ONMEAS®

Rev.A2.0

AT686A/686

High Voltage Insulation Resistance Tester



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 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 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 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 Use the instrument in areas with strong magnetic or electric fields	Using the instrument in areas with strong magnetic or electric fields may lead to instrument malfunction and even fire due to electromagnetic pulses.
DO NOT Use the instrument near sensitive test equipment and receiving equipment	If these devices are used near the instrument, noise generated by breakdown of the device under test may affect them.With a test voltage exceeding 3kV, the electric field between test leads can ionize air to produce corona, causing significant radio-frequency interference between the leads.To reduce this effect, ensure sufficient distance between the test leads.In addition, keep the test leads away from conductive surfaces (especially sharp metal ends).
DO NOT 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 Use the instrument beyond instructions specified in this manual	If out of scope, the protection provided by the instrument will be invalid

Limited Warranty And Limitation Of Liability

Applent Instruments, Inc. ((shortened form Applent)) guarantees that every AT686A you purchase is fully qualified in quality and measurement. This warranty does not cover fuses and damage caused by negligence, misuse, contamination, accidental or abnormal use.

From the date of shipment, Applent provides a 90-day replacement guarantee and one year free warranty, which also covers the VFD and LCD. During the 90-day replacement period, the replacement guarantee shall be void if the damage is caused by improper operation on the part of the user.Within the one year warranty period, if the instrument is damaged due to improper user operation, all repair costs shall be borne by the user. After the one year warranty period and for the remainder of the instrument's service life, Applent will provide repair services on a chargeable basis.The replacement cost of VFD or LCD shall be calculated according to the current cost price.

If the product is found damaged, please contact Applent to obtain information on the approval for return or replacement. Thereafter, please send the product to the distributor for return or exchange. Be sure to state the cause of damage, and prepay the postage and insurance fees to the destination.

For the repair or replacement of products within the warranty period, Applent will bear the cost of return shipping. For the repair of non-warranty products, Applent will provide a quotation for the repair fee and will only proceed with the repair upon your approval. All costs arising from the repair shall be borne by the user, including the return shipping fee.

This warranty is the sole and exclusive warranty provided by Applent and constitutes your exclusive remedy. No other warranties, either express or implied (including but not limited to the implied warranty of fitness for a particular purpose), are provided. All other warranties are expressly disclaimed. Neither Applent nor any of its agents have made any oral or written representations to establish an additional warranty or extend the scope of this warranty in any way. Applent shall not be liable for any special, indirect, incidental or consequential damages or losses (including loss of data) arising from any cause outside the scope of the specifications. If any provision of this warranty conflicts with local laws or regulations, or if the exclusion or limitation of implied warranties is not permitted in any jurisdiction, such local laws or regulations shall prevail, and this provision may not apply to you. However, the invalidation of such a provision shall not affect the validity and enforce ability of the other provisions.

People's Republic of China
Jiangsu Province
Applent Instruments, Inc.
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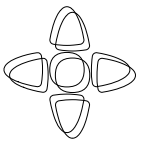
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1. The Install and Setup Wizard



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

- Packing list
- Power requirements
- Operation 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
Withstand Voltage Test Rod	1 pc
Withstand Voltage Grand Cable	1 pc
3A (220-240V) Slow-blow Fuse	2 pcs
Power Cord	1 pc
AT686A Series User Manual	1 pc
RS232 Interface Cable	1 set

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

1.2 Power Requirements

AT686A can only be used in the following power conditions:

Voltage: 220VAC (1±10%)

Frequency: 50Hz (1±10%)



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 Operation Environment

AT686A must be used under the following environmental conditions:

Temperature: 0°C～55°C,

Humidity: 23°C,＜70%RH

1.4 Cleaning

To prevent electrical shock, disconnect the AT686 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 AT686A internally.

Warning: do not use organic solvents (such as alcohol or gasoline) to clean the instrument

1.5 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:

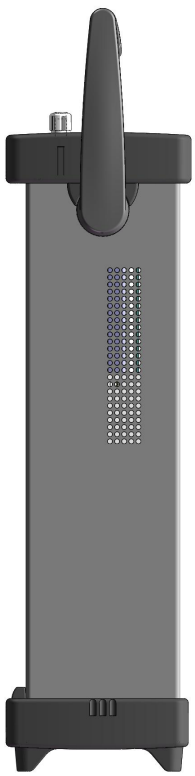
Figure 1- 2 Instrument Handle(Schematic,Panel Graphics Do Not Match The Actual)



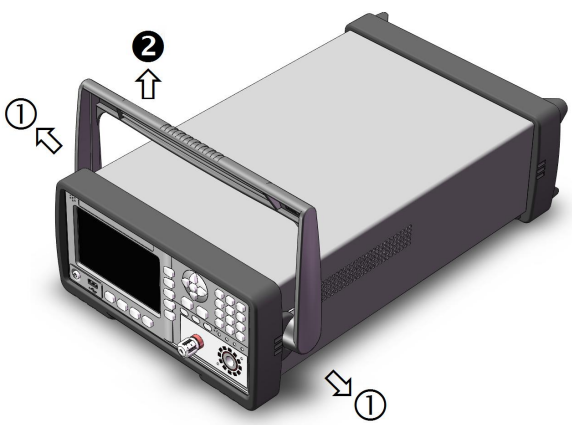
Visible position 1 [Hands hold both sides of the handle at the same time, gently pull it to the sides until it can rotate freely, then switch to the visible position 2]



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]

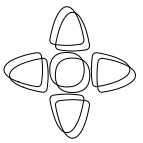


Handheld position



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

2. Overview



You will learn the following in this chapter:

- Safety Rules
- Product Performance

2.1 Safety Rules



WARNING: This instrument generates a test high voltage of 5kV that can cause personal injury or even death. When operating the instrument, extreme caution must be exercised and all the notes, warnings and other instructions given in this chapter must be followed.

2.1.1 Workstation Arrangement

➢ Work Location

The workstation must be situated in an open area not traversed by general personnel, ensuring non-staff remain distant from the workstation.The workstation must be segregated from other facilities and clearly marked with the designation"High Voltage Test Workstation". During testing, signage must be displayed stating: "DANGER! TEST IN PROGRESS. UNAUTHORIZED PERSONNEL KEEP OUT!"

➢ Input Power Supply

Ensure the instrument is connected to electrical ground (earth) for safety purposes. The workstation must be equipped with an independent power switch, which shall be installed in a conspicuous position at the workstation entrance and clearly labeled for easy identification by all personnel. In case of an emergency, the power supply must be switched off immediately before handling the incident.

➢ Workplace

Insulated workbenches or tables must be used. No metal objects are allowed between the operator and the device under test. The workplace layout shall avoid requiring the operator to step over the device under test to operate the test instrument.The workplace must be kept neat and clean. Unused instruments and test leads shall be stored in designated locations. It is mandatory to clearly distinguish devices under test, devices to be tested, and tested devices for all personnel.The test station and its surrounding area shall be free of flammable and corrosive gases. The instrument must not be used near flammable materials.

2.1.2 Operator Regulations

➢ Personnel Qualifications

The operation of this series of testers involves hazards. Incorrect operation may cause personal injury, or even life-threatening consequences. Therefore, operators must receive prior training and strictly comply with the user manual.

➢ Safety Rules

Operators must be provided with safety education and training at all times to ensure they understand the importance of standardized safe operations and operate the tester in accordance with the safety rules.

➢ Dress Code

Operators shall not wear clothing with metal decorations, nor carry metal jewelry, watches, or similar items, as these metal accessories are highly likely to cause accidental electric shock. Operators must wear insulating gloves when operating the tester.

➢ Medical Restrictions

This series of testers must never be operated by personnel with heart disease, or those wearing cardiac regulators or pacemakers.

2.1.3 Prohibited Operations

✓ Do not switching the power supply on and off repeatedly

After turning off the power switch, ensure an interval of several seconds or longer before switching it on again. Do not repeatedly switch the power on and off frequently; otherwise, the instrument's protection mechanisms may fail to perform their protective functions fully. Do not turn off the power switch while the instrument is generating test voltage, except under special or emergency circumstances.

✓ Do not short-circuit the output terminals to ground

Handle the instrument's high-voltage test leads with care, and avoid short-circuiting them to nearby AC power cables connected to ground or other adjacent equipment (e.g., transmission devices). In case of a short circuit, the instrument's housing may be charged with dangerous high voltage.

✓ Do not connect external voltage to the test terminals

Do not connect any external voltage to the instrument's output terminals. The instrument has no external discharge function when in a non-discharge state, and connecting external voltage to the output terminals may damage the instrument.

2.1.4 Testing Precautions

● Precautions for Pausing the Test

To change the test conditions, press the [STOP] key once first to make the instrument exit the test ready state. If you need to take a break or leave the test area, turn off the power switch to prevent safety hazards caused by accidental contact with the start switch.

● Live Components During High Voltage Testing

During high voltage testing, the test leads, test probes and the device under test are all energized with high voltage. The instrument is equipped with a discharge circuit, and discharge may still be required even after the output is cut off in some cases. There is still a risk of electric shock during the discharge process. To avoid electric shock, ensure that the device under test, test leads, probes and high-voltage output terminals do not come into contact with anything other than the test components. If such contact is likely to occur, confirm that the high-voltage hazard indicator light is off and eliminate the potential hazard. Once the test is completed, the instrument's discharge circuit will initiate forced discharge. Do not disconnect the device under test during the test or before the completion of discharge. Under normal circumstances, the voltage of the test circuit will be within the safe voltage range upon the completion of discharge. If incomplete discharge occurs due to an excessively large capacitance of the device under test or its special structure, technical personnel must modify the test method to ensure complete discharge.



Discharge Time:

Discharge time Calculating Formula: $t = -\ln(30 / U) \times R \times C$

t: Discharge Time

30: Residual safe discharge voltage of 30V

U: Test set voltage

R: Insulation resistance of the device under test, approximately 2kΩ when discharging connected to the instrument.

C: Capacitance of the device under test

Generally, only DC high voltage tests require discharge, and the duration of discharge depends on the characteristics of the device under test.

During the test, the discharge of the device under test is achieved through the transformer secondary side (with an approximate resistance of 2kΩ). The discharge time for a 1μF capacitor charged with 6000V high voltage to 30V is approximately 0.1 seconds. The instrument has a fixed discharge time of 0.2 seconds, which ensures the complete discharge of the device.

- Conditions for Ensuring Long-Term Trouble-Free Operation

Due to the instrument's size, weight and actual operating conditions, the heat dissipation design of its voltage generation module is relatively compact. Therefore, it is recommended to use the instrument within the following parameters. If the fan has been running continuously for 30 minutes, the instrument must be shut down temporarily; otherwise, the power amplifier output module may burn out due to overheating.

Table 2- 1 Prerequisites for Withstand Voltage Testing

Environment Temperature	Maximum Output power		Downtime	Output Time Limit
T≤40℃	ACW	>6mA	At least equal to the output time	Max. 1 minute
		<4mA	No requirement	Continuous output available
	DCW	>3mA	At least equal to the output time	Max. 1 minute
		<2mA	At least equal to the charge waiting time	Continuous output available

NOTE: Test Time <= Output Time <= Voltage Rise Time + Test Time + Voltage Fall Time

2.2 Main Function

2.2.1 Product Overview

The AT686A high-voltage insulation resistance tester adopts a 5-inch color LCD display screen (with touch control). It is equipped with a mainstream high-performance 32-bit ARM processor. Small size、light weight (8kg)，ultra-high cost performance, and easy operation.

The AT686A insulation and voltage withstand tester can be widely used for safety performance inspection of household appliances, transformers, electrical equipment and components. This instrument is equipped with a Controller interface (PLC interface) and RS232C for convenient data communication and remote control with a PC, meeting the requirements of automated testing and improving production efficiency.

2.2.2 Product Features

AT686A supports 5kVAC/20mA withstand voltage 、 6kVDC/10mA withstand voltage 、 and insulation resistance Test.

Instrument principle and structure： The high-voltage module consists of a DA reference, a controllable sine wave generator, a Class AB power amplifier, a 40 ～ 600Hz high-voltage transformer for voltage boosting, and adopts closed-loop control for output voltage.

DA reference: Ensures the controllable amplitude of the output voltage.

Controllable sine wave generator: Allows setting the operating frequency to 50Hz or 60Hz for AC output, independent of the line voltage.

Linear power amplifier: Features low distortion of voltage waveform, simple control and high reliability.

40～600Hz high-voltage transformer for voltage boosting: Aiming at the large power supply ripple issue in DC and insulation resistance tests, the tester generates a 600Hz AC power supply, which is rectified to form a DC voltage as the power source. This ensures that the ripple of the DC power supply is far lower than that of the traditional voltage regulator-type withstand voltage testers.

Closed-loop control for output voltage: Guarantees an extremely small load regulation rate and reliable test data.

The AT686A series can not only perform AC withstand voltage test, DC withstand voltage test and insulation resistance test independently, but also conduct multi-item sequential testing through the project setting of test schemes.

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

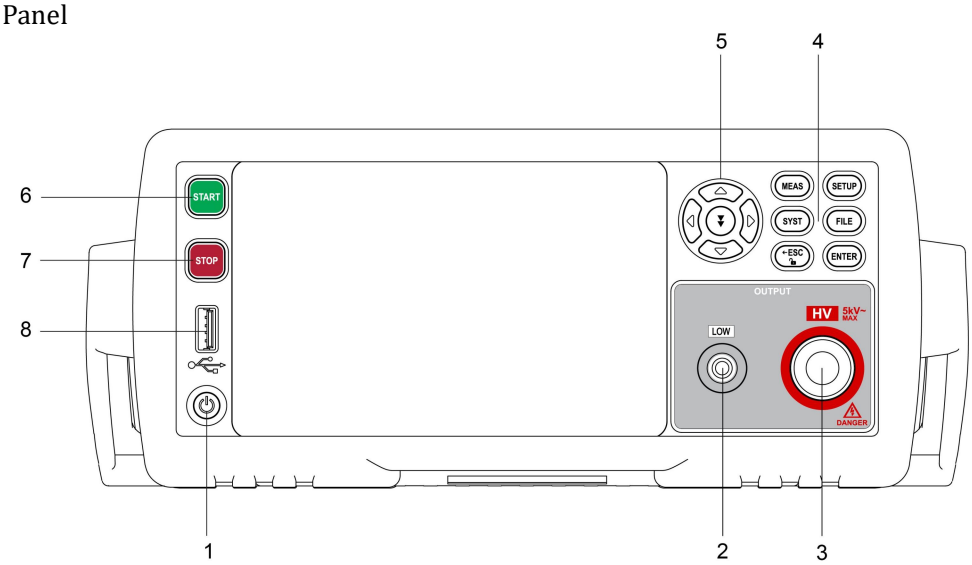


Table 3- 1 Front Panel Function Description

No.	Function
1	Power Switch
2	Circuit end of the withstand voltage test: Do not touch when the test light is on and high-voltage output is present.
3	High-voltage output terminal: Do not touch when the test light is on and high-voltage output is present.
4	Function area keys: MEAS: Press this key to initiate test preparation. SETUP: Press this key to enter the instrument's parameter settings interface. SYST: Press this key to enter the system settings interface. FILE: Press this key to enter the file management interface.
5	Direction keys: Used to move the cursor on the screen. The middle key can be used to input data.
6	Start key: Starts the current test
7	Stop key: stops the current test
8	USB Disk Port(HSB-Host)

3.1.2 Rear Panel

Figure 3- 2 Rear Panel

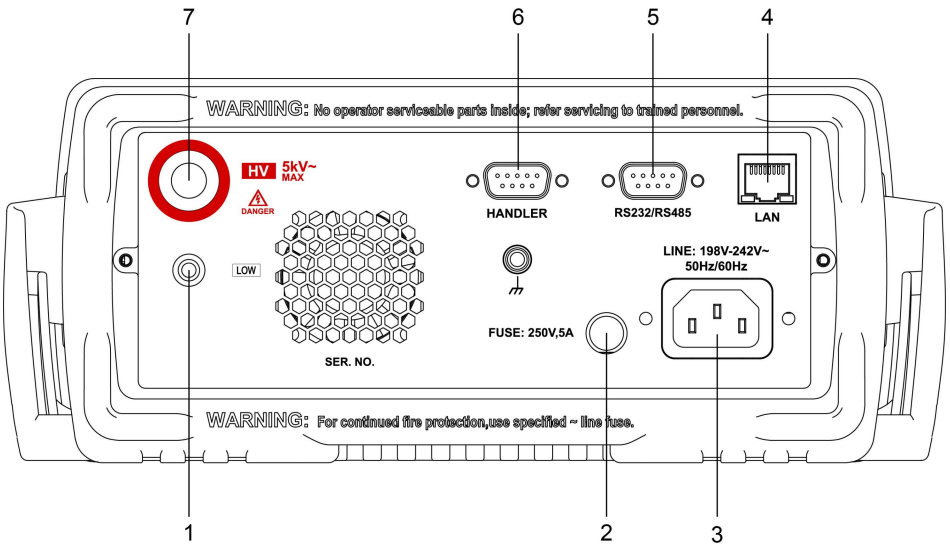


Table 3- 2 Rear Panel Function Description

No.	Function
1	Backplane circuit end for voltage withstand test
2	Fuse (5A) socket
3	Power Socket
4	LAN communication interface
5	RS232/RS485 communication interface
6	HANDLER (PLC) Communication Interface
7	High-voltage output terminal of the rear panel

3.2 Power On Startup

3.2.1 Power On

The button labeled" ⏻" at the bottom left of the panel is the power switch. AT686A 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 off，release the Power button.

