

**SMU5990**  
**Precision Source/Measure Unit**

**User Manual**

**scientific**

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## Table of Contents

<b>Chapter 1 Overview</b>	<b>6</b>
1.1 Introduction	6
1.2 General Specifications	6
1.2.1 Power Supply	6
1.2.2 Environment / Temperature / Humidity / Altitude	6
1.2.3 Warm-up	7
1.2.4 Volume and Weight	7
1.2.5 Attention to the Problem	7
1.3 Safety Standards	7
1.3.1 Insulation Resistance	7
1.3.2 Dielectric Strength	8
1.3.3 Leakage Current	8
<b>Chapter 2 View Description</b>	<b>9</b>
2.1 Front Panel Description	9
2.2 Rear Panel Description	10
2.3 Page Summary	11
2.3.1 Home Page	11
2.3.2 Config Page	12
2.3.3 Quick I/V Page	12
2.3.4 Expert Page	13
2.3.5 File Page	13
2.3.6 System Page	14
<b>Chapter 3 Basic Technical Specifications</b>	<b>15</b>
3.1 Source/ Measurement Unit	15
3.1.1 Measurement Parameters	15
3.1.2 Limit Values/ Compliance	15
3.2 Technical Specifications	16
3.2.1 Source Specification	16
3.2.2 Output Specification	20
3.2.3 Measurement Specifications	24

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3.2.4 Trigger and Timing Specifications.....	28
<b>Chapter 4 Function Instructions.....</b>	<b>29</b>
4.1 Basic Operation .....	29
4.2 Display Screen Description.....	29
4.2.1 Home Show Page .....	29
4.2.2 Channel Output Settings .....	31
4.2.3 Config Display Page.....	43
4.2.4 Quick IV Show Page .....	48
4.2.5 Expert Page.....	51
4.2.6 File Page .....	52
4.2.7 System Page .....	52
<b>Chapter 5 Interface Instructions.....</b>	<b>57</b>
5.1 Measurement Terminals .....	57
5.1.1 Connection Method .....	57
5.1.2 Test Leads and Fixtures.....	58
5.1.3 Cautions .....	58
5.2 Remote Control RS232 .....	58
5.2.1 RS232C Introduction.....	58
5.2.2 Communication with Computers .....	60
5.3 Handler Interface Usage Notes .....	62
5.3.1 Basic Information.....	62
5.3.1 Interlocking Circuits .....	63
<b>Chapter 6 Command Reference.....</b>	<b>65</b>
6.1 Command Structure.....	65
6.1.1 Structure Rules.....	65
6.1.2 Multiple Commands Rule. ....	66
6.1.3 Abbreviation Rules .....	66
6.2 Symbol Conventions and Definitions.....	67
6.2.1 Symbols.....	67
6.2.2 Suffix Numbers.....	68
6.2.3 Channel List Parameters.....	68

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6.3 Data Output Format .....	68
6.4 Command Reference.....	69
6.4.1 DISPlay Subsystem Command.....	69
6.4.2 FORMat Subsystem Command .....	71
6.4.3 FETCh Subsystem Command .....	71
6.4.4 MEASure Subsystem Command .....	74
6.4.5 OUTPut Subsystem Command.....	75
6.4.6 SENSE Subsystem Command .....	79
6.4.7 SOURce Subsystem Command.....	85
6.4.8 SYSTem Subsystem Command .....	95
6.4.9 TRIGger Subsystem Command .....	102
6.4.10 Public Command .....	104
6.5 Error .....	105
<b>Chapter 7 Dispatch Procedure, E-Waste management and Warranty .....</b>	<b>106</b>
7.1 Dispatch Procedure for service .....	106
7.2 E-Waste management.....	106
7.3 Warranty .....	106

## Chapter 1 Overview

Thank you for purchasing and using our products. Before you use this instrument, please read the manual.

### 1.1 Introduction

SMU5991/SMU5992 is a series of precision source/measure units, referred to as SMU. It offers touch screen, front panel keys and knobs to apply voltage/current or measure voltage/current/resistance. The instrument also supports several functions such as sweep output, pulse output, arbitrary waveform generation, limit test, trace buffer, mathematical expressions, and graphical printing. Thus, the SMU5991 / SMU5992 can be DC (constant) voltage/current source, sweep voltage/current source, pulse generator, arbitrary waveform generator and multimeter.

Model	Number of Channels	Valid Settings and Measured Values			
		Minimum Resolution		Maximum Current	Maximum Voltage
		Source	Measurement		
SMU5991C	1	1pA,1uV	100fA,100nV	DC: ±1.515A Pulse: None	±63V
SMU5991B		100fA,1uV	10fA,100nV	DC: ±3.03A Pulse: None	±210V
SMU5991A		1pA,1uV	100fA,100nV	DC: ±3.03 Pulse: ±10.5V	
SMU5991		10fA,100nV	10fA,100nV		
SMU5992B	2	100fA,1uV	10fA,100nV		
SMU5992A		1pA,1uV	100fA,100nV		
SMU5992		10fA,100nA	10fA,100nV		

Table 1-1 SMU5991 / SMU5992 Series Product

### 1.2 General Specifications

#### 1.2.1 Power Supply

- Supply voltage: 90V to 264V
- Power frequency: 50Hz/60Hz ( $1\pm 5\%$ )
- Power consumption: <250VA

#### 1.2.2 Environment / Temperature / Humidity / Altitude

- Environment: suitable for indoor equipment use
- Operation status:
  - Temperature: 0°C to +55°C

- Humidity: 30% to 80% RH (no condensation)
- Altitude: 0~2000m (6561ft)
- Storage status:
  - Temperature: -30°C to +70°C
  - Humidity: 10% to 90% RH (no condensation)
  - Altitude: 0~4600m (15092ft)

### 1.2.3 Warm-up

Warm-up time after power -on: ≥ 60 minutes

### 1.2.4 Volume and Weight

- Whole machine size (W\*H\*D): 235\*154\*530
- Upper frame size (W\*H\*D): 215\*132\*490
- Weight: 10kg (dual channel) / 8.5kg (single channel)

### 1.2.5 Attention to the Problem

- Please do not use it in adverse environment such as dusty, vibration, direct sunlight, corrosive gas, etc.
- If the instrument is not used for a long time, please store it in the original packing box or similar box in the ventilated room. The air should not contain harmful impurities that corrode the instrument and should be protected from direct sunlight.
- This instrument should be used in the low noise environment as much as possible. If this cannot be avoided, please install the power filter.
- Please make sure the instrument is in a well-ventilated condition with forced ventilation with air intake at the side and exhaust at the rear of the instrument to avoid the internal temperature rising and affecting the accuracy.
- Do not switch the instrument on and off frequently to avoid loss of stored data.

## 1.3 Safety Standard

This instrument is a Class I safety instrument

EMC Standard: IEC61326-1/EN61326-1/AS/NZS CISPR 11

### 1.3.1 Insulation Resistance

- The insulation resistance between the power supply terminals and the housing is not less than 50MΩ under reference operating conditions.
- Under hot and humid transportation conditions, the insulation resistance between the power terminals and the housing is not less than 2MΩ.

### **1.3.2 Dielectric Strength**

Under reference operating conditions, the power supply terminals and the housing can withstand the rated voltage of 1.5kV, frequency of 50Hz AC voltage for 1 minute, no breakdown and flying arc phenomenon.

### **1.3.3 Leakage Current**

Leakage current is not more than 3.5mA.

### **1.3.4 Security Certification**

CE, cCSAus, C-Tick



## Chapter 2 View Description

The content of this chapter is only a general description; the specific operation and detailed explanation refer to the corresponding content of Chapter 4.

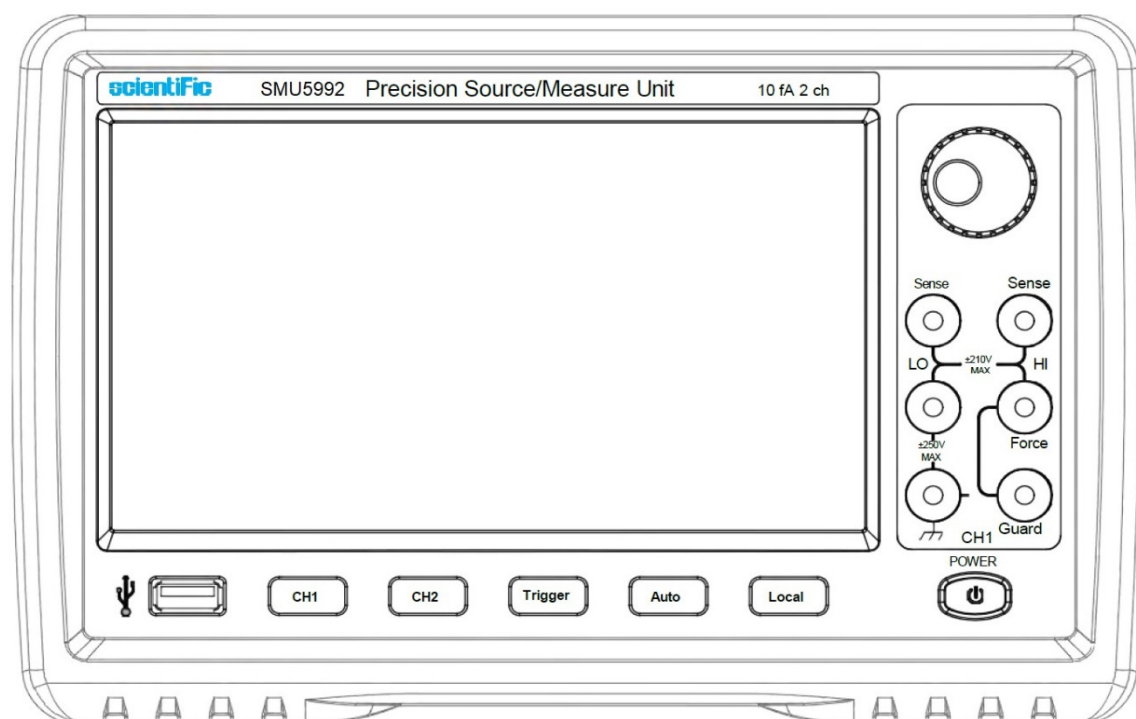


Figure 2-1 Front Panel Diagram

### 2.1 Front Panel Description

- **USB-A connector:** Used to connect USB memory. After disconnecting the USB memory, wait for 10 seconds and then connect it again or connect a new memory.  
**※Note:** If the instrument is turned off while the USB memory is being accessed, the device may be damaged.
- **CH1/CH2:** Used to enable or disable the SMU channel. Disables the channel if it is in the output state, even if it is in the remote state. 1- channel models have 1 button; 2-channel models have 2 buttons.
  - If the channel is enabled, the button will turn yellow.
  - If the channel is in the high voltage state, the switch will turn red.
- **Trigger:** Starts a single measurement. Stops repeated measurements if they are being made.**Auto:** Starts a repeat measurement. Stops repeated measurements if they are being performed.
- **Local:** If the instrument is in the remote state, return it to the local state
- **Line switch:** Turns the instrument on and off.
- **Channel 1 source/measurement terminals:** High Force, Low Force, High Sense, Low Sense, Guard, and Chassis Ground. (See 5.1 Measurement Terminals)

✖**Note:** Do not connect the Guard terminal to any output, including the common circuit, chassis ground wire, or any other protective terminal; otherwise this may damage the instrument.

✖**Note:** The maximum current of the chassis ground terminal is 3A DC.

- **Knob:** If the field pointer is in the Parameter Setup page or Setup box, turn the knob to change the value of the setup parameter. Press the knob to fix the value and exit the value setting page.

If the field pointer is on the Graph and Roll view pages, turn the knob to adjust the interval of the display of the axis pages.

## 2.2 Rear Panel Description

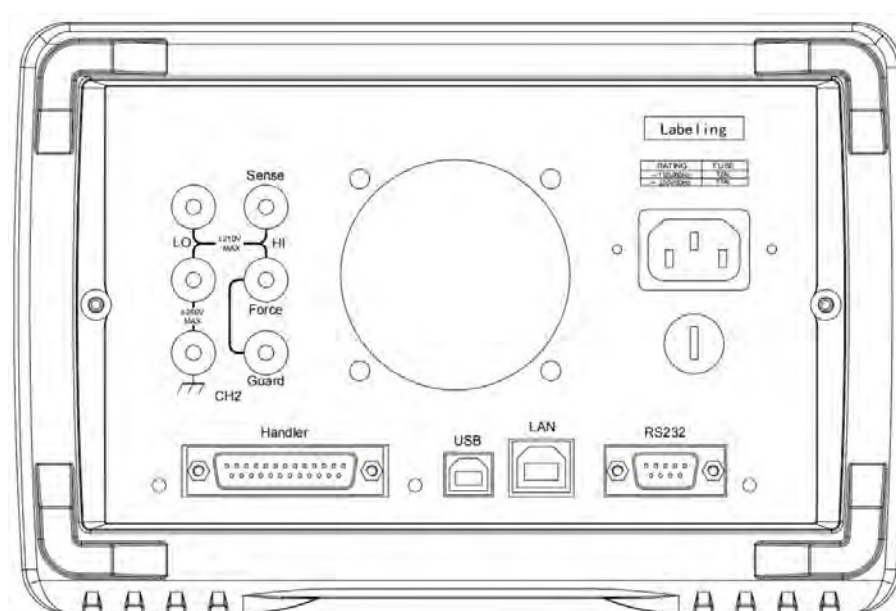


Figure 2-2 Rear Panel Diagram

- **Channel 2 source/measurement terminals:** For 2-channel models only, High Force, Low Force, High Sense, Low Sense, Guard, and Chassis Ground. (See 5.1 Measurement Terminals)
- **Cooling fan:** Forced ventilation to avoid internal temperature rising and affecting accuracy.
- **Three-wire power outlet:** Voltage is 90V to 264V, and the power frequency is 50Hz.
- **Handler connector:** DSUB25 pin female connector is used for general purpose I/O. It can be used for data input/output, trigger input/output terminals and other functions.
- **USB-B connector:** Used to connect USB memory.
- **LAN interface connector:** Connects to the 10/100 Base-T interface. Left LED indicates the active status, and the right LED indicates link integrity.
- **RS232 connector:** Provides a universal communication interface between the

instrument and external devices, all parameter settings, commands, etc. can be set and obtained by the computer for realizing remote control without the instrument panel.

## 2.3 Page Summary

### 2.3.1 Home Page



Figure 2-3 Home Page

The Home page is the main power-up screen of the instrument and displays the Dual view. The upper area is for channel 1 and the lower area is for channel 2. Each area displays the measurement results, the source, and the measurement settings. The parameters that can be set are as follows:

- Source: Source function, voltage source VOLTS (V) or current source AMPS (I).
- V-range: If the source is the voltage source, this parameter is the output voltage range.  
If the source is the current source, this parameter is the measured voltage range.
- I-range: If the source is the current source, this parameter is the output current range; if the source is the voltage source, this parameter is the measured current range.
- Output: The source output value.
- Limit: Limit (compliance) value.

**※Note:** Double click on the display area of Channel 1 or Channel 2 to enter the specific setting with 3 pages of parameters for different channels. 3 pages can be turned by swiping left and right on the touch screen.

### 2.3.2 Config Page

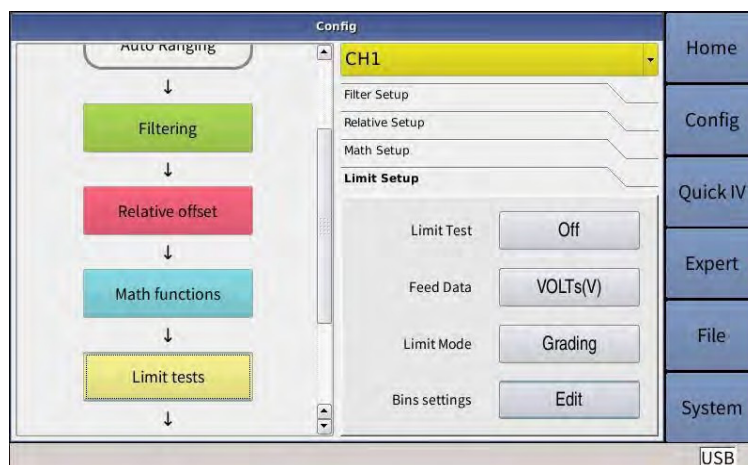


Figure 2-4 Config Page

The Config page is for processing the measurement output data for filtering, deduction of deviations, mathematical operations, or limit tests. The parameters that can be set are as follows:

- CH1/CH2: Select Channel 1 or Channel 2 for data processing.
- Filter Setup: Filter Setup.
- Relative offset: The relative offset setting.
- Math Function: Math operation function setting.
- Limit tests: Limit test setting.

### 2.3.3 Quick I/V Page

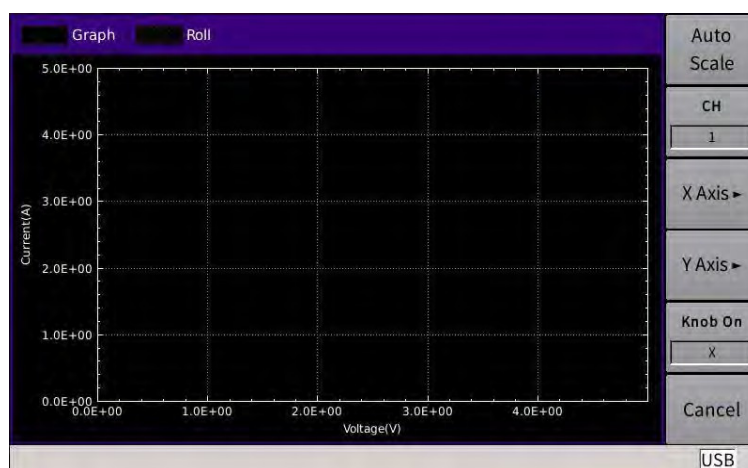


Figure 2-5 Quick I/V Page

The Quick I/V page mainly displays the Graph and Roll views. The Graph view shows the graph that plots the results of measurements or mathematical operations for Channel 1 or Channel 2, and the Roll view shows the time-domain diagram that plots the measurement data for Channel 1 or Channel 2.

### 2.3.4 Expert Page

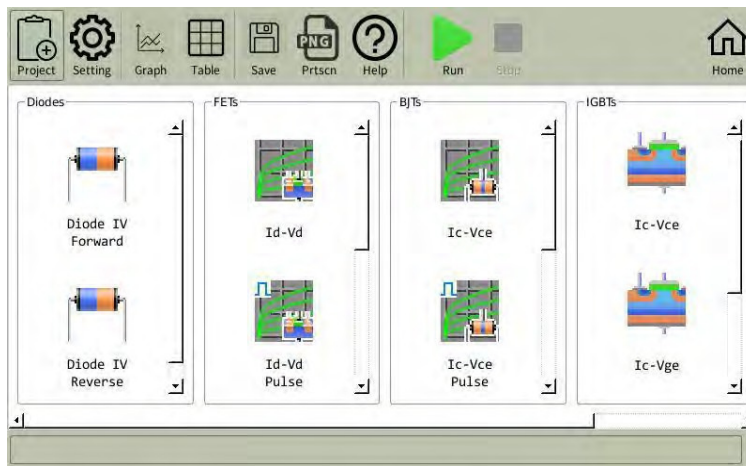


Figure 2-6 Expert Page

The Expert page is the graphical analysis of semiconductor parameters, which is the advanced function and contains the following test functions:

- Diodes: Diode Testing
- FETs: Field Effect Transistor Testing
- BJTs: Triode Testing
- IGBTs: Insulated Gate Bipolar Transistor Testing
- Utility: Universal Testing

### 2.3.5 File Page

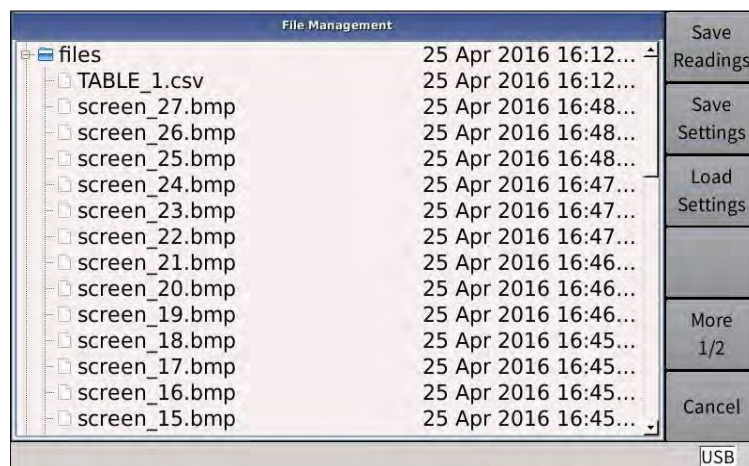


Figure 2-7 File Page

The File page displays a list of files, including file name, file type, file creation time, and other information. You can store data, copy, and paste files, rename, and delete files on this page.

### 2.3.6 System Page



Figure 2-8 System Page

- RS232/GPIB: Serial/GPIB communication setting
- Usb device: USB setting
- Network: Network setting
- Digital I/O: Input/output pin setting
- User Setup: User setup
- Date Time: Device date and time setting
- Update: Update information setting
- Tools: System tools setting



## Chapter 3 Basic Technical Specifications

### 3.1 Source/Measurement Unit

**Source/Measurement Unit (SMU):** can apply voltage or current and measure current or voltage.

SMU can perform the following operations:

- Apply voltage and measure current
- Apply current and measure voltage
- Apply voltage and measure voltage
- Apply current and measure current

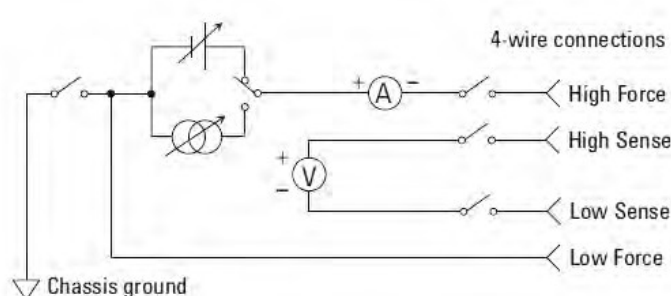


Figure 3-1 Display Simplified SMU Circuit Diagram

#### 3.1.1 Measurement Parameters

U: Voltage      I: Current

R: Resistance    P: Power

The resistance data is specified by  $\text{Resistance} = V_{\text{meas}} / I_{\text{meas}}$ .

The power data is specified by  $\text{Power} = V_{\text{meas}} \times I_{\text{meas}}$ .

In the above equation,  $V_{\text{meas}}$  is the voltage measurement data,  $I_{\text{meas}}$  is the current measurement data.

#### 3.1.2 Limit / Compliance

The SMU5991/SMU5992 has the compliance function that limits the output voltage or current to prevent damage to the device under test. When the SMU applies voltage, the current limit/compliance can be specified. When the SMU applies current, the voltage limit/compliance can be specified.

When the channel reaches compliance, the channel will act as the constant voltage source or constant current source. When the compliance is achieved, the channel will retain the output value. The compliance can be set by using the same resolution and accuracy as the output current or output voltage.

**※Note:** When setting compliance

- Minimum compliance value:
  - Current compliance: 1% of range (in the range 100nA), 1nA (in the range 10nA).
  - Voltage compliance: 1% of range.
- If the current compliance value is too low, the SMU will take a long time to stabilize.
- If the SMU is unable to force the specified current due to the following reasons, the SMU will achieve voltage compliance:
  - Test equipment overcurrent.
  - Another channel has reached compliance.
  - The current measurement data of the other channel has reached the limit of the current measurement range.

## 3.2 Technical Specifications

This chapter lists the specifications and features of the SMU5991/SMU5992 series. The specifications are based on the standards that test SMU5991/SMU5992, and the requirements which they conform at the factory.

### 3.2.1 Source Specifications

#### 3.2.1.1 Voltage Sources

Measurement Range	Programming Resolution				Accuracy (gain error (% of reading) + offset error)	Noise (peak-to-peak) 0.1Hz to 10Hza	Maximum Voltage (over range)
	SMU5991C	SMU5991B SMU5992B	SMU5991A SMU5992A	SMU5991 SMU5992			
±200mV	1μV		1μV	0.1μV	± (0.015%+225μV)	≤10μV	±210mV
±2V	10μV		10μV	1μV	± (0.02% + 350μV)	≤20μV	±2.1V
±20V	100μV		100μV	10μV	± (0.015%+5mV)	≤200uV	±21V
±200Vb	-	1mV	1mV	100μV	± (0.015%+50mV)	≤2mV	±210V

Table 3-1 Voltage Source Specifications

**\*Note:** Superscript a: Additional features

- Voltage limit/compliance: Accuracy is the same as the voltage source. The minimum value is 1% of the range or 20mV of the 200mV range.
- Over range: 105% of source range.
- Voltage output stabilization time (time required for 0.1% range of final value under open circuit load conditions): Steps are 10% to 90% range.
  - 200mV and 2V range: <50us, 20V range: <110us.



- 200V range: <700us
- Noise 10Hz to 20MHz (V source): 50mVrms, 20V range
- V source overshoot:  $\leq \pm(0.1\%+10\text{mV})$  Step size is 10% to 90% range, resistive load.
- Voltage source range change overshoot:  $\leq 250\text{mV}$ ,  $100\text{k}\Omega$  load, 20MHz bandwidth.

Superscript b:  $\pm 200\text{V}$  does not apply to SMU5991C.

