User Manual

PA300 User Manual

PA300 Series Power Meters

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Type	Content
Keyword	PA300 Series Power Meters
Abstract	Describe how to use PA300 series power meters

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Revision History

版本	日期	原因
V1.01	2014/11/25	Revision
V1.02	2015/07/28	Added PA333H model
V1.03	2015/10/12	Added 1000V range
V1.04	2015/11/9	Corrected the range parameters of PA333H current sensor
V1.05	2016/3/29	Revised and added PA310H and PA323, and deleted PA333
V1.06	2017/4/26	Content revision
V1.07	2018/08/06	Revised and improved the mechanical dimension drawing
V1.08	2018/12/24	Added independent settings of PA323 and PA333H three-phase power measurement range
V1.09	2019/03/01	Updated the document header and footer, "Sales & Service Network" content and "Disclaimer" content
V1.10	2021/02/24	Updated the document header and footer, "Sales & Service Network" content and "Disclaimer" content

Contents

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1. Safety Instructions

The use of this instrument involves high voltage. In order to prevent death and injury caused by electric shock or other hazards, please carefully read and fully understand the relevant contents in the section of "Safety Instructions" before installing, using or maintaining this product.

To ensure that you can use the instrument correctly and safely, please be sure to follow the following instructions. If the instrument is not operated in accordance with the method specified in this manual, the protective function of the instrument may be damaged. Guangzhou Zhiyuan Electronics Co., Ltd. shall not be liable for any damage caused by operating the instrument in violation of the following instructions.

1.1 Warning Signs

Caution

The **Caution** symbol indicates danger. It prompts the user that if the rules are not performed or followed correctly when operating a process, operation method or similar situation, the product may be damaged or important data may be lost. Do not proceed until you have fully read and understood the matters required by **Caution**.

Warning

The **Warning** symbol indicates critical danger. It prompts the user that if the rules are not performed or followed correctly when operating a process, operation method or similar situation, it may result in personal injury or even death. Do not proceed until you have fully read and understood the matters required by **Warning**.

1.2 Security Information

Do not disable the safe grounding function of the power cord. Insert the instrument into a well-grounded power socket.

Do not use the instrument in a way other than specified in this manual.

In case of a failure, please do not replace parts or adjust the product without authorization. You should contact Guangzhou Zhiyuan Electronics Co., Ltd. for processing.

The safety symbols of the power meter are shown in Table 1.1.

Table 1.1 Safety symbol

	Caution, Danger		**CE certification**		**Ground terminal**
	Caution, electric shock		**Do not throw used batteries into the trash can**		**Recyclable**

PA310 and PA323

CAT Ⅱ (600V) IEC measurement category Ⅱ, the input can be connected to the power supply (max 600VAC) belonging to category Ⅱ overvoltage conditions.

PA310H and PA333H

CAT Ⅱ (1000V) IEC measurement category Ⅱ, the input can be connected to the power supply (max 1000VAC) belonging to category Ⅱ overvoltage conditions.

1.2.1 Measurement Category

Measurement Category IV Suitable for measurements performed at the source of the low-voltage installation.

- Examples are electricity meters and measurements on primary overcurrent protection devices and ripple control units, overhead lines, cable systems, etc.

Measurement Category III Suitable for measurements performed in the building installation.

- Examples are measurements on distribution boards, circuit-breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and equipment for industrial use and some other equipment, for example, stationary motors with permanent connection to the fixed installation.

Measurement Category II Suitable for measurements performed on circuits directly connected to the low voltage installation.

- Examples are measurements on household appliances, portable tools and similar equipment.

Measurement Category 0 Suitable for measurements performed on circuits not directly connected to mains.

- Examples are measurements on circuits not derived from mains, and specially protected (internal) mains-derived circuits. In the latter case, the transient stress is not the same. When the instrument is used for this type of measurement, please ensure that the transient voltage is ≤3000V peak value.

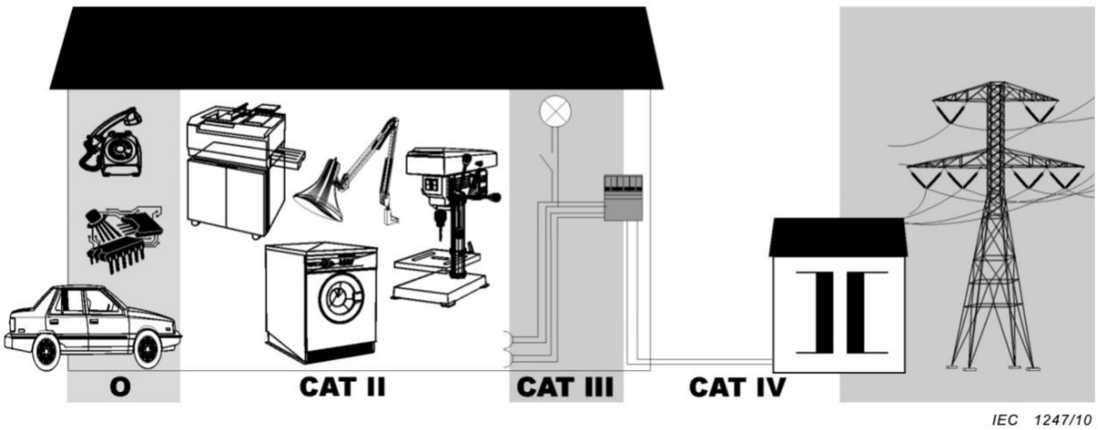

Figure 1.1 CAT rating chart

1.2.2 General Notes

For personal safety and equipment protection, the precautions are listed as follows:

- **The protection function fails.** Before using the instrument, please confirm the protection function. If the protective ground or fuse is found to be defective, please do not continue to use the instrument;
- **Do not disassemble the instrument chassis.** The high voltage in the instrument is very dangerous. For internal inspection and debugging of the instrument, please consult Guangzhou Zhiyuan Electronics Co., Ltd.;
- **When there is a peculiar smell or smoke.** When there is an abnormal situation such as smoke or peculiar smell, please turn off the power directly, unplug the power plug from the socket, and cut off the power supply of the measurement circuit connected to the input terminal.
- **Do not operate the instrument in a flammable environment.** Do not use this instrument in

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an environment containing flammable and explosive liquids or gases.

- **Do not damage the power cord.** Do not place objects on the power cord, and keep the power cord away from heat sources. When unplugging the power plug from the socket, do not pull the wire, but pull the plug by hand. If the power cord is damaged, please confirm the part number before ordering from the dealer;
- **Do not approach live objects.** Do not bring live objects close to the input terminals, otherwise the internal circuit will be damaged;
- **Cut off the power supply.** When the instrument will be out of use for a long time, please cut off the power supply of measurement circuit and instrument and unplug the power plug of the instrument from the socket.

- **Do not place objects on the instrument.** Do not stack the instrument or place other instruments or water containers on the instrument, otherwise it may cause malfunction;
- **Do not operate the instrument in humid environment.** In order to avoid the risk of short circuit or electric shock inside the instrument, do not operate the instrument in a humid environment;
- **When handling the instrument.** First, cut off the power supply of the measurement circuit and remove the measurement cable. Next, turn off the power switch of the instrument and remove the power cord and other cables. When handling, pay attention to holding the handle with both hands;
- **During measurement operations.** Before measurement, the measured signal must be disconnected for wiring; during measurement, the instrument must be far away from the measured signal and the instrument terminal; after measurement, the measured signal must be disconnected first before the instrument is turned off.
- **When cleaning stains.** When cleaning the stains on the chassis and operation panel, please cut off the power supply of the measurement circuit and the instrument, unplug the power plug of the instrument from the socket, and wipe gently with a clean soft dry cloth. Do not use volatile chemicals, which may cause discoloration or deformation.

1.2.3 Power Supply Connection and Grounding

- **Use the correct power supply.** Before connecting the power cord, please ensure that the supply voltage is consistent with the rated voltage and is less than the maximum rated voltage of the power cord.
- **Use the correct power cord and power plug.** To prevent electric shock and fire, please use the power cord provided by the company. Be sure to connect the main power plug into the power socket with protective ground. Do not use a terminal board without protective ground.
- **Connect the protective ground terminal.** To prevent electric shock, be sure to connect the protective ground terminal before turning on the power. The power cord provided with the instrument is a three-core power cord with ground wire. Therefore, please use a three-hole socket with a protective ground terminal.
- **Adopt protective ground.** Do not cut off the internal and external protective ground wire of the instrument, or pull out the wire of the protective ground terminal, otherwise there will be a potential risk of electric shock.

1.2.4 Precautions for Instrument Placement

The precautions related to the instrument placement site are as follows:

- **Keep away from harsh environments.** Keep away from direct sunlight, heat sources, large amount of smoke, steam, corrosive or flammable gases, strong magnetic field sources, high-voltage equipment and power lines, water, oil, and chemical agents;
- **Level and flat ground.** Please place the instrument in a level and flat place. If the use place is not level or flat, it may affect the measurement precision;
- **Good ventilation.** Both the upper cover and the bottom of the instrument have vent holes. In order to prevent the internal temperature from being too high, the distance between the vent holes and the placement surface should be set above 20mm. When connecting the test line or various cables, please reserve the necessary space for operation additionally;
- **Ambient temperature and humidity.** Ambient temperature: 5~40 ℃, ambient humidity: 20~80%RH.

1.2.5 Measurement Circuit Connection

In order to prevent electric shock and damage to the instrument, the following precautions must be observed when connecting the measurement circuit:

- **Adopt protective ground.** Before connecting the measurement cable, please adopt protective ground for the instrument. The power cord provided with the instrument is a three-pin plug, so please use a three-core power cord with ground wire. If you intend to touch the circuit by hand, please turn off the power supply of the circuit and confirm that no voltage exists before operation;
- **Cut off the power supply of circuit.** Please cut off the power supply of the measurement circuit before connecting the measurement circuit. It is dangerous to connect or remove the measurement cable without cutting off the power supply;
- **Ensure correct measurement circuit connection.** Do not connect the current circuit to the voltage input terminal or the voltage circuit to the current input terminal;
- **Prevent electric shock from cables.** When stripping the insulation of the measurement cable, make sure that the wire (bare wire) connected to the input terminal is not exposed to the terminal. At the same time, please fix the screws of the input terminal to ensure that the connected cable will not fall off from the input terminal;
- **Do not touch the input port.** Do not touch the input port of the current sensor when the voltage of the measurement circuit is introduced into the current input terminal. These ports are dangerous because they are electrically connected inside the instrument;
- **Ensure sufficient voltage endurance capability of voltage transformer and current transformer.** When using a potential transformer (PT) or current transformer (CT) externally, please make sure that it has sufficient voltage endurance capability to the measured voltage (U). In addition, make sure that the secondary side of the CT is short-circuited when the power is on. Otherwise, the secondary side of the CT can produce dangerous high voltage;
- **Set a power cut-off switch if a rack is used for fixing.** When a rack is used for fixing the instrument, to ensure safety, please set a switch in front of the rack that can cut off the power supply of the measurement circuit of the instrument.

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警告

If the test accessories are not used in the manner specified by Guangzhou Zhiyuan Electronics Co., Ltd., the protective function provided by the test accessories will be weakened. In addition, damaged or worn test accessories may cause instrument damage or personal injury, please do not use it.

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2. Product Introduction

2.1 Introduction

With the continuous introduction of new energy efficiency standards, many companies are engaged in fierce competition on how to improve energy-saving performance in the development and production of household appliances represented by white goods and industrial equipment represented by large-scale air conditioners. This requires that the power measuring instrument used to evaluate the energy-saving performance of the equipment should have the characteristics of high-precision, ultra-low standby power consumption measurement, etc.

According to the number of channels, PA300 series high-precision power meters include models PA310/PA310H (single channel) and PA323/PA333H (three channels), with a power measurement precision of 0.1%, which can meet the measurement needs of users from small current[Note] of 5mA to large current of 50A; and adopt DSP + FPGA dual-core processing architecture to quickly and accurately calculate the harmonic parameters of the signal. It is also equipped with GPIB, USB, Ethernet and other interfaces to meet the different test communication needs of users.

Note: The minimum current range is 5mA for PA310, 500mA for PA323, and 1A for PA310H/PA333H.

Figure 2.1 PA310 series high-precision power meters

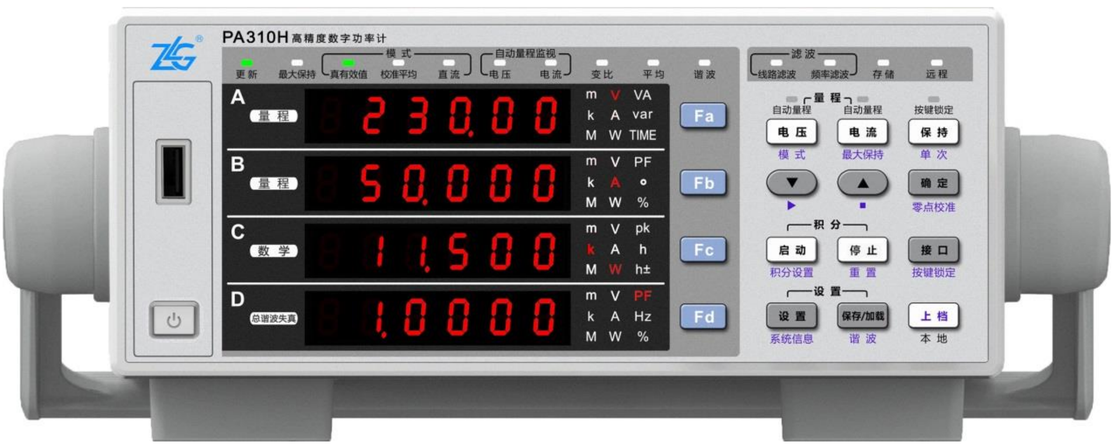

Figure 2.2 PA310H series high-precision power meters

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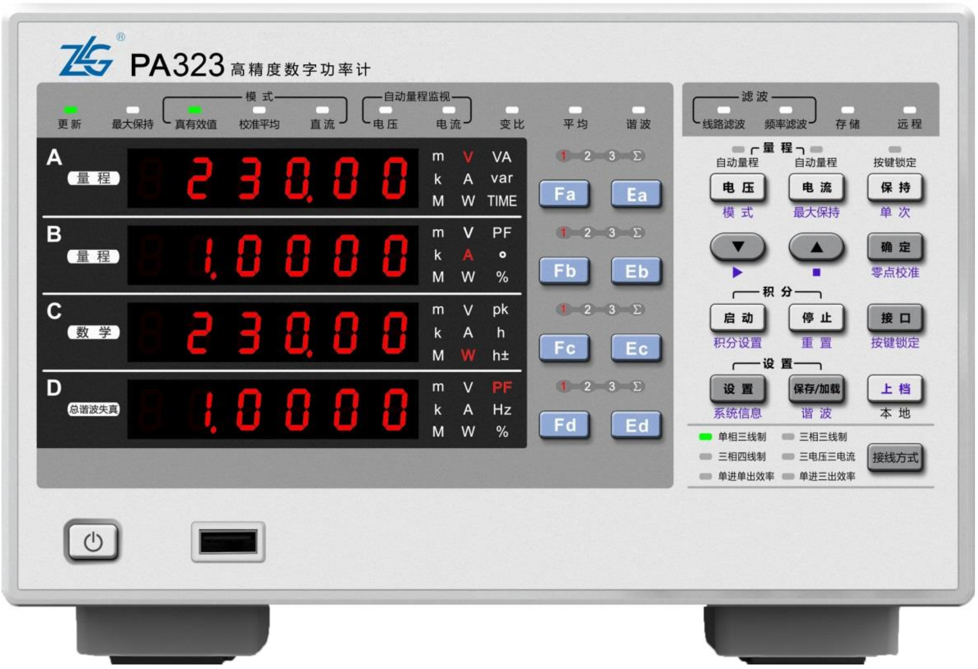