3.3 Connect to Device Under Test(DUT)

- Withstand voltage test lead connected to the L and N terminals of the DUT;
- Withstand voltage grounding lead connected to the grounding terminal or enclosure of the DUT.

4. [SETUP] Page

You will learn about all the setting functions：

- Test Step Setting
- AC Withstand Voltage Test Parameter Setting
- DC Withstand Voltage Test Parameter Setting
- Insulation Resistance Test Parameter Setting

When the high voltage is stopped,You only need to press the 【Setup】key,the instrument will enter the main setup page.

4.1 Test Step Setting

All measurement-related settings are configured on the <MEAS SETUP> page.

Figure 4- 1 Test Step Setting Page



Current Step 1 - Total Steps 1: Step identifier for the test scheme, indicating which step of the test scheme the current parameter corresponds to - and the total number of steps in the scheme.

Table 4- 1 Test Scheme Modification Instructions

Key	Function	Notes
F1	INSERT	Add a new test step after the current step. The new step and subsequent steps will be shifted backward by one position in sequence.
F2	DELETE	Delete the current test step. The subsequent steps will be shifted forward by one position in sequence.
F3	NEW	Create a new test program, and the system will automatically generate a default test item. Remember to save the file after customizing your test scheme.
F4	PREV	Access parameters of the step before current displayed step.
F5	NEXT	Access parameters of the step after current displayed step.

As shown in Figure 4-1, The current working mode of the test item is AC withstand voltage. You can use the cursor keys to select [Function] to switch to DC withstand voltage or insulation resistance test.

4.1.1 AC Withstand Voltage Test Parameter Setting

Figure 4- 2 AC Withstand Voltage Test Parameter Setting Page



Table 4- 2 AC Withstand Voltage (ACW)Test Parameter Description

Item	Input Range	Default	Description
Output Voltage	(50~5000)V	1000V	Output voltage during AC withstand voltage test
Test Upper Limit	(Test Lower Limit~20.00)mA, Off	20.00mA	Upper limit of breakdown current alarm
Test Lower Limit	(0.01~Test Upper Limit)mA, Off	OFF	Lower limit of breakdown current alarm
TEST TIME	(0.5~999.9)s, Continuous Test	1.0 s	Test time of the current step
RISE TIME	(0.4~999.9)s	0.5s	Limited voltage rises slowly within this time period
FALL TIME	(0.1~999.9)s, Off	0.5	Limited voltage falls slowly within this time period
Current Range	Auto, Fixed	AUTO	Set current range to auto shift or fixed range.If set to Auto, the instrument will automatically select a suitable current range.If set to Fixed, a value needs to be set in Test Upper Limit to determine the current range, which can shorten the test time. If the upper limit is off, the instrument will automatically select the maximum range in this mode.

<table>
<tr><td>Output Frequency</td><td>50Hz, 60Hz</td><td>50Hz</td><td>Output frequency of AC withstand voltage</td></tr>
<tr><td></td><td>Off, On, Auto Test</td><td>OFF</td><td>Leakage current zero setting.Please directly press the [Auto Test] key on the side bar to let the analyzer automatically measure the leakage current of the test cable and fixture and perform zero setting. At this time, the DUT on the test cable must be removed first.Press the [Off] key on the side bar to clear.</td></tr>
<tr><td>ARC Level</td><td>0~9</td><td>0</td><td>Alarm level for arc test.The arc alarm level can be preset and judged. The preset range is 0, 1~9 levels. 0 means the arc detection function is off, and level 9 is the most sensitive. The peak current corresponding to each alarm level is shown in the table below:
<table>
<tr><td>Arc Alarm Level</td><td>Threshold Peak Current (mA)</td></tr>
<tr><td>9</td><td>2.8</td></tr>
<tr><td>8</td><td>5.5</td></tr>
<tr><td>7</td><td>7.7</td></tr>
<tr><td>6</td><td>10</td></tr>
<tr><td>5</td><td>12</td></tr>
<tr><td>4</td><td>14</td></tr>
<tr><td>3</td><td>16</td></tr>
<tr><td>2</td><td>18</td></tr>
<tr><td>1</td><td>20</td></tr>
</table></td></tr>
</table>

4.1.2 DC Withstand Voltage Test Parameter Setting

Figure 4- 3 DC Withstand Voltage Test Parameter Setting Page



Table 4- 3 DC Withstand Voltage(DCW) Test Parameter Description

Item	Input Range	Default Value	Description
Output Voltage	(50~6000)V	1000V	Output voltage during AC withstand voltage test
TEST UPPER	(Test Lower Limit~10.00)mA, OFF	10.00mA	Upper limit of breakdown current alarm
TEST LOWER	(0.1 μA~Test Upper Limit), OFF	OFF	Lower limit of breakdown current alarm
TEST TIME	(0.5~999.9)s , Continuous Test	1.0 s	Test time of the current step
RISE TIME	(0.4~999.9)s	0.5s	Limited voltage rises slowly within this time period
FALL TIME	(0.1~999.9)s, OFF	0.5	Limited voltage falls slowly within this time period
Current Range	Auto, Fixed	AUTO	Set current range to auto shift or fixed range. If set to Auto, the instrument will automatically select a suitable current range. If set to Fixed, a value needs to be set in Test Upper Limit to determine the current range, which can shorten the test time. If the upper limit is off, the instrument will automatically select the maximum range in this mode.
ARC Level	0~9	0	Alarm level for ARC test.
OFFSET	OFF,ON, AUTO TEST	OFF	Leakage current zero setting. Please directly press the [Auto Test] key on the side bar to let the analyzer automatically measure the leakage current of the test cable and fixture and perform zero setting. At this time, the DUT on the test cable must be removed first. Press the [OFF] key on the side bar to clear.
RISE UPPER	OFF, ON	OFF	
CHG LOWER	OFF, Manual input (1-3500)uA, Auto Test	OFF	Minimum charging current setting for testing capacitive loads. Used to detect whether the connection of the test cable or test fixture is normal to ensure the correctness of the test results. Since the leakage current is usually very small during DC withstand voltage testing, it is difficult to use the lower limit value of the leakage current as the basis for judging whether the connection of the test cable or test fixture is normal.

			Since the DUT actually has some capacitive existence, you can use the detection of the charging current of the DUT as the basis for detecting whether the connection of the test cable or test fixture is normal. ➢ To manually set the minimum charging current value, use the numeric keys to enter the value. ➢ To automatically set the minimum charging current value, first connect the instrument, DUT, and test cable/fixture properly, and ensure the set output voltage and rising time parameters are exactly the same as the data to be used in the actual test later.

4.1.3 IR Test Parameter Setting

Figure 4- 4 Insulation Resistance Test Parameter Setting Page



Table 4- 4 Insulation Resistance（IR）Test Parameter Description

Item	Input Range	Default Value	Description
Output Voltage	(50~6000)V	1000V	Insulation resistance test voltage value
TEST UPPER	(Test Lower Limit~100GΩ), Off	OFF	insulation resistance upper limit no judgment for insulation resistance upper limit
TEST LOWER	(1~Test Upper Limit)MΩ, Off	1MΩ	insulation resistance lower limit (less than the upper limit)
TEST TIME	(0.5~999.9)s, Continuous Test	0.5~999.9S OFF	insulation resistance test time unlimited test time

RISE TIME	(0.4~999.9)s	0.4~999.9S OFF	insulation voltage rise time default = 0.1S (integrated with test time)
FALL TIME	(0.1~999.9)s, OFF	0.5	insulation voltage fail time The voltage output is cut off immediately after the test. (The DUT may have electricity)
Current Range	Auto, Fixed	AUTO	Set current range to auto shift or fixed range.If set to Auto, the instrument will automatically select a suitable current range.If set to Fixed, a value needs to be set in Test Upper Limit to determine the current range, which can shorten the test time. If the upper limit is off, the instrument will automatically select the maximum range in this mode.
CHG LOWER	OFF,Manual input (0.001-3.5)uA, Auto Test	OFF	minimum charging current setting for capacitive load testing. This function is used to detect whether the connection of test leads or test fixtures is normal, so as to ensure the accuracy of test results. Since the leakage current during insulation testing is usually very small, it is difficult to use the lower limit of leakage current as the basis for judging whether the connection of test leads or test fixtures is normal. In practice, the device under test always has a certain capacitive component. Therefore, the charging current of the device under test can be detected to verify whether the test leads or test fixtures are properly connected. ➢ To manually set the minimum charging current value, enter the value using the numeric keypad. ➢ To automatically set the minimum charging current value: first connect the instrument, the device under test, and the test leads or fixtures correctly. Ensure that the set output voltage and rise time parameters are exactly the same as those to be used in the actual test.
Delay Time	Off, Manual input (0.5~Test Time)	OFF	Input time **t**. The instrument will judge the upper/lower limit after starting IR test for **t** time. If the input time is larger than Test Time, it is meaningless.

5. [Meas] Measure Display

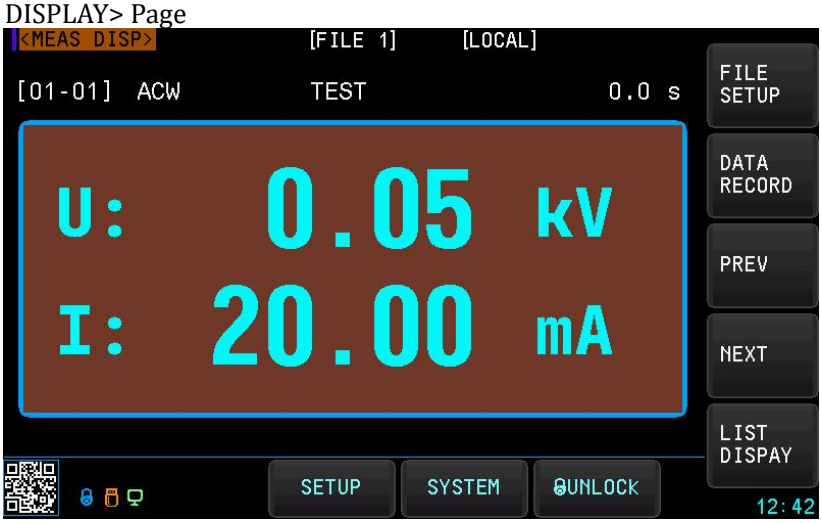
You will learn the following in this chapter:

- <MEAS DISPLAY> Page
- Test Function Principles and Operating Instructions

5.1 <MEAS DISPLAY> Page

Press the 【Meas】key to enter the【MEAS DISPLAY】Page.

Figure 5- 1 <MEAS DISPLAY> Page



You can press **[START]** in this interface to apply high voltage and perform high voltage measurement on the DUT. For safety and test accuracy reasons, this page is for display only; **no parameters can be set though the physical keys (parameters for the current step can be modified though touch control).** All test parameters must be set in detail and correctly in the Setup Interface.
Real-time test data is displayed during the test. After the test is completed, the results of the last test will remain displayed until the **[STOP]** key is pressed.

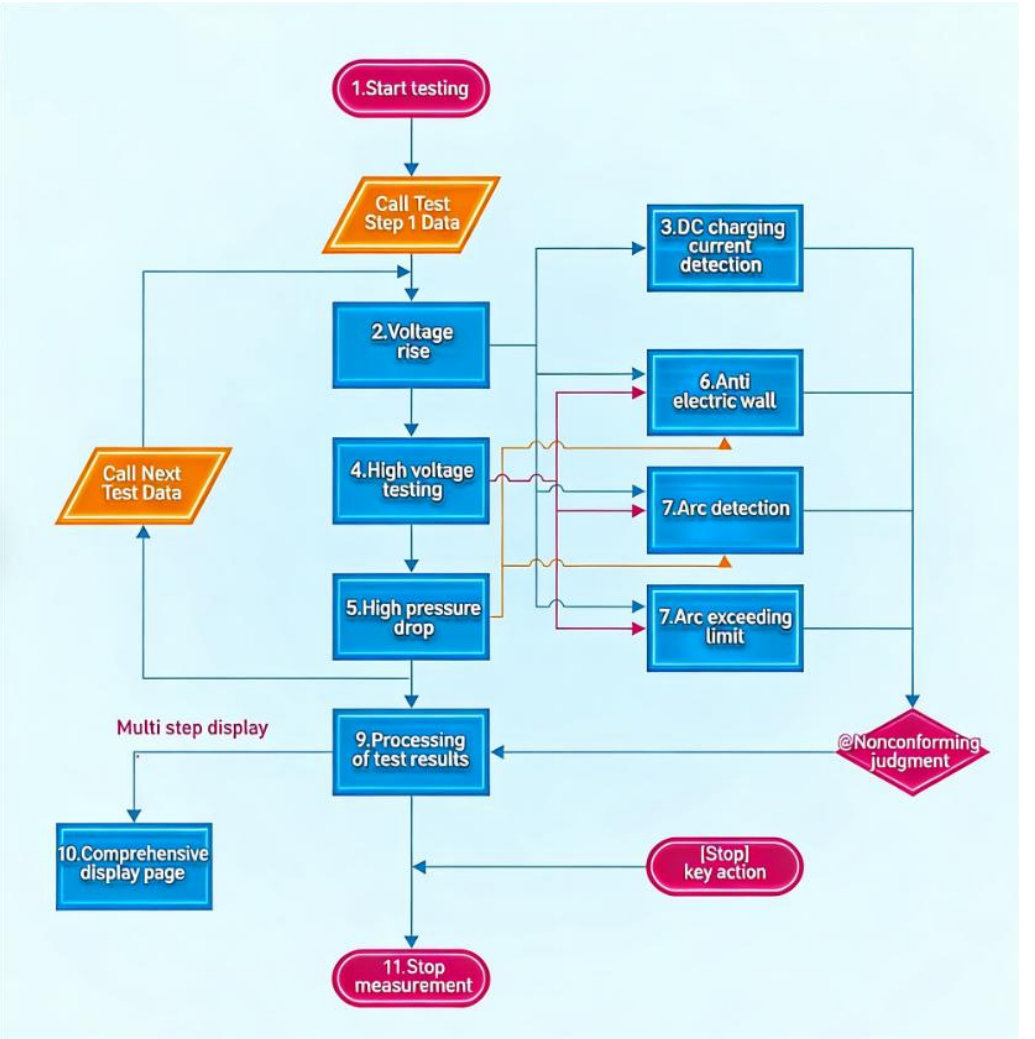
After starting the measurement, two data are displayed in large fonts **in the middle of the instrument's LCD screen:**
The upper one is the high-voltage output voltage, in kilovolts (kV) for withstand voltage tests.
The lower one is the measured current or insulation resistance at the test low side, in milliamps (mA), microamps (μA), mega ohms (MΩ) or giga ohms (GΩ).

In the lower part of the instrument's LCD screen displays two data in small fonts:
The left one is the remaining time for the corresponding step during high-voltage testing. If the test time function is disabled by the user, the displayed value represents the elapsed time since entering the test mode, and the count stops incrementing after exceeding 999.9. If the test result is not FAIL, the test mode can only be exited by pressing the [Stop] key. This allows the user to intuitively analyze the test status of the DUT. The unit is seconds (s).

The right one displays the status of the high-voltage test (OFF, RISE, TEST, FALL), along with the upper and lower limit comparison results (PASS, HI FAIL, LOW FAIL) and the alarm status (ARC, SHORT, GFI).

5.2 Test Function Principles and Operating Instruments

Figure 5- 2 Test Flow Chart



5.2.1 Start

When the instrument is in the test mode, check the test conditions. After the DUT is connected correctly, press the **[START]** key to start the test.

5.2.2 Voltage Rise

Some DUTs are sensitive to sudden changes in voltage, so this function is required. When the instrument starts to output, the voltage is zero, and then the control voltage rises steadily at 0.1s each step. The voltage step range is determined according to the test voltage and rise time （ΔV = V / (10 * S)).If the voltage rise time is disabled (RISE OFF), the default voltage rise time is 0.1 seconds.

5.2.3 DC Charge Current Detection

It is mainly used to judge the reliable connection of the DUT. The DUT is generally capacitive.
In DC mode, the distributed capacitance will have a charging process during the voltage rise time (ie, at the beginning of the test), and the current at this time is much larger than the set current under test. The charging current decreases rapidly when it is fully charged, and it can be judged

whether the DUT is reliably connected by judging whether there is a charging AT686A User ‘s Guide current or not. When using this function, set the test waiting time longer than the charging time to avoid misjudgment.

