ **To change language**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [LANGUAGE] field
**Step 3** Use the soft keys to select a language you understand.

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

### 6.1.2 Setting the system date and time

AT688 features a built-in 24-hour clock.

■ **To change the date:**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [Date] field
**Step 3** Use the soft keys to set date.

| Soft key | Function |
|---|---|
| YEAR INCR+ | Increases the year in steps of 1. |
| YEAR DECR- | Decreases the year in steps of 1. |
| MONTH INCR+ | Increases the month in steps of 1. |
| DAY INCR+ | Increases the day in steps of 1. |
| DAY DECR- | Decreases the day in steps of 1. |

■ **To change the time**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [Time] field
**Step 3** Use the soft keys to set time.

| Soft key | Function |
|---|---|
| HOUR INCR+ | Increases the hour in steps of 1. |
| HOUR DECR- | Decreases the hour in steps of 1. |
| MINUTE INCR+ | Increases the minute in steps of 1. |
| MINUTE INCR+ | Decreases the minute in steps of 1. |
| SECOND DECR- | Increases the second in steps of 1. |
| SECOND DECR- | Decreases the second in steps of 1. |

### 6.1.3 Account Setting

AT688 provides two accounts, administrator and user:

- Administrator: All functions can be configured by administrator except <SYSTEM SERVICE> page, and the parameters set by the administrator are saved in the system memory after a delay of 5 seconds, which is convenient for loading after the next boot.
- User: All functions can be configured by user except < SYSTEM SERVICE> page and <FILE> page. The data modified by the user is restored to the value set by the administrator after the next power-on.

■ **To Change Account:**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [Account] field
**Step 3** Use the soft keys to set.

| Soft key | Function |
|---|---|
| ADMIN | All functions except the [System Services] page are open.<br>If you forget your password, please call our sales department. |
| USER | Except the functions of the [System Services] page and the [File] page can be operated, the set data cannot be saved. |

■ **To Change Administrator's Password**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [Account] field
**Step 3** Use the soft keys to set.

| Soft key | Function |
|---|---|
| CHANGE PASSWORD | Enter a numeric password of up to 9 digits. The password only includes numbers and symbols. |
| DELETE PASSWORD | Administrator will not be password protected |

### 6.1.4 [Baud Rate] Setting

The instrument provides built-in RS-232 interface. After sensing the signal conversion of the RS-232 interface,

the instrument immediately communicates with the host at the set baud rate, and the keyboard is locked.

Before you can control the AT688 by issuing RS-232 commands from built-in RS-232 controller connected via its DB-9 connector, you have to configure the RS-232 baud rate. If host computer and the instrument's baud rate is different, it will not be able to communicate correctly.
The AT688's built-in RS-232 interface uses the SCPI language.
RS-232 configuration is as follows:

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

■ **To set up the baud rate:**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [BAUD] field
**Step 3** Use the soft keys to select.

| Soft key | Function |
|---|---|
| 1200 | Use this baud rate if you are using a communication converter with optocoupler isolation. |
| 9600 | |
| 38400 | |
| 57600 | |
| **115200** | It is recommended to use this high speed baud rate to communicate with the host computer. |

### 6.1.5 Command Handshake

After the instruction handshake is turned on, all commands sent by the host to the instrument are returned to the host as they are, after which the data is returned.
After the instruction handshake is turned off, the commands sent by the host to the instrument will be processed immediately.

■ **To set up the command handshake:**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [Command Handshake] field
**Step 3** Use the soft keys to select.

| Soft key | Function |
|---|---|
| SCPI | Do not use command handshake. If there is no special requirement, please set the command handshake to off. |
| Modbus | |

### 6.1.6 RS485【StationNo.】 selection

If Modbus (RTU) protocol is used, be sure to set the station number and address of this machine.
This station number can also be used for SCPI communication protocol for multi-machine communication.

The SCPI communication protocol extended by Amber Instrument can also be used for multi-computer communication.
At the beginning of each instruction, add addr #; : The subsystem can select the slave.
Example: addr 02; :fetch? Acquire data from the slave machine representing the station number 2.

Select RS485 station number:

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [Station No.] field
**Step 3** Use the soft keys to select.

| Soft key | Function |
|---|---|
| 00 broadcast | |
| 01 | |
| 02 | |
| 03 | |
| 04 | |
| 05 | |
| 06 | |

| | |
|---|---|
| 07 | |
| 08 | |
| 09 | |
| 10 | |
| 11 | |
| 12 | |
| 13 | |
| 14 | |
| 15 | |

Under Modbus protocol, in order to facilitate the simultaneous operation of multiple identical instruments, the instruments are allowed to use station number 00 for broadcast communication, and station number 00 is used for communication. The instruments only receive instructions, but do not return response codes.

### 6.1.7 Instruction handshake (only for SCPI protocol)

After the handshake is turned on, all instructions sent by the host to the instrument will be returned to the host as they are, and then the data will be returned.
After the handshake is closed, the instructions sent by the host to the instrument will be processed immediately.

■ **To set the instruction handshake:**

**Step 1** Enter the < system configuration > page.
**Step 2** Use the cursor keys to select the [instruction handshake] field;
**Step 3** Use the soft keys to select.

| Soft key | Function |
|---|---|
| OFF | Do not use instruction handshake. No special requirements, please set the instruction handshake to OFF. |
| ON | |

### 6.1.8 Result Sending (only for SCPI protocol)

`Communication commands:` **`{FETCH,AUTO}`**

The instrument supports the ability to automatically send data to the host. Data is automatically sent to the host after each test is completed, without the host sending a FETCH? command.
After each test, the test results and comparator results are sent to the host. For the format, please refer to the Fetch? subsystem.

**To set up the result send:**

**Step 1** Enter <SYSTEM CONFIG> page
**Step 2** Use the cursor key to select [Result Send] field
**Step 3** Use the soft keys to select.

| Soft key | Function |
|---|---|
| FETCH | Use the command FETCH? To get all measurement data |
| Auto | Automatically sent to the host after each test is completed |

## 6.2 < System Information> page

Press [Meas] or [Setup] key, press the [System] key at bottom to enter the <System Config> page, press the soft key to select [System Information].
There are no configurable options in the system information page

Figure 6- 2 < System Information> page



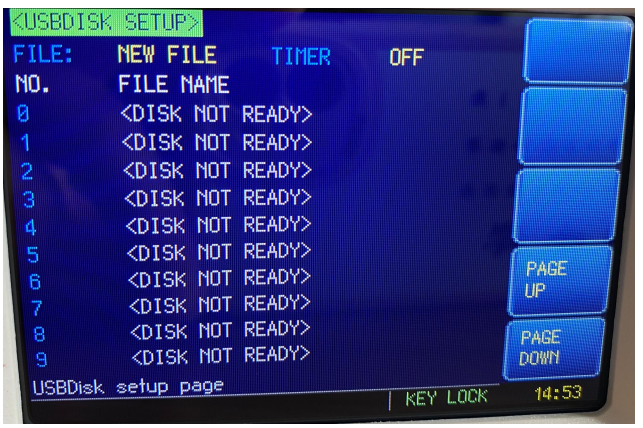
# 7. U disk storage

You will learn the following:

- Use u disk to record test data.

Press the [Setup] key, and then press the [U disk storage] function key to enter the < U disk storage > page.

Figure 7- 1 < USB flash drive storage > page




## 7.1 Create a [new file]

Create [New File] field, which is used to create a new file in the USB flash drive. The file name is user-defined. The file format is fixed to CSV format.

■ **Steps to create a [new file]:**

**Step 1** Enter the < u disk storage > page.

**Step 2** Use the cursor key to select [File] field

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

| Soft key | Function |
|---|---|
| Create files | The character keyboard will pop up and enter a custom file name.<br>After input, press the function key [OK] to create a new file, and the file name will be displayed in the list. |

## 7.2 Save regularly

When the trigger mode is Internal, according to the set time. In the test state, save the data regularly. Other triggering methods of are invalid. Time is entered directly through the numeric keypad.

## 7.3 【File】selection

**Step 1** Enter the < u disk storage > page.

**Step 2** Use the cursor keys to select [File 0] ~ [File 9] page.

**Step 3** Select using function keys.

| Soft key | Function |
|---|---|
| Create files | The character keyboard will pop up and enter a custom file name.<br>After input, press the function key [OK] to create a new file, and the file name will be displayed in the list. |

## 7.4 U disk data storage mechanism

Under internal trigger and external trigger, files store data in different ways.

- Internal trigger record

  Under the internal trigger, the instrument is in the test state, the timing is up, and the data is stored in the file.

- External trigger record

Under the external trigger, when the instrument is in the test state, once it receives a trigger signal or a trigger instruction, the data will be stored in a file.

- Manual data recording

In the [MEAS] interface, press the function key [Save to USB flash drive] to store the data into a file.