### 3.2.1.2 Current Source

Measurement Range	Programming Resolution				Accuracy (gain error (% of reading) + offset error)	Noise (peak-to- peak) 0.1Hz to 10Hz <sup>a</sup>	Maximum Current (over range)
	SMU5991C	SMU5991B SMU5992B	SMU5991A SMU5992A	SMU5991 SMU5992			
$\pm 10\text{nA}^b$	-	100fA	-	10fA	$\pm(0.10\%+50\text{pA})$	$\leq 2\text{pA}$	$\pm 10.5\text{nA}$
$\pm 100\text{nA}^b$	-	1pA	1pA	100fA	$\pm(0.06\%+10\text{pA})$	$\leq 5\text{pA}$	$\pm 105\text{nA}$
$\pm 1\mu\text{A}$	10pA		10pA	1pA	$\pm(0.025\%+500\text{pA})$	$\leq 25\text{pA}$	$\pm 1.05\mu\text{A}$
$\pm 10\mu\text{A}$	100pA		100pA	10pA	$\pm(0.025\%+1.5\text{nA})$	$\leq 60\text{pA}$	$\pm 10.5\mu\text{A}$
$\pm 100\mu\text{A}$	1nA		1nA	100pA	$\pm(0.02\%+25\text{nA})$	$\leq 3\text{nA}$	$\pm 105\mu\text{A}$
$\pm 1\text{mA}$	10nA		10nA	1nA	$\pm(0.02\%+200\text{nA})$	$\leq 6\text{nA}$	$\pm 1.05\text{mA}$
$\pm 10\text{mA}$	100nA		100nA	10nA	$\pm(0.02\%+2.5\mu\text{V})$	$\leq 200\text{nA}$	$\pm 10.5\text{mA}$
$\pm 100\text{mA}$	1uA		1uA	100nA	$\pm(0.02\%+20\mu\text{V})$	$\leq 600\text{nA}$	$\pm 105\text{mA}$
$\pm 1\text{A}$	10uA		10uA	1uA	$\pm(0.03\%+1.5\text{mA})$	$\leq 70\text{uA}$	$\pm 1.05\text{A}$
$\pm 1.5\text{A}$	10uA		10uA	1uA	$\pm(0.05\%+3.5\text{mA})$	$\leq 150\text{uA}$	$\pm 1.515\text{A}$
$\pm 3\text{A}^d$	-	-	100uA	10uA	$\pm(0.4\%+7\text{mA})$	-	$\pm 3.03\text{A}$
$\pm 10\text{A}^{d,e}$	-	-	100uA	10uA	$\pm(0.4\%+25\text{mA})^f$	-	$\pm 10.5\text{A}$

Table 3-2 Current Source Specifications

**※Note:**

- Superscript a: Additional features
  - Current limit/compliance: Accuracy is the same as current source, the minimum value is 1% of the range, or 1nA of the 10nA range.
  - Over range: 1.5A and 3A range are 101% of the source range, the rest is 105% of the source range.
  - Current output stabilization time: (time required for 0.1% range of final value under short circuit conditions): Steps are 10% to 90% range.  
 10nA and 100nA range: <10ms, 1uA range: <500us  
 10uA and 100uA range: <250us, 1mA to 3A range: <80us
  - I source overshoot: <±0.1%, the step size is 10% to 90% range, resistive load.
  - Current source range change overshoot: ≤250mV/R<sub>load</sub>, 20MHz bandwidth.
- Superscript b: ±10nA does not apply to SMU5991A/C and SMU5992A.
- Superscript c: ±100nA is not applicable to SMU5991C.
- Superscript d: ±3A, ±10A do not apply to SMU5991B/C and SMU5992B.
- Superscript e: ±10A range is for pulse mode only, not for DC mode.
- Superscript f: Measurement speed: 0.01 PLC.

**3.2.1.3 Pulse source**

	Maximum Voltage	Maximum Peak Current	Maximum Base Current	Maximum Pulse Width	Maximum Duty Cycle
DC or Pulse	6V	3.03A <sup>a</sup>	303A <sup>a</sup>	DC, Infinite Value	100%
	21V	1.515A <sup>a</sup>	1.515A <sup>a</sup>	DC, Infinite Value	100%
	210V	0.105A	0.105A	DC, Infinite Value	100%
Pulse Only	6V	10.5A	0.5A	1ms	2.5%
	180V	10.5A	50mA	10ms	2.5%
	200V	1.515A	50mA	2.5ms	2.5%

Table 3-3 Maximum Pulse Width and Duty Cycle

**※Note:**

- Superscript a: For two channels, the maximum total current for both channels is limited.
- Pulse width definition: Time from 10% leading edge to 90% trailing edge, as shown in the figure below.
- The pulse source is always measured with the fixed range.

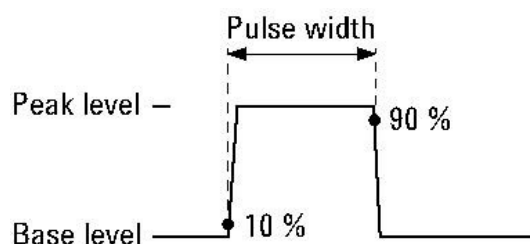


Figure 3-2 Pulse Width (10% leading edge to 90% trailing edge)

Source Value	Limit Value	Load	Source Stabilization (% of range)	Minimum Pulse Width
200V	1.5A	200 $\Omega$	0.1%	1ms
6V	10.5A	0.6 $\Omega$	0.1%	0.2ms
1.5V	200V	65 $\Omega$	0.1%	2.5ms
10.5V	6A	0.5 $\Omega$	0.1%	0.2ms

Table 3-4 Minimum Pulse Width for Given Voltage and Current with Stability Condition

**✖Note:** The appropriate resistance load is connected for the above voltage and current conditions.

### 3.2.1.4 Source Characteristics

- Temperature coefficient (0°C to 18°C and 28°C to 50°C):  $\pm (0.1 \times \text{accuracy specification}) / ^\circ\text{C}$ .
- Maximum output power: 31.8W.
- Source/reverse limit: Four-quadrant source or reverse operation, value is  $\pm 6\text{V} @ \pm 3.03\text{A}$ ,  $\pm 21\text{V} @ \pm 1.515\text{A}$ , or  $\pm 210\text{V} @ \pm 105\text{mA}$ .
- Over-temperature protection: Shuts down all channel outputs and locks out the cause channel when over-temperature is sensed internally.
- Minimum programmable pulse width: 50 $\mu\text{s}$ .
- Pulse width programming resolution: 1 $\mu\text{s}$ .

### 3.2.2 Output Specifications

#### 3.2.2.1 Voltage/Current Output

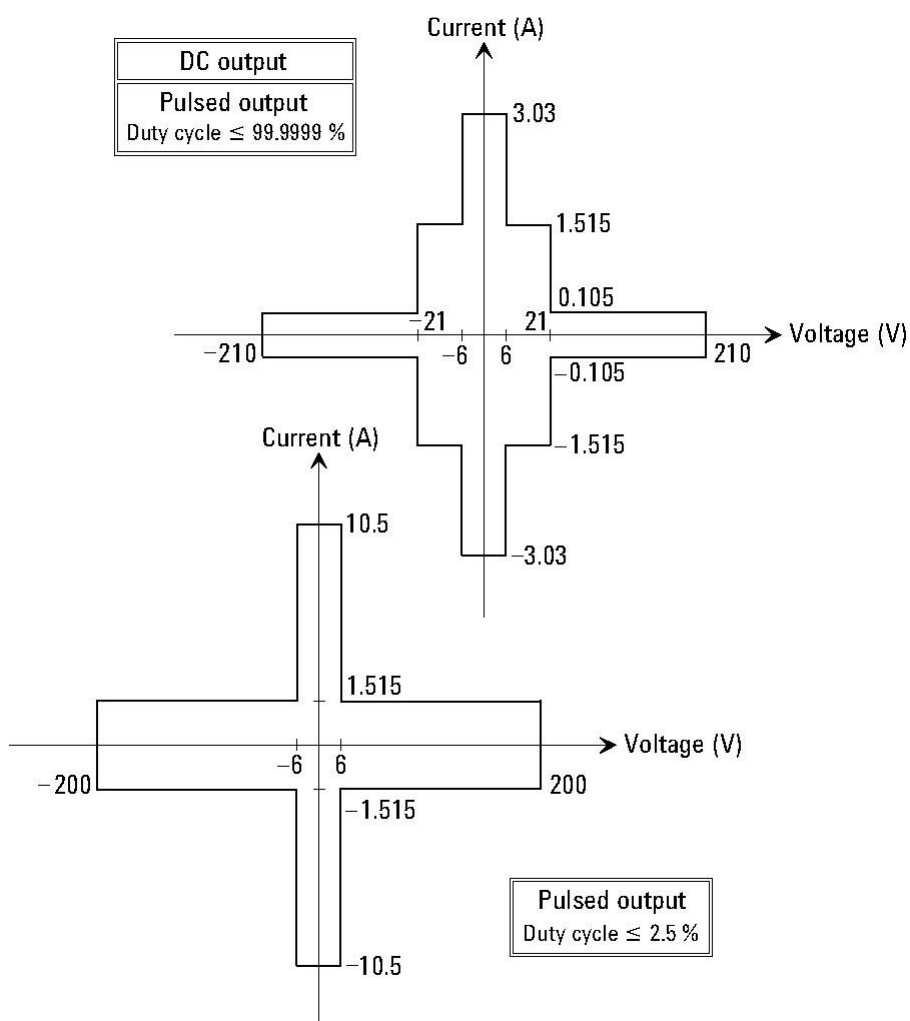


Figure 3-3 Output Range

	Maximum Voltage in V	Maximum Current in A	Total Current Limit When Using Channel 1 (I1, V1) and Channel 2 (I2, V2)		
			V1 in V	V2 in V	Current Limit in A
DC or Pulse	6V	3.03A	$\pm(0 \leq V1 \leq 6)$	$\pm(0 \leq V2 \leq 6)$	$I1 + I2 \leq 4$
	21 V	1.515A		$\pm(6 \leq V2 \leq 21)$	$I1 + I2 * 1.6 \leq 4$
	210 V	0.105A	$\pm(6 \leq V1 \leq 21)$	$\pm(0 \leq V2 \leq 6)$	$I1 + I2 * 0.625 \leq 2.5$
Pulse Only	6 V	10.5A		$\pm(6 \leq V2 \leq 21)$	$I1 + I2 \leq 2.5$
	200 V	1.515A			

Table 3-5 Maximum Voltage and Current

Measurement Range Value	Voltage Output Value	Set Resolution				MaximumCurrent		Pulse Width	
		SMU5991C	SMU5991B SMU5992B	SMU5991A SMU5992A	SMU5991 SMU5992	DC Output	Pulse Output		
0.2V	0≤ V  ≤0.21V	1uV			0.1uV	±3.03A	±10.5 A	50us ≤t≤ 100ks	
2V	0≤ V  ≤2.1V	10uV			1uV				
20V	0≤ V ≤6V	100uV			10uV	±1.515 A	±1.515 A		
	0≤ V  ≤21V								
200V	0≤ V ≤6V	1mV		1mV	100uV	±3.03A	±3.03 A	50us≤t ≤1ms	
							±10.5 A		
	0≤ V  ≤21V					±1.515 A	±1.515 A	50us ≤t≤ 100ks	
	0≤ V  ≤180V	1mV (0-60V)	1mV			-	±1.05 A	50us≤t ≤10ms	
	0≤ V  ≤200V	-				-	±1.515 A	50us ≤t≤ 2.5ms	
	0≤ V  ≤210V	-				±0.105 A	-	-	

Table 3-6 Voltage Output Range

Measurement Range Value	Current Output Value	Set Resolution				Maximum Voltage		Pulse Width
		SMU5991C	SMU5991B SMU5992B	SMU5991A SMU5992A	SMU5991 SMU5992	DC Output	Pulse Output	
10nA <sup>a</sup>	0≤ I ≤ 10.5nA	1pA	100fA	-	10fA	±210V	±210V	50us ≤t≤ 100ks
100nA	0≤ I ≤ 105nA	10pA	1pA	1pA	100fA			
1uA	0≤ I ≤ 1.05uA	100pA	10pA	10pA	1pA			
10uA	0≤ I ≤ 10.5uA	1nA	100pA	100pA	10pA			
100uA	0≤ I ≤ 105uA	10nA	1nA	1nA	100pA			
1mA	0≤ I ≤ 1.05mA	100nA	10nA	10nA	1nA			
10mA	0≤ I ≤ 10.5mA	1uA	100nA	100nA	10nA			
100mA	0≤ I ≤ 105mA	10uA	1uA	1uA	100nA			
1A	0≤ I ≤ 105mA	100uA	10uA	10uA	1uA	±210V	-	-
	105mA ≤  I  ≤ 1.05A					±21V	-	-
1.5A	0≤ I ≤ 105mA	100uA	10uA			±210V	-	-
	105mA ≤ I ≤ 1.515A					±21V	-	-

	$0 \leq  I  \leq 1.515A$					-	$\pm 21V$	$50\mu s \leq t \leq 100\mu s$
	$0 \leq  I  \leq 1.05A^a$					-	$\pm 180V$	$50\mu s \leq t \leq 10ms$
	$0 \leq  I  \leq 1.515A^a$					-	$\pm 200V$	$50\mu s \leq t \leq 2.5ms$
3A	$0 \leq  I  \leq 105mA$	1mA	100uA	100uA	10uA	$\pm 210V$	-	-
	$105mA \leq  I  \leq 1.515A$					$\pm 21V$	-	-
	$1.515A \leq  I  \leq 3.03A$	-				$\pm 6V$	-	-
10A <sup>b</sup>	$0 \leq  I  \leq 10.5A$	-	-			-	$\pm 6V$	$50\mu s \leq t \leq 1ms$

Table 3-7 Current Output Range

**※Note:**

- Superscript a: Limit of pulse base (instant) current level is  $\pm 50mA$
- Superscript b: Limit of pulse base (instant) current level is  $\pm 500mA$

**3.2.2.2 Output Characteristics****a) General Features**

- Sense mode: 2-wire or 4-wire (remote sensing) connection
- Ground connection: Chassis ground or floating
- Output position: Front panel channel 1, rear panel channel 2
- Maximum load:
  - Normal mode:  $0.01\mu F$
  - High capacitance mode:  $50\mu F$
- DC floating voltage:  $\pm 250V$  DC maximum between low voltage and chassis ground
- Protection offset voltage (V source):  $< 4mV$
- Remote sensing operation range:

- Maximum voltage between high voltage and high induction terminals: 3V
- Maximum voltage between low voltage and low induction terminals: 3V
- Common mode isolation:  $>1\text{G}\Omega$ ,  $<4500\text{pF}$
- Maximum sensing lead resistance: Set accuracy  $1\text{k}\Omega$
- Inductive input impedance:  $>10\text{G}\Omega$

#### b) High Capacitance Mode

- Voltage output stabilization time: The time required to reach 0.1% of the final value at the capacitive load of  $4.7\mu\text{F}$  over the fixed range.
  - 200mV and 2V range:  $600\mu\text{s}$  at 1A limit
  - 20V range: 1.5ms at 1A limit
  - 200V range: 20ms at 1A limit
- Current output stabilization time: The time required to reach 0.1% of the final value after the voltage source has stabilized at the fixed range under the short-circuit condition.  $V_{\text{out}}$  is 5V unless otherwise specified.
  - 1uA range: 230ms
  - 10uA and 100uA range: 23ms
  - 1mA and 10mA range: 0.23ms
  - 100mA and 3A range: 100us

The 10nA and 100nA range are not available for high capacitance mode.
- Mode change delay:
  - Delay into high capacitance mode: 1uA range: 230ms  
10uA and 100uA range: 1ms
  - Delay beyond high capacitance mode: all ranges: 10ms
- Noise 10Hz to 20MHz (20V range):  $50\text{mV}_{\text{rms}}$
- Voltage source range change overshoot (20V range or less):  $\leq 250\text{mV}$ , 20MHz bandwidth
- High capacitance mode operating conditions:
  - V/I mode: Voltage source mode only
  - Range: Current measurement ranges are the fixed ranges only.  
(10nA and 100nA range are not available)
  - Current limit:  $\geq 1\mu\text{A}$

### 3.2.3 Measurement Specifications

#### 3.2.3.1 Voltage/Current Measurement



Range Value	Voltage Measurement Value	Measurement Resolution				Accuracy (gain error (% of reading) + offset error)
		SMU 5991C	SMU5991B SMU5992B	SMU991A SMU992A	SMU991 SMU992	
$\pm 0.2\text{V}$	$0 \leq  V  \leq 0.212\text{V}$	100nV		0.1uV		$\pm(0.015\%+225\text{uV})$
$\pm 2\text{V}$	$0 \leq  V  \leq 2.12\text{V}$	1uV		1uV		$\pm(0.02\%+350\text{uV})$
$\pm 20\text{V}$	$0 \leq  V  \leq 21.2\text{V}$	10uV		10uV		$\pm(0.015\%+5\text{mV})$
$\pm 200\text{V}$	$0 \leq  V  \leq 212\text{V}$	-	100uV	100uV		$\pm(0.015\%+50\text{mV})$

Table 3-8 Voltage Measurement Range

**※Note:** The specific content of the superscript a in the above table:  $\pm 200\text{V}$  is not applicable to SMU5991C.

Range Value	Current Measurement Value	Measurement Resolution				Accuracy (gain error (% of reading) + offset error)
		SMU 5991C	SMU5991B SMU5992B	SMU991A SMU992A	SMU991 SMU992	
$\pm 10\text{nA}^{\text{a}}$	$0 \leq  I  \leq 10.6\text{nA}$	-	10fA	-	10fA	$\pm(0.10\%+50\text{pA})$
$\pm 100\text{nA}^{\text{b}}$	$0 \leq  I  \leq 106\text{nA}$	-	100fA	100fA		$\pm(0.06\%+100\text{pA})$
$\pm 1\text{uA}$	$0 \leq  I  \leq 1.06\text{uA}$	1pA		1pA		$\pm(0.025\%+500\text{pA})$
$\pm 10\text{uA}$	$0 \leq  I  \leq 10.6\text{uA}$	10pA		10pA		$\pm(0.025\%+1.5\text{nA})$
$\pm 100\text{uA}$	$0 \leq  I  \leq 106\text{uA}$	100pA		100pA		$\pm(0.02\%+25\text{nA})$
$\pm 1\text{mA}$	$0 \leq  I  \leq 1.06\text{mA}$	1nA		1nA		$\pm(0.02\%+200\text{nA})$
$\pm 10\text{mA}$	$0 \leq  I  \leq 10.6\text{mA}$	10nA		10nA		$\pm(0.02\%+2.5\text{uV})$
$\pm 100\text{mA}$	$0 \leq  I  \leq 106\text{mA}$	100nA		100nA		$\pm(0.02\%+20\text{uV})$
$\pm 1\text{A}$	$0 \leq  I  \leq 1.06\text{A}$	1uA		1uA		$\pm(0.03\%+1.5\text{mA})$
$\pm 1.5\text{A}$	$0 \leq  I  \leq 1.53\text{A}$	1uA		1uA		$\pm(0.05\%+3.5\text{mA})$
$\pm 3\text{A}^{\text{c}}$	$0 \leq  I  \leq 3.06\text{A}$	-	-	10uA		$\pm(0.4\%+7\text{mA})$
$\pm 10\text{A}^{\text{c, d}}$	$0 \leq  I  \leq 10.6\text{A}$	-	-	10uA		$\pm(0.4\%+25\text{mA})^{\text{e}}$

Table 3-9 Current Measurement Range

**※Note:** The specific contents of the superscripts a, b, c, d, and e in the above table

- Superscript a:  $\pm 10\text{nA}$  does not apply to SMU5991A/C and SMU5992A.
- Superscript b:  $\pm 100\text{nA}$  does not apply to SMU5991C.
- Superscript c:  $\pm 3\text{A}$ ,  $\pm 10\text{A}$  are not applicable to SMU5991B/C.

- Superscript d:  $\pm 10A$  applies to pulse mode, not DC mode.
- Superscript e: Measurement rate is 0.01PLC.

### 3.2.3.2 Resistance Measurement

Resistance measurements can be performed under automatic or manual test conditions. The automatic resistance measurement is performed in current source and voltage measurement mode. The total error of the automatic resistance measurement is shown in Table 2-11. The voltage and current accuracy information can be used to calculate the total error of the manual resistance measurement as shown below:

- Source I mode, manual ohms measurement (4-wire):  

$$\text{Total error} = V_{\text{measure}}/I_{\text{source}} = R \text{ reading} * (\text{gain error of V range} + \text{gain error of I range} + \text{offset error of I range}/I_{\text{source}} * 100) \% + (\text{offset error of V range}/I_{\text{source}})$$

There into, the gain error and offset error can be specified by Table 2-2 and Table 2-8.
- Source V mode, manual ohmic measurement (4-wire):  

$$\text{Total error} = V_{\text{source}}/I_{\text{measure}} = 1/[1/R \text{ reading} * (\text{gain error of I range} + \text{gain error of V range} + \text{offset error of V range}/V_{\text{source}} * 100) \% + (\text{offset error of I range}/V_{\text{source}})]$$

There into, the gain error and offset error can be specified by Table 2-3 and Table 2-7.

**※Note:** Example of total error calculation: (I source= 1mA at 1mA range, V measurement range = 2V range)

$$\text{Total error} = (0.02\% + 0.02\% + 200\text{nA}/1\text{mA} * 100) \% + (350\text{uV}/1\text{mA}) = 0.06\% + 0.35\Omega$$

- Test speed = 1PLC
- Applicable temperature:  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$

Range Value	Resistance Measurement Value	Display Resolution	Test Current
2 $\Omega$	$0 \leq R \leq 2\Omega$	1 $\mu\Omega$	1A
20 $\Omega$	$2\Omega \leq R \leq 20\Omega$	10 $\mu\Omega$	100mA
200 $\Omega$	$20\Omega \leq R \leq 200\Omega$	100 $\mu\Omega$	10mA
2k $\Omega$	$200\Omega \leq R \leq 2\text{k}\Omega$	1m $\Omega$	1mA
20k $\Omega$	$2\text{k}\Omega \leq R \leq 20\text{k}\Omega$	10m $\Omega$	100 $\mu\text{A}$
200k $\Omega$	$20\text{k}\Omega \leq R \leq 200\text{k}\Omega$	100m $\Omega$	10 $\mu\text{A}$
2M $\Omega$	$200\text{k}\Omega \leq R \leq 2\text{M}\Omega$	1 $\Omega$	1 $\mu\text{A}$
20M $\Omega$	$2\text{M}\Omega \leq R \leq 20\text{M}\Omega$	10 $\Omega$	100nA
200M $\Omega$	$20\text{M}\Omega \leq R \leq 200\text{M}\Omega$	100 $\Omega$	10nA

Table 3-10 Resistance Measurement Range

Range Value	Display Resolution	Test Current	Current Range	Total Error (% reading + offset)
2Ω	1uΩ	1A	1A	0.02%+0.00035Ω
20Ω	10uΩ	100mA	100mA	0.006%+0.0035Ω
200Ω	100uΩ	10mA	10mA	0.065%+0.035Ω
2kΩ	1mΩ	1mA	1mA	0.06%+0.35Ω
20kΩ	10mΩ	100uA	100uA	0.065%+3.5Ω
200kΩ	100mΩ	10uA	10uA	0.06%+35Ω
2MΩ	1Ω	1uA	1uA	0.095%+350Ω
20MΩ	10Ω	100nA	100nA	0.18%+3.5kΩ
200MΩ	100Ω	10nA	100nA	1.08%+35kΩ

Table 3-11 Typical Performance of Automatic Resistance Measurement (4-wire) (2V Range)

### 3.2.3.3 Measurement Characteristics

- Temperature coefficient (0°C to 18°C and 28°C to 50°C):  $\pm (0.1 \times \text{accuracy specification}) / ^\circ\text{C}$ .
- Over range: 1.5A and 3A range are 102% of the source range, therest are 106% of the source range.
- Voltage measurement range change overshoot:  $\leq 250\text{mV}$ , 100kΩ load, 20MHz bandwidth.
- Current measurement range change overshoot:  $\leq 250\text{mV}/R$  load, 20MHz bandwidth.
- Derating accuracy of the measuring speed less than 1PLC: Use Table2-11 below to measure by using  $\text{PLC} < 1$  for increasing the percentageof the range.

PLC Settings	Voltage Range		Current Range			
	0.2V	2V to 200V	10nA	100nA	1uA to 100mA	1A to 3A
0.1PLC	0.01%	0.01%	0.1%	0.01%	0.01%	0.01%
0.01PLC	0.05%	0.02%	1%	0.1%	0.05%	0.02%
0.001PLC	0.5%	0.2%	5%	1%	0.5%	0.2%

Table 3-12 Derating Accuracy &lt;1PLC

### **3.2.4 Trigger and Timing Specifications**

#### **3.2.4.1 Trigger Characteristics**

- Handler trigger input to trigger output:  $\leq 1\text{ms}$
- Handler trigger input to source change:  $\leq 1\text{ms}$

#### **3.2.4.2 Timer Features**

- Trigger timing resolution:  $1\mu$  to  $100\text{ms}$
- Timer accuracy:  $\pm 50\text{ppm}$
- Switch on/trigger delay: 0 to  $100,000\text{s}$
- Switch on/trigger interval:
  - SMU5991/SMU5992:  $20\mu\text{s}$  to  $100,000\text{s}$
  - SMU5991A/SMU5992A:  $10\mu\text{s}$  to  $100,000\text{s}$
  - SMU5991B/SMU5992B:  $200\mu\text{s}$  to  $100,000\text{s}$
  - SMU5991C:  $50\mu\text{s}$  to  $100,000\text{s}$
- Switch on/trigger event: 1 to  $100,000$
- Event stamp: TIMER values are automatically saved when each measurement is triggered.

## Chapter 4 Function Instructions

### 4.1 Basic Operation

The basic operation of the instrument is described below.

- Use the touch screen to click on the main menu on the right to access the desired main page.
- After using the touch screen to click on the different parameter setting boxes on the main page, there are selectable parameters on the right side or access to the setting page.
- Use the touch screen to slide up and down, left and right and move to the desired area.
- Turn the knob to change the parameter if you are in the Setup Box or Setup Number screen and press the knob to determine the selected parameter; if you are in the Graph and Roll interface, you can change the axis spacing by fixing the different axes.

### 4.2 Display Screen Description

#### 4.2.1 Home Display Page



Figure 4-1 General Home display page

Touch **Home** menu in the screen to access the Dual display page which displays the output and measurement results along with a number of settable parameters: Source type (Source), Voltage range (V-range), Current range (I-range), Source output (Output), and limit value (Limit).