5.2.4 High Pressure Test

Perform a high voltage test on the DUT. At this time, it should be ensured that the test circuit is correct, and the test result will not be affected by some special incidental parameters, which is the actual withstand voltage current required for the test.

5.2.5 Voltage Drop

The rise of the same test voltage is determined by the characteristics of the DUT. When the high-voltage test is over, the current drop, At that time, the instrument will control the output voltage to drop at pace of 0.1s each step. The step-down value is determined according to the test voltage and voltage drop time（ΔV =- V / (10*S)）.
If the voltage fall time is disabled (FAIL OFF), the default voltage fall time is 0.1 seconds.

5.2.6 Electric Wall

The ground wire current detection is to detect the current flowing through the casing of the instrument to prevent electric shock. When the high voltage is output, the current flows back from the voltage output terminal through the human body to the instrument shell, causing serious consequences.
The circuitry response of testing and judging ground wire current of instrument:

- The ground wire current detection is enabled, and when the ground wire current is greater than 0.5mA , it is judged as electric shock.
- When it is judged that there is an electric shock, the instrument will end the high voltage output within 0.3S, exit the test state, and display (GFI)



When the current reaches 30mA, if there is indeed a electric shock, the consequence will be very serious in that it may cause coma or death. Hence, if the product allow, it is suggested that start the ground current detection function

5.2.7 Over-current and ARC Detection Function

Current over-limit classification: current lower limit, current upper limit, current over-limit, arc detection.

- Current lower limit judgment: generally used as a test low-end open circuit judgment. When the instrument tests the equipment, the equipment will have leakage current. When the leakage current tested by the instrument is less than the lower limit set current value, it can be considered that the test fails (no equipment is connected). If the leakage current of the tested element is small, this function must be turned off. Judgment display (LOW FAIL) when the limit is exceeded, this judgment is only valid in test mode. And it is timing sampling at rate of 100ms.
- Current upper limit judgment: When the instrument tests the equipment, when the leakage current of the test equipment is greater than the upper limit set current value, it is considered that the withstand voltage level of the equipment is not enough, and the test fails. Judgment display (HI FAIL) when the limit is exceeded. It is timing sampling at rate of 100ms.
- Current limit judgment: The current sampling judgment is slow, the current changes quickly when the insulation collapses, and the sampling circuit cannot respond immediately. When the current peak value exceeds the allowable output range of the instrument, the limit judgment will be triggered and displayed (SHORT). Because the data cannot be collected after such current exceeds the limit, the system output result is the test result 100ms before the limit is exceeded. The current limit is twice the allowable output constant current of the instrument (AC is 1.5 times the peak value), the fall time is [Meas] Page invalid, and this judgment cannot be masked.
- ARC detection: The test is to test the local current oscillation caused by the instantaneous discharge of the local circuit in the high-voltage test circuit. Since it is superimposed on the normal test current and the mutation time is short, ordinary current detection circuits cannot make appropriate judgments in response to current changes. The arc detection circuit filters out normal current values and only handles high-speed current pulse changes. Due to the randomness of low-pass filtering and arc size, this function can only estimate the extent of

localized sparking. Since the data cannot be collected after the current exceeds the limit, the output result at this time is the last test result when the current is qualified, and it is displayed (ARC) when the limit is exceeded. The ARC current is a qualitative analysis of the test, and the randomness of the effect of the amplitude,test environment,test line distributed capacitance are very big, which make the attention necessary.

5.2.8 Unqualified Judgment

- During the test, if the current exceeds the maximum output current that the instrument can withstand, or the instrument finds that there is a potential safety hazard, the instrument will immediately cut off the voltage output and judge it to be unqualified.
- If the test result exceeds the limit set by the test item, the instrument will determine that the DUT is unqualified, and immediately stop the current test, cut off the voltage output, and deal with the unqualified test result.

5.2.9 Test Result Processing

If the test result is judged to be qualified after the test time, the display (PASS) will be displayed, and the pass indicator will be on. Take the test results as PASS and SHORT as examples below.

Figure 5- 3 Test Result <PASS>



Figure 5- 4 Test Result<SHORT>



5.2.10 List Display

When measuring in multiple steps, the results are displayed in a list

Figure 5- 5 List Display





After a test scheme is completed, the test data can be reviewed though [List Display] on the sidebar of the display page or the setup page.

5.2.11 Stop Test

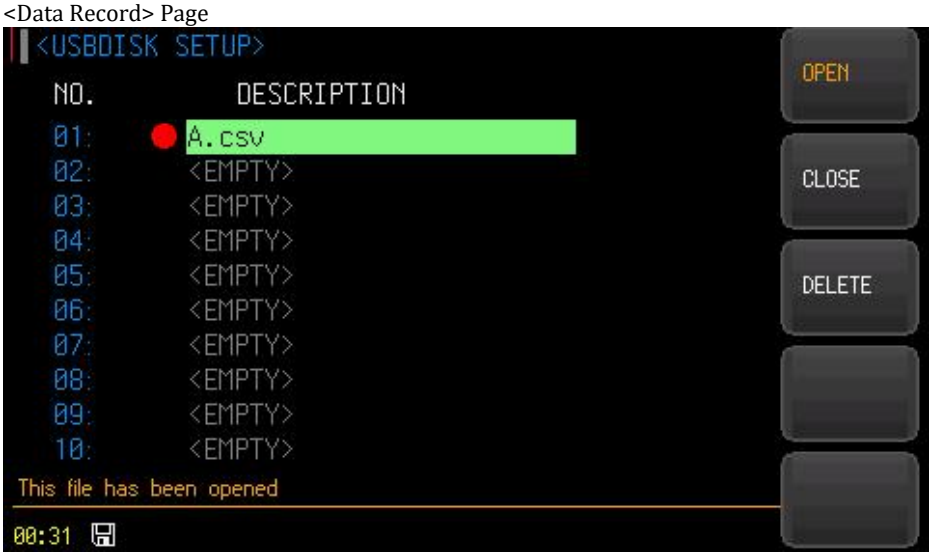
Press the **[STOP]** key during the whole test process, the instrument will end the test,No test result judgment will be output when the test is ended. However, for the post test status, the customer can query the data measured by the instrument before the [STOP] key is pressed though software.

5.3 Data Record

The instrument features USB data recording capability, automatically saving measurement data in.csv format upon test completion. Users can directly access these files via PC using Excel software.

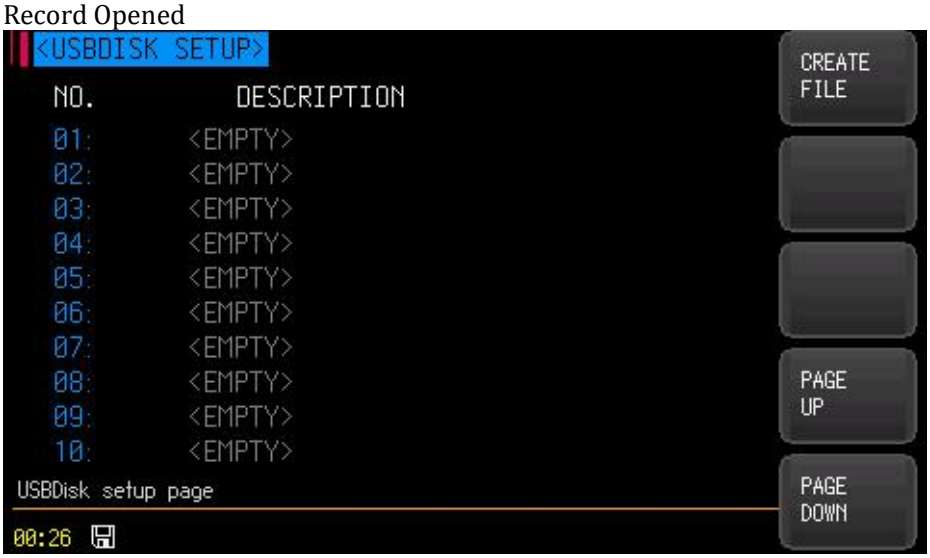
On the <Measurement Display> main page, press the function key to enter the <Data Record> page.

Figure 6- 9 <Data Record> Page



On this page, tap the "Create New Record" button in the right sidebar to create a ".csv" file and name it.
When users need to record measurement data in a table, tap the screen or select the created file with the cursor. After clicking 'Record Open', the instrument will automatically record each test data. A relevant prompt will appear in the lower left corner of the screen after each successful recording.

Figure 6- 10 Record Opened



Note: If the [STOP] button is pressed during testing, the instrument will not record the current date

6. [SYSTEM] Page

This chapter you will learn about the following information：

- <SYSTEM CONFIG>
- <SYSTEM INFORMATION>

In the high voltage stop state, once you press the [MEAS] or [SETUP] key, and the [SYSTEM SETUP] key will show up in the sidebar.

6.1 SYSTEM CONFIG

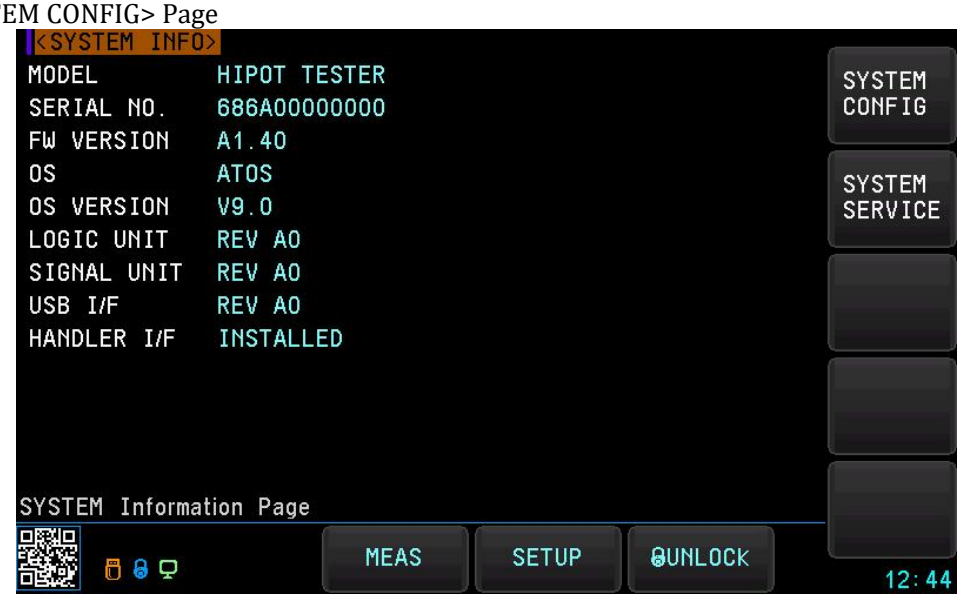
On the【Meas】or【Setup】page，Press the【SYSTEM SETUP】to enter the <SYSTEM CONFIG> page.

The system configuration page includes the following settings：

- LANGUAGE
- DATA/TIME
- ACCOUNT
- BAUD
- GFI

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

Figure 6- 1 <SYSTEM CONFIG> Page



6.1.1 【LANGUAGE】

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

Instrument supports Chinese and English.

■ **Steps to set the language**

Step 1 Enter the <SYSTEM CONFIG>page.

Step 2 Use the cursor key to select the【LANGUAGE】.

Step 3 Use the function key to select the language.

Soft keys	Function
Chinese[CHN]	
ENGLISH	English

6.1.2 Modify【DATA】 and 【TIME】

The instrument uses 24-hour clock format.

■ **Modify Data:**

Step 1 Enter the <SYSTEM CONFIG> page

Step 2 Use the cursor key to select the【DATA】field

Step 3 Use the function key to select:

Soft keys	Function
YEAR INCR+	+1year
YEAR DECR-	-1 year
MONTH INCR+	+1 month
MONTH DECR-	-1 month
DAY INCR+	+1 day
DAY DECR+	-1 day

■ **Modify Time:**

Step 1 Enter the <SYSTEM CONFIG> page

Step 2 Use the cursor key to select the【TIME】field

Step 3 Use the function key to set time:

Soft keys	Function
HOUR INCR+	+1 hour
HOUR DECR-	-1 hour
MINUTE INCR+	+1 minute
MINUTE DECR-	-1 minute
SECOND INCR+	+1 second
SECOND DECR-	-1 second

6.1.3 【ACCOUNT】 Setting

The instrument has two user modes to choose from:

- Administrator - Except the [System Services] page, other functions are open to the administrator, and the parameters set by the administrator are saved in the system memory after a delay of 5 seconds, which is convenient for loading at the next boot.
- User - Except the [System Service] and [File] pages, other functions can be operated by the user, the data modified by the user will not be saved, and the parameter values set by the administrator will be loaded next time the system is powered on.

■ **Step to set the account:**

Step 1 Enter the <SYSTEM CONFIG> page

Step 2 Use the cursor key to select the【ACCOUNT】field

Step 3 Use the function key to change:

Soft Keys	Function
Administrator	Except the [System Services] page, other functions are open to the administrator. If you forget your password, please contact our Sales Department.
User	All functions except the [System Service] and [File] pages are operable; saved settings for modified data are not permitted.

■ **Step to set password for administrator:**

Step 1 Enter the <SYSTEM CONFIG> page

Step 2 Use the cursor key to select the【ACCOUNT】field

Step 3 Use the function key to select

Soft keys	Function
Change password	Input 9 digits numeric password. If you forget the password, please contact our sales department.
Delete password	The administrator account will no longer be protected by a password.

6.1.4 【BAUD】Setting

The instrument has a built-in RS-232 interface. Upon detecting a signal change on the RS-232 interface, the instrument immediately communicates with the host computer at the set baud rate, with the keyboard locked simultaneously.
To ensure proper communication, confirm that the baud rate of the host computer is consistent with that of the instrument; otherwise, communication will not be possible.
The instrument's RS-232 interface is programmed using the SCPI language.

The RS-232 configuration is as follows:

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

Step to set baud rate:

Step 1 Enter the <SYSTEM CONFIG> page

Step 2 Use the cursor keys to select【BAUD】field

Step 3 Use the function key to select

Soft keys	Function
1200	Use this baud rate if you use a communication converter with optocoupler isolation.
9600	
38400	
57600	
115200	For communication with the host computer, it is recommended to use this high speed baud rate.

6.1.5 【Command Handshake】

After the handshake is established, all commands sent by the host to the instrument will be returned to the host in their original form, followed by the data.When the handover is disabled, the host will process the commands sent to the instrument immediately.

■ **Set the procedure for instruction handshake:**

Step 1 Go to the System Configuration page

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

Step 3 Use the function key to select

Function keys	Function
OFF	Do not use command handshake. If there are no special requirements, set command handshake to off.
OPEN	

6.1.6 【Send】

The instrument supports automatic data transmission to the host. After each test, the data is automatically sent to the host without requiring the host to send a FETCH? command.
After each test is completed, the instrument sends the test results and comparator results to the host.

Refer to the FETCH subsystem for the format.

Set the [Result Send] step:

Step 1 Enter the System Configuration page

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

Step 3 Use the function key to select

Function keys	Function
FETCH	Use the FETCH command to retrieve all measurement data
Auto	Automatically send to the host after each test

6.1.7 【Electric Shock Protection】 Switch

Ground current detection (electric wall)

Steps to set up electric shock protection:

Step 1 Enter the System Configuration page

Step 2 Use the cursor keys to select the [Electric Shock Protection] field.

Step 3 Use the function key to select

Function keys	Function
OFF	The firewall function is not enabled
ON	The firewall function is enabled

6.1.8 【Failure Mode】

Failure modes are divided into two categories: "Abort" and "Continue".

■ **Failure mode settings:**

Step 1 Enter the System Configuration page

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

Step 3 Use the function key to select

Function keys	Function
continue	Test steps that fail (only for exceeding upper and lower limits) will terminate the current test step and proceed to the next test step.
Discontinue	If a test step fails during testing, the entire test process will be terminated immediately. Press the 'Start' key to restart the test process.

6.1.9 【Volume Settings】

Set the buzzer volume to alert when testing is complete or abnormal.

■ **Sound volume settings:**

Step 1 Enter the System Configuration page

Step 2 Use the cursor keys to select the Volume Settings field.

Step 3 Use the function key to select

Function key	Function
high pitch	High-pitched alert when testing completes or encounters an exception
low pitch	Low-frequency notification when testing completes or encounters an exception
close	No sound notification is displayed when testing is completed or an exception occurs

6.1.10 【Trigger Mode】

Set the instrument to start testing in the control mode, accepting only trigger signals under the current control mode.

■ **Trigger mode settings:**

Step 1 Enter the System Configuration page

Step 2 Use the cursor keys to select the Trigger Mode field.
Step 3 Use the function key to select

Function key	Function
LOCAL	Controlled by the [Start] button on the instrument's front panel
PLC	Controlled by the control signal provided by HANDLER
BUS	Control commands are sent via RS232/485.

