S Series High Precision Desktop Source Measure Unit User Manual

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Foreword

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Maintenance: Please use product according to the operation manual. If there is any problem with the source measure unit, please do not disassemble the source measure unit without permission, and do not install replacement parts or perform any unauthorized modification on the source measure unit. Please return the source measure unit to after-sales service office for service (sales@whprecise.com) and repair to ensure its safety features are maintained.

Latest Info: For the latest firmware/software/manuals/specs/support information, go to www.precisesmu.com.

Safety Notice

- Before using the source measure unit, please learn and observe the following safety notice to avoid potential safety hazards in the use of the source measure unit.
- Please use the correct power cord.

  To avoid the danger of fire or electric leakage caused by the damage of the inferior power cord, be sure to use the power cord designated by this product and certified.
- Turn on/off rightly.

  When building the circuit, be sure to source measure unit off to ensure the safety of the person and the source measure unit.
- Please do not operate the source measure unit in a humid environment

  A humid environment will not only cause damage to the source measure unit, but also endanger the personal safety of testers.
- Please do not use source measure unit in explosive air.

  And do not operate the SourceMeter in the presence of flammable gases or fumes, as operating any electrical instrument in such an environment will create safety hazard.
- Please do not replace components or modify the source measure unit
- Since installing replacement parts or making any unauthorized changes to the source table may bring other dangers, please do not do so and return the source measure unit to a Precise Instruments sales and service facility for repair to ensure that the safety features are maintained.
- Please keep the surface of the source table clean and dry.

  sundries or water droplets on the surface of the source measure unit may cause electric shock and endanger the personal safety of testers. Therefore, please keep the surface of the source measure unit clean and dry at all times.
- Ensure ventilation and heat dissipation when the source measure unit is in use.

  The source measure unit will generate a certain amount of heat during operation, which is dissipated through the heat dissipation plate and fan of its own structure. It is necessary to ensure a good external heat dissipation environment to avoid high temperature damage to the source measure unit due to failure of heat dissipation.
- It is forbidden to plug and unplug banana plugs in 4-wire mode.

  There is a risk of electric shock when plugging and unplugging the banana plug in 4-wire mode, so do not plug or unplug the banana plug in 4-wire mode.

- Ground the product.

  To avoid electric shock, the SourceMeter needs to be grounded through the ground conductor of the power cord.

Safety Signs：

 "Attention to Danger". In any case, when the instrument is marked with this symbol, the user must refer to the operating instructions in the user manual.

 “Safety ground terminal”. Protect earth terminal to prevent electric shock in a fault.

 “Connect to the chassis terminal”. Indicates the terminal block attached to the device shell.

Content

1 Product Introduction

1.1 Product Description

Figure 1-1 S300 desktop source measure unit

The S series source measure unit is the first China produce source measure unit with high precision, large dynamic range and digital touch built by Precise Instrument for so many years. It integrates various functions such as voltage and current input, output and measurement. The maximum output voltage is 300V, the minimum test current is 100pA, and it supports four-quadrant operation. It has a 5-inch touch screen, supports LAN, RS-232, GPIB and other communication methods, and the resolution can reach 5 digits. It is widely used in various electrical characteristics testing: semiconductor IC or components, power devices, sensors, organic materials and nanomaterials and other characteristics testing and analysis.

- Discrete semiconductor device characteristic test: resistors, diodes, light-emitting diodes, Zener diodes, PIN diodes, BJT transistors, MOSFETs, SIC, GaN and other devices;

- Energy and efficiency tests: LED/AMOLED, solar cells, DC-DC converters, etc.;
- Sensor characteristic test: resistivity, Hall effect, etc.;
- Organic materials characteristic test: electronic ink, printed electronic technology, etc.;
- Nanomaterials characteristics test: graphene, nanowires, etc.

1.2 Product Model and Specifications

The S series SMU have three models: S100, S200 and S300. The output and test voltage ranges of each model are different to meet the needs of different users and ensure that users use the most cost-effective source measure unit.

S100 includes 3 voltage ranges, 8 current ranges:

Range	Mode	Source		Measurement	
		Resolution	Accuracy	Resolution	Accuracy
300mV	Voltage	30uV	0.1%±300uV	30uV	0.1%±300uV
3V		300uV	0.1%±500uV	300uV	0.1%±500uV
30V		3mV	0.1%±3mV	3mV	0.1%±3mV
100nA	Current	10pA	0.1%±0.5nA	10pA	0.1%±0.5nA
1uA		100pA	0.1%±3nA	100pA	0.1%±3nA
10uA		1nA	0.1%±5nA	1nA	0.1%±5nA
100uA		10nA	0.1%±50nA	10nA	0.1%±50nA
1mA		100nA	0.1%±300nA	100nA	0.1%±300nA
10mA		1uA	0.1%±5uA	1uA	0.1%±5uA
100mA		10uA	0.1%±20uA	10uA	0.1%±20uA
1A		100uA	0.1%±2mA	100uA	0.1%±2mA

Form 1-1 S100 Voltage and current range and accuracy

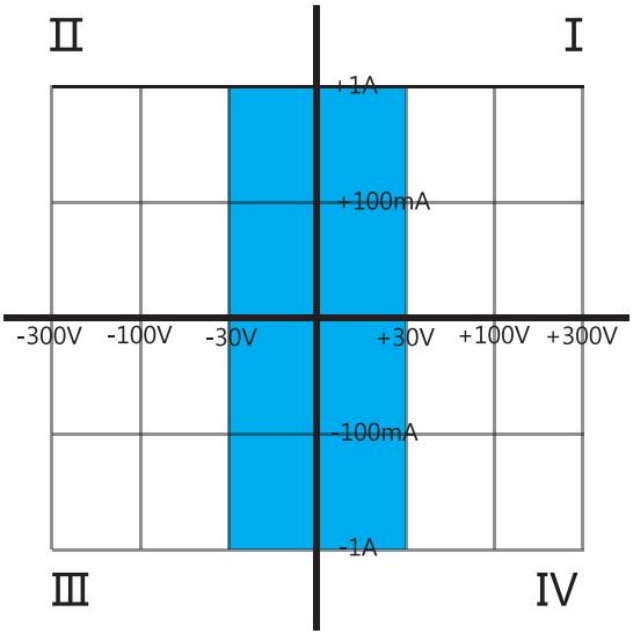


Figure 1-2 S100 four-quadrant working diagram

S200 includes 4 voltage ranges, 8 current ranges:

range	mode	source		measurement	
		resolution	accuracy	resolution	accuracy
300mV	voltage	30uV	0.1%±300uV	30uV	0.1%±300uV
3V		300uV	0.1%±500uV	300uV	0.1%±500uV
30V		3mV	0.1%±3mV	3mV	0.1%±3mV
100V		10mV	0.1%±10mV	10mV	0.1%±10mV
100nA	current	10pA	0.1%±0.5nA	10pA	0.1%±0.5nA
1uA		100pA	0.1%±3nA	100pA	0.1%±3nA
10uA		1nA	0.1%±5nA	1nA	0.1%±5nA
100uA		10nA	0.1%±50nA	10nA	0.1%±50nA
1mA		100nA	0.1%±300nA	100nA	0.1%±300nA
10mA		1uA	0.1%±5uA	1uA	0.1%±5uA
100mA		10uA	0.1%±20uA	10uA	0.1%±20uA
1A		100uA	0.1%±2mA	100uA	0.1%±2mA

Form 1-2 S200 Voltage and current range and accuracy

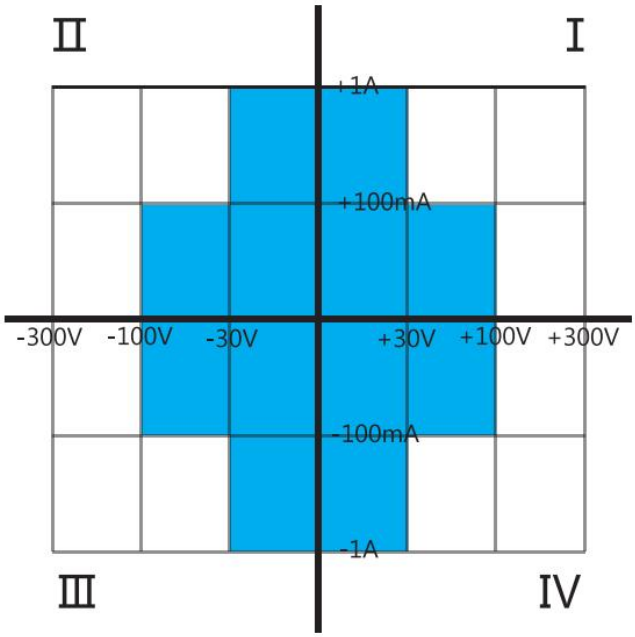


Figure 1-3 S200 four-quadrant working diagram

S300 includes 4 voltage ranges, 8 current ranges:

range	model	source		measurement	
		resolution	accuracy	resolution	accuracy
300mV	voltage	30uV	0.1%±300uV	30uV	0.1%±300uV
3V		300uV	0.1%±500uV	300uV	0.1%±500uV
30V		3mV	0.1%±3mV	3mV	0.1%±3mV
300V		30mV	0.1%±30mV	30mV	0.1%±30mV
100nA	current	10pA	0.1%±0.5nA	10pA	0.1%±0.5nA
1uA		100pA	0.1%±3nA	100pA	0.1%±3nA
10uA		1nA	0.1%±5nA	1nA	0.1%±5nA
100uA		10nA	0.1%±50nA	10nA	0.1%±50nA
1mA		100nA	0.1%±300nA	100nA	0.1%±300nA
10mA		1uA	0.1%±5uA	1uA	0.1%±5uA
100mA		10uA	0.1%±20uA	10uA	0.1%±20uA
1A		100uA	0.1%±2mA	100uA	0.1%±2mA

Form 1-3 S300 Voltage and current range and accuracy

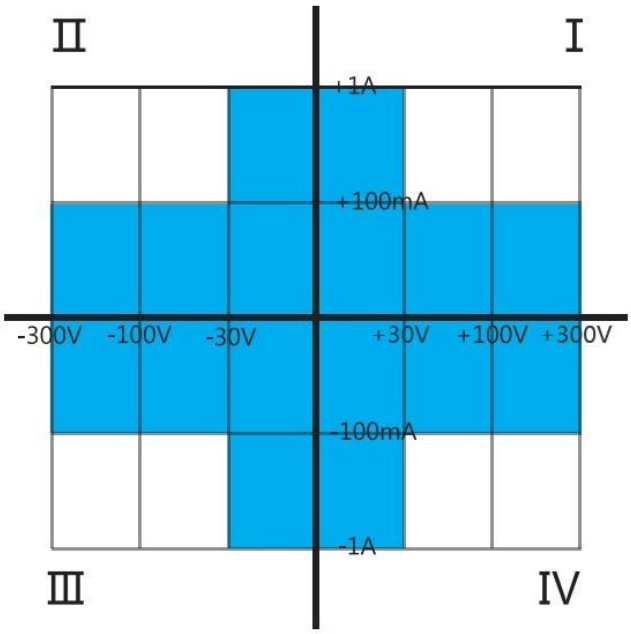


Figure 1-4 S300 four-quadrant working diagram

1.3 Main Technical Parameters

Max output power:30W;
Source output accuracy:0.1%;
Measurement accuracy:0.1%;
Over range:105% of range, source and measurement;
Max sampling rate:1000 S/s;
Output way:Support front and back panel;
Measurement way:Support front and back panel、2/4 wire and GUARD measurement;
Communication interface:RS-232、GPIB、LAN;
Trigger:Support IO trigger input and output,trigger polarity can be configured;
As the continuous iteration of the equipment, the technical parameters will be optimized and updated, please refer to the latest source measure unit specifications.

1.4 Product Structure

1.4.1 Front Panel

Figure 1-6 SXX Series source measure unit front panel

Front panel control buttons introduction:

①power:Down is on, and up is off;

②USB interface:Save test data or upgrade source measure unit software;

③BACK:Back to last control interface

④、⑤、⑥Enter button, menu button, home button respectively: No function is assigned at present, and green light and orange light will flash when power on;

⑦Screen touch: Set various parameters of the source measure unit directly on screen;

⑧Meter model: S series source measure unit has three models: S100, S200, and S300. For the different parameters of the three models, please refer to Section 1.2;

⑨Adjust parameters: Turn it counterclockwise to decrease the parameter, and turn it clockwise to increase the parameter;

⑩Output button: The button lights up green when the output is clicked;

⑪Output terminals: FORCE (force) terminal can output current or voltage, and measure current or voltage at the same time, use FORCE terminal in two-wire mode; SENSE (induction) terminal is used to test voltage, SENSE terminal test voltage can

eliminate the voltage drop in the wire, four-wire mode makes voltage measurements of the device under test (DUT) is more accurate.

1.4.2 Back Panel

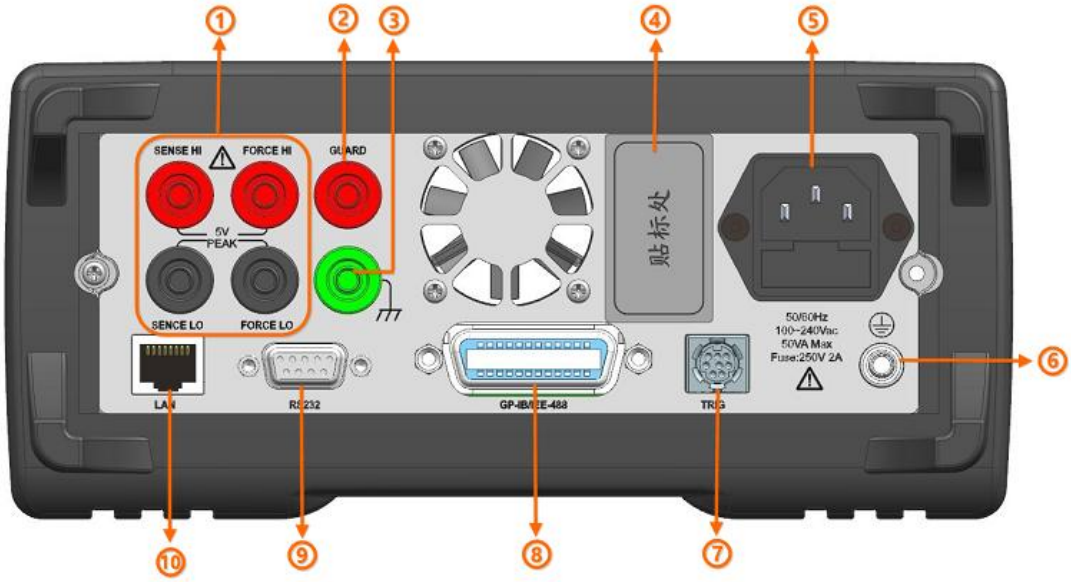


Figure 1-7 SXX Series source measure unit back panel

Back panel control buttons introduction:

①Output terminal:It has the same function as the output terminal on the front panel. Pleas note that only front panel output or back panel output can be used, and they cannot be output at the same time.

②GUARD connection terminal:A protection terminal, which connects the metal shielding net of the middle layer of the triaxial cable to form a signal protection layer;

③Shell connection terminal;

④SN code:The SN code will be pasted here, which is the identification code of the source measure unit;

⑤Power interface:Please use the national standard power cable to connect;

⑥Ground terminal;

⑦TRIG signal connection port:The TRIG signal is the trigger signal, and this port needs to be connected when multiple sets of source measure unit used together;

⑧GPIB connection port:Connect this port when using the GPIB communication way;

⑨RS232:Connect this port when using the serial port communication method;

⑩Ethernet connection port(LAN):When using Ethernet communication to connect this port, it is necessary to ensure that the source table and the control PC are in the same network domain.

1.5 Operation UI Window

Below is the main window of the source measure unit touch screen.

Figure 1-8 Main menu window

Including six parts: measure, scan, setting, quick set,version,calibration.

1.5.1 Measure Window

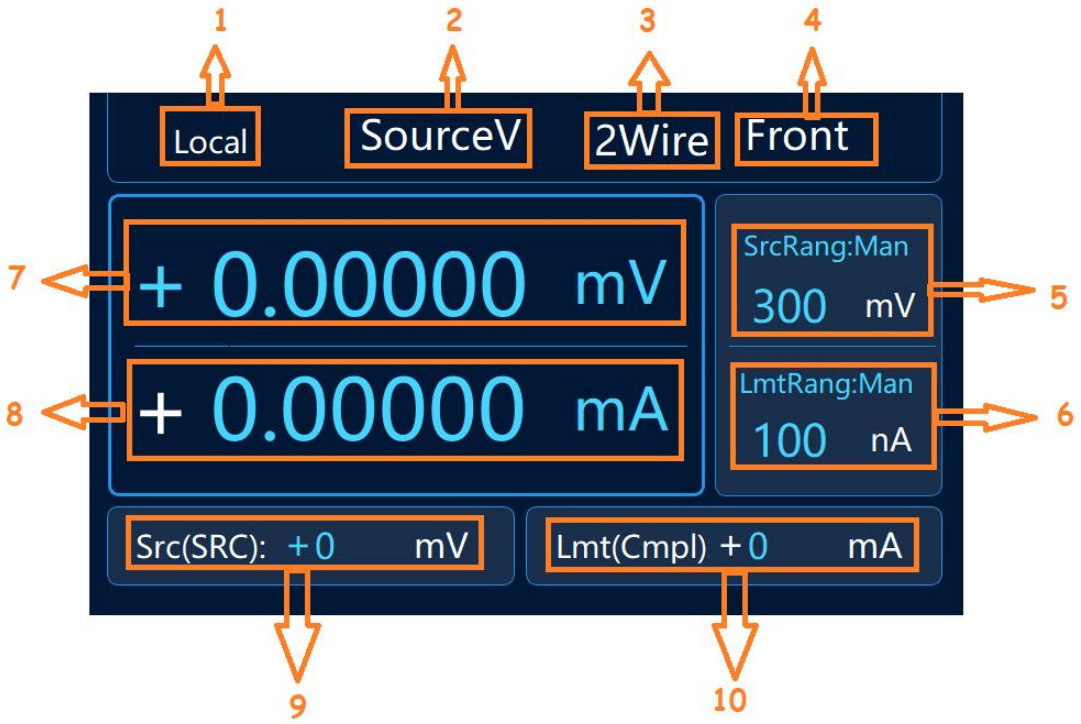


Figure 1-9 Measurement function window

①Control mode: Set the parameters on the source measure unit directly, or remote control the source measure unit by the host computer software or debugging assistant;

②Power mode: Voltage source mode and current source mode. Switch the power mode by directly clicking on the power mode;

③Measurement mode: 2-wire and 4-wire measurement modes, and different measurement modes can be modified in the settings;

④Front and back panel output display: When selecting the output port on the front panel, it will display "Front", and when selecting the output port on the back panel, it will display "back";

⑤Source range setting: You can switch between different source ranges by clicking on the source range;

⑥Limited range setting: You can switch between different limited range by clicking on the limited range;

⑦Source value setting: Select the one's digit or the ten's digit or the hundreds' digit, and turn the adjusting rotation to set the desired source value;

⑧Limit setting: Select the one's digit or the ten's digit or the hundred's digit, and turn to adjust the rotation to set the required limit value;

⑨Source value display: Display the set source value, and can change the source value at the same time;

⑩Limit value display: Display the set limit value, and the limit value can be changed at the same time;

The blue display part in the interface can be changed, the white display cannot be changed, when the source measure unit is in the output state, the source range, source value setting, limit range and limit setting will turn into white display and cannot be changed.

1.5.2 Setting Window

Below is setting window.

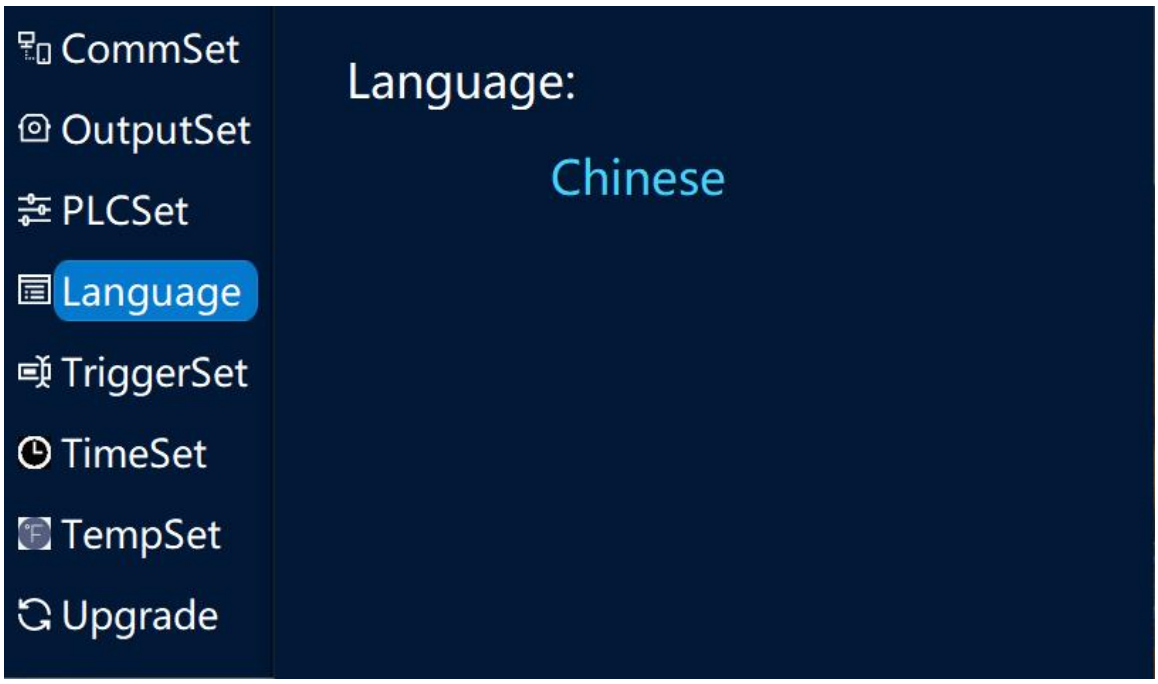


Figure 1-10 Setting window

Settings mainly include communication configuration, output settings, PLC settings, mode settings, trigger settings, time settings and other parts.