##### 4.2.1.1 <Source>

**Description:** Source is the source type setting which is divided into voltage source VOLTS (V) and current source AMPS (I).

**Operation:** Touch the screen and click on the parameter white box after Source; when the

edge of the box turns yellow, click on the menu bar on the right of the screen to select the source type.

#### 4.2.1.2 <V-range>/<I-range>

**Description:** V-range is the voltage range setting and I-range is the current range setting, both are divided into Auto range (Auto) and Fixed range (Fixed).

When Source is the voltage source, V-range is the output voltage range refer to Table 3-6 and I-range is the measured current range refer to Table 3- 9; when Source is the current source, V-range is the measured voltage range refer to Table 3-8 and I-range is the output current range refer to Table 3-7.

**Operation:** Touch screen to click on the parameter white box after V- range or I-range; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the range.

#### 4.2.1.3 <Output>

**Description:** Output is the setting of the source output specification, voltage source refers to Table 3-1, and current source refers to Table 3-2.

**Operation:** Touch screen and click on the parameter white box after Output to enter the parameter value setting page, source specification value can be set on the screen by clicking the normal number setting and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

#### 4.2.1.4 <Limit>

**Description:** Limit is the limit value and the output limiter that prevent damage to test equipment due to overcurrent or overvoltage. The voltage limit is used for the current output channel and the current limit is used for the voltage output channel. (Limit value refer to 3.1.2 for details)

**Operation:** Touch screen and click on the white box after Limit to pop up the parameter value setting page, value of the limit can be set on the screen by clicking on the normal number setting and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine

### 4.2.2 Channel Output Settings

Double-click any channel page on Home page to access the main three pages of that channel's output settings.



Figure 4-2 Channel Specific Setup Page 1

#### 4.2.2.1 Setup Page 1

##### a) <Function>

**Description:** Functions is the channel output function setting, which is divided into four functions: Power Supply, Voltmeter, Ammeter, Ohmmeter.

**Operation:** Touch screen to click on the parameter white box after Functions; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the channel function.

##### b) <Low T>

**Description:** Low T is the connection status setting of the mid to low-end measurement terminals which are divided into Ground and Float.

**Operation:** Touch screen to click on the parameter white box after Low T; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the low-end status.

##### c) <High C>

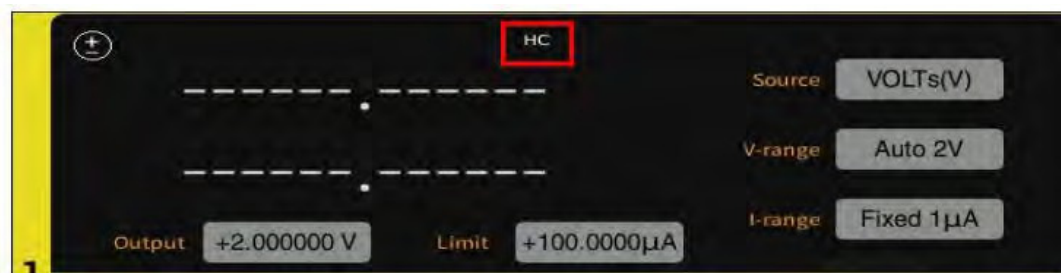


Figure 4-3 HC Mode Open Page Display Status

**Description:** High C is the high capacitance mode, which is divided into On or Off.

High capacitance mode can effectively measure capacitive loads that are greater than 0.01μF, up to 50μF. If the measurement result data is unstable, set this function to ON and the measurement data may be stable.

**Operation:** Touch screen to click on the parameter white box after High C. The parameters On or Off will be switched to each other with the click.

**d) <Off State>**

Status	Conditions After the Output is Closed
High Z	<ul style="list-style-type: none"> <li>● Output relay: Off (open circuit or broken circuit)</li> <li>● Voltage source and current source settings remain unchanged</li> <li>● If the current range is set <math>\geq 1\text{A}</math>, this mode is not applicable</li> </ul>
Normal	<ul style="list-style-type: none"> <li>● Source function: Voltage source</li> <li>● Output voltage: 0V</li> <li>● Current compliance: If the previous range is set <math>\leq 100\mu\text{A}</math>, then it is <math>100\mu\text{A}</math> in the range of <math>100\mu\text{A}</math>; if the previous range is set <math>\geq 1\text{mA}</math>, then it is <math>100\mu\text{A}</math>, but the range remains the same.</li> <li>● Output relay: Off (open circuit or broken circuit)</li> </ul>
Zero	<ul style="list-style-type: none"> <li>● Source function: Voltage source</li> <li>● Output voltage: 0V, the range is unchanged</li> <li>● Current compliance: If the previous range is set <math>\leq 100\mu\text{A}</math>, then it is <math>100\mu\text{A}</math> in the range of <math>100\mu\text{A}</math>; if the previous range is set <math>\geq 1\text{mA}</math>, then it is <math>100\mu\text{A}</math> in the range of <math>100\mu\text{A}</math>.</li> </ul>

Table 4-1 Output off Each State Condition

**Description:** Off State is the output off state, and the condition that is automatically set to it after the SMU output is turned off immediately and must be specified before enabling the source output. The output off state is classified as Normal, High Z, and Zero state.

**Operation:** Touch screen to click on the parameter white box after Off State; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the output off state.

**e) <OVP/OCP>**

**Description:** OVP/OCP is over voltage/over current protection, which is divided into On and Off.

The over voltage/current protection function can effectively prevent damage to the test device due to overcurrent or overvoltage. If this function is enabled, when the source/measurement unit (SMU) reaches compliance, it will automatically shut down the output immediately.

**Operation:** Touch screen to click on the parameter white box after OVP/OCP, the parameter On or Off will be switched to each other with the click.

**f) <Digit>**

**Description:** Digits is the digital display resolution, which is divided into Auto, 3.5, 4.5, 5.5, 6.5. The page displays 4, 5, 6, and 7 digits, respectively, except Auto.

**Operation:** Touch screen to click on the parameter white box after Digits; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the digital display resolution.



## g) &lt; Aperture &gt;

**Description:** Aperture is the measurement time, and the measurement time is the time that is required to obtain the measurement data. To make accurate and reliable measurements, the measurement time must be increased.

**Operation:** Touch screen and click on the white box after Aperture to pop up the parameter value setting page, measurement time value can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

## h) &lt; LPF-τ &gt;

**Description:** LPF-τ is the time constant of the source output filter (5μs~500μs), and the filter is installed in the source/measurement unit (SMU). It ensures that the source output is clean and free of any spike or overshoot.

※**Note:** All filters may increase the SMU stabilization time.

**Operation:** Touch screen and click on the parameter white box after LPF-τ to pop up the parameter value setting page, time constant of the output filter can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

## i) &lt;Sensing&gt;



Figure 4-4 Connected 4-Wire Page Display Status

**Description:** Sensing is the terminal connection type setting, which is divided into 2-wire connection and 4-wire connection.

**Operation:** Touch screen to click on the parameter white box after Sensing; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the connection type.

### 4.2.2.2 Setup Page 2

AWG is the source output waveform, which is divided into DC Constant Voltage/Current Source, Pulse Source (Pulse), Sweep Source (Sweep) and List source (List).

#### a) <AWG> (DC Source)



Figure 4-5 Channel Specific Setup Page 2 – DC Source

#### Source/Measurement Unit (SMU) as DC:

##### ■ Ranging Auto(I)>/<Ranging Auto(V):

**Description:** Ranging Auto (I) is the current auto-range operation mode and Ranging Auto(V) is the voltage auto-range operation mode, which is divided into Normal, Speed and Resoln mode.

When DC is the voltage source, the current auto range is the measured current range and the voltage auto range is the output voltage range; when DC is the current source, the current auto range is the output current range, and the voltage auto range is the measured voltage range.

Operation	Description (see notes below the table for specific descriptions)
Normal	Support basic operation and downward change operation
Speed	Support basic operation and upward and downward operation
Resoln	Support basic operation and upward change operation

Table 4-2 Auto Adjustment Range Mode

- **Basic operation:** The channel automatically sets the range, which provides the best resolution for performing measurements.
- **Upward operation:** If the measured data  $\geq$  value1, the range is changed upward after the measurement. (value1=measurement range x ratio/100)
- **Downward operation:** If the measured data  $\leq$  value2, the range is changed upward after the measurement. (value2=measurement range x ratio/1000)

**Operation:** Touch screen to click on the parameter white box after Ranging Auto (I)> or <Ranging Auto(V); when the edge of the box turns yellow, click on the menu bar on the

right of the screen to select the auto range mode.

■ **Threshold:**

**Description:** Threshold is the ratio value setting and is the shift threshold value used for the above automatic adjustment range operation. When the measured data is compared with the threshold value calculation to reach the condition of the automatic adjustment range, the adjustment range operation will be performed automatically.

**Operation:** Touch screen and click on the white box after Threshold to pop up the parameter value setting page, shift threshold can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

■ **Meas1/Meas2:**

**Description:** Meas1/Meas2 is the measurement parameter type setting displayed on the page, which is divided into VOLTs (V) Voltage, AMPs(I) Current, OHMs(R) Resistance, and WATTs(P) Power.

**Operation:** Touch screen to click on the parameter white box after Meas1 or Meas2; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the measurement parameter displayed on the page.

**b) <AWG> (Pulse Source)**

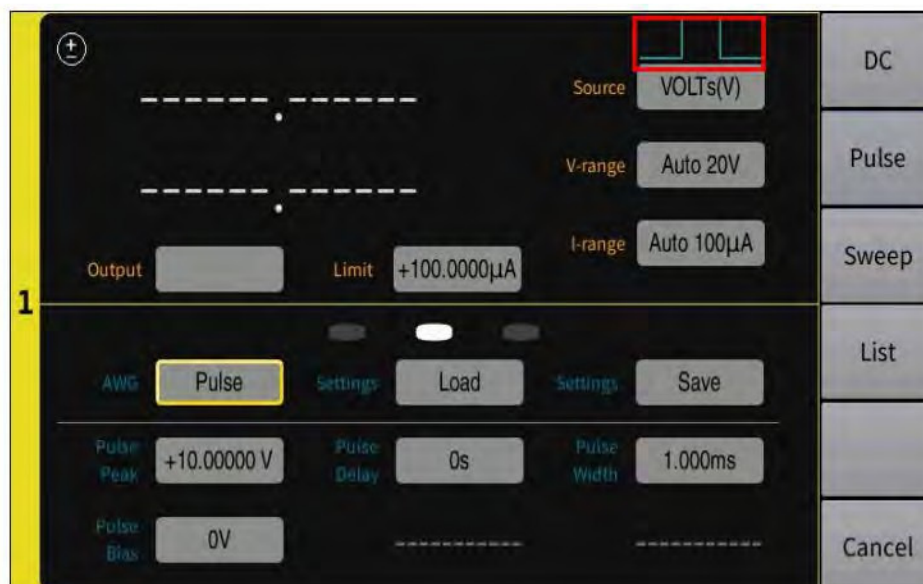


Figure 4-6 Channel Specific Setting Page 2 - Pulse Source

**Source/Measurement Unit (SMU) as Pulse:** (see 3.2.1.3 Pulse Source for specific settings, the red box shows the pulse source output status)

■ **Settings (left)/Settings (right):**

**Description:** Settings (left)/Settings (right) is to recall or save different setting data about the Pulse Source, mainly including Pulse Peak, Pulse Delay, Pulse Width and Pulse

Bias.

**Operation:** Touch screen to click on the parameter white box after Settings (left) or Settings (right); when the edge of the box turns yellow, click on the menu bar on the right of the screen to choose calling or saving different settings.

■ **Pulse Peak:**

**Description:** Pulse Peak is the pulse peak value and is not applicable to set the sweep output value as the sweep source of the pulse peak.

**Operation:** Touch screen and click on the white box after Pulse Peak to pop up the parameter value setting page, pulse peak can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

■ **Pulse Delay:**

**Description:** Pulse Delay is the pulse delay time. After the delay time following the trigger delay, the pulse source changes the output level from the base value to the peak value.

**Operation:** Touch screen and click on the white box after Pulse Delay to pop up the parameter value setting page, pulse delay can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

■ **Pulse Width:**

**Description:** Pulse Width is the setting of pulse width.

**Operation:** Touch screen and click on the white box after Pulse Width to pop up the parameter value setting page, pulse width can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

■ **Pulse Bias:**

**Note:** Pulse Bias is the setting of pulse bias.

**Operation:** Touch screen and click on the white box after Pulse Bias to pop up the parameter value setting page, pulse bias can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

## c) &lt;AWG&gt; (Sweep Source)

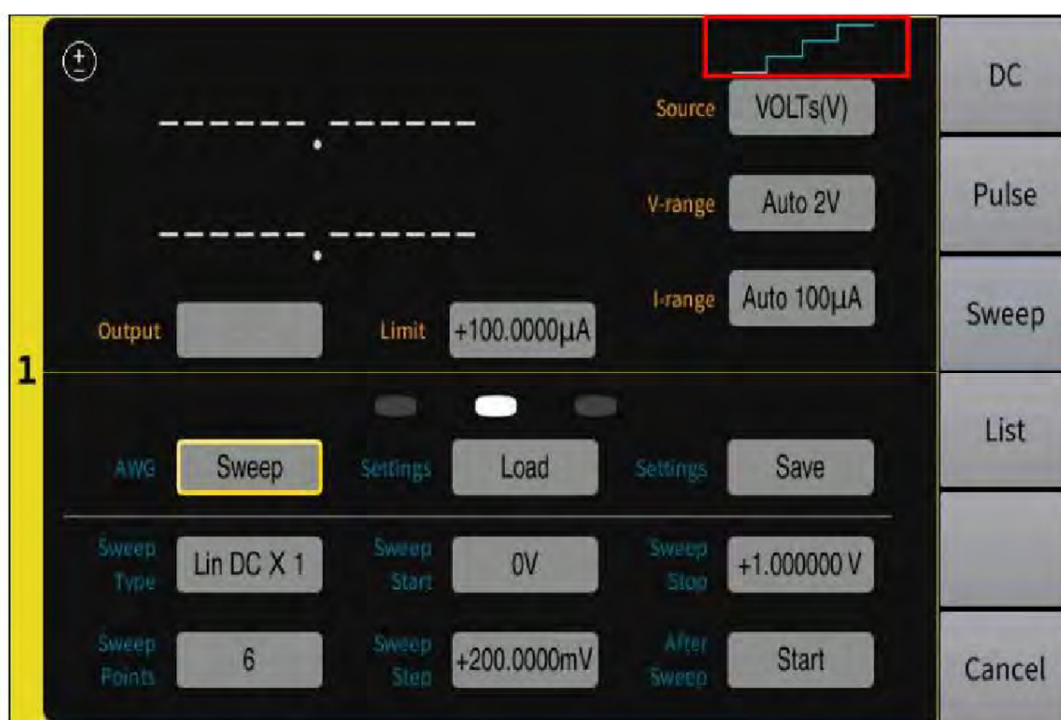


Figure 4-7 Channel Specific Setting Page 2 - Pulse Source

**Currently, the source/measurement unit (SMU) as Sweep:** (red box is sweeping source output status)

■ **Settings (left)/Settings (right):**

**Description:** Settings (left)/Settings (right) is to recall or save different setting data about Sweep Source, mainly including Sweep Type, Sweep Start, Sweep Stop, Sweep Points, Sweep Step and After Sweep.

**Operation:** Touch screen to click on the parameter white box after Settings (left) or Settings (right); when the edge of the box turns yellow, click on the menu bar on the right of the screen to choose calling or saving different settings.

■ **Sweep Type**

**Description:** Sweep Type is the type setting of sweep source, which is divided into Single Lin DC (Lin DC×1), Single Lin Pulse (Lin Pul×1), Double Lin DC(Lin DC×2), Double Lin Pulse(Lin Pul×2), Single Log DC( Log DC×1), Single Log Pulse(Log Pul×1), Double Log DC(Log DC×2)and Double Log Pulse(Log Pul×2).

- Single Lin DC (Lin DC×1) denotes the DC source in linear incremental steps sweeping from the starting point to the end point.
- Single Lin Pulse (Lin Pul× 1) denotes the pulse source in linear incremental steps sweeping from the starting point to the end point.
- Double Lin DC (Lin DC×2) denotes the DC source in linear incremental steps sweeping from the starting point to the end point and back again.
- Double Lin DC (Lin DC×2) denotes the pulse source in linear incremental steps

sweeping from the starting point to the end point and back again.

- Single Log DC (Log DC×1) denotes the DC source in logarithmic incremental steps sweeping from the starting point to the end point.
- Single Log Pulse (Log Pul×1) denotes the Pulse source in logarithmic incremental steps sweeping from the starting point to the end point.
- Double Log DC (Log DC×2) denotes the DC source in logarithmic incremental steps sweeping from the starting point to the end point and back again.
- Double Log DC (Log DC × 2) denotes the Pulse source in logarithmic incremental steps sweeping from the starting point to the end point and back again.

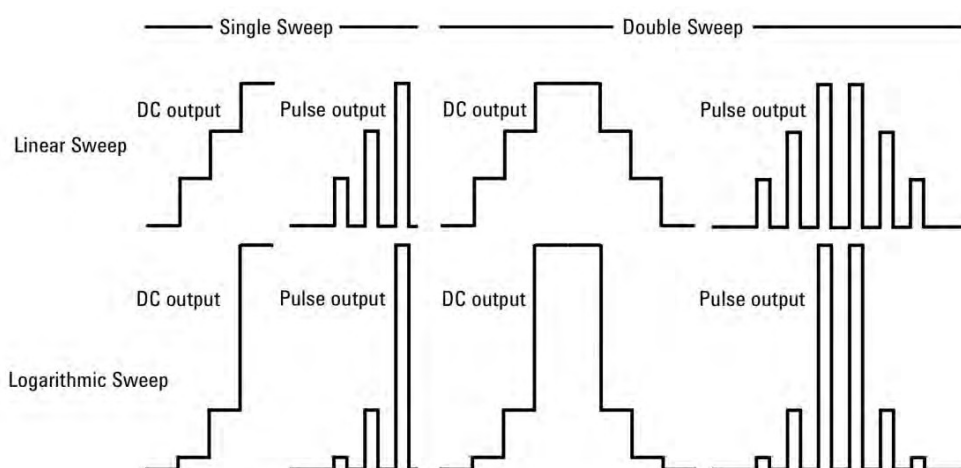


Figure 4-8 Sweep Source Status Bit Display Type

**Operation:** Touch screen to click on the parameter white box after Sweep Type; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the sweep type.

#### ■ Sweep Start/Sweep Stop

**Description:** Sweep Start is the setting of the sweep start point, and Sweep Stop is the setting of the sweep end point.

**Operation:** Touch screen and click on the white box after Sweep Start or Sweep Stop to pop up the parameter value setting page, starting point or end point can be set by clicking on the normal number and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

#### ■ Sweep Points/Sweep Step

**Note:** Sweep Points is the setting of the number of sweep steps, Sweep Step is the setting of the sweep step value (step value is not applicable to Log and List sweep operations).

**Operation:** Touch screen and click on the white box after Sweep Points or Sweep Step to pop up the parameter value setting page, step number or step value can be set by

clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

#### ■ After Sweep

**Description:** After Sweep is the setting of the stop point after the sweep is completed, divided into Start and End.

**Operation:** Touch screen click **After Sweep** parameter white box, when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the location of the stop point after the sweep is completed.

#### d) <AWG> (List Source)

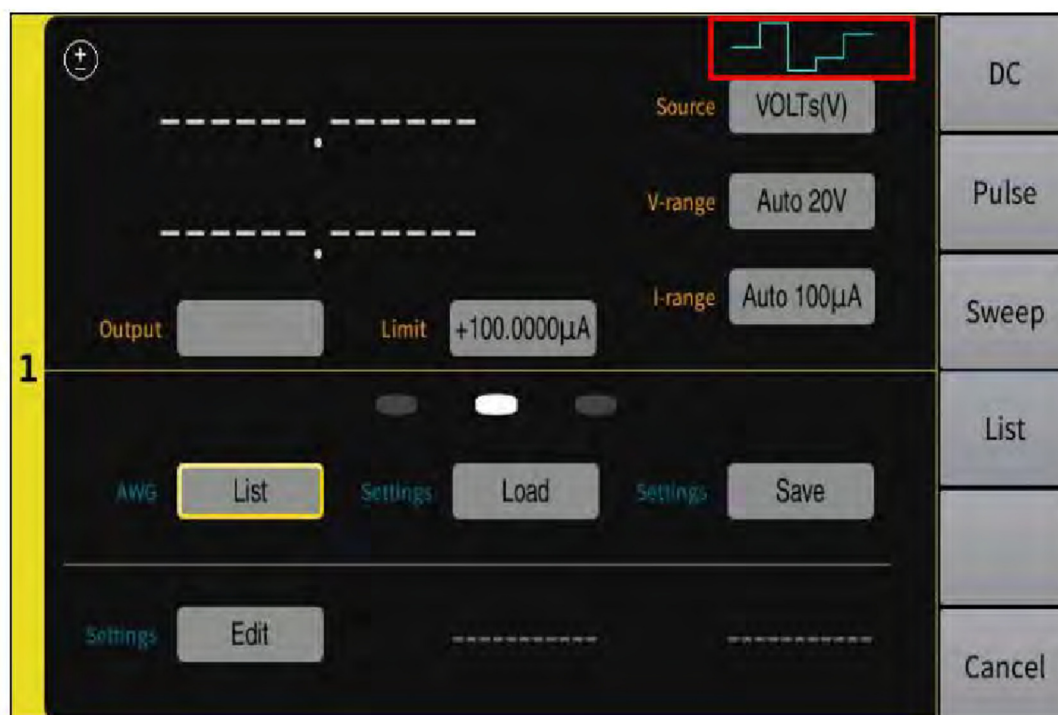


Figure 4-9 Channel Specific Setting Page 2 - Sweep Source

**Currently, the source/measurement unit (SMU) as List:** (Red box is the list source output status)

#### ■ Settings (top left)/Settings (top right)

**Description:** Settings (top left)/Settings (top right) is to call or save different setting data about List, mainly including the data of the list measurement settings.

**Operation:** Touch screen to click on the parameter white box after Settings (top left)/Settings (top right); when the edge of the box turns yellow, click on the menu bar on the right of the screen to choose calling or saving different settings.

#### ■ Settings (Downward)

**Description:** Settings (Downward) is to set the data related to the List sweep.

**Operation:** Touch screen and click on the white box parameter after Settings3 to pop up the parameter setting page, you can add and delete measurement points, and each



measurement point value can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

#### 4.2.2.3 Setup Page 3

**Trigger Layer is the trigger layer type setting, which is divided into ARM and FPGA.**

##### a) Trigger Layer (ARM)



Figure 4-10 Channel Specific Setting Page 3 - ARM Trigger Layer

**Currently, this is triggered by the ARM layer. When the trigger system starts, the ARM layer will wait for the specified source and measurement signals. After the ARM condition is met, the control will be passed to the FPGA layer.**

**Description:** Src Trig Signal / Meas Trig Signal is the trigger type setting of source and measurement signal; both have various modes respectively as follows:

- Auto: The trigger source is automatically selected by the instrument using internal algorithm to suit the current operation mode.
- Bus: The source is the signal specific to the control interface. For IEEE 488.1, the Group Execution Trigger (GET) should satisfy this condition. In VXI, the word serial command TRIGger will perform this function. \*TRG command can be used.
- Manual: Manual trigger source, the key Trigger on the instrument.
- EXT0, EXT1, EXT2, EXT3, EXT4, EXT5, EXT6, EXT7, EXT8, EXT9, EXT10, EXT11, EXT12, or EXT13 will select the external signal jack (Handler pin on the rear panel) as the source.

**Operation:** Touch screen to click on the parameter white box after Src Trig Signal or Meas Trig Signal; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the trigger type settings of the source signal and measurement signal.



## b) Trigger Layer (FPGA)



Figure 4-11 Channel Specific Setting Page 3 - FPGA Trigger Layer

**Currently, this is triggered by the FPGA layer. After the control is passed to the FPGA layer, the FPGA layer will wait for the specified internal timer signal and will start device operation when the FPGA conditions are met.**

■ **Src Trig Count / Meas Trig Count**

**Description:** Src Trig Count / Meas Trig Count are the source trigger count and measurement trigger count settings respectively, which is divided into Infinity and Number.

**Operation:** Touch screen to click on the parameter white box after Src Trig Count / Meas Trig Count; when the edge of the box turns yellow, click on the menu bar on the right of the screen to select the source trigger and measurement departure count form. When Number is selected, pop up the parameter setting page, and the value can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

■ **Src Trig Delay / Meas Trig Delay**

**Description:** Src Trig Delay / Meas Trig Delay are the source trigger delay and measurement trigger delay settings, respectively.

**Operation:** Touch screen and click on the parameter white box after Src Trig Delay / Meas Trig Delay to pop up the parameter value setting page, trigger delay can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

■ **Src Trig Period / Meas Trig Period**

**Description:** Src Trig Period / Meas Trig Period are the source trigger period and measurement trigger period settings respectively; the duration of this period is set by the user to touch screen.

**Operation:** Touch screen and click on the parameter white box after Src Trig Period / Meas Trig Period to pop up the parameter value setting page, trigger period can be set by clicking on the normal number on the screen and Enter to confirm, or

use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

#### 4.2.2.4 Setup Page 4



Figure 4-12 Channel Specific Setting Page 4 - Limit Test Status

**Description:** This display page will only be displayed when the limit test is turned on in the Config page, and the data displayed mainly includes measurement data and test pass/fail status.