6.1.11 【Result Display】

The results show that the item can be divided into two modes: single step test and group test.

■ **Display settings：**

Step 1 Enter the System Configuration page
Step 2 Use the cursor keys to select the [Show Results] field.
Step 3 Use the function key to select

Function key	Function
Single-step test results	After completing the test flow, the test results remain at the failure step or the first step.
Group test results	After completing the test process, the test results for each step within the test group are displayed in a list format.

6.2 SYSTEM INFORMATION

On the [MEAS] or [SETUP] page, press the [SYSTEM SETUP] key to enter the <SYSTEM CONFIG> page,press [SYSTEM INFO] key to enter <SYSTEN INFORMATION> page. There are no configurable options in the <SYSTEM INFORMATION> page.

Figure 6- 2 <SYSTEM INFORMATION>Page



7. [FILE] Page

You will learn the following in this chapter:

- Media
- Recall
- Save
- File set

User can save up to 10 files to internal non-volatile memory.

7.1 [FILE] Page

On the【Meas】or【Setup】page，Press the【FILE SETUP】to enter the <FILE>page.

Figure 7- 1 <FILE>Page



On this page, placing the cursor on the corresponding field can set the following controls:

- Select files from instrument internal memory or external USB stick
- Recalling files at instrument startup

7.1.1 MEDIA

The memory function is to select files from the instrument memory or external U disk. Up to 10 files can be accessed.

■ **Step to modify the media**

Step 1 Enter the <FILE> page

Step 2 Use the cursor keys to select【MEDIA】field

Step 3 Use the function key to select

Soft keys	Function
Internal	Access instrument memory files
External	Access external USB drive files

7.1.2 RECALL

Recall FILE0 or the current file when the instrument is powered on.

■ **Step to set the recall:**

Step 1 Enter the <FILE> page

Step 2 Use the cursor keys to select【RECALL】field

Step 3 Use the function key to select

Soft keys	Function
LAST FILE	Recall the last used file at boot
FILE 0	Recall FILE0 at boot

7.1.3 [FILE] Setting

■ **Step to set the file:**

Step 1 Enter the <FILE> page

Step 2 Use the cursor keys to select【FILE Name: 0~9】field

Step 3 Use the function key to select

Soft keys	Function
SAVE	Save user settings data to the currently selected file
RECALL	Load setup data from the currently selected file
DELETE	Delete the selected file, and restore the default value of the setting data next time you start up
MODIFYDES	Modify file description

8. Handler（PLC）

You will learn the following in this chapter：

- Terminals
- How to connect and Interface schematic

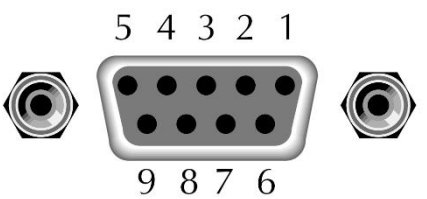
The instrument provides users with a wealth of processor interfaces. Through this interface, the instrument can easily complete the automatic control function with the user's system control components.

8.1 Terminals and Signals

This series of testers features a 9-PIN to 25-PIN adapter cable that provides PLC remote control input/output signals (compatible with PLC controllers), as shown in the diagram. The connection terminals are designed to match standard 25-PIN D-type connectors, which must be provided by the user.

For optimal performance, shielded cables are recommended for both control and output connections. To prevent the shielded cable from forming a loop that compromises shielding effectiveness, only one end of the shielded cable should be grounded.

Figure 8- 1 Terminals



To use the HANDLER function, set the Trigger Mode to PLC in the Instrument <System Configuration>. If not, the HANDLER function will not work. When the Trigger Mode is PLC, the 'Start' button on the front panel will be disabled to prevent dangerous repeated startups.

Table 8- 1 Definition of Each Pin on PLC Port

Input/output	pin	name	illustration
signal input	4	START	Press the START button to receive remote input signals and initiate the instrument's measurement.
	5	STOP	Press the STOP button to receive remote input signals and halt the measurement.
signal output	6	TEST1	During the instrument measurement, TEST1 and TEST2 short-circuited; after testing, TEST1 and TEST2 were open-circuited.
	1	TEST2	
	7	PASS1	When the test passes, PASS1 and PASS2 are short-circuited.
	2	PASS2	
	8	FAIL1	When the test fails, a short circuit occurs between FAIL1 and FAIL2.
	3	FAIL2	

All input signals must be switch quantities (e.g., PLC). Do not connect any external voltage or current sources, as this may damage the instrument's internal control circuitry or cause malfunctions.

8.2 Connection Method

- Interface principle

Figure 8- 2 Handler Interface Internal Circuit Structure

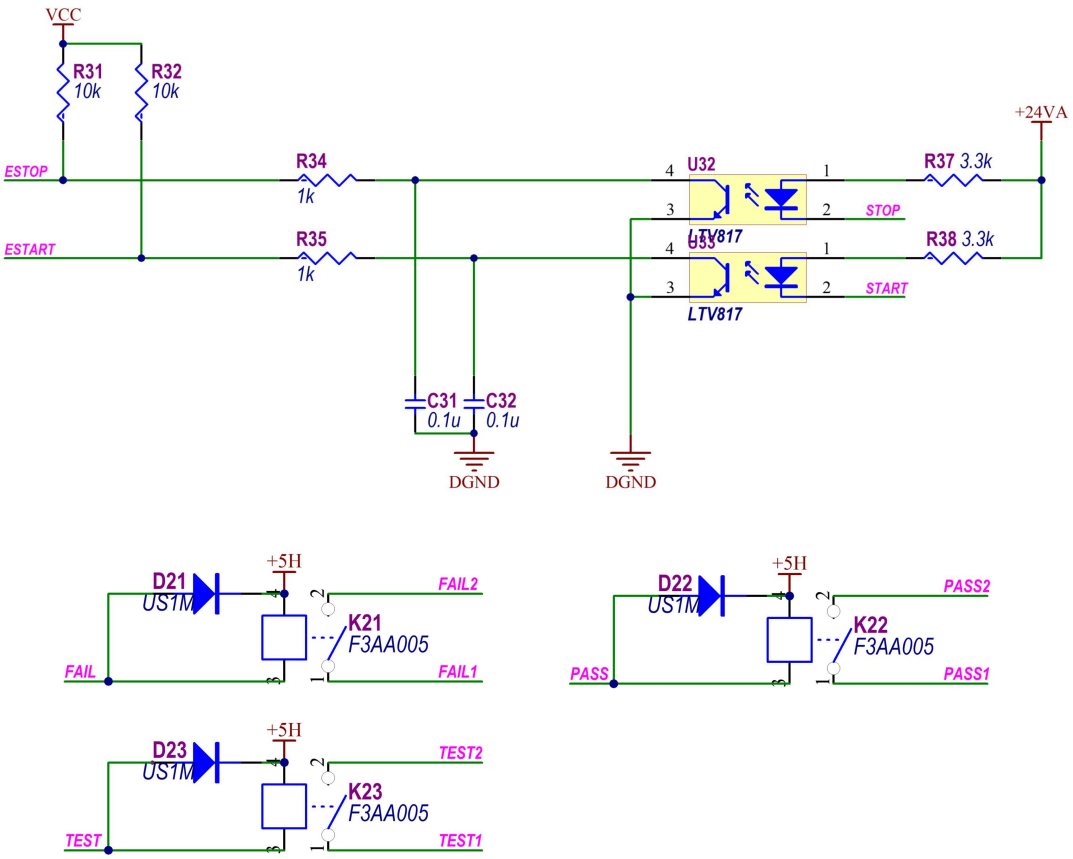
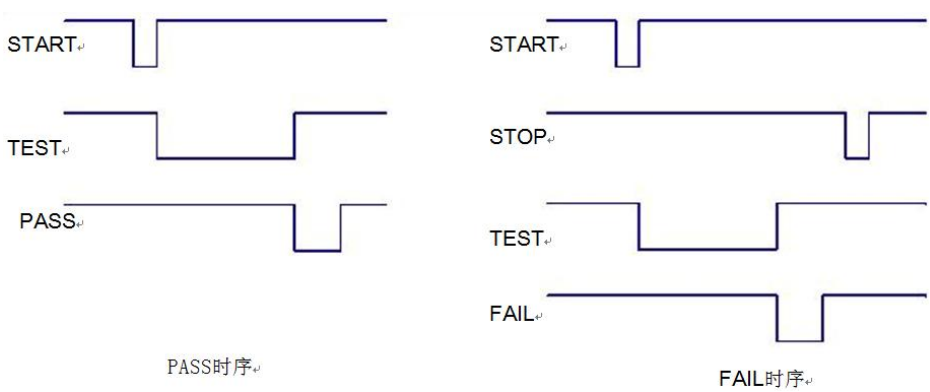


Figure 8- 3 Handler Interface Default Test Timing



- Instrument Interface Usage

The control interface is generally used for remote control and test synchronization or indication.

Table 8- 2 PLC Timing Specification

Signal	Illustration
Start the test with the PLC port	1. Verify the TEST (Testing) signal in the interface. The START signal can only be sent when the TEST (Testing) signal is invalid. 2. When the conditions specified in Article 1 are met, send a START signal with a transmission duration of 40ms to 200ms (i.e., the switch closing time) to initiate the test.
Stop testing via PLC port	To terminate the test at any time, simply send a STOP signal with a duration of 40ms to 200ms (i.e., the switch's closed time).
Signal output—testing	When the instrument is being tested, the relay connects PIN10 and PIN22. After testing is complete, the relay disconnects PIN10 and PIN22.
Signal output—test passed	When the test object passes the test, the relay connects PIN11 and PIN23, maintaining the state. When another test program begins or the stop switch is pressed, the relay disconnects PIN11 and PIN23.
Signal output—test failed	When the test fails, the relay connects PIN12 and PIN24, maintaining the state. When another test begins or the stop switch is pressed, the relay disconnects PIN12 and PIN24.

Instruction：

1.Switches can be replaced by isolated switching elements such as optocoupler secondary side, and the current direction refers to the principle above (COM terminal is low-end).

2.The indicator light here can be replaced by other drive control components, and the current direction depends on the power supply.

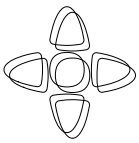
3.Instrument internal power performance:

a) DC voltage output +24V

b) The maximum instantaneous current should not be greater than 1A, and the stable working current should be less than 0.5A. Please bring your own power supply if you need a large current.

c) If the external control voltage is greater than 220V voltage or 2A current, the internal relay of the instrument cannot bear it, please transfer it by yourself.

9. Remote Control



You will learn the following in this chapter:

- About RS-232
- RS-232 connection
- Select baud rate
- Software protocol

The instrument communicates with a computer though its standard RS-232 interface to implement all instrument functions. With standard SCPI commands, users can also easily program various data acquisition systems tailored to their own needs.

9.1 RS-232C

RS-232 is a widely adopted serial communication standard at present, also known as an asynchronous serial communication standard. It is used to realize data communication between computers, as well as between computers and peripheral devices. RS is the abbreviation of "Recommended Standard", and 232 is the standard number. This standard was officially released by the Electronic Industries Alliance (EIA) of the United States in 1969. It specifies that data is transmitted bit by bit through a single data line.

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

Table 9- 1 Common RS-232 Signal

Signal	Symbol	DB-25	DB-9
Request to Send	RTS	4	7
Clear to Send	CTS	5	8
Data Set Ready	DSR	6	6
Data Carrier Detect	DCD	8	1
Data Terminal Ready	DTR	20	4
Transmit Data	TXD	2	3
Receive Data	RXD	3	2
Ground	GND	7	5
Request to Send	RTS	4	7

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

Table 9- 2 RS-232 Minimum Subset Of Standards

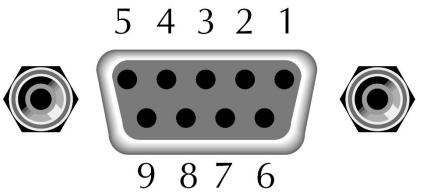
Signal	Symbol	DB-9
Transmit Data	TXD	2
Receive Data	RXD	3
Ground	GND	5

9.1.1 RS232C Connection

You can connect a controller (i.e. PC and PLC) to the RS-232 interface using Applent RS-232 DB-9 cable.

NOTE:
The instrument cannot use cable null modem.
You can directly make or purchase a 9-core straight-through cable from Applent Instruments format.
User-made 3-wire cable should pay attention to:
Using the DB9 port of PC, it may be necessary to short the 4-6 and 7-8 of the DB-9 connector (pin) on the computer side.

Figure 9- 1 The RS-232 Connector in the Rear Panel



Suggestion: To avoid electrical shock, turn off the instrument power supply before inserting or removing the connector.

- Default communication settings of the instrument:
  Transmission mode: Full-duplex Asynchronous communication with start bit and stop bit
  Data bit: 8-bit
  Stop bit: 1-bit
  Parity bit: None

9.2 Handshake Protocol

Because the instrument uses the minimum subset of RS-232 standard and does not use hardware handshake signal, in order to reduce the possible data loss in communication. Or data error, the instrument can enable software handshaking, and the senior language software engineer should strictly follow the following handshaking protocol to perform computer.

Compilation of communication software:

- The instrument command parser only accepts ASCII format, and the command response also returns ASCII code.
- The command string sent by the host must end with NL ('\ n'), and the instrument command parser will not start executing the command string until it receives the end.
- The instrument can set instruction handshake: the instrument immediately sends the character back to the host after receiving each character, and the host can only continue to send the next character after receiving the returned character.

Tip: If the host cannot receive the data returned by the instrument, you can use the following methods to try to solve it:
1. The software handshake is turned off. Please refer to the instrument < System Settings > page to turn it on.
2. Serial port connection failure, please check the cable connection.。
3. The communication format of the computer-side high-level language program is wrong. Please try to check whether the serial port number, communication format and baud rate are correct or not.
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 can't be solved, please consult Applent Instrument Technical Engineer immediately.>

9.3 SCPI Language

Standard Commands for Programmable Instruments (SCPI) is a kind used by Amber Instruments. General command set for testing instruments. SCPI is also called TMSL-Test and Measurement System Language. Developed by Agilent Technologies according to IEEE488.2, it has been widely used by test equipment manufacturers.

Reference:

The built-in command parser of the instrument is responsible for parsing various command formats of users. Because the command parser is based on SCPI protocol, but it is not completely consistent with SCPI,
please read the chapter "SCPI command reference" carefully before starting work.

9.4 LAN

To facilitate remote control of the instrument, the instrument also provides LAN function, LAN is a local area network connection, you can let your computer and the instrument through the same network connection, remote control function.

Enter the <SYSTEM CONFIG> page, use the function key or use the cursor key to select [LAN], and click to Switch to the ,<LAN> page.

Figure 9- 2 LAN



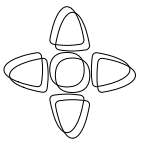
Parameters	Description
MAC	Physical address, which uniquely identifies the device
IP	Logical addresses, which are used to locate and communicate in the network
PORT	The connection point between the pressure gauge and the network device
NET MASK	A dividing line used to separate network addresses from host addresses
GATEWAY	Connect devices of different networks for data forwarding

Through the [LAN] function, you can connect the voltage gauge to the local area network through the LAN port to realize remote communication and data exchange with other equipment. Here's how to use it:

(1) Ensure that the LAN port of the voltage gauge is connected to the switch or router in the LAN normally
(2) Configure the correct IP address, network mask and gateway in the <LAN> page of the voltage gauge to ensure that it is in the same network segment as other devices in the LAN

Open the network connection assistant, set the protocol type, IP address and port number, and click the connection to communicate.

10. SCPI Command Reference



You will learn the following in this chapter:

- Command Parser - Learn about the rules of the command parser.
- Command Syntax - Writing rules for command lines
- Query Syntax - Writing rules for query commands
- Query Response - Format of query responses
- Command Reference

This Chapter provides all the SCPI commands used by the instrument, and by these SCPI commands give complete control of all functions of the instrument.

10.1 Command String Parsing

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

For example:

Legal command String：

AAA:BBB CCC;DDD EEE;:FFF

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

10.1.1 Command Parsing Rule

1. The command parser only parses and responds to ASCII code data.
2. The SCPI command string must end with NL ('\ NL(‘ \n' ASCII 0x0A), and the command parser will not start executing the command string until it receives the end or the buffer overflows.
3. If the instruction handshake is turned on, the command parser will immediately send the character back to the host after receiving each character, and the host can only continue to send the next character after receiving this echo character.
4. The command parser immediately terminates the parsing after parsing the error, and the current instruction is invalid.
5. After the command parser parses the query command, it terminates the parsing of this command string, and then the string is ignored.
6. The command parser is case-insensitive.
7. The command parser supports command abbreviations. Please refer to the following chapter for abbreviation specifications.