(1) Communication configuration

The source measure unit supports three communication modes: Ethernet communication, RS-232 serial communication, and GPIB communication.

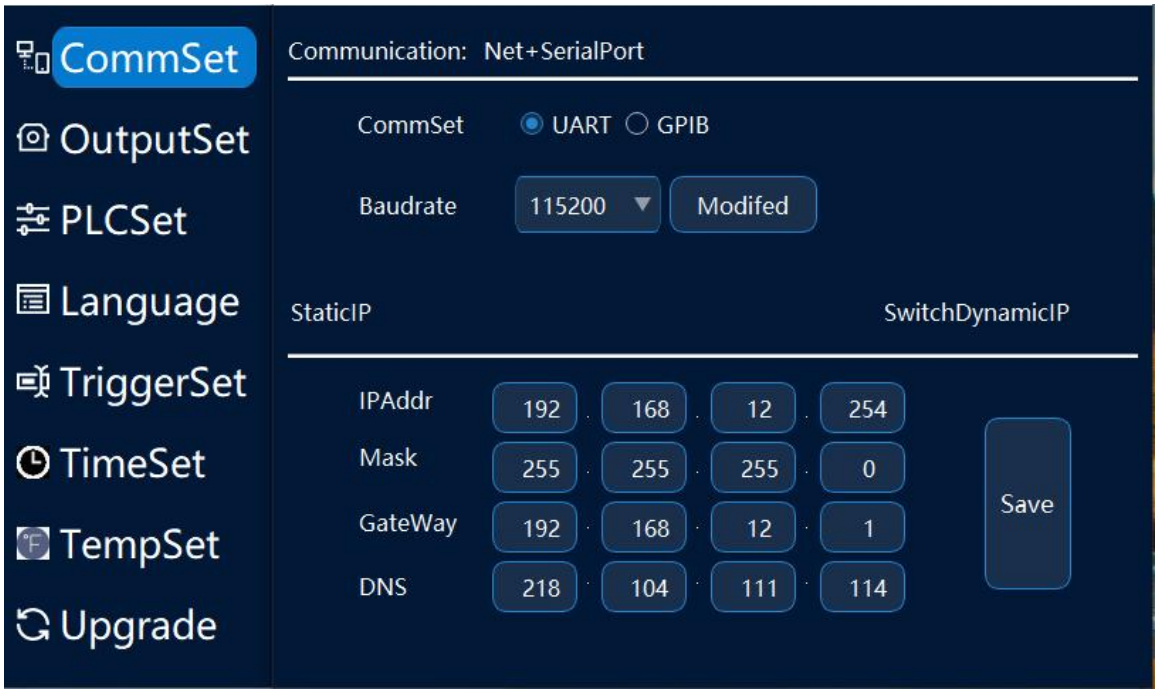


Figure 1-11 Communication configuration

The up part of the screen is the communication settings of the serial port and GPIB, and the down part is the communication settings of the network port.

To select serial communication, select "UART" in the communication settings, set the baud rate, support "9600" and "115200", and then click to modify and screen will remind "modification successful".

To select the GPIB communication method, select "GPIB" in the communication settings, set the device address, select "1-30", and then click Modify and screen will remind "Modification Successful". If you want to choose the network port communication, set the IP address, gateway, DNS of the same network domain as the PC, click Save, and the screen will remind "Modification Successful". If you connect to a router, it can be switched to dynamic IP directly.

(2) Output settings:

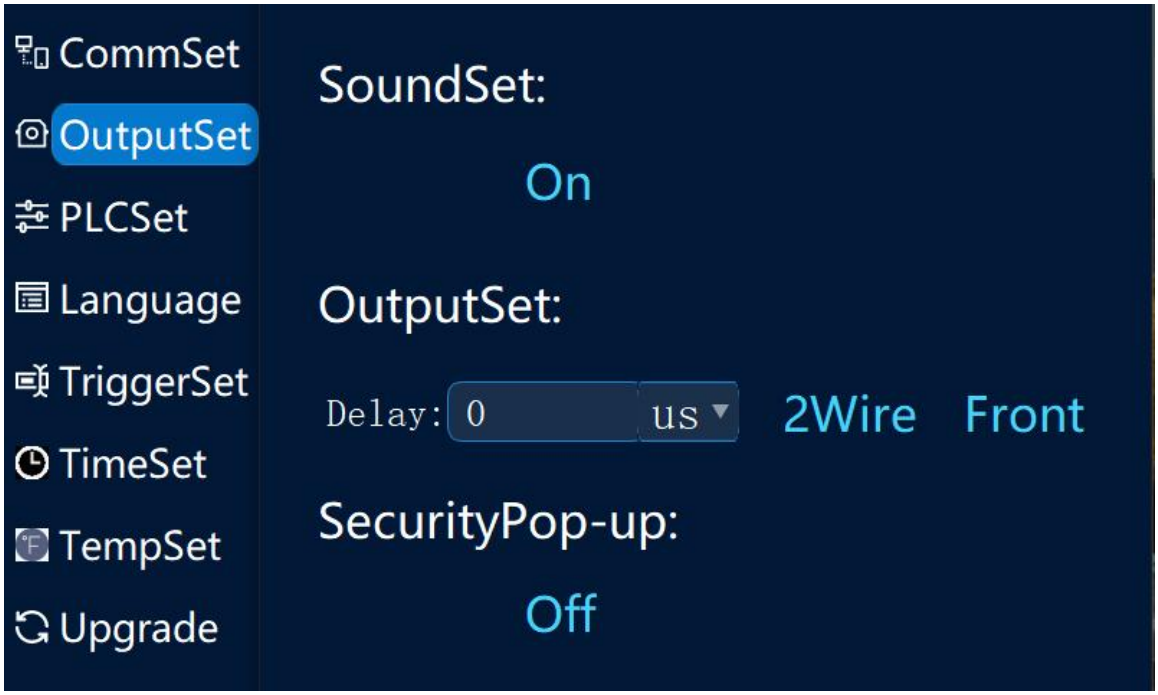


Figure 1-12 Output settings

Buzzer switch: when buzzer switch is on, pressing the button or turning the adjustment knob will make a buzzer sound;

Output setting: set 2-wire or 4-wire output mode, front panel or back panel output mode;

Security pop-up window: when pop-up window is on, there will be some security tips during the operation.

(3) PLC settings

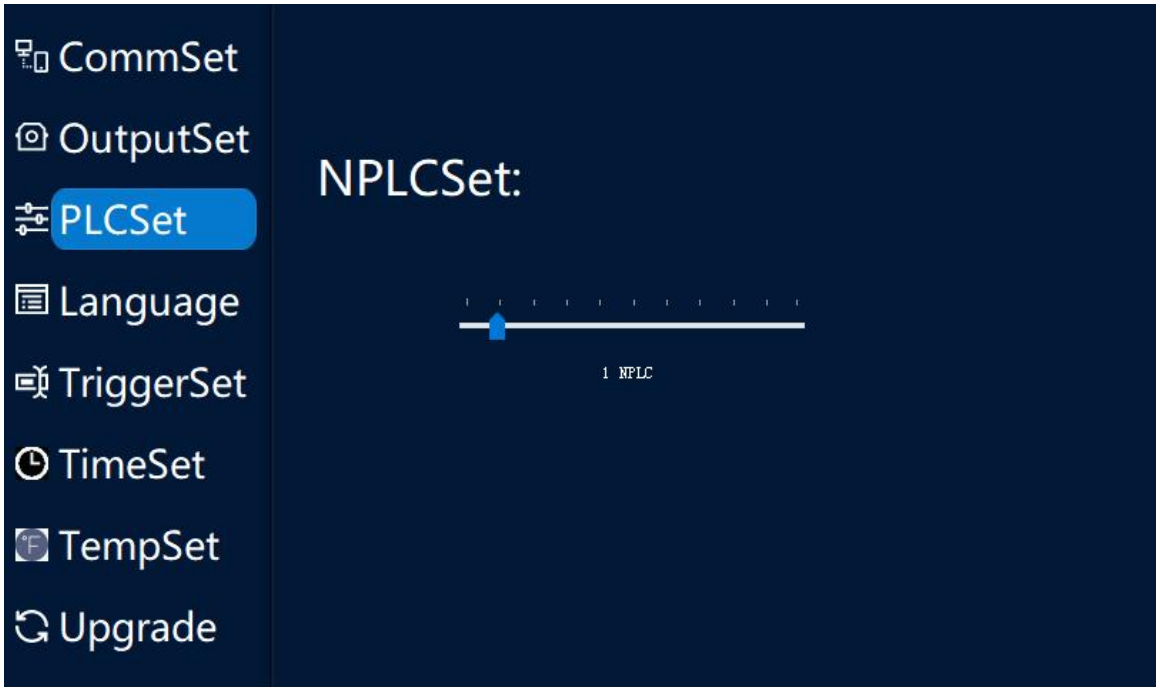


Figure 1-13 PLC settings

NPLC refers to the number of power frequency cycles, 1NPLC represents 1 power frequency cycle = 0.02 seconds, and different NPLC values represent the data volume (time interval) of each integration. For example, 1NPLC represents an integral calculation with the collected data every 0.02 seconds to remove the power frequency noise. The more time it takes to calculate with more data, the longer the source measure unit will take to measure, but the greater the resulting accuracy. That is to say, the smaller the NPLC setting value, the faster the scanning speed, but the lower the accuracy; the larger the NPLC setting value, the slower the scanning speed, but the higher the accuracy. NPLC is generally set between 0.1 and 10. Note: NPLC is a method to improve the test accuracy from the software. To improve the test accuracy in the actual test, hardware protection measures are also required, such as adding a shield, using a coaxial cable or a triaxial cable.

(4) Trigger settings

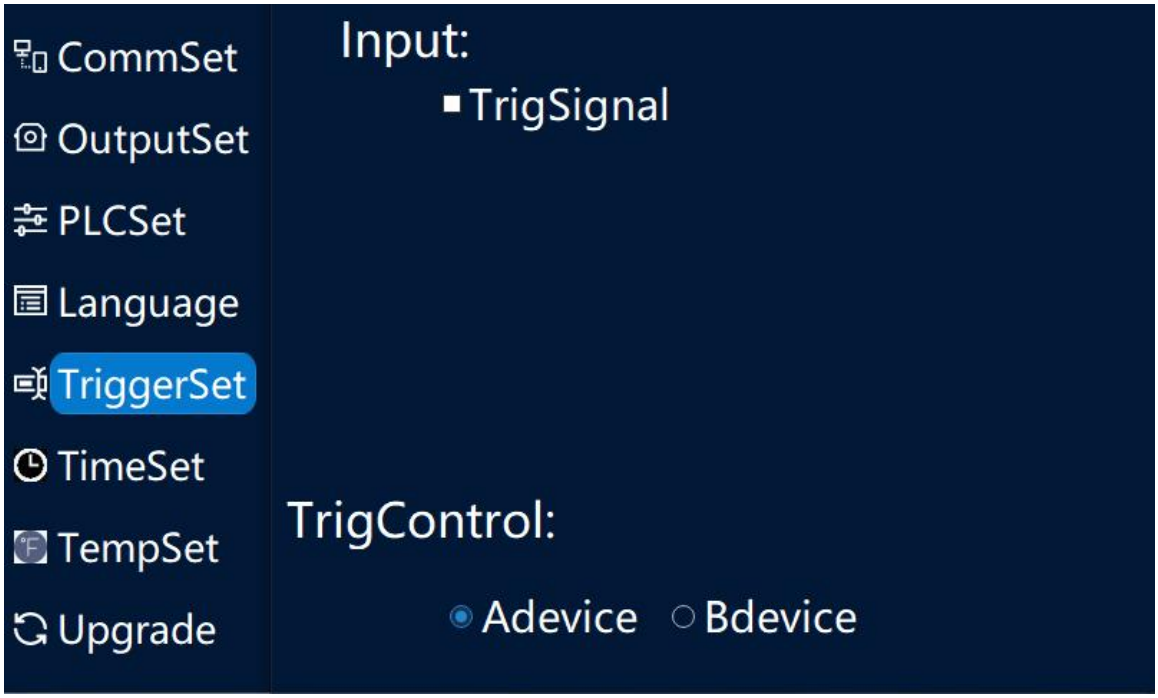


Figure 1-14 Trigger settings

Trigger settings are mainly used to set master-slave control during synchronous testing of multiple source measure units.

(5) Time settings

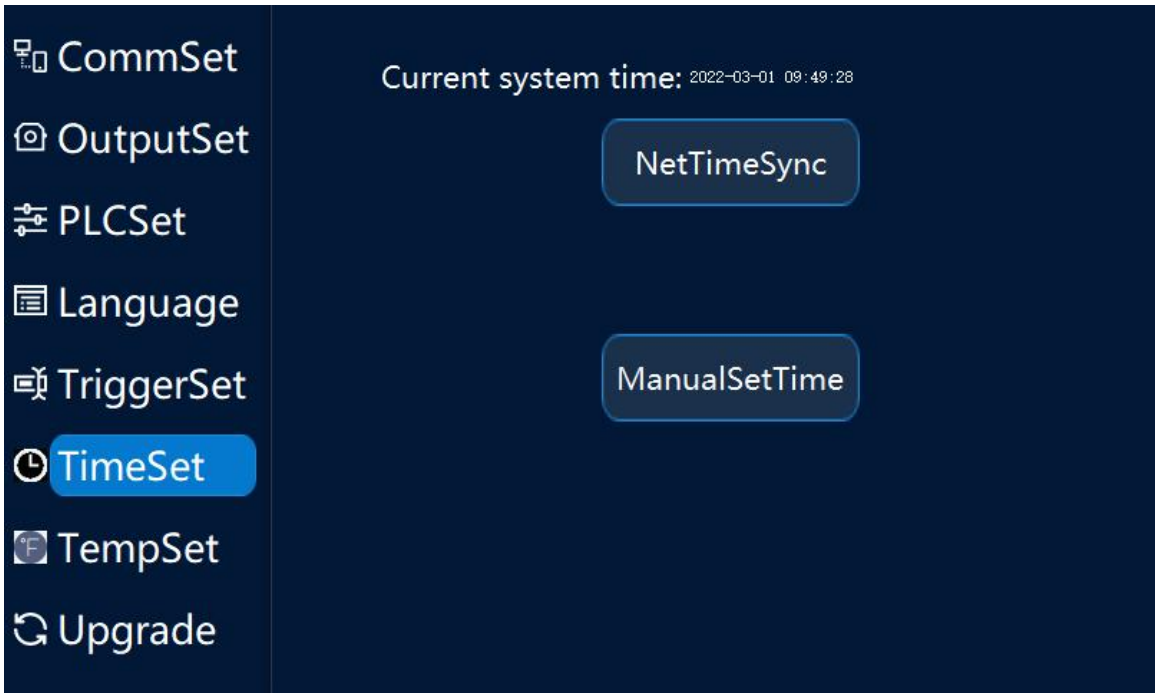


Figure 1-15 Time settings

There are two ways to set the time, the first is to synchronize the time on the PC, and another is to set time by hand.

(6) Temperature setting

Source measure unit can monitor its own temperature and automatically start the fan to cool down when the temperature is too high. When the temperature of the source measure unit exceeds 50℃, the fan will start, and when the temperature drops to 40℃, the fan will stop.

(7) Version upgrade

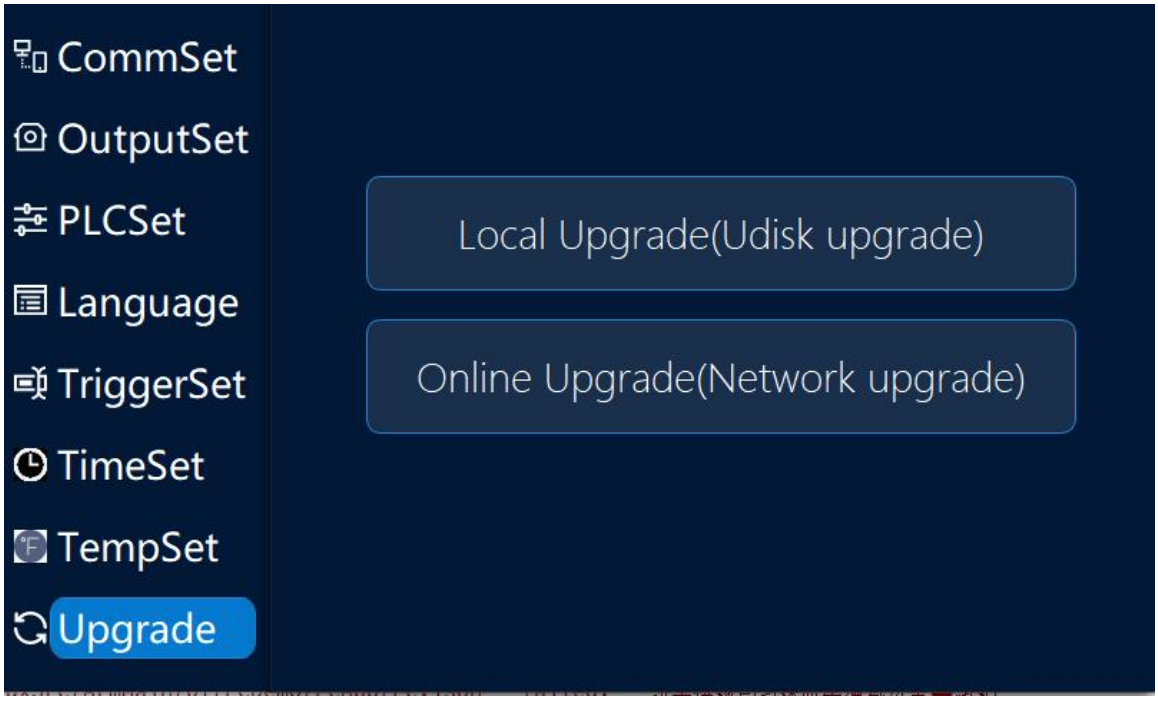


Figure 1-16 Version upgrade

To upgrade of the embedded software of the source measure unit, there are two ways. One is upgrade local through U disk, and another is online upgrade.

1.5.3 Version Information Window

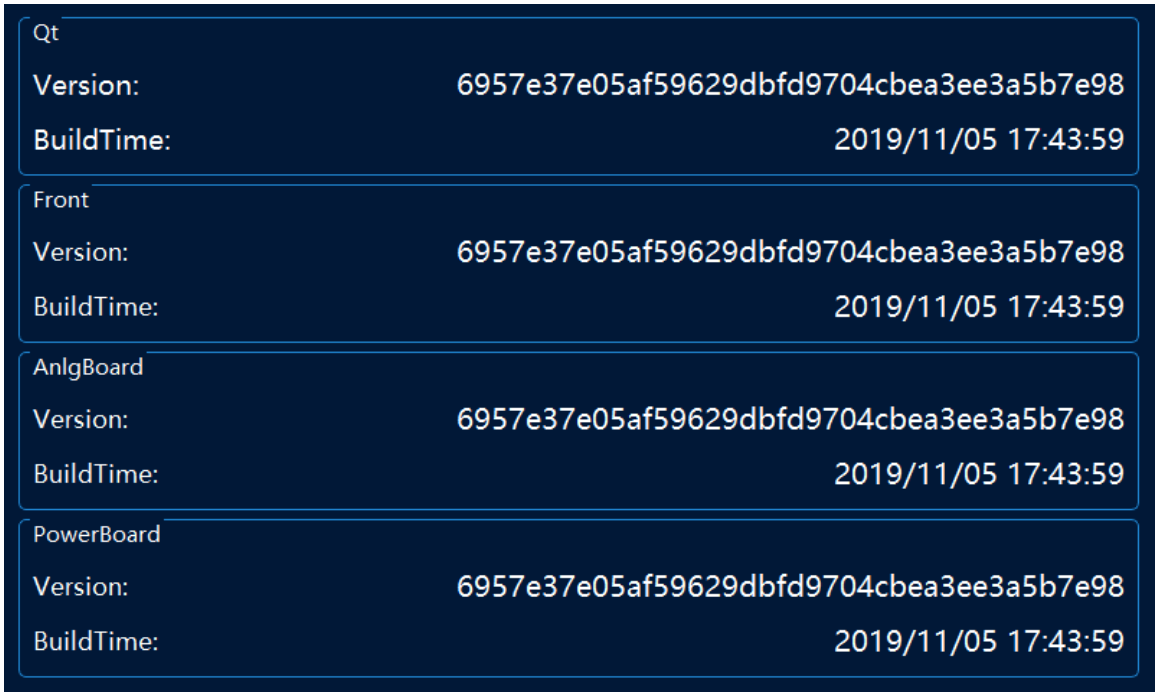


Figure 1-17 Version information

Version information includes version of Qt, front panel, analog board, and power board.