Figure 2.3 PA323 series high-precision power meters

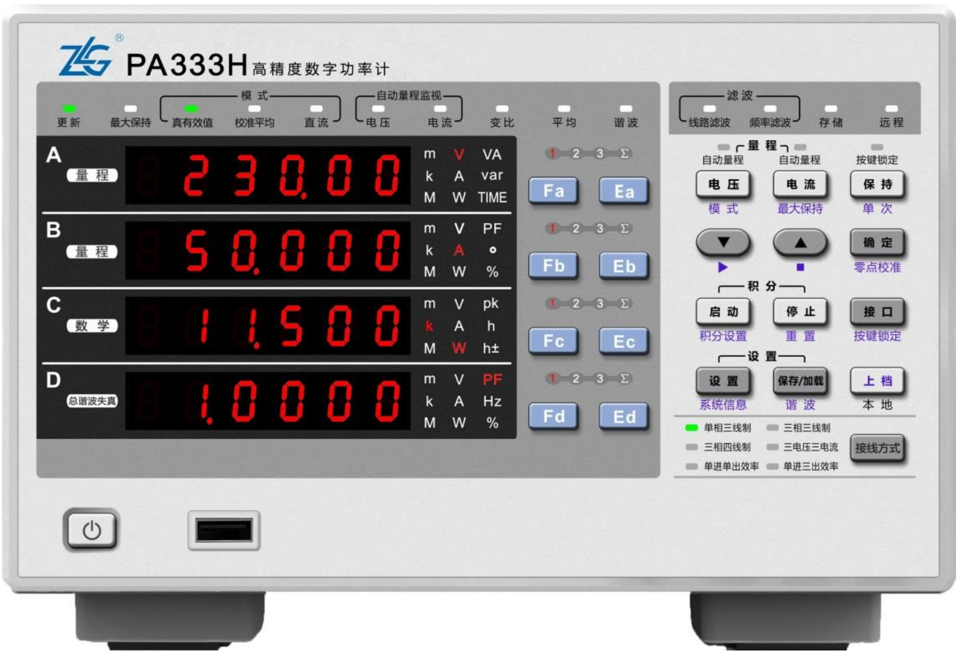

Figure 2.4 PA333H series high-precision power meters

PA300 series high-precision power meters are suitable for power measurement from the production line to the research and development field:

- Can be used for DC,1P2W, 3P4W measurement;
- Can be used for household appliances such as air conditioners and induction cookers;
- Can be used for office equipment such as monitors and printers;
- Can be used for energy equipment such as LEDs, power supplies, and batteries;
- Can be used to evaluate the energy-saving performance of industrial equipment such as inverters and large air conditioners.

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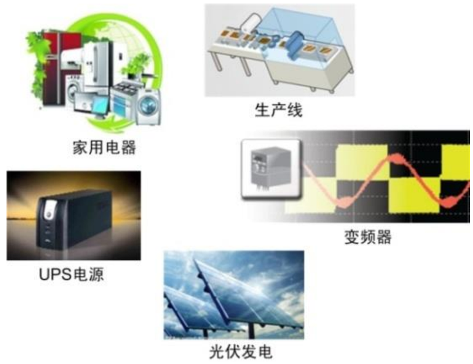
2.2 Functional Characteristics



The main functional characteristics of PA300 series high-precision power meters are as follows:

- **Basic power parameter measurement.** It can measure voltage, current, power, power factor and other basic power parameters, as well as AC and DC signals;
- **Harmonic measurement function (standard).** It supports IEC61000-4-7 harmonic measurement, can analyze the harmonic content in the signal, such as voltage, current, power, phase angle, etc., and can display harmonic measurement results up to 50 times;
- **Integral measurement.** It can calculate Ah, Ah+, Ah-, Wh, Wh+, Wh-, average integral active power, integrator time parameters, and can set continuous integral mode or normal integral mode;
- **Auto range function.** It can automatically select or change the range within the specified ranges;
- **USB Hot interface (standard).** It can be connected to external mobile storage such as U disk to store voltage, current, power, harmonics and other data for a long time, and can import/export the configuration parameters of the instrument;
- **All Chinese key operation and display;**
- **Filter function.** It has LINE and FREQ functions and built-in digital filters of 5.5kHz, 9kHz and 10kHz, so as to suppress unwanted noise and harmonic components during fundamental wave measurement;
- **Power meter PC-side analysis software.** The software can be used to remotely control and set up PA300 series high-precision power meters, acquire, display, analyze and save the measured values, harmonics and waveform data, etc.;
- **MAX HOLD function**. The values include RMS/PEAK value of voltage and current, active power P, reactive power Q and apparent power S;
- **High-level power measurement precision:** 0.1%; the power, harmonics, integral and other values of the power meter are the results of calculations after the data acquisition of voltage and current. The power measurement precision of the power meter directly affects the precision of these measurement results;
- **Sampling frequency:** The sampling frequency of PA310/PA310H is 500kS/s, and of PA323/PA333H is 200kS/s;
- Bandwidth: The bandwidth DC of PA310, PA310H, PA333H is 0.1Hz~300kHz, and of PA323 is 0.1Hz~100kHz;
- **50μA low current measurement**, which can accurately measure the standby power consumption of household appliances;
- **Wide current sensor input range:** 50mV~10V, which is compatible with more sensors, and very suitable for power consumption measurement of intermittently operating equipment;
- **Wide current input range:** 5mA~20A, with super-current measurement of up to 50A;
- **Up to 100ms of data update rate.** The PA300 series high-precision power meters can freely change the data refresh rate: 100ms, 250ms, 500ms, 1s, 2s, 5s, 10s, 20s, Auto, to meet the measurement requirements of different frequency signals.

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2.3 Application System

The application system diagram of PA300 series high-precision power meters is as shown in

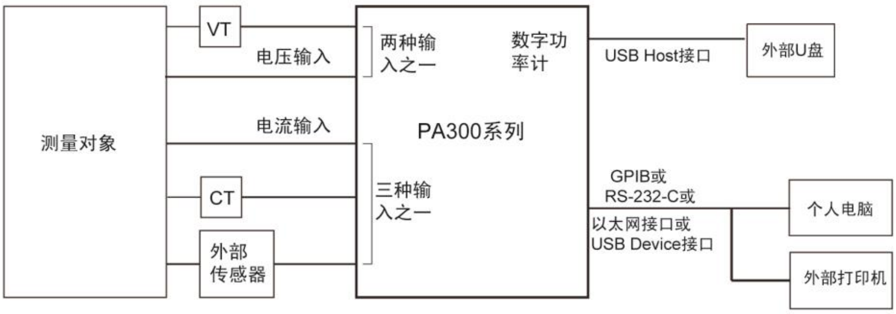

Figure 2.5 Application system diagram

2.4 Product Selection

PA300 series high-precision power meters include PA310, PA310H, PA323, and PA333H, as shown in Table 2.1.

Table 2.1 Product selection

Model		PA310	PA310H	PA323	PA333H
Input channel		1	1	3	3
Basic power precision (50/60Hz)		**0.1% reading+0.05% range**			
Bandwidth		DC，0.1Hz ~ 300kHz	DC，0.1Hz~300kHz	DC，0.1Hz ~ 100kHz	DC，0.1Hz ~ 300kHz
Sampling rate		500kS/s		200kS/s	
Current range (Peak factor of 3)	Direct input	5mA, 10mA, 20mA, 50mA, 100mA, 200mA, 0.5A, 1A, 2A, 5A, 10A, 20A	1A, 2A, 5A, 10A, 20A, 50A	0.5A, 1A, 2A, 5A, 10A, 20A	1A, 2A, 5A, 10A, 20A, 50A
	External current Sensor input	50mV ~ 10V	100mV ~ 10V	50mV ~ 10V	100mV ~ 10V
Maximum display value of voltage and current (Peak factor of 3)		0.5%~ 140%	0.5% ~ 140% 50A range: 0.5% ~ 100%	0.5% ~ 140%	0.5% ~ 140% 50A range: 0.5% ~ 100%
Number of displayed items		Four values displayed simultaneously	Four values displayed simultaneously	Four values displayed simultaneously	Four values displayed simultaneously
Harmonics measurement		IEC61000-4-7 (standard)	IEC61000-4-7 (standard)	IEC61000-4-7 (standard)	IEC61000-4-7 (standard)
Set the maximum analysis times for THD calculation		1-50 times	1-50 times	1-50 times	1-50 times
Efficiency measurement		No	No	Yes	Yes

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Continued

Model		PA310	PA310H	PA323	PA333H
Integral measurement and automatic range in integral mode		Yes	Yes	Yes	Yes
Communication interface	USB-Host	Standard	Standard	Standard	Standard
	GPIB				
	RS-232				
	Ethernet				
Line filter, frequency filter		Standard	Standard	Standard	Standard
Does GPIB comply with IEEE standards		IEEE488.2	IEEE488.2	IEEE488.2	IEEE488.2

Note: Configuration mode of peak factor 3: The peak factor of 1000V range is 1.5, the maximum effective value is 1000V, and the maximum peak value is 1500V;

Configuration mode of peak factor 6: The peak factor of 500V range is 3, the maximum effective value is 500V, and the maximum peak value is 1500V.

3. Panel Introduction

3.1 PA323/PA333H Power Meter Panel

3.1.1 Front Panel

The panels of PA323 and PA333H power meters are basically the same and only differ in the different PVC models. The front panel description taking PA333H as an example is shown in Figure 3.1.

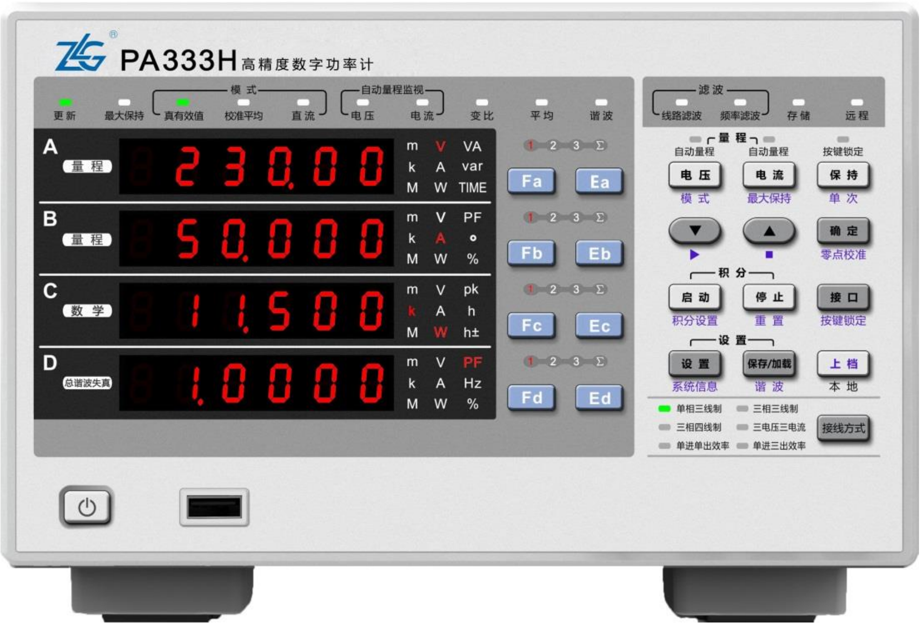

Figure 3.1 Front panel description

1. Status display area

The status display area is used to indicate the running function. When the function status indicator is on, it indicates that the corresponding function is running, as shown inFigure 3.2.

Figure 3.2. Status display area

The wiring display area is used to indicate the current wiring method selected by the user, as shown in Figure 3.3 When the user selects a wiring method, the corresponding wiring indicator will be on. If the user chooses 1P2W system, the wiring indicator is still displayed in the current display state.

Figure 3.3 Wiring display area

2. Measurement display area

Figure 3.4 Measurement display area description

The measurement display area description is as shown in Figure 3.4 It is used to display the output results of the current measurement function.

(1) A-D display area

The measurement display area includes A-D four display screens, which can display multiple measurement functions simultaneously. All the display screens adopt 7-segment digital tubes, so special symbols are needed to display each character, see Figure 3.5or details.

Figure 3.5 Character display of digital tube

(2) Prefix symbol indicator

The prefix symbol is a factor symbol that is added in front of the measurement unit to form a decimal multiple or a fraction. It must be used in conjunction with the measurement unit. For example, 3kΩ cannot be written as 3k. When the factor corresponding to the prefix is equal to or greater than 10^6, the prefix symbol must be capitalized; while if it is less than or equal to 10^3, the prefix symbol must be lowercase. The prefix symbol indicator

Table 3.1 Prefix

Corresponding factor	Prefix
10^6	M
10^3	k (lower case)
10^{-3}	m

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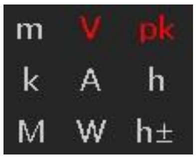
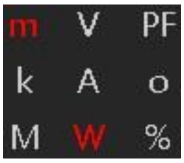
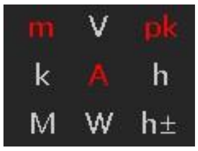
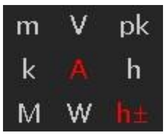
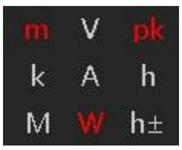
display area as shown in Figure 3.4cludes three characters of m, k, and M. The decimal multiple or fraction corresponding to each prefix character is shown in Table 3.1.