10.1.2 Symbol Convention and Definition

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

< > Text in the pointed brackets indicates the parameters of the command

[ ] Text in square brackets indicates optional commands

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

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

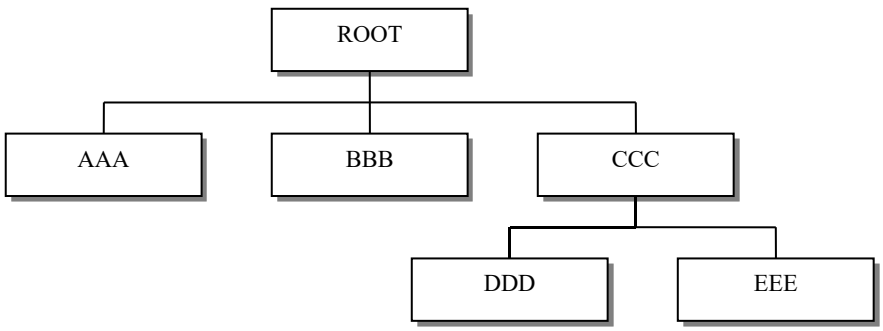
Capital letter The abbreviated form of the capital letter command.

10.1.3 Command Tree Structure

If the SCPI command adopts a tree structure, it can go down to three levels (note: the

command parser of this instrument can parse any layer down), and the highest level here is called subsystem command. Only when a subsystem command is selected, its subordinate command is valid. SCPI uses a colon (:) to separate high-level commands from low-level commands.

Figure 10- 10- 1 Command Tree Structure



For 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 commands and [parameters] separated by a space (ASCII: 20H)

For example

AAA:BBB 1.234
Command [Parameter]

10.2.1 Command

Command words can be in long command format or abbreviated form. Using long format is convenient for engineers to better understand the meaning of command string. Abbreviated forms are suitable for writing.

10.2.2 Parameter

- Single command word command,no parameters.
  For example：AAA:BBB
- Parameters can be in the form of strings, and their abbreviation rules still follow the “command abbreviation rules” in the previous section.
  For example：AAA:BBB 1.23
- Parameters can be in numerical form.
  - <*integer*> Integer 123，+123， -123
  - <*float*> Floating point number
    1. <fixfloat>：Fixed point floating point number：1.23，-1.23
    2. <Sciloat>：Floating point number by scientific counting method ：1.23E+4，+1.23e-4
    3. <mpfloat>: Floating point number expressed by magnification ：1.23k，1.23M，1.23G，1.23u

Table 10- 1 Multiplication Condensation

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

Tip: the magnification is case-insensitive, and its writing is different from the standard name.

10.2.3 Separator

The instrument command parser only accepts allowed delimiters, and the other delimiters will generate an “Invalid separator”error. These delimiters include:

; Semicolon, used to separate two commands.
For example：AAA:BBB 100.0;CCC:DDD

: Colon, used to separate the command tree, or command tree restart.
For example：AAA:BBB:CCC 123.4;:DDD:EEE 567.8

? Question mark, used for query
For example：AAA?

□ Spaces, used to separate parameters.
For example：AAA:BBB□1.234

10.3 Command Reference

All commands are explained in subsystem command order, all subsystems are listed below.

- DISPlay Display subsystem
- FUNCtion Function subsystem
- FETCh Get results subsystem
- FILE File management subsystem
- SYSTem System subsystem

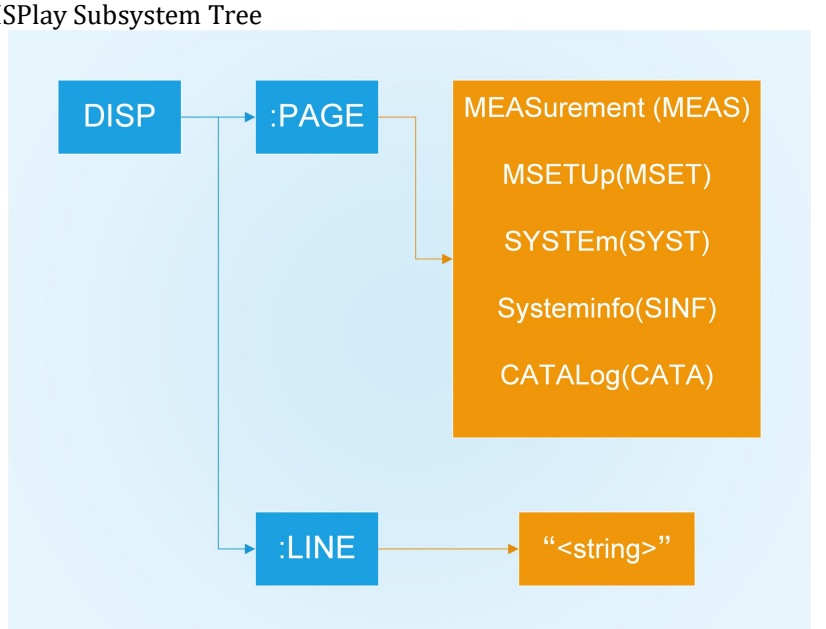
Public Order：

- IDN? Instrument information query subsystem

10.4 DISPlay Display Subsystem

DISPlay subsystem Can be used to switch between different display pages or to display text on the page tool tip.

Figure 10- 10- 2 DISPlay Subsystem Tree



10.4.1 DISPlay:PAGE

DISP:PAGE used to switch to the specified page

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

Parameter: <page name> include:

MEASurement	Measure Display
MSETUp	Setup Display
SYSTem	System Display
SYSTEMINFO(SINF)	system Information
CATALog(CATA)	File Display

For example: send> **disp:page mset**<NL> //switch to setting page

Query Syntax: **DISP:PAGE?**

Query Response:

<page name> abbreviation
ACW MEAS
DCW MEAS
IR MEAS
SETUP
SYST
SINF
CATA

For example: Send> **disp:page?**<NL>
return> **SETUP**<NL>

10.4.2 DISP:LINE

DISP:LINE Used to display text in the prompt bar at the bottom of the page, up to 30 characters.

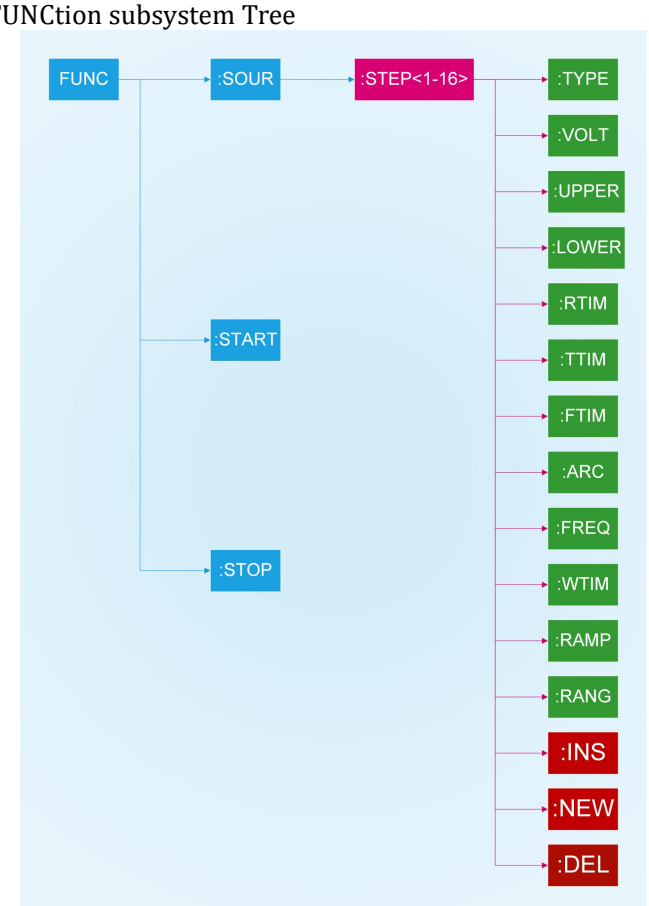
Command Syntax: **DISPlay:LINE <*string*>**

Parameter: **<string> up to 30 characters**

For example: send> **DISP:LINE "This is a Comment."**<NL>

10.5 FUNCtion Subsystem

Figure 10- 10- 3 FUNCtion subsystem Tree



10.5.1 High Voltage Start/Stop Command Set

FUNC:START used to starting high voltage output

Command Syntax: `FUNCtion:STARt`

For example: send> `FUNC:STARt<NL>` //Start the test , the function is equivalent yo the [START] button

FUNC:STOP used to stop high voltage output

Command Syntax: `FUNCtion:STOP`

For example: send> `FUNC:STOP<NL>` //Stop the test , the function is equivalent yo the [STOP] button

10.5.2 Test Step Instruction Set

FUNC:SOUR:STEP? Used to query the current test steps and the total test steps

Query Syntax: `FUNC:SOUR:STEP?`

Query Response: **Current Step – Total Steps**
`STEP <1-16> - TOTAL <1-16>`

For example: send> `FUNC:SOUR:STEP?<NL>`
return> `STEP 5 - TOTAL 11 <NL>`

FUNC:SOUR:STEP1:INS add a new test item to an existing test plan

Command Syntax: `FUNC:SOUR:STEP:INS`

For example: send> `FUNC:SOUR:STEP:INS <NL>` //add a new test item

FUNC:SOUR:STEP1:DEL delete the current test project within an existing test plan

Command Syntax: `FUNC:SOUR:STEP:DEL`

For example: send> `FUNC:SOUR:STEP:DEL <NL>` //delete the current test project

FUNC:SOUR:STEP1:NEW crate a new empty test plan to write a new test plan

Command Syntax: `FUNC:SOUR:STEP:NEW`

For example: send> `FUNC:SOUR:STEP:NEW <NL>` //crate a new empty test plan

10.5.3 Function Parameter Instruction Set

FUNC:SOUR:STEP<1-16>: TYPE In an existing test plan,set the function of the current test step.

Command Syntax: `FUNC:SOUR:STEP<1-16>:TYPE {ACW,DCW,IR}`

For example: send> `FUNC:SOUR:STEP5:TYPE IR<NL>` //Under the premise of total steps ≥5,set the function of step 5 to IR

Query syntax: `FUNC:SOUR:STEP<1-16>:TYPE?`

Query Response: `{ACW,DCW,IR}`

FUNC:SOUR:STEP<1-16>: VOLT In an existing test plan,set the voltage of the current test step

Command Syntax: `FUNC:SOUR:STEP<1-16>:VOLT <float>`

Parameter: <float>（data unit is kV）:
ACW : 0.050 - 5.000，Without unit
DCW : 0.050 - 6.000，Without unit
IR : 0.050 - 1.000，Without unit

For example: send> `FUNC:SOUR:STEP5:VOLT 1<NL>` //Under the premise of total steps ≥5,set the Voltage of step 5 to 1kV

Query Syntax: `FUNC:SOUR:STEP<1-16>:VOLT?`

Query Response: <float>:
ACW : 0.050 - 5.000，With unit
DCW : 0.050 - 6.000，With unit
IR : 0.050 - 1.000，With unit

For example: send> **FUNC:SOUR:STEP5:VOLT?**<NL>
return> **1.000KV** <NL>

FUNC:SOUR:STEP<1-16>: UPPER In an existing test plan,set the upper of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:UPPER <float>**

Parameter: **<float>** (data unit is mA / MΩ) :
ACW : 0.001 - 10.00, Without unit
DCW : 0.001 - 5.000, Without unit
IR : 0 , 0.1 - 1E4 , Without unit (Where 0 means the upper limit is OFF)

For example: **send> FUNC:SOUR:STEP5:UPPER 1**<NL> //Under the premise of total steps ≥5,set the upper of step 5 to 1mA

Query Syntax: **FUNC:SOUR:STEP<1-16>:UPPER?**

Query Response: **<float>**:
ACW : 0.001 - 10.00, With unit
DCW : 0.001 - 5.000, With unit
IR : OFF, 0.1 - 1E4 , With unit

For example: send> **FUNC:SOUR:STEP5:UPPER?**<NL>
return> **1.000mA** <NL>

FUNC:SOUR:STEP<1-16>: LOWER In an existing test plan,set the lower of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:LOWER <float>**

Parameter: **<float>** (data unit is mA / MΩ) :
ACW: 0, 0.001 - 10.00, Without unit (Where 0 means lower limit OFF)
DCW : 0, 0.001 - 5.000, Without unit (Where 0 means lower limit OFF)
IR : 0.1 - 1E4 , Without unit

For example: **send> FUNC:SOUR:STEP5:LOWER 0.1**<NL> //Under the premise of total steps ≥5,set the lower of step 5 to 0.1mA

Query Syntax: **FUNC:SOUR:STEP<1-16>:LOWER?**

Query Response: **<float>**:
ACW : OFF, 0.001 - 10.00, With unit
DCW: OFF, 0.001 - 5.000, With unit
IR : 0.1 - 1E4 , With unit

For example: send> **FUNC:SOUR:STEP5:LOWER?**<NL>
return> **0.100mA** <NL>

FUNC:SOUR:STEP<1-16>: RTIM In an existing test plan,set the rise time of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:RTIM <float>**

Parameter: **<float>** (data unit is S) :
Synthetic floating point number, 0, 0.1 - 999.9, Without unit

For example: **send> FUNC:SOUR:STEP5:RTIM 10**<NL> //Under the premise of total steps ≥5,set the rise time of step 5 to 10s

Query Syntax: **FUNC:SOUR:STEP<1-16>:RTIM?**

Query Response: **<float>** (data unit is S) :
Synthetic floating point number, OFF, 0.1 - 999.9, With unit

For example: send> **FUNC:SOUR:STEP5:RTIM?**<NL>
return> **10.0s** <NL>

FUNC:SOUR:STEP<1-16>: TTIM In an existing test plan,set the test time of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:TTIM <float>**

Parameter: **<float>** (data unit is S) :
Synthetic floating point number, 0, 0.1 - 999.9, Without unit (0 means continuous testing)

For example: **send> FUNC:SOUR:STEP5:TTIM 10**<NL> //Under the premise of total steps ≥5,set the test time of step 5 to 10s

Query Syntax: **FUNC:SOUR:STEP<1-16>:TTIM?**

Query Response: **<float>**（data unit is S）:

Synthetic，OFF，0.1 - 999.9，With unit

For example: send > **FUNC:SOUR:STEP5:TTIM?**<NL>

return> **10.0s** <NL>

FUNC:SOUR:STEP<1-16>：FTIM In an existing test plan,set the fall time of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:FTIM <float>**

Parameter: **<float>**（data unit is S）:

Synthetic floating point number，0，0.1 - 999.9，Without unit

For example: send> **FUNC:SOUR:STEP5:FTIM 10**<NL> //Under the premise of total steps ≥5,set the fall time of step 5 to 10s

Query Syntax: **FUNC:SOUR:STEP<1-16>:FTIM?**

Query Response: **<float>**（data unit is S）:

Synthetic floating point number，OFF，0.1 - 999.9，With unit

For example: send> **FUNC:SOUR:STEP5:FTIM?**<NL>

return> **10.0s** <NL>

FUNC:SOUR:STEP<1-16>：ARC In an existing test plan,set the ARC level of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:ARC < *int* >**

Parameter: **< int>**:

Integer，0 - 9，Without unit （ This function is not available under **IR** ; 0 = OFF）

For example: send> **FUNC:SOUR:STEP5:ARC 1**<NL> //Under the premise of total steps ≥5,set the ARC level of step 5 to 1

Query Syntax: **FUNC:SOUR:STEP<1-16>ARC?**

Query Response: **<int>**:

Integer，OFF，1 - 9，With unit

For example: send> **FUNC:SOUR:STEP5:ARC?**<NL>

return> **LEVEL 1** <NL>

FUNC:SOUR:STEP<1-16>：FREQ In an existing test plan,set the frequency of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:FREQ < *int* >**

Parameter: **< int>**:

Integer，50 / 60，Without unit （Only available under **ACW**）

For example: send> **FUNC:SOUR:STEP5:FREQ 60**<NL> //Under the premise of total steps ≥5,set the frequency of step 5 to 60Hz

Query Syntax: **FUNC:SOUR:STEP<1-16>FREQ?**

Query Response: **<int>**:

Integer，50 / 60，With unit

For example: send> **FUNC:SOUR:STEP5:FREQ?**<NL>

return> **60HZ** <NL>

FUNC:SOUR:STEP<1-16>：WTIM In an existing test plan,set the waiting time of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:WTIM <float>**

Parameter: **<float>**（data unit is S）:

Synthetic floating point number，0，0.1 - 999.9，Without unit（Only available under **DCW**）

For example: send> **FUNC:SOUR:STEP5:WTIM 10**<NL> //Under the premise of total steps ≥5,set the waiting time of step 5 to 10s

Query Syntax: **FUNC:SOUR:STEP<1-16>:WTIM?**

Query Response: **<float>**（data unit is S）:

Synthetic floating point number，OFF，0.1 - 999.9，With unit

For example: send> **FUNC:SOUR:STEP5:WTIM?**<NL>

return> **10.0s** <NL>

FUNC:SOUR:STEP<1-16>: RAMP In an existing test plan,set the boost judgment of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:RAMP {ON,OFF} (Only available under DCW)**

For example: send> **FUNC:SOUR:STEP5:RAMP ON**<NL> //Under the premise of total steps ≥5,set the RAMP of step 5 to on

Query Syntax: **FUNC:SOUR:STEP<1-16>:RAMP?**

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

FUNC:SOUR:STEP<1-16>: RANG In an existing test plan,set the rang of the current test step

Command Syntax: **FUNC:SOUR:STEP<1-16>:RANG <int> (Only available under IR)**

Parameter: **<int>**:

Integer, 0 - 5, Without unit (Where 0 is AUTO , 5 is 5mA, 4 is 1mA, 3 is 100uA, 2 is 10uA, 1 is 1uA)

For example: send> **FUNC:SOUR:STEP5:RANG 1**<NL> //Under the premise of total steps ≥5,set the range of step 5 to 5mA

Query Syntax: **FUNC:SOUR:STEP<1-16>:RANG?**

Query Response: **<int>**:

Integer, AUTO, 1 - 5, With unit

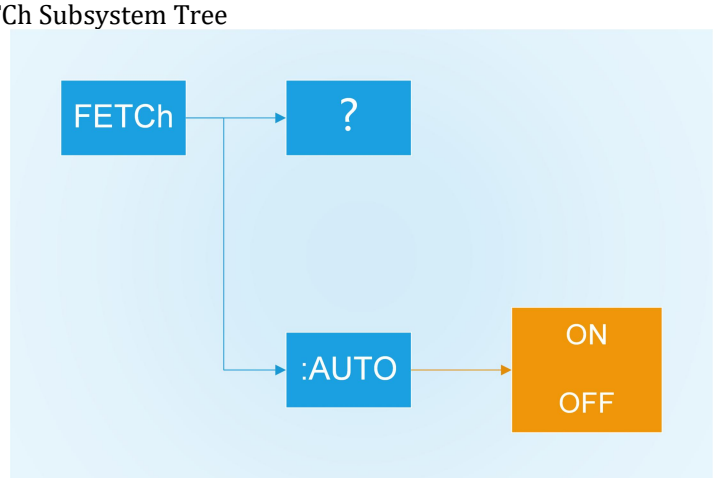
For example: send> **FUNC:SOUR:STEP5:RANG?**<NL>

return> **NOM: Range_1mA** <NL>

10.6 FETCh Subsystem

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

Figure 10- 4 FETCh Subsystem Tree



FETCh:AUTO Set whether the result of each measurement by the instrument is returned.

Command syntax: **FETCh:AUTO {ON,OFF}**

For example: send> **FETCh:AUTO ON**<NL> //Automatic transmission of each measurement result

Query syntax: **FETCh?**

For example: send> **FETC?** <NL>

return> IR,0.050kV,34.59MΩ,PASS;ACW,0.050kV,0.000mA,PASS; <NL> //The instrument returns the result of each measurement.

10.7 FILE Subsystem

FILE subsystem commands are used to perform file operations.

Figure 10- 5 FILE Subsystem Tree

FILE	*:SAVE*	*<File NO.>*
	:LOAD	*<File NO.>*
	:DELete	*<File NO.>*

10.7.1 FILE?

FILE？Command is used to query the file number used by the system.

Query syntax: **FILE?**

Query Response: **<int>**:

Integer，0 – 9，File Number

For example:

send> **FILE?**<NL>

return> 1<NL>

10.7.2 FILE:SAVE <n>

FILE:SAVE command is used to save the user setting to the current file.

Command Syntax: **FILE:SAVE**

For example: send> **FILE:SAVE**<NL>

FILE:SAVE <n>command is used to save the user setting to the specified file.

Command Syntax: **FILE:SAVE <n>**

Parameter: **<int>**:

Integer，0 - 9，

For example: send> **FILE:SAVE 1**<NL>

10.7.3 FILE:LOAD <n>

FILE:LOAD command is used to load all user setting from the currently used file.

Command Syntax: **FILE:LOAD**

For example: send> **FILE:LOAD**<NL>

FILE:LOAD <n> command is used to load all user setting from the specified file

Command Syntax: **FILE:LOAD <n>**

Parameter: **<int>**:

Integer，1 - 10，

For example: send> **FILE:LOAD 1**<NL>

10.7.4 FILE:DELete <n>

FILE: DELete command is used to delete all user setting from the currently use file.

Command Syntax: **FILE: DELete**

For example: send> **FILE: DELete** <NL>

FILE: DELete <n>command is used to delete all user setting from the specified file.

Command Syntax: **FILE: DELete <n>**

Parameter: **<int>**:

Integer，1- 10，

For example: send> **FILE: DELete 1**<NL>

10.8 SYSTem Subsystem

SYSTem subsystem used to set system-related parameters.
SYSTem subsystem set data is not kept together internally

Figure 10- 6 SYSTem Subsystem Tree

SYSTem	*:LANGuage*	*{ENGLISH,CHINESE,EN,CH}*
	:GFI	*{ON,OFF}*
	:BEEP	*{ON,OFF}*

10.8.1 SYSTem:LANGuage

SYST:LANG Set Language

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

For example: send> **SYST:LANG EN**<NL> //Set to display in English

Query Syntax: **SYST:LANG?**

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

10.8.2 SYSTem:GFI

SYST:GFI Set electric shock protection status.

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

For example: send> **SYST:GFI ON**<NL>//Set electric shock protection on

Query Syntax: **SYST:GFI?**

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

10.8.3 SYSTem:BEEP

SYST:GFI Set beep

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

For example: send> **SYST:BEEP ON**<NL> //Set beep on

Query Syntax: **SYST:BEEP?**

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

10.9 WRITEPARA

WRITEPARA Used to set step parameters

Command Syntax:

WP <STEP,ACW,VOLT,TIME,RISETIME,FALLTIME,HIGH,LOW,ARC,FREQ>
WP <STEP,DCW,VOLT,TIME,RISETIME,FALLTIME,HIGH,LOW,ARC,CHG,RUPPER>
WP <STEP,IR,VOLT,TIME,RISETIME,FALLTIME,HIGH,LOW,RANGEMODE,CHG>

Example:

send> **WP 1,DCW,1000.0,1.0,0.5,0.5,5.0,1.0,0,1,1**<NL>
// Set Step 1 Function to DCW, Voltage 1000V, Test Time 1s, Rise Time 0.5s, Fall Time 0.5s, Upper 5mA, Lower 1mA, ARC Level 0, Charge Lower 1uA, Enable Rise Upper Limit

send> **WP 1,ACW,1000,1.0,0.5,0.5,1,0.1,0,0**<NL>
// Set Step 1 Function to ACW, Voltage 1000V, Test Time 1s, Rise Time 0.5s, Fall Time 0.5s, Upper 1mA, Lower 0.1mA, ARC Level 0, Frequency 50Hz

send> **WP 1,IR,1000,1.0,0.5,0.5,1000.0,1.0,1,1.0**<NL>
// Set Step 1 Function to IR, Voltage 1.0kV, Test Time 1s, Rise Time 0.5s, Fall Time 0.5s, Upper 1000MΩ, Lower 1MΩ, Range Mode NOM, Charge Lower 1uA

10.10 READPARA

Query Syntax: **RP? <STEP>**

Response: <ACW>,<VOLT>,<TIME>,<RISETIME>,<FALLTIME>,<HIGH>,<LOW>,<ARC>,<FREQ>
<DCW>,<VOLT>,<TIME>,<RISETIME>,<FALLTIME>,<HIGH>,<LOW>,<ARC>,<CHG>,<RUPPER>
<IR>,<VOLT>,<TIME>,<RISETIME>,<FALLTIME>,<HIGH>,<LOW>,<RANGEMODE>,<CHG>

Example: send> **RP? 1** <NL>
ret> **DCW,300.00,1.0,0.5,0.5,10.0000,1.0000,0,0.0,0**<NL>

10.11 READDATA

Query Syntax: **RD? <STEP>**

Response: **<STEP>,<FUNC>,<VOLT>,<CUR>,<STATE>,<TIME>,<LOAD>**
STEP: STEP 1~16
FUNC: ACW,DCW,IR
VOLT: Test Voltage Value
CUR: ACW,DCW: Current Value，IR: Resistance Value
STATE: Test Status
0->Idle State

3->Voltage Ramp-Up
4->Voltage Testing
5->Voltage Ramp-Down
Test Result Status
6->PASS Test Passed
7->SHORT Short Circuit Protection
8->ARC Arc Protection
9->GFI Ground Fault Interrupt
10->BREAKDOWN Breakdown Protection
11->ERROR Amplifier Board Error
12->OV Over-voltage Protection (
13->UPPER Exceeds Upper Limit
14->LOWER Below Lower Limit
15->RISELOW Ramp-Up Upper Limit Alarm
TIME: Test Time
LOAD: 0->STOP TEST
1->TESTING

Example: send> **RD? 1** <NL>
ret> **1,DCW,0.30,0.00u,6,5,1.0,0**<NL>
// Test Step 1: Function DCW, Voltage 1.000kV, Current 1.79uA, Result PASS, Status Voltage Ramp-Down, Test Time 1.0s, Test Completed

10.12 STEP

DEL: Used to Set Steps

Command Syntax: `STEP <int>`

Example: send> **STEP 1**<NL> *// Set Current Step to 1*

Query Syntax: `STEP?`

Query Response:
```
<step>,<totalstep>
Step:       Current Step
Totalstep:  Total Number of Steps
```

10.13 INS

DEL: Used to Add Steps

Command Syntax: `DEL <int>`

Example: send> **INS 1**<NL> *// Add a new step after Step 1*
send > INS <NL> *// Add a new step after the current step*

10.14 DEL

DEL: Used to Delete Steps

Command Syntax: `DEL <int>`

Example: send> **DEL 1***<NL>* *// Delete Step 1*
send > **DEL***<NL>* **// Delete Current Step**

10.15 KEYLOCK

KEYLOCK: Used to Set Keyboard Lock

Command Syntax: **KEYLOCK <ON,OFF>**

Example: send> **KEYLOCK ON** *<NL>//Enable Keyboard Lock*

10.16 IDN? Subsystem

IDN? Subsystem tree

`IND?`	

IDN? Subsystem is used to return the version number of the instrument

Query Syntax: **IDN?**

Query Response: **<MODEL>,<Revision>,<SN>,< Manufacturer>**

Example: send> **IDN?** *<NL>*
ret> **APPLENT,AT9620,0000000,A1.00***<NL>*

11. Modbus (RTU) COMM Protocol

In this chapter, you will learn:

- Data Format – Understand the Modbus communication structure
- Functions
- Variable Area
- Function Codes

11.1 Data Format

This instrument adheres to the Modbus (RTU) communication protocol. The instrument responds to commands from the host and returns standard response frames.

Refer to

You can contact our sales department to obtain the Applent Instrument Communication Measurement Tool, which includes Modbus communication debugging methods, a CRC-16 calculator, and floating-point to Modbus format converter.

11.1.1 Instruction Frame

Figure 11- 1 Modbus Command Frame

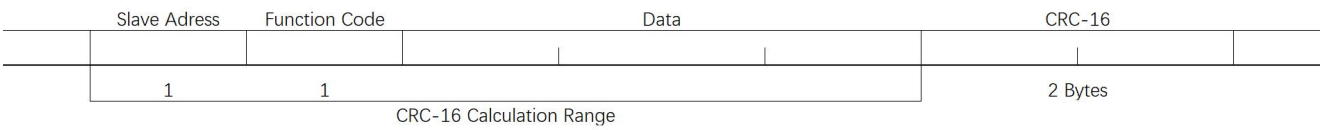


Table 11- 1 Description of Command Frame Fields

	At least 3.5 character times of silence before and after the frame
Slave Address	1 byte. Modbus supports Slave Addresses from 00 to 0x63 (99). Broadcast address is 00. Default Slave Address is 0x01 if RS485 option is not configured.
Function Code	1 byte: 0x03: Read multiple registers 0x04: Same as 0x03 (not used) 0x06: Write single register (can be replaced by 0x10) 0x08: Loopback Measurement (for debugging only) 0x10: Write multiple registers
Data	Register address, quantity, and values
CRC-16	2 bytes (low byte first). CRC is computed from Slave Address to data end

11.1.2 CRC-16 Calculation Method

1. Initialize the CRC-16 register with the value 0xFFFF.
2. XOR the first byte of the message with the CRC register.
3. Shift the CRC register right by 1 bit, padding with 0 on the left.
4. If the LSB (Least Significant Bit) was 0, repeat step 3.
5. If the LSB was 1, XOR the CRC register with 0xA001.
6. Repeat steps 3 and 4 for 8 shifts.
7. If more bytes remain in the message, XOR the next byte and repeat from step 3.

CRC16 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 = &H01
    CH = &HA0

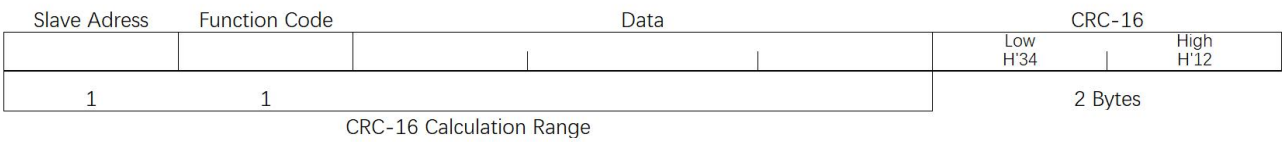
    FOR I = 0 TO UBOUND(DATA)
       CRC16LO = CRC16LO XOR DATA(I)      ' XOR EACH DATA BYTE WITH THE CRC REGISTER
       FOR FLAG = 0 TO 7
          SAVEHI = CRC16HI
          SAVELO = CRC16LO
          CRC16HI = CRC16HI \ 2           ' SHIFT HIGH BYTE RIGHT BY ONE
          CRC16LO = CRC16LO \ 2           ' SHIFT LOW BYTE RIGHT BY ONE
          IF ((SAVEHI AND &H1) = &H1) THEN   ' IF THE LAST BIT OF HIGH BYTE IS
1
             CRC16LO = CRC16LO OR &H80     ' ADD 1 AT FRONT AFTER SHIFT
          END IF
          IF ((SAVELO AND &H1) = &H1) THEN   ' IF LSB IS 1, XOR WITH POLYNOMIAL
             CRC16HI = CRC16HI XOR CH
             CRC16LO = CRC16LO XOR CL
          END IF
       NEXT FLAG
    NEXT I