1.5.4 Scanning Window

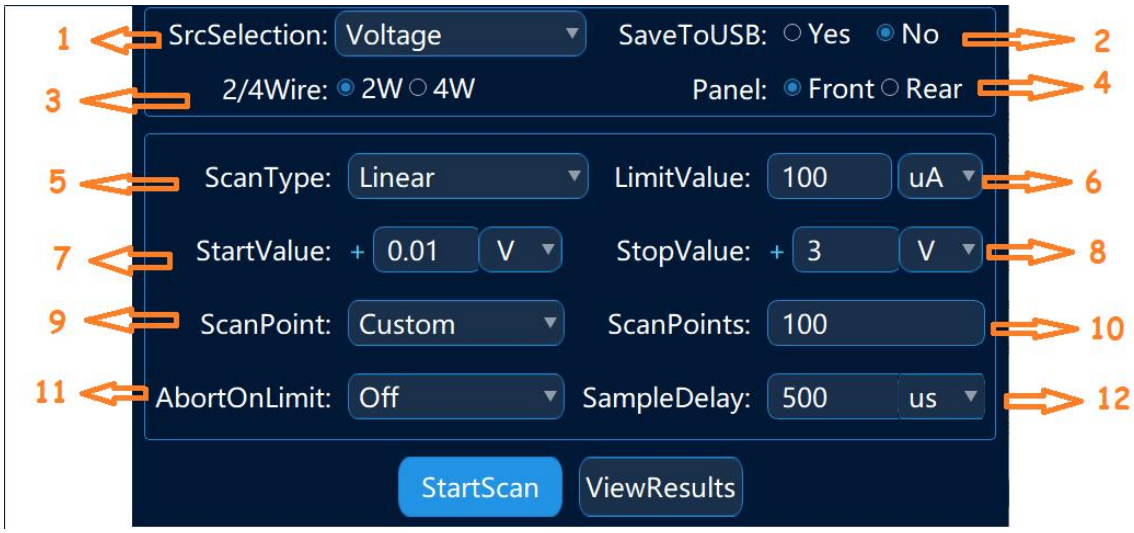


Figure 1-18 Scanning function window

①Power supply: Voltage source or current source;

②Save data: When you select "Yes", the scan results will be saved in the connected U disk;

③Measurement mode: 2-wire measurement mode or 4-wire measurement mode

④Output mode: Front panel output or the back panel output ;

⑤Scan type: Currently, only linear scanning can be set on the source measure unit, and nonlinear mode can be customized by PC software;

⑥Limit setting: Set limit protection circuit;

⑦Start value: The starting point of the scanning interval;

⑧End value: The end point of the scanning interval;

⑨Scan point type: Currently all are customized;

⑩Number of Scan Points: Set the number of points to be scanned. Currently, the source measure unit supports a maximum of 2000 points to be scanned at one time;

⑪Over-limit stop switch: Over-limit stop is set to "ON", when the test value in the circuit exceeds the limit, the source measure unit stops output;

⑫Sample delay:

Start scanning: After clicking, the source table starts to output;

View results: You can view the results of the last scanning.

1.5.5 QuickSet Mode Window

In the quickset mode, the source measure unit can quickly enter the voltmeter and ammeter modes.

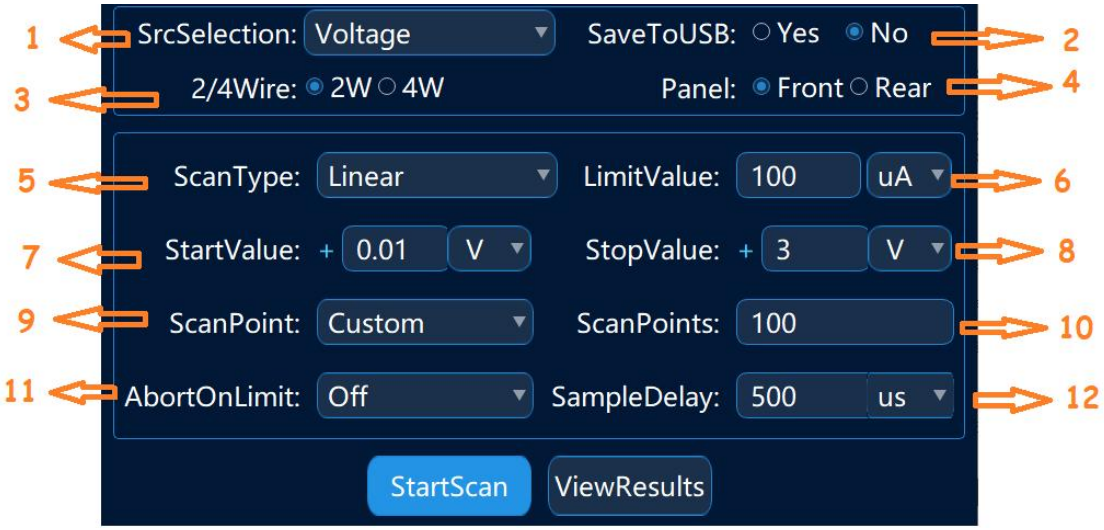


Figure 1-19 Quick mode

Click on the quickset mode, you can see two options "Voltmeter" and "Ammeter". Let's take a voltmeter as an example.

It can be seen that the voltmeter mode is very close to the measurement interface, and considering measurement safety, the limit value will be automatically set to the maximum value of the range. When measuring, value should be set from high range to low range.

Figure 1-20 Volmeter interface

2 Professional Test Software Introduction

To meet various requirements, PRECISE source measure unit is equipped with Pss SMU Tools PC professional test software. The software is developed kinds of devices test mode to make testing rapid and improve testing efficiency.

2.1 Software Main Window

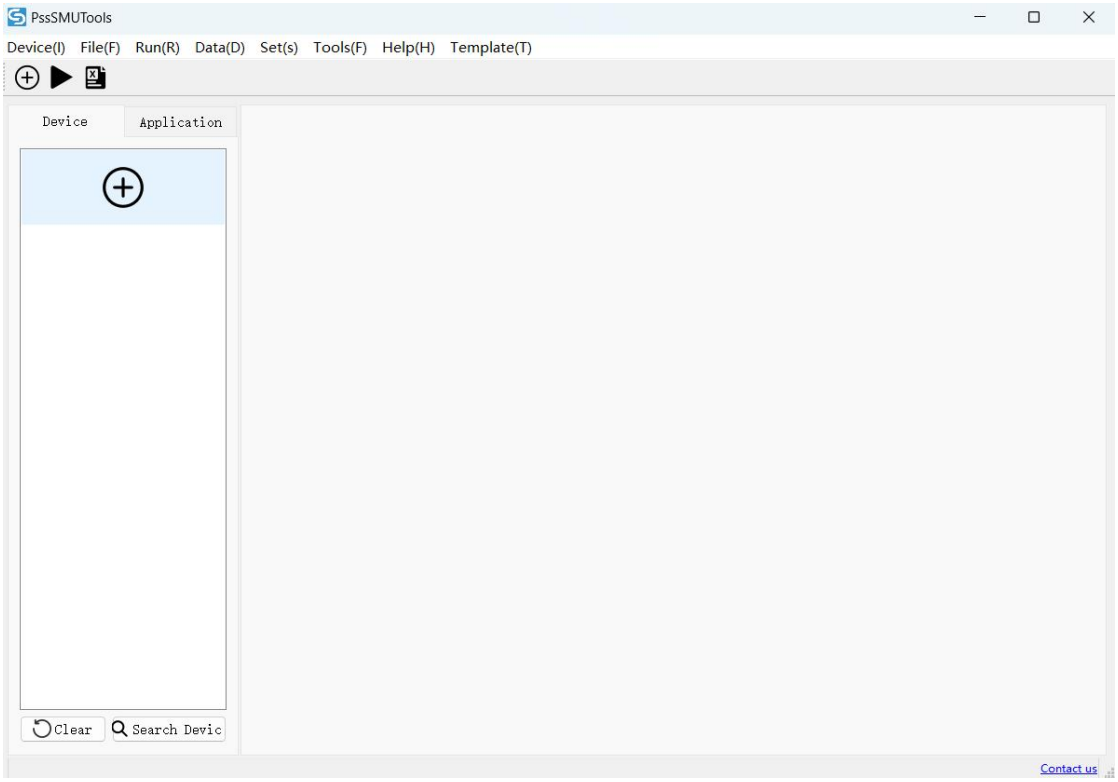


Figure 2-1 Software main window

Main menu introduction as follows:

(1) Device

Connect to device: Click it and there will be a "connect to device" pop-up window. Putting device information, it can be connected to the corresponding source measure unit.

Upgrade device: Used to remotely upgrade the source measure unit program.

Search device: You can search the source measure unit connected in the local area

network where the PC is located.

(2) Files

Open project file: Used to open the previously saved project file;

Save project file: Used to save the currently created or opened project file;

Save as: Used to save the opened project file as another project file;

Operation log: Record some wrong operations in PC.

(3)Run

Run the current project: Click to run the project displayed on the current interface:

Run All Projects: Click to run all test projects created in the software.

(4)Data

Save current data: Click to save the test data of the project displayed on the current interface. The table format is .csv format and .xlsx format.

Save current Figure: Click to save the test curve of the project displayed on the current interface. The Figure format is .png, .jpg and .bmp.

(5)Settings

Options: No functionality has been added yet.

(6)Tools

Data Compare/Convert:After importing the file, you can compare the voltage and current.

(7) Help

About: You can check the software version of the host computer.

(8) Template

A test template with default settings can be opened for quick testing.

2.2 SMU Connection

There are three regular connecting ways of connection source measure unit to PC: Ethernet connection, RS-232 connection, and GPIB connection.

(1) Ethernet connection

First set proper IP on source measure unit.Please note that the IP address of the source measure unit must be in the same LAN as the IP address of the PC. For example, the IP address is set to 192.168.12.201 in the figure, and the address of the PC side is also 192.168.12.X, and "X" is any value in 2-254 except 201. And fill in the correct gateway and DNS, and then click Save, after the setting is successful, there will be a successful

setting prompt in the below right corner. In the host computer software, click "Device - Connect to Device" in turn, or click the pop-up window of "Connect to Device" as shown in Figure 2-3.

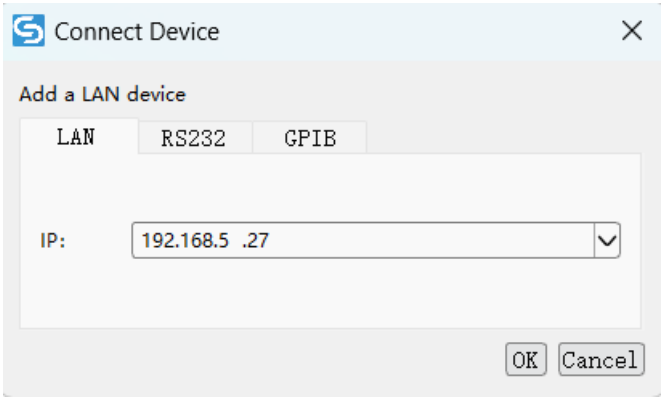


Figure 2-2 PC network port connection settings

Enter the IP address set on the source measure unit, and click OK to see that a source measure unit device has been added to the device column on the left side of software.

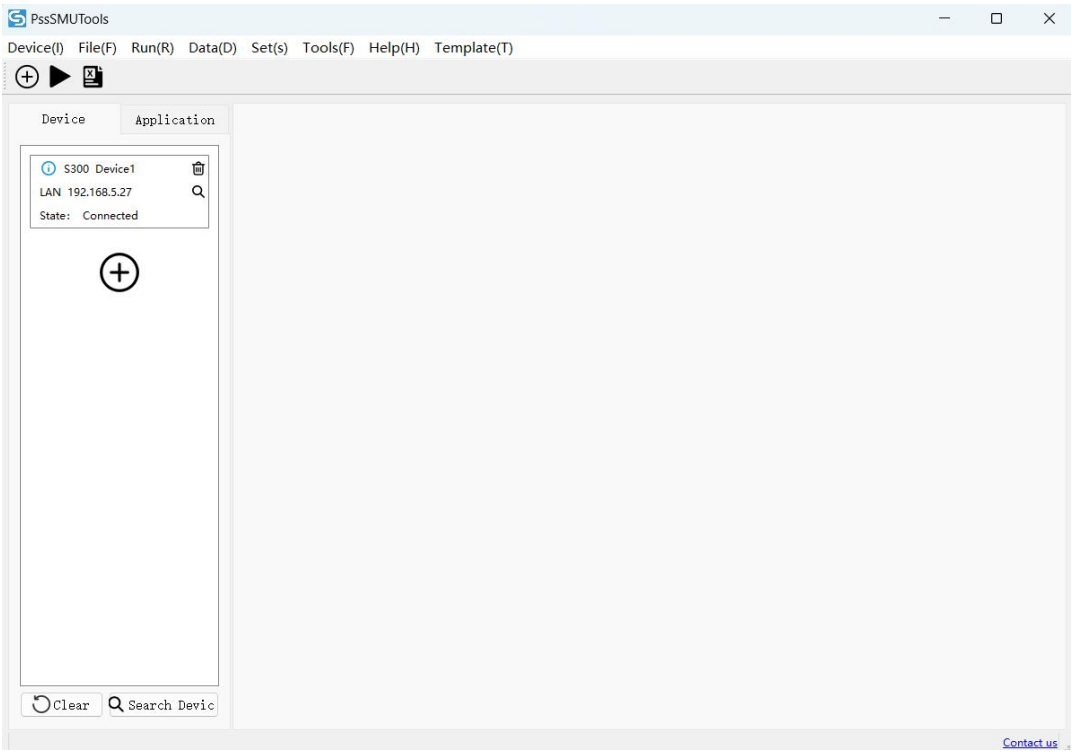


Figure 2-3 Network port connected new devices

From the Figure 2-3, you can see the connected source measure unit, IP address and source measure unit working status. Click  to delete the added source measure unit,

and click 🔍 to find the connected source measure unit.

⑵ RS-232 connection

First set the source measure unit.

In the communication configuration, select "UART" for the communication setting, then select the desired baud rate, and then click Modify. When the screen prompts that the setting is successful, it means the setting is successful.

After the source measure unit setting is completed, use the host computer to connect, click "Device - Connect New Device" in the host computer software, or click "⊕", "Connect Device" popup will pop up.

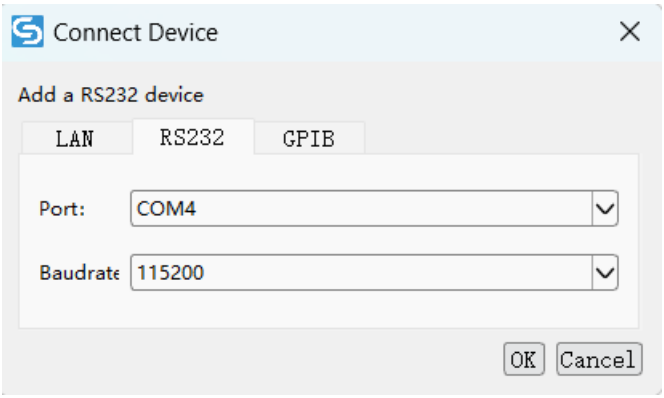


Figure 2-4 PC serial port connection settings

Select "serial port", the corresponding port number and baud rate, click OK, you can see the newly added source measure unit device in the device column.

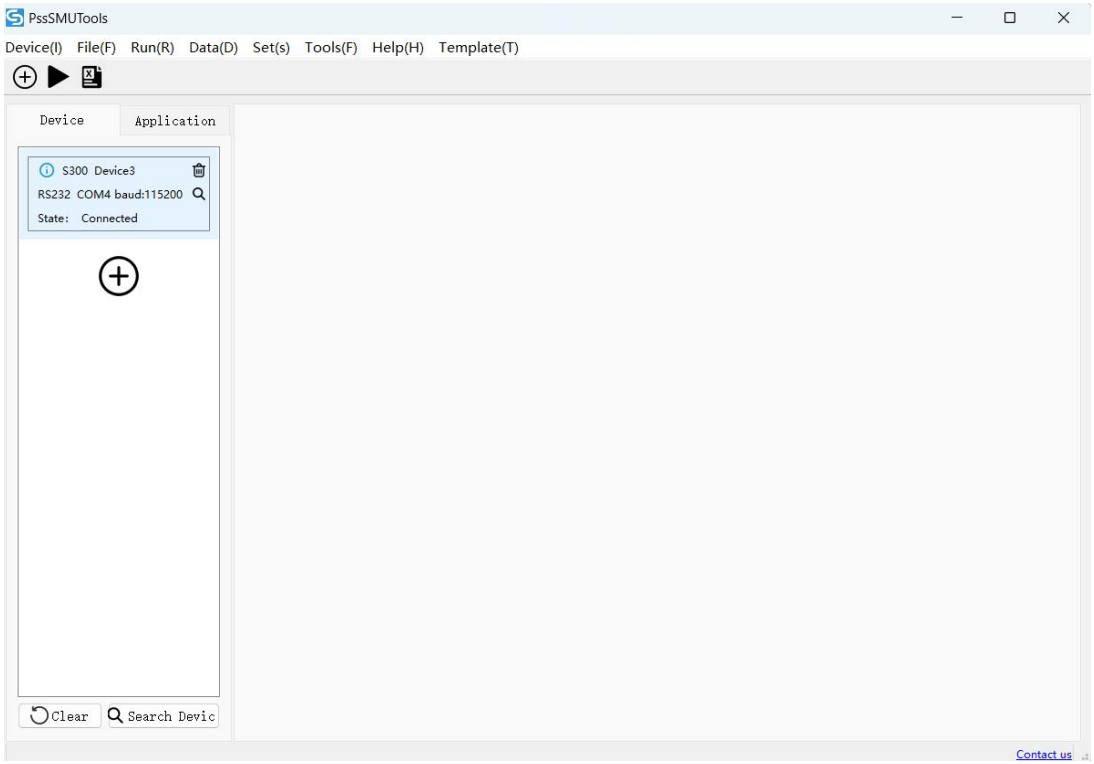


Figure 2-5 Serial port add new device

can see model, port number, baud rate and working status of the newly added device.

(3) GPIB connection

First set the source measure unit, select GPIB in the communication settings, then set the device address (1-29), and then click "Modify", until the screen prompts that the setting is successful, it means the setting is successful.

After the source measure unit setting is completed, to collect it with PC, click "Device" - Connect New Device" in PC software, or click "⊕", "Connect Device" popup will pop up.

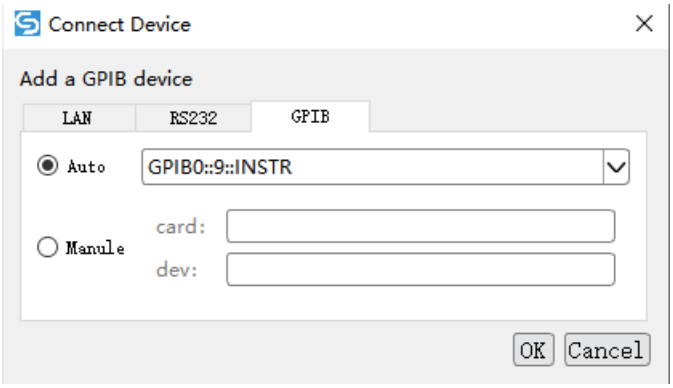


Figure 2-6 GPIB connection setting

Select GPIB, you can choose automatic or manual mode, the automatic mode is the address recognized by the host computer software itself, and the manual mode is to manually input the connected address. For convenience, you can select the automatic mode, drop down the option, select the address set on the connected source table, and then click OK. The new device will be found at device column.

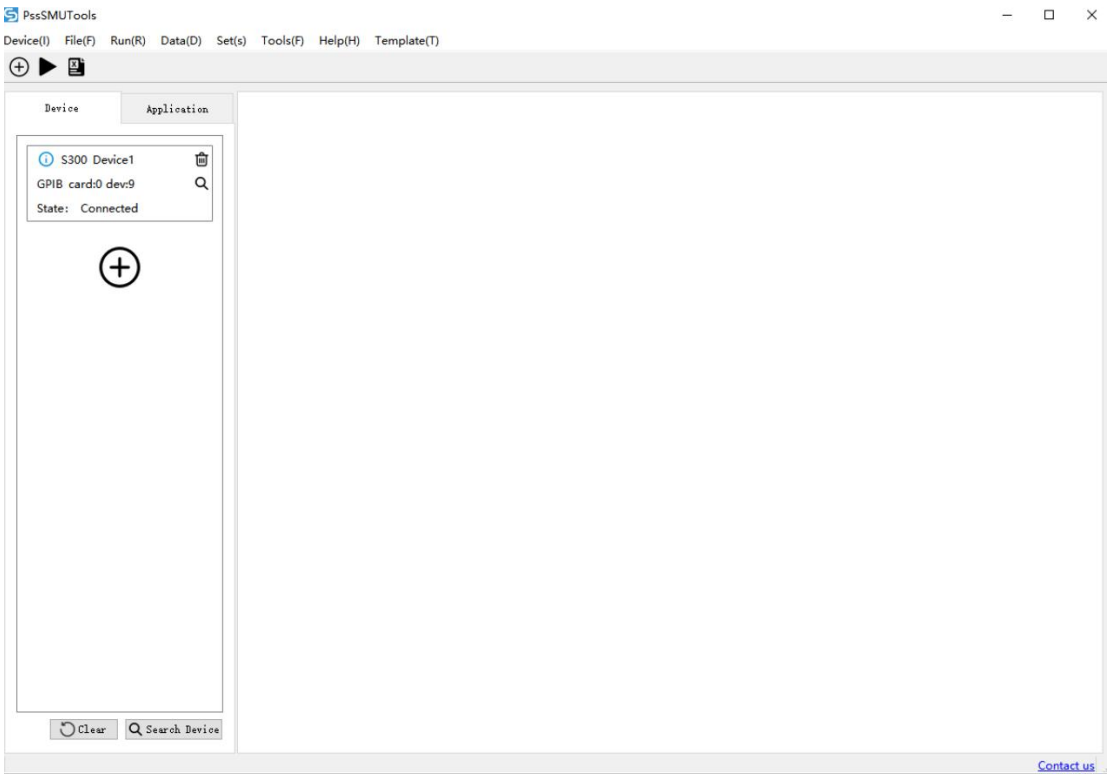


Figure 2-7 GPIB add new device

When connected,can see model, communication address, working status of the device.