# 8. PLC（Handler）Interface

This chapter provides information of AT688's built-in handler interface. Include:

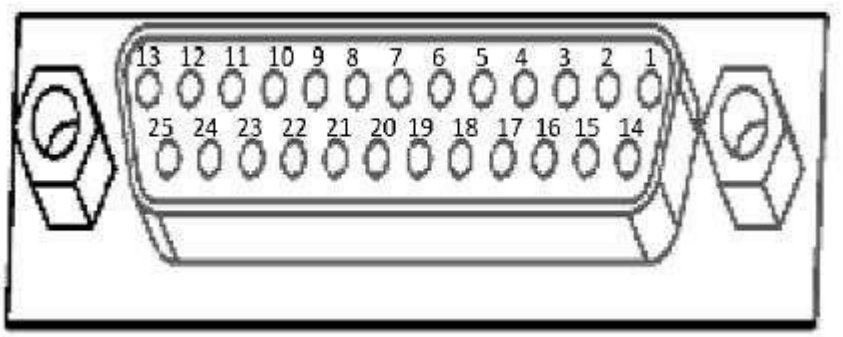
- Pin Terminal
- How to connect and interface schematics
- Timing Chart

AT688 provides users with a full-featured processor interface that includes sorting output, EOC (test completion signal), TRIG (external trigger start) input and other signals. Through this interface, the instrument can be easily controlled automatically with the user system control components features.

The Handler interface can only be used in "External Trigger Mode".

## 8.1 Pin Terminal and signals

Figure 8- 1 Pin Terminal




■ Output Terminal（All signals are valid low level）

Table 8- 1 Description of Handler Interface Output Signals

| Pin | Pin Name | Signal Description |
|---|---|---|
| 1 | /EOC | Test completion signal (busy signal). Need to connect to an external power supply! |
| 2 | /NG | The comparator NG output. Need to connect to an external power supply! |
| 3 | /GD | Comparator GD output. Need to connect to an external power supply! |
| 4 | /OPEN | Independent open circuit signal, when open circuit, low level . Need to be connected to external power supply! When the circuit is open, the sorting signals (/NG and /GD) are reset to high level. |
| 5 | /KNG | Comparator relay NG output. /KNG and /COM are closed; |
| 6 | /COM | Comparator relay output common terminal |
| 7 | /KGD | Comparator relay GD output. /KGD and /COM are closed; |

■ Input Terminal

Table8- 2 Description of Handler Interface Input Signals

| Pin | Pin Name | Signal Description |
|---|---|---|
| 12 | DISCH | Discharge signal (test status is valid). Need to connect to an external power supply! |
| 13 | CHAR | Charge/test signal (discharge status is active). Need to connect to an |

| | | |
|---|---|---|
| | | external power supply! |
| 24 | TRIG | Test the trigger. (Valid only for external trigger). Need to connect external power supply! |
| 25 | KLOCK | Keyboard lock signal. Need to connect to an external power supply! |

■ Power Rating

Table 8- 3 Description of Handler Interface Power Rating Signals

| Pin | Pin Name | Signal Description |
|---|---|---|
| 16 | EX-GND | External power supply GND |
| 17 | EX-VCC | External power supply VCC |

## 8.2 Connection Method

■ Connect external power supply

Without an external power supply, the Handler only provides the comparator relay output signal!
In order for all functions of the Handler to work properly, please connect the appropriate external power supply!

In the case of unknown or uncertain power, the internal power supply cannot be used, otherwise the meter will not work properly.
In low-power applications, using internal power supplies can degrade the instrument's immunity to interference.
***Therefore, AT688 cancels the internal power port and recommends the user to select the external power supply.***

■ Electrical Characteristics

Power requirements: +3.3V~24VDC
Output signal: Collector output with built-in pull-up resistor. Optocoupler isolation. Low valid.
Maximum voltage: Power supply voltage.
Input signal: Optocoupler isolation. Low valid.
Maximum current: 50mA

Note: To avoid damage to the interface, do not exceed the power supply voltage requirements.
To avoid damage to the interface, wire the instrument after it has been turned off.
If the output signal is used by users to control the relay, the relay must use a reverse energy release diode.

Figure 8- 2 Input terminal schematic

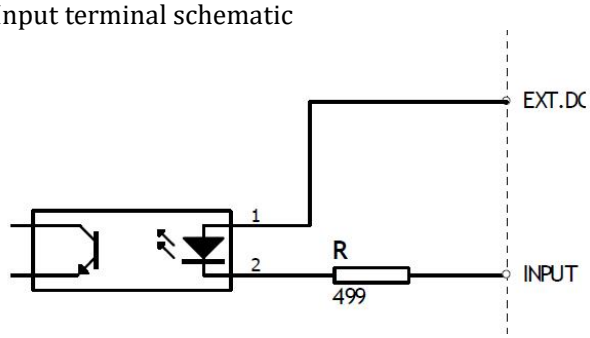
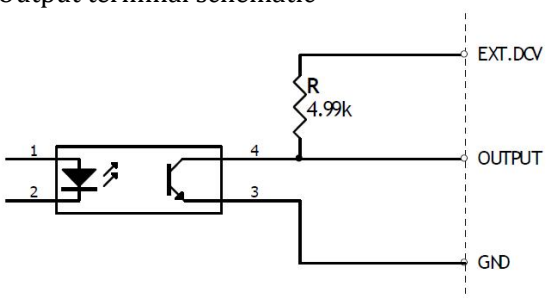



Figure 8- 3 Output terminal schematic



## 8.3 Timing Chart

Figure 8- 4 Timing Chart

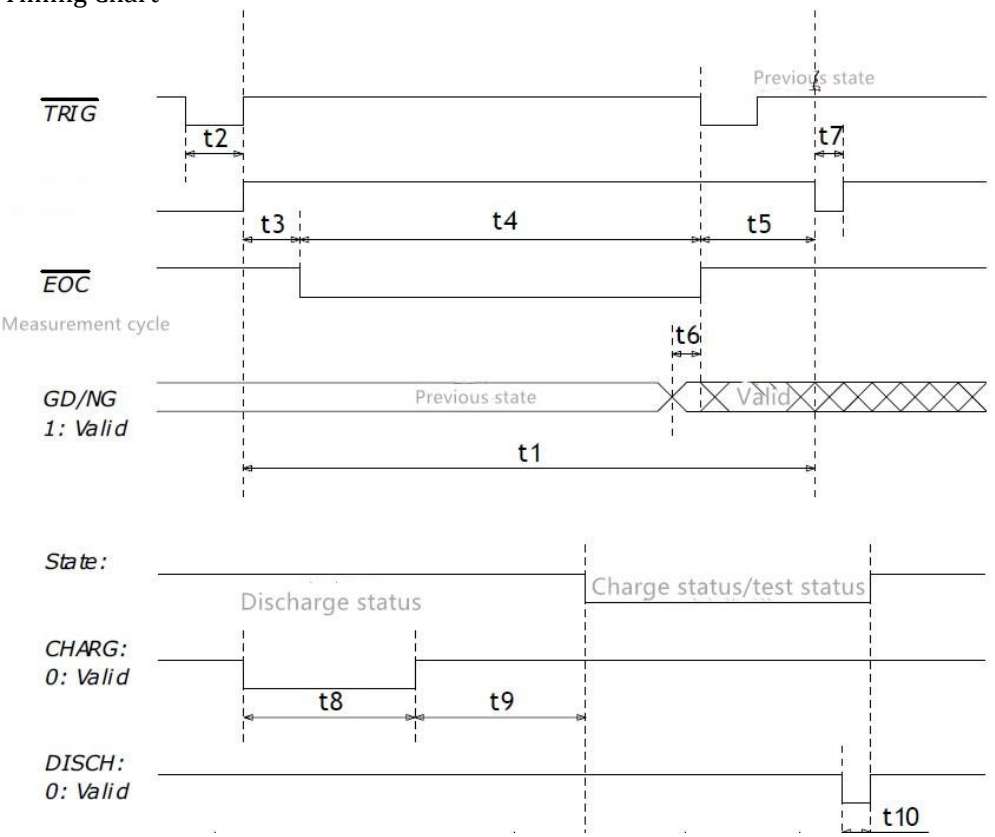



Table 8- 4 Timing description

| Time | Description |
|---|---|
| T1 | One conversion cycle |
| T2 | Trig signal pulse width |
| T3 | Trig is valid until the start of the conversion interval |
| T4 | AD conversion time (EOC[BUSY]) (current sampling) |
| T5 | Display result time |
| T6 | Sort output to EOC end time |
| T7 | Immediately next conversion start interval |
| T8 | CHARG /test signal low level valid hold time |
| T9 | Delay time before the system enters the charging/testing |
| T10 | DISCH signal low level valid hold time |

## 8.4 Foot Switch

In addition to control, the CHARG and DISCH signals of the Handler interface can also be used for external auxiliary key inputs, such as external foot switch is used to switch the discharge or state of charge.
Installation method:
Step 1: Connect the switch between the CHARG/DISCH output and GND.
Step 2: The EXVCC port provides a suitable external power supply

# 9. Remote Control

This chapter provides the following information:

- About RS-232 Interface
- RS-232 Connection
- Select Baud Rate.
- About SCPI

AT688 can use RS-232 interface (standard configuration) to communicate with the computer to complete all the instrument functions. With standard SCPI commands, users can also easily create a variety of acquisition systems that are suitable for them.

## 9.1 RS-232C

RS-232 is a widely used serial communication standard, also known as asynchronous serial communication standard, for data communication between computers and computers, between computers and peripherals. RS is the English abbreviation of "Recommended Standard", and 232 is the standard number. The standard is officially published by the Electronic Industries Association (EIA) in 1969. It is required to transmit one bit at a time via one data line.