(3) Display function indicator

As shown in Figure 3.4, the display function indicators are used to indicate the measurement functions displayed in the A, B, C, and D areas. The display function indicators and corresponding functions are shown in Table 3.2

Table 3.2 Display function indicators and display functions

SN	Display Function Indicator	Function	SN	Display Function Indicator	Function
1		Display voltage	9		Display phase angle
2		Display current	10		Display peak voltage
3		Display active power	11		Display peak current
4		Display apparent power	12		Display power factor
5		Display reactive power	13		Display integral charge
6		Display integrator time	14		Display positive/negative current integral
7		Display voltage frequency	15		Display current frequency
8		Display peak power	16		Display mathematical operation function

3. **Setting key area**

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The setting key area of the instrument is shown in Figure 3.6.

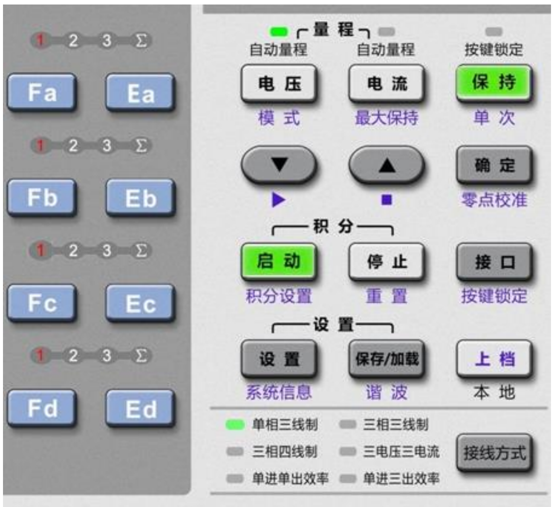


Figure 3.6 Setting key area

(1) Display function switch keys

The user can switch the measurement function displayed in the A-D display area through the display function switch keys FA, FB, FC and FD, as shown in Figure 3.7.

Figure 3.7 Fa function example

(2) Input unit switch keys

The input unit switch keys (Ea, Eb, Ec and Ed) are used to select the input unit to be displayed (input unit 1, input unit 2, input unit 3 can be selected) or wiring group ∑. The indicator of the selected input unit or wiring group will be on. As shown in Figure 3.8, the input unit 1 indicator is on.

Figure 3.8 Input unit switch keys

(3) SHIFT key

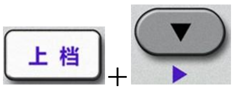
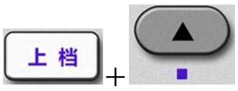
Figure 3.9Universal key diagram

As shown in Figure 3.9, the SHIFT key is used to switch the function of the multi-function key. Press the SHIFT key once to enter the shift state, press the multi-function key at this time to call the second function of the key, and then exit the shift state. If you press the shift key twice, the shift state is locked; at this time, pressing the multi-function key to activate the second key function will not exit the shift state, but it will exit the state if you press the shift key again.

(4) Universal keys

The user can perform menu operations, numerical settings and other operations through the universal keys, as shown in the label in Figure 3.9. For the description of the key functions, seeTable 3.3 and Figure 3.10.

Table 3.3Function description of universal keys

Key	Function Description
	Down key. Decrease the value, select the next menu option, select the next display area
	Up key. Increase the value, select the previous menu option, select the previous display area
	Confirm the current settings
	Move the cursor one numerical digit to the right or from the rightmost position to the leftmost position
	Move the cursor one place to the right or from the rightmost position to the leftmost position

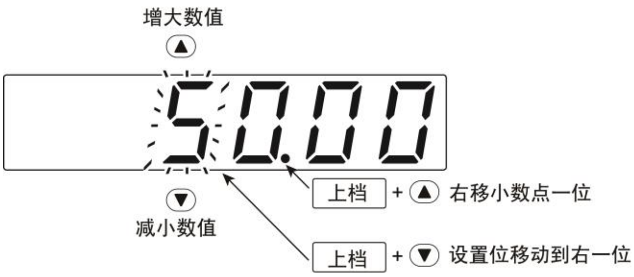


Figure 3.10 Function description of universal keys

Select value

The flashing numerical bit is the numerical bit currently being set. The user can adjust the size of the setting bit value by ▲ or ▼ key, as shown inFigure 3.10.

Move setting bit

Move setting bit. As shown in Figure 3.10, press the SHIFT +▼ (►) key to set the number in the right. If the numerical bit currently set is on the rightmost, press the SHIFT+▼ (►) key to jump to the leftmost numerical bit for setting.

Move decimal point

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Press SHIFT +▼ (.) key to move the decimal point to the right. As shown in Figure 3.10, when the decimal point is on the rightmost position, press SHIFT +▲ (.) key to move the decimal point to the leftmost position.

(5) RANGE key

The user can set the voltage measuring range and current measuring range through the RANGE key. The range setting key includes VOLTAGE and CURRENT keys, as shown in Figure 3.11 When pressing the VOLTAGE key, it will display the voltage range setting menu; when pressing the CURRENT key, it will display the current range setting menu. Figure 3.12shows the voltage range menu after pressing the VOLTAGE key.

Figure 3.11 Range setting key

Figure 3.12 Voltage range setting menu

The user can select the automatic range mode or set the range from the voltage or current range menu. After selecting AUTO mode, the AUTO indicator above the VOLTAGE or CURRENT key will be on.

(6) MODE setting key

The user can set the current measurement mode to RMS or VOLTAGE MEAN or DC mode through the MODE setting key.

The measurement mode setting key is a key combination, which is composed of the SHIFT and VOLTAGE key. Press the SHIFT key and the key indicator will be on, and press the VOLTAGE key to switch the measurement mode. When switching to a measurement mode, the corresponding measurement mode indicator in the statue indication area of Figure 3.2 will be on, as shown inFigure 3.13.

Figure 3.13 Measurement mode

(7) INTEGRATOR key

The INTEGRATOR key control the running of the integrator, as shown in Figure 3.14. Its description is as shown in Table 3.4 INTEGRATOR key description.

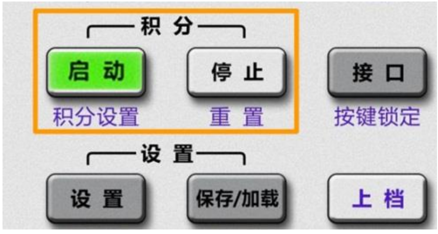
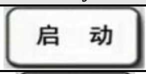
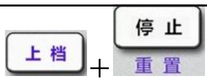


Figure 3.14 INTEGRATOR key

Table 3.4 INTEGRATOR key description

Key	Function Description
	Start integrator function
	Stop integrator function
	The integrator setting menu is as shown in Figure 3.15 Integrator setting menu, which can set the mode, timing, time and other parameters
	Clear integrator value and time

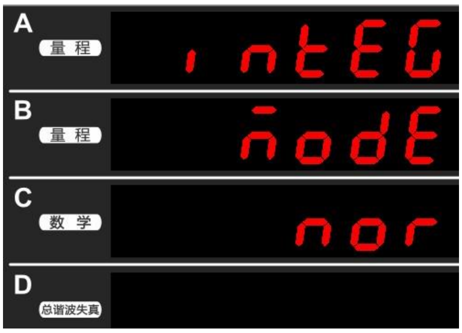


Figure 3.15 Integrator setting menu

(8) SINGLE/HOLD key

The SINGLE/HOLD key is as shown inFigure 3.16 The user can perform the following functions through the single measurement/hold key:

- **Hold function.** When the measurement display is normally updated, press the HOLD key and the instrument will enter the hold state. At this time, except for integral calculation, the display update and measurement operation of the instrument will be suspended and the display of the current measurement results will be maintained;
- **Single measurement.** The instrument will perform single measurement and return to the hold state after measurement;
- **Return function.** When the menu operation is carried out, press the HOLD key to perform the return function and return to the display interface of measurement results;
- **MAX HOLD function.** When the MAX HOLD function is enabled, the instrument will continuously select the maximum value from the current measurement results for display.

Figure 3.16 SINGLE/HOLD key

Figure 3.17 KEY PROTECT key

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(9) KEY PROTECT key

The KEY PROTECT key is a key combination. The user presses the SHIFT key and the key will be light on; and then press the INTERFACE key to enable/disable the key lock function, as shown in Figure 3.17. When the key lock function is enabled, all keys, except the POWER and KEY PROTECT keys (INTERFACE+SHIFT), will be invalid, and the KEY PROTECT indicator above the HOLD key will be on. If you need to release the key lock state, you can press the KEY PROTECT key again. At this time, the KEY PROTECT indicator is off, and all the keys on the front panel are available.

Figure 3.18CAL key

(10) CAL key

The CAL function can set the internal circuit input in the instrument to 0 and calibrate the zero level to prevent drifting. The CAL key is a key combination which composes of SHIFT and SET, as shown inFigure 3.18. The user can press the SHIFT key and the key indicator will be on, and press the SET key to perform the CAL function.

(11) INTERFACE key

Press the INTERFACE key to display the communication interface menu and connection information.

(12) SETUP key

The SETUP key can be used to set the measurement synchronous source, frequency filter, line filter, sensor scaling, averagFigure 3.19.

Figure 3.19 SETUP key

(13) UTILITY key

The UTILITY key is a key combination, which is composed of the SETUP and SHIFT keys. Press the SHIFT key and the key indicator will be on; then press the SETUP key and the UTILITY menu will be displayed. The UTILITY menu includes system information, factory reset, peak factor, configuration information, range setting menu, etc., as shown in Figure 3.20

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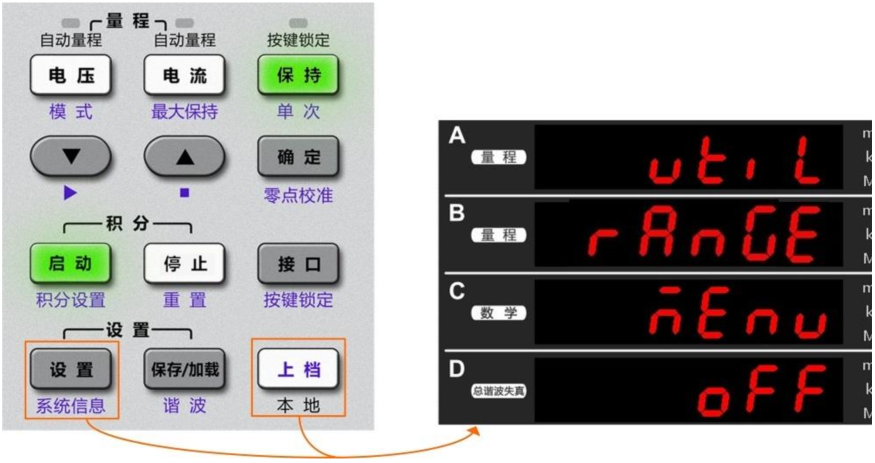

Figure 3.20 UTILITY

(14) HARMONICS key

The HARMONICS key is a key combination, which is composed of SAVE/LOAD and SHIFT keys. Press the SHIFT key and the key will be light on; and then press the SAVE/LOAD key to display the HARMONICS function menu, as shown in Figure 3.21. The user can select the harmonic measurement mode, set the On/Off of the harmonic measurement display, and set the PLL source in the HARMONICS function menu.

Figure 3.21 HARMONICS key

(15) SAVE/LOAD key

The SAVE/LOAD key is used to read and save setting information. After pressing the key, the SAVE/LOAD menu will be displayed, as shown in Figure Figure 3.22.

(16) WIRING setting key

As shown in Fig. 3.23, press the "WIRING" key to switch the wiring mode and the corresponding indicator will be on.

Figure 3.2SAVE/LOAD key

Figure 3.22 WIRING setting key

3.1.2 Rear Panel

The rear panel functions of PA323 and PA333H high-precision power meters are shown in Figure 3.23The rear panel interface of PA333H and PA323 is the same, but the difference is that PA333H has a maximum current of 50A and a maximum voltage of 1000V.

Figure 3.23Rear panel description of PA323 power meter

3.2 PA310/PA310H Power Meter Panel

3.2.1 Front Panel

The front panel of PA310 and PA310H high-precision power meters is basically the same, but the difference lies in the different PVC types. Taking PA310 as an example, its functions are shown inFigure 3.24 The functions of all areas and keys on the panel are basically the same as PA323 and PA333H (except wiring mode), which will not be described here.

Figure 3.24Front panel description

3.2.2 Rear Panel

The rear panel functions of PA310 high-precision power meter is shown in Figure 3.25. The rear panel interface of PA310H and PA310 is the same, but the difference is that PA310H has a maximum current of 50A and a maximum voltage of 1000V.

Figure 3.25 PA310 rear panel description

4. Circuit Connection

4.1 Direct Connection Measurement Circuit

This section explains how to use the measurement cable to connect the measurement circuit to the current and the voltage input terminals of the PA300 series high-precision power meters.

4.1.1 Terminal and Symbol

The description of voltage and current terminal symbols of PA310/PA310H power meters is shown inFigure 4.1. The voltage and current terminal symbols of PA310H and PA310 are the same, but the difference is that PA310H has a maximum current of 50A and a maximum voltage of 1000V.

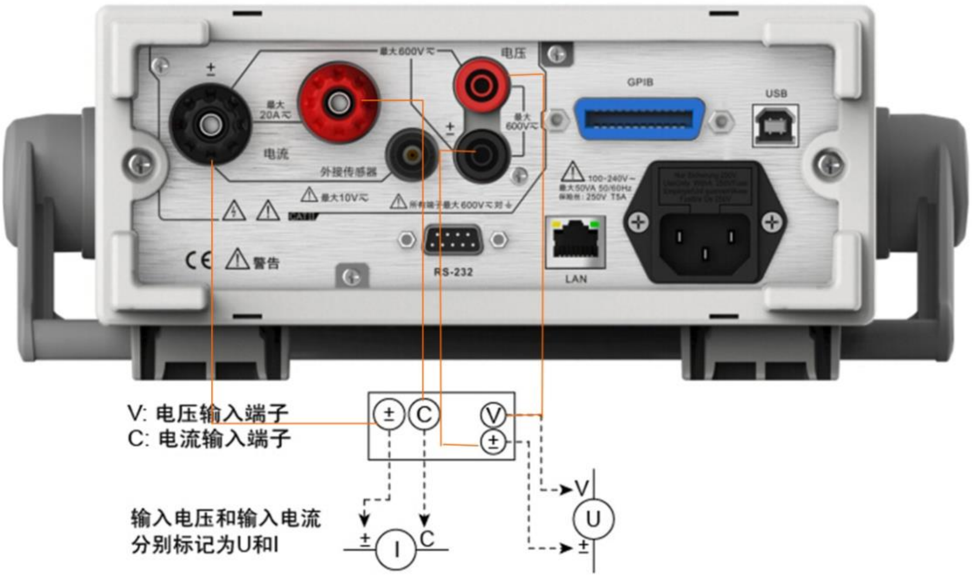

Figure 4.1Voltage and current terminal symbols (PA310)

The description of voltage and current terminal symbols of PA323/PA333H power meters is shown inFigure 4.2. The voltage and current terminal symbols of PA323 and PA333H are the same, but the difference is that PA333H has a maximum current of 50A and a maximum voltage of 1000V.