2.3 Function Introduction

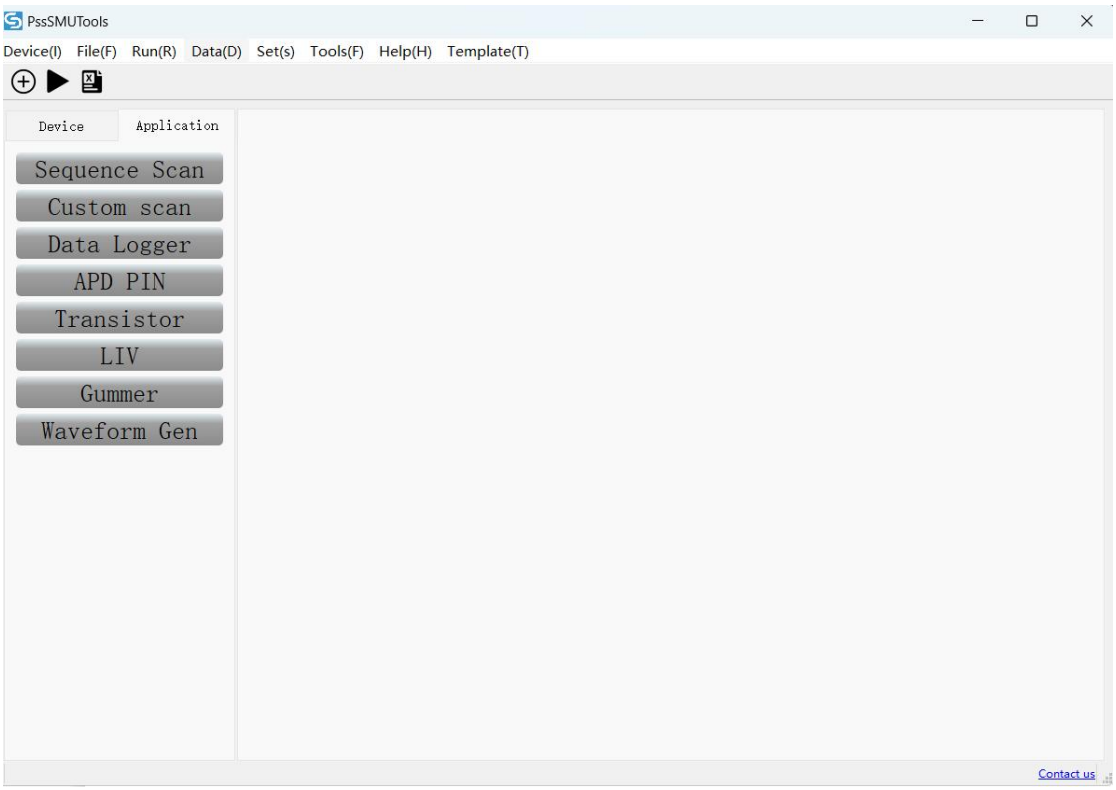


Figure 2-8 Function interface of software

At present, there are eight functional modules: Sequence scan,Custom scan, Data logger, APD PIN, Transistor, LIV, Gummer,Waveform generator.

⑴Sequence scan

After clicking the sequence scan, the "Select Device" window will pop up.

Figure 2-9 Select the test source measure unit

Select the connected device and click OK. Then can see the sequence scan test interface,as follows:

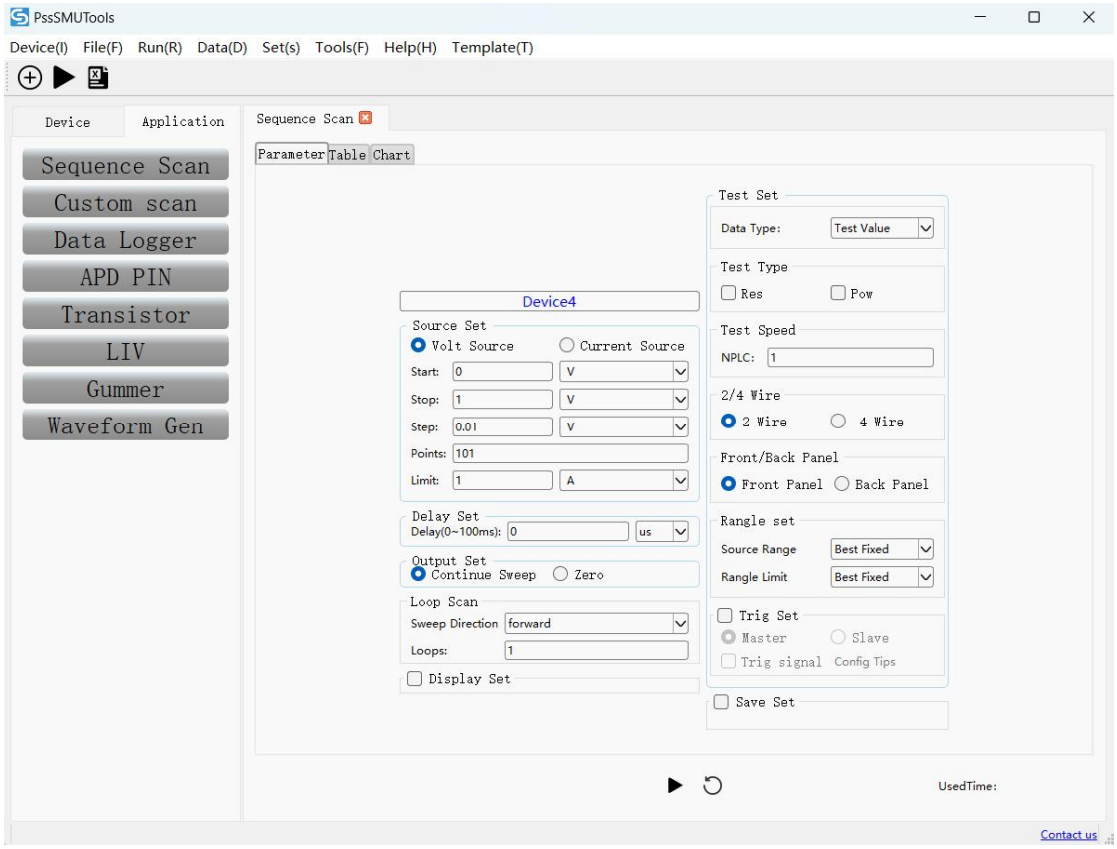


Figure 2-10 Sequence scan interface

The sequence scan test includes three interfaces:Parameter configuration, Table and Chart. The parameter configuration interface includes source/limit settings, measurement settings, other measurements, test speed, 2/4-wire settings, front/rear panel settings, and Trig control settings.

Source and limit setting: You can set voltage source mode or current source mode, source value interval, number of test points, limit value;

Test Set: Divided into set value and measured value; when the set value is selected, the abscissa of the obtained curve is the set interval value, and when the measured value is selected, the abscissa of the obtained curve is the actual measured value;

Test Type: Click resistance or power, the test result will have the value and curve of resistance or power;

Test speed: NPLC is the number of power frequency cycles, and the variation range is between 0.1-10. The larger the value, the slower the test speed and the higher the test accuracy.

2/4-wire: select 2-wire mode or 4-wire mode test according to test requirements;

Front/rear panel: Select front panel output or rear panel output according to actual wiring;

Range set: "Best Fixed" means self-adaptive, the upper computer will set the appropriate range according to the set parameters; if you need to set a specific range, you can pull down and select the desired range.

Trig set: Set master and slave when multiple units are linked.

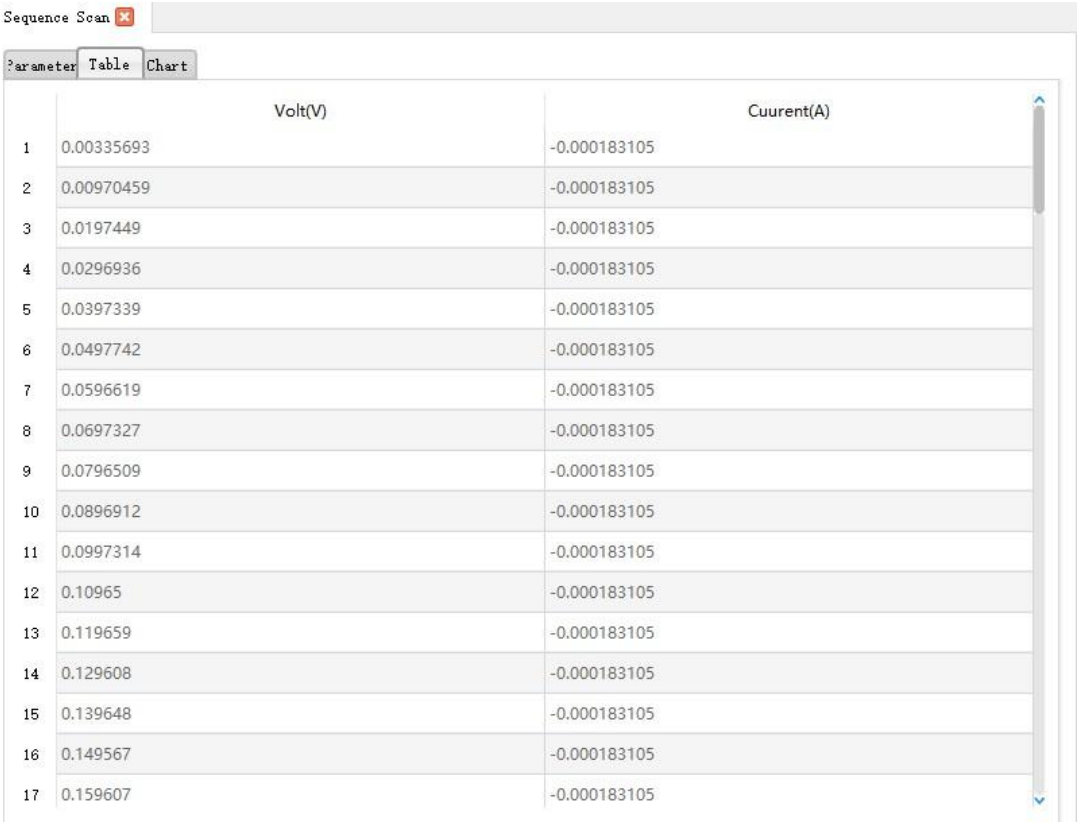
Delay set: The sampling delay of the sampling point can be set;

Output set:Continue Sweep, that is, after one scanning point is completed, it directly increases in steps to the next scanning point (such as 1-2-3);

Zero means that after a scanning point is completed, it returns to the 0 value, and the next scanning point starts scanning from the 0 value (such as 1-0-2-0-3).

Loop Scan: Bi-directional scanning can be set (such as from 0-1V to 1-0V), and the number of circular scans can be set;

Click "Table" in the upper left corner to switch to the table interface.



	Volt(V)	Cuurent(A)
1	0.00335693	-0.000183105
2	0.00970459	-0.000183105
3	0.0197449	-0.000183105
4	0.0296936	-0.000183105
5	0.0397339	-0.000183105
6	0.0497742	-0.000183105
7	0.0596619	-0.000183105
8	0.0697327	-0.000183105
9	0.0796509	-0.000183105
10	0.0896912	-0.000183105
11	0.0997314	-0.000183105
12	0.10965	-0.000183105
13	0.119659	-0.000183105
14	0.129608	-0.000183105
15	0.139648	-0.000183105
16	0.149567	-0.000183105
17	0.159607	-0.000183105

Figure 2-11 Sequence scan table window

The table interface will record the obtained test data, and the data can be saved locally by clicking "Save current data" in the data in the upper left menu bar.

Click "Charts" in the upper left corner to switch to the chart interface.

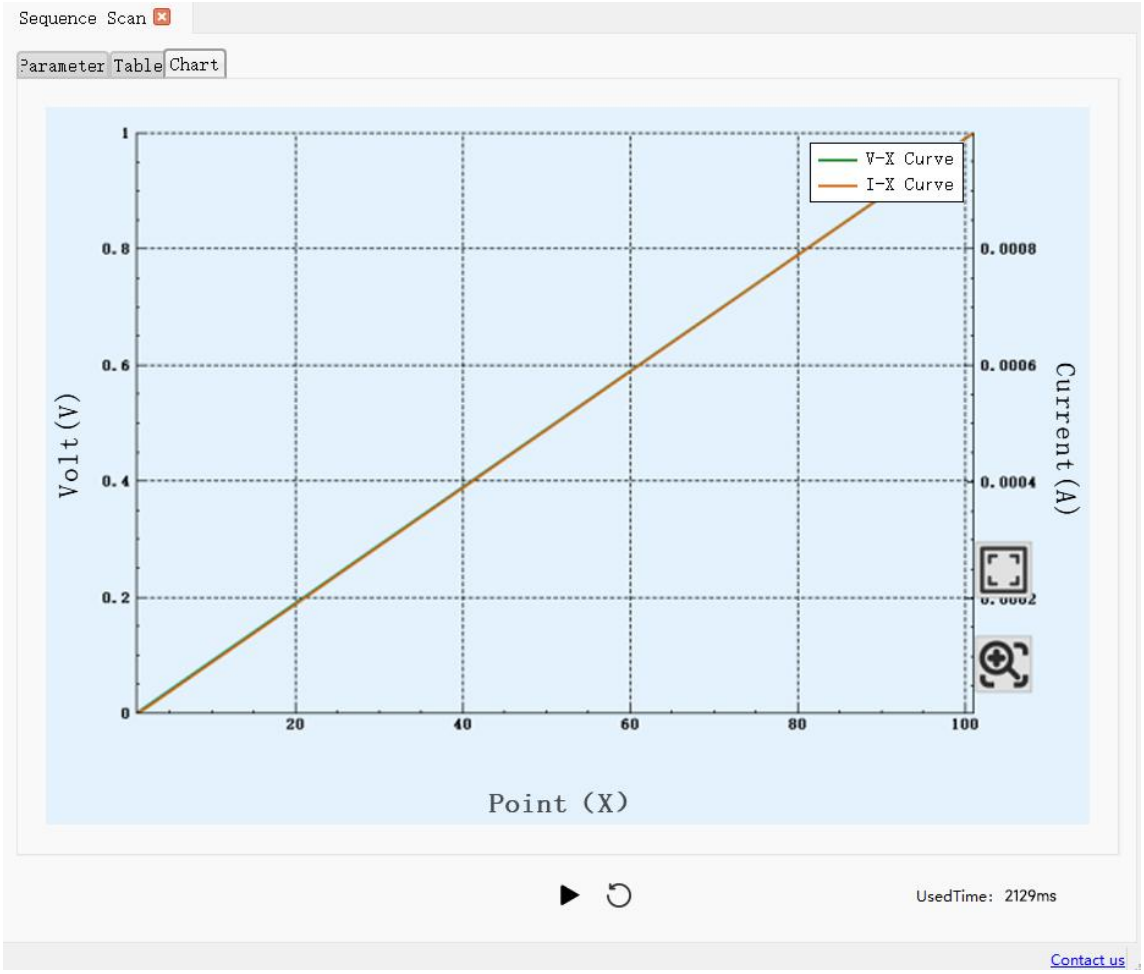


Figure 2-12 Sequence scan chart window

The chart interface will present the characteristic curve obtained from the test, and the displayed curve type can be changed by placing the cursor on the left, right and lower sides of the graph. The curve can be saved locally by clicking "Save current Figure" in the data in the upper left menu bar.

(2) Custom scan

Custom scan compared with sequence scan, the number of points within the scanning interval can be freely set. Additionally, you can import the edited. csv data table. It is recommended to use a single column format for the imported data, and other parameter

settings should be consistent with sequence scanning.

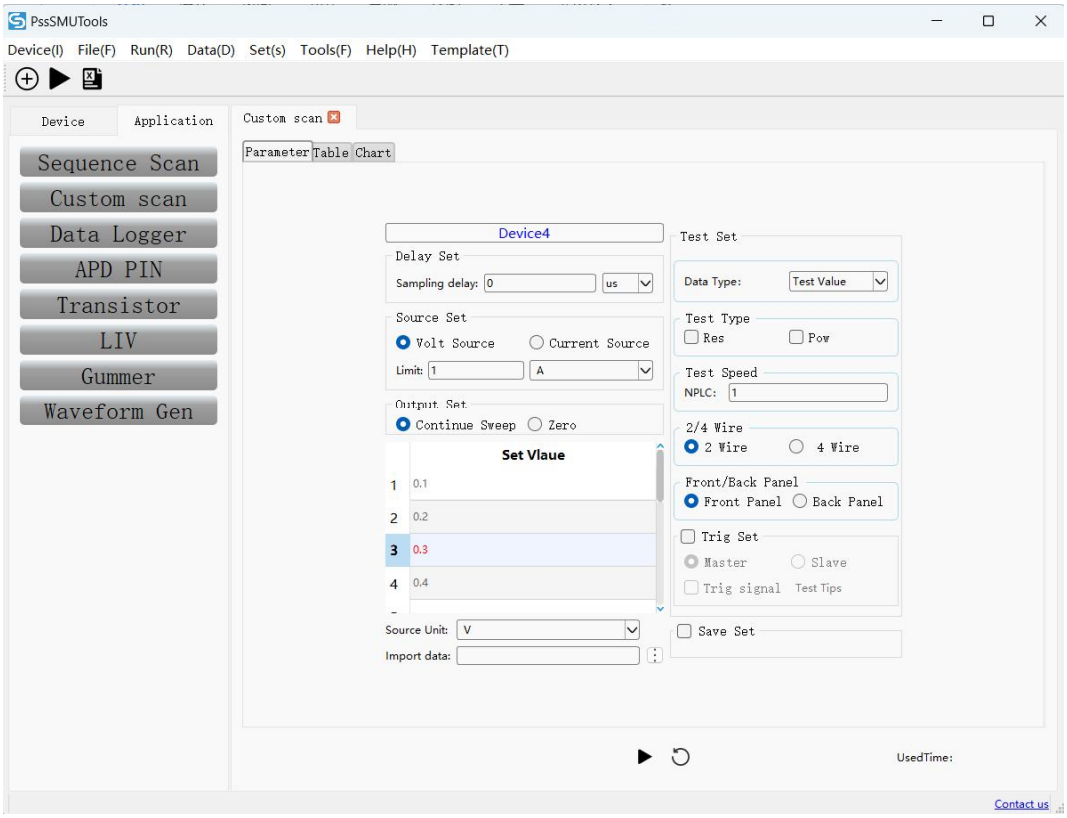


Figure 2-13 Custom Scan Window

(3) Data logger

The data logger is a mode that continuously outputs a constant voltage source or constant current source for testing.

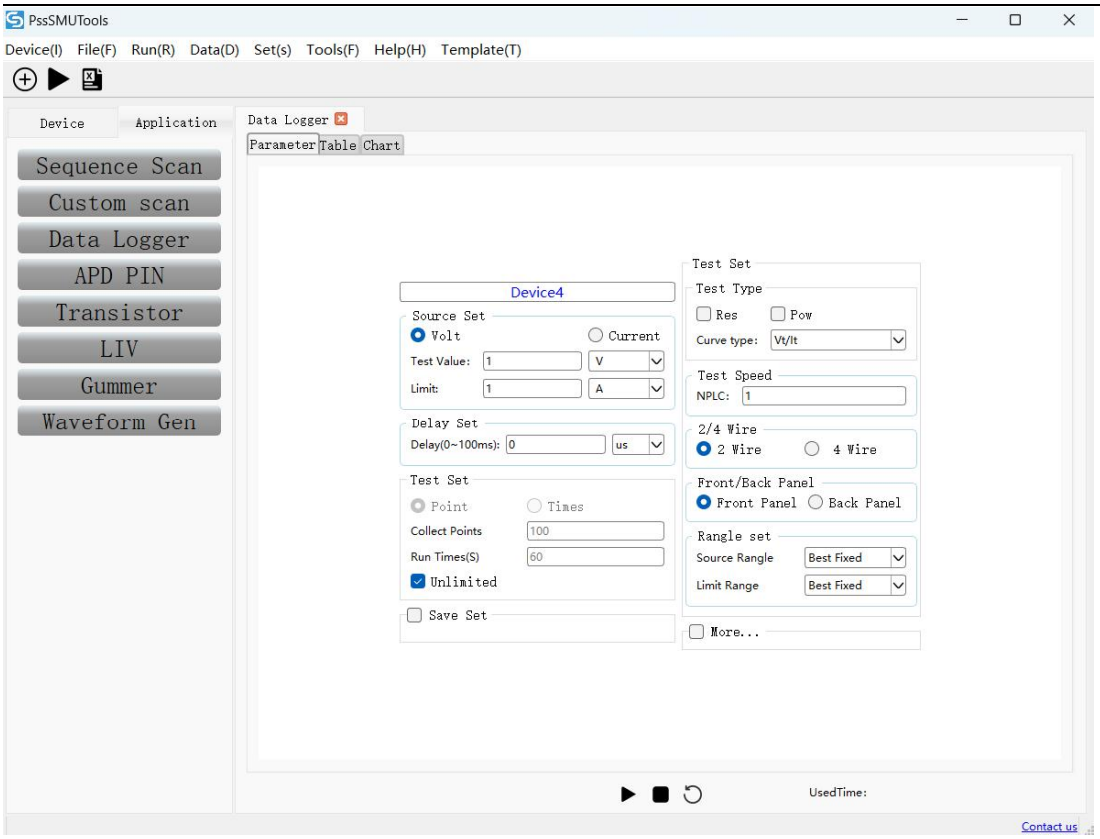


Figure 2-14 Data logger interface

As data logger is in constant voltage source or constant current source mode, so in the source limit setting, you only need to select the constant voltage source or constant current source first, and then set the required source limit.

Delay setting: The sampling delay of the sampling point can be set;

Test settings: You can set three modes: fixed sampling points, fixed test duration, or infinite measurement points;

Save Settings: Check Save Settings to automatically save the data after the test stops, or you can click on the directory to save it to the specified folder.