Most serial port configurations are usually not strictly based on the RS-232 standard: 25-pin connectors are used on each port (now computers basically use 9-pin connectors). The most commonly used RS-232 signals are shown in the table:

Table 9- 1 Commonly used RS-232 signals

| Signal | Sign | 25-pin connector pin number | 9-pin connector pin number |
|---|---|---|---|
| Request to send | RTS | 4 | 7 |
| Clear send | CTS | 5 | 8 |
| Data setup preparation | DSR | 6 | 6 |
| Data carrier detection | DCD | 8 | 1 |
| Data terminal preparation | DTR | 20 | 4 |
| send data | TXD | 2 | 3 |
| Receive data | RXD | 3 | 2 |
| GND | GND | 7 | 5 |
| Request to send | RTS | 4 | 7 |

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

Table 9- 2 The minimum subset of the RS-232 standard

| Signal | Sign | 9-pin connector pin number |
|---|---|---|
| Send | TXD | 2 |
| Receive | RXD | 3 |
| GND | GND | 5 |

### 9.1.1 RS232C Connection

RS-232 serial interface can be interconnected to the serial interface of a controller (eg PC or industrial computer) via a straight-through DB-9 cable.

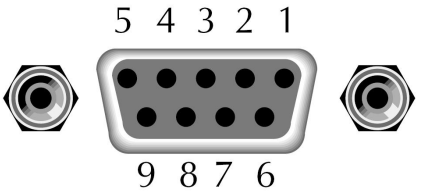
Note: The instrument cannot use a null modem cable.

Users can make or purchase a 9-pin straight-through cable directly from the Applent Instruments Inc..

User-made 3-wire cable should pay attention to:

· Using the DB9 port that comes with the PC, may need to short the 4-6, 7-8 of the DB-9 connector (needle) on the computer side.

Figure 9- 1 RS-232 interface on the rear panel




Recommendation: To avoid electrical shock, turn off AT688 when connect or disconnect the connector.

- AT688 default communication settings:
  Transmission method: Full-duplex asynchronous communication with start and stop bits
  Data bits: 8-bit
  Stop bits: 1-bit
  Parity: none

## 9.2 Handshake Protocol

Since the AT688 uses the minimum subset of the RS-232 standard and does not use hardware handshaking signals, the AT688 can use software handshaking in order to reduce possible data loss or data errors in communication. High-level language software engineers should strictly follow the handshake below agreement to make preparation of computer communication software:

- The instrument terminator only accepts ASCII format, and the command response also returns ASCII code.
- The command string sent by the host must be terminated with NL ( ' \n' ). The instrument terminator starts executing the command string after receiving the terminator.
- The instrument can set the command handshake: the instrument will send the character back to the host immediately after receiving one character. The host can only continue to send the next character after receiving the returned character.

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

1. The software handshake is turned off, please refer to the <System Setup> page of the instrument to turn it on.
2. The serial port connection is faulty, please check the cable connection.
3. The communication format of the high-level language program on the computer side is incorrect. Try on checking the serial port number, whether the communication format is correct, and the baud rate is the same as the instrument setting.
4. If the instrument is parsing the last command and the host cannot receive the response from the instrument, please try again later.

<The problem still cannot be solved, please consult Applent Technical Engineer immediately>

## 9.3 SCPI Language

SCPI-Standard Commands for Programmable Instruments is a universal command set used by Applent Instruments for test instruments. SCPI, also known as TMSL-Test and Measurement System Language, was developed by Agilent Technologies under IEEE 488.2 and has been widely adopted by test equipment manufacturers until now.

Reference:

The instrument built-in terminator is responsible for user command format parsing. Since the terminator is based on the SCPI protocol, but not exactly the same as the SCPI, please read the "SCPI Command Reference" chapter carefully before starting work.

# 10. SCPI Command Reference

This chapter contains the following information:

- Terminator - rules of the terminator
- Command syntax - command line writing rules
- Query syntax - writing rules of query command
- Query response - format of the query response
- Command reference

This section provides all SCPI commands used by AT688. With these SCPI commands, users can complete control over all functions of the instrument.

## 10.1 Terminator

Host can send a string of command to instrument, instrument terminator will begin parsing after it captures end mark (\n) or after input buffer overflows.

*For example:*

Legal command string:

AAA:BBB CCC;DDD EEE;:FFF

AT688 terminator is responsible for parsing and performing all commands, before programming, users must know about parsing rules.

### 10.1.1 Terminator Rules

1. Terminator only parses and responds ASCII code's data.
2. SCPI command string must be ended with terminator **NL(' \n'ASCII 0x0A)**, terminator will begin performing command string only after it receives end mark or after buffer overflows.
3. If command handshake is turned on, every time terminator receives one string, it will promptly return this string to the host, only when host receives this returned string, can it continues sending the next string.
4. After terminator parses error, it will promptly stop parsing, and the current command is canceled.
5. When terminator parses the query command, it will terminate parsing this command string, the latter command string will be ignored.
6. When parsing command string, terminator is case insensitive.
7. Terminator supports command abbreviated form, please refer to the latter chapter regarding abbreviation norms.

### 10.1.2 Notation Conventions and Definitions

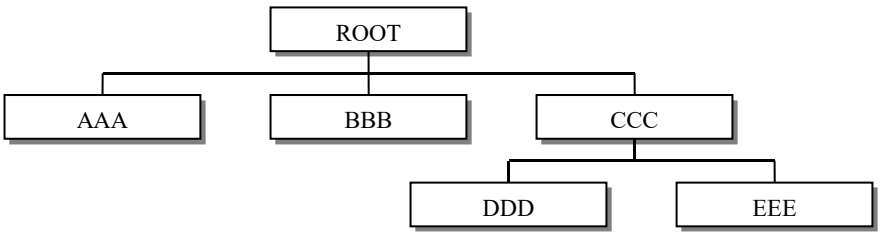
This chapter employs some marks, these marks are not a part of command tree; they are only for better understanding of command string.

| | |
|---|---|
| <> | the character in <> means this command's parameter |
| [ ] | the character in [] means optional command |
| {} | When there includes several parameter items in {}, means that users can only choose one item from it. |
| ( ) | the abbreviated form of parameter is put in () |
| Capital letter | Abbreviated form of command. |

### 10.1.3 Command Structure

For the SCPI command, the tree structure can be down to three levels (Note: the command parser of this instrument can parse any layer down), which is called the subsystem command at the highest level. The subordinate command is valid only if the subsystem command is selected. SCPI uses a colon (:) to separate the high level command and the low level command.

Figure 10- 1 Command Tree Structure




*Example*

ROOT:CCC:DDD ppp
ROOT Subsystem Command
CCC Level 2
DDD Level 3
ppp Parameter

## 10.2 Commands and Parameters

A command tree consists of header and parameters, it uses a space (ASCII: 20H) to separate in the middle

*Example*

AAA:BBB 1.234
Header [Parameter]

### 10.2.1 Command

Headers can be of the long form or the short form. The long form allows easier understanding of the program code and the short form is suitable for writing.

### 10.2.2 Parameter

- Single command word, no parameter.
  Example: AAA:BBB
- Parameter can be character string form, the abbreviation rules are the same as the rules for command.
  Example: AAA:BBB 1.23
- Parameter can be numeric form
  - *<integer>* integer 123, +123, -123
  - *<float>* floating number
  1. <Fixfloat>：fixed point floating number：1.23, -1.23
  2. <Scifloat>：scientific notation floating number：1.23E+4, +1.23e-4
  3. <Mpfloat>: multiplier expressed by floating number: 1.23k, 1.23M,1.23G,1.23u

Table 10- 1 Multiplier Mnemonics

| Definition | Mnemonic |
|---|---|
| 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 |

Multiplier is Case Insensitive, its writing style is different from standard name.

### 10.2.3 Separator

The AT688 terminator only accepts allowed separators, terminator will occur "Invalid separator (illegal separator)"error if beyond this separator, and these separators include:

; a semicolon that separates two commands.
Example: AAA:BBB 100.0;CCC:DDD

: colon, used for separate command tree, or restart command tree.
Example: AAA:BBB:CCC 123.4;:DDD:EEE 567.8

? question mark, used for query
Example: AAA?

□ space, used for separate parameter
Example: AAA:BBB□1.234

## 10.3 Command Reference

All commands are interpreted in the order of subsystem commands. All subsystems are listed below:

- Display display page subsystem
- Function measurement function subsystem
- TRIGger trigger subsystem
- COMParator sorting subsystem
- SYSTem subsystem
- FETCh subsystem
- STATe subsystem
- CORRection subsystem

Public command:

- IDN? Instrument Information Query Subsystem

## 10.4 Display Subsystem

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

Figure 10- 2 DISPlay Subsystem tree

| | | |
|---|---|---|
| **DISPlay** | **:PAGE** | **{MEASurement(MEAS),SETUp(MSET),SYSTem(SYST), SYSTEMINFO(SINF)}** |
| | **:LINE** | **<string>** |

### 10.4.1 DISPlay:PAGE

DISP:PAGE Used to switch to the specified page.