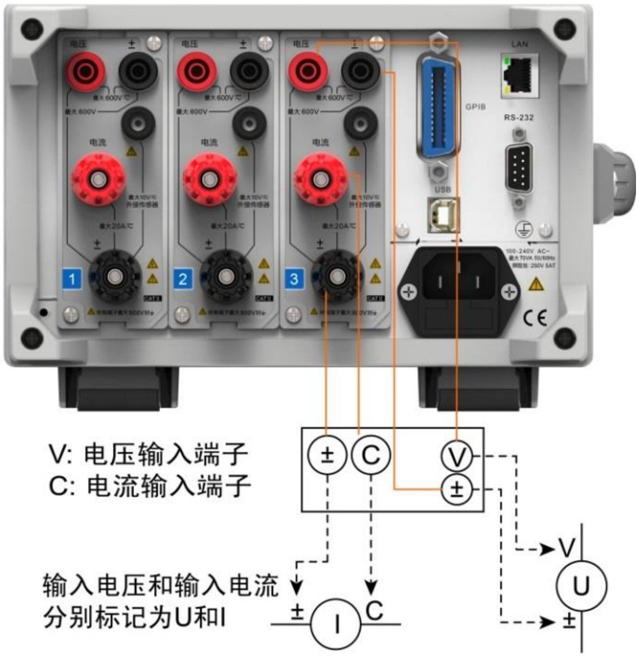

Figure 4.2Voltage and current terminal symbols (PA323)

4.1.2 Single-phase Connection

1. 1P2W connection

The PA310/PA310H power meters have only one input unit and only supports 1P2W connection.

(1) Wiring considering the influence of stray capacitance

In order to minimize the impact of stray capacitance on measurement accuracy when measuring the power of single-phase equipment, the user can connect the current input of the power meter to the place closest to the power source, as shown in Figure 4.3.

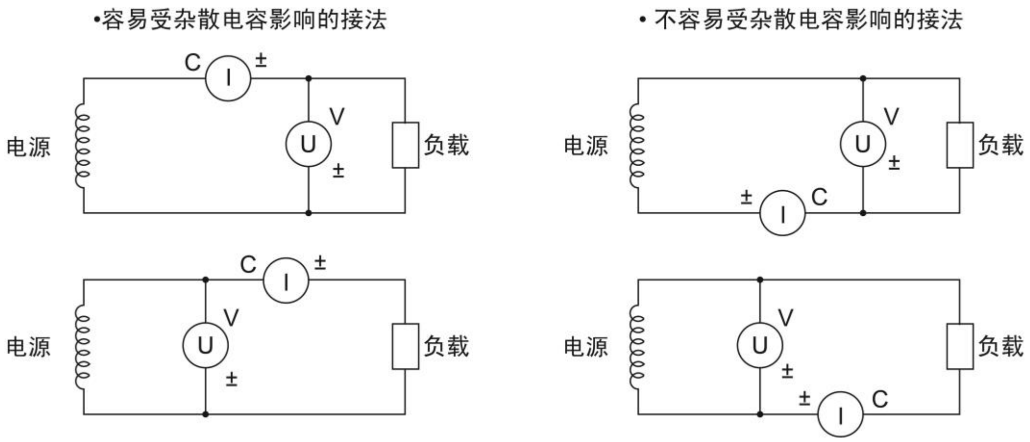

Figure 4.3 Influence of stray capacitance

(2) Wiring considering the accuracy of voltage and current amplitude measurement

When it is important to consider the measurement accuracy of voltage and current amplitudes, you can refer to the instructions shown in Figure 4.4 for wiring.

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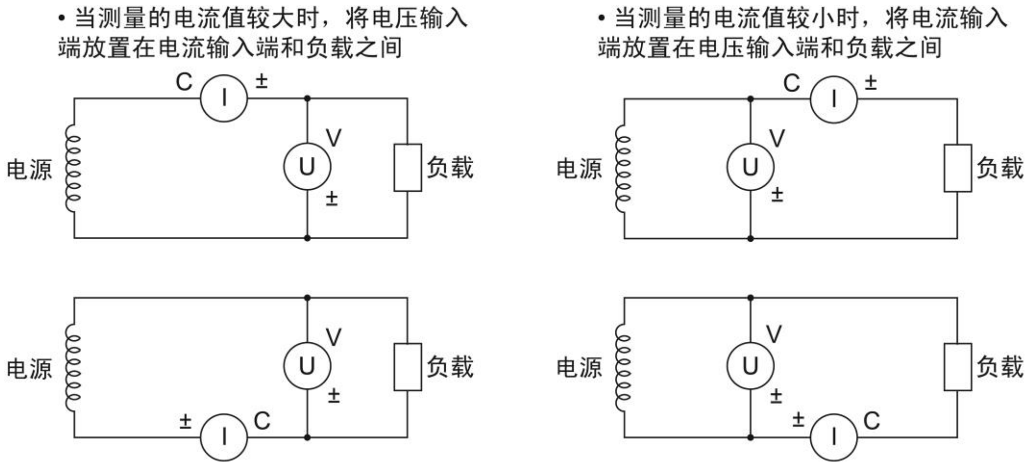

Figure 4.4Influence on voltage and current amplitude measurement

(3) Wiring schematic diagram

In summary, the 1P2W connection schematic diagram of input unit 1 is shown in Figure 4.5, and the connection methods of other input units are also the same (PA310/PA310H power meters have only one input unit).

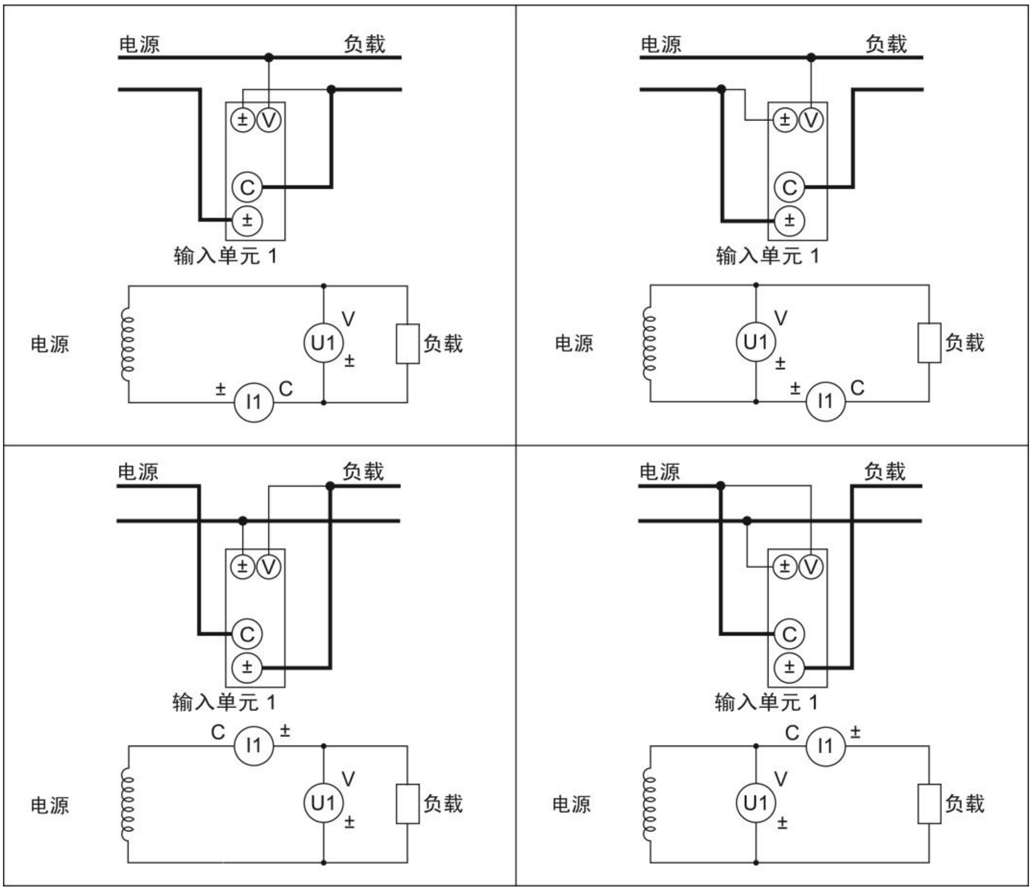

Figure 4.5 1P2W connection schematic diagram

2. 1P3W connection

Only PA323 and PA333H power meters support 1P3W connection. The 1P3W connection schematic

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diagram of input unit 1 is shown inFigure 4.6, and the connection methods of other input units are also the same.

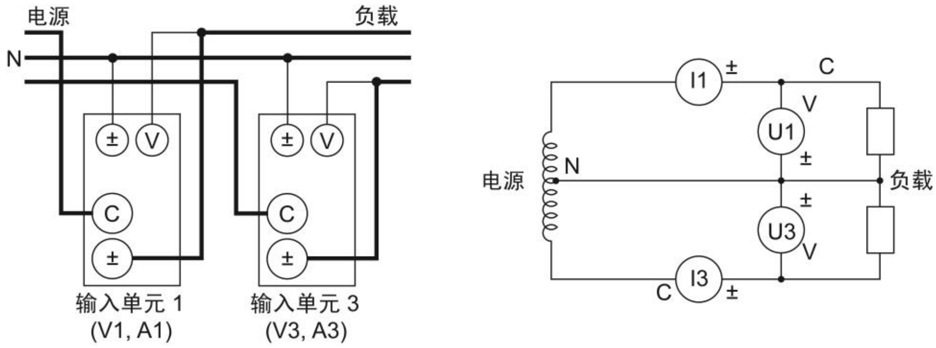

Figure 4.6 1P3W connection schematic diagram

4.1.3 Three-phase Connection

1. 3P3W connection

Only PA323 and PA333H power meters support 3P3W connection, and the connection schematic diagram is as shown in Figure 4.7

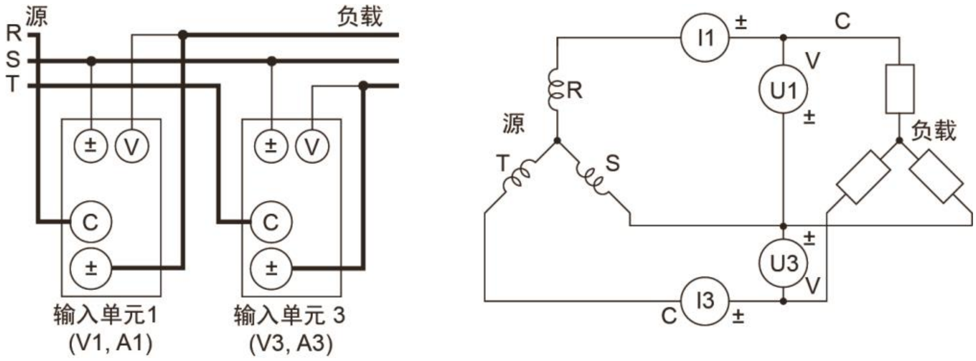

Figure 4.7 3P3W connection schematic diagram

2. 3P4W connection

Only PA323 and PA333H power meters support 3P4W connection. The 3P4W connection schematic diagram of input unit 1 is shown in Figure 4.8, and the connection methods of other input units are also the same.

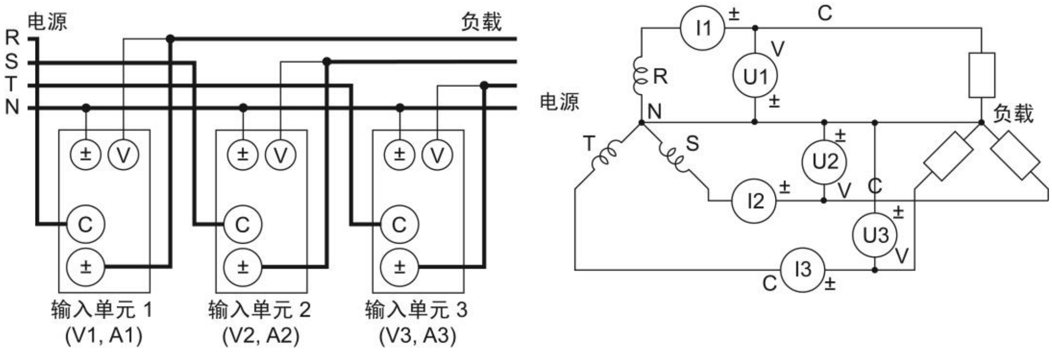

Figure 4.8 3P4W connection schematic diagram

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3. 3V3A connection

Only PA323 and PA333H power meters support 3V3A connection. The connection schematic diagram is as shown in Figure 4.9, and the connection methods of other input units are the same.

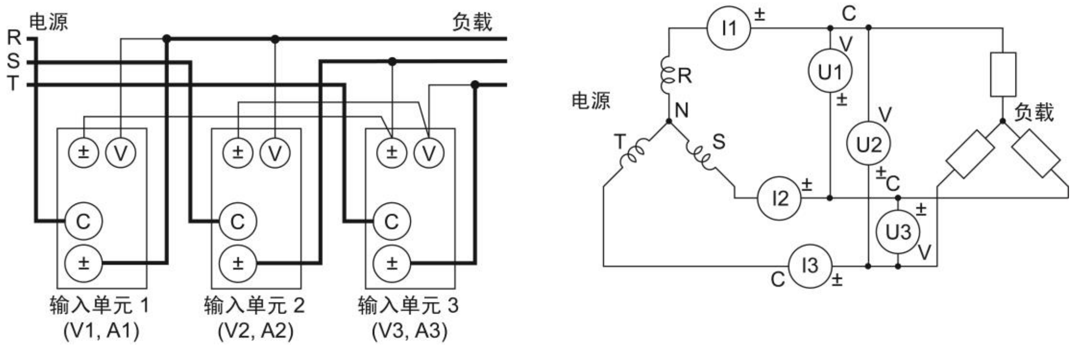

Figure 4.9 3V3A connection schematic diagram

4.1.4 P3/P1 Measurement Connection

Only PA323 and PA333H power meters support P3/P1 connection, and the connection method is as shown iFigure 4.10.