Cache mode: This option is a test optimization for old version source tables, which can be ignored in new versions;

Advanced settings: Set the number of data displayed in the table and the number of data displayed in the curve interface;

Data statistics: It can quickly calculate the maximum, minimum, and average values of test data over a period of time;

(4) APD PIN

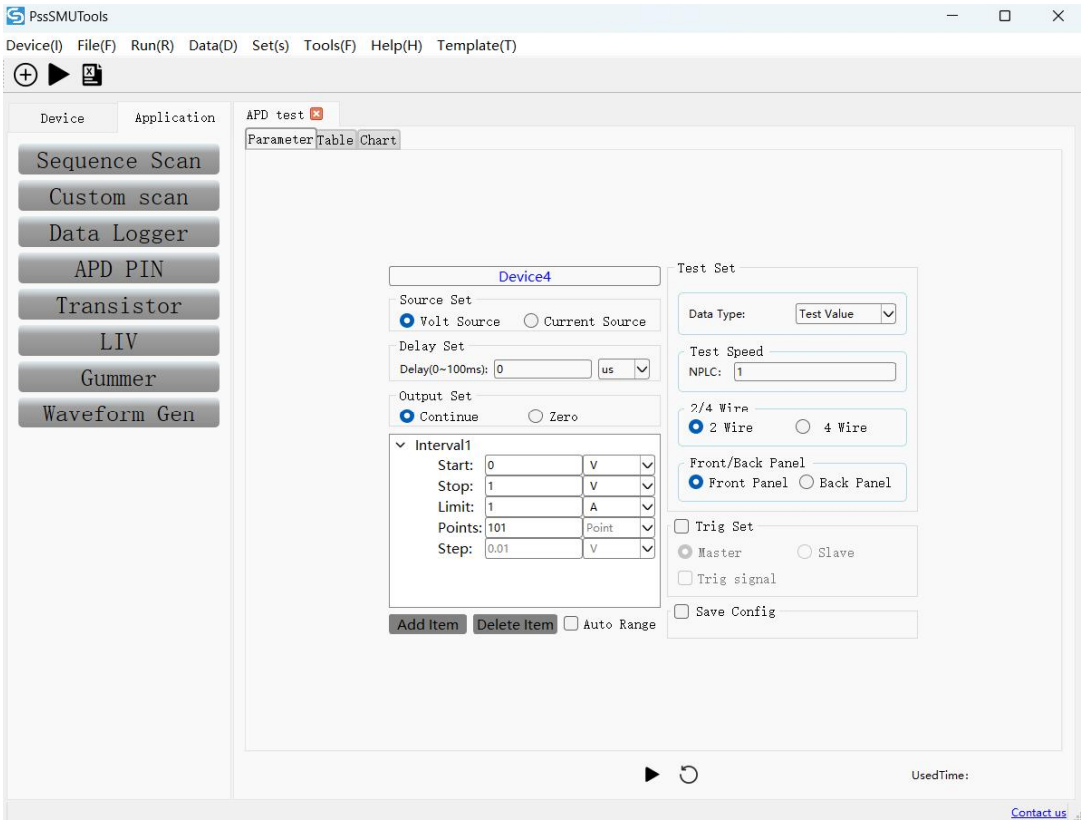


Figure 2-15 APD test module interface

This module test is also a scan test, and the module adds the function of adding a new scan interval to the sequence scan. In this module, we can set multiple scan intervals to scan at the same time, and then draw the obtained test data in a curve. This mode is convenient for us to understand the overall characteristic curve of the device, and at the same time, we can focus on observing the characteristic changes of the device in a certain interval, and can also meet the needs of some customers for repeated testing.

(5) Transistor

The transistor test module includes MOSFET test and triode test.

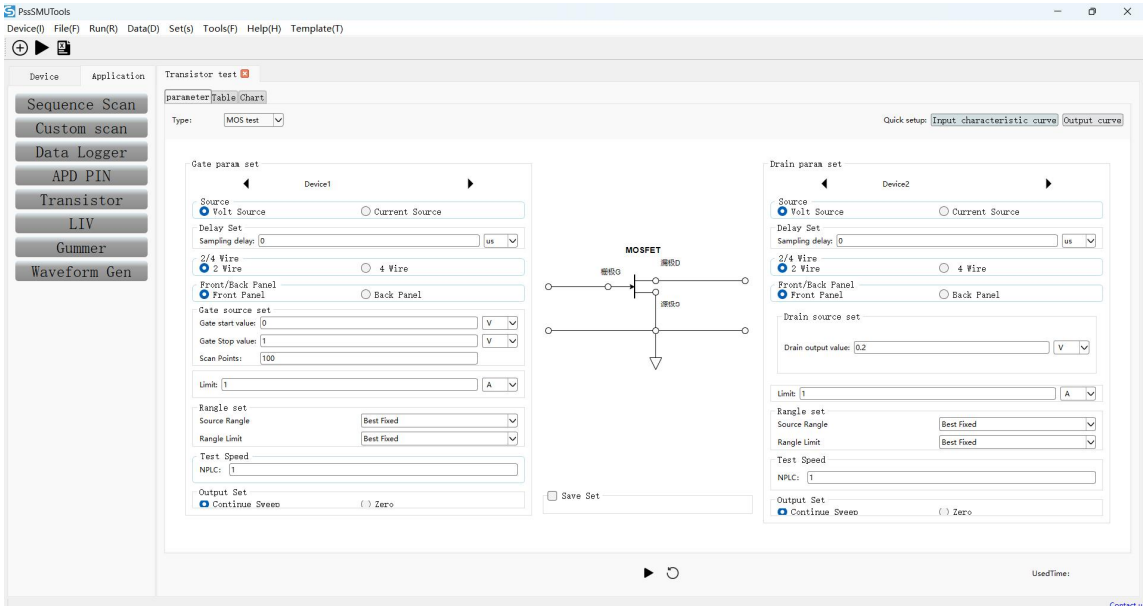


Figure 2-16 MOSFET test interface

The MOSFET test module adopts the common source mode, so when building the circuit, it needs to be consistent with the model and use the common source mode to connect.

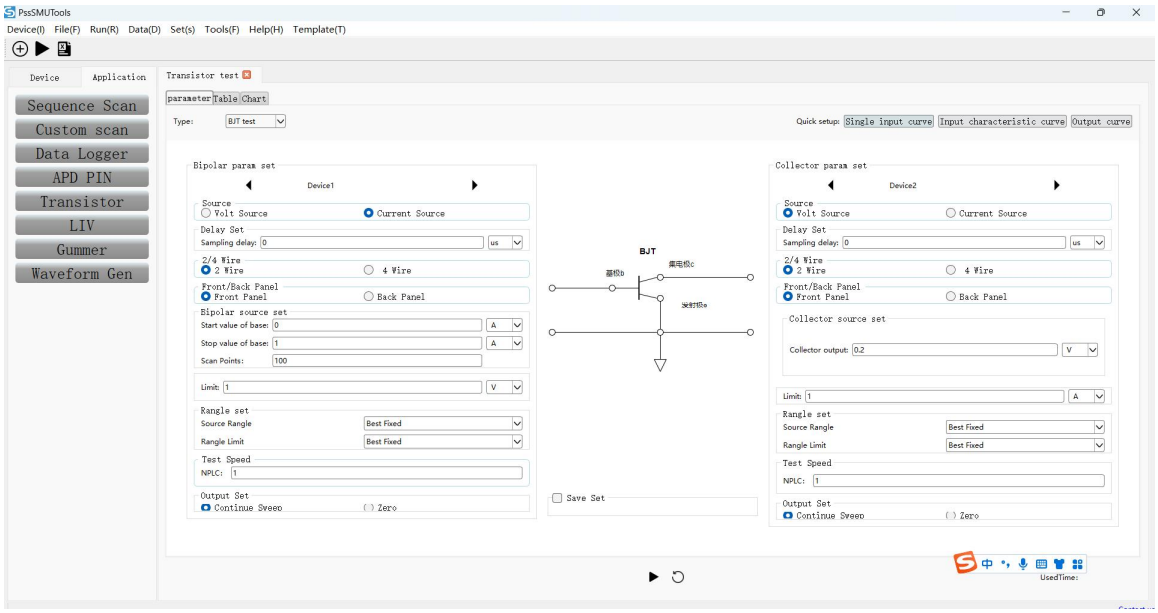


Figure 2-17 Triode test inferface

The triode test module adopts the common-emitter mode, so when building the circuit, it should be consistent with the model and use the common-emitter mode to connect.

(6) LIV scanning

LIV scanning module is for PIN scanning test.

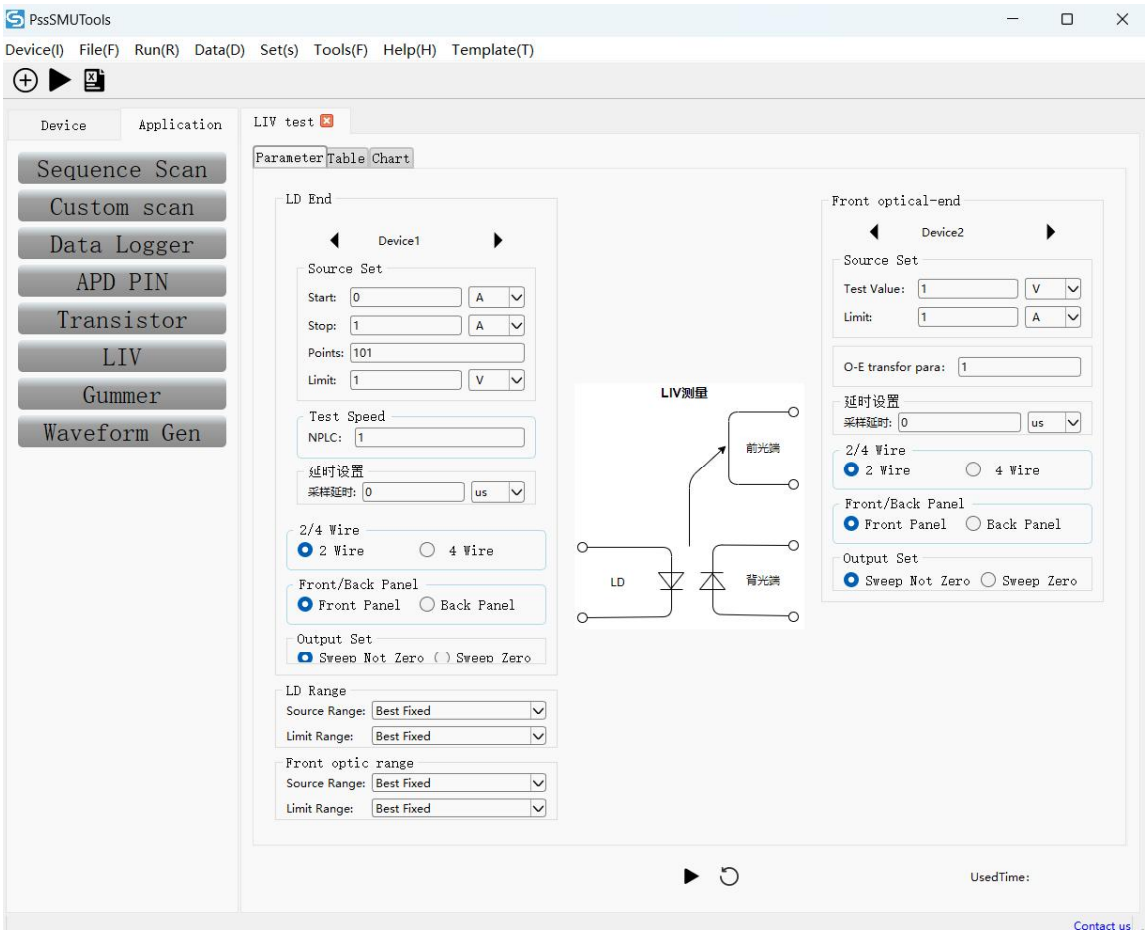


Figure 2-18 LIV scanning interface

Before setting the parameters, you need to select the corresponding test equipment according to the actual connection circuit. The triangle icons on the left and right sides of the equipment name can be adjusted.

(7) Gummer Scan

Gummer scanning is the implementation of dual source measure units using the same parameters for scanning, mainly to meet the special testing requirements of multi terminal devices.

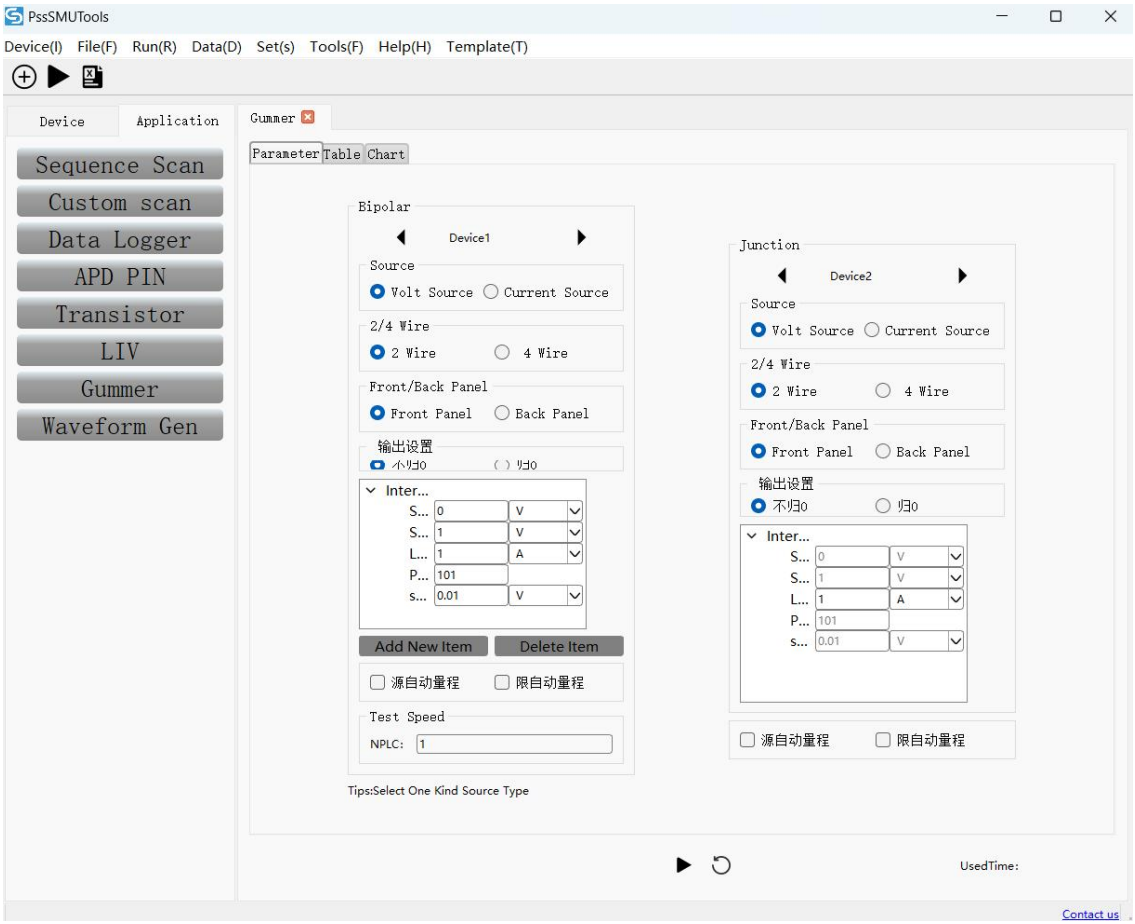


Figure 2-19 Gummer scanning interface

3 S Series Test Examples

3.1 Diode Test

The main parameters of the diode include forward voltage drop (V_F), reverse leakage current (I_R) and reverse breakdown voltage (V_R), etc. And its characteristics curve as below Figure:

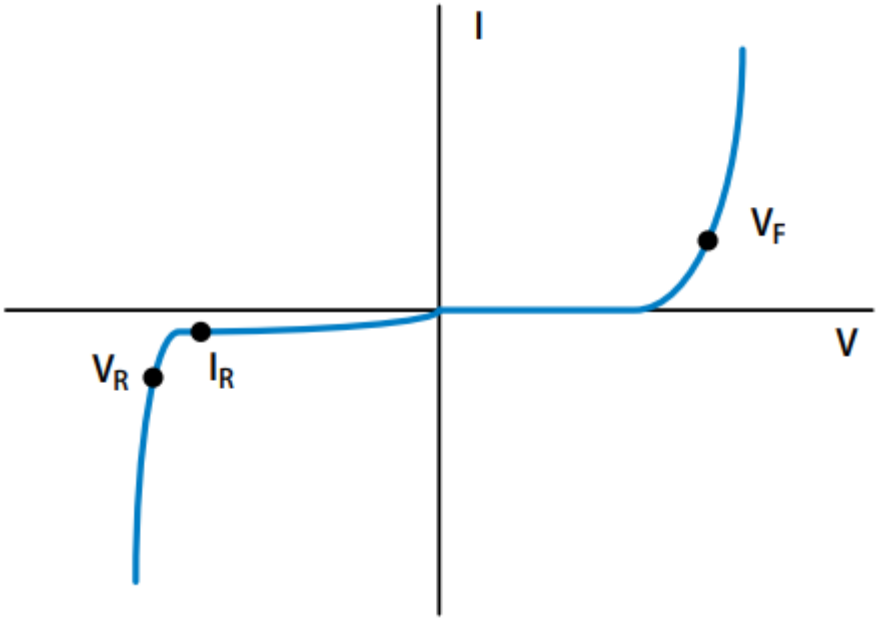


Figure 3-1 Diode typical I-V curve

Test steps:

Figure 3-2 Diode test circuit diagram

Build the test circuit as the above Figure. After the circuit is built, use any one of the three connection methods of Ethernet, RS-232 and GPIB to connect the source measure

unit to the host computer software.

(1) Forward voltage drop test

1) Select the sequence scan function in the host computer software;

2) Set appropriate test parameters according to the diode specification;

3) Click " start ";

4) Switch to the table interface to view the test data, and switch to the graph interface to view the test curve.

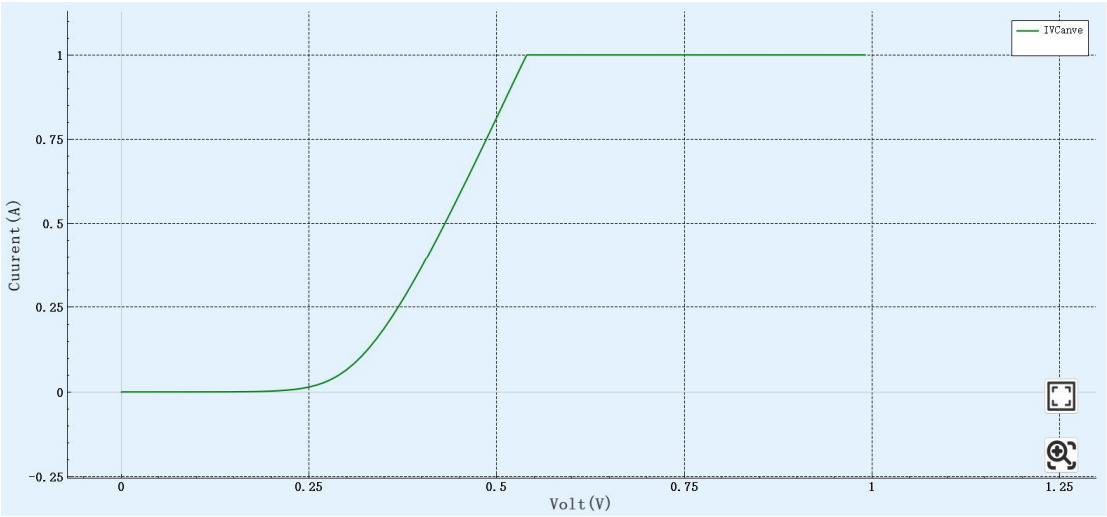


Figure 3-3 Diode forward characteristic curve

(2) Reverse leakage current (I_R) and reverse breakdown voltage (V_R)

As source measure unit supports four-quadrant operation, there is no need to change the circuit for reverse testing, just output the reversed voltage or current. The specific operation steps are the same as those in (1).

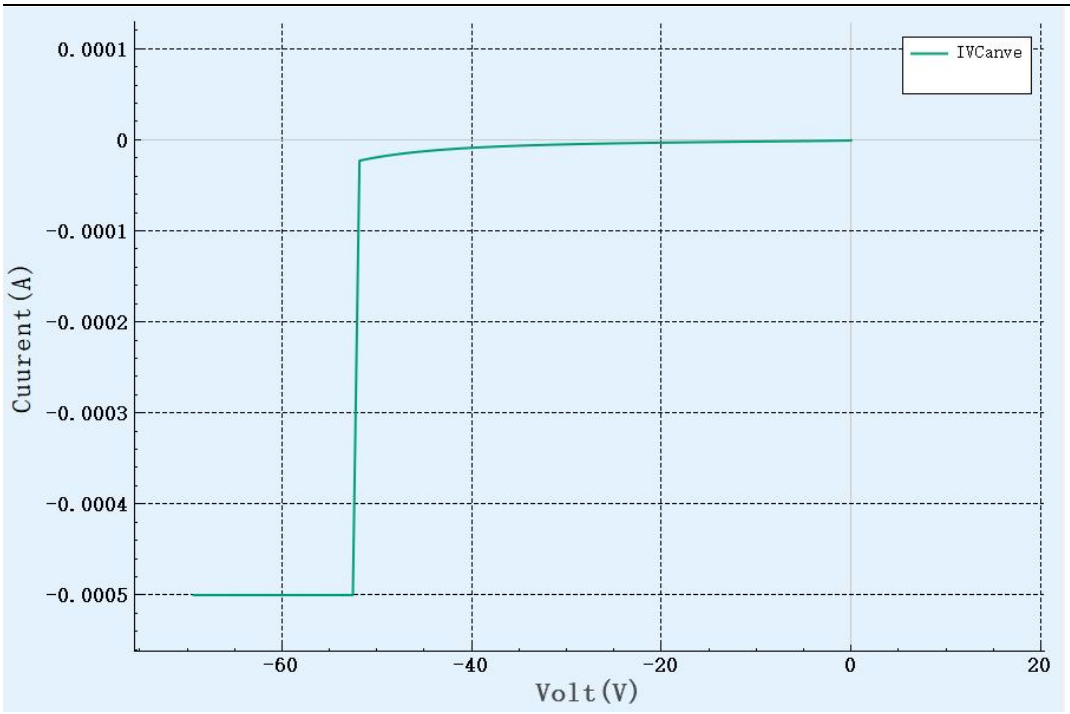


Figure 3-4 Diode reverse characteristic curve

The maximum reverse current of the diode used in the test is 0.5mA, so the limit current is 0.5mA in the test, so the current is limited to 0.5mA after the diode reverse breakdown. Switch the interface to the table interface, you can see that when the current is limited, the voltage is stable at 53.8V. The reverse breakdown voltage of the diode used in the test is 53.8V. For reverse leakage current, look for the current value corresponding to the voltage before breakdown.