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

Parameter: <page name> includes:

| | |
|---|---|
| **MEASurement(MEAS)** | MEAS DISPLAY page |
| **SETUp(MSET)** | SETUP page |
| **SYSTem(SYST)** | SYSTEM CONFIG page |
| **SYSTEMINFO(SINF)** | SYSTEM INFORMATION page |

Example: SEND>**disp:pagesetup**<NL> // switch to the Setup page

Query Syntax **DISP:PAGE?**

Query Response:

**<page name> abbreviation**
**meas**
**mset**
**syst**
**sinf**

*Example:*

SEND>**disp:page?**
RET>**meas**
SEND>**disp:page meas;page?**
RET>**meas**

### 10.4.2 DISP:LINE

DISP:LINE Used to display a string of text in the prompt bar at the bottom of the page. The text can display up to 30 characters and the text will stay for 10 seconds.

| | |
|---|---|
| Command Syntax: | **DISPlay:LINE<*string*>** |
| Parameter: | **<string>** max.30 characters |
| Example: | SEND>**DISP:LINE "This is a Comment."** |
| Query Syntax: | **DISPlay:LINE?** |
| Query Response: | The prompt bar text on the screen, if the prompt bar is empty, will return NULL. |

## 10.5 Function Subsystem

Measurement function subsystem is used to set the instrument test function, including test parameters and range settings.

Figure 10- 3 Function Subsystem tree

| | | | |
|---|---|---|---|
| **Function** | *:VOLTage* | *<float>* | |
| | *:APERture* | *{slow,med,fast}* | |
| | *:TIMEr* | *<float>* | |
| | *:count* | *{UP,DOWN}* | |
| | *:CHECK* | *{ON,OFF}* | |
| | *:RANGe* | *{<integer>,MIN,MAX}* | |
| | | *:mode* | *{hold,auto,nom}* |

### 10.5.1 FUNCtion: VOLTage

FUNCtion: VOLTage Used to set the test voltage.

| | |
|---|---|
| Command Syntax: | **FUNCtion:VOLTage <float>** |
| Parameter: | <float><br>**Floating point number, 1~1000** |
| Example: | SEND>**FUNCtion:VOLT** 10.2 // Set the current voltage to 10.2V<br>SEND>**FUNCtion:VOLT** 500 //Set the current voltage to 500V |
| Query Syntax: | **FUNCtion:VOLT?** |
| Query Response: | <float><br>**Floating point number, 1~1000** |
| Example: | SEND**> FUNCtion:VOLT?**<br>RET**>10.0**<br>**Restriction: Can only be used in the discharge state.** |

### 10.5.2 FUNCtion: APERture

FUNCtion: APERture Used to set the sampling speed.

| | |
|---|---|
| Command Syntax: | **FUNCtion:APERture {slow,med,fast}** |
| Parameter: | {slow,med,fast}<br>Here, slow: slow speed med: medium speed fast: fast speed |
| Example: | SEND>**FUNCtion:APERture** fast // Set the sampling speed to fast |
| Query Syntax: | **FUNCtion:APERture?** |
| Query Response: | {slow,med,fast} |
| Example: | SEND**>FUNCtion:APERture?**<br>RET**>**fast |

### 10.5.3 FUNCtion: TIMEr

FUNCtion: TIMEr Used to set the charge timer.

| | |
|---|---|
| Command Syntax: | **FUNCtion:TIMEr <float>** |
| Parameter: | <float><br>Mixed floating point number, 0-999.9, Without a unit. |
| Example: | SEND>FUNCtion: TIMEr 100.1 // Set the charging time to 100.1s<br>SEND>FUNCtion: TIMEr 0 //Set the charging time to 100.1s (turn of charging time) |
| Query Syntax: | **FUNCtion:TIMEr?** |
| Query Response: | <float> |

Standard floating point number, 0.0-999.9

Example: SEND>**FUNCtion:TIMEr?**
RET>50.0
**Restriction: Can only be used in the discharge state.**

### 10.5.4 FUNCtion: Count

FUNCtion: Count Used to set the timing mode of the charging timer.

Command Syntax: **FUNCtion:Count {UP,DOWN}**
Parameter: **{UP,DOWN}**
Here, UP: Positive timing DOWN: Countdown
*Example:* SEND>FUNCtion: Count UP // Set the charging timing mode to positive timing
SEND>FUNCtion: Count DOWN // Set the charging timing mode to countdown
Query Syntax: **FUNCtion:Count?**
Query Response: **{UP,DOWN}**
*Example:* SEND>**FUNCtion:Count?**
RET>**UP**
**Restriction: It can only be used in the discharge state.**

### 10.5.5 FUNCtion: Check

FUNCtion: Check Used to choose whether to open contact detection.

Command Syntax: **FUNCtion:Check {ON,OFF}**
Parameter: **{ON,OFF}**
Here, ON: turned on OFF: turned off
*Example:* SEND>FUNCtion:Check ON //Contact detection turned on
SEND>FUNCtion:Check OFF // Contact detection turned off
Query Syntax: **FUNCtion:Check?**
Query Response: **{ON,OFF}**
*Example:* SEND>**{ON,OFF}?**
RET>**ON**
**Restriction: Can only be used in the discharge state.**

### 10.5.6 FUNCtion: RANGe

FUNCtion: RANGe Used to set the instrument range number. If the current range is automatic, it will be changed to lock.

Command Syntax: **FUNCtion:RANGe {<integer>,MIN,MAX}**
Parameter: **{<integer>,MIN,MAX}**
**Here,**
**<interger> Indicates the range number, integer 1-6**
**MIN: Indicates the minimum range,=1**
**MAX: Indicates the maximum range,=6**
*Example:* SEND> func:rang 5 // Set the current range to range 5
SEND> func:rang min // Set the current range to range 1
SEND> func:rang max // Set the current range to range 6
Query Syntax: **FUNCtion:RANGe?**
Query Response: **<integer>**
**Range number, integer 1-6**
*Example:* SEND> **FUNCtion:RANGe?**
RET>**5**

### 10.5.7 FUNCtion: RANGe:Mode

FUNCtion: RANGe:Mode Used to set range auto, lock or nominal.

Command Syntax: **FUNCtion:RANGe:Mode {Auto,Hold,Nom}**
Parameter: **{Auto,Hold,Nom}**
Here, Auto: Auto range Hold: Hold range Nom: Nominal range

| | |
|---|---|
| *Example:* | SEND> FUNCtion:RANGe:Mode Auto //Set the current range to automatic |
| | SEND> FUNCtion:RANGe:Mode Hold //Set the current range to hold |
| | SEND> FUNCtion:RANGe:Mode Nom //Set the current range to nominal |
| Query Syntax: | **FUNCtion:RANGe:Mode?** |
| Query Response: | **{auto,hold,nom}** |
| *Example:* | SEND>**FUNCtion:RANGe:Mode?** |
| | RET>auto |

# 10.6 TRIGger Subsystem

TRIGger subsystem is used to control the trigger mode and perform bus triggering.

Figure 10- 4 TRIGger Subsystem tree

| | | |
|---|---|---|
| **TRIGger** | *:IMMediate* | |
| | *: SOURce* | *{MAN,INT,BUS,EXT}* |
| | *: Delay* | *<float>* |
| | *: Edge* | *{Rising,Falling}* |

## 10.6.1 TRIGger: IMMediate

TRIGger: IMMediate command is used to trigger a measurement (in bus trigger mode).

| | |
|---|---|
| Command Syntax: | **TRIGger: IMMediate** |
| Parameter: | None |
| *Example:* | SEND>TRIG:IMM // Start a trigger |
| Query Syntax: | None |
| | **Restriction: Can only be used in bus trigger mode.** |

## 10.6.2 TRIGger: SOURce

TRIGger: SOURce command is used to select the trigger source.

| | |
|---|---|
| Command Syntax: | **TRIGger:SOURce {MAN,INT,BUS,EXT}** |
| Parameter: | **{MAN,INT,BUS,EXT}** |
| | Here, **MAN**: manual trigger |
| | **INT**: internal trigger |
| | **BUS**: bus trigger |
| | **EXT**: external trigger |
| *Example:* | SEND> TRIG:SOUR BUS // Select bus trigger |
| Query Syntax: | **TRIGger:SOURce?** |
| Query Response: | **{MAN,INT,BUS,EXT}** |
| *Example:* | SEND>**TRIGger:SOURce?** |
| | RET>**EXT** |

## 10.6.3 TRIGger: Edge

TRIGger: Edge command is used to select the edge of the external trigger.

| | |
|---|---|
| Command Syntax: | **TRIGger:Edge {Rising,Falling}** |
| Parameter: | **{Rising,Falling}** |
| | Here, **Rising**: Rising edge trigger |
| | **Falling**: Falling edge trigger |
| *Example:* | SEND> TRIG:Edge Rising // Select rising edge trigger |
| Query Syntax: | **TRIGger:Edge**? |
| Query Response: | **{Rising,Falling}** |
| *Example:* | SEND> **TRIGger:Edge**? |
| | RET> **Falling** |

# 10.7 COMParator Sorting Subsystem

COMParator subsystem is used to set the comparator parameters, including the upper and lower limit

reference values and signal settings.

Figure 10- 5 COMParator sorting Subsystem tree

| | | |
|---|---|---|
| **COMParator** | *:MODE* | *{ON,OFF}* |
| | *: Limit* | *{float1,float2}* |
| | *: Beep* | *{ON,OFF}* |

### 10.7.1 COMParator:MODE

COMParator:MODE command is used to set whether the comparator is turned on.

Command Syntax: **COMParator:MODE {ON,OFF}**

Parameter: **{ON,OFF}**

Here, **ON**: comparator is turned on

**OFF**: comparator is turned off

*Example:* SEND> **COMParator:MODE ON** // Select comparator to turn on

Query Syntax: **COMParator:MODE**?