## 4.2.3 Config Display Page

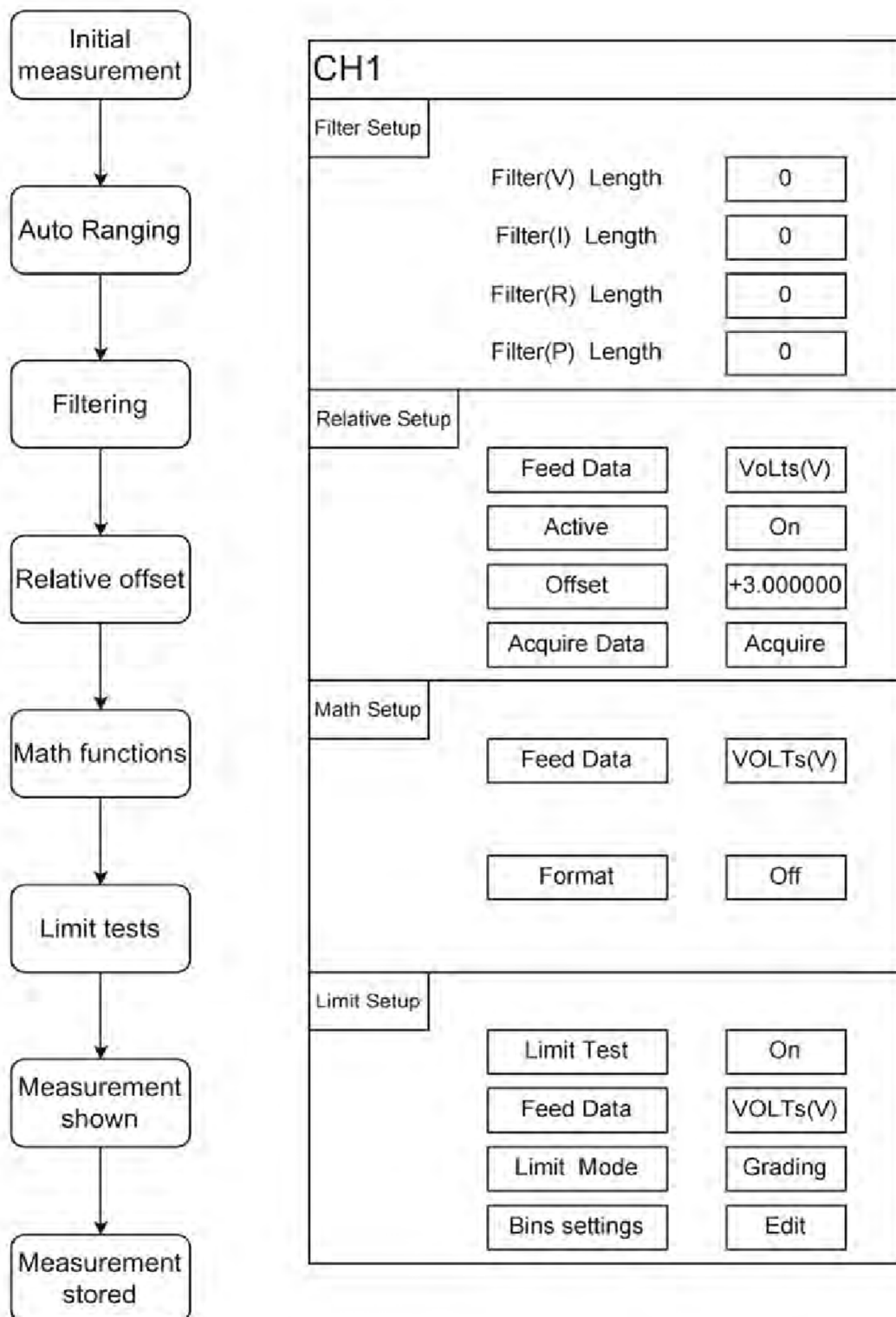


Figure 4-13 Processing Steps of Config Page Detailed Data

#### 4.2.3.1 Filter Setup

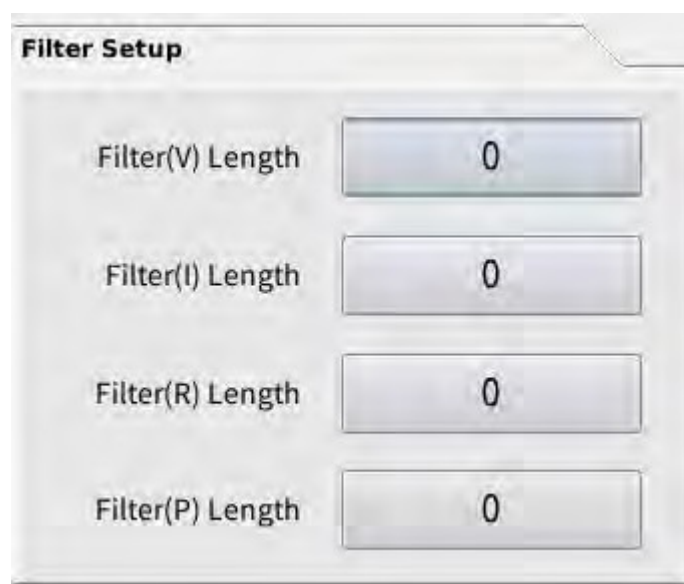


Figure 4-14 Filter Setup

**Description:** The setup of the measurement output filter is to filter the measurement results of voltage, current, resistance and power separately. The filtering effect depends on the filter length (value 0~10). If the length is set to 0, it is equivalent to turn off the filter of the corresponding function.

**Operation:** Touch screen and click on the parameter white box after Filter (V) Length or Filter(I) Length or Filter(R) Length or Filter(P) Length to pop up the parameter value setting page, filter length can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

#### 4.2.3.2 Relative Setup

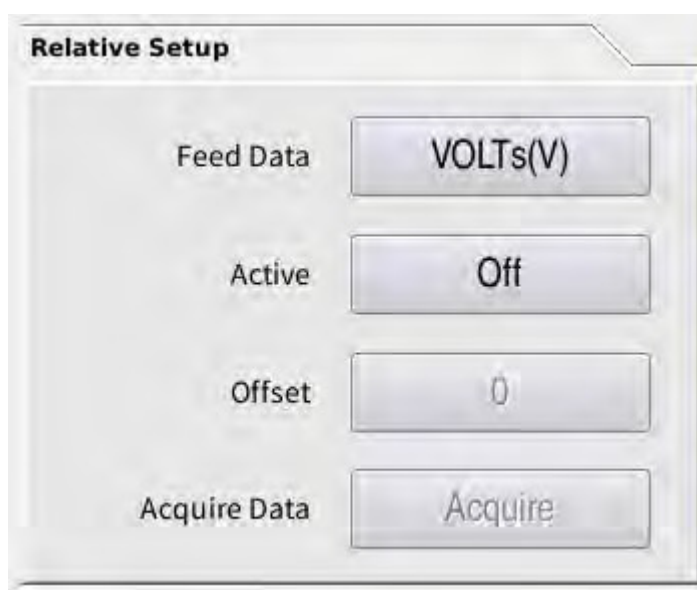


Figure 4-15 Deviation Setup

**Description:** The deviation deduction setting is to deduct the deviation from the output value of the previous data processing step for voltage, current, resistance and power measurement results respectively (see Figure 4-12 for data processing steps) to obtain more accurate data.

$$y = x - \text{offset}$$

y denotes the result after performing deviation deduction and x denotes the output value of the previous data processing step. Offset can be set manually or obtain a real-time reading.

**Operation:**

- Touch screen to click on the parameter white box after Feed Data; when the dummy frame is added to the edge the box, click on the menu bar on the right of the screen to select the data type of the deviation deduction.
- Touch screen and click on the parameter white box after Active and the parameters On or Off will be switched to each other with the click, indicating whether the selected parameter is deviated.
- Touch screen and click on the parameter white box after Offset(deviation value) to pop up the parameter value setting page, deviation value can be set by clicking on the normal number on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.
- Touch screen to click on Acquire in the white box after Acquire Data, get a real-time parameter for deviation.

#### 4.2.3.3 Math Setup



Figure 4-16 Mathematical Operation

**Description:** Mathematical operation setting can perform mathematical operation on the output value of the previous data processing for voltage, current, resistance and power

measurement results respectively.

**Operation:**

- Touch screen to click on the parameter white box after Feed Data; when the dummy frame is added to the edge of the box, click on the menu bar on the right of the screen to select the data type of mathematical operations.
- Touch screen to click on the parameter white box after Format; when the dummy frame is added to the edge of the box, click on the menu bar on the right of the screen to select the mathematical formula.
  - $mx+b: y=mx+b$

Math Setup		
	Feed Data	VoLts(V)
	Format	$mx+b$
	m	0
	b	0

Figure 4-17 Operation Rule 1

Touch screen and click on the parameter white box after m / b to pop up the parameter value setting page, click on the normal number on the screen to set and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

- Percent (percentage):  $y=(x-ref)/ref$

Math Setup		
	Feed Data	VoLts(V)
	Format	Percent
	ref	0

Figure 4-18 Operation Rule 2

Touch screen and click on the parameter white box after ref to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine.

- Recipe (inverse):  $y=1/x$

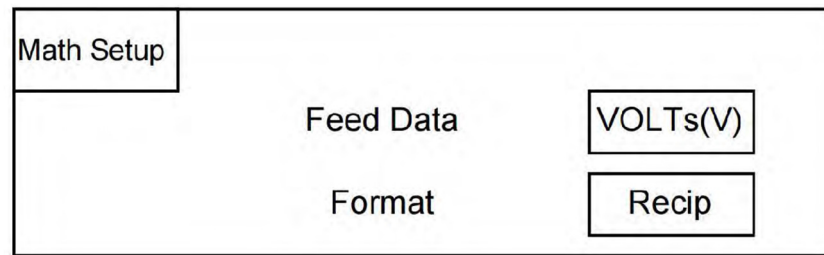


Figure 4-19 Operation Rule 3

#### 4.2.3.4 Math Setup

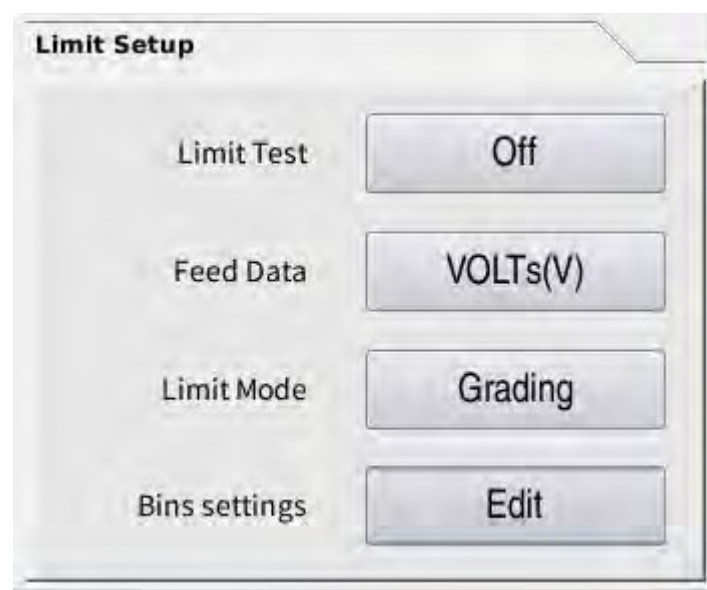


Figure 4-20 Limit Value Test

**Description:** Limit test setting - limit test is the pass/fail judgment of the measurement data or mathematical operation result data acquired by the channel. The limit test can be performed on the output value of the previous data processing of the measurement results for voltage, current, resistance and power respectively.

**Operation:**

- Touch screen and click on the parameter white box after Limit Test, the parameters On or Off will be switched to each other with the click, indicating whether the limit test is performed for the selected parameter.
- Touch screen and click on the parameter white box after Feed Data; when the dummy frame is added to the edge of the box, click the menu bar on the right of the screen to select the data type to be tested for the complex limits.
- Touch screen and click on the parameter white box after Limit Mode; when the dummy frame is added to the edge of the box, click the menu bar on the right of the screen to select the way to carry out the composite limit test Gring mode or Sorting mode.

Touch screen and click on the parameter white box after ref, the test gear page will pop up to set the following figure:

档# 1

Limit Test ☒ Enable

Fail On ☐ In ☒ Out

Pass Pattern 00000000000001

Fail Pattern 00000000000001

Upper Limit +0.000000E+00

Lower Limit +0.000000E+00

Figure 4-21 Limit Test Gear Setup

- Touch screen and click on the drop-down box after Bin to select the gear you want to set from the drop-down options.
- Touch screen to click on the back box after Limit Test, checking or unchecking the box is to indicate whether to perform the limit test for the selected gear.
- Touch screen to click on the round reel in front of the parameter In or Out after Fail On, and the round reel is all black or all white. In is all black to indicate that the value within the limit range is classified as failing the limit test, Out is all black to classify the value outside the limit range as failing the limit test.
- Touch screen and click on the parameter white box after PassPattern / Fail Pattern to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm, indicating the output pin number corresponding to the pass and fail.
- Touch screen and click on the parameter white box after Upper Limit / Low Limit to pop up the parameter valuesetting page, click on the normal number setting on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to confirm, indicating the upper and lower limit values about the selected gear.

#### 4.2.4 Quick IV Show Page

All displayed waveforms on the Quick IV page can be viewed by swiping up and down, left and right on the touch screen to see the different ranges of waveform patterns.



### 4.2.4.1 Graph Page

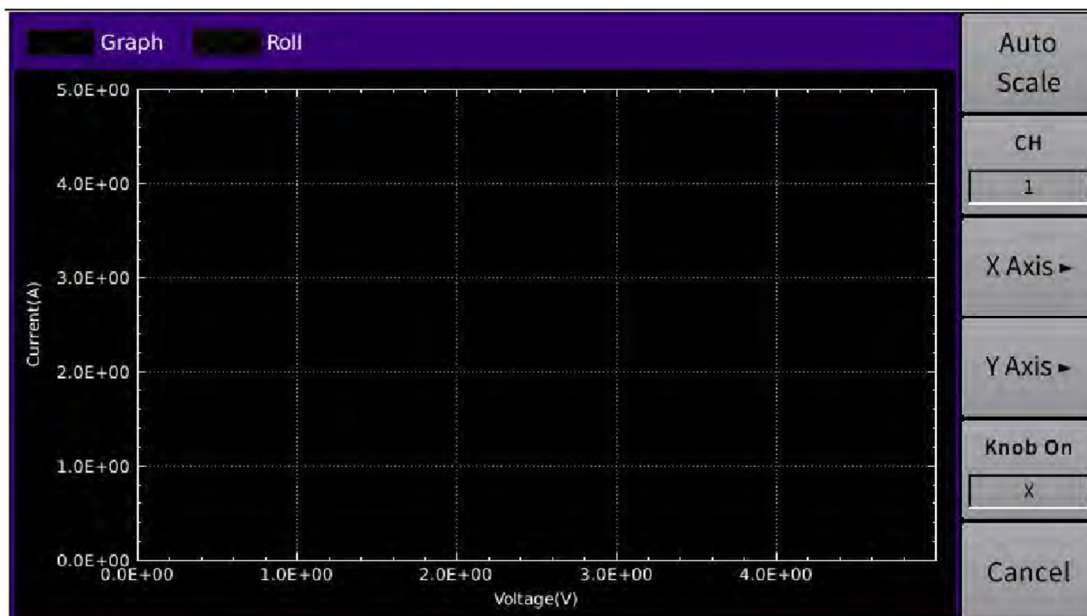


Figure 4-22 Graph Display Page

**Description:** Graph displays the graph plotting the results of measurements or mathematical operations of Channel 1 and/or Channel 2.

**Operation:**

- Touch screen and click on the box of Auto Scale to change the graph calibration that automatically fits the traces in the graph.
- Touch screen to click on the parameter box under CH, and right menu to access channel options; select Graph to display the measurement output graph of channel 1 or 2.
- Touch screen and click on the box of X Axis / Y Axis to access the X or Y Axis setting menu from the right menu:
  - Touch screen and click on the parameter box under Parameter to set the element I, V, R, or P to be displayed for the axis.
  - Touch screen and click on the parameter box under Scale to set the interval displayed for that axis to Lin (Linear) or Log (Logarithm).
  - Touch screen and click on the parameter box under Grid and the parameter On or Off will be switched to each other with the click, indicating whether the spacer wire is displayed.
- Touch screen and click on the parameter box under Knob On and the parameters X or Y will be switched to each other with the click, indicating that the knob can be used to expand or contract the page display setting corresponding to the axis interval.

#### 4.2.4.2 Roll Page

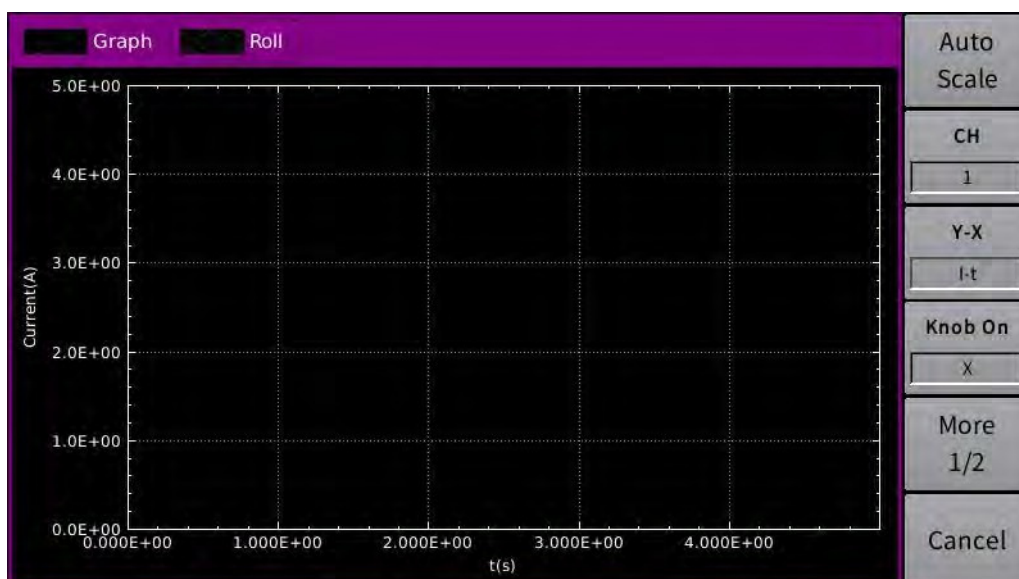


Figure 4-23 Roll Display Page

**Description:** Roll displays the time-domain graph for plotting the measurement data of channel 1 and/or 2.

**Operation:**

- Touch screen and click on the box of Auto Scale to change the graph calibration that automatically fits the traces in the graph.
- Touch screen to click the parameter box under CH, and right menu to access channel options; select Roll to display the measurement output graph of channel 1 or 2.
- Touch screen and click on the box of Y-X, and right menu to access the element type setting menu to set the element I-t, V-t, R-t or P-t to be displayed for the axis.
- Touch screen and click on the parameter box under Knob On and the parameters X or Y will be switched to each other with the click, indicating that the knob can be used to expand or reduce the page axis interval.
- Touch screen and click on the parameter box under Y Scale to set the interval displayed for that Y coordinate axis to Lin (Linear) or Log (Logarithm).
- Touch screen and click on the box of Line Style, and right menu to access the graph line type setting menu to set the line type displayed for this axis as Lin, Step or Impulse.
- Touch screen and click on the parameter box under X Grid / Y Grid to set this axis to display the grid lines at each small interval, and the parameters On or Off will be switched to each other with the click, indicating whether to display the grid lines.

## 4.2.5 Expert Page

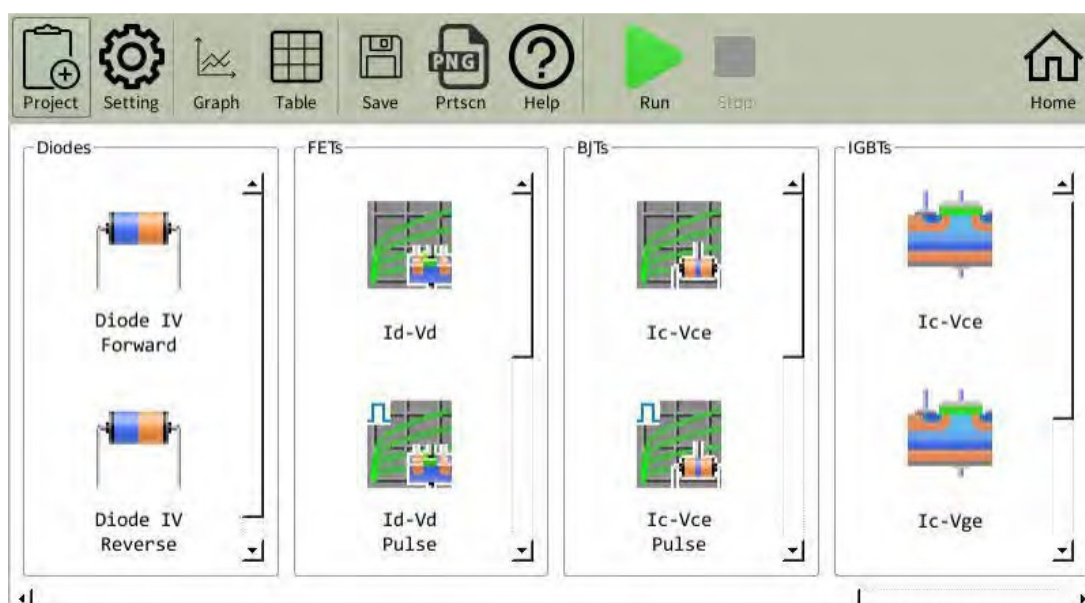


Figure 4-24 Expert Test Function Page

**Description:** For Diodes: Diode Test, FETs: Field Effect Transistor Test, BJTs: Triode Test, IGBTs: Insulated Gate Bipolar Transistor Test, Utility: Universal Test all have several functions as shown above.

**Operation:**

- Touch screen and click on Setting marker to skip the setting interface.
- Touch screen and click on Graph marker to skip the measurement graphical display interface.
- Touch screen and click on Table marker to skip the data table interface.
- Touch screen and click on Save marker to save the setting.
- Touch screen and click on Ptsn marker to save the measurement graph.
- Touch screen and click on Help marker to skip the detailed description interface of the different measurement functions.
- Touch screen and click on Home marker to skip the initial instrument Home interface.

## 4.2.6 File Page

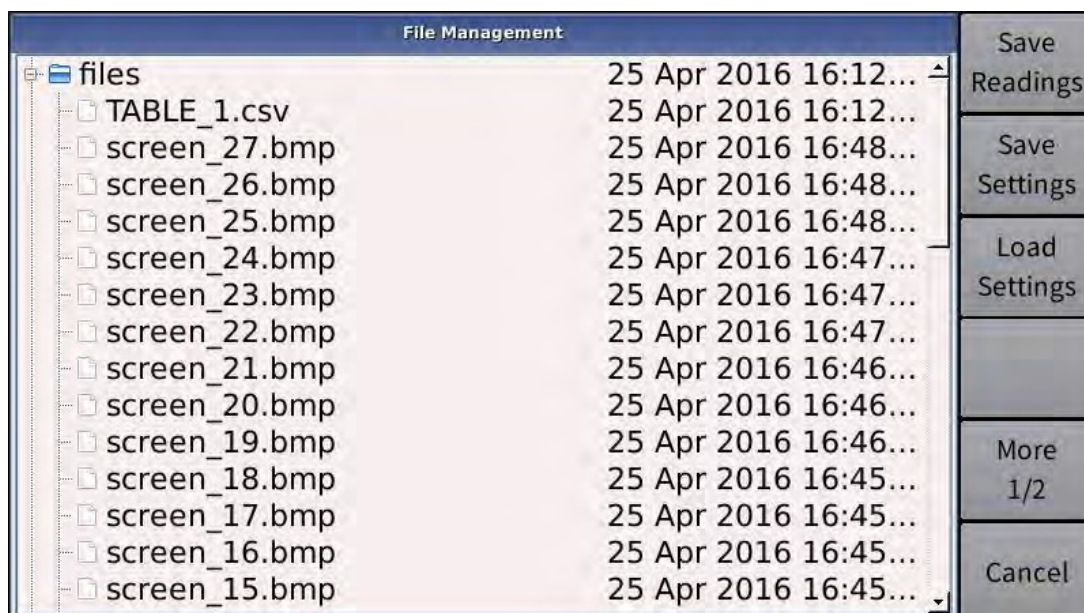


Figure 4-25 File Function Page

**Description:** The main stored file postfixes displayed on the page are .swp (sweep source setup), .pls (pulse source setup), .dat (measurement data), .bmp (expert page screenshot) and .csv (expert page form).

**Operation:** Touch screen and click on the right menu option to save readings, save settings, recall settings, copy, paste, delete, rename files, etc.

## 4.2.7 System Page



Figure 4-26 System Setup Page 1

#### 4.2.7.1 RS232/GPIB

**Description:** RS232 is the asynchronous serial communication standard which is used for the data communication between computers and computers and between computers and peripherals.

**Operation: (see Figure 4-26)**

- Touch screen and click on the parameter white box after Baud Rate; when the dummy frame is added to the edge of the box, click on the menu bar on the right of the screen to select the RS232 transmission rate.
- Touch screen to click on the parameter white box after GPIB Active, the parameters On or Off will be switched to each other with the click, indicating whether the GPIB interface is enabled.
- Touch screen and click on the parameter white box after GPIB Address to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm, or use the  
← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to set the GPIB interface address.

#### 4.2.7.2 RS232/GPIB

**Operation: See Figure 4-26**

- Touch screen and click on the parameter white box after Language; when the dummy frame is added to the edge of the box, click on the menu bar on the right of the screen to select the language mode of the instrument.
- Touch screen and click on the parameter white box after Back Light to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine, indicating the intensity of the background light of the instrument.
- Touch screen and click on the parameter white box after Power On; when the dummy frame is added to the edge of the box, click on the menu bar on the right of the screen to select the instrument's power- on settings (Factory) or Last Saved settings.
- Touch screen and click on the parameter white box after Beeper, the parameters On or Off will be switched to each other with the click, indicating whether the buzzer is on or off.