Parameter Table Chart

	Volt(V)	Cuurent(A)
1	-53.8106	-0.000500277
2	-53.8201	-0.00050028
3	-53.8262	-0.000500284
4	-53.8294	-0.000500279
5	-53.831	-0.000500284
6	-53.8318	-0.000500286
7	-53.8354	-0.000500284
8	-53.8357	-0.000500287
9	-53.8378	-0.000500278
10	-53.8394	-0.000500287
11	-53.8402	-0.000500282
12	-53.8416	-0.000500285
13	-53.8427	-0.000500282
14	-53.8436	-0.000500283
15	-53.8442	-0.000500286
16	-53.8461	-0.000500282
17	-53.8456	-0.000500282
18	-53.8474	-0.000500284
19	-53.8484	-0.000500284

Figure 3-5 Diode reverse breakdown voltage

Parameter | Table | Chart

	Volt(V)	Cuurent(A)
16	-53.8461	-0.000500282
17	-53.8456	-0.000500282
18	-53.8474	-0.000500284
19	-53.8484	-0.000500284
20	-53.8472	-0.000500287
21	-53.8474	-0.000500285
22	-53.8507	-0.000500288
23	-53.8496	-0.000500292
24	-53.8501	-0.000500286
25	-53.1668	-3.01376e-5
26	-52.4672	-2.73919e-5
27	-51.7685	-2.55265e-5
28	-51.0656	-2.38795e-5
29	-50.3665	-2.2405e-5
30	-49.6679	-2.1066e-5
31	-48.9689	-1.98415e-5
32	-48.2686	-1.87168e-5
33	-47.5699	-1.76855e-5
34	-46.8666	-1.67287e-5

Figure 3-6 Diode reverse leakage current

The complete I-V characteristic curve of the diode as below:

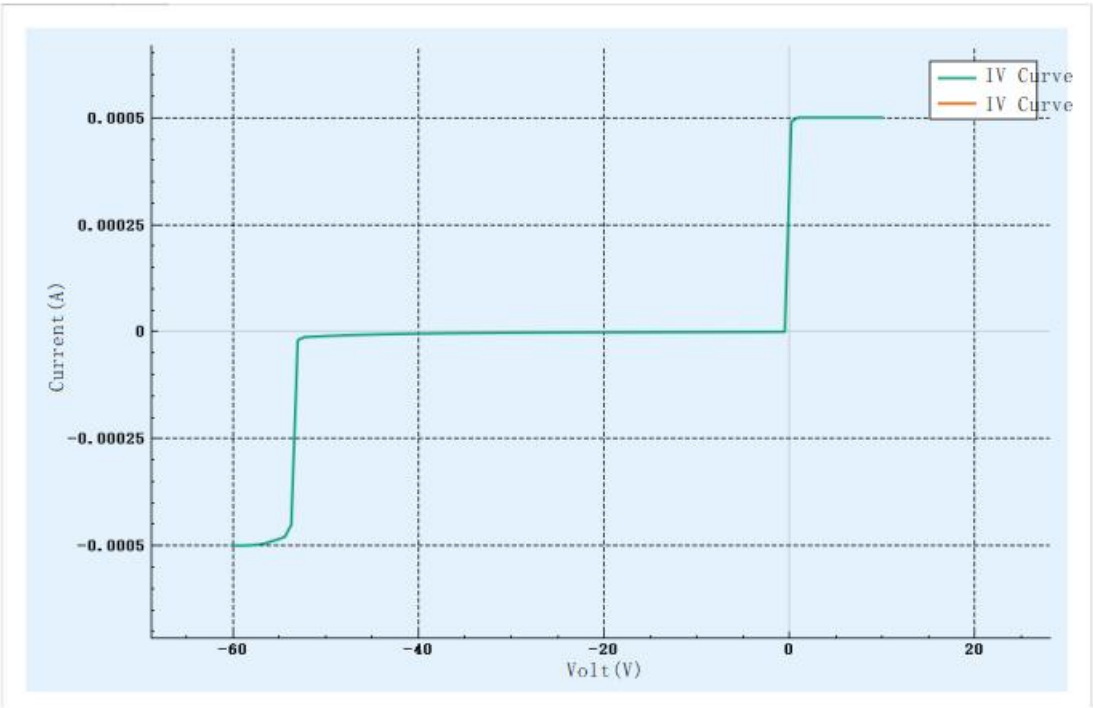


Figure 3-7 Complete diode characteristic curve

3.2 Triode Test

The triode is a current amplifier device, and its main parameters include current amplification factor, reverse current between electrodes, reverse breakdown voltage, and input and output characteristic curves of the triode.

(1) Input and output characteristic curve

The triode has three connection modes in the amplifier circuit, common base, common emitter, and common collector, that is, the base, emitter, and collector are used as the common terminal of the input and output ports respectively. The three connection methods must ensure the forward bias of the emitter junction and the reverse bias of the collector junction to make the triode have amplifying effect. For the convenience of testing, we use the common emitter test uniformly. The connection method is shown in Figure 3-8.

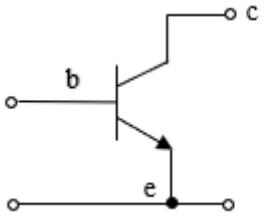


Figure 3-8 Common Emitter Connection

In the common-emitter connection mode, our input terminal is the be, and the output terminal is the ce. The input characteristic curve we tested is the relationship of Vbe and Ibe with a certain Vce; the output characteristic curve is a certain relationship of Vce and Ice with certain Ibe.

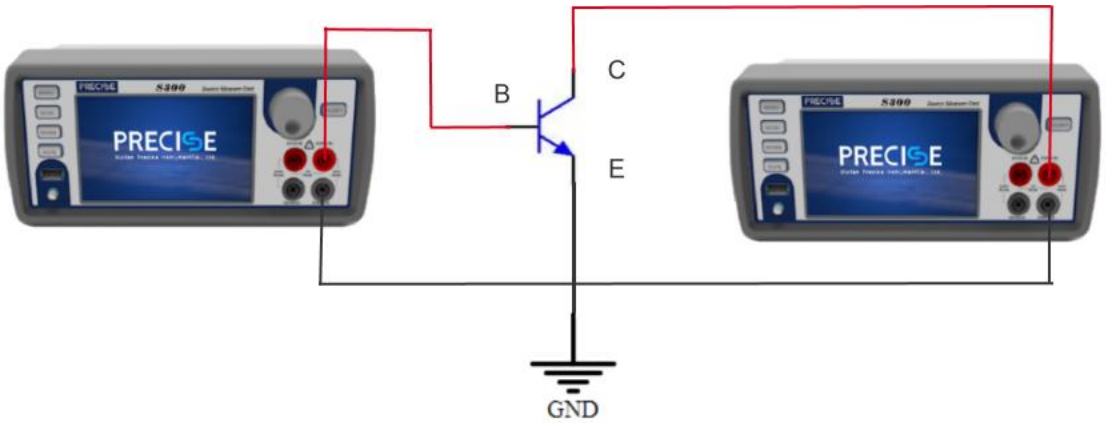


Figure 3-9 Triode test circuit

Note: Be sure to connect the back-end trig ports of the two source measure units with a trig signal line to form a master-slave devices, and short-circuit the "FORCE LO" of the other two devices, otherwise the image will be distorted.

Build the test circuit according to the above figure. After the circuit is built, use any one of the three connection methods of Ethernet, RS-232 and GPIB to connect the source measure unit and the host computer software.

Input characteristic curve:

⑴Open the transistor test function in the computer software PssSMUTools;

(2)Select "BJT tube test" in the transistor type, and select "input characteristic curve" in the quick settings in the upper right corner;

(3)Input the base and collector test parameters according to the specifications of the transistor under test; (Before inputting the parameters, it is necessary to confirm whether the base source measure unit and the collector source measure unit displayed on the host computer software are consistent with the source measure unit connected in the actual circuit.)

⑷Click“▶” to start.

Switch to the graph interface to see the resulting input and output characteristic curve.

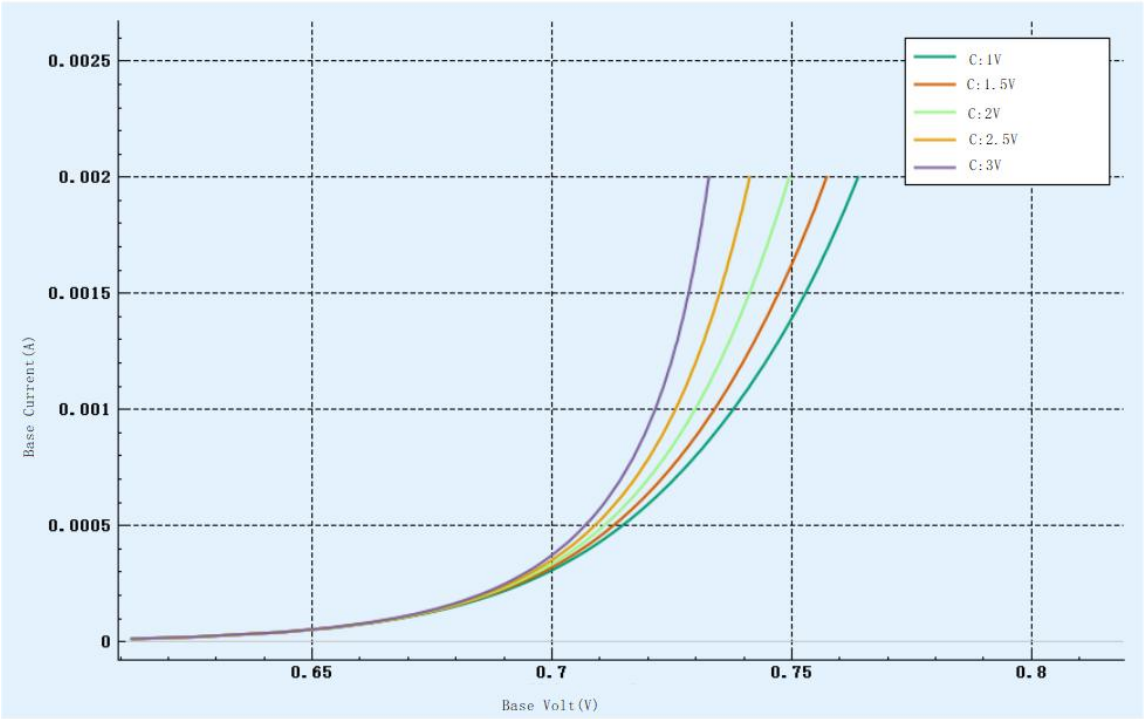


Figure 3-10 Transistor input characteristic curve

Output characteristic curve:

⑴Return to the parameter setting interface, select "Output characteristic curve" in the quick setting in the upper right corner;

(2) Enter the base and collector test parameters of the specification of the triode to be measured;

(3) Click "▶" start.

Switch to the graphical interface to see the resulting output characteristic curve

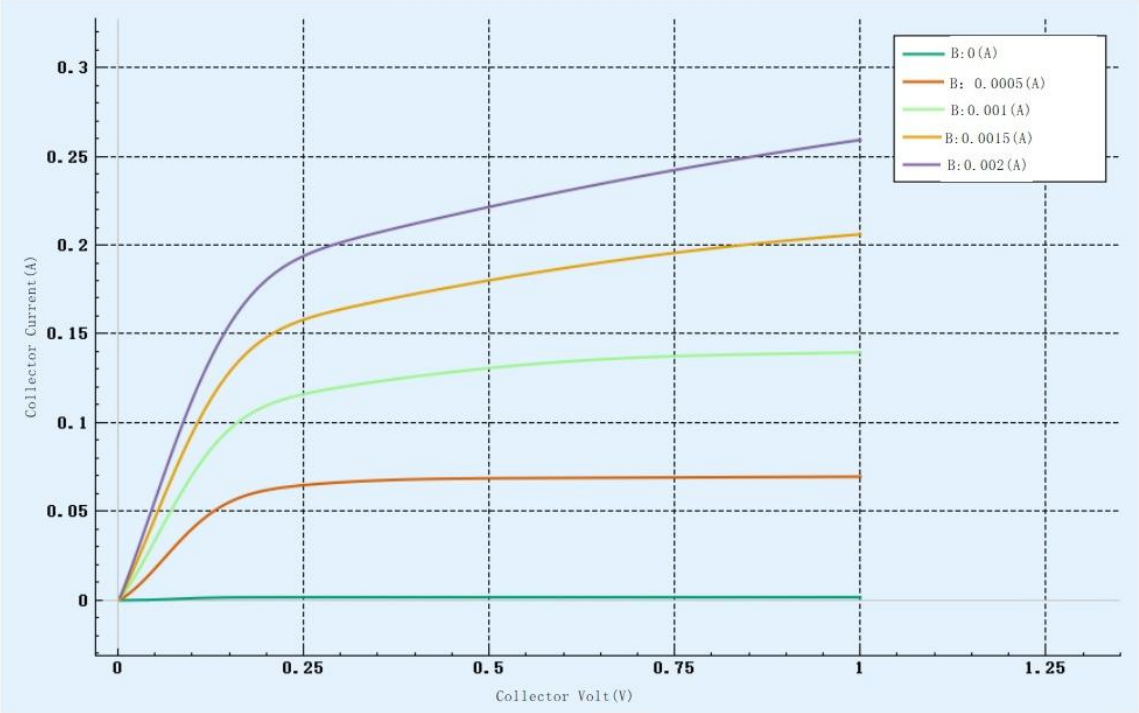


Figure 3-11 Transistor output characteristic curve

(2) Current amplification factor

The amplification factor of a triode is defined as the ratio of the collector current to the base current. Collector and base current values can be found in the table interface.

	Base Volt(V)	Base Current(A)	Collector Volt(V)	Collector Current(A)
1	0.623942	1.54811e-05	1.99978	0.0021746
2	0.641201	3.01314e-05	1.99987	0.00427328
3	0.659297	6.0339e-05	2	0.00865284
4	0.66984	9.05496e-05	2.00007	0.0130471
5	0.677303	0.000120706	2.00014	0.0174497
6	0.683173	0.000151374	2.00007	0.0219489
7	0.687882	0.000181601	2.00007	0.0263793
8	0.69186	0.000211806	2.00002	0.0308247
9	0.695284	0.000241888	2.00004	0.0352539
10	0.698363	0.000272558	2.00004	0.0397774
11	0.701066	0.000302776	2.00001	0.0442455
12	0.703504	0.000332988	1.99999	0.0487241
13	0.705725	0.000363152	1.99997	0.0531991
14	0.707767	0.000393358	1.99998	0.057692
15	0.709689	0.000424038	1.99999	0.0622657
16	0.711436	0.00045425	1.99998	0.0667751
17	0.713076	0.0004845	1.99995	0.071286
18	0.714613	0.000514701	1.99995	0.0758119
19	0.716078	0.000545369	1.99994	0.0804068

Figure 3-12 Triode test data

These test data are saved in a local file, and then each set of values can be calculated by excel

base voltage(V)	base current(A)	collector V (V)	collector C (A)	β
0.623942	1.55E-05	1.99978	0.0021746	1.40E+02
0.641201	3.01E-05	1.99987	0.00427328	1.42E+02
0.659297	6.03E-05	2	0.00865284	1.43E+02
0.66984	9.05E-05	2.00007	0.0130471	1.44E+02
0.677303	0.000120706	2.00014	0.0174497	1.45E+02
0.683173	0.000151374	2.00007	0.0219489	1.45E+02
0.687882	0.000181601	2.00007	0.0263793	1.45E+02
0.69186	0.000211806	2.00002	0.0308247	1.46E+02
0.695284	0.000241888	2.00004	0.0352539	1.46E+02
0.698363	0.000272558	2.00004	0.0397774	1.46E+02
0.701066	0.000302776	2.00001	0.0442455	1.46E+02
0.703504	0.000332988	1.99999	0.0487241	1.46E+02
0.705725	0.000363152	1.99997	0.0531991	1.46E+02
0.707767	0.000393358	1.99998	0.057692	1.47E+02
0.709689	0.000424038	1.99999	0.0622657	1.47E+02
0.711436	0.00045425	1.99998	0.0667751	1.47E+02
0.713076	0.0004845	1.99995	0.071286	1.47E+02
0.714613	0.000514701	1.99995	0.0758119	1.47E+02
0.716078	0.000545369	1.99994	0.0804068	1.47E+02
0.71744	0.000575578	1.99993	0.0849458	1.48E+02
0.718728	0.00060575	1.99995	0.0894893	1.48E+02
0.719954	0.00063595	1.99992	0.0940349	1.48E+02
0.721144	0.000666629	1.99991	0.0986667	1.48E+02
0.722251	0.000696844	1.99993	0.103233	1.48E+02
0.723307	0.000726916	1.99991	0.107788	1.48E+02
0.724324	0.000757132	1.9999	0.112371	1.48E+02
0.725304	0.000787356	1.9999	0.116954	1.49E+02
0.726261	0.000818021	1.99988	0.121624	1.49E+02
0.727159	0.00084818	1.99987	0.12621	1.49E+02
0.728028	0.000878392	1.9999	0.130823	1.49E+02

Figure 3-13 Transistor current amplification factor

β Variation curve obtained by plotting the calculated value

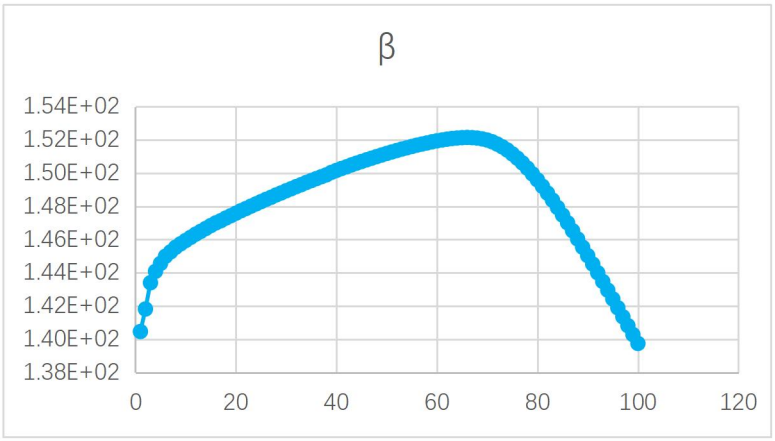


Figure 3-14 β variation curve

(3) Reverse breakdown voltage between poles

The reverse breakdown voltage between poles includes V_{EBO}、V_{CBO}、V_{CEO}. During the test, pay attention to the reverse test current of the device, which is easy to damage the device if it is too large. The circuit diagram of each reverse breakdown voltage test is as following:

Figure 3-15 V_{EBO} test circuit

Figure 3-16 V_{CBO} test circuit

Figure 3-17 V_{CEO} test circuit

Testing method:

1) Constant current source mode

① build a test circuit;

② Select the measurement function on the touch screen;

③ Select the current source, and set the source range, source value, limit range and limit value according to the device specification;

④ click“OUTPUT”.

For more accurate reading of measured values, please set the NPLC value to the maximum.

2) Scan Mode

①. connect source measure unit to software;

②. Select the sequence scan;

③ .Select the voltage source, and set the appropriate source value and limit according to the device specification;

④ click“▶” to start。

Switch to table interface to view the test data; switch to the graph interface to view the test characteristic curve.

3.3 MOSFET Test

MOS tube is a semiconductor device that uses electric field effect to control its current. The main parameters are turn-on voltage V_T（Also called threshold voltage $V_{GS(th)}$）or pinch-off voltage V_P、Zero gate voltage leakage current I_{DSS}，Input/output characteristic curve, low frequency mutual conductance g_m, output resistance R_{DS}, Maximum drain-source voltage, etc.

(1) Input and output characteristic curve

There are three circuit connection methods for MOSFET: common source, common gate, and common drain. We use the common source connection here. The specific connection method is shown in Figure 3-18.

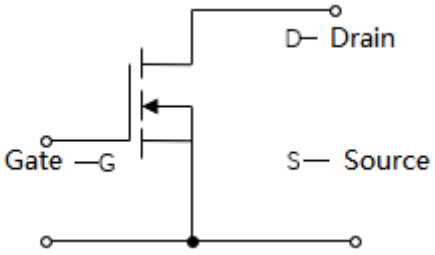


Figure 3-18 MOSFET connection method

The input characteristic curve in the common source connection method is under certain v_{DS}, the relationship between v_{GS} and i_D. And the the relationship between v_{GS} and i_D is also called transfer characteristic curve.

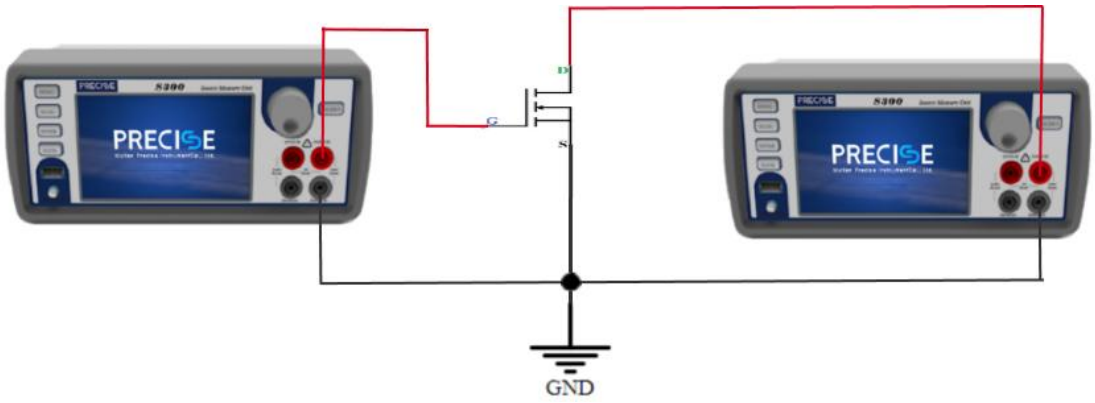


Figure 3-19 MOSFET test circuit

Note: Be sure to connect the back-end trig ports of the two source measure units with a trig signal line to form a master-slave device, and short-circuit the "FORCE LO"

of the two devices, otherwise the image will be distorted.