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

*Example:* SEND> **COMParator:MODE**?

RET> **OFF**

### 10.7.2 COMParator:LIMit

COMParator:LIMit command is used to set the upper and lower limits of the comparator resistance.

Command Syntax: **COMParator:LIMit *{float1,float2}***

Parameter: ***{float1,float2}***

Here,

***float1***: Lower limit of comparator resistance

***float2***: Upper limit of comparator resistance

*Example:* SEND> **COMParator:Limit 2E10,1E13** // Set the lower limit to 20G and the upper limit to 10T

Query Syntax: **COMParator:LIMit?**

Query Response: ***{float1,float2}***

*Example:* SEND> **COMParator:LIMit?**

RET> **2.000000e+10,1.000000e+13**

**Restriction: Can only be used when the comparator is turned on.**

### 10.7.3 COMParator:Beep

COMParator:Beep command is used to set the comparator beeper switch.

Command Syntax: **COMParator:Beep {OFF,GD,NG}**

Parameter: **{OFF,GD,NG}** here, **OFF**: turned off **GD**: GD beeper NG: NG beeper

*Example:* SEND> **COMParator:Beep GD** // When the comparator is selected, the beeper will sound.

Query Syntax: **COMParator:Beep**?

Query Response: **{OFF,GD,NG}**

*Example:* SEND> **COMParator:Beep**?

RET> **GD**

## 10.8 SYSTem Subsystem

SYSTem subsystem is used to set system-related parameters.

Figure 10- 6 SYSTem Subsystem tree

| | | |
|---|---|---|
| **SYSTem** | *:LANGuage* | *{ENGLISH,CHINESE,EN,CN}* |
| | *:SHAKEHAND(SHAK)* | *{ON,OFF}* |
| | *:SENDmode* | *{Auto,Fetch}* |

### 10.8.1 SYSTem:LANGuage

Instrument language settings.

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

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

Query Syntax: **SYST:LANG?**

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

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

### 10.8.2 SYSTem:SHAKhand Communication Handshake Command

After the communication handshake is turned on, the instrument will return the received command to the host as it is, and then return the data.

Command Syntax: **SYSTem:SHAKhand {ON,OFF}**

*Example:* SEND**>SYST:SHAK ON**

Query Syntax: **SYSTem:SHAKhand?**

Query Response: **{on,off}**

### 10.8.3 SYSTem:SENDmode Get Mode Command

Used to set the setting of the measurement result acquisition mode.

Command Syntax: **SYSTem:SENDmode {auto,Fetch}**

Parameter: **{auto,Fetch}**

Here, **auto:** Automatically return results

**Fetch:** return results via sending FECH?

*Example:* SEND> SYSTem:SENDmode Auto

Query Syntax: **SYSTem:SENDmode**?

Query Response: **{auto,Fetch}**

*Example:* SEND**> SYSTem:SENDmode**?

RET**> auto**

## 10.9 FETCh Subsystem

Figure 10- 7 FETCh? Subsystem tree

| FETCh? | |
|---|---|

FETCh? Used to get test data.

Before using this command, users need to set [Result Send] field under the <System Configuration> page to [FETCH].

Command Syntax: **FETCh?**

Parameter: According to measurement parameter: <float>,<float>,{PASS,UPPER,LOWER,OPEN}

Here, <float> Floating point number, Rx

<float> Floating point number, Ix

{PASS,UPPER, LOWER,OPEN} Sorting results and contact test results

*Example:* SEND> **FETCh?**

RET> 1.008860e+09,9.912178e-08,PASS

**Restriction: Only valid in the test state.**

## 10.10 STATe Subsystem

STATe subsystem is used to convert the state of the instrument.

Figure 10- 8 STATe Subsystem tree

| STATe | *:CHARage* |
|---|---|
| | *:DISCharge* |

### 10.10.1 STATe?

STATe? Used to query the working state of the instrument;

Command Syntax: STATe?

Parameter: **{charge,discharge,test}**
**Here,**
**charge: charging state**
**discharge: discharging state**
**test: test state**

*Example:* SEND> STATe?
RET> discharge

Query Syntax: **COMParator:Beep**?

Restriction: None

**Note: The STATe subsystem commands, including the subordinate commands, are state switch commands.**
**The state switch command can only be placed at the end of the command string.**

### 10.10.2 STATe: DISCharge

Switching from the state of charge or test state to discharge state.

Command Syntax: STATe:DISCharge

No parameter

*Example:* SEND> STAT? // Query current status
RET> test // Current status is test status
SEND> STAT:DISC // Switch to discharge status

Query Syntax: **No query**

### 10.10.3 STATe: CHARage

Switching from a discharged state to a charged state, or from a charged state to a test state.

Command Syntax: STATe:CHARage

No parameter

*Example:* SEND > STAT? / / Query the current state
RET > discharge //The current state is the discharge state
SEND > STAT: CHAR / / switch to the charging state

SEND > STAT? / / Query the current state
RET > charge //The current state is the charging state
SEND > STAT:CHAR //Switch to test state

Query Syntax: **No query**

## 10.11 CORRection Subsystem

Figure 10- 9 CORRection Subsystem tree

| CORRection | |
|---|---|

CORRection subsystem clears the instrument to zero. Please leave the test leads open before clearing.

Command Syntax: CORRection

No parameter

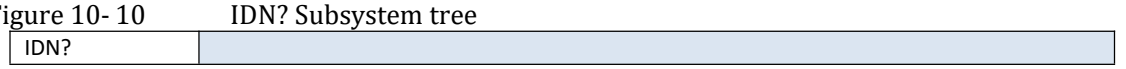
*Example:* SEND > CORR // start clearing zero
RET > Open Clear Zero Starting... //Please wait for clearing zero
RET >PASS //Clear completed

Query Syntax: **No query**

**Note: The positive test leads must first be opened and left unconnected, not in contact with anything.**
**Then send a clear calibration command.**
**In clear, the command parser refuses to accept any commands.**

## 10.12 IDN? Subsystem

Figure 10- 10 IDN? Subsystem tree




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

Query Syntax: **IDN?**

Query Response: **<Manufacturer>,<MODEL>,<SN>,<Revision>**
Manufacturer, model, serial number, instrument version

*Example:*

SEND> **IDN?** <NL>

RET> **APPLENT,AT688,0000000,REV A1.0**<NL>

# 11. Modbus（RTU）protocol

This chapter contains the following information:：

- Data format-Understand Modbus communication format
- Function
- Variable region
- Function code

## 11.1 Data format

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

Ref: You can contact the sales department of our company to obtain the communication test tool of Amber Instrument, which contains Modbus communication debugging method. Includes CRC-16 calculator and floating-point number, which is converted into Modbus floating-point number format.

### 11.1.1 Instruction frame

Figure 11- 1 Modbus instruction frame

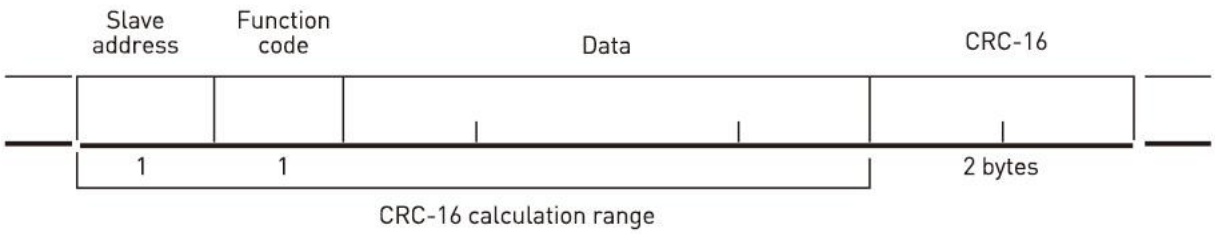



Table 11-1 Instruction frame description

| | |
|---|---|
| | A squelch interval of at least 3.5 characters is required. |
| Address of slave station | 1 byte<br>Modbus can support 00~0x63 slave stations.<br>Specify 00 when broadcasting uniformly.<br>In instruments without RS485 option, the default slave address is 0x01. |
| Function code | 1 byte<br>0x03：Read out multiple registers<br>0x04：=03H，Do not use<br>0x06：Write to a single register, which can be replaced by 10H.<br>0x08: Echo test (only for debugging)<br>0x10：Write to multiple registers |
| Data | Specify the register address, number and content. |
| CRC-16 | 2 bytes, with lower bits first.<br>CyclicRedundancy Check<br>Calculate all the data from the station address to the end of the data to obtain the CRC16 check code. |
| | A squelch interval of at least 3.5 characters is required. |

### 11.1.2 CRC-16 Calculation method

1. Set the initial value of CRC-16 register to 0xFFFF.
2. XOR the CRC-16 register and the first byte of information, and return the calculation result to the CRC register.
3. Fill the MSB with 0, and shift the CRC register by 1 bit to the right.
4. If the bit moved from LSB is "0", repeat step (3) (processing the next shift). If the bit moved from LSB is "1", XOR operation is performed on CRC register and 0xA001, and the result is returned to CRC register.
5. Repeat steps (3) and (4) until 8 bits are moved.
6. If the information processing is not finished yet, XOR the CRC register and the next byte of the

information, and return it to the CRC register. Repeat from step (3).