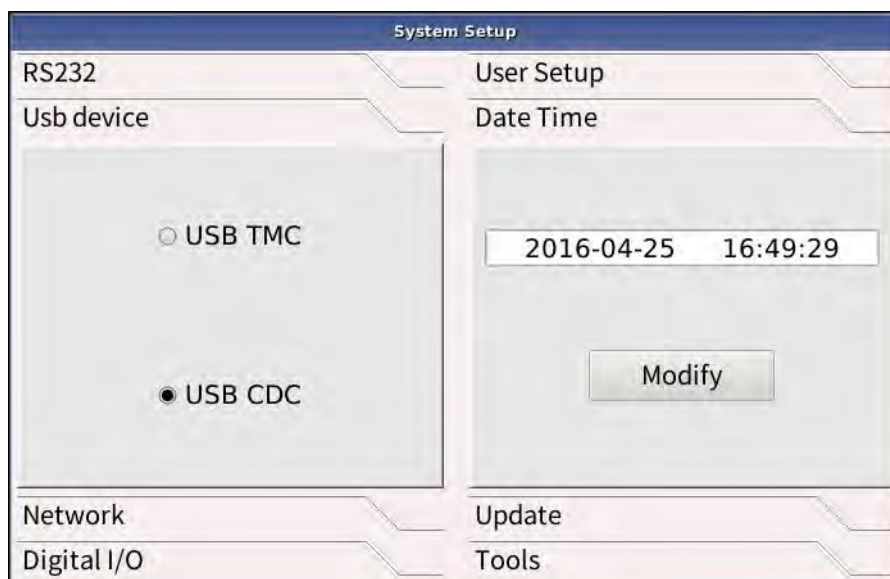


Figure 4-27 System Setup Page 2

#### 4.2.7.3 USB Device

**Operation:** (see Figure 4-27) Touch screen to click on the front round reel of USB TMC/USB CDC. The round reel is either all black or all white. Selecting USB TMC in all black indicates that the USB interface uses USBTMC Protocol, and selecting USB CDC in all black indicates that the USB interface uses the USB communication device class.

#### 4.2.7.4 Date Time

**Operation:** (see Figure 4-27) Touch screen and click on Modify to modify the date and time displayed in the white box.

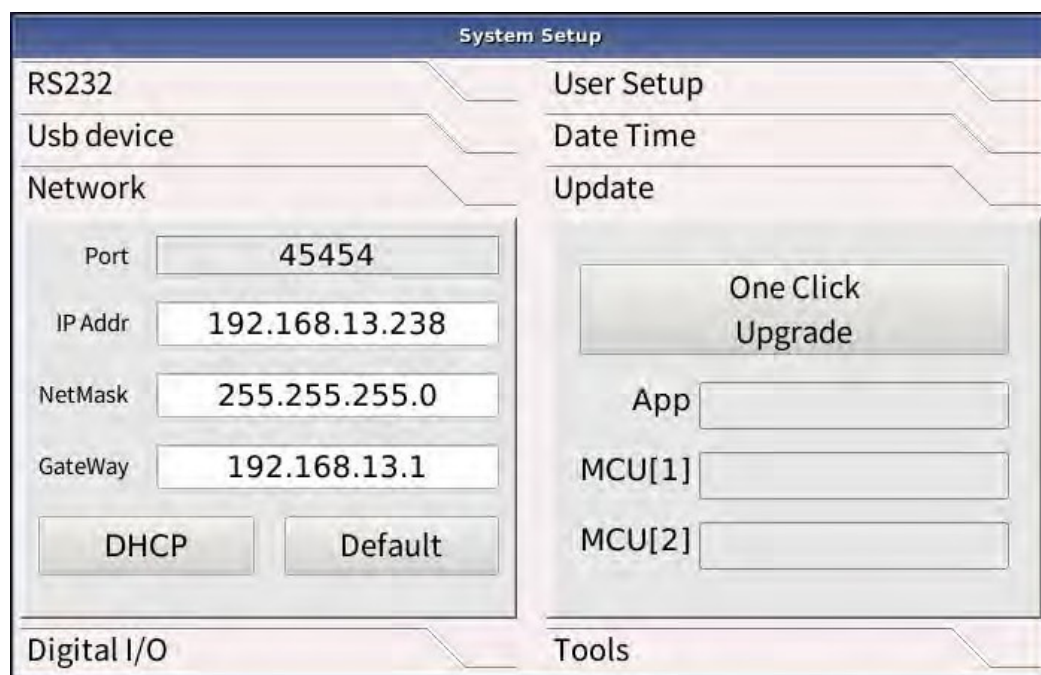


Figure 4-28 System Setup Page 3

#### 4.2.7.5 Network

**Operation:** (see Figure 4-28)

- Touch screen and click on the parameter white box after Port to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm to set the network port number.
- Touch screen and click on the parameter white box after IP Addr to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm to set the IP address.
- Touch screen and click on the parameter white box after NetMask to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm to set the mask address.
- Touch screen and click on the parameter white box after GateWay to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm to set the gateway address.
- Touch screen to click on the white box of DHCP whether to enable Dynamic Host Configuration Protocol.
- Touch screen and click on the white box of Default to enable the default network configuration.

#### 4.2.7.6 Update

**Operation:** (See Figure 4-28) Touch screen and click on One ClickUpgrade to upgrade with one click.

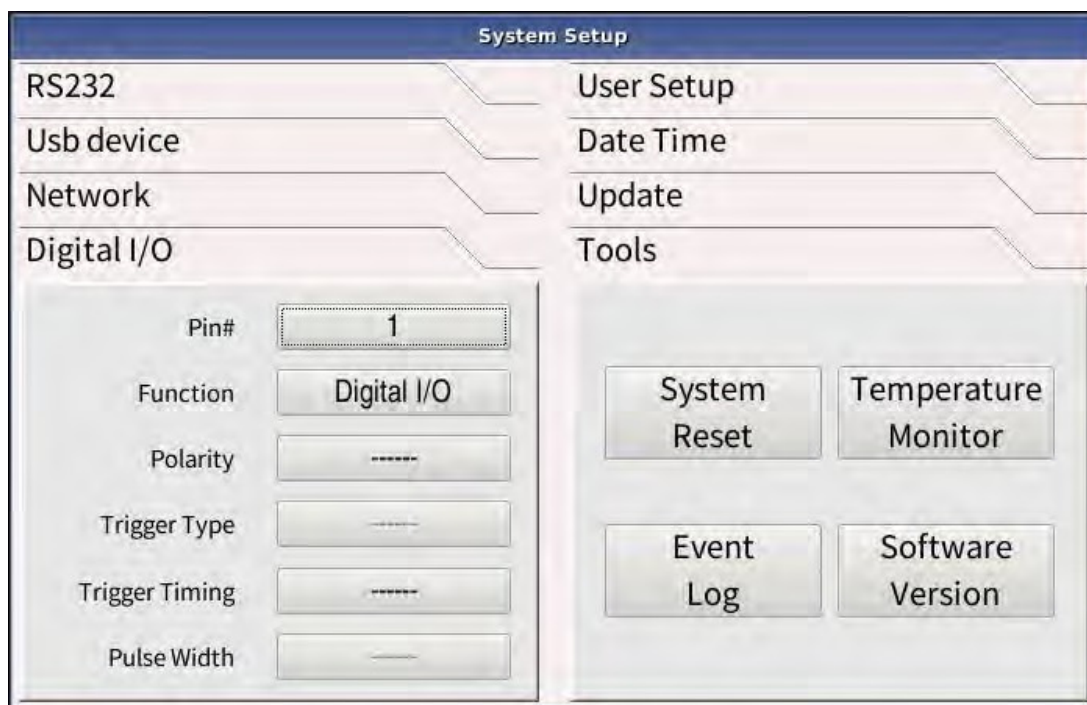


Figure 4-29 System Setup Page 4

#### 4.2.7.7 Digital I/O

**Operation:** (see Figure 4-29)

- Touch screen to click on the parameter white box after Function, select the function of the specified pin on the right menu, such as Digital I/O, Digital In, Trigger Out, Trigger In or HV Lamp.
- Touch screen to click on the parameter white box after Polarity, select the polarity of the specified pin on the right menu.
- Touch screen to click on the parameter white box after Trigger Type, select the trigger type on the right menu.
- Touch screen to click on the parameter white box after Trigger timing, select the timing mode on the right menu.
- Touch screen and click on the parameter white box after Pulse Width to pop up the parameter value setting page, click on the normal number setting on the screen and Enter to confirm, or use ← and → to adjust the value of the marker on the number of digits combined with the knob adjustment and then press the knob to determine, indicating to set the trigger pulse width.

#### 4.2.7.8 Tools

**Operation:** (see Figure 4-29)

- Touch screen and click on System Reset to set up the system reboot.
- Touch screen and click on Temperature Monitor to display the instrument temperature monitor.
- Touch screen and click on Event Log to display the event log.
- Touch screen and click on Software Version to display the instrument software version.



## Chapter 5 Interface Instructions

This chapter simply describes the various interfaces that connect the device to the instrument.

### 5.1 Measurement Terminals

Device Under Test (DUT for short)

#### 5.1.1 Connection Method

The instrument has four pairs of test terminals: current-driven high end Hc, current-driven low end Lc, voltage detection high end Hp, voltage detection low end Lp and a shield corresponding to each test terminal.

- Two-wire connection: Connect only the Force terminal, and then open the Sense terminal. The Force terminal can be used to apply and measure DC voltage or current.

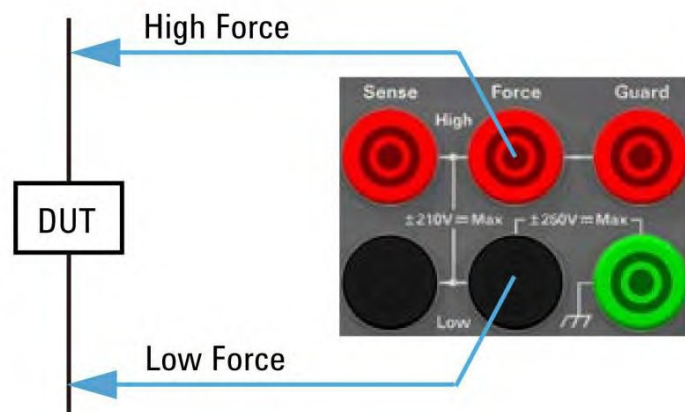


Figure 5-1 Two-wire Connection

- Four-wire connection: Use both Force and Sense terminals. Connecting both Force and Sense wires to the terminals of the DUT can minimize measurement errors caused by residual resistance of the test leads or cables. This connection is effective for low resistance measurements and high current measurements.

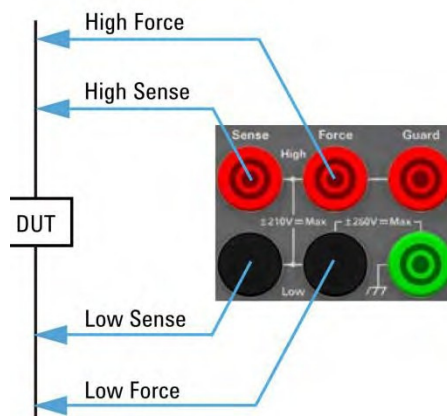


Figure 5-2 Four-wire Connection

## 5.1.2 Test Leads and Fixtures

### 5.1.2.1 To be added

#### 5.1.2.2 Protective Circuit

The protection can reduce the leakage current between the instrument and the DUT. Figure 5-3 shows the principle of the protection. The buffer amplifier (-1) can keep the potential of the protective conductor as the same as the potential of the forced conductor so that there is no current between the forced and protected conductors. Therefore, since there is no leakage current, the instrument measures the same current as the DUT terminal.

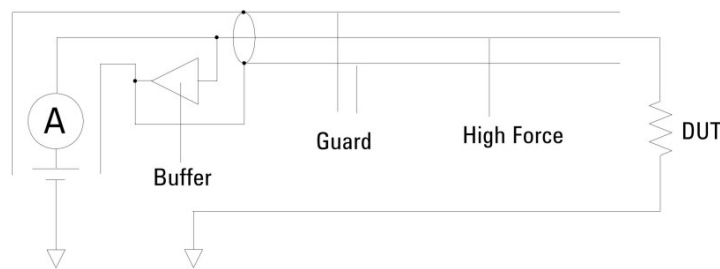


Figure 5-3 Protective Circuit

## 5.1.3 Cautions

- Preheat for 60 minutes or more.
- Connect the appropriate test fixture or test cable.
- Do not apply voltage or current to the test as this may damage the test instrument.
- When changing the connection method, confirm that the channel output setting is off first and the CH1 and CH2 button lights have been turned off, otherwise the DUT will be damaged.

## 5.2 Remote Control RS232

The instrument can use the RS232C serial interface (standard) for data communication and remote control without the instrument panel. The instrument provides a rich set of programmable commands; through the RS232C interface, the computer can implement almost all function operations on the instrument panel. See Chapter 6 for details of the interface commands.

### 5.2.1 RS232C Introduction

#### 5.2.1.1 General Standards

The widely used serial communication standard is the RS-232 standard, which can also be called the asynchronous serial communication standard and is used to implement data communication between computers and computers and between computers and peripherals. The configuration of most serial ports is usually not strictly based on the RS-232 standard: the 25-pin connector is used on each port (IMB AT uses the 9-pin connector). The most

commonly used RS-232 signals are shown in the table:

Signal	Symbols	25-pin Connector Pin Number	9-pin Connector Pin Number
Request to Send	RTS	4	7
Clear to Send	CTS	5	8
Data Set Ready	DSR	6	6
Data Carrier Detection	DCD	8	1
Data Terminal Ready	DTR	20	4
Transmit Data	TXD	2	3
Receive Data	RXD	3	2
Ground	GND	7	5

Table 5-1 RS-232 Signal Information

### 5.2.1.2 Serial Port and Socket

- **Minimum subset:** As with most serial ports, the easiest and cheapest way to make serial port communication work is to provide only a minimum subset.

Signal	Symbols	Connector Pin Number
Transmit Data	TXD	3
Receive Data	RXD	2
Ground	GND	5

Table 5-2 Minimum Subset of Serial Ports for the Instrument

- ✖ **Note:** The serial port pin definition of the instrument is basically the same as the pin definition of the standard 9-pole RS232C connector.

- **Socket:** The RS232C connector of the instrument uses the 9-pin DB-type socket with the following pin sequence:

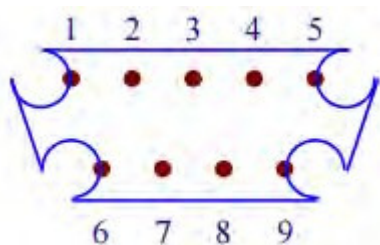


Figure 5-4 DB Type Socket

- ✖ **Note:** To avoid electrical shock, turn off the power when plugging or unplugging the connector.

- ✖ **Note:** Do not short-circuit the output terminal or the case to avoid damaging the device.

### 5.2.2 Communication with Computers

- The instrument is connected to the computer as shown in the figure:

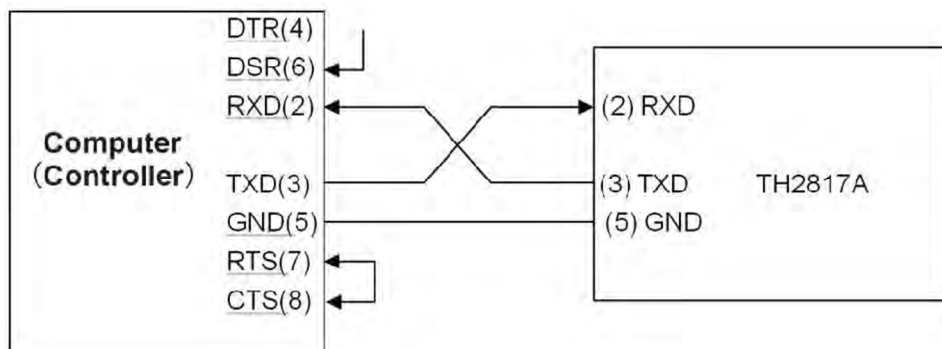


Figure 5-5 Instrument and Computer Connection Method

As you can see from the above diagram, the pin definition of the instrument is the same as the pin definition of the 9-pin connector serial interface used by the IMB AT compatible machine. The user can use the two-core shielded cable as shown in the diagram to make their own three-wire connection cable (length should be less than 1.5m) or purchase the serial interface cable between the computer and the instrument from Scientific or directly purchase the standard DB9 core cable.

When making your own connection cable, it is noted that pin 4 and 6 should be short-circuited and pin 7 and 8 should be short-circuited on the computer connector.

- When communicating with the computer through the serial port, first set the bus mode of the instrument, as described in 4.2.7 RS232 Setup of the System Settings Page for details.
- The main parameters of the serial port are shown in Table 5-3:

Transmission Mode	Full Duplex Asynchronous Communication with Start and Stop Bits
Baud Rate (bps)	4800 / 9600 / 19200 / 38400 / 115200
Data Bit	8 BIT
Stop Bit	1 BIT
Calibration	None
Terminator	NL (Line separator, ASCII code 10)
Contact Information	Software Contact
Connector	DB9 Core

Table 5-3 Main Parameters of Serial Port

- Software Protocols

Since the hardware communication is not used on the RS232 interface, the instrument

uses the character return method for software communication to minimize possible data loss or data errors in communication. Please refer to the following content when preparing the computer communication software:

- The command string syntax and format are described in Chapter 6, "Command Reference".
- The command sent by the host computer is transmitted in ASCII code with NL (i.e., Line separator, ASCII code 10) as the terminator, and the instrument starts to execute the command string after receiving the terminator.
- Whenever the instrument receives a character, it immediately sends the character back to the host, and the host should continue to send the next character after receiving the return character. If the return character is not received, the possible factors are:
  - (1) Serial port connection failure.
  - (2) Check the instrument whether the RS232 port function is turned on and TALK ONLY is not turned on.
  - (3) The instrument is executing the bus commands and cannot respond to serial accept for the moment. At this point, the last sent character is ignored by the instrument, and the host should resend the unreturned character if the command string is to be kept complete.
- The instrument sends information to the host computer only in the following two cases:
  - (1) The command character of the host is received normally and sent back with that character.
  - (2) Execute the query command and send the query result to the host.
- Once the instrument executes the query command, it will send the query result immediately, regardless of whether the current command string has been fully executed. Therefore, a command string can have multiple queries in it, but the host has to have the corresponding number of reading result operations. This protocol recommends that only one query is included in a command string.
- The query result is sent as the ASCII string with NL (i.e., Line separator, ASCII code 10) as the terminator.
- When the instrument sends the query result, it is sent continuously (span is about 1ms), and the host should be in the state of receiving data, otherwise it may cause the loss of data.
- After the host generates the query, ensure that it reads the null query result (accepting NL indicates the end) to avoid conflicts between the query and the return; similarly, the host should read the null return character before reading the query result.
- For some bus commands that take a long time to complete, such as clearing, the host should actively wait or synchronize the execution of the previous command

by responding to the confirmation of the user keyboard input to avoid the next command being ignored or error during the command execution.

- The communication software prepared by DOS application software should be run in the pure DOS environment that support serial port, if it is run under WINDOWS, it may generate errors due to different management of serial port.

## 5.3 Handler Interface Instructions

### 5.3.1 Basic Information

The instrument provides the user with the powerful Handler interface, which is the D-sub25 pin female connector; this interface is mainly used for:

- Trigger Input
- Trigger Output
- Digital Signal Input/Output
- Digital Signal Input
- Start of Test (SOT) Input (for component handlers)
- Busy Status Output (for component handlers)
- End of Test (EOT) Output (for component handlers)
- Interlock Control
- High Voltage Status Output (shared with digital signal input/output DIO 14)

**※Note:** For the use of the Handler pin, please refer to 4.2.3.4 LimitTest and 4.2.7.7 Digital I/O System Setup.

#### 5.3.1.1 Pin Assignments

Description	Pin Number		Description
+5V <sup>a</sup>	25	13	Bit 13
Interlock Control <sup>b</sup>	24	12	Bit 12
+5V <sup>a</sup>	23	11	Bit 11
+5V <sup>a</sup>	22	10	Bit 10
GND	21	9	Bit 9
GND	20	8	Bit 8
GND	19	7	Bit 7
GND	18	6	Bit 6
GND	17	5	Bit 5
Interlock Control <sup>c</sup>	16	4	Bit 4
GND	15	3	Bit 3
Bit 14 or High Voltage Status	2	Bit 2	
		1	Bit 1

Table 5-4 Handler Pin Assignments

✖Note: Superscript

- a: Current limit value 600mA.
- b: For positive logic, pin 25 of negative logic has been connected.
- c: For negative logic, pin 17 of positive logic has been connected.

### 5.3.1.2 Internal Circuit

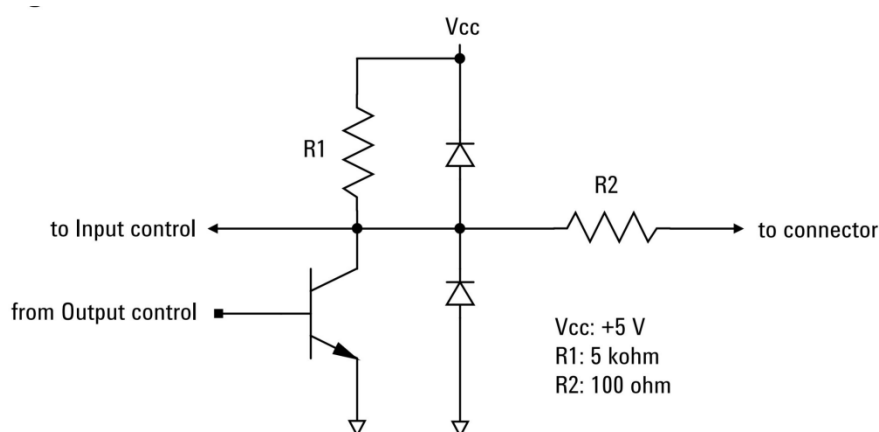


Figure 5-6 Handler Internal Circuit

The input/output circuitry is internally connected to each pin of the Handler connector.

### 5.3.2 Interlock Circuits

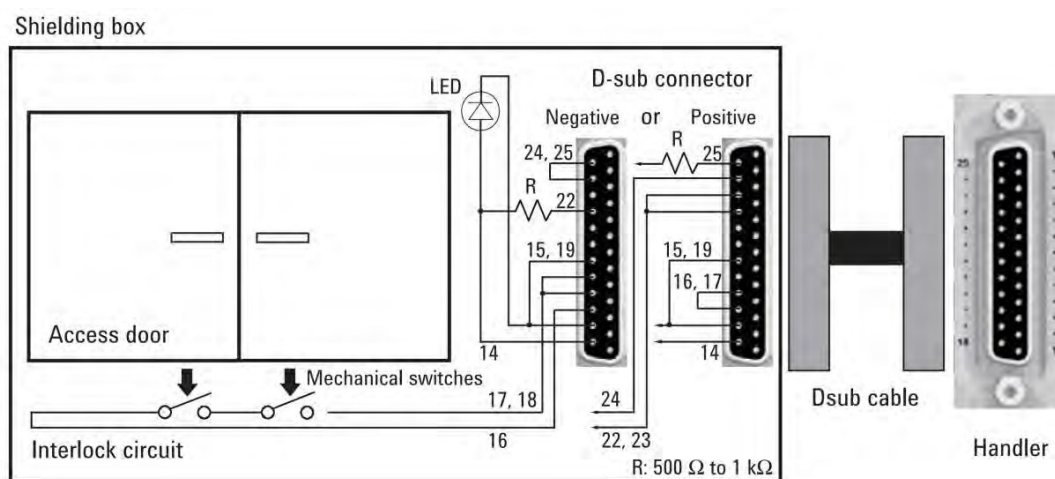


Figure 5-7 Interlock circuit

The interlock function is designed to prevent the user from getting the electric shock when touching the measurement terminals. If the interlock terminal is open, then the maximum output limit is  $\pm 42V$ .

To perform high voltage measurements exceeding  $\pm 42V$ , connect the interlock terminal to the test fixture or the interlock circuit of the shielding box. The interlock circuit must have an LED

and two mechanical switches mounted near the shield box door. They must be connected.

**The working principle** of the interlock function is described below:

- When the interlock terminal is open, the maximum output limit is  $\pm 42\text{V}$ .
- When the interlock terminal is close, the source channel can apply its maximum output value.
- When the interlock terminal is disconnected at high voltage conditions exceeding  $\pm 42\text{V}$ , the output voltage is set to  $0\text{V}$  immediately.

**✖Note:** If the actual output value is not set to  $0\text{V}$  within 120 msec, the instrument will automatically perform initialization. Then the self-test is executed, and the channel may have errors.

**✖Note:** When the interlock circuit is close, the dangerous voltage up to  $210\text{V}$  may exist on the High Force, High Sense and Guard terminals. To prevent the electric shock, do not leave these wires exposed.

**✖Note:** When the source/measurement terminal is accessible or open, the SMU cannot apply the dangerous voltage by opening the interlock terminal.



## Chapter 6 Command Reference

### 6.1 Command Structure

The instrument commands are SCPI (Standard Commands for Programmable Instruments) commands, and the use of the command set has been streamlined in general, mainly including the following 10 subsets DISPlay, FORMat, FETCh, MEASure, OUTPut, READ, SENSE, SOURce, SYSTem, and TRIGge. The SCPI commands are tree-structured and have multi-layer structure, where the highest level is called the subsystem command, as shown in the following Figure 7-1 command tree example:

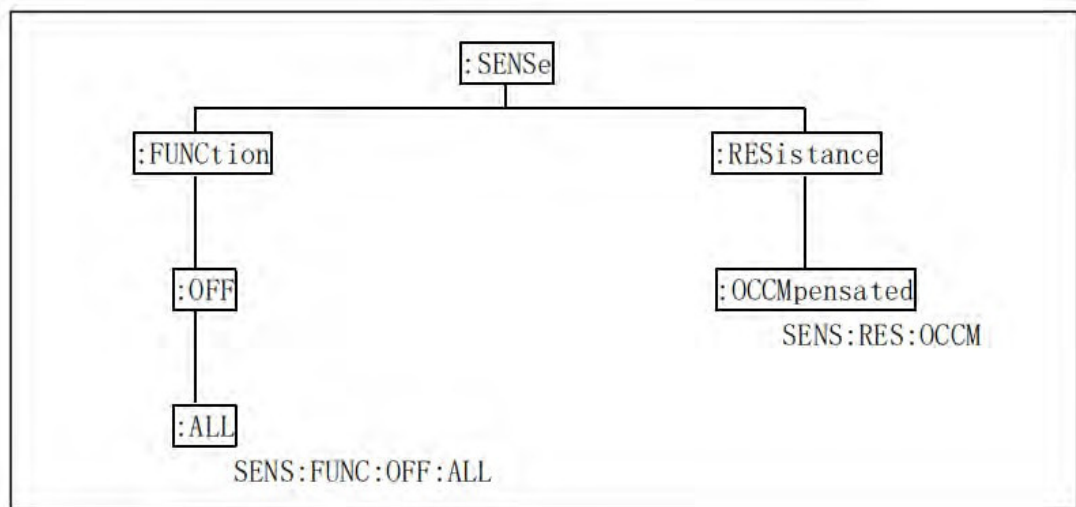


Figure 6-1 Command Tree Hierarchy

#### 6.1.1 Structure Rules

- Ignore case.