Build the test circuit as the above Figure. Then connect the source measure unit to host computer software by any one of the three connection methods of Ethernet, RS-232 and GPIB.

Input characteristic curve :

⑴ Open the transistor test function in the host computer software;

(2) Select "MOS tube test" in the transistor type, and select "input characteristic curve" in the quick setting in the upper right corner;

(3) Input the gate and drain test parameters according to the specifications of the MOS tube to be tested; (Before entering the parameters, it is necessary to confirm whether the base source measure unit and collector source measure unit displayed on the host computer software are consistent with the source measure unit connected in the actual circuit. .)

⑷ click “▶” to start.

Then switch to the chart interface, and get input characteristic curve.

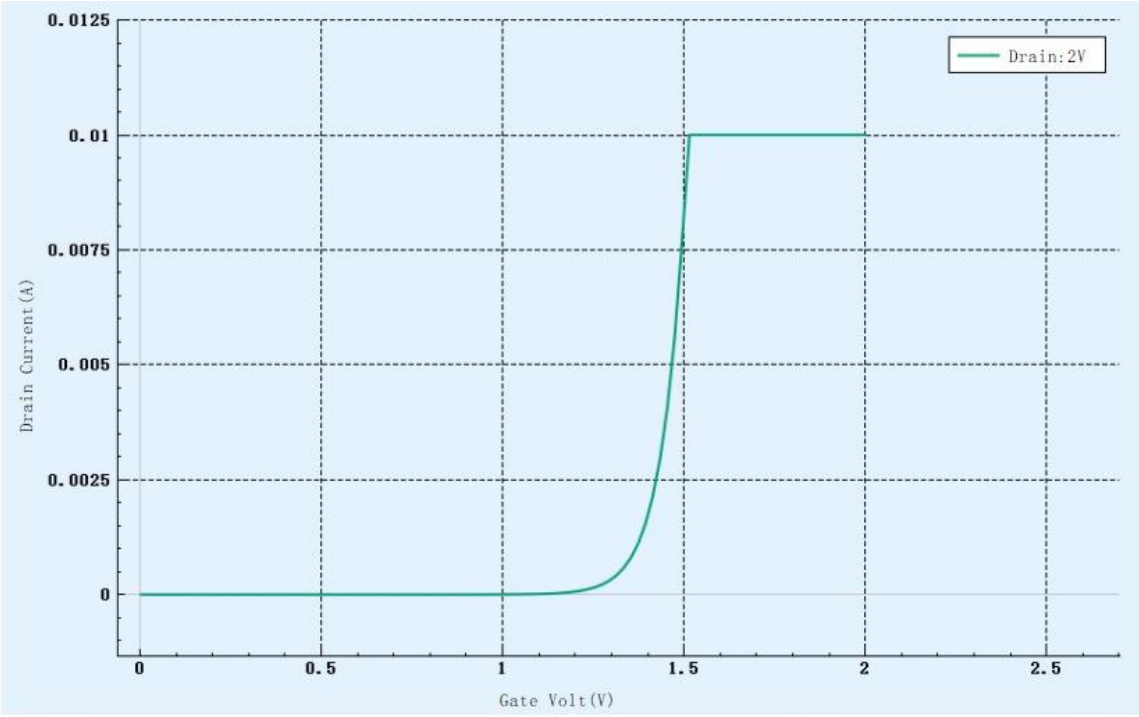


Figure 3-20 MOS input characteristic curve

Output characteristic curve :

⑴ Return to the parameter setting interface, select "Output characteristic curve" in

the quick setting in the upper right corner;

(2) Input the base and collector test parameters according to the specification of the tested MOS tube;

(3) click "▶" to start.

Then switch to the graph interface, and get output characteristic curve.

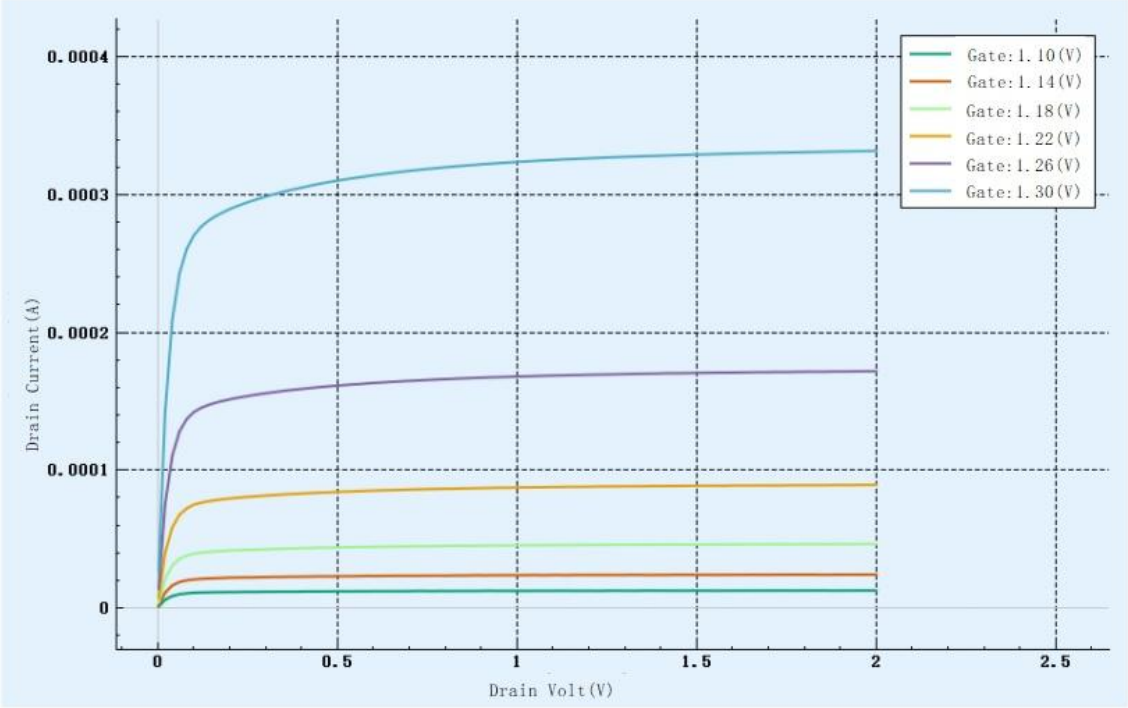


Figure 3-21 MOS output characteristic curve

（2）Threshold voltage $V_{GS(th)}$

Threshold voltage $V_{GS(th)}$ is also called turn-on voltage， and its test circuit as Figure 3-22.

Figure 3-22 $V_{GS(th)}$ test circuit

Test steps:

① build a test circuit;

② Select the measurement function on the touch screen;

③ Select the current source, and set the source range, source value, limit range and limit value according to the device specification;

④. Click "OUTPUT".

For more accurate reading of measured values, it is recommended to set the NPLC value to the maximum.

（3）Maximum drain-source voltage V_{DS}

Figure 3-23 V_{DS} test circuit

Test steps:

① build a test circuit;

② Select the measurement function on the touch screen;

③ Select the current source, and set the source range, source value, limit range and limit value according to the device specification;

④ Click "OUTPUT".

For more accurate reading of measured values, it is recommended to set the NPLC value to the maximum.

Threshold voltage, maximum drain-source voltage can also be tested using the measurement function and the characteristic curve can be viewed.

3.4 APD Test

APD is called avalanche photodiode, it works in the reverse state, and its main test items is reverse breakdown voltage and dark current.

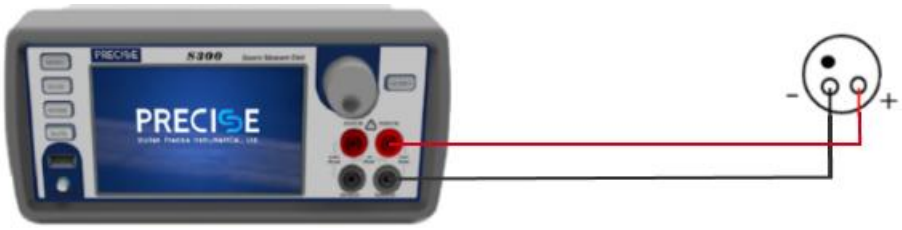


Figure 3-24 APD test circuit

Build the test circuit as above Figure. Then connect the source measure unit to host computer software by any one of the three connection methods of Ethernet, RS-232 and GPIB .

Test steps:

①, build a test circuit;

②. Open the source table used for the connection test of the host computer software;

③. Select the APD test in the function;

④ .Select the voltage source, and set the appropriate source value and limit according to the device specification;

⑤ click “▶” to start.

Then switch to graph interface and get characteristic curve.

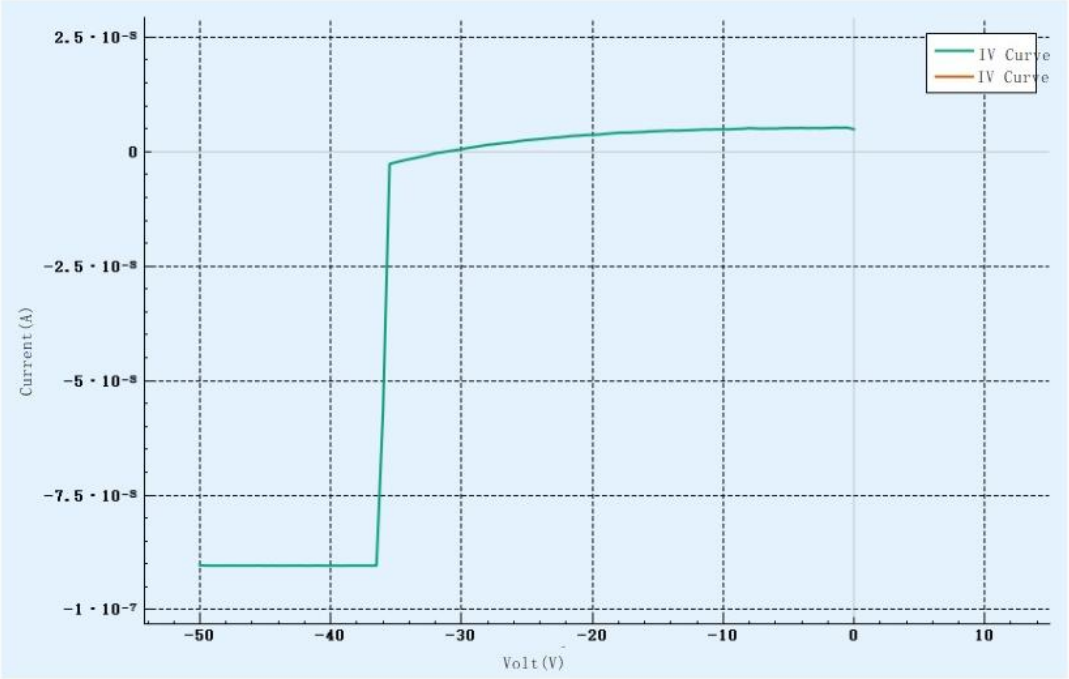


Figure 3-25 APD characteristic curve

The breakdown process of the APD tube can be gotten from the graph, and then the dark current value can be obtained in the table according to the voltage specified in the specification sheet.

3.5 PIN Test

PIN electrical parameters mainly include threshold current I_{th}、working current I_{OP}、working voltageV_{OP}、output power P_O、monitor current I_M、monitor dark current I_D.

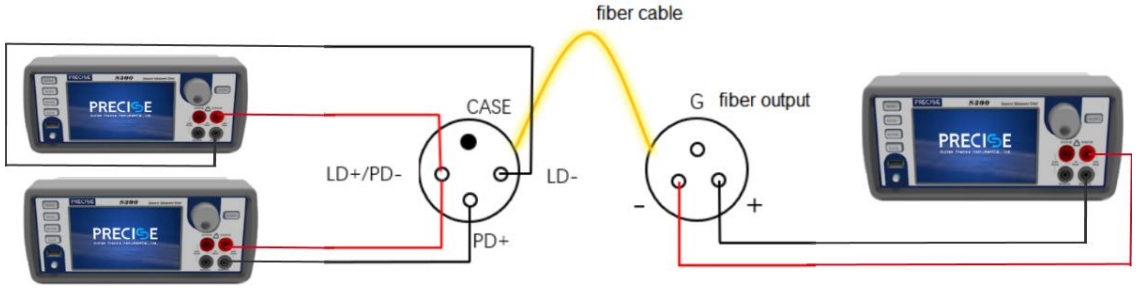


Figure 3-26 PIN test circuit

Note: When building the circuit, we must connect the three source measure units with trig signal lines to ensure that we can send signals synchronously to the three source measure units.

Build the test circuit as above Figure. Then connect the source measure units to the host computer software by any one of the three connection methods of Ethernet, RS-232 and GPIB. As to LIV test function in the host computer software. LD, PD, fiber connected device must be correspond correctly on the host computer.

Test steps:

① build a test circuit;

② connect source measure unit to host computer software;

③ select the LIV scan function;

④ set the appropriate LD end test parameters, PD end test parameters, and fiber end test parameters according to the device specification;

⑤ click "▶" to start.

Then finish the introduction of the testing steps.

3.6 Solar Cells Test

For the test of solar panels, we generally test the open circuit voltage of the panels V_{OC}、short circuit current I_{sc}、max powerP_{max}、filled factor FF、conversion efficiencyη. Building circuit as below Figure.

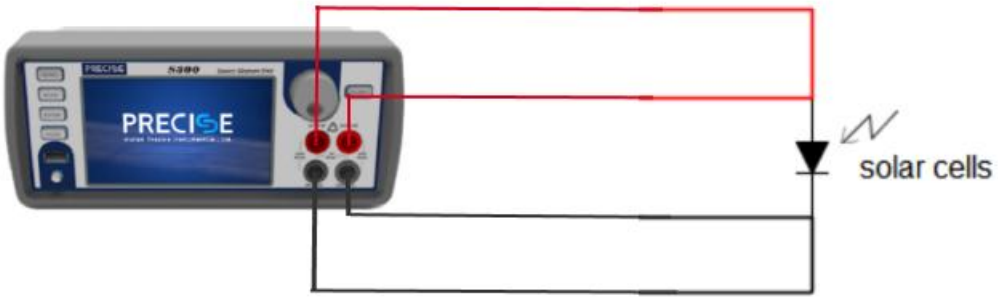


Figure 3-27 Solar cells test circuit

To ensure the accuracy of the test results, we use the four-wire mode measurement. Note: Build and dismantle circuits in 2-wire mode, and prohibit plugging and unplugging in 4-wire mode.

(1) Open circuit voltage and short circuit current：

Supplying constant lighting,

①. Select the 4-wire mode in the output settings in the settings;

②. Click the fast mode on the source measure unit, select the voltmeter mode, select the appropriate limit range, and directly click "OUTPUT" to get the open circuit voltage;

③. Select the ammeter mode, select the appropriate limit range, and directly click "OUTPUT" to get the short-circuit current.

To get stable test values, it is recommended to maximize the NPLC modulation.

(2) Max power

Select the sequence scan function on the host computer software, select the voltage source mode, set the 0- scan range, set the limit value, check the power test, and click Run to get the V-I image of the forward bias and the power change curve.

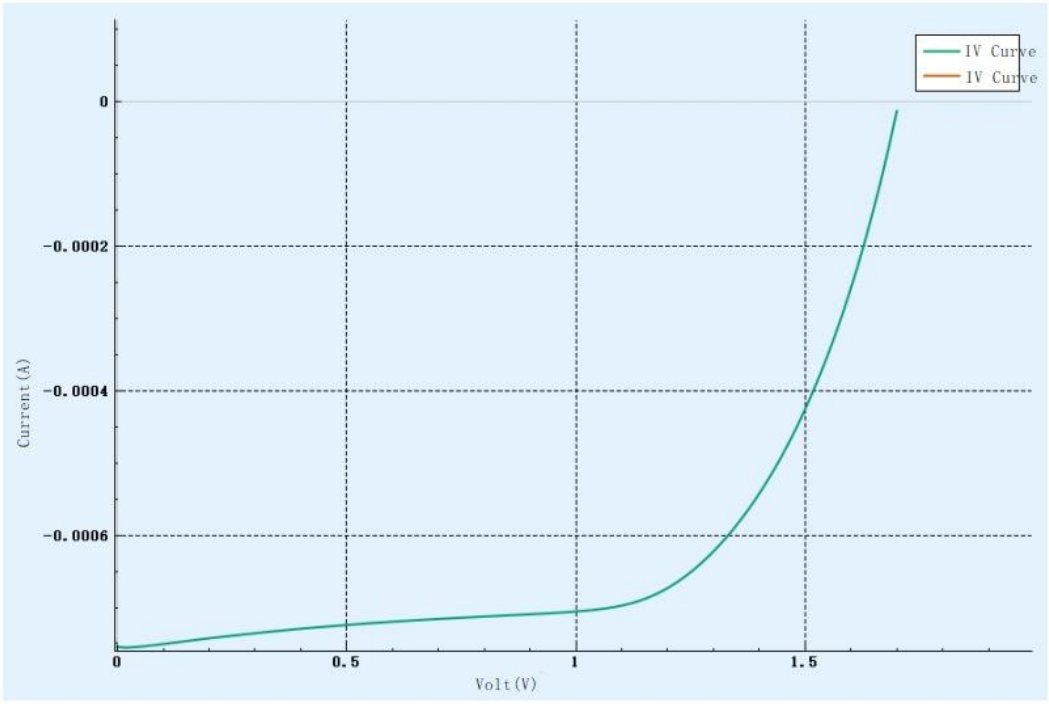


Figure 3-28 Solar cells scanning curve

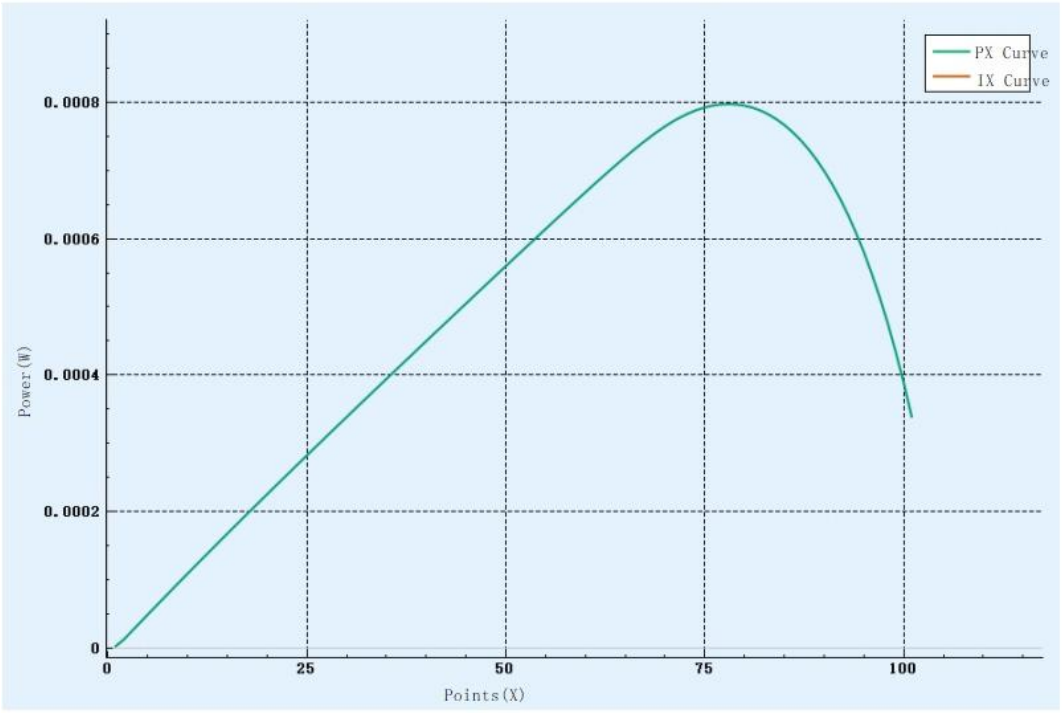


Figure 3-29 Power changing curve

The orange curve is the power change curve. From Figure 3-29, we can see that the max power appears near the sampling point 210. We can switch to the table interface to see the

max power value.

	Volt (V)	Current (A)	Power (W)
207	1.06438	-0.000493563	0.000525339
208	1.06951	-0.000491632	0.000525805
209	1.07464	-0.000489637	0.000526184
210	1.07989	-0.000487624	0.00052658
211	1.08502	-0.000485561	0.000526843
212	1.09012	-0.000483478	0.000527049
213	1.09526	-0.000481376	0.000527232
214	1.1005	-0.000479191	0.00052735
215	1.10564	-0.000477003	0.000527394
216	1.11077	-0.000474801	0.000527395
217	1.11602	-0.000472408	0.000527217
218	1.12116	-0.000470037	0.000526987
219	1.12629	-0.000467636	0.000526694
220	1.13153	-0.000465128	0.000526306
221	1.13667	-0.000462636	0.000525864
222	1.1418	-0.000460079	0.000525318
223	1.14703	-0.000457548	0.000524821
224	1.15216	-0.00045497	0.000524198
225	1.1573	-0.000452254	0.000523394

Figure 3-30 Max power

It can be seen from Figure 3-30 that the power starts to decrease after reaching 527uW, and the maximum power that can be obtained is 527uW; and the corresponding maximum battery voltage is 1.111V, and the maximum battery current is 0.475mA.

(3) Filled factor and conversion efficiency

Filled factor is a measure of how far the I-V characteristics of an actual photovoltaic cell differ from an ideal cell. Specifically defined as:

$$FF = \frac{P_{max}}{I_{SC}V_{OC}}$$

In 3.6.1, we measured the short-circuit current I_{SC} and open-circuit voltage V_{OC} ,and in 3.6.2 got max power, so filled factor FF can be calculate directly .