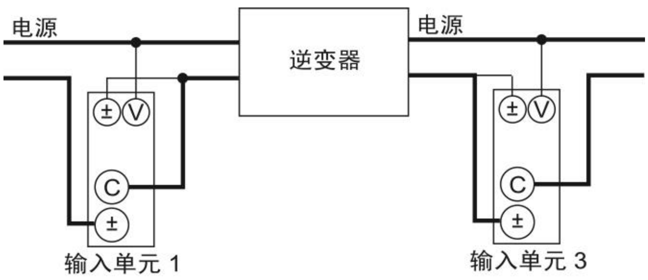

Figure 4.10 P3/P1 measurement connection

4.1.5 (P1+P3)/P2 Measurement Connection

Only PA323 and PA333H power meters support (P1+P3)/P2 connection, and the connection method is as shown in Figure 4.11.

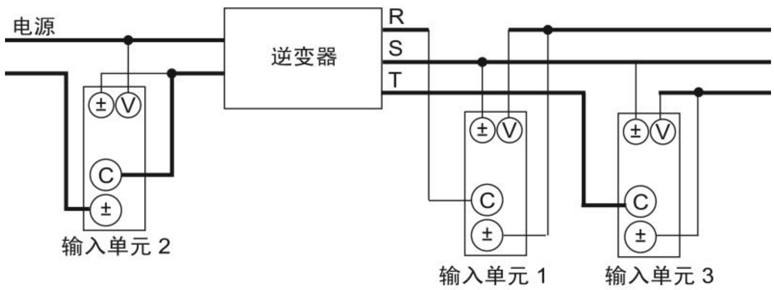

Figure 4.11 (P1+P3)/P2 measurement connection

4.2 Connect Measurement Circuit Through Current Sensor

4.2.1 Warning

- **Using bare sensors** can be dangerous, because accidental touch may cause electric shock. Please ensure that the sensor is equipped with a box, and the energized part of the sensor is insulated from the box and has sufficient voltage endurance capability to the service voltage of the measurement circuit;
- **When using the shunt**, do not connect the wires when the power is on. Because there is voltage on the shunt when the power is on, accidental touch can be very dangerous. When wiring, be sure to turn off the power supply of the measurement circuit;
- **When using a clamp-type current sensor**, please check whether there are dangerous factors (such as electric shock) after fully grasping the voltage of the measurement circuit and the specifications and operation methods of the clamp-type current sensor;
- **When using the external sensor input terminal,** do not touch the current input terminal with your hands or connect the measurement cable. After turning on the power supply of the measurement circuit connected to the input terminal of the external sensor, the current input terminal will produce the voltage of the measurement circuit, which is very dangerous;
- **Please use a connector with a safety interface structure to connect the external sensor's input terminal of the instrument.** If the connector falls off, voltage will be generated at the conductive part, which is very dangerous.

4.2.2 Terminal and Symbol

The terminal and symbol description of the external current sensor of the PA323 power meter is shown in Figure 4.12. The terminal and symbol of PA333H and PA323 external current sensor are the same, and the figure will not be shown again.

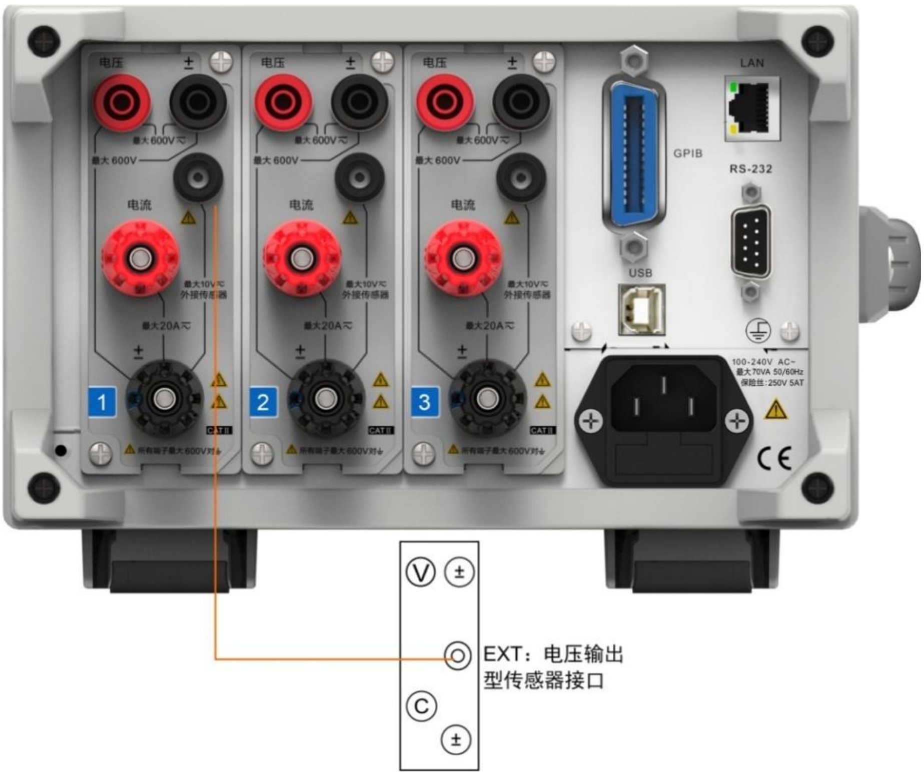

Figure 4.12Terminal and symbol of PA323 external current sensor

The terminal and symbol description of the external current sensor of PA310/PA310H power meters is shown inFigure 4.13 The terminal and symbol of PA310H and PA310 external current sensor are the same, and

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the figure will not be shown again.

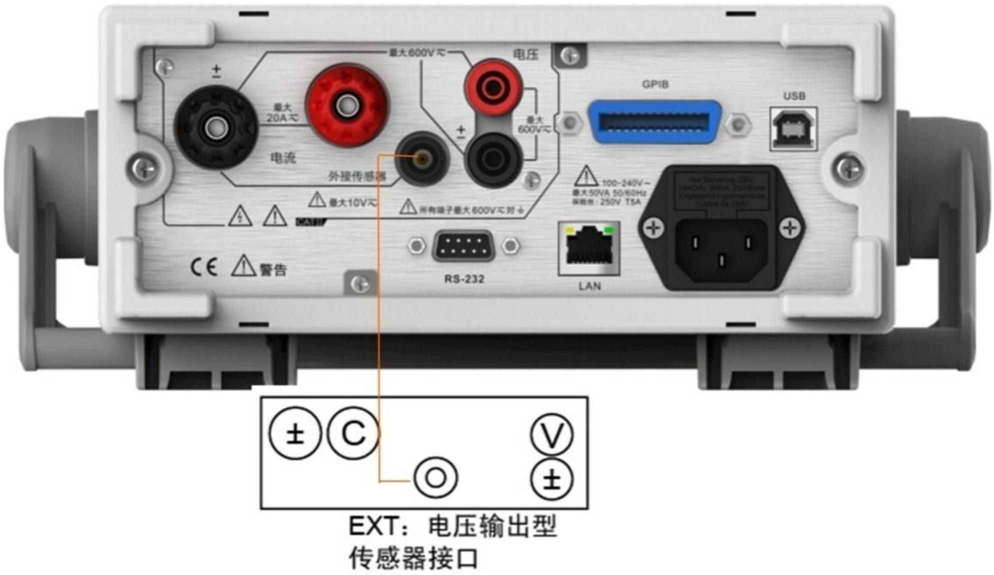

Figure 4.13Terminal and symbol of external current sensor

4.2.3 Connection Between Sensor and Power Meter

1. Connection Schematic Diagram

The connection schematic diagram of the shunt current sensor and the power meter is shown in Figure 4.14. If a voltage output type clamp current sensor needs to be connected, replace the shunt current sensor in the circuit shown in Figure 4.14 with a voltage output type clamp current sensor.

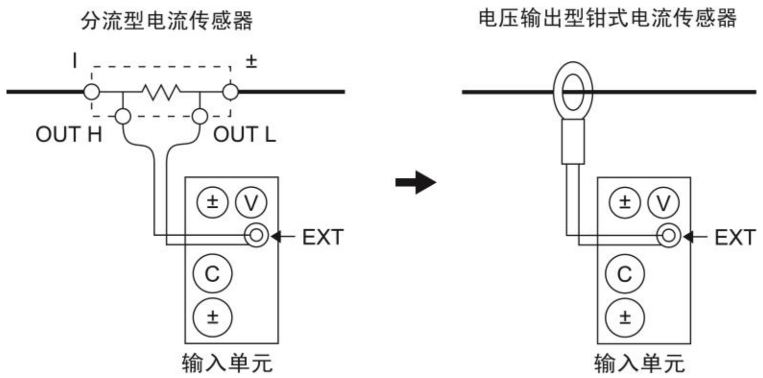

Figure 4.14Connection schematic diagram

2. Wiring precautions

(1) Wiring polarity

Ensure the polarity is not wrong when connecting. Otherwise, the polarity of the measured current will be reversed, making the correct measurement impossible. Especially when measuring with a clamp-type current sensor, it is very easy to make mistakes, so please pay more attention.

(2) Wiring length

When an external sensor is used, the frequency and phase characteristics of the sensor will affect the measured data. In order to reduce

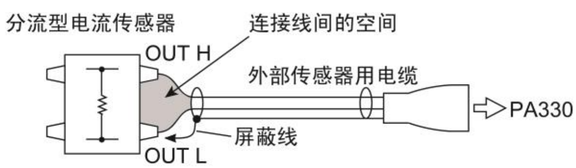

Figure 4.15Connection of shunt current sensor and power

the measurement error caused by stray capacitance and wiring resistance, the wiring length between the external sensor and the instrument must be reduced as much as possible.

(3) Error reduction

In order to minimize error when using a shunt current sensor, please pay attention to the following aspects when connecting cables for external sensors.

Shielded wire connection

As shown in Figure 4.15connect the external sensor with the shielded wire of the cable to the L end of the output terminal (OUT) of the shunt current sensor.

Space reduction

As shown in Figure 4.16, minimize the space created by the connection of the cable from the shunt current sensor to the external sensor, thus reducing the influence of magnetic force lines and external noise in the space occupied by the connecting wire.

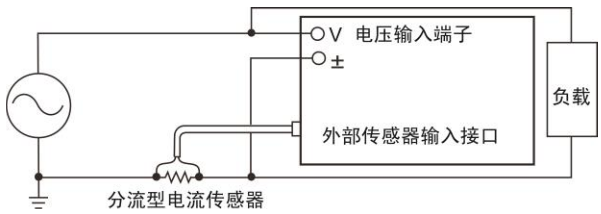

Figure 4.16Connection of shunt current sensor

Grounding

Connect the shunt current sensor to the power ground as shown in Figure 4.24 When the grounding is not possible, in order to reduce the influence of the common mode voltage, a connecting wire thicker than AWG18 (AWG is the abbreviation of American wire standard, the cross-sectional area of the wire conductor is about $1mm^2$) must be used between the current sensor and the power meter; and the safety and error reduction of cables for external sensors are fully considered when they are made.

Connection using isolated sensors

When the measurement circuit is not grounded or in the case of high frequency and high power, the inductive influence of the connecting cable of the shunt current sensor will increase. At this time, please use isolated sensors (CT, DC-CT, current clamp) for measurement, as shown in Figure 4.17.

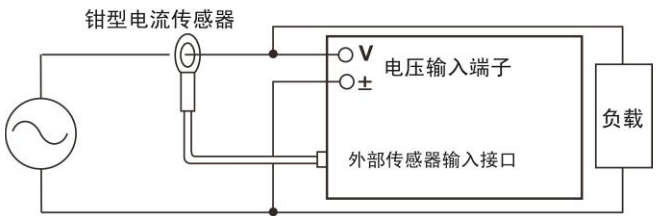

Figure 4.17Use a clamp type current sensor

4.2.4 Single-phase Connection

1. 1P2W connection

The 1P2W measurement circuit connection through the current sensor is shown in Figure 4.18

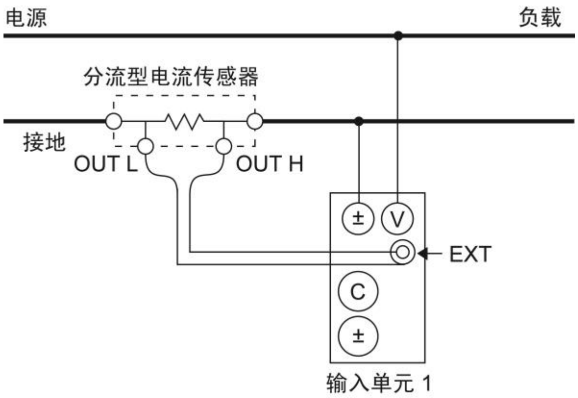

Figure 4.181P2W connection based on shunt current sensor

2. 1P3W connection

The 1P3W measurement circuit connection through the current sensor is shown inFigure 4.19. Only PA323 and PA333H power meters support 1P3W connection.

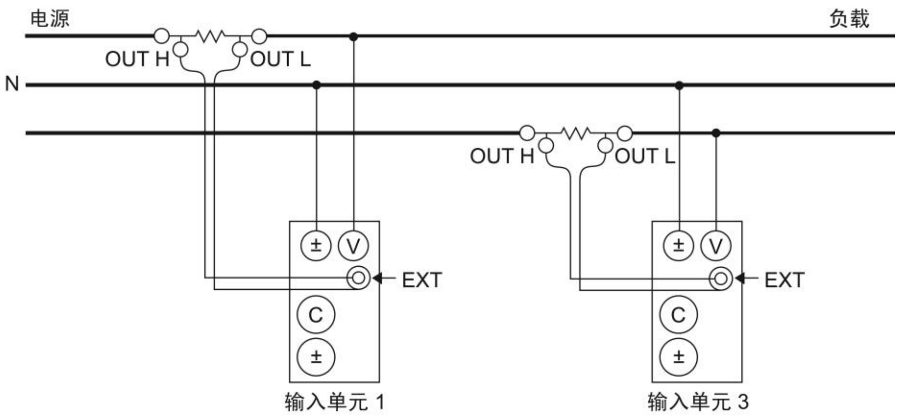

Figure 4.191P3W measurement circuit

4.2.5 Three-phase Connection

1. 3P3W connection

The 3P3W measurement circuit connection through the current sensor is shown inFigure 4.20. Only PA323 and PA333H power meters support 1P3W connection.