Example:

:SENS1:RES:OCCM ON is equivalent to :sens1:res:ocm on is equivalent to In:SENS1:Res:Occm On.

- A space is to separate the command and the parameter of the command - the command before the space and the parameter corresponding to the command after the space.

Example:

:SENS1:RES:OCCM ON where OCCM is the command and ON is its parameter.

- Some commands have no parameters.

Example:

:SENS1:FUNC:OFF:ALL Disable all measurement functions.

- Spaces ( \_ indicates the space) cannot be placed before or after the colon.

Example: The wrong space is written as SENS1\_: \_RES:OCCM ON, and the correct space is written as SENS1:RES:OCCM ON.

- Commands can be abbreviated or spelled out in their entirety (in subsequent command narratives, abbreviations are given in capital letters).

Example: The abbreviated form :SENS1:RES:OCCM ON is equivalent to the fully spelled out form :SENSe1:RESistance:OCCMpensated ON.

- The command followed by a question mark (?) executes a query corresponding to the command.

Example:

:SENSe1:RES:OCCM? command is the query of :SENSe1:RES:OCCM command.

### 6.1.2 Multiple Command Rules

The semicolon (;) is used to separate multiple commands on the same command line, and the following are the multiple command rules:

- On a multiple command line, use the semicolon (;) to separate commands at the same level under the same subsystem command.

Example:

:SENS1:RES:OCCM ON;MODE AUTO

In the above example, OCCM ON and MODE AUTO are the same level commands, i.e., both are subcommand under RES.

- The semicolon (;) is used as a separator, immediately followed by a colon (:), indicating that the command is restarted from the highest level of the command tree.

Example:

:SENS:RES:OCCM ON;;SENS:FUNC:OFF:ALL

- Public commands can be inserted before, in the middle or at the end of the command line, separated by semicolons, without affecting the hierarchy of the command line.

Example:

\*trg;;SENS1:RES:OCCM ON;MODE AUTO

:SENS1:RES:OCCM ON;\*trg;MODE AUTO

:SENS1:RES:OCCM ON;MODE AUTO;\*trg

Here OCCM ON and MODE AUTO are the same level commands, i.e., they are both subcommands under "RES", so the insertion of the public command \*trg will not affect the hierarchical relationship between the two commands.

✖ **Note:** All punctuations in the command syntax are English punctuations.

### 6.1.3 Abbreviation Rules

- If the number of characters of the complete command or parameter (later called long form) is less than 4 (inclusive), the abbreviation and long form are the same.
- When the number of long form characters is greater than 4:
  - If the fourth character is a vowel, the abbreviation takes the first 3 characters.
  - If the fourth character is not a vowel, the abbreviation takes the first 4 characters.

Example: MODE is abbreviated as MODE; TRIGger is abbreviated as TRIG; LEVel is abbreviated as LEV.

- Some commands or parameters are described by more than two words, and their long form is taken with the first character of the first word and all of the last word, and then the abbreviated format is taken from the long form.

For example, the long form of Percent TOLerance (Percent TOLerance) is PTOLerance, abbreviated as PTOL.

**✖Note:** This instrument is not case sensitive in the processing of the commands, including units.

## 6.2 Symbol Conventions and Definitions

### 6.2.1 Symbols

- Syntax notation used in the command:
  - : The colon is the level of the command, indicating that it goes to the next level of the command
  - ; The semicolon indicates the start of multiple commands
  - \* The commands after the asterisk are public commands
  - ? The question mark indicates the query
  - , The comma is the separator of multiple parameters
  - The space is the separator between the command and the parameter
  - " " The quotation mark is the content quoted in the original form, and the command analysis program does not do any processing on them
- Symbols that may be used in the command interpretation.
  - NR1 : Integer, e.g. 123
  - NR2 : Fixed point, e.g. 12.3
  - NR3 : Floating point, e.g. 12.3E+5
  - NRf: Contains NR1, NR2, NR3
  - Bool: Can be 1 or 0, or equal to ON or OFF
  - SPD: String program data, string parameters enclose in single or double quotation marks
  - CPD: Character program data, program discrete parameters, accept short and long forms
  - SRD: String response data, string parameters enclose in single or double quotation marks
  - CRD: Character response data, returns discrete data, and returns abbreviated forms only
  - Expr: Channel list, group list, or mathematical expression
  - NL: Line separator, integer 10, is the terminator of the string input and output
  - < > The characters contained in the angle brackets indicate program code parameters, but only one of them is selected when several optional parameters are included

- [ ] Square brackets indicate that the items included are optional or not
- { } Curly brackets indicate that multiple parameters are optional

### 6.2.2 Postfix Numbers

- [c] : c is integer 1 and 2, specifying channel 1 and channel 2 respectively
- [d] : d is integer 1 and 2, specifying the top and bottom half of the frontpanel display area, respectively
- [h]: h is integer between 1 and 100, used to specify the variables in the program memory
- [m]: m is integer between 1 and 12, used to specify the limit test
- [n]: n is integer between 1 and 14, used to specify digital I/O pins

**✖Note:** The abbreviated numeric postfix is equivalent to the result of the number 1.

### 6.2.3 Channel List Parameters

- The symbol (@1) specifies the channel list including channel 1
- The symbol (@2) specifies the channel list including channel 2
- The symbol (@1,2) specifies the channel list including channel 1 and 2
- The symbol (@1:2) specifies the channel list including channel 1 through 2
- The symbol (@2,,1) specifies the channel list including channel 2 and 1
- The symbol (@2:1) specifies the channel list including channel 2 through 1

## 6.3 Data Output Format

The data contains all elements specified by :FORM:ELEM:SENS and :FORM:ELEM:CALC commands. Therein, the available elements are voltage measurement data, current measurement data, resistance measurement data, calculation result data, time data, status data and source output setting data. A terminator <NL> (0x0a, 1 byte) is appended to the end of each data.

- ASCII data format: set by :FORMat[:DATA] ASCii command, returns comma-separated results and contains three special data
  - +9.910000E+37 indicates "not a number"
  - +9.900000E+37 indicates positive infinity
  - -9.900000E+37 indicates negative infinity

Example: The data contains 3 elements and the instrument will return the transmit data in the following form: +1.000001E-06,+1.000002E-06,+9.999999E-07<NL>
- IEEE-754 single-precision format: set by :FORMat[:DATA] REAL,32 command, 4-byte data block #<byte length in bits><byte length><byte>...<byte><terminator>. Each data element uses one 4-byte data and has three special data in it
  - NAN indicates "not a number"
  - +infinity indicates positive infinity

- -infinity indicates negative infinity
- IEEE-754 double-precision format: set by :FORMat[:DATA] REAL,64 command, 8-byte data block #<byte length in bits><byte length><byte>...<byte><terminator>. Each data element uses one 8- byte data and has three special data in it
  - NAN indicates "not a number"
  - +infinity indicates positive infinity
  - -infinity indicates negative infinity

## 6.4 Command Reference

The instrument supports the following subsystem commands:

- |          |          |        |          |
|----------|----------|--------|----------|
| ●DISPlay | ●FORMat  | ●FETCh | ●MEASure |
| ●OUTPut  | ●READ    | ●SENSe | ●SOURce  |
| ●SYStem  | ●TRIGger |        |          |

The instrument supports the following public commands:

- |       |       |       |       |
|-------|-------|-------|-------|
| ●*RST | ●*TRG | ●*IDN | ●*OPC |
|-------|-------|-------|-------|

In the subsequent command narrative, the explanation of each subsystem command is given within the following contents:

- 1 Subsystem command names, command trees and their hierarchy
- 2 Full name of each command (including subcommands) and its abbreviation (in upper case)
- 3 Specific description of the subcommand
- 4 The syntax of the command and the specific content of the command that conforms to the syntax rules
- 5 Query syntax and the specific content of commands that conform to the syntax rules
- 6 Query return content

### 6.4.1 DISPlay Subsystem Command

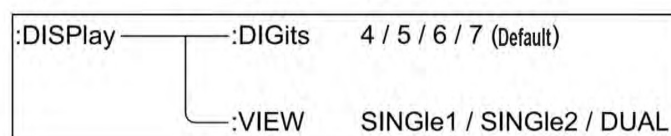


Figure 6-2 DISPlay Subsystem Command Tree

#### 6.4.1.1 :DISPlay:DIGits

This command is to set the display resolution of the front panel display data.

Set statement:

:DISPlay:DIGits <digits>

Set content: <digits>value (4~7, default value is 7), and the parameter data type is NR1.

**Specific settings:**

:DISPlay:DIGits 4	3½Bit Resolution
:DISPlay:DIGits 5	4½Bit Resolution
:DISPlay:DIGits 6	5½Bit Resolution
:DISPlay:DIGits 7	6½Bit Resolution

Query statement:

:DISPlay:DIGits?

Query response: <digits> <NL>

**Specific response:** <digits> Returns the current settings 4, 5, 6 or 7 of the display resolution, the return data type is NR1.

#### 6.4.1.2 :DISPlay:VIEW

This command is to set the display mode.

Set statement:

:DISPlay:VIEW <mode>

Set content: <mode> SINGle1 / SINGle2 / DUAL, and the parameter data type is CPD.

**Specific settings:**

:DISPlay:VIEW SINGle1 Sets the channel 1 display mode (the default setting of 1-channel type instruments).

:DISPlay:VIEW SINGle2 Sets the channel 2 display mode (only available for 2-channel type instruments).

:DISPlay:VIEW DUAL Sets the channel 1 and 2 display mode (only available for 2-channel type instruments and is the default setting of 2-channel model instruments).

Query statement:

:DISPlay:VIEW?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current settings SING1, SING2 or DUAL of the display mode, and the response data type is CRD.

## 6.4.2 FORMat Subsystem Command

```
:FORMat —:ELEMEnts —:SENSe  VOLTage / CURRent / RESistance / TIME
```

Figure 6-3 FORMat Subsystem Command Tree

### 6.4.2.1 :FORMat:ELEMEnts:SENSe

This command is to specify the elements contained in the measurement result data, and these elements are returned by the following command.

- FETCh?
- MEASure?

Set statement:

```
:FORMat:ELEMEnts:SENSe <type{,type}>
```

Set content: <type> VOLTage / CURRent / RESistance / TIME, and the parameter data type is CPD.

**✖Note:** The order of the set elements is exclusive, in the order of VOLT, CURR, RES, and TIME. If some elements are not selected, the remaining elements are still set as parameters in the order.

Query statement:

```
:FORMat:ELEMEnts:SENSe?
```

Query response: <format> <NL>

**Specific response:** <format> Returns the currently specified element VOLTage, CURRent, RESistance, or TIME, with multiple responses separated by commas, and the response data type is CRD.

## 6.4.3 FETCh Subsystem Command

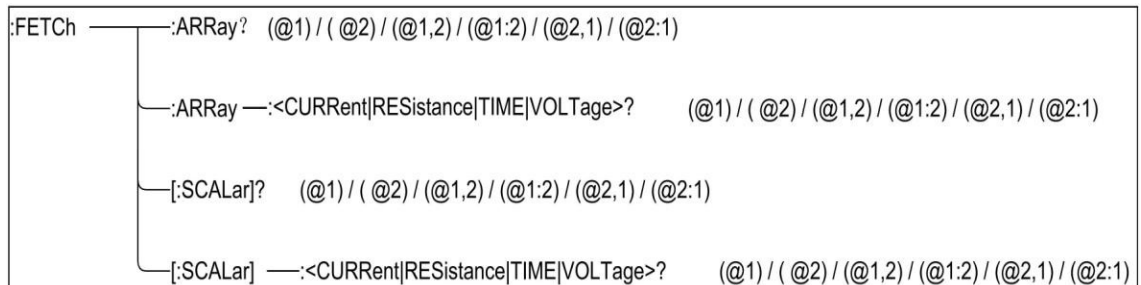


Figure 6-4 FETCh Subsystem Command Tree

### 6.4.3.1 :FETCh:ARRay?

This command is to return the array of all voltage measurement data, current measurement data, resistance measurement data, time data, status data, or source output setting data specified by :FORMat:ELEMEnts:SENSe command, and the data will not be cleared before the following commands are executed: :INITiate or :MEASure.

Query statement:

:FETCh:ARRay? [chanlist]

Query content: [chanlist] Channel list (@1) (default) / (@2) / (@1,2) / (@1:2) / (@2,1) / (@2:1), and the parameter data type is Expr.

Query response: <response> <NL>

**Specific response:** <response> Returns the array data specified by :FORMat:ELEMents:SENSe command, the response data type is NR3, and see 8.3 Data Output Format for details.

Example: ch1curr1, ch1sour1, ch2curr1, ch2sour1, ch1curr2, ch1sour2, ch2curr2, ch2sour2, .....ch1curr5, ch1sour5, ch2curr5, ch2sour5, ch1curr6, ch1sour6, +9.910000E+37, +9.910000E+37, ..... ch1curr10, ch1sour10, +9.910000E+37, +9.910000E+37

The data shown in the above example contains current measurement data (ch1currN) and source data (ch1sourN) of the 1-channel 10-step sweep measurement, and current measurement data (ch2currN) and source data (ch2sourN) of the 2-channel 5-step sweep measurement.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no data.

#### 6.4.3.2 :FETCh:ARRay:<CURRent|RESistance|TIME|VOLTage>?

This command is to return the data specified by CURRent, RESistance, TIME, or VOLTage, and the data is not cleared before the following command is executed: :INITiate or :MEASure.

Query statement:

:FETCh:ARRay:<CURRent|RESistance|TIME|VOLTage>? [chanlist]

Query content: [chanlist] Channel list (@1) (default) / (@2) / (@1,2) / (@1:2) / (@2,1) / (@2:1), and the parameter data type is Expr.

Query response: <response> <NL>

**Specific response:** <response> Returns the array data specified by CURRent, RESistance, TIME, or VOLTage. The response data type is NR3, as specified in 8.3 Data Output Format.

Example: ch1curr1,ch2curr1,ch1curr2,ch2curr2, .....  
ch1curr5,ch2curr5,ch1curr6,+9.910000E+37, .....  
ch1curr10,+9.910000E+37

The data shown in the above example contains current measurement data (ch1currN) of the 1-channel 10-step sweep measurement, and current measurement data



(ch2currN) of the 2-channel 5-step sweep measurement.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no data.

#### 6.4.3.3 :FETCh[:SCALar]?

This command is to return the array of all the latest voltage measurement data, current measurement data, resistance measurement data, time data, status data, or source output setting data specified by :FORMat:ELEMents:SENSe command, and the data will not be cleared before the following commands are executed: :INITiate or :MEASure.

Query statement:

:FETCh[:SCALar]? [chanlist]

Query content: [chanlist] Channel list (@1) (default) / (@2) / (@1,2) / (@1:2) / (@2,1) / (@2:1), and the parameter data type is Expr.

Query response: <response> <NL>

**Specific response:** <response> Returns the latest data specified by :FORMat:ELEMents:SENSe command. The response data type is NR3, and see 8.3 Data Output Format for details.

Example: ch1curr10,ch1sour10,ch2curr5,ch2sour5

The data shown in the above example contains the latest current measurement (ch1currN) and the latest source data (ch1sourN) of the 1- channel 10-step sweep measurement as well as the latest current measurement data (ch2currN) and the latest source data (ch2sourN) of the 2- channel 5 step sweep measurement.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no data.

#### 6.4.3.4 :FETCh[:SCALar]:<CURRent|RESistance|TIME|VOLTage>?

This command is to return the latest data specified by CURRent, RESistance, TIME, or VOLTage, and the data will not be cleared before the following commands are executed: :INITiate or :MEASure

Query statement:

:FETCh[:SCALar]:<CURRent|RESistance|TIME|VOLTage>? [chanlist]

Query content: [chanlist] Channel list (@1) (default) / (@2) / (@1,2) / (@1:2) / (@2,1) / (@2:1), and the parameter data type is Expr.

Query response: <response> <NL>

**Specific response:** <response> Returns the latest data specified by CURRent, RESistance, TIME, or VOLTage. The response data type NR3, as specified in 8.3 Data output format.

Example: ch1curr10,ch2curr5

The data shown in the above example contains the latest current measurement (ch1currN) of the 1-channel 10-step sweep measurement and the latest current measurement data (ch2currN) of the 2-channel 5-step sweep measurement.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no Data.

#### 6.4.4 MEASure Subsystem Command

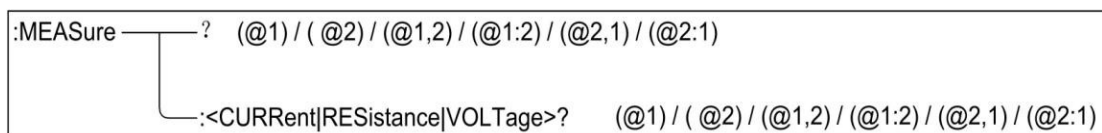


Figure 6-5 MEASure Subsystem Command Tree

##### 6.4.4.1 :MEASure?

This command is to perform the point measurement (single measurement) and return the measurement result data.

**✖Note:** Before executing this command, the measurement conditions must be set by the SCPI command or the front panel operation. The measurement elements can be selected by :FORMat:ELEMents:SENSe command.

Query statement:

:MEASure? [chanlist]

Query content: [chanlist] Channel list (@1) (default) / (@2) / (@1,2) / (@1:2) / (@2,1) / (@2:1), and the parameter data type is Expr.

Query response: <response> <NL>

**Specific response:** <response> Returns the current measurement data, the response data type is NR3, and see 8.3 Data Output Format for details.

Example: ch1curr,ch1sour,ch2curr,ch2sour

The data shown in the above example contains the present current measurement data and the current source data of 1-channel as well as the present current measurement data and the current source data of 2-channel.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no data.

#### 6.4.4.2 :MEASure:<CURRent|RESistance|VOLTag>?

This command is to perform the point measurement (singlemeasurement) and return the measurement result data.

**✖Note:** Before executing this command, the measurement conditions must be set by the SCPI command or the front panel operation. The measurement elements can select current, resistance or voltage directly from this command.

Query statement:

:MEASure:<CURRent[:DC]|RESistance|VOLTag[:DC]>? [chanlist]

Query content: [chanlist] Channel list (@1) (default) / (@2) / (@1,2)

/ (@1:2) / (@2,1) / (@2:1), and the parameter data type is Expr.

Query response: <response> <NL>

**Specific response:** <response> Returns the current measurement data, the response data type is NR3, and see 8.3 Data Output Format for details.

Example: ch1curr,ch2curr

The data shown in the example above contains the present current measurement data of 1-channel and the present current measurement data of 2-channel.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no Data.

#### 6.4.5 OUTPut Subsystem Command

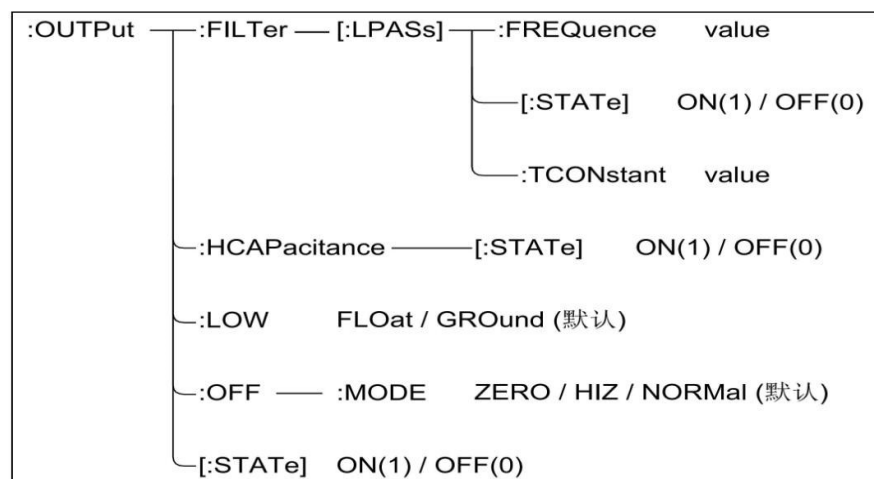


Figure 6-6 OUTPut Subsystem Command Tree

##### 6.4.5.1 :OUTPut:FILTer[:LPASs]:FREQuency

This command is to set the cut-off frequency of the output filter.

Set statement:

:OUTPut[c]:FILTer[:LPASs]:FREQuency <frequency>

**※Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <frequency> value (31.830Hz ~ +31.831kHz), value is set to the number with Hz in unit, but not in the command statement, and the parameter data type is NRf.

Query statement:

:OUTPut[c]:FILTer[:LPASs]:FREQuency?

Query response: <frequency> <NL>

**Specific response:** <frequency> Returns the value of the currently set cut-off frequency, and the response data type is NR3.

**※Note:** If the time constant is set by :OUTPut:FILTer[:LPASs]:TCONstant command, then the cut-off frequency can be obtained from the following formula. And the latest command setting is valid for both time constant and cut-off frequency.

$$\text{frequency} = 1/(2 * \pi * \text{time\_constant})$$

#### 6.4.5.2 :OUTPut:FILTer[:LPASs][:STATE]

This command is to enable or disable the output filter.

Set statement:

:OUTPut[c]:FILTer[:LPASs][:STATE] <mode>

**※Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode> 1 / ON (default) / 0 / OFF, and the parameter data type is Bool.

Query statement:

:OUTPut[c]:FILTer[:LPASs][:STATE]?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current state 0 or 1 of the output filter, and the response data type is NR1.

#### 6.4.5.3 :OUTPut:FILTer[:LPASs]:TCONstant

This command is to set the time constant of the output filter.

Set statement:

:OUTPut[c]:FILTer[:LPASs]:TCONstant <time\_constant>

**※Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <time\_constant> value (5us~5ms), value is set to the number with s in unit, but not in the command statement, and the parameter data type is NR3.

Query statement:

:OUTPut[c]:FILTer[:LPASs]:TCONstant?

Query response: <time\_constant> <NL>

**Specific response:** <time\_constant> Returns the value of the current time constant, and the response data type is NR3.

**✖Note:** If the cut-off frequency is set by :OUTPut:FILTer[:LPASs]:FREQuency command, then the time constant can be obtained from the following formula. And the latest command setting is valid for both time constant and cut-off frequency.

$$\text{time\_constant} = 1 / (2 * \pi * \text{frequency})$$

#### 6.4.5.4 :OUTPut:HCAPacitance[:STATe]

This command is to enable or disable high capacitance mode, and high capacitance mode is effective for the high capacitance DUTs..

Set statement:

:OUTPut[c]:HCAPacitance[:STATe] <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Setting content: <mode>1 /ON / 0 / OFF (default), and the parameter data type is Bool.

Query statement:

:OUTPut[c]:HCAPacitance[:STATe]?Query response: <mode> <NL>

**Specific response:** <mode> Returns the current state 0 or 1 of the high-capacitance mode, and the response data type is NR1.

#### 6.4.5.5 :OUTPut:LOW

This command is to set the state of the low end. Before this command is executed, you must turn off the source output by OUTPut[:STATe] command, otherwise the error will be generated.

Set statement:

:OUTPut[c]:LOW <low\_state>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <low\_state> FLOat|GROund (default), and the parameter data type is CPD.

Query statement: OUTPut[c]:LOW?

Query response: <low\_state> <NL>

**Specific response:** <low\_state> Returns to the current state FLOat or GROund of the low end, and the response data type is CRD.

#### 6.4.5.6 :OUTPut:OFF:MODE

This command is to set the source mode after the source output is disabled.

Set statement:

:OUTPut[c]:OFF:MODE <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Setting content: <mode>ZERO / HIZ / NORMAl (default). The parameter data type is CPD.

**✖Note:** ZERO / HIZ / NORMAl modes are set as follows

- ZERO mode setup:
  - Source function: Voltage source
  - Output voltage: 0V
  - Current compliance: 100uA (in the 100uA range)
- HIZ mode setup:
  - Output relay: closed (open circuit or broken circuit)
  - If the voltage of 40 V or less is applied, the voltage source setting will not be changed.
  - If the source uses 100mA range or lower current, the current source setting will not be changed.
- NORMAl mode setup:
  - Source function: Voltage source
  - Output voltage: 0V
  - Current compliance: 100uA (in the 100uA range)
  - Output relay: closed (open circuit or broken circuit)

**✖Note:** This command setting is not suitable for the output shutdown triggered by over-voltage/over-current protection, interlock open circuit, over-temperature protection, etc. If the output shutdown is triggered by emergency, the output voltage should be set to 0V immediately, and the output switch should be set to off.

Query statement:

:OUTPut[c]:OFF:MODE?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current mode ZERO, HIZ or NORMAl of the source after the output is disabled, and the response data type is CRD.

#### 6.4.5.7 :OUTPut[:STATe]

This command is to set the source output to be enabled or disabled.

Set statement:

:OUTPut[c][:STATe] <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode> 1 / ON / 0 / OFF (default), and the parameter data type is Bool.

Query statement:

:OUTPut[c]:STATe)?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current state 0 or 1 of the source output, and the response data type is NR1.