Conversion efficiency is the ratio of maximum power to battery power input:

$$\eta = \frac{P_{max}}{P_{in}}$$

P_{in} is solar cells power input, defined as the total radiant energy incident on the surface of solar cells, which can be obtained by multiplying the irradiance of the light source by the light-receiving area of the solar cells.

4 SCPI Programming Specification

4.1 SCPI Instruction Format

The S series source measure unit adopts the SCPI compatible format, <space> represents a space, %1, %2 respectively represent the number of parameters, all SCPI commands must end with "\n", the detailed format is defined as follows:

Device Identity

(1) Command format: *IDN?

output format is: WuhanPrecise Instrument, Sx00, XXXX

output information includes: company name, device name, firmware version.

(2) Source selection

Command format: :SOUR:FUNC<space>%1

%1 can be VOLT or CURR;

VOLT means voltage source;

CURR stands for current source.

(3) Source range

Command format: :SOUR:%1:RANG<space>%2

%1 can be VOLT or CURR;

VOLT means voltage source;

CURR means current source;

%2 can be a valid number, for example: 0, 0.1, 1.3, 1E+0, the unit of voltage is V, and the unit of current is A.

(4) Source value

Command format: :SOUR:%1:LEV<space>%2

%1 can be VOLT or CURR;

VOLT means voltage source;

CURR means current source;

%2 can be a valid number, for example: 0, 0.1, 1.3, 1E+0, the unit of voltage is V, and the unit of current is A.

(5) Limited range

Command format: :SENS:%1:RANG<space>%2

%1 can be VOLT or CURR;

VOLT means limit voltage;

CURR means limit current;

%2 can be a valid number, for example: 0, 0.1, 1.3, 1E+0, the unit of voltage is V, and the unit of current is A.

(6) Limits

Command format: :SOUR:%1:%2<space>%3

%1 can be VOLT or CURR;

VOLT means voltage source;

CURR means current source;

%2 can be VLIM or ILIM.

VLIM means limit voltage under current source mode; ILIM means limit current under voltage source mode;

%3 can be a valid number, for example: 0, 0.1, 1.3, 1E+0, the unit of voltage is V, and the unit of current is A.

(7) 2/4 wire switching

Command format: :SYST:RSEN<space>ON Switch to 4-wire mode

Command format: :SYST:RSEN<space>OFF Switch to 2-wire mode

(8) Front and rear panel switching

Command format: :ROUT:TERM<space>FRON Switch to front panel output mode

Command format: :ROUT:TERM<space>REAR Switch to rear panel output mode

(9) Output control

Command format: :OUTP<space>%1

%1 can be ON or OFF;

ON means to start the output;

OFF means to turn off the output;

After the output is started, it needs to delay at least 100ms, wait for the data stable, and then send the READ? frame to read the data.

(10) Data read

Command format: :READ? “%1,%2”

%1 can be: RELA, indicating the relative sampling time of the returned data, the time unit is ms

%2 can be: CR, indicating that the data pairs are separated by \r (tabs)

LF, indicating that the data pairs are separated by \n (carriage return)

COMMA, means that the data pairs are separated by , (comma)

The %1 parameter can be ignored, and the %2 parameter can be ignored. When %2 is ignored, the data pairs returned by the device are separated by \r\n (carriage return and line feed)

The output format is:

%1,%2,%3\r\n

%1 represents the current voltage measurement value, %2 represents the current current measurement value, the format is valid numbers, for example: 0, 0.1, 1.3, 1E+0, the voltage unit is V, the current unit is A, %3 represents the sampling time, and the time refers to The relative interval between sampling points of the device, in ms.

In scan mode, this command reads all scan results. Each pair of voltage and current values is separated by the delimiter specified by the user, and the voltage and current values are separated by commas (,). The format is as follows (with the default delimiter \r\ n for example): <v,i\r\nv2,i2\r\n…>, angle brackets (<>) are not included in the returned data. When the %1 parameter is valid, the returned data format is <t,v,i\r\nt2,v2,i2\r\n…>, and angle brackets (<>) are not included in the returned data.

Note: After the output is turned on in the multi-channel scanning mode, the device will return the string "ON\r\n" to the user after the output is executed. The user must ensure that the returned string is read before receiving the scanning result.

(11)set trigger line

Command format: :TRIG:ILIN<space>%1

%1 can be 1 or 2;

1 means set trig line1 as input port and line2 as output port;

2 means to set trig line1 as output port and line2 as input port.

(12) Set the device mode

Command format: :TRIG:DIR<space>%1

%1 can be: SOUR or ACC;

SOUR means to set the machine as the main device;

ACC means setting the machine as a slave.

(13) Set the device TRIG input switch

Command format: :TRIG:INP<space>%1

%1 can be: ON or OFF

ON means the device trig input is on;

OFF means the device trig input is off.

(14) Set the scan mode

Command format: :SOUR:%1:MODE<space>%2

%1 can be: VOLT or CURR;

VOLT means scan voltage mode;

CURR means scan current mode;

%2 can be: SWE or LIST or FIXED;

SWE: Indicates voltage or current scan mode;

LIST: Indicates the voltage or current list scan mode;

FIXED: Indicates fixed source mode (not yet implemented).

(15) Set the scan starting point value

Command format: :SOUR:%1:STAR<space>%2

%1 can be VOLT or CURR;

VOLT means to set the starting voltage value;

CURR means to set the current starting point value;

%2 can be a valid number, for example: 0,0.1,1.3,1E+0, the unit of voltage is V, and the unit of current is A.

(16) Set the scan end point value

Command format: :SOUR:%1:STOP<space>%2

%1 can be VOLT or CURR;

VOLT means to set the voltage end value;

CURR means to set the current end point value;

%2 can be a valid number, for example: 0,0.1,1.3,1E+0, the unit of voltage is V, and the unit of current is A.

(17) Set the number of scan points

Command format: :SOUR:SWE:POIN<space>%1

%1 can be an integer significant number, for example: 10, 50, 100, 200.

(18) Customized scan parameters

Command format: :SOUR:LIST:%1 <space>%2,%3,%4,%5…

%1 can be VOLT or CURR;

%2,%3,%4,%5… can be valid numbers, such as 1,+0.1,-0.2,2, the unit of voltage is V, and the unit of current is A. (Note: The number of points sent at a time can not exceed

50)

Remarks: This command will clear the previously set custom scan parameters, and set the current parameters. The settings are only for the current scan.

(19) Additional settings for customized scan parameters

Command format: :SOUR:LIST:%1:APP <space>%2,%3,%4,%5…

%1 can be VOLT or CURR;

%2,%3,%4,%5… can be valid numbers, such as 1,+0.1,-0.2,2, the unit of voltage is V, and the unit of current is A. (Note: the number of additional sending points in a single time does not exceed 50) Note: This command will not clear the custom scan parameters that have been set before, and append the current parameter settings to the previously set parameters. The settings are only for the current scanning.

(20) Overrange stop switch setting

Command format: :SOUR:SWE:CAB<space>%1

When %1 is ON, it means that the overrange stops opening;

OFF means overrange stop and close;

Example: Turn on overrun stop: :SOUR:SWE:CAB ON\n.

NPLC settings

(21)Command format: :SENS:%1:NPLC<space>%2

%1 means VOLT means setting voltage, CURR means setting current;

%2 is a floating point number, the value range is 0.01~10, where 0.01 is the minimum NPLC, 10 is the maximum NPLC, the device will match the best NPLC value according to the user input value;

For example to set the voltage NPLC to the maximum value: :SENS:VOLT:NPLC 10\n.

(22) Output status query

Command format: :OUTP?

The return status is: ON means the output is open; OFF means the output is not open.

(23) Clear error cache

Command format: :SYST:CLE

Description: Clear the SCPI error code cache in the device. There is no error code returned by this command, and the error code will not be stored in the device cache. After the command is executed, the error code cache in the device is empty.

Example: Currently the error codes in the device cache are 0,0, -1, -2,0. After executing this command, the error code cache in the device is empty.

(24) Get error code

Command format: :SYST:ERR:CODE?

Description: Get the error code returned by the earliest SCPI operation in the device, return 0 means the operation is successful, other means error, this command returns no error code, that is, after the command is executed, the device error code cache will only return the earliest SCPI error code, Then clear the returned code in the cache.

Example: The error code currently cached in the device is 0, -1, 0. After executing this command, the 0 error code will be returned, indicating that there is no error, and the remaining -1,0 error code in the device cache.

(25) Get source type

Command format: :SOUR:FUNC?

Description: Get the device source type, return CURR to indicate that the device is a current source, and VOLT to indicate that the device is a voltage source.

(26) Enter measurement mode

Command format: :MEAS:%1?

Description: Set the device to enter the measurement mode, the UI enters the measurement interface, and %1 can be VOLT, CURR.

When %1 is VOLT, it means to enter the measurement mode with a voltage source; %1 is CURR, it means to enter the measurement mode with a current source;

Example: Enter the measurement mode with a voltage source: :MEAS:VOLT? Change the command to return the last sampled value, if %1 is VOLT, return the last sampled voltage value, if %1 is CURR, return the last sampled current value.

(27) Set source auto range

Command format: :SOUR:%1:RANG:AUTO <space>%2\n

Description: Set the device source automatic range switch, %1 can be VOLT, CURR;

%1 is VOLT, which means voltage source; %1 is CURR, which means current source;

%2 is ON or OFF, ON means open auto range, OFF means close auto range;

Example: Turn on the automatic range of the voltage source: :SOUR:VOLT:RANG:AUTO ON\n.

(28) Set limit auto range

Command format: :SENS:%1:RANG:AUTO <space>%2\n

Description: Set the device source automatic range switch, %1 can be VOLT, CURR;

%1 is VOLT, which means voltage is limited; %1 is CURR, which means current is limited;

%2 is ON or OFF, ON means to turn on auto range, OFF means to turn off auto range; Example: Turn on limit voltage auto range: :SENS:VOLT:RANG:AUTO ON\n.

(29) Source auto range request

Command format: :SOUR:%1:RANG:AUTO?\n

Description: Set the device source automatic range switch, %1 can be VOLT, CURR;

%1 is VOLT, which means voltage source; %1 is CURR, which means current source;

Example: To request whether the voltage source is autorange: :SOUR:VOLT:RANG:AUTO?\n

Returns: ON: indicates that the auto range is turned on; OFF indicates that the auto range is turned off.

(30) Limit auto range request

Command format: :SENS:%1:RANG:AUTO?\n

Description: Set the device source automatic range switch, %1 can be VOLT, CURR

%1 is VOLT, which means voltage is limited; %1 is CURR, which means current is limited;

Example: Turn on voltage limit auto range: :SENS:VOLT:RANG:AUTO?\n

Returns: ON: indicates that the auto range is turned on; OFF indicates that the auto range is turned off.

(31)Source range value request

Command format: :SOUR:%1:RANG?\n

%1 can be VOLT or CURR.

VOLT means voltage source;

CURR means current source;

Example: Request voltage source range value :SOUR:VOLT:RANG?\n

Return: Return the actual voltage range string (eg 300mV).

(32) Limit value request

Command format: :SENS:%1:RANG?\n

%1 can be VOLT or CURR;

VOLT means limited to voltage;

CURR means limited to current;

Example: Request voltage limit range value :SENS:VOLT:RANG?\n

Return: Return the actual voltage range string (eg 300mV).

(33) Open device cache

Command format: :TRAC:TRIG\n

Description: Turn on device caching.

(34) Turn off device cache

Command format: :TRAC:CLE\n

Description: Turn off device caching.

(35) Set the network IP

Command format; :SYST:COMM:LAN:CONF <"type, ip,netmask,gateway">\n

The format of ip, netmask and gateway must be in decimal point system (192.168.0.1)

ip: device IP address;

netmask: device mask address;

gateway: device network management address;

type: dhcp type, can only be AUTO: means dhcp is automatic, MAN: means dhcp is off, and the device is a static IP;

Note: This command will only take effect after updating the network configuration command;

Such as setting the device static IP: 192.168.12.12, mask: 255.255.255.0, gateway: 192.168.12.1;

:SYST:COMM:LAN:CONF "MAN,192.168.12.12,255.255.255.0,192.168.12.1"\n.

(36) Get device network configuration

Command format: :SYST:COMM:LAN:CONF?\n

Return format: type, ip, netmask, gateway\n

type is dhcp type;

ip is the device IP address;

netmask is the device mask address;

gateway is the device gateway address;

Such as return: AUTO, 192.168.12.12, 255.255.255.0, 192.168.12.1\n

Indicates that the current device obtains an IP address automatically, the IP address is 192.168.12.12, the mask address is 255.255.255.0, and the gateway address is 192.168.12.1.

(37) Update device network configuration

Command format: :SYST:COMM:LAN:UPD\n

Description: This command writes the IP information set by the user into the device immediately. After the operation is successful, all network information of the device will use the newly set configuration.

(38) Set the device GPIB configuration

Command format: :SYST:COMM:GPIB:ADDR %1\n

Description: Set the device GPIB communication, and the address is set to %1, %1 must be an integer between 1-30;

Note: This command takes effect immediately.

(39) Get device GPIB configuration

Command format: :SYST:COMM:GPIB:ADDR?\n

Description: This command returns the GPIB address of the device as an integer.

(40) Set the device serial port configuration

Command format: :SYST:COMM:UART:BAUD %1\n

Description: This command sets the device to serial communication mode, and sets the baud rate to %1, and %1 is a valid baud rate number (such as 115200);

Remarks: Currently the baud rate only supports 9600 and 115200, and this command takes effect immediately.

(41) Get device serial port configuration

Command format: :SYST:COMM:UART:BAUD?\n

Description: This command obtains the baud rate of the serial port of the device and returns it as a baud rate integer (such as 115200).

(42) Command format: :SOUR:DEL %1\n

Description: This command sets the sampling delay of the device, which refers to the waiting delay between the device opening the output and starting the measurement, and the time unit is us.

4.2 SCPI Command Control Example

(1) SCPI operating device for V/I measurement,
:MEAS:VOLT? /* The device enters the measurement interface and is set as a voltage source */
:SOUR:VOLT:RANG 3 /* Set the source range to 3V */
:SOUR:VOLT:LEV 1.23 /* Set the source value to 1.23 V */
:SENS:CURR:RANG 0.1 /* Set the limit range to 100mV */
:SOUR:VOLT:ILIM 0.05 /* Set the limit to 50mV */
:OUTP ON /* Turn on output */
:READ? /* Read the measured value: the output form is: voltage value, current value */
:OUTP OFF /* Turn off output */
(2) A single device SCPI command performs a scan operation
:SOUR:VOLT:MODE<space>SWE /* Set the sweep voltage mode*/
:TRIG:DIR<space>SOUR /*Set as master device*/
/* set the trig trigger line (optional, must be the opposite of the slave setting in dual channel scan mode) */
:TRIG:ILIN<space>1
:TRIG:INP<space>OFF
/*Set the device Trig input on (must be set to OFF for single-channel scanning, and ON for multi-channel scanning)*/
:SOUR:FUNC<space>VOLT /* set as voltage source */
:SOUR:VOLT:RANG<space>3E+1 /* Set the voltage range to 30V */
:SOUR:VOLT:STAR <space>0 /* Set the starting point of the sweep voltage to 0V */
:SOUR:VOLT:STOP<space>10 /* Set the scan voltage end point to 10V */
:SOUR:SWE:POIN<space>100 /* Set the number of scan points to 100 */
:SENS:CURR:RANG<space>10E-3 /* Set the current range to 10mA */
:SOUR:VOLT:ILIM<space>10E-3 /* Set the current value to 10mA */
:SYST:RSEN<space>OFF /* set 2-wire */
:ROUT:TERM<space>FRON /* set the front and rear panels (optional)*/
:OUTP ON /* Turn on the output (waiting for the device to scan and the device to draw successfully)*/
:READ? /* Execute the :READ? command to obtain data after scanning is completed */

(3) Master-slave multi-channels scanning

Slave device:

/* Set scan current mode */

:SOUR:CURR:MODE<space>SWE /* Set sweep current mode */

/* set as slave */

:TRIG:DIR<space>ACC /* set as slave */

/* Set the trigger line of the trig: the trigger line of the master and slave devices must be reversed in multi-channel scanning */

:TRIG:ILIN<space>1

/* Set device Trig input to on */

:TRIG:INP<space>ON Set device Trig input ON (slave device must be ON)

/* set as current/voltage source */

:SOUR:FUNC<space>CURR /* set to current */

/* Set current/voltage range */

:SOUR:CURR:RANG<space>1 /* Set the current range to 1A */

/*Set current/voltage value */

:SOUR:CURR:LEV<space>1 /* Set the current value to 1A */

:SOUR: CURR:STAR <space>0 /* Set the scan voltage starting point 0A */

:SOUR: CURR:STOP<space>1 /* Set the scan voltage end point 1A */

/* Set the number of scan points */

:SOUR:SWE:POIN<space>100 /* Set the number of scan points to 100 */

/*Set voltage/current range */

:SENS:VOLT:RANG<space>3E+1 /* Set the voltage range to 30V */

/* set limit */

:SOUR:CURR:VLIM<space>5 /* Set the voltage value to 5V */

/* set 2/4 wire (optional) */

:SYST:RSEN<space>OFF

/* Set the front and rear panels (optional) */

:ROUT:TERM<space>FRON

/* The output must be turned on before the main device turns on the output. After the device receives the output command, it will return to the setting state "ON\r\n". The user can ensure that the output has been received by the device according to the return status received */

:OUTP<space>ON
/*After the scan is completed, execute the :READ? command to get data */
:READ?
Main device:
:SOUR:VOLT:MODE<space>SWE /* Set the sweep voltage mode */
:TRIG:DIR<space>SOUR /* set as master device */
/* set the trig trigger line (optional, must be the opposite of the slave setting in dual channel scan mode) */
:TRIG:ILIN<space>1
:TRIG:INP<space>ON /* Set the device Trig input on (must be set to OFF for single-channel scanning, and ON for multi-channel scanning)
:SOUR:FUNC<space>VOLT /* set as voltage source*/
:SOUR:VOLT:RANG<space>3E+1 /* Set the voltage range to 30V */
:SOUR:VOLT:STAR <space>0 /* Set the starting point of the sweep voltage to 0V */
:SOUR:VOLT:STOP<space>10 /* Set the scan voltage end point to 10V */
:SOUR:SWE:POIN<space>100 /* Set the number of scan points to 100 */
:SENS:CURR:RANG<space>10E-3 /* Set the current range to 10mA */
:SOUR:VOLT:ILIM<space>10E-3 /* Set the current value to 10mA */
/* set 2/4 wire (optional) */
:SYST:RSEN<space>OFF
/* Set the front and rear panels (optional) */
:ROUT:TERM<space>FRON
/* If it is a multi-channel scan, it must be ensured that the slave device opens output before the master device, and the device will return to the setting state after receiving the output command
state "ON\r\n", the user can ensure that the output has been received by the device according to the return status received */
:OUTP ON Open output
/* Execute the :READ? command to get data after the scan is complete */
:READ?

5 FAQ

Source Measure Unit FAQ

1. The measurement interface range cannot be changed manually

①. Check whether the range is in the state of automatic range. If so, please change it to manual and then change it;

②. Check whether the source table is in the remote control state. If so, please press the "BACK" button to change the source table to the local control state before making changes.

2. The measurement value is unstable

Please check whether the unstable digit of the measured value is within the accuracy range of the set range. If not, please change to a suitable range for measurement and increase the NPLC value appropriately; or select the automatic range and increase the NPLC value appropriately.

3.The source table IP address cannot be set manually

Check whether the local IP address is in the automatic IP state. If so, please change the IP address to the static IP address state before setting.

4.Multiple linked debugging source measure units are stuck

This phenomenon occurs because the Tirg cable is not connected, and multiple source measure units need to use the Trig cable to connect to form a master-slave devices.

5.How to measure resistance

At present, the touch screen of the source measure unit does not support viewing the resistance value. You can check the resistance test in "Other Tests" on the host computer software, and you can see the corresponding resistance value after the test.

6. Voltage of measuring small resistance is too large

When measuring small resistances, the current in the circuit is often too large. If the 2-wire measurement mode is used, the voltage on the connection line will increase and the measurement result will be too large. In this case, the 4-wire measurement mode should be used instead.

7. Scan data cannot be saved to U disk

Please check if Save Results is selected

8. The measurement of high resistance and small current is unstable

①. Use coaxial cable or triaxial cable to connect and test;

②. Connect the negative terminal of the source measure unit and the DUT to the ground;

③. Shield the device under test with a metal cover;

④. Appropriately increase NPLC.

9. When the probe station is used to test small current, the voltage appears negative

The base of the probe station needs to be grounded, otherwise it will interfere with the small current test

10.The test effect of using a long coaxial cable is not ideal

The shielding layer of the coaxial cable needs to be grounded when using the coaxial cable, otherwise the shielding effect will be poor, which will have an impact on the test, and the longer the coaxial cable, the greater the impact.

11.No-load output constant voltage is unstable

Check if the cable is unloaded and the current limit is set to nA level. Test in the case of low current, connect to the load or test without line.

12.Small voltage test is not accurate

Check whether the current in the circuit is too large, and the larger current is measured using 4-wire mode.

13.The test value is incorrect when using the four-wire measurement mode

①、FORCE HI and SENSE HI are at the same test point

Check whether the wiring is correct and whether the source measure unit is set to 4-wire measurement mode;

②、FORCE HI and SENSE HI are not at the same test point

Measure whether the voltage difference between FORCE HI and SENSE HI exceeds 3V; the voltage difference between the two points needs to be less than 3V.

PssSMUTools Software FAQ

14.The source measure unit and the PC cannot be connected through the network port

① Check whether the IP address and gateway are set correctly;

②. If the PC and the source measure unit are directly connected by a network cable, if the PC and the source measure unit are directly connected by a network cable, a local connection is required.

15.Serial port and GPIB connection failed

Check whether the corresponding communication mode is set in the communication configuration on the source table.

16.The source limit value is illegal

The S series desktop source measure unit supports a maximum of 30W. Check whether the set source limit power exceeds 30W.

17. GPIB version host computer software installation error

Before installing the GPIB version of the host computer software, you need to install the GPIB driver on the PC.