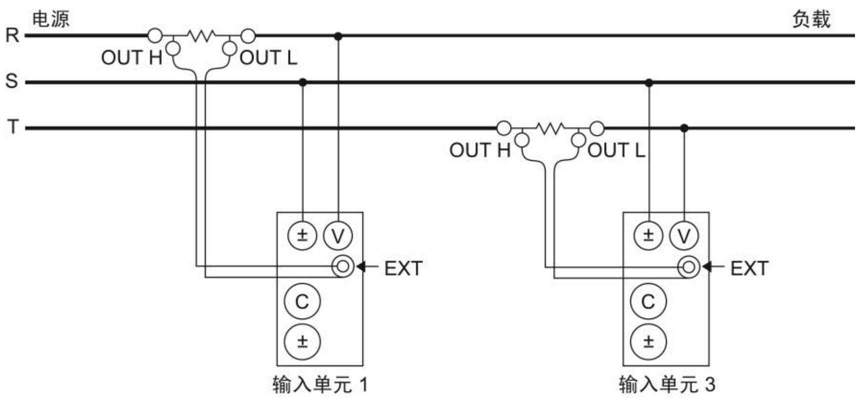

Figure 4.20 3P3W measurement circuit

2. 3P4W connection

The 3P4W measurement circuit connection through the current sensor is shown inFigure 4.21. Only PA323 and PA333H support 3P4W connection.

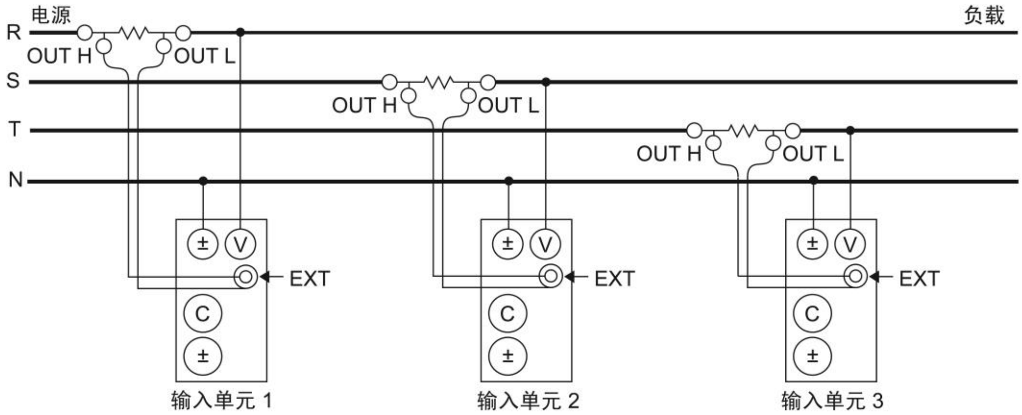

Figure 4.21 3P4W measurement circuit

3. 3V3A connection

The 3V3A measurement circuit connection through the current sensor is shown in Figure 4.22Only PA323 and PA333H support 3V3A connection.

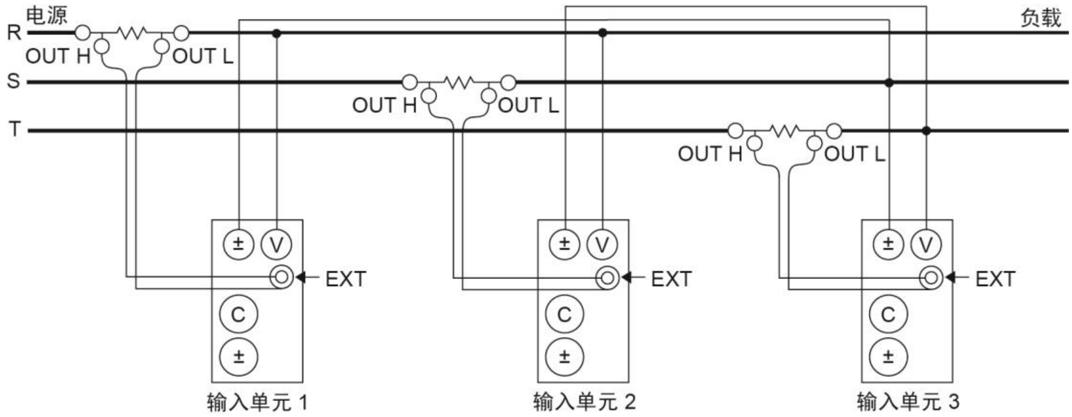

Figure 4.22 3V3A measurement circuit connection through the current sensor

4.3 Connect Measurement Circuit Through Voltage and Current Converter

4.3.1 Connection Between CT and Power Meter

When the maximum current value of the measurement object exceeds the maximum measurement range of the instrument, the current converter (CT) shall be used for measurement; to connect the external CT, connect the current input terminals of the power meter to the secondary side terminals of the external CT.

See Figure 4.23 for the connection example of CT and power meter, and the connection method of through-type CT and current output type clamp current sensor is the same, as shown in Figure 4.23.

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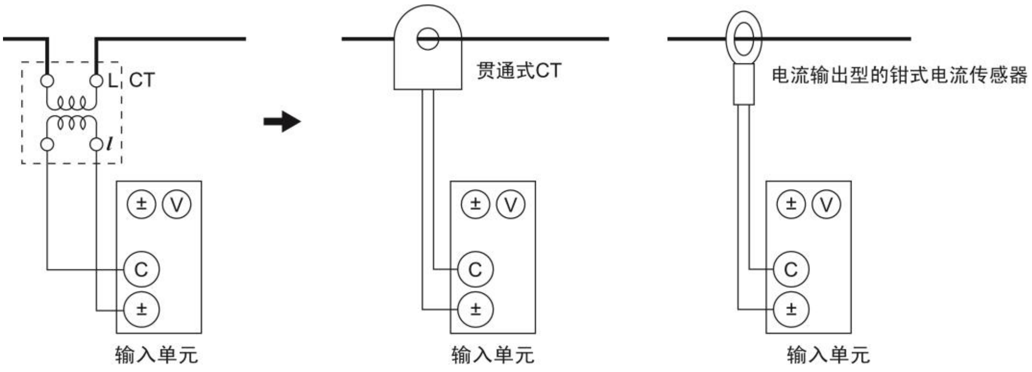

Figure 4.23 Power meter connection CT

When using an external CT, avoid open circuits on the secondary side of the CT with current flowing on the primary side. Otherwise, the secondary side of the CT will generate high voltage, which is dangerous. For safety, please ground the VT/CT secondary side's public port (+/-).

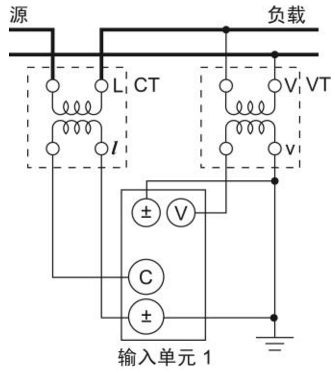

Figure 4.241P2W measurement

4.3.2 Single-phase Connection

1. 1P2W connection

The 1P2W measurement circuit connection through the current and voltage sensors is shown inFigure 4.24

2. 1P3W connection

The 1P3W measurement circuit connection through the current and voltage sensors is shown in Figure 4.25 Only PA323 and PA333H power meters support 1P3W connection.

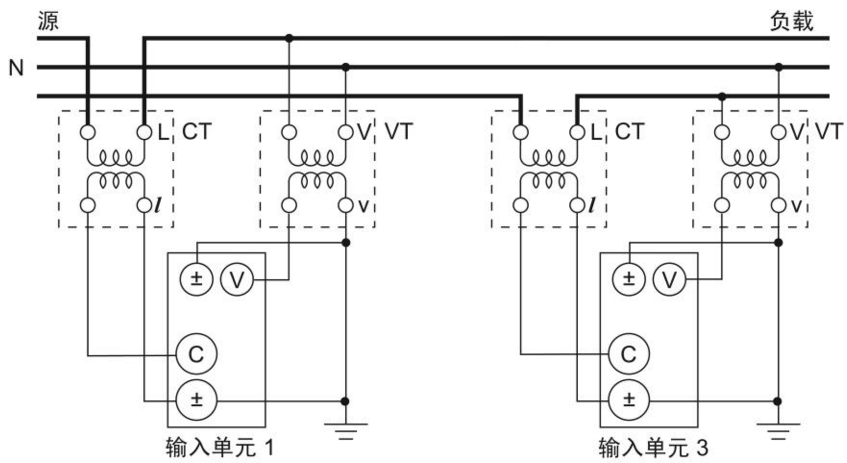

Figure 4.25 1P3W measurement circuit

4.3.3 Three-phase Connection

1. 3P3W connection

The 3P3W measurement circuit connection through the current and voltage converter is shown in Figure 4.26. Only PA323 and PA333H power meters support 3P3W connection.

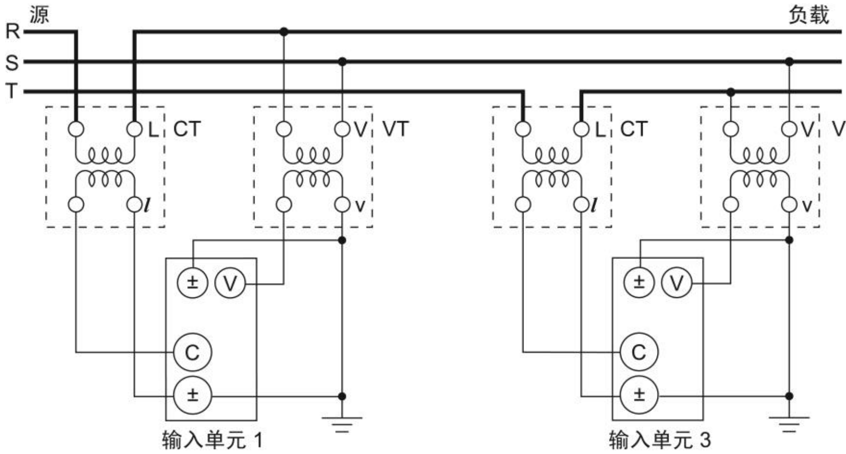

Figure 4.26 3P3W measurement circuit connection

2. 3P4W connection

The 3P4W measurement circuit connection through the current and voltage converter is shown in Figure 4.27. Only PA323 and PA333H support 3P4W connection.

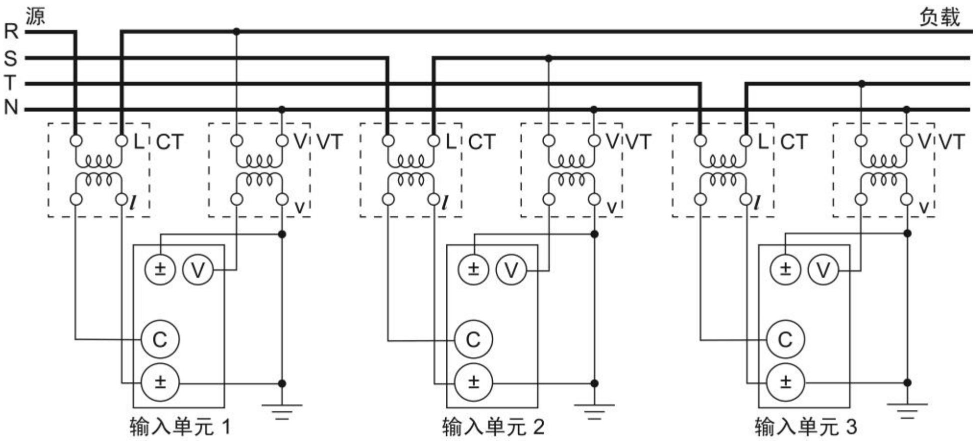

Figure 4.27 3P4W measurement circuit based on VT and CT

3. 3V3A connection

The 3V3A connection through the current and voltage converter is shown in Figure 4.28. Only PA323 and PA333H power meters support 3P3W connection.

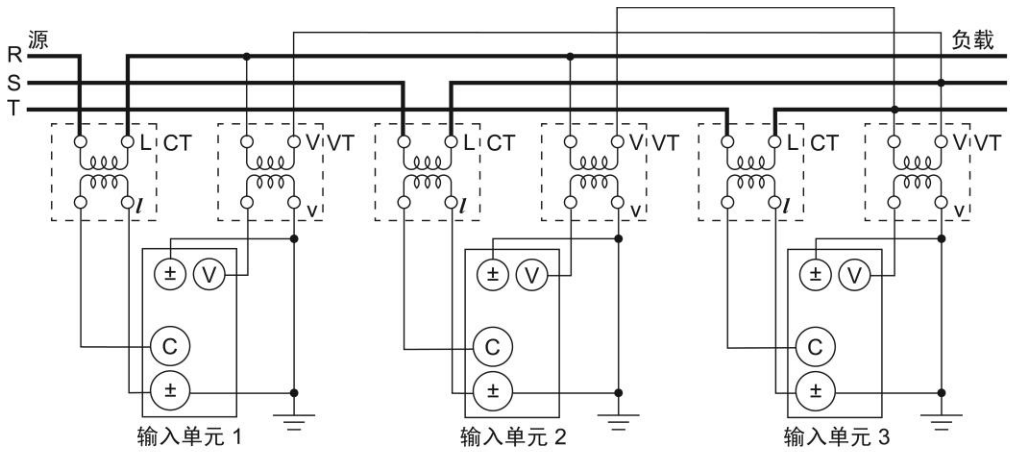

Figure 4.28 3V3A wiring method based on VT and CT

5. Communication Interface Description

The PA300 series high-precision power meters support USB, Ethernet, GPIB, RS-232 communication interfaces. The following describes the relevant characteristics and setting process of communication interfaces.

5.1 USB Interface

5.1.1 Communication Features

Users can send commands to the power meter to perform functions corresponding to the keys on the front panel of the power meter. After receiving relevant commands, the power meter can return measurement and calculation data, setting parameters and status bytes of the control panel, and error codes. Note that when performing USB communication, do not use other communication interfaces to control the power meter at the same time.