#### 6.4.6 SENSE Subsystem Command

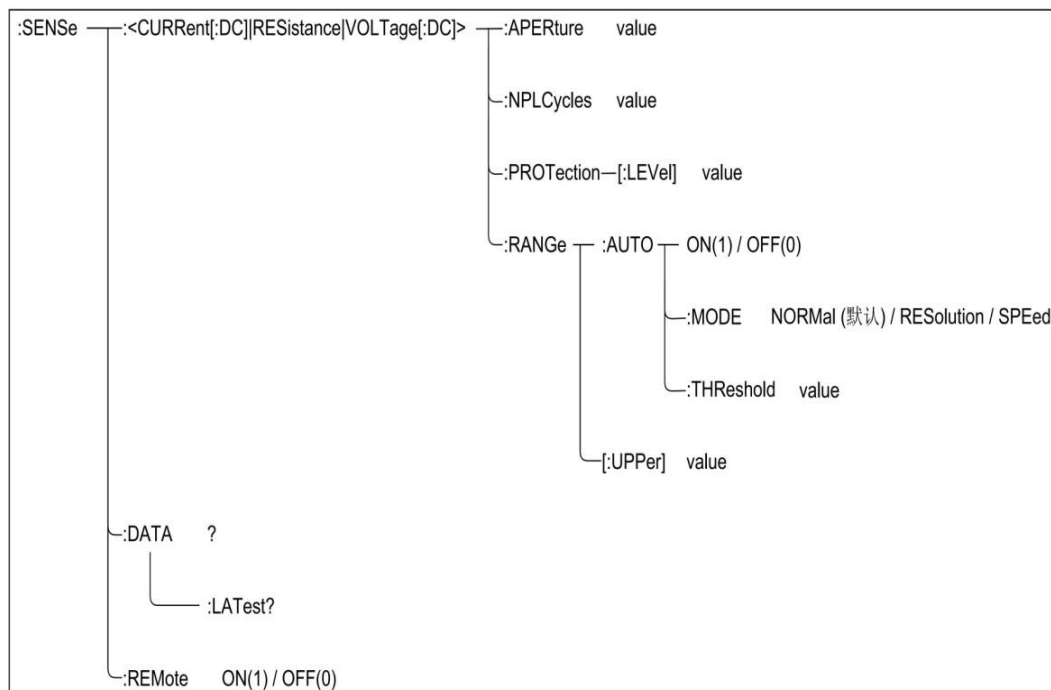


Figure 6-7 SENSE Subsystem Command Tree

##### 6.4.6.1 :SENSe:<CURRent[:DC]|RESistance|VOLTage[:DC]>:APERTure

This command is to set the aperture time for the single measurement.

Set statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:APERTure <time>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <time> value (1E-6s~2s) (default value is 0.1PLC), value is set to the number with s in unit, but not in the command statement, and the parameter data type is NRf.

**✖Note:** If the number of power line cycles is set by the following command (NPLC):SENSe:<CURRent[:DC]|RESistance|VOLTage[:DC]>:NP LCycles, then the

aperture time of the single measurement can be obtained from the following formula, where power line frequency is the power line frequency. And the latest command setting is valid for both integration time and the number of power line cycle.

$$\text{time} = \text{nplc} / \text{power line frequency}$$

Query statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:APERture?

Query response: <time> <NL>

**Specific response:** <time> Returns the value of the aperture time for the currently set single measurement, and the response data type is NRf.

#### 6.4.6.2 :SENSe:<CURRent[:DC]|RESistance|VOLTage[:DC]>:NPLCycle s

This command is to set the power line cycle value (NPLC).

Set statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:NPLCycles <nplc>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <nplc> value (5E-5~200) (default value is 0.1PLC), and the parameter data type is NRf.

Query statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:NPLCycles?

Query response: <nplc> <NL>

**Specific response:** <nplc> Returns the currently set number of power line cycles, and the response data type is NRf.

#### 6.4.6.3 :SENSe:<CURRent[:DC]|VOLTage[:DC]>:PROTection[:LEVel]

This command is to set the compliance value of the specified channel.

Set statement:

:SENSe[c]:<CURRent[:DC]|VOLTage[:DC]>:PROTection[:LEVel]<compliance>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <compliance> value (valid value from the minimum measured value to the maximum measured value of the channel, see Table 2-

5) (default value is 100uA or 2V), value is set to the number, and current is in A, voltage is in V, but the unit is not set in the command statement, and the parameter data type is NRf.

Query statement:

:SENSe[c]:<CURRent[:DC]|VOLTage[:DC]>:PROTection[:LEVel]?



[compliance]

Query response: <compliance> <NL>

**Specific response:** <compliance> Returns the currently set compliance value. The response data type is NRf.

#### 6.4.6.4 :SENSe:<CURRent[:DC]|RESistance|VOLTage[:DC]>:RANGe:A UTO

This command is to enable or disable the auto-set measurement range function of the specified measurement channel.

Set statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:RANGe:AU TO <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode>1 / ON (default) / 0 / OFF, and the parameter datatype is Bool.

- The mode is 0 or OFF, indicating that the auto-set measurement range function is disabled, and the measurement is performed with the range set by :SENSe:<CURRent[:DC]|RESistance|VOLTage[:DC]>:RANGe[:UPPer] command.
- The mode is 1 or ON, indicating that the auto-set measurement range function is enabled, and will automatically set the range that provides the best resolution for the measurement.

Query statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:RANGe:AUTO?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current status 0 or 1 of the auto-set measurement range function, and the response data type is NR1.

#### 6.4.6.5 :SENSe:<CURRent[:DC]|VOLTage[:DC]>:RANGe:AUTO:MODE

This command is to select the mode of the auto-set measurement range operation. The command setting is valid only when the auto-set measurement range function is enabled.

Set statement:

:SENSe[c]:<CURRent[:DC]|VOLTage[:DC]>:RANGe:AUTO:MODE<mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode> NORMAl (default) / RESolution / SPEEd, and the parameter data type is CPD.

- Mode is NORMAl, indicating support for both basic operations with downward change operations

- Mode is RESolution, indicating support for basic operations with upward change operations
- Mode is SPEed, indicating support for basic operations with upward and downward change operations

**✖Note:** The basic operation, upward change operation and downward change operation in the above settings are as follows:

- Basic operation: The channel automatically provides the range with the best resolution for performing measurements.
- Upward change operation:
  - If the measurement data  $\geq$  value1, the range is shifted upwards after the measurement.
  - $\text{value1} = \text{measurement range} * \text{rate} / 100$
- Downward change operation:
  - If the measurement data  $\leq$  value2, the range is shifted downwards after the measurement.
  - $\text{value2} = \text{measurement range} * \text{rate} / 1000$

**✖Note:** In the above statement, the rate value is set by the following command, measurement range is the current setting of the measurement range.

SENSe:<CURRent[:DC]|VOLTage[:DC]>:RANGe:AUTO:THReshold

Query statement:

:SENSe[c]:<CURRent[:DC]|VOLTage[:DC]>:RANGe:AUTO:MODE?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current setting NORMal, RESolution, or SPEed of the mode that automatically sets the measurement range, and the response data type is CRD.

#### 6.4.6.6 :SENSe:<CURRent[:DC]|VOLTage[:DC]>:RANGe:AUTO:THRes hold

This command is to set the threshold value of auto-set measurement range operation.

Set statement:

:SENSe[c]:<CURRent[:DC]|VOLTage[:DC]>:RANGe:AUTO:THReshold  
<rate>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <rate> value (11%~100%) (default is 90%), % is not set in the command statement, and the parameter data type is NR1.

Query statement:

:SENSe[c]:<CURRent[:DC]|VOLTage[:DC]>:RANGe:AUTO:THReshold?

Query response: <rate> <NL>

**Specific response:** <rate> Returns the current setting of the threshold value, and the response data type is NR1.

#### 6.4.6.7 :SENSe:<CURRent[:DC]|RESistance|VOLTage[:DC]>:RANGe[:UPPer]

This command is to specify the expected measurement value and set the measurement range for the operation that provides the best resolution for measuring the specified value.

Set statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:RANGe:UPPer<range>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <range> value (see Table 2-9 for Current Measurement, Table 2-10 for Resistance Measurement, and Table 2-8 for Voltage Measurement), and the parameter data type is NRf.

Query statement:

:SENSe[c]:<CURRent[:DC]|RESistance|VOLTage[:DC]>:RANGe:UPPer?

Query response: <range> <NL>

**Specific response:** <range> Returns the current setting of the measurement range, and the response data type is NRf.

#### 6.4.6.8 :SENSe:DATA?

This command is to return the array data including all current measurement data, voltage measurement data, resistance measurement data, source output setting data, status data, and time data specified by :FORMat:ELEMents:SENSe command. The data is not cleared until the command :INITiate or :MEASure is executed.

Query statement:

:SENSe[c]:DATA? <offset,size>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Query content:

- [offset] Specifies the opening of the received data, n / CURRent / STARt (default), and the parameter data type is NR1 or CPD.
  - offset is n, indicating that data is received from n+1, n is an integer, 0 to the maximum value (the maximum value depends on the buffer state)
  - offset is CURR, indicating to start from the current data position
  - offset is STAR, indicating to start at the top position of the data buffer (equivalent to n=0)
- [size] Specifies the number of received data, from 1 to the maximum value (the

maximum value depends on the buffer state), and the parameter data type is NR1.

Query response: <response> <NL>

**Specific response:** <response> Returns the data set specified by :FORMat:ELEMents:SENSe command, and the response data type is NR3, as described in 8.3 Data Output Format.

Example: ch1curr1,ch1sour1,ch1curr2,ch1sour2,ch1curr10,ch1sour10

The data shown in the example above contains current data (ch1currN) and the source data (ch1sourN) of 1-channel 10-step sweep measurement.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no data.

#### 6.4.6.9 :SENSe:DATA:LATest?

This command is to return the latest current measurement data, voltage measurement data, resistance measurement data, source output setting data, status data, or time data specified by :FORMat:ELEMents:SENSe command. This data is not cleared until the command :INITiate or :MEASure is executed.

Query statement:

:SENSe:DATA:LATest?

Query response: <response> <NL>

**Specific response:** <response> Returns the latest measurement data, and the response data type is NR3, as described in 8.3 Data Output Format.

Example: ch1curr10,ch1sour10

The data shown in the example above contains the latest current measurement data (ch1currN) and source data (ch1sourN) of 1-channel 10-step sweep measurement.

**✖Note:** If the measurement function is not enabled or the data does not exist, the return value is +9.910000E+37 (ASCII) or NaN (IEEE-754), and this return content indicates no data.

#### 6.4.6.10 :SENSe:REMOte

This command is to enable or disable the remote function and the remote must be enabled to use the measurement connection method with the 4-wire connection (Kelvin connection).

Set statement:

:SENSe[c]:REMOte <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode>1 / ON / 0 / OFF (default), and the parameter data type is Bool.

Query statement: SENSE[c]:REMOte?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current state 0 or 1 of the remote function, and the response data type is NR1.

#### 6.4.7 SOURce Subsystem Command

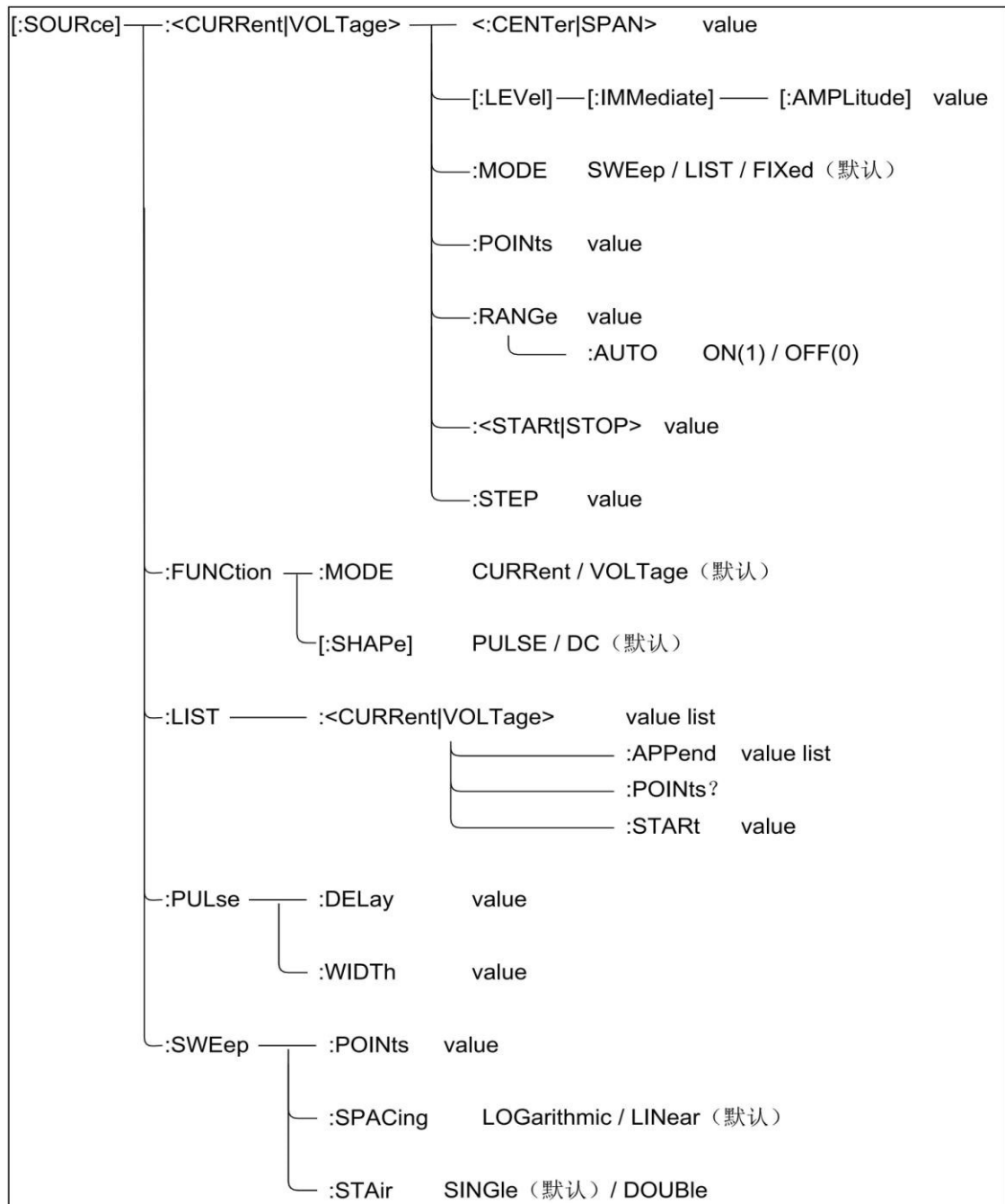


Figure 6-8 SOURce Subsystem Command

#### 6.4.7.1 [:SOURce]:<CURRent|VOLTage>:<CENTer|SPAN>

This command is to set the center or span value of the current or voltage sweep output.

Set statement: [:SOURce[c]]:<CURRent|VOLTage>:<CENTer|SPAN> <data>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <data> value (see Table 2-6 for Voltage Source Output Range Table and Table 2-7 for Current Source Output Range Table), value is set as the number, and current is in A, voltage is in V, but the unit is not set in the command statement, and the parameter data type is NR3.

**✖Note:** The center and span value can be expressed by the following formula, and the start and stop value within the formula is set by [:SOURce]:<CURRent|VOLTage>:<START|STOP> command, and the last command setting is valid for all these sweep parameters.

- $\text{center} = (\text{start} + \text{stop}) / 2$
- $\text{span} = \text{stop} - \text{start}$

Query statement: [:SOURce[c]]:<CURRent|VOLTage>:<CENTer|SPAN>?

Query response: <data> <NL>

**Specific response:** <data> Returns the center or span value of the currently set current or voltage sweep output, and the response data type is NR3.

#### 6.4.7.2 [:SOURce]:<CURRent|VOLTage>[:LEVel][:IMMediate][:AMPLitude]

This command is to change the output level of the specified source channel immediately.

Set statement: [:SOURce[c]]:<CURRent|VOLTage>[:LEVel][:IMMediate][:AMPLitude] <level>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <level> value (See Table 2-6 for Voltage Source Output Range Table and Table 2-7 for Current Source Output Range Table), value is set to the number, and current is in A, voltage is in V, but the unit is not set in the command statement, and the parameter data type is NRf.

Query statement:

[:SOURce[c]]:<CURRent|VOLTage>[:LEVel][:IMMediate][:AMPLitude]?

Query response: <level> <NL>

**Specific response:** <level> Returns the currently changed output level value of the specified source channel, and the response data type is NRf.

#### 6.4.7.3 [:SOURce]:<CURRent|VOLTage>:MODE

This command is to select the source mode of the specified source channel.

Set statement: [:SOURce[c]]:<CURRent|VOLTage>:MODE <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode> SWEep (sweep source) / LIST (list sweep source)  
/ FIXed (DC source, default setting), and the parameter data type is CPD.

Query statement: [:SOURce[c]]:<CURRent|VOLTage>:MODE?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current source mode setting FIX, LIST, or SWE, and the response data type is CRD.

#### 6.4.7.4 [:SOURce]:<CURRent|VOLTage>:POINTS

This command is to set the number of steps of current or voltagesweep output.

Set statement: [:SOURce[c]]:<CURRent|VOLTage>:POINTS <points>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <points> value (1~2500) (default value is 1), and the parameter data type is NR1.

**✖Note:** The value of points can be defined by the following formula, and the value of step in the formula is defined by [:SOURce]:<CURRent|VOLTage>:STEP command and the value of span is set by [:SOURce]:<CURRent|VOLTage>:<CENTer|SPAN> command.

$$\text{points} = \text{span} / \text{step} + 1 \quad (\text{step is not } 0)$$

Special case: when points=1, step=0

**✖Note:** The calculated point values are rounded down to integers.

**✖Note:** The sweep measurement is performed from the start value to the stop value calculated with the following formula, even if the specified stop value does not satisfy the following formula.  $\text{stop} = \text{start} + \text{step} \times (\text{points} - 1)$

**✖Note:** For the logarithmic sweeping, the step value is ignored and is not used for sweep point calculation.

Query statement: [:SOURce[c]]:<CURRent|VOLTage>:POINTS?

Query response: <points><NL>

**Specific response:** <points> Returns the currently set number of sweep output steps, and the response data type is NR1.

#### 6.4.7.5 [:SOURce]:<CURRent|VOLTage>:RANGe

This command is to set the current and voltage output range of the specified source channel, and the command is valid when the auto-set output range function is disabled.

Set statement: [:SOURce[c]]:<CURRent|VOLTage>:RANGe <range>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <range> value (see Table 2-6 for Voltage Source Output Range Table and Table 2-7 for Current Source Output Range Table), value is set to the number, and current is in A, voltage is in V, but the unit is not set in the command statement, and the parameter data type is NR3.

Query statement: [:SOURce[c]]:<CURRent|VOLTage>:RANGe?

Query response: <range><NL>

**Specific response:** <range> Returns the current setting of the source output range, and the response data type is NR3.

#### 6.4.7.6 [:SOURce]:<CURRent|VOLTage>:RANGe:AUTO

This command is to enable or disable the auto-set output range function of the specified source channel.

Set statement: [:SOURce[c]]:<CURRent|VOLTage>:RANGe:AUTO<mode>

Set content: <mode> 1 / ON (default) / 0 / OFF, and the parameter data type is Bool.

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

**✖Note:** If the range of the source channel is selected manually by

[:SOURce]:<CURRent|VOLTage>:RANGe command, this auto-set output range function should be disabled.

Query statement: [:SOURce[c]]:<CURRent|VOLTage>:RANGe:AUTO?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current state 0 or 1 of the auto-set output range function, and the response data type is NR1.

#### 6.4.7.7 [:SOURce]:<CURRent|VOLTage>:<START|STOP>

This command is to set the start or stop value of the current or voltage sweep output.

Set statement: [:SOURce[c]]:<CURRent|VOLTage>:<START|STOP> <data>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <data> value (see Table 2-6 for Voltage Source Output Range Table and Table 2-7 for Current Source Output Range Table), value is set to the number, and



current is in A, voltage is in V, but the unit is not set in the command statement, and the parameter data type is NR3.

**✖Note:** The center and span values set by

[ :SOURce]:<CURRent|VOLTAge>:<CENTer|SPAN> command can be used to calculate the start and stop values by the following formula, and the last command setting is valid for all these sweep parameters.

$$\text{start} = \text{center} - \text{span} / 2$$

$$\text{stop} = \text{center} + \text{span} / 2$$

Query statement: [ :SOURce[c]]:<CURRent|VOLTAge>:<START|STOP>?

Query response: <data><NL>

**Specific response:** <data> Returns the current setting for the start or stop value of the sweep output, and the response data type is NR3.

#### 6.4.7.8 [ :SOURce]:<CURRent|VOLTAge>:STEP

This command is to set the sweep step value of current or voltage sweep output.

Set statement: [ :SOURce[c]]:<CURRent|VOLTAge>:STEP <step>

**✖Note:** c is 1 or 2, **representing** channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <step> value (see Table 2-6 for Voltage Source Output Range Table and Table 2-7 for Current Source Output Range Table), value is set to the number, and current is in A, voltage is in V, but the unit is not set in the command statement, and the parameter data type is NR1.

**✖Note:** The step value is defined by the following formula, the value of points in the formula is set by [ :SOURce]:<CURRent|VOLTAge>:POINTs command and the value of span is set by [ :SOURce]:<CURRent|VOLTAge>:<CENTer |SPAN> command.

$$\text{step} = \text{span} / (\text{points} - 1) \quad (\text{points is not } 1)$$

Special case: when points=1, step=0

**✖Note:** The calculated point values are rounded down to integers.

**✖Note:** The sweep measurement is performed from the start value to the stop value calculated with the following formula, even if the specified stop value does not satisfy the following formula.

$$\text{stop} = \text{start} + \text{step} \times (\text{points} - 1)$$

**✖Note:** For the logarithmic sweeping, the step value is ignored and is not used for sweep point calculation.

**✖Note:** The step and span must be the same polarity, otherwise the error will be generated.

Query statement: [:SOURce[c]]:<CURRent|VOLTage>:STEP?

Query response: <step><NL>

**Specific response:** <step> Returns the current setting of the sweep stepvalue, and the response data type is NR1.

#### 6.4.7.9 [:SOURce]:FUNCTION:MODE

This command is to select the source output mode of the specified channel.

Set statement: [:SOURce[c]]:FUNCTION:MODE <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode> CURRent / VOLTage, and the parameter datatype is CPD.

Query statement: [:SOURce[c]]:FUNCTION:MODE?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current source type setting CURR or VOLT of the specified channel, and the response data type is CRD.

#### 6.4.7.10 [:SOURce]:FUNCTION[:SHAPE]

This command is to select the source output shape of the specified channel.

Set statement: [:SOURce[c]]:FUNCTION[:SHAPE] <shape>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <shape> PULSe (pulse) / DC (default, voltage regulator), and the parameter data type is CPD.

Query statement: [:SOURce[c]]:FUNCTION[:SHAPE]?

Query response: <shape> <NL>

**Specific response:** <shape> Returns the current shape setting DC or PULS of the specified channel, and the response parameter type is CRD.

#### 6.4.7.11 [:SOURce]:LIST:<CURRent|VOLTage>

This command is to set the source output current or voltage data of the specified channel.

Set statement: [:SOURce[c]]:LIST:<CURRent|VOLTage> <list>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <list> output current or voltage data list (the default value is 0, see Table 2-6 for Source Output Range Table and Table 2-7 for Specific Value Ranges), value is set to the number, and current is in A, voltage is in V, but the unit is not set in the

command statement. A list is up to 2500 data, and each data is separated by the comma. The parameter data type is NRf.

Query statement: [:SOURce[c]]:LIST:<CURRENT|VOLTage>?

Query response: <list> <NL>

**Specific response:** <list> Returns the current list data, and each data is separated by the comma. The response data type is NR3.

#### 6.4.7.12 [:SOURce]:LIST:<CURRENT|VOLTage>:APPend

This command is to add the source output current or voltage data to the data list set by the following command [:SOURce]:LIST:<CURRENT|VOLTage>.

Set statement: [:SOURce[c]]:LIST:<CURRENT|VOLTage>:APPend <append\_list>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <append\_list> output current or voltage data list (the default value is 0, see Table 2-6 and Table 2-7 for Source Output Range Table), value is set to the number, and current is in A, voltage is in V, but the unit is not set in the command statement, each data is separated by the comma, and the parameter data type is NRf.

**✖Note:** The overall data table consisting of the list data table set by [:SOURce]:LIST:<CURRENT|VOLTage> command and this added list have a maximum of 2500 data.

#### 6.4.7.13 [:SOURce]:LIST:<CURRENT|VOLTage>:POINts?

This command is to return the number of data in the combined data list set by the [:SOURce]:LIST:<CURRENT|VOLTage> command and [:SOURce]:LIST:<CURRENT|VOLTage>:APPend command.

Query statement: [:SOURce[c]]:LIST:<CURRENT|VOLTage>:POINts?

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Query response: <number\_of\_data> <NL>

**Specific response:** <number\_of\_data> Returns the number of the currently set list data, and the response data type is NR1.

#### 6.4.7.14 [:SOURce]:LIST:<CURRENT|VOLTage>:STARt

This command is to specify the starting point of the list sweep using the list index.

Set statement: [:SOURce[c]]:LIST:<CURRENT|VOLTage>:STARt <start>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is

not selected, the default is channel 1. Set content: <start> value (value is 1~2500), the default value is 1 (first data of the list, top of the list), and parameter data type is NR1.

**✖Note:** <start> as 0 or greater than 2500 will result in an error.

Query statement: [:SOURce[c]]:LIST:<CURRent|VOLTag>:STARt?

Query response: <start> <NL>

**Specific response:** <start> Returns the starting point of the currently set list sweep, and the response data type is NR1.

#### 6.4.7.15 [:SOURce]:PULSe:DELay

This command is to set the pulse delay time of the specified channel.

Set statement: [:SOURce[c]]:PULSe:DELay <delay>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <delay> value (value is 0.0s~99999.9s) (default value is 0), value is set to the number with s in unit, but the unit will not be set in the command statement, and the parameter data type is NRf.

Query statement: [:SOURce[c]]:PULSe:DELay?

Query response: <delay> <NL>

**Specific response:** <delay> Returns the current setting of the specified channel pulse delay time. The response data type is NR3.