7. Attach the calculation result (the value of CRC register) from the lower byte to the information.

**The following is a CRC calculation function in VB language:**

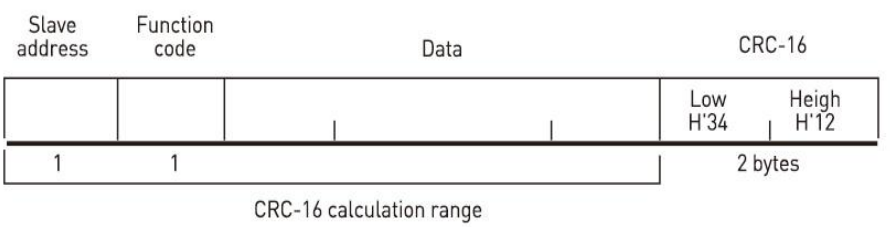
```
Function CRC16(data() As Byte) As Byte()
    Dim CRC16Lo As Byte, CRC16Hi As Byte   'CRC register
    Dim CL As Byte, CH As Byte       'polynomial code &HA001
    Dim SaveHi As Byte, SaveLo As Byte
    Dim i As Integer
    Dim flag As Integer
    CRC16Lo = &HFF
    CRC16Hi = &HFF
    CL = &H1
    CH = &HA0
    For i = 0 To UBound(data)
        CRC16Lo = CRC16Lo Xor data(i) 'Each data is XOR with CRC register.
        For flag = 0 To 7
            SaveHi = CRC16Hi
            SaveLo = CRC16Lo
            CRC16Hi = CRC16Hi \ 2     'The high bit is shifted to the right by
one bit.
            CRC16Lo = CRC16Lo \ 2     'Move the lower bit to the right by one
bit.
            If ((SaveHi And &H1) = &H1) Then 'If the last bit of the upper byte
is 1
                CRC16Lo = CRC16Lo Or &H80   'The lower byte is shifted to the
right, followed by the front. 1
            End If            'Otherwise, zero will be added automatically.
            If ((SaveLo And &H1) = &H1) Then 'If LSB is 1, XOR with 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 position
    ReturnData(1) = CRC16Lo      'CRC low post
    CRC16 = ReturnData
    End Function
```

Reference: :

My company's "Amber Instrument Communication Testing Tool" contains Modbus communication debugging methods. Includes CRC-16 calculator.

The calculate CRC-16 data needs to be append to that end of the instruction frame, for example: 1234H:

Figure 11- 2 Modbus Additional CRC-16 value




### 11.1.3 Response frame

Unless it is an instruction broadcast by 00H slave station address, other slave station address instruments will return a response frame.

Figure 11- 3 Normal response frame

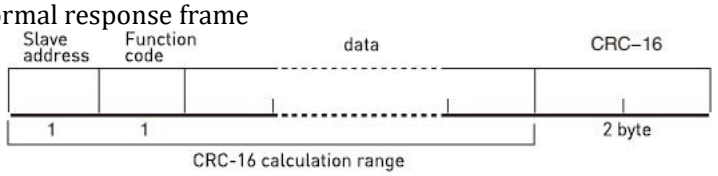



Figure 11- 4 Abnormal response frame

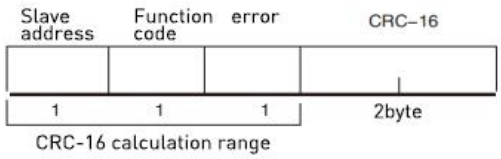



Table 11- 2 Exception frame description

| | |
|---|---|
| Address of slave station | 1byte<br>Return from the station address as it is |
| Function code | 1byte<br>BIT7(0x80) on the function code logic OR (OR) of the instruction frame, for example: 0x03 OR 0x80 = 0x83 |
| Error code | Abnormal code：<br>0x01 Error in function code (function code is not supported)<br>0x02 Register error (register does not exist)<br>0x03 Data error<br>0x04 Execution error |
| CRC-16 | 2 bytes, with lower bits first.CyclicRedundancy Check<br>Calculate all the data from the station address to the end of the data to obtain the CRC16 check code. |

### 11.1.4 No response.

Under the following circumstances, the instrument will not do any processing or respond, resulting in communication timeout.

1. The slave address is wrong.
2. Transmission error
3. CRC-16 Error
4. Wrong number of digits. For example, the total number of digits in function code 0x03 must be 8, but the received digits are less than 8 or more than 8 bytes.
5. When the slave station address is 0x00, it represents the broadcast address, and the instrument does not respond.

### 11.1.5 Error code

Table 11- 3 Description error code

| Error code | Name | Explain | Priority |
|---|---|---|---|
| 0x01 | Code error | Function code does not exist. | 1 |
| 0x02 | Register error | Register does not exist. | 2 |
| 0x03 | Data error | Wrong number of registers or bytes. | 3 |
| 0x04 | Execution error | The data is illegal, and the written data is not within the allowed range. | 4 |

## 11.2 Function code

The instrument only supports the following function codes, and other function codes will respond to error frames.

Table 11- 4 Function code

| Function code | Name | Explain |
|---|---|---|
| 0x03 | Read out multiple registers | Read out data of a plurality of consecutive registers |
| 0x04 | Same as 0x03 | Use 0x03 instead. |
| 0x08 | Echo test | The received data is returned as it is |
| 0x10 | Write to multiple registers | Write to multiple consecutive registers |

## 11.3 Register

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

Data：

The instrument supports the following numerical values：

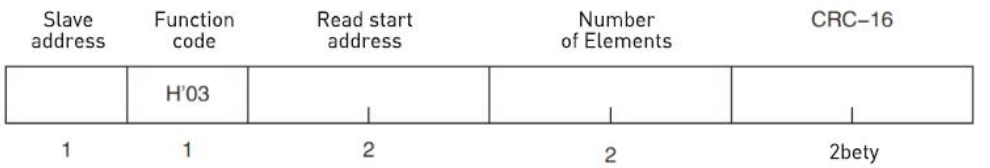
1. 1 register, double-byte (16-bit) integer, for example: 0x64 → 00 64

2. 2 registers, four-byte (32-bit) integers, for example:0x12345678 → 12 34 56 78
3. 2 registers, four-byte (32-bit) single-precision floating-point numbers,3.14 → 40 48 F5 C3

Ref: My company's "Amber Instrument Communication Testing Tool" contains Modbus communication debugging methods. A floating-point converter is included.

## 11.4 Read out multiple registers

Figure 11- 5 Read out multiple registers（0x03）

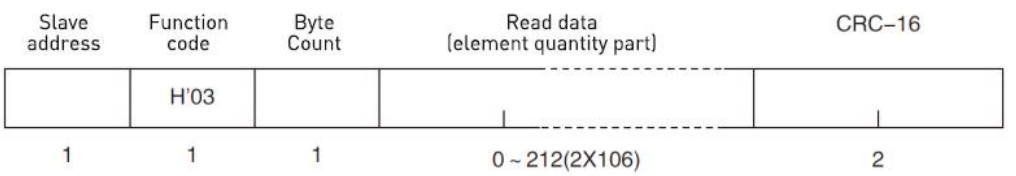



The function codes of the read-out registers are 0x03.

Table 11- 5 Read out multiple registers

| | Name | Explain |
|---|---|---|
| | Address of slave station | When no RS485 address is specified, the default value is 01. |
| 0x03 | Function code | |
| | Start address | Register start address, please refer to Modbus instruction set. |
| | Number of read registers0001~006A（106） | Number of consecutive registers read. Please refer to Modbus instruction set to ensure that these register addresses exist, otherwise an error frame will be returned. |
| CRC-16 | Verify code | |

Figure 11- 6 Read out the response frame of multiple registers (0x03)




| | Name | Explain |
|---|---|---|
| | Address of slave station | Return to the original |
| 0x03 Or 0x83 | Function code | No abnormality：0x03<br>Error code：0x83 |
| | Number of bytes | = Number of registers x2<br>For example: 1 register returns 02 |
| | Data | Read data |
| CRC-16 | Verify code | |

## 11.5 Write to multiple registers

Figure 11- 7 Write to multiple registers（0x10）

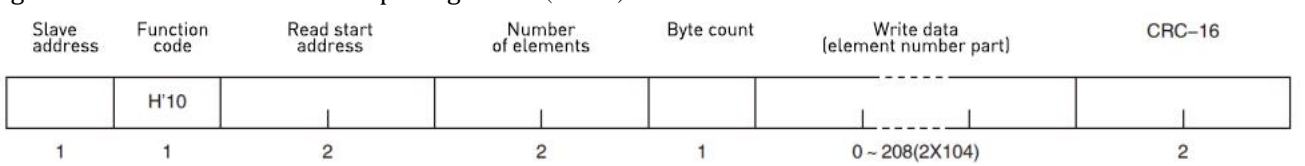
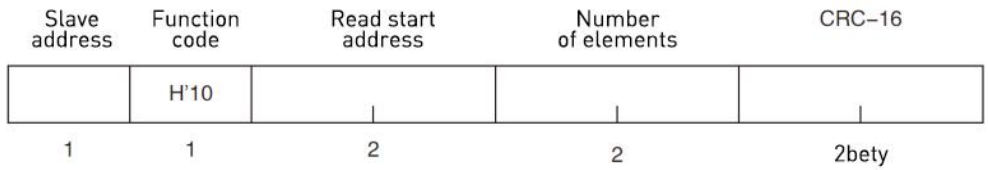