5.1.2 Interface Description

Table 5.1 Interface description

Item	Description
Number of port	1
Connector	Type B connector (socket)
Electrical and mechanical specifications	Compatible with USB Rev.2.0
Supported transmission modes	High-speed and full-speed
Supported protocol	Custom protocols
PC system requirements	USB-supported Windows 7 (32-bit/64-bit), Vista (32-bit), XP (SP2 or higher, 32-bit)

5.1.3 USB Interface Setting Process

The user does not need to set USB interface parameters on the power meter.

5.2 GPIB Interface

5.2.1 Communication Features

Users can send commands to the power meter via the GPIB interface to perform functions corresponding to the keys on the front panel of the power meter. After receiving relevant commands, the power meter can return measurement and calculation data, setting parameters and status bytes of the control panel, and error codes.

5.2.2 Interface Description

Table 5.2 GPIB interface

Applicable device	National Instruments Corporation ● PCI-GPIB or PCI-GPIB, PCIe-GPIB or PCIe-GPIB+ ● PCMCIA-GPIB or PCMCIA-GPIB+ (Windows Vista or Windows 7 not supported) ● GPIB-USB-HS uses NI-488.2M Ver. 2.8.1 or later driver
Electrical and	Conform to IEEE St'd 488-1978(JIS C 1901-1987

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mechanical specifications	

Note: In order to ensure the reliable and stable GPIB communication, please use the genuine GPIB cable.

5.2.3 GPIB Setting Process

Each GPIB device has a unique GPIB address, which is used to distinguish different GPIB devices. Therefore, when using the GPIB interface of the power meter, the user first needs to set the GPIB address of the power meter. The GPIB address setting process is shown in Figure 5.1.

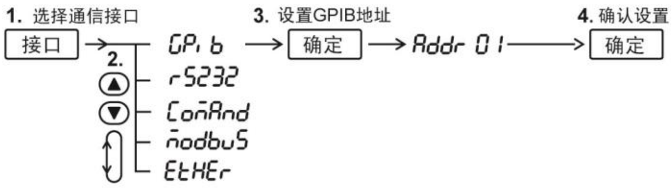

Figure 5.1 GPIB setting process

Note: Do not modify the GPIB address while the power meter is communicating with GPIB. Besides, when using GPIB for remote control, do not use other communication interfaces to control the power meter at the same time.

5.3 RS-232 Interface

5.3.1 Communication Features

Users can send commands to the power meter via the RS-232 interface to perform functions corresponding to the keys on the front panel of the power meter. After receiving relevant commands, the power meter can return measurement and calculation data, setting parameters and status bytes of the control panel, and error codes.

5.3.2 Interface Description

Table 5.3 Serial interface

Interface type	D-Sub 9-pin (plug)
Electrical specifications	Conform to EIA-574 (EIA-232(RS-232) 9-pin standard)
Baud rate	1200, 2400, 4800, 9600, 19200, 115200 are available

5.3.3 RS-232 Interface Setting Process

The RS-232 interface setting process is shown in Figure 5.2.

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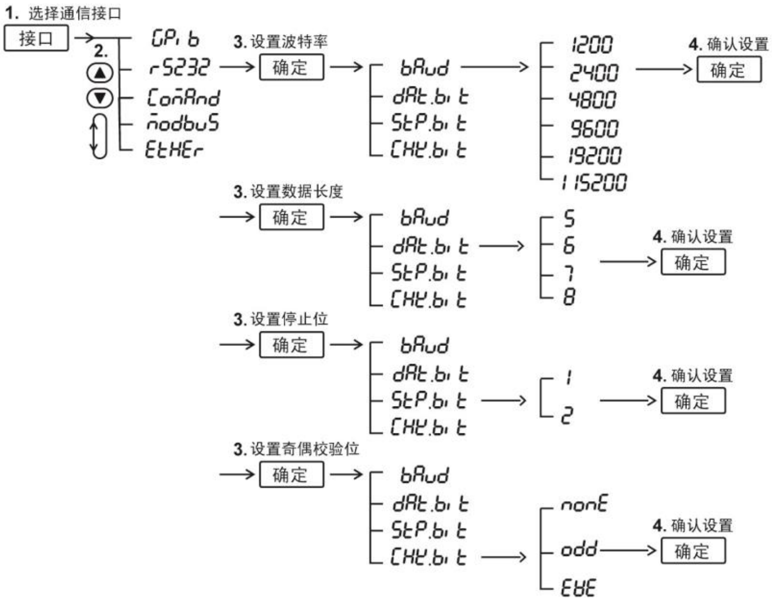

Figure 5.2 RS-232 interface setting process

5.4 Ethernet Interface

5.4.1 Communication Features

Users can send commands to the power meter via the Ethernet interface to perform functions corresponding to the keys on the front panel of the power meter. After receiving relevant commands, the power meter can return measurement and calculation data, setting parameters and status bytes of the control panel, and error codes.

5.4.2 Interface Description

Table 5.4 Ethernet interface

Number of port	1
Interface type	RJ-45 interface
Electrical and mechanical specifications	Conform to IEEE802.3 standard
Transmission system	Ethernet (100BASE-TX, 10BASE-T)
Transmission rate	Max 100Mbps
Communication protocol	TCP/IP
Supported service	DHCP, remote control

5.4.3 Ethernet Interface Setting Process

The Ethernet interface setting process is shown in Figure 5.3.

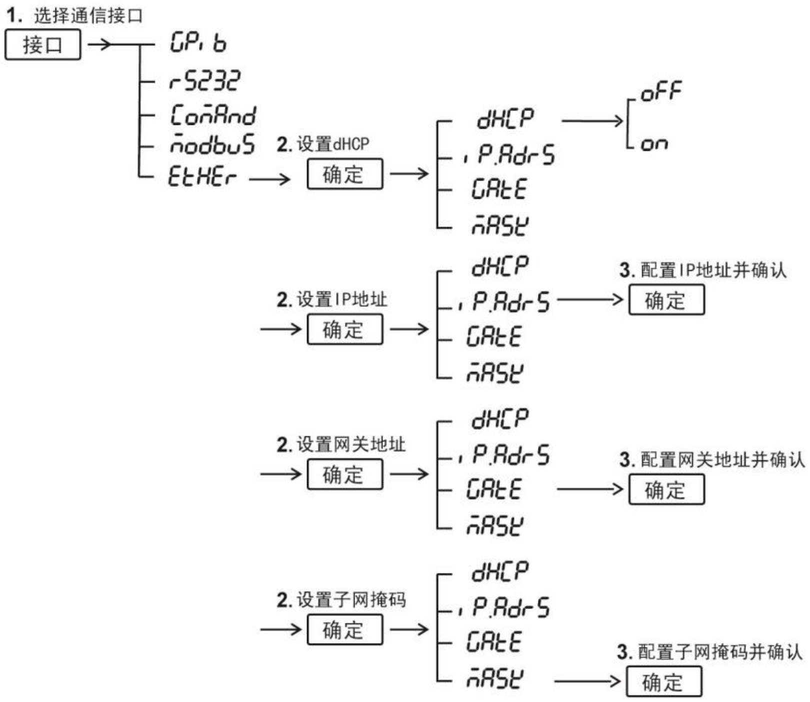

Figure 5.3 Ethernet interface setting process

5.5 Modbus Communication Protocol

5.5.1 Supported Protocol

It supports Ethernet TCP/IP and serial link RTU communication modes. TCP communication uses port 502.

5.5.2 Use Limit

When using Ethernet TCP/IP connection, a maximum of 4 connections are supported. When the serial port is connected, a maximum of 1 connection is supported. The Modbus device address range is 1~247.

5.5.3 Flow Chart of Modbus Communication Protocol Setting

The setting flow chart is as shown in Figure 5.4.

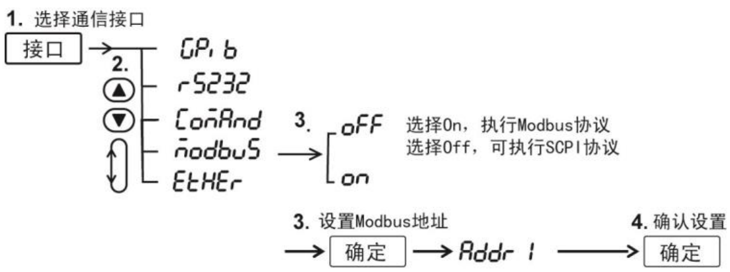

Figure 5.4 Modbus protocol setting process

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6. Set Measurement Conditions

6.1 Wiring Setting

PA300 series high-precision power meters have many different models, and different models support different wiring methods. The user needs to select the correct wiring method according to the model used and the circuit being measured, otherwise the measurement will be wrong. Only PA323 and PA333H power meters support the wiring setting.

PA323/PA333H power meters have three input units (input unit 1, input unit 2, input unit 3), and the user can select 1P3W (single-phase three-wire system), 3P3W (three-phase three-wire system), 3P4W (three-phase four-wire system), 3V3A (three voltage and three current connection method), P3/P1 measurement, or (P1+P3)/P2 measurement wiring method.

The user can press the "WIRING" key on the front panel to switch the primary wiring method, as shown in Figure 6.1.

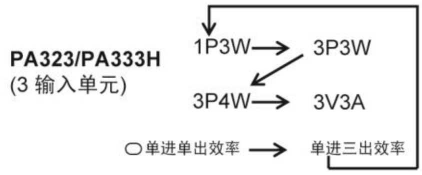

Figure 6.1 Switch of wiring method

6.2 Select Input Unit or Wiring Group

For PA323 and PA333H power meters, the input unit or wiring group that displays the measurement results must be designated, as shown in Figure 6.2.

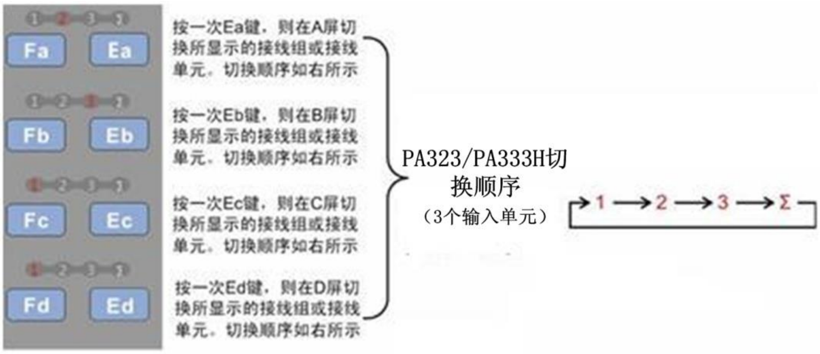

Figure 6.2 Select the input unit or wiring group for display

In Figure 6.2 Select the input unit or wiring group for display 1, 2, and 3 refer to the measured values of display input units 1, 2, and 3 respectively, and "Σ" is the wiring group.

6.3 Measurement Mode Setting

6.3.1 Introduction

The instrument supports three measurement modes as shown in Table 6.1 Measurement mode, with an initial value of RMS.

Table 6.1 Measurement mode

Indicator	Voltage	Current	Computational Formula
RMS	Measure and display RMS	Measure and display RMS	$\sqrt{\frac{1}{T}\int_0^T f(t)^2 dt}$
VOLTAGE MEAN	Display the average rectification value calibrated to effective value	Measure and display RMS	$\frac{\pi}{2\sqrt{2}} \times \frac{1}{T}\int_0^T \lvert f(t) \rvert dt$
DC	Display simple average value	Display simple average value	$\frac{1}{T}\int_0^T f(t)dt$

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Note: f(t) is the input signal, and T is one period of the input signal.

6.3.2 Operation Instruction

Press the SHIFT + VOLTAGE key on front panel to select the measurement mode. Press the SHIFT + VOLTAGE key once, and the measurement mode will switch in the order shown in Figure 6.3 Switch order. The corresponding indicator of the selected measurement mode will be on, as shown in Figure 6.3 Switch order.

Figure 6.3 Switch order

6.4 Select Measurement Synchronous Source

6.4.1 Introduction

The power meter obtains the measurement data by averaging the sampled data in the period synchronization interval of the input signal. The input signal period is measured by the synchronization source signal; therefore, the synchronization source signal also determines the period for performing the averaging processing. The user can select the following measurement synchronization sources:

- **Current.** Measure the period of the current signal first and set it as the synchronous source. The current signal becomes the synchronous source of the various input units. If the period of the current signal cannot be measured, set the voltage signal as the synchronization source;
- **Voltage.** Measure the period of the voltage signal first and set it as the synchronous source. The voltage signal of each input unit becomes the synchronous source of the various input units. If the period of the voltage signal cannot be measured, set the current signal as the synchronization source;
- **OFF (no voltage or current is used)**. The measurement is no longer synchronized with the voltage or current signal, but averages the sampled data in the entire display update period.

6.4.2 Operation Instruction

PA323 power meter is taken as an example to illustrate the operation of synchronous source selection. The operations of PA310, PA310H and PA333H are the same.

According to the operation process of the synchronization source menu as shown inFigure 6.4 Operation instruction of synchronization source menu, the user presses the SETUP key on the front panel to enter the setting menu; and then selects the synchronization source menu. In the synchronization source menu, the user can complete the synchronization source selection, and then select Volt (voltage), Curr (current), or OFF.

Note: The synchronization source signal of PA323 and PA333H power meters select Current by default, while PA310, PA310H power meters select Voltage by default.

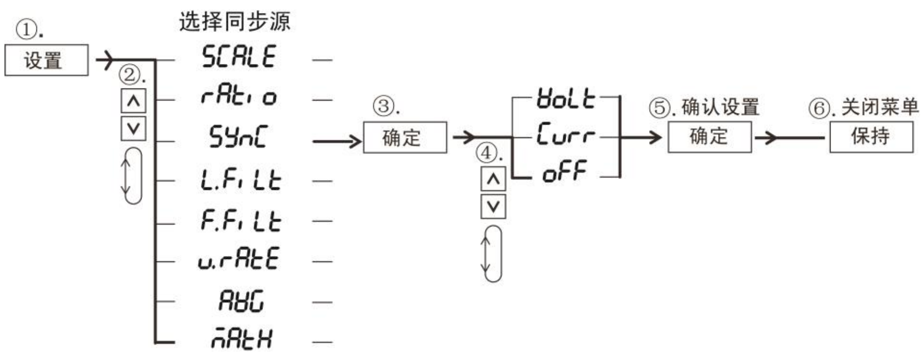

Figure 6.4 Operation instruction of synchronization source menu

6.5 Turn On/Off the Input Filter

6.5.1 Introduction

The user can select to enable LINE and FREQ functions, so as to suppress unwanted noise and harmonic components during fundamental wave measurement:

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- **Line filter.** The filter is embedded in the measurement circuit to remove the noise component of the input signal. The cut-off frequency of PA310/PA310H power meters can select 500Hz, 5.5KHz, 9KHz and 10KHz (of which 5.5KHz, 9KHz and 10KHz are digital filters), while PA323 and PA333H power meters can only select 500Hz;
- **Frequency filter.** Because the instrument is synchronized with the input signal before measurement, it is necessary to correctly measure the frequency of the input signal. The frequency filter is embedded in the frequency measurement circuit with a cut-off frequency of 500Hz.