#### 6.4.7.16 [:SOURce]:PULSe:WIDTh

This command is to set the pulse width of the specified channel.

Set statement: [:SOURce[c]]:PULSe:WIDTh <width>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <width> value (value is 5E-5s~100000s) (default value is 0), value is set to the number with s in unit, but the unit will not be set in the command statement, and the parameter data type is NRf.

**✖Note:** The minimum time of pulse basic output is 50us, and the minimum pulse period is 100us.

Query statement: [:SOURce[c]]:PULSe:WIDTh?

Query response: <width> <NL>

**Specific response:** <width> Returns the current setting of the specified channel pulse width, and the response data type is NR3.

#### 6.4.7.17 [:SOURce]:SWEep:POINts

This command is to set the number of sweeping steps for the specified channel. The command is valid for either current or voltage sweeping.

Set the statement: [:SOURce[c]]:SWEep:POINts <points>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <points> value (value is 1~2500), and the parameter datatype is NR1.

**✖Note:** The value of points can be defined by the following formula, the value of step in the formula is set by

[SOURce]:<CURRent|VOLTage>:STEP command and the value of span is set by [SOURce]:<CURRent|VOLTage>:<CENTer|SPAN> command.

$$\text{points} = \text{span} / \text{step} + 1 \quad (\text{step is not } 0)$$

Special case: when points=1, step=0

- If points change, span is used as the constant, and step changes
- If step changes, span is used as the constant and points change
- If span changes, points is used as the constant and step changes

**✖Note:** The calculated point values are rounded down to integers.

**✖Note:** The sweep measurement is performed from the start value to the stop value calculated with the following formula, even if the specified stop value does not satisfy the following formula.

$$\text{stop} = \text{start} + \text{step} \times (\text{points} - 1)$$

**✖Note:** For the logarithmic sweeping, the step value is ignored and is not used for sweep point calculation

Query statement: [:SOURce[c]]:SWEep:POINts?

Query response: <points> <NL>

**Specific response:** <points> Returns the number of currently set sweep steps, and the response data type is NR1.

#### 6.4.7.18 [:SOURce]:SWEep:SPACing

This command is to select the sweep output mode of the specified channel.

Set statement: [:SOURce[c]]:SWEep:SPACing <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode> LOGarithmic / LINer (default), and the parameter data type is CPD.

- LOG: Selects the logarithmic sweep output, and the logarithmic sweep ignores the sweep step.

- LIN: Selects the linear sweep output.

Query statement: [:SOURce[c]]:SWEep:SPACing?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the currently set output mode LOG or LIN, and the response data type is CRD.

#### 6.4.7.19 [:SOURce]:SWEep:STAir

This command is to set the sweep mode of the specified channel.

Set statement: [:SOURce[c]]:SWEep:STAir <mode>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <mode> SINGle (default) / DOUBle, and the parameter data type is CPD.

- SING: Single sweep mode.
- DOUB: Dual sweep mode, performs the sweep from start to stop and back again.

Query statement: [:SOURce[c]]:SWEep:STAir?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the currently set sweep mode SING or DOUB, and the response data type is CRD.

### 6.4.8 SYSTem Subsystem Command

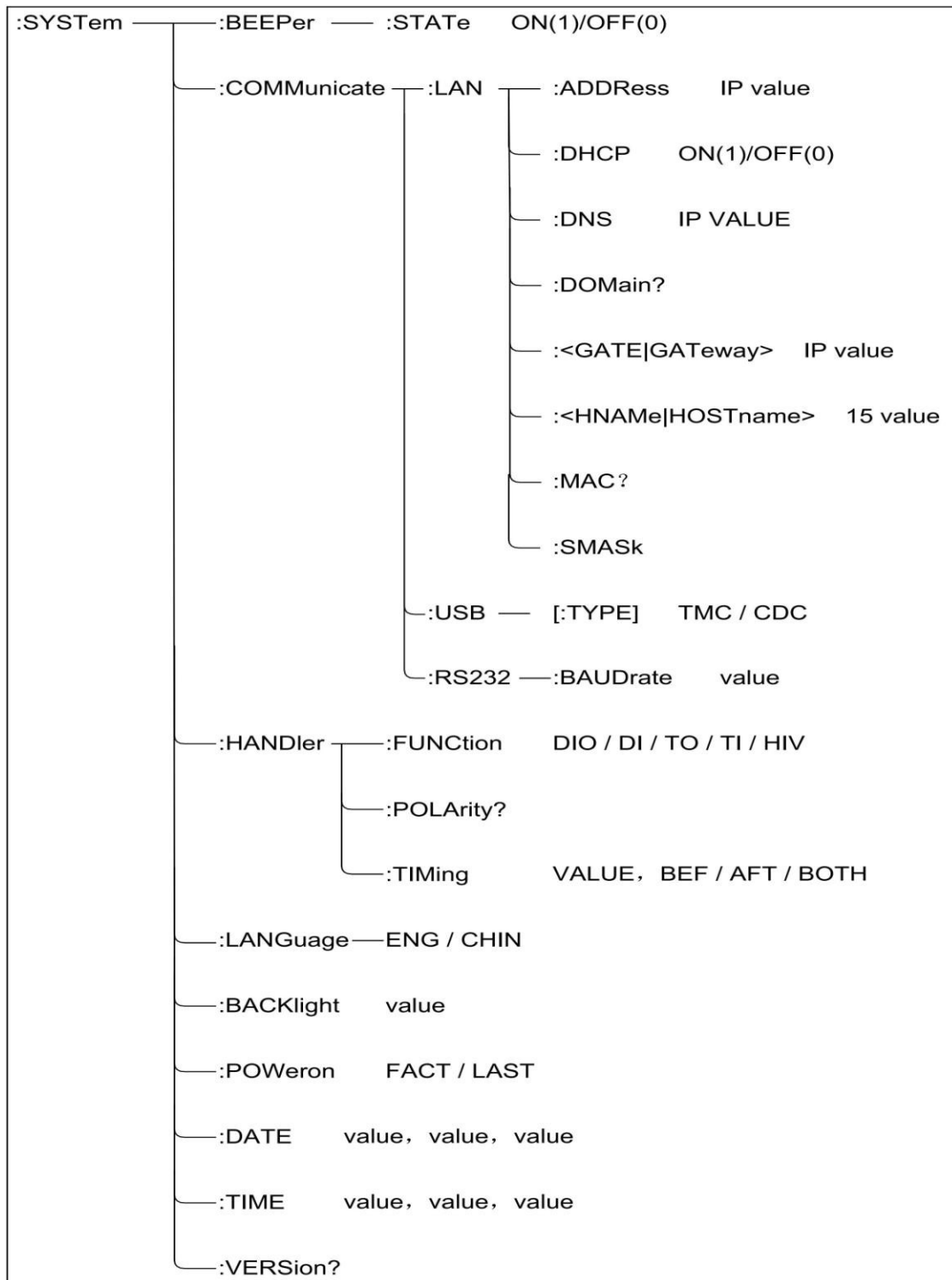


Figure 6-9 SYSTem Subsystem Command Tree

#### 6.4.8.1 :SYSTem:BEEPer:STATe

This command is to enable or disable the buzzer, and the command setting will not be changed by power off or "RST" command.

Set statement:

:SYSTem:BEEPer:STATe <mode>

Set **content**: <mode> 1 / ON / 0 / OFF, and the parameter data type is Bool.

Query statement:

:SYSTem:BEEPer:STATe?

Query response: <mode> <NL>

**Specific response:** Returns the current state 0 or 1 of the buzzer, and the response data type is NR1.

#### 6.4.8.2 :SYSTem:COMMunicate:LAN:ADDRes

This command is to set the static LAN (IP) address of the instrument, and the command setting will not be changed by power off or "RST" command.

Set statement:

:SYSTem:COMMunicate:LAN:ADDRes <address>

Set content: <address> "A.B.C.D" format, separated by ".", the values of A, B, C and D must be numbers between 0 and 255 with at most 15 characters, and the parameter data type is SPD.

Query statement:

:SYSTem:COMMunicate:LAN:ADDRes?

Query response: <address> <NL>

**Specific response:** <address> Returns the static LAN (IP) address of the instrument, and the response data type is SRD.

#### 6.4.8.3 :SYSTem:COMMunicate:LAN:DHCP

This command is to enable or disable the Dynamic Host Configuration Protocol (DHCP), and the command setting will not be changed by power off or "RST" command.

Setup statement:

:SYSTem:COMMunicate:LAN:DHCP <mode>

Set content: <mode> 1 / ON / 0 / OFF, and the parameter data type is Bool.

- Mode is 0 or OFF indicating that DHCP is disabled, and the instrument will use the static IP address, subnet mask, and default gateway at power-up.
- Mode is 1 or ON indicating that DHCP is enabled, and the instrument will attempt to obtain the IP address from the DHCP server. When the DHCP connects to the instrument, it will assign the dynamic IP address, subnet



mask, and default gateway to the instrument; if no address is assigned, the static IP address, subnet mask, and default gateway will be used after about 2 minutes.

Query statement:

:SYSTem:COMMunicate:LAN:DHCP?

Query response: <mode> <NL>

**Specific response:** <mode> Returns the current state 0 or 1 of DHCP, and the response data type is NR1.

#### 6.4.8.4 :SYSTem:COMMunicate:LAN:DNS

This command is to set the IP address of the DNS server, and the command setting will not be changed by power off or "RST" command.

Setup statement:

:SYSTem:COMMunicate:LAN:DNS[c] <address>

**✖Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <address> "A.B.C.D" format, separated by ".", the values of A, B, C and D must be numbers between 0 and 255 with at most 15 characters, and the parameter data type is SPD.

Query statement:

:SYSTem:COMMunicate:LAN:DNS[c]?

Query response: <address> <NL>

**Specific response:** <address> Returns the IP address of the DNS server, and the response data type is SRD.

#### 6.4.8.5 SYSTem:COMMunicate:LAN:DOMain?

This command is to return the domain name of the network where the instrument is connected.

Query response: <domain\_name> <NL>

**Specific response:** <domain\_name> Returns the domain name of the instrument that is currently connected to the network, and the response data type is SRD.

#### 6.4.8.6 :SYSTem:COMMunicate:LAN:<GATE|GATeway>

This command is to set the IP address of the default gateway, and the command setting will not be changed by power off or "RST" command.

Set statement:

:SYSTem:COMMunicate:LAN:<GATE|GATeway> <address>

Set content: <address> "A.B.C.D" format, separated by ".", the values of A, B, C and D must be numbers between 0 and 255 with at most 15 characters, and the parameter data type is SPD.

Query statement:

:SYSTem:COMMunicate:LAN:<GATE|GATeway>?

Query response: <address> <NL>

**Specific response:** <address> Returns the IP address of the default gateway, and the response data type is SRD.

#### 6.4.8.7 :SYSTem:COMMunicate:LAN:<HNAME|HOSTname>

This command is to set the host name of the instrument, and the command setting will not be changed by power off or "RST" command.

Set statement:

:SYSTem:COMMunicate:LAN:<HNAME|HOSTname> <hostname>

Set content: <hostname> is up to 15 characters, and the parameter datatype is SPD.

Query statement:

:SYSTem:COMMunicate:LAN:<HNAME|HOSTname>?

Query response: <hostname> <NL>

**Specific response:** <hostname> Returns the host name of the instrument, and the response data type is SRD.

#### 6.4.8.8 SYSTem:COMMunicate:LAN:MAC?

This command is the MAC address of the instrument.

Query response: <mac\_address> <NL>

**Specific response:** <mac\_address> Returns the MAC current address of the instrument, and the response data type is SRD.

#### 6.4.8.9 :SYSTem:COMMunicate:LAN:SMASK

This command is to set the static subnet mask, and the command setting will not be changed by power off or "RST" command.

Set statement:

:SYSTem:COMMunicate:LAN:SMASk <subnet\_mask>

Set content: <address> "A.B.C.D" format, separated by ".", the values of A, B, C and D must be numbers between 0 and 255 with at most 15 characters, and the parameter data type is SPD.

Query statement:

:SYSTem:COMMunicate:LAN:SMASk?

Query response: <subnet\_mask> <NL>

**Specific response:** <subnet\_mask> Returns the subnet mask, and the response data type is SRD.

#### 6.4.8.10 :SYSTem:COMMunicate:RS232:BAUDrate

This command is to set the baud rate of RS232.

Set statement:

:SYSTem:COMMunicate:RS232:BAUDrate <baudrate>

Set content: <baudrate> 4800 / 9600 / 19200 / 38400 / 115200, and the parameter data type is NR1.

Query statement:

:SYSTem:COMMunicate:RS232:BAUDrate?

Query response: <baudrate> <NL>

**Specific response:** <baudrate> Returns the current setting 4800, 9600, 19200, 38400, or 115200 of the baud rate, and the response data type is NR1.

#### 6.4.8.11 :SYSTem:COMMunicate:USB[:TYPE]

This command is to set the USB communication type.

Set statement:

:SYSTem:COMMunicate:USB[:TYPE] <type>

Set content: <type> TMC / CDC, and the parameter data type is CPD.

Query statement:

:SYSTem:COMMunicate:USB:TYPE?

Query response: <type> <NL>

**Specific response:** <type> Returns the current setting TMC or CDC of the USB communication type, the response data type is CRD.

#### 6.4.8.12 :SYSTem:HANDler:FUNCTION

This command is to set the function of the Handler specified pin.

Set statement:

:SYSTem:HANDler:FUNCTION <pin>,<function>

Set content: <pin> 1~14, <function> DIO (digital signal input/output) / DI (digital signal input) / TO (trigger output) / TI (trigger input) / HV (high voltage status output), and the parameter data type is CPD.

Query statement:

:SYSTem:HANDler:FUNCTION? <pin>

Query response: <function> <NL>

**Specific response:** <function> Returns the function DIO, DI, TO, TI, or HV of the specified pin, and the response data type is CRD.

#### 6.4.8.13 :SYSTem:HANDler:POLArity

This command is to set the polarity of the Handler specified pin.

Set statement:

:SYSTem:HANDler:POLArity <pin>,<polarity>

Set content: <pin> EXT1~14, <polarity> NEGative (negative) / 0 / POSitive (positive) / 1, and the parameter data type is CPD.

Query statement:

:SYSTem:HANDler:POLArity? <pin>

Query response: <polarity> Returns the polarity 0 or 1 of the specified pin, and the response data type is NR1.

#### 6.4.8.14 :SYSTem:HANDler:TIMing

This command is to set the trigger timing of the Handler specified pin.

Set statement:

:SYSTem:HANDler:TIMing <pin>,<timing>

Set content: <pin> EXT1~14, <timing> BEFore / AFTEr / BOTH, and the parameter data type is CPD.

- timing is BEFore, indicating that triggering is initiated at the start of ARM layer, trigger layer and instrumentation operations.
- timing is AFTEr, indicating that triggering is initiated at the end of ARM layer, trigger layer and instrumentation operations.
- timing is BOTH, indicating that triggering is initiated at the start and end of ARM layer, trigger layer, and instrumentation operations.

Query statement: :SYSTem:HANDler:TIMing? <pin>

Query response: <timing> <NL>

**Specific response:** <timing> Returns the trigger timing BEFore, AFTEr or BOTH of the specified pin, and the response data type is CRD.

#### 6.4.8.15 :SYSTem:LANGuage

This command is to select the language of the instrument.

Set statement:

:SYSTem:LANGuage <language>

Set content: <language> ENGLISH, and the parameter data type is CPD.

Query statement:

:SYSTem:LANGuage?

Query response: <language> <NL>

**Specific response:** <language> Returns the current setting ENGLISH of the instrument language, and the response data type is CRD.

#### 6.4.8.16 :SYSTem:BACKlight

This command is to set the percentage of the background light brightness of the display surface.

Set statement:

:SYSTem:BACKlight <percent>

Set content: <percent> 50~100, and the parameter data type is NR1.

Query statement:

:SYSTem:BACKlight?

Query response: <percent> <NL>

**Specific response:** <percent> Returns the current setting of the instrument brightness percentage, and the response data type is NR1.

#### 6.4.8.17 :SYSTem:POWeron

This command is to set the state when the power is on.

Set statement:

:SYSTem:POWeron <status>

Set content: <status> FACTory / LAST, and the parameter data type is CPD.

Query statement:

:SYSTem:POWeron?

Query response: <status> <NL>

**Specific response:** <status> Returns the current setting of the status when the power is on, and the response data type is CRD.

#### 6.4.8.18 SYSTem:DATE

This command is to set the date of the internal clock, and the command setting will not be changed by power off or "RST" command.

Set statement: SYSTem:DATE <year>,<month>,<day>

Set content: <year> 4-bit integer; <month> integer from 1 to 12. <day> integer from 1 to 31. The parameter data type is NR1.

Query statement: SYSTem:DATE?

Query response: <response> <NL>

**Specific response:** <response> Returns the current settings for the year, month, and

day, with each value separated by the comma, and the response data type is NR1.

#### 6.4.8.19 SYSTem:TIME

This command is to set the time of the instrument internal clock, and the command setting will not be changed by power off or "RST" command.

Set statement: SYSTem:TIME <hour>,<minute>,<second>

Set content: <hour> integer from 0 to 23; <minute> integer from 0 to 59; <second> integer from 0 to 59. The parameter data type is NR1.

Query statement: SYSTem:TIME?

Query response: <response> <NL>

**Specific response:** Returns the current setting of the internal clock hours, minutes, and seconds, with each value separated by the comma. The response data type is NR1.

#### 6.4.8.20 SYSTem:VERsion?

This command is to return the SCPI standard version, and the command setting will not be changed by power off or "RST" command.

Query response: <response> <NL>

**Specific response:** <response> Returns the SCPI standard version, and the response data type is NR2.

### 6.4.9 TRIGger Subsystem Command

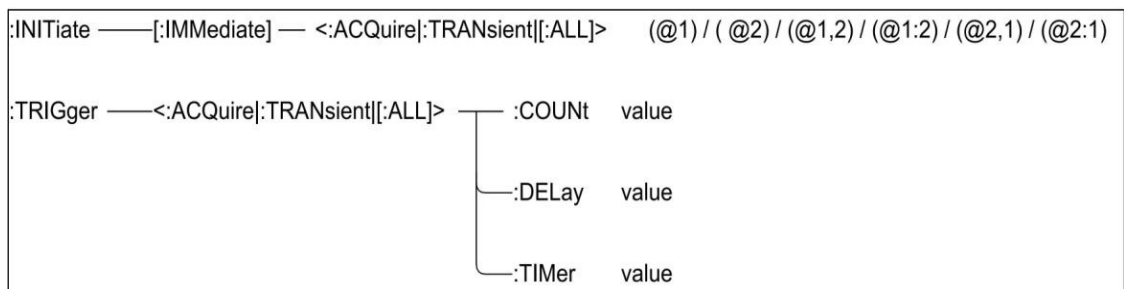


Figure 6-10 TRIGger Subsystem Command Tree

#### 6.4.9.1 :INITiate[:IMMEDIATE]<:ACQUIRE:TRANSient[:ALL]>

This command is to start the specified device operation of the specified channel, and the trigger status is changed from idle to started.

Set statement:

:INITiate[:IMMEDIATE]<:ACQUIRE:TRANSient[:ALL]> [chanlist]

Set content: <chanlist> (@1) (default) / (@2) / (@1,2) / (@1:2) / (@2,1) / (@2:1), and the parameter data type is Expr.

✖**Note:** ACQuire is used for measurement and TRANsient is used for source output.

#### 6.4.9.2 :TRIGger<:ACQuire|:TRANsient|[:ALL]>:COUNT

This command is to set the trigger count of the specified device operation.

Set statement:

:TRIGger[c]<:ACQuire|:TRANsient|[:ALL]>:COUNT <trigger\_count>

✖**Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <trigger\_count> value (1~100000) (default value is 1), and the parameter data type is NRf.

✖**Note:** Arm count×Trigger<100001 The inequality must hold.

✖**Note:** ACQuire is used for measurement and TRANsient is used for source output.

Query statement: TRIGger[c]<:ACQuire|:TRANsient|[:ALL]>:COUNT?

Query response: <response> <NL>

**Specific response:** <response> Returns the current setting of the trigger number, and the response data type is NR1.

#### 6.4.9.3 TRIGger<:ACQuire|:TRANsient|[:ALL]>:DELAy

This command is to set the trigger delay of the device operation.

Set statement: TRIGger[c]<:ACQuire|:TRANsient|[:ALL]>:DELAy<delay>

✖**Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <delay> value (0s~100s) (default value is 0), value is set to the number with s in unit, but the unit is not set in the command statement, and the parameter data type is NRf.

✖**Note:** ACQuire is used for measurement and TRANsient is used for source output.

Query statement: TRIGger[c]<:ACQuire|:TRANsient|[:ALL]>:DELAy?

Query response: <response> <NL>

**Specific response:** <response> Returns the current setting of the trigger delay, and the response data type is NR3.

#### 6.4.9.4 TRIGger<:ACQuire|:TRANsient|[:ALL]>:TIMer

This command is to set the time interval of the TIMer trigger source for the specified device operation.

Set statement: TRIGger[c]<:ACQuire|:TRANsient|[:ALL]>:TIMer<interval>

✖**Note:** c is 1 or 2, representing channel 1 or channel 2 respectively, but when [c] is not selected, the default is channel 1.

Set content: <interval> value (1E-5s ~ 1E+5s) (default is 1E-5), value is set to the number with s in unit, but the unit is not set in the command statement, and the parameter data type is NRf.

Query statement: TRIGger[c]<:ACQuire|:TRANSient|[:ALL]>:TIMer?

Query response: <response> <NL>

**Specific response:** <response> Returns the current setting of the time interval, and the response data type is NR3.

#### 6.4.10 Public Commands

This instrument currently only offer the following common commands:

##### 6.1.10.1 \*RST

This command is used to reset the instrument.

Set statement: \*RST

##### 6.1.10.2 \*TRG

This command is used to trigger the instrument measurement and write the measurement result into the output buffer. Namely equivalent to TRIG +FETCh? command.

Set statement: \*TRG

On the non-measurement page, the trigger is ignored, and the instrument returns the measurement result of "9.9E37,9.9E37".

##### 6.1.10.3 \*IDN?

This command is used to query the instrument information.

Query statement: \*IDN?

Query response: <product>,<version> <NL^END>

Specific response: <product> SMU5991 Precision Source/Measure Unit  
or SMU5992 Precision Source/Measure Unit <version> Software version number

##### 6.4.10.4 \*OPC

This command is to start monitoring the pending operation and set/clear the operation complete bit in the standard event status register, as shown below:

- If there is no pending operation, the OPC bit is set to bit 1.
- If there is a pending operation, the OPC bit will be set to 0; when all pending operations are completed, this bit will be set to 1 again.

Set statement: \*OPC

Query statement: OPC?



**Specific response:** Returns the current state 0 or 1 of the operation, and the response data type is NR1.

## 6.5 Error Information

The bus commands sent to the instrument may contain incorrect commands or syntax, or incorrect parameters. The instrument executes the command string while analyzing it. If the error is encountered, the error message is displayed and the command analysis is aborted, thus the content after the error in the command string is ignored by the instrument.

The following is the table of common error messages on the bus. The error messages will be shown in the pop-up window on the display.

Error Message	Description Explain
Unknow Message!	Unknown messages, i.e. unrecognized commands (Examples of command statements, command spelling errors, command omissions, forgetfulness of numeric suffixes, etc.)
Syntax Error!	Grammatical errors, misspelled, overwritten, or omitted grammatical symbols
Data Error!	Data errors, value overruns or unsupported values
Error Parameter.	Parameter error, unrecognized command parameter (Examples of nominal value setting without attached units, types of measurement parameters that is not supported by the instrument, etc.)
Error Suffix.	Suffix errors, usually mismatched units, multipliers, etc.
Data Too Long!	The number of data characters is not specified (Examples of numeric parameters over 20 characters, filename over 18 characters)
Cannot Executed!	Unable to execute, commands that cannot be executed in the current state (Examples of cannot execute the FETCh command when the READ command is used)
Record Not Exist!	The record does not exist, and the file record to be loaded does not exist.

Table 6-4 Common Error Messages

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## Chapter 7 Dispatch procedure for service, E-Waste Management and Warranty

### 7.1 Dispatch procedure for service

No user serviceable parts are inside the instrument, should it become necessary to send back the instrument to factory for service, please observe the following procedure:

Before dispatching the instrument please write to us at following link giving full details of the fault noticed. <https://www.scientificindia.com/services-support/service-request>

1. After receipt of your communication, our service department will advise you whether it is necessary to send the instrument back to us for repairs or the adjustment is possible in your premises.
2. Dispatch the instrument (only on the receipt of our advice) securely packed in original packing duly insured and freight paid along with accessories and a copy of the fault details noticed at our Service Center or factory.

### 7.2 E-Waste

We support environmentally sustainable measures and solicit your cooperation in this endeavor by way of sending the equipment to us at the end of the life of the product. The equipment will be sent for recycling through authorised recyclers as per E-Waste Management Rules. Please write to us at [support@scientificindia.com](mailto:support@scientificindia.com) for this purpose. Your support will go a long way as each and everybody's action can lead to improve global environment.

### 7.3 Warranty

Scientific warrants all its Instruments to be free from defects in material and workmanship when used under normal operating conditions in accordance with the instructions given in the manual for a period of 12 (Twelve) months from date of purchase from Scientific or its authorized dealers. The service during the warranty period will be rendered on return to factory / service center basis.

1. Its obligation under this warranty is limited to repairing or replacing at its own discretion. This warranty shall not apply to any defect, failure or damage caused by accident, negligence, misapplication, alteration or attempt to repair, service or modify in any way.
2. This warranty does not include display, fuses, batteries or accessories. This warranty is only valid with the original purchaser who must have properly registered the product within 15 days from date of purchase. No other warranty is expressed or implied.
3. When it becomes necessary to return the instrument to our Factory facility, kindly pack it carefully in the original carton or equivalent and ship it duly insured, transportation charges prepaid.
4. Your Scientific instrument is a complex electronic device and deserves the best service available by technicians thoroughly familiar with its service and calibration procedures.