Table 11- 6 Write to multiple registers

| | Name | Explain |
|---|---|---|
| | Address of slave station | When no RS485 address is specified, the default value is 01. |
| 0x10 | Function code | |

| | | |
|---|---|---|
| | Start address | Register start address, please refer to Modbus instruction set. |
| | Number of written registers 0001~0068 （104） | Number of consecutive registers read. Please refer to Modbus instruction set to ensure that these register addresses exist, otherwise an error frame will be returned. |
| | Number of bytes | = Number of registers x2 |
| CRC-16 | Verify code | |

Figure 11- 8 Write to multiple registers（0x03）response frame

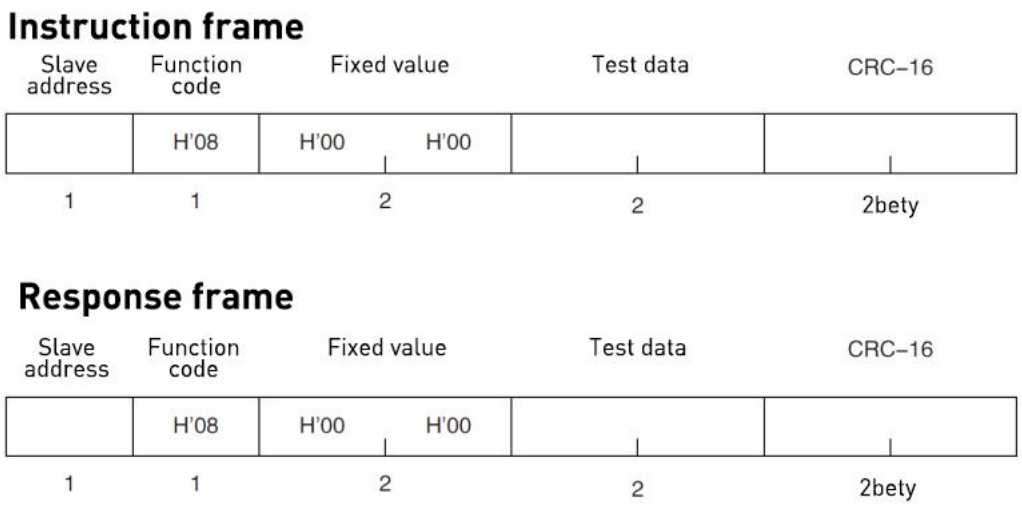



| | Name | Explain |
|---|---|---|
| | Address of slave station | Return to the original |
| 0x10 Or 0x90 | Function code | No abnormality：0x10 Error code：0x90 |
| | Start address | |
| | Number of registers | |
| | CRC-16 Verify code | |

## 11.6 Echo test

The echo function code 0x08 is used for debugging Modbus.

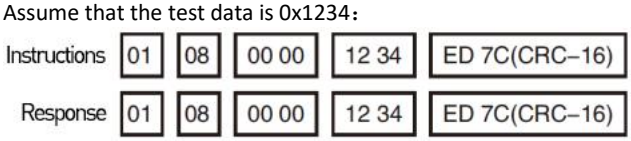
Figure 11- 9 Echo test（0x08）




| | Name | Explain |
|---|---|---|
| | Address of slave station | Return to the original |
| 0x08 | Function code | |
| | Fixed value | 00 00 |
| | Test data | Arbitrary value: for example 12 34 |
| | CRC-16 Check code | |

For example：

Assume that the test data is 0x1234：



# 12. Modbus（RTU）instruction set



This chapter includes the following aspects.：

- Register address

Ref: 

Be sure to contact the sales department of our company to obtain the communication test tool of Amber Instrument, which contains Modbus communication debugging method. Includes CRC-16 calculator and floating-point number, which is converted into Modbus floating-point number format.



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

## 12.1 Register overview

All register addresses used by the instrument are listed below, and any address that is not in the table will return an error code 0x02.

Table 12- 1 Register overview

| Register address | Name | Data | Explain |
|---|---|---|---|
| 2000 | Read the voltage measurement result | 4-byte floating point number | Read-only register, data occupies 2 registers. |
| 2002 | Read insulation resistance measurement results. | 4-byte floating point number | Read-only register, data occupies 2 registers. |
| 2004 | Read the leakage current measurement result | 4-byte floating point number | Read-only register, data occupies 2 registers. |
| 2006 | Get comparator result | 2-byte integer<br>FFFF: Qualified<br>0000：Unqualified | Read-only register, data occupies 1 register. |
| | | | |
| 3000 | Output voltage | 4-byte floating point number | Read and write registers, data occupies 2 registers. |
| 3002 | Test speed | 0000：low speed<br>0001：intermediate speed<br>0002：fast | Read-write register, 2-byte integer |
| 3004 | Charging time | 4-byte floating point number | Read and write registers, data occupies 2 registers. |
| 3006 | Insulation resistance range | 0001~0006 | Read-write register, 2-byte integer |
| 3008 | Insulation resistance range mode | 0000：Automatic measuring range<br>0001：Manual range<br>0002：Nominal range | Read-write register, 2-byte integer |
| 300A | Contact detection | 0000：OFF<br>0001：OPEN | Read-write register, 2-byte integer |
| 3010 | Trigger mode | 0000：Internal<br>0001：Manual<br>0002：Bus<br>0003：External | Read-write register, 2-byte integer |
| 3012 | Trigger edge | 0000：Rising edge trigger<br>0001：Falling edge trigger | Read-write register, 2-byte integer |
| 3014 | Automatic discharge | 0000：OFF | Read-write register, 2-byte integer |

| | | | |
|---|---|---|---|
| | | 0001：ON | |
| 3016 | Beeper | 0000：OFF<br>0001：GD beeper<br>0002：NG beeper | Read-write register, 2-byte integer |
| 3020 | Comparator status | 0000：comparator is turned off<br>0001：comparator is turned on | Read-write register, 2-byte integer |
| 3022 | Upper limit of insulation resistance | 4-byte floating point number | Read and write registers, data occupies 2 registers. |
| 3024 | Upper limit of insulation resistance | 4-byte floating point number | Read and write registers, data occupies 2 registers. |
| | | | |
| | | | |
| 5000 | Get the status of the test. | fixed value：0001 | Read-only register with 2 bytes of data. |
| 5100 | Keyboard lock | 0000：unlock<br>0001：lock | Read-write register with 2 bytes of data. |
| 5200 | Charging/testing | fixed value：0001 | Read-write register with 2 bytes of data. |
| 5300 | discharge | fixed value：0001 | Read-write register with 2 bytes of data. |
| 5400 | Trigger once = Handler Trig pin | fixed value：0001 | Read-write register with 2 bytes of data. |

## 12.2 Obtain measurement data

### 12.2.1 Obtain the measurement results.

Registers 2000~2004 are used to obtain instrument measurement data.

Instruction：

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 2000 | | 0002 | | CRC-16 | |
| slave station | read | register | | number of registers | | Check code | |

Respond

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

- **Acquire a voltage measurement result：**

Send:

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

Respond:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 04 | 42 | C7 | 8F | 9B | 7A | 2D |
| 01 | 03 | byte | Single precision floating point number | | | | CRC-16 | |

B4~B6 are measured data: 42C78F9B represents 99.78 (V) (the lower bit comes first)

- **Get resistance measurement results.**

Send:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 20 | 02 | 00 | 02 | 6E | 0B |
| Slave station | Eead | Register | | Number of registers | | Check code | |

Respond:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 04 | 60 | AD | 78 | EC | 56 | 5F |
| 01 | 03 | Byte | Single precision floating point number | | | | CRC-16 | |

B4~B6 are the measured data: 60AD78EC represents 1E20 (the lower bit comes first).

- **Acquire voltage and resistance measurement results**
- Send:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| 01 | 03 | 20 | 00 | 00 | 04 | 4F | C9 |
| Slave station | Read | Register | | Number of registers | | Check code | |

- Respond:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | 03 | 08 | 42 | C8 | 9B | 7A | 60 | AD | 78 | EC | 30 | 7F |

4 ~ B7: 42c89b7a represents 100.3
Resistance 8 ~ B11: 60 Ad78EC represents 1E20

### 12.2.2 Obtaining Comparator Results【2006】

The register 2006 records the comparator result, which is opened before use.
16-bit storage domain：
Among： BIT15~BIT10 Representative voltage file 0000：Unqualified FFFF：qualified

Send:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **03** | **20** | **06** | **00** | **01** | **6F** | **CB** |
| Slave station | Read | Register | | Number of registers | | Check code | |

Respond:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **01** | **03** | **02** | **FF** | **FF** | **B9** | **F4** |

## 12.3 Parameter setting

### 12.3.1 Output voltage【3000】

- Write (set the output voltage to 200V)

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 113 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **01** | **10** | **30** | **00** | **00** | **02** | **04** | **43** | **48** | **00** | **00** | **32** | **3C** |
| | Write | Register | | Number of registers | | Byte | Data | | | | CRC | |

Respond：

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **10** | **30** | **00** | **00** | **02** | **4E** | **C8** |
| | | Register | | Number of registers | | CRC | |

- Read

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **03** | **30** | **00** | **00** | **02** | **CB** | **0B** |
| | Read | Register | | Number of registers | | CRC | |

Respond：

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|
| **01** | **03** | **04** | **43** | **48** | **00** | **00** | **6F** | **A1** |
| | | Byte | Data | | | | CRC | |

In which 43480000 stands for 200.0.