    DIM RETURNDATA(1) AS BYTE
    RETURNDATA(0) = CRC16HI     ' HIGH BYTE OF CRC
    RETURNDATA(1) = CRC16LO     ' LOW BYTE OF CRC
    CRC16 = RETURNDATA
END FUNCTION
```

Our“Applent Instrument Communication Measurementing Tool”includes debugging methods for Modbus communication and features a built-in CRC-16 calculator.

Example: 1234H The calculated CRC-16 data needs to be appended to the end of the instruction frame. Example: 1234H:

Figure 11- 2 Modbus Appended CRC-16 Value.



11.1.3 Response Frame

Except for instructions with Slave Address 00H (broadcast), all other Slave Addresses will cause the instrument to return a response frame.

Figure 11- 3 Normal Response Frame

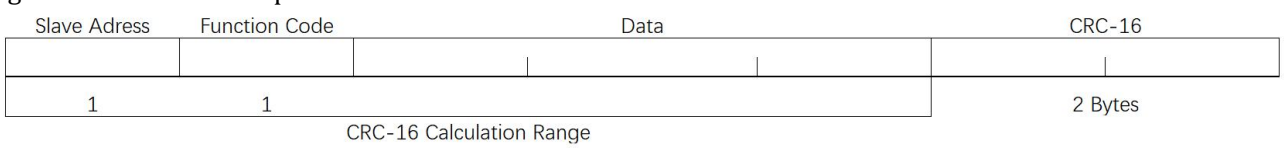


Figure 11- 4 Exception Response Frame

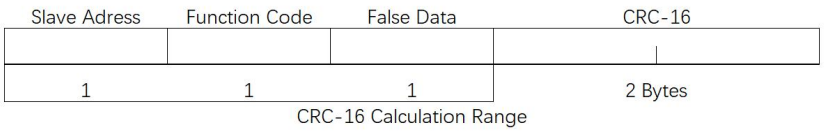


Table 11- 2 Exception Response Frame Description

Slave Address	1 byte Returned as-is from the instruction frame
Function Code	1 byte Original function code OR'ed with BIT7 (0x80) Example: 0x03 OR 0x80 = 0x83
Error Code	Exception code: 0x01 Function code error (unsupported) 0x02 Register error (nonexistent register) 0x03 Data error 0x04 Execution error
CRC-16	2 bytes Cyclic Redundancy Check Low byte first. CRC-16 is calculated from the Slave Address to the end of the data

11.1.4 No Response

In the following scenarios, the instrument will neither process the instruction nor respond, resulting in a communication timeout:

1. Slave Address Error
2. Transmission Error
3. CRC-16 Error
4. Byte count Error
   Example: Function code 0x03 requires exactly 8 bytes; receiving more or fewer will result in no response
5. Slave Address is 0x00 ,it indicates the broadcast address,and broadcast, which the instrument will not respond.

11.1.5 Error Codes

Table 11- 3 Error Code Definitions:

Error Code	Name	Description	Priority
0x01	Function Code Error	Function code not supported	1
0x02	Register Error	Register does not exist	2
0x03	Data Error	Incorrect register count or byte count	3
0x04	Execution Error	Illegal data or data out of valid range	4

11.2 Function Codes

The instrument only supports the following function codes. Any unsupported function codes will return an error frame.

Table 11- 4 Supported Function Codes

Function Code	Name	Description
0x03	Read Multiple Registers	Reads multiple continuous register values
0x04	Same as 0x03	Please use 0x03 instead
0x08	Loopback Measurement	Echoes back received data (for debugging)
0x10	Write Multiple Registers	Writes multiple continuous register values

11.3 Registers

The instrument uses a 2-byte register format, meaning each write operation must write exactly 2 bytes. Example: To write the measurement speed to register 0x3002, the data length must be 2 bytes, such as: 0x0001

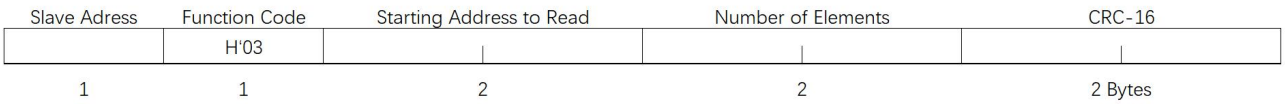
Data:
The Instrument Supports the Following Data Formats:

1. 1 Register – 2 Bytes (16-bit Integer) Example: 0x64 → 00 64
2. 2 Registers – 4 Bytes (32-bit Integer) Example: 0x12345678 → 12 34 56 78
3. 2 Registers – 4 Bytes (32-bit Float) Example: 3.14 → 40 48 F5 C3

Our proprietary tool, "Applent Communication Measurement Tool," includes Modbus communication debugging functions, such as a floating-point number converter.

11.4 Read Multiple Registers

Figure 11- 5 Reading Multiple Registers (Function Code 0x03)

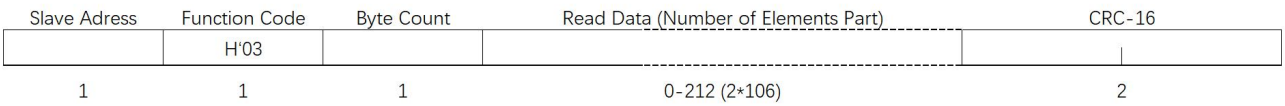


Function code 0x03 is used to read multiple registers.

Table 11- 5 Reading Multiple Registers:

	Name	Description
	Slave Address	Default is 01 if no specific RS485 address is assigned
0x03	Function Code	
	Start Address	Register starting address. Refer to the Modbus register map.
	Register Count 0001~006A(106)	Number of consecutive registers to read. Range: 0001~006A (max 106). Ensure that all specified addresses exist, or an error frame will be returned.
CRC-16	Cyclic Redundancy Check	

Figure 11- 6 Response Frame for Reading Multiple Registers (Function Code 0x03)



	Name	Description
	Slave Address	Echoed back from request
0x03 or 0x83	Function Code	0x03 if successful 0x83 if an error occurred
	Byte Count	Equal to the number of registers × 2 *Example: 1 register returns 02 bytes*
	Data	The actual register values
CRC-16	CRC checksum	

11.5 Write Multiple Registers

Figure 11- 7 Writing Multiple Registers (Function Code 0x10)

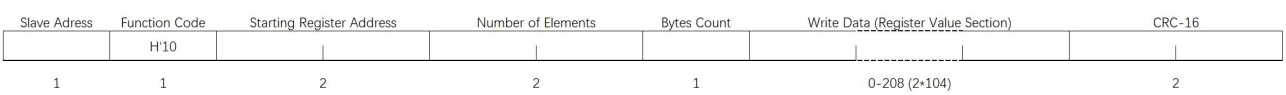
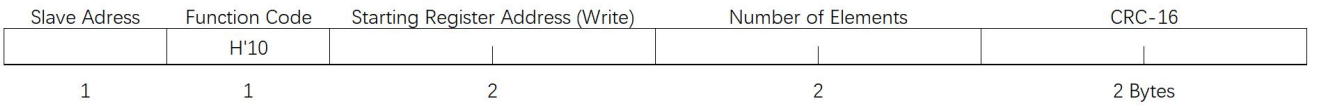


Table 11- 6 Writing Multiple Registers

	Name	Description
	Slave Address	If no RS485 address is specified, the default is 01.
0x10	Function Code	
	Starting Address	Starting register address; please refer to the Modbus register map
	Number of Registers to Write	。 0001~0068 (up to 104 registers). Ensure all specified register addresses exist, otherwise an error response will

	0001~0068(104)	be returned
	Byte Count	=number of registers x 2
CRC-16	Checksum	

Figure 11- 8 Response Frame for Writing Multiple Registers (0x10)

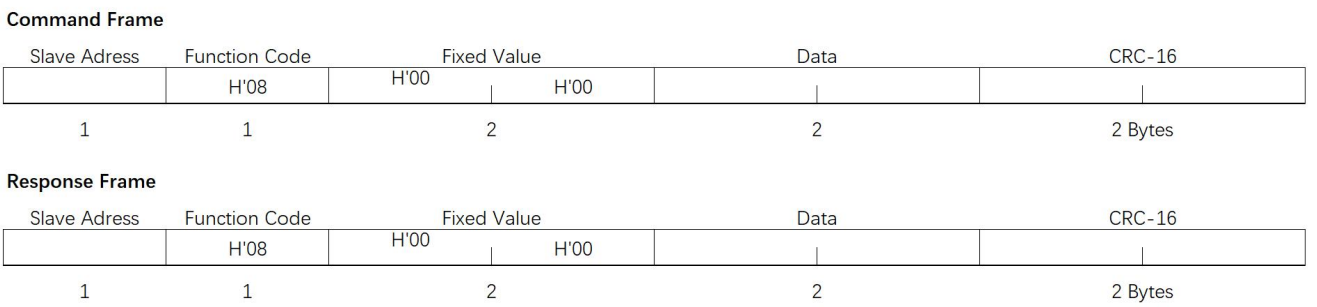


	Name	Description
	Slave Address	Returned as is
0x10 Or 0x90	Function Code	0x10 if successful 0x90 if an error occurred
	Starting Address	
	Number of Registers	
	CRC-16Checksum	

11.6 Echo Measurement

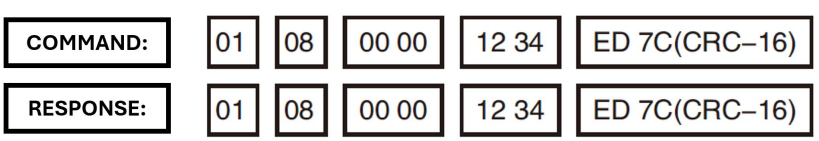
Function code 0x08 is used for debugging Modbus communication.

Figure 11- 9 Echo Measurement (0x08)



	Name	Description
	Slave Address	Echoed from the Request
0x08	Function Code	
	Fixed Value	00 00
	Measurement Data	Any Value: Example 12 34
	CRC-16Checksum	

Example:
Assuming the Measurement data is 0x1234



12. Modbus(RTU) Instruction Set

This chapter includes the following aspects:

- Register Overview - Overview of all register addresses used in the MODBUS instruction set.
- Command Syntax - Rules for writing command lines.
- Query Syntax - Rules for writing query commands.
- Query Response - Format of query responses.
- Command Reference - Reference for commands.

This chapter provides all SCPI commands for instrument use, allowing full control of all instrument functions via these commands.

12.1 Register Overview

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

Figure 12- 1 Register Overview

Register Address	NAME	VALUE	DESCRIPTION
Read-Only Register Setting			
2000	Voltage Result	4-bite float	R Reg, 2 Reg Occupied
2002	Current Result	4-bite float	R Reg, 2 Reg Occupied
2004	File Number for Call	2-bite integer	R Reg, 1 Reg Occupied
2005	Total Steps - Current Step	4-bite integer	R Reg, 2 Reg Occupied Example：00 02 00 02 Total Steps: 2, Current Step: 2
Read/Write Function in Setup Page			
3000	TEST FUNCTION	0000：ACW 0001：DCW 0002：IR	RW Reg, 1 Reg Occupied
3001	TEST VOLTAGE	4-bite float	RW Reg, 2 Reg Occupied
3003	TEST TIME	4-bite float	RW Reg, 2 Reg Occupied
3005	RISE TIME	4-bite float	RW Reg, 2 Reg Occupied
3007	FALL TIME	4-bite float	RW Reg, 2 Reg Occupied
3009	UPPER	4-bite float	RW Reg, 2 Reg Occupied
300B	LOWER	4-bite float	RW Reg, 2 Reg Occupied
300D	RANGE MODE	0000：AUTO RANGE 0001：FIXED RANGE	RW Reg, 1 Reg Occupied Write Mode: IR Only
300E	RANGE	0000：1uA Range 0001：10uA Range 0002：100uA Range 0003：1mA Range	RW Reg, 1 Reg Occupied IR Mode Only
300F	ARC	0000：LEVEL0 0001：LEVEL1 … 0005：LEVEL9	RW Reg, 2 Reg Occupied Func Supports ACW/DCW
3010	FREQ	0000：50Hz 0001：60Hz	RW Reg, 1 Reg Occupied ACW Mode Only
3011	CHG LOWER	4-bite float	RW Reg, 2 Reg Occupied Func Supports DCW/IR
3013	RISE UPPER	0000：ON 0001：OFF	RW Reg, 1 Reg Occupied DCW Mode Only
Read/Write Function in System Page			

3100	LANGUAGE	0000：ENGLISH 0001：CHINESE	RW Reg, 1 Reg Occupied
3101	KEY BEEP	0000：ON 0001：OFF	RW Reg, 1 Reg Occupied
3102	REMOTE CTRL	0000：RS232 0001：RS485 0002：LAN	RW Reg, 1 Reg Occupied
3103	BAUD	0000：9600 0001：19200 0002：38400 0003：57600 0004：115200	RW Reg, 1 Reg Occupied
3104	PROTOCOL	0000：SCPI 0001：MODBUS	RW Reg, 1 Reg Occupied
3105	HAND SHAKE	0000：OFF 0001：ON	RW Reg, 1 Reg Occupied
3106	ADDRESS	0000：00(BC） 0001：01 … 000F：15	RW Reg, 1 Reg Occupied
3107	RESULT SEND	0000：FETCH 0001：AUTO	RW Reg, 1 Reg Occupied
3108	END MARK	0000：OFF 0001：ON	RW Reg, 1 Reg Occupied
3109	GFI	0000：OFF 0001：ON	RW Reg, 1 Reg Occupied
310A	FAIL MODE	0000：CONTINUE 0001：ABORT	RW Reg, 1 Reg Occupied
310B	VOLUME	0000：HIGH 0001：LOW 0002：OFF	RW Reg, 1 Reg Occupied
310C	TRIG MODE	0000：LOCAL 0001：PLC 0002：BUS	RW Reg, 1 Reg Occupied
310D	RESULT DISP	0000: GROUP RESULTS 0001： STEP RESULT	RW Reg, 1 Reg Occupied
Instrument Control Function			
4000	Start/Stop Test	0000：Stop Test 0001：Start Test	W Reg, 1 Reg Occupied
4001	Switch Interface	0000：MEAS PAGE 0001：SETUP PAGE 0002：SYSTEM PAGE 0003：FILE PAGE 0004：UDISK PAGE 0005：LIST PAGE 0006：INFO PAGE 0007：LAN PAGE	W Reg, 1 Reg Occupied
4002	KEYLOCK	0001：Lock Keyboard	W Reg, 1 Reg Occupied
4003	Test Steps	0000: Add a New Test Item 0001: Delete a New Test Item 0002: Restore to a Single Default Test Item	W Reg, 1 Reg Occupied
4004	File Management	Functions: 0000: Delete Current File 0001: Save File 0002: Read File File num：	W Reg, 2 Reg Occupied Example: 00 00 00 01 Delete the First File

		0001~000A	
4006	CHARGE LOWER	Auto Test: 0001	W Reg, 1 Reg Occupied
4007	OFFSET	Auto Test: 0001	W Reg, 1 Reg Occupied

12.2 READ-ONLY WRITEREGISTER

12.2.1 Voltage Result Register【2000】

READ

1	2	3	4	5	6	7	8
01	**03**	**20**	**00**	**00**	**02**	**CF**	**CB**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7	8	9
01	**03**	**04**	**3F**	**80**	**00**	**BB**	**B7**	**BC**
01	03	BYTE	DATA				CRC-16	

12.2.2 Current Result Register【2002】

READ

1	2	3	4	5	6	7	8
01	**03**	**20**	**02**	**00**	**02**	**6E**	**0B**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4			5	6	7
01	**03**	**04**	**00**	**00**	**00**	**00**	**FA**	**33**
01	03	BYTE	DATA				CRC-16	

12.2.3 File Number Register Call【2004】

READ

1	2	3	4	5	6	7	8
01	**03**	**20**	**04**	**00**	**01**	**CE**	**0B**
	READ	REGISTER		Num of Regs	CRC		

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
01	03	BYTE	DATA		CRC-16	

12.2.4 Current Step Register【2005】

READ

1	2	3	4	5	6	7	8
01	**03**	**20**	**05**	**00**	**02**	**DF**	**CA**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	5	6	7
01	**03**	**02**	**00**	**02**	**00**	**02**	**DA**	**32**
01	03	BYTE	DATA				CRC-16	

Note: The data is split into two parts. The first part 00 01 indicates the total steps, and the second part 00 01 indicates the current step. For example, the current step is [01-01].

12.3 Read/Write Register in Setup Page

12.3.1 Test Function Register【3000】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**00**	**00**	**01**	**02**	**00**	**00**	**96**	**53**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**30**	**00**	**00**	**01**	**0E**	**C9**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**O 0**	**00**	**01**	**8B**	**0A**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE：

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.3.2 Set Voltage Register【3001】

WRITE(Set voltage:1kV)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**30**	**01**	**00**	**02**	**04**	**44**	**7A**	**00**	**00**	**53**	**4B**
	WR ITE	REGISTE R		Num of Regs		Byte	DATA				CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**30**	**01**	**00**	**02**	**1F**	**08**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**3 0**	**O1**	**00**	**02**	**9 A**	**CB**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE：

1	2	3	4	5	6	7	8	9
01	**03**	**04**	**3F**	**80**	**00**	**00**	**F7**	**CF**
01	03	Byte	DATA				CRC-16	

12.3.3 Testing Time Register【3003】

WRITE(testing time :1s)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**30**	**03**	**00**	**02**	**04**	**3F**	**80**	**00**	**00**	**EA**	**47**
	WR ITE	REGISTE R		Num of Regs		Byte	DATA				CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**30**	**03**	**00**	**02**	**BE**	**C8**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**O 3**	**00**	**02**	**3B**	**0B**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE：

1	2	3	4	5	6	7	8	9
01	**03**	**04**	**3F**	**80**	**00**	**00**	**F7**	**CF**
01	03	Byte	DATA				CRC-16	

12.3.4 Rise Time Register【3005】

WRITE（Set the ramp-up time :1s）

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**30**	**05**	**00**	**02**	**04**	**3F**	**80**	**00**	**00**	**6A**	**6D**
	WRITE	REGISTER		Num of Regs		Byte	DATA				CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**30**	**05**	**00**	**02**	**5E**	**C9**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**O6**	**00**	**02**	**2B**	**0A**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE：

1	2	3	4	5	6	7	8	9
01	**03**	**04**	**3F**	**80**	**00**	**00**	**F7**	**CF**
01	03	Byte	DATA				CRC-16	

12.3.5 Slow Descent Time Register【3007】

WRITE（slow descent time:1s）

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**30**	**07**	**00**	**02**	**04**	**3F**	**80**	**00**	**00**	**EB**	**B4**
	WRITE	REGISTER		Num of Regs		Byte	DATA				CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**30**	**07**	**00**	**02**	**FF**	**09**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**O7**	**00**	**02**	**7A**	**CA**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE：

1	2	3	4	5	6	7	8	9
01	**03**	**04**	**3F**	**80**	**00**	**00**	**F7**	**CF**
01	03	Byte	DATA				CRC-16	

12.3.6 Test Upper Limit Register【3009】

WRITE(Set the current step test upper limit for ACW to 1mA)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**30**	**09**	**00**	**02**	**04**	**3F**	**80**	**00**	**00**	**6A**	**38**
	WRITE	REGISTER		Num of Regs		Byte	DATA				CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**30**	**09**	**00**	**02**	**9E**	**CA**
		REGISTER		Num of Regs		CRC	

Note:

The ACW mode uses mA as the unit, with an input range of (0.01~20) mA.
The DCW mode uses mA as the unit, with an input range of (0.0001~10) mA.
The IR mode uses MΩ as the unit, with an input range of (1~50000) MΩ.

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**09**	**00**	**02**	**1B**	**09**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7	8	9
01	**03**	**04**	**3F**	**80**	**00**	**00**	**F7**	**CF**