### 12.3.2 Resistance range register【3006】

- write

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **01** | **10** | **30** | **06** | **00** | **01** | **02** | **00** | **01** | **57** | **F5** |
| | Write | Register | | Number of registers | | Byte | Data | | CRC | |

Respond：

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **10** | **30** | **06** | **00** | **01** | **EE** | **C8** |
| | | Register | | Number of | | CRC | |

| | | | registers | |
|---|---|---|---|---|

- Read

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **03** | **30** | **06** | **00** | **01** | **6B** | **0B** |
| | read | register | | Number of registers | | CRC | |

Respond：

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| **01** | **03** | **02** | **00** | **01** | **79** | **84** |
| | | byte | data | | CRC | |

In which data values：

| Date | Function |
|---|---|
| 0000 | measuring range 0 |
| 0001 | measuring range 1 |
| 0002 | measuring range 2 |
| 0003 | measuring range 3 |
| 0004 | measuring range 4 |
| 0005 | measuring range 5 |
| 0006 | measuring range 6 |

### 12.3.3 Resistor range mode register【3008】

- write

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **01** | **10** | **30** | **08** | **00** | **01** | **02** | **00** | **00** | **97** | **1B** |
| | write | register | | Number of registers | | byte | data | | CRC | |

Respond：

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **10** | **30** | **08** | **00** | **01** | **8F** | **0B** |
| | | register | | Number of registers | | CRC | |

- Read

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **03** | **30** | **08** | **00** | **01** | **0A** | **C8** |
| | read | register | | Number of registers | | CRC | |

Respond：

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

In which data values：

| data | Function | Explain |
|---|---|---|
| 0000 | Automatic measuring range | |
| 0001 | Hold range | |
| 0002 | Nominal range | Select the range according to the nominal value. |

### 12.3.4 Trigger once【5400】

**The trigger state is not [internal], and the instrument is under normal test. Sending the trigger instruction is effective.**

- write

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| **01** | **10** | **54** | **00** | **00** | **01** | **02** | **00** | **01** | **72** | **55** |
| | write | register | | Number of registers | | byte | data | | CRC | |

Respond：

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|
| **01** | **10** | **54** | **00** | **00** | **01** | **11** | **F9** |
| | | register | | Number of registers | | CRC | |

*Other instructions, according to the above example. See register overview for details.*

# 13. Specification



This chapter describes the following information:

- Technical indicators
- General specifications
- Environmental requirements
- Dimensions

## 13.1 Technical Indicators

Accuracy is defined as meeting all of the following conditions.
Temperature: 23℃±5℃
Humidity: 65% R.H.
Zeroing: Open Correction
Warm up time: >60 minutes
A 1-year calibration cycle
Sampling rate: Fast: about 55 times/sec. Medium speed: about 25 times/sec. Slow speed: about 3 times/sec.
Test voltage accuracy: <10V ±10% >10V ±1%

### AT688

Insulation resistance:11 typical voltage <1M: ±5% >1M: ±1% ≥1G: ±3% ≥10G: ±5% ≥1T: ±10% M=$10^6$,G=$10^9$,T=$10^{12}$

| Range / Voltage | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| 1V | 不考究 | 100k~1M | 1M~10M | 10M~100M | 100M~1G | 1G~10G |
| 10V | 100k~1M | 1M~10M | 10M~100M | 100M~1G | 1G~10G | 10G~100G |
| 25V | 250k~2.5M | 2.5M~25M | 25M~250M | 250M~2.5G | 2.5G~25G | 25G~250G |
| 50V | 500k~5M | 5M~50M | 50M~500M | 500M~5G | 5G~50G | 50G~500G |
| 75V | 750k~7.5M | 7.5M~75M | 75M~750M | 750M~7.5G | 7.5G~75G | 75G~750G |
| 100V | 1M~10M | 10M~100M | 100M~1G | 1G~10G | 10G~100G | 100G~1T |
| 125V | 2.5M~12.5M | 12.5M~125M | 125M~1.25G | 1.25G~12.5G | 12.5G~125G | 125G~1.25T |
| 250V | 5M~25M | 25M~250M | 250M~2.5G | 2.5G~25G | 25G~250G | 250G~2.5T |
| 500V | 10M~50M | 50M~500M | 500M~5G | 5G~50G | 50G~500G | 500G~5T |
| 750V | 10M~75M | 75M~750M | 750M~7.5G | 7.5G~75G | 75G~750G | 750G~7.5T |
| 1000V | 10M~100M | 100M~1G | 1G~10G | 10G~100G | 100G~1T | 1T~10T |

## 13.2 General Specification

Display: TFT-LCD true color display, screen size 3.5 inches.
Test voltage: -1.0VDC ~ -1000VDC
Voltage accuracy: <10V ±10% > 10V ±1%
Test range: 100kΩ～10TΩ
Test accuracy: Slow range resistance: <1M: ±5% >1M: ±1% >1G: ±3% >10G: ±5% >1T: ±10%
Max. charging current: 30mA ± 5mA

| | |
|---|---|
| Charging time: | 999.9s Accuracy: ±0.5% |
| Test speed: | Manual range mode:<br>Slow speed: 3 times / sec<br>Medium speed: 25 times / sec<br>Fast: 55 times / sec |
| Maximum reading: | 9999 |
| Range mode: | Auto, Hold and Nominal |
| Comparator: | Output PASS, LOWER, UPPER. |
| Beeper: | Off, GD, NG. |
| Trigger: | Internal, external, manual, and remote triggering. |
| Interface: | Handler interface, RS232 interface |
| Optional interface: | RS485 and USB-232 interface |
| Programming language: | SCPI |
| Accessibility: | Keyboard lock |

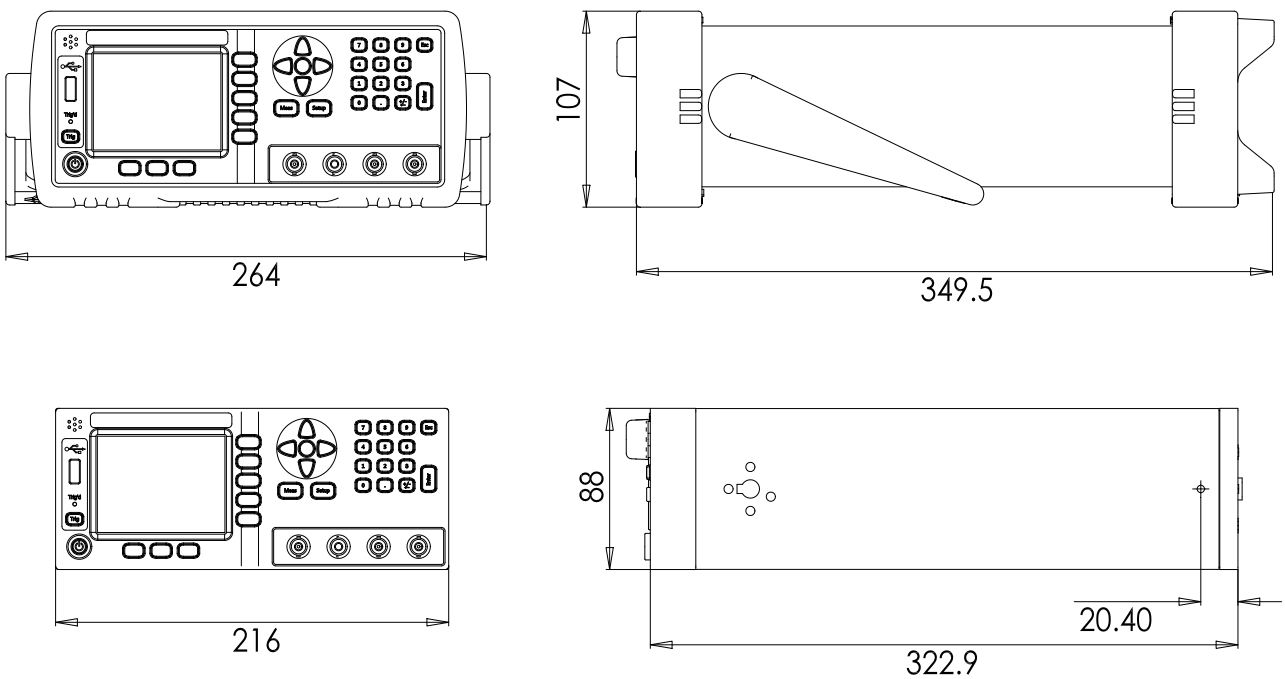
## 13.3 Environment Requirements

| | | | |
|---|---|---|---|
| Environment: | Indicator: | Temperature 18℃ ~ 28℃ | Humidity ≤ 65% RH |
| | Operation: | Temperature 10℃ ~ 40℃ | Humidity 10 ~ 80% RH |
| | Storage: | Temperature 0°C~50°C | Humidity 10~90% RH |

| | |
|---|---|
| Power supply: | 198V ~ 252VAC 48.5Hz ~ 52.5Hz |
| Fuse: | 250V 1A Slow-Blow |
| Power: | up to 30VA |
| Weight: | about 5 kg. |
| Supplied accessories: | User manual, ATL680 test cable, AC power cord, Quality assurance certificate. |

## 13.4 Dimensions

(Dimensions)





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