01	03	Byte	DATA				CRC-16	

12.3.7 Test Lower Bound Register【300B】

WRITE(Set the lower limit of the current ACW step test to 1mA)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**30**	**0B**	**00**	**02**	**04**	**3F**	**80**	**00**	**00**	**EB**	**E1**
	WRITE	REGISTER		Num of Regs		Byte	DATA				CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**30**	**0B**	**00**	**02**	**3F**	**0A**
		REGISTER		Num of Regs		CRC	

Note:
The ACW mode uses mA as the unit, with an input range of (0.01~20) mA.
The DCW mode is measured in mA, with an input range of (0.0001~10) mA.
The IR mode is measured in MΩ, with an input range of (1~50000) MΩ.

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**0B**	**00**	**02**	**BA**	**C9**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7	8	9
01	**03**	**04**	**3F**	**80**	**00**	**00**	**F7**	**CF**
01	03	Byte	DATA				CRC-16	

12.3.8 Range Mode Register【300D】

WRITE（Set the current step test range mode to AUTO）

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**0D**	**00**	**01**	**02**	**00**	**00**	**97**	**4E**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**30**	**0D**	**00**	**01**	**9F**	**0A**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**0D**	**00**	**01**	**1A**	**C9**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7

01	03	02	00	01	79	84
01	03	Byte	DATA		CRC-16	

Note: This feature is only available in IR mode

12.3.9 Test Range Register【300E】

WRITE（Set the current step test range mode to Range_1uA）

1	2	3	4	5	6	7	8	9	10	11
01	10	30	0E	00	01	02	00	00	97	7D
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	10	30	0E	00	01	6F	0A
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	03	30	0E	00	01	EA	C9
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

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

Note: This feature is only available in IR mode

12.3.10 Arc Rating Register【300F】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	10	30	0F	00	01	02	00	00	96	AC
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	10	30	0F	00	01	3E	CA
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	03	30	0F	00	01	BB	09
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

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

12.3.11 A-C cycle Register【3010】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	10	30	10	00	01	02	00	00	94	C3
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	10	30	10	00	01	0F	0C
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8

01	**03**	**30**	**10**	**00**	**01**	**8A**	**CF**
	REA D	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.3.12 Lower Charging Limit Register【3011】

WRITE(Set the lower charging limit in DCW mode to100uA)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**30**	**11**	**00**	**02**	**04**	**42**	**C8**	**00**	**00**	**F2**	**E8**
	WRITE	REGISTER		Num of Regs		Byte	DATA				CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**30**	**11**	**00**	**02**	**1E**	**CD**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**11**	**00**	**02**	**9B**	**0E**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4			5	6	7
01	**03**	**04**	**42**	**C8**	**00**	**00**	**6F**	**B5**
01	03	Byte	DATA				CRC-16	

12.3.13 Rising Limit Register【3013】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**30**	**13**	**00**	**01**	**02**	**00**	**00**	**94**	**F0**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**30**	**13**	**00**	**01**	**FF**	**0C**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**30**	**13**	**00**	**01**	**7A**	**CF**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4 System Interface Read/Write Register

12.4.1 System Language Register【3100】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**00**	**00**	**01**	**02**	**00**	**00**	**86**	**93**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**00**	**00**	**01**	**0F**	**35**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O0**	**00**	**01**	**8A**	**F6**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.2 Keypad Tone Register【3101】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**01**	**00**	**01**	**02**	**00**	**00**	**87**	**42**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**01**	**00**	**01**	**5E**	**F5**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O1**	**0 0**	**01**	**DB**	**36**
	READ	REGISTER		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.3 Remote Control Register【3102】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**02**	**00**	**01**	**02**	**00**	**00**	**87**	**71**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**02**	**00**	**01**	**AE**	**F5**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 2**	**00**	**01**	**2B**	**36**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.4 Baud Rate Register【3103】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**03**	**00**	**01**	**02**	**00**	**00**	**86**	**A0**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8

01	**10**	**31**	**03**	**00**	**01**	**FF**	**35**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 3**	**00**	**01**	**7A**	**F6**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.5 Protocol Register【3104】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**04**	**00**	**01**	**02**	**00**	**00**	**87**	**17**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**04**	**00**	**01**	**4E**	**F4**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 4**	**00**	**01**	**CB**	**37**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**01**	**79**	**84**
01	03	Byte	DATA		CRC-16	

12.4.6 Command Handshake Register【3105】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**05**	**00**	**01**	**02**	**00**	**00**	**86**	**C6**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**05**	**00**	**01**	**1F**	**34**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 5**	**00**	**01**	**9A**	**F7**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.7 Slave Register【3106】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**06**	**00**	**01**	**02**	**00**	**00**	**86**	**F5**
	WRITE	REGISTER		Num of		Byte	DATA		CRC	

			Regs			

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**06**	**00**	**01**	**EF**	**34**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 6**	**00**	**01**	**6A**	**F7**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.8 Result Send Register【3107】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**07**	**00**	**01**	**02**	**00**	**00**	**87**	**24**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**07**	**00**	**01**	**BE**	**F4**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 7**	**00**	**01**	**3B**	**37**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.9 Error Code Register【3108】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**08**	**00**	**01**	**02**	**00**	**00**	**87**	**DB**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**08**	**00**	**01**	**8E**	**F7**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 8**	**00**	**01**	**0B**	**34**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.10 Electric Shock Protection Register【3109】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**09**	**00**	**01**	**02**	**00**	**00**	**86**	**0A**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**09**	**00**	**01**	**DF**	**37**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O 9**	**00**	**01**	**5A**	**F4**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.11 Failure Mode Register【310A】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**0A**	**00**	**01**	**02**	**00**	**00**	**86**	**39**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**0A**	**00**	**01**	**2F**	**37**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O A**	**00**	**01**	**AA**	**F4**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.12 Volume Settings Register【310B】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**0B**	**00**	**01**	**02**	**00**	**00**	**87**	**E8**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**0B**	**00**	**01**	**7E**	**F7**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**O B**	**00**	**01**	**FB**	**34**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.13 Trigger Mode Register【310C】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**0C**	**00**	**01**	**02**	**00**	**00**	**86**	**5F**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**0C**	**00**	**01**	**CF**	**36**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**OC**	**00**	**01**	**4A**	**F5**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.4.14 Result Display Register【310D】

WRITE

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**31**	**0D**	**00**	**01**	**02**	**00**	**00**	**87**	**8E**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**31**	**0D**	**00**	**01**	**9E**	**F6**
		REGISTER		Num of Regs		CRC	

READ

1	2	3	4	5	6	7	8
01	**03**	**31**	**OD**	**00**	**01**	**1B**	**35**
	RE AD	REGISTE R		Num of Regs		CRC	

RESPONSE:

1	2	3	4	5	6	7
01	**03**	**02**	**00**	**00**	**B8**	**44**
01	03	Byte	DATA		CRC-16	

12.5 Instrument Control Register

12.5.1 Start/Stop Test Register【4000】

WRITE(Stop test)

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**40**	**00**	**00**	**01**	**02**	**00**	**00**	**E7**	**94**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE:

1	2	3	4	5	6	7	8
01	**10**	**40**	**00**	**00**	**01**	**14**	**09**
		REGISTER		Num of Regs		CRC	

Note: Set the trigger mode to【BUS】

12.5.2 Switch Interface Register【4001】

WRITE(Switch to the measurement page)

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**40**	**01**	**00**	**01**	**02**	**00**	**00**	**E6**	**45**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**40**	**01**	**00**	**01**	**45**	**C9**
		REGISTER		Num of Regs		CRC	

12.5.3 Keyboard Lock Register【4002】

WRITE(Keyboard Lock)

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**40**	**02**	**00**	**01**	**02**	**00**	**01**	**27**	**B6**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**40**	**02**	**00**	**01**	**B5**	**C9**
		REGISTER		Num of Regs		CRC	

12.5.4 Test Steps Register【4003】

WRITE（Add a test plan to the existing steps）

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**40**	**03**	**00**	**01**	**02**	**00**	**00**	**E7**	**A7**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**40**	**03**	**00**	**01**	**E4**	**09**
		REGISTER		Num of Regs		CRC	

12.5.5 File Management Register【4004】

WRITE (Delete the first file: This DATA consists of two values. 00 00 indicates the delete function, and 00 01 indicates the first file.)

1	2	3	4	5	6	7	8	9	10	11	12	13
01	**10**	**40**	**04**	**00**	**02**	**04**	**00**	**00**	**00**	**01**	**02**	**5F**
	WRITE	REGISTER		Num of Regs		Byte	DATA				CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**40**	**04**	**00**	**02**	**15**	**C9**
		REGISTER		Num of Regs		CRC	

12.5.6 Lower Limit Register【4006】

WRITE（Auto test for charging lower limit enabled）

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**40**	**06**	**00**	**01**	**02**	**00**	**01**	**26**	**32**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**40**	**06**	**00**	**01**	**F4**	**08**
		REGISTER		Num of Regs		CRC	

12.5.7 Compensation Reset Register【4007】

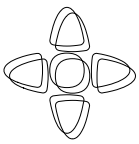
WRITE（Enable auto test for zero compensation）

1	2	3	4	5	6	7	8	9	10	11
01	**10**	**40**	**07**	**00**	**01**	**02**	**00**	**01**	**27**	**E3**
	WRITE	REGISTER		Num of Regs		Byte	DATA		CRC	

RESPONSE：

1	2	3	4	5	6	7	8
01	**10**	**40**	**07**	**00**	**01**	**A5**	**C8**
		REGISTER		Num of Regs		CRC	

13. Specification



This chapter provides the following information:

- Technical specifications
- Function model
- Environmental requirements
- Dimension

13.1 Technical Specifications

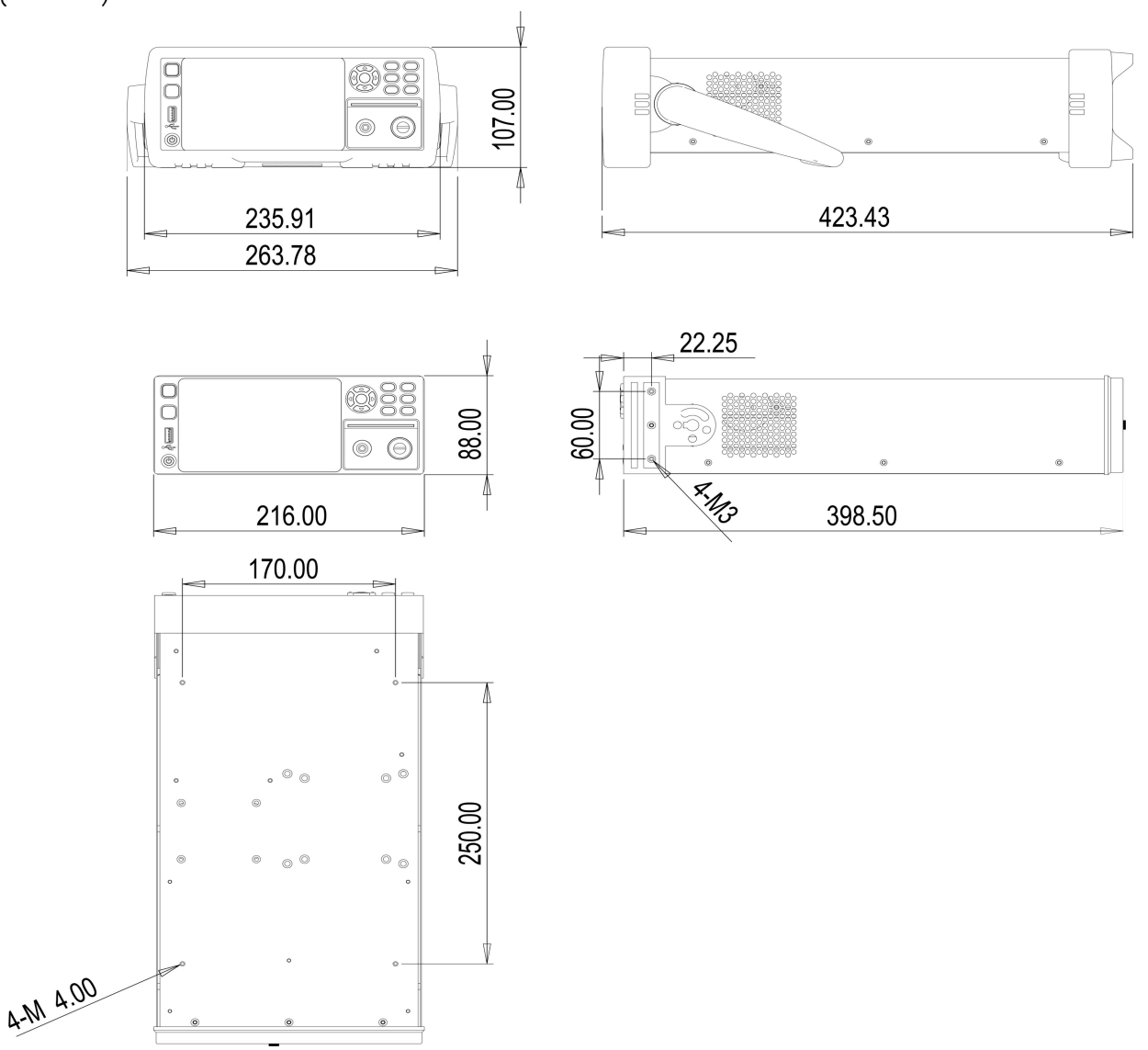
AT686A AC/DC Withstanding Voltage Insulation Tester			
AC Withstand Voltage Test			
Rated Output	5kV / 10mA		
	Range	Resolution	Accuracy
Output Voltage	0.05kV-5.00kV	0.01 (10V)	±（2%×Reading + 5dgt）
Test Current	0.01mA-10.00mA	0.01	±（2%×Reading + 5dgt)
Working Frequency	50Hz or 60Hz， ±0.1%		
Output waveform	Sine wave，distortion less than 3%（Pure Resistive Load）		
Voltage regulation rate	±（2%×Reading+5V）（From no load to full load）		
DC Withstand Voltage Test			
Rated Output	6kV / 10mA		
	Range	Resolution	Accuracy
Output Voltage	0.05kV-6.00kV	0.01 (10V)	±（2%×Reading + 5dgt）
Test Current	1.0~350.0/300~3500/3000~9900~9999 μA/10mA	0.1/1/10μA/0.01mA	±（2%×Reading + 5dgt）
Insulation Resistance			
Rated Output	5kV / 100GΩ		
	Range	Resolution	Accuracy
Output Voltage	0.05kV-5.00kV	0.01 (10V)	±（1%×Reading + 5dgt）
Resistance Measurement Range	1.0MΩ-100GΩ		
Resistance Measurement Accuracy	≥1000V	<1000V	
	1MΩ-1GΩ ±（5% Reading+5dgt）	1.0MΩ-1GΩ ±（10% Reading+5dgt）	
	1GΩ-100GΩ ±（10% Reading+5dgt）	1GΩ-10GΩ For Reference Only,No Accuracy Requirements	
General			
Discharge Function	Automatic discharge after testing		
ARC Detector	1-9 Level（AC / DC）		
Voltage Rise Time	0.1s-999.9s		
Voltage Test Time	0.1s-999.9s		
Voltage Drop Time	0.1s-999.9s		
Interface	Handler（PLC）、RS232/RS485、USB、LAN、Alarm Light Interface、External Remote Control Interface		

13.2 Environment Requirements

Environment：	Index：	Temperature	18℃~28℃	Humidity ≤ 65% RH
	Operation：	Temperature	10℃~40℃	Humidity 10~80% RH
	Storage：	Temperature	0℃~50℃	Humidity 10~90% RH
Power Supply：	Power supply voltage：220VAC，Maximum permissible error:±10%			
	Power supply frequency：50Hz/60Hz,Maximum permissible error:±5%			
Fuse：	250V 10A Slow Melting			
Power：	Max 300VA			
Weight：	About 8.6 kg			

13.3 Dimensions

(Schematic)



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Applent Instruments Ltd.

Changzhou ONMEAS Instruments Ltd.
#14,No. 9 Caoxi Road, Wujin district, Changzhou, Jiangsu province, China.

400-600-1217

TEL：0519-88805550

https://www.onmeas.com

Sales Service Email: sales@applent.com

Tech Support Email: tech@applent.com

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