6.5.2 Operation Instruction

Press the SETUP key on the front panel of mark ① as shown inFigure 6.6, and then press the universal keys in mark ② as shown in the figure to enter the line filter and frequency filter menu.

1. Line Filter Configuration

The menu setting process of frequency filter is as shown in Figure 6.5 According to the setting process of frequency filter menu as shown in Figure 6.6select frequency filter F.Fi Lt in the setting menu, and the cut-off frequency of the frequency filter is fixed at 500Hz. The user only must select whether the filter is OFF or ON, as shown in Figure 6.7. When the frequency filter is turned on, the indicator light of the corresponding frequency filter at mark ③ in Figure 6.6will be on, otherwise it will be off.

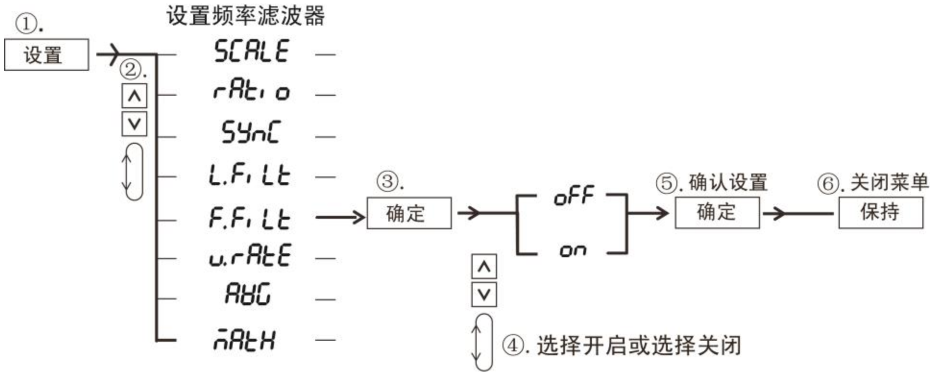

Figure 6.5 Setting process of frequency filter menu

Figure 6.6 Enter frequency filter menu

Figure 6.7 On/Off of frequency filter

2. Line filter

The line filter menu setting process of PA323 and PA333H power meters is shown in Figure 6.8, and of PA310 and PA310H power meters is shown in Figure 6.9. Select the frequency filter L.FiLt in the setting menu, and then select the cut-off frequency of the line filter, as shown in Figure 6.10. After selection, the line filter indicator on the front panel will be on.

The user can also select to turn OFF the line filter, as shown in Figure 6.11. After selecting "OFF", the line filter indicator light on the front panel will be off.

Note: When measure the small current signal, especially current signals below 1mA, it is highly recommended to turn on the line filter.

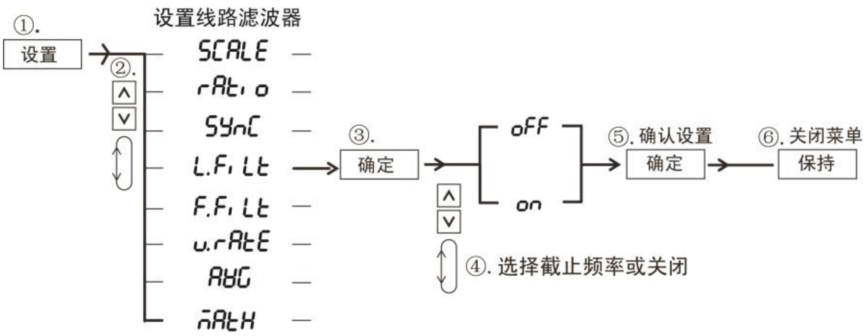

Figure 6.8 Line filter menu setting process (PA323/PA333H)

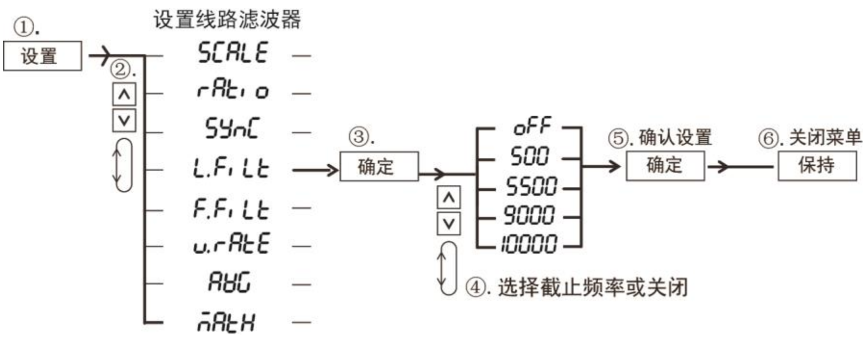

Figure 6.9 Line filter menu setting process (PA310/PA310H)

Figure 6.10 Cut-off frequency selection of line filter

Figure 6.11 Turn off line filter

6.6 Configure Input Range

6.6.1 Introduction

1. Setting of Input Range

Depending on how the external voltage signal or current signal is input to the power meter, the range setting method is also different.

(1) Direct input range setting

When the external voltage or current signal is directly connected to the input of this instrument, the direct input range of the instrument can be set.

(2) Range setting when connecting voltage/current sensor externally

When connecting the secondary output side of the external VT or CT to the input of this instrument, the conversion ratio to convert the measured value to direct display or output must be set. The instrument can set the proportional constants of VT ratio, CT ratio or power coefficient, as shown in Table 6.2.

Table 6.2 Set proportional constants

Measurement Value	Conversion Result	Description
Voltage V	P×V	P: Voltage proportional constant (VT ratio) C: Current proportional constant (CT ratio) F: Power proportional constant
Current A	C×A	
Active power W	F×P×C×W	
Reactive power var	F×P×C×var	
Apparent power VA	F×P×C×VA	

2. Auto range and fixed range

When setting the range, the user can select automatic range or fixed range. Under the automatic range mode, the voltage range and the current range will automatically switch the measuring range according to the size of the input signal. The type of switching range is the same as that of the fixed range.

(1) Fixed range

Under the fixed range mode, the current range available for the PA300 series high-precision power meters is as follows:

Current range of PA310 power meter:

- **When the peak factor is 3:** 20A, 10A, 5A, 2A, 1A, 500mA, 200mA, 100mA, 50mA, 20mA, 10mA, 5mA;
- **When the peak factor is 6:** 10A, 5A, 2.5A, 1A, 500mA, 250mA, 100mA, 50mA, 25mA, 10mA, 5mA, 2.5mA;

Current range of PA310H power meter:

- **When the peak factor is 3:** 50A, 20A, 10A, 5A, 2A, 1A;
- **When the peak factor is 6:** 25A, 10A, 5A, 2.5A, 1A, 500mA

Current range of PA323 power meter:

- **When the peak factor is 3:** 20A, 10A, 5A, 2A, 1A, 500mA;
- **When the peak factor is 6:** 10A, 5A, 2.5A, 1A, 500mA, 250mA;

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Current range of PA333H power meter:

- **When the peak factor is 3:** 50A, 20A, 10A, 5A, 2A, 1A;
- **When the peak factor is 6:** 25A, 10A, 5A, 2.5A, 1A, 500mA

Under the fixed range mode, the voltage range available for the PA310H and PA333H power meters is as follows:

- **When the peak factor is 3:** 15V, 30V, 60V, 150V, 300V, 600V, 1000V (peak factor of 1.5);
- **When the peak factor is 6:** 7.5V, 15V, 30V, 75V, 150V, 300V, 500V (peak factor of 3).

Under the fixed range mode, the voltage range available for the PA310 and PA323 power meters is as follows:

- **When the peak factor is 3:** 15V, 30V, 60V, 150V, 300V, 600V;
- **When the peak factor is 6:** 7.5V, 15V, 30V, 75V, 150V, 300V.

Under the fixed range mode, the voltage range available for the PA310 and PA323 external voltage type current sensor is as follows:

- **When the peak factor is 3:** 50mV, 100mV, 200mV, 500mV, 1V, 2V, 2.5V, 5V, 10V;
- **When the peak factor is 6:** 25mV, 50mV, 100mV, 250mV, 0.5V, 1V, 1.25V, 2.5V, 5V.

Under the fixed range mode, the voltage range available for the PA310H and PA333H external voltage type current sensor is as follows:

- **When the peak factor is 3:** 100mV, 200mV, 400mV, 1V, 2V, 5V, 10V;
- **When the peak factor is 6:** 50mV, 100mV, 200mV, 0.5V, 1V, 2.5V, 5V.

(2) Auto range

The PA300 series high-precision power meters adopt the leading measurement and control technology, which can automatically and quickly switch the range, enabling continuous and accurate measurement.

- **Range upshift.** When the measured value of voltage or current exceeds 130% of the rated range or the instantaneous voltage or peak current value obtained by sampling exceeds about 300% of the rated range (600% when the peak factor is 6), when the measured value is updated next time, the range is automatically upshifted;
- **Range downshift.** When the measured value of voltage or current is less than or equal to 30% of the rated range and less than 125% of the next range, and the peak value is less than or equal to 300% of the next range (600% when the peak factor is 6), when the measured value is updated next time, the range is automatically downshifted.

6.6.2 Configure Direct Input Range

1. PA310/PA310H power meters

Press the VOLTAGE or CURRENT key at mark ① as shown in Figure 6.12 Enter range setting menu to display the voltage or current range menu; then the user selects the auto range and other fixed range by using the universal keys at mark ② inFigure 6.12 Enter range setting menu. If auto range is selected, the corresponding auto range indicator at mark ① in Figure 6.12 Enter range setting menu will light upFigure 6.12 Enter range setting menu is an example of PA310 voltage range configuration, and Figure 6.14 PA310H voltage range selection exampleis an example of PA310H voltage range configuration.

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Figure 6.12 Enter range setting menu

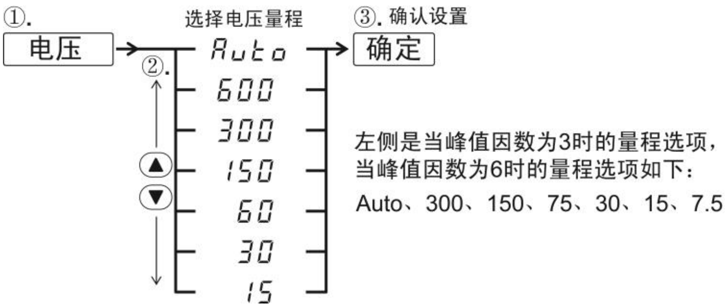

Figure 6.13 PA310 voltage range selection example

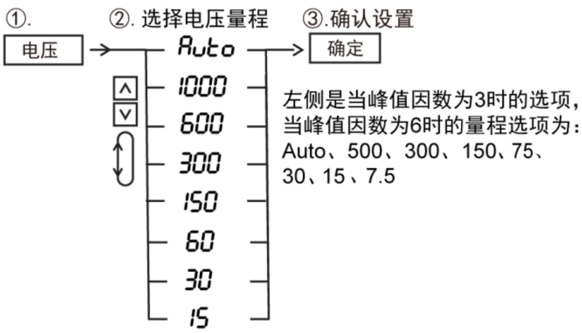

Figure 6.14 PA310H voltage range selection example

If only direct measurement of the input signal is required, the user must also confirm that the VT/CT ratio conversion function of the power meter is turned off. For details, see the section "Enable/Disable External VT/CT Conversion".

2. PA323/PA333H power meters

The user needs to first select the input unit and wiring group that need to be configured with a range, see "Figure 6.15 Enter range setting menu for details. Press the VOLTAGE or CURRENT key at mark ① as shown in Figure 6.15to display the voltage or current range menu; then the user selects the auto range and other fixed range of input unit or wiring group by using the universal keys at mark ② in Figure 6.15. If auto range is selected, the corresponding auto range indicator at mark ① in Figure 6.15 will light up. Figure 6.15 is an example of PA323 voltage range selection, Figure 6.16 is an example of PA333H voltage range selection, Figure 6.17 is an example of PA323 current range selection, and Figure 6.18 is an example of PA333H current range selection.

Figure 6.15 Enter range setting menu

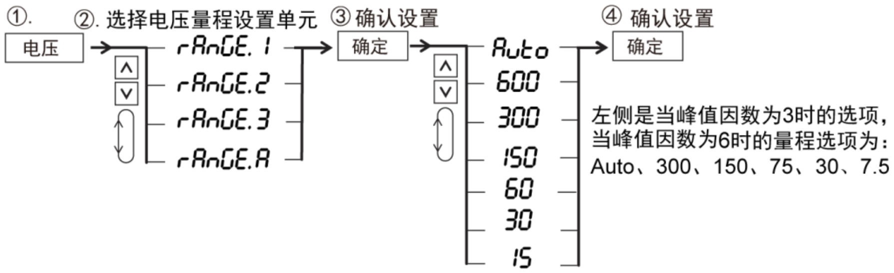

Figure 6.16 PA323 power meter voltage range selection example

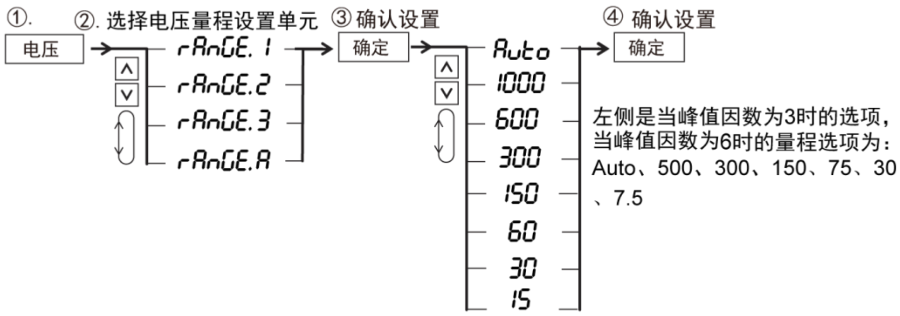

Figure 6.17 PA333H voltage range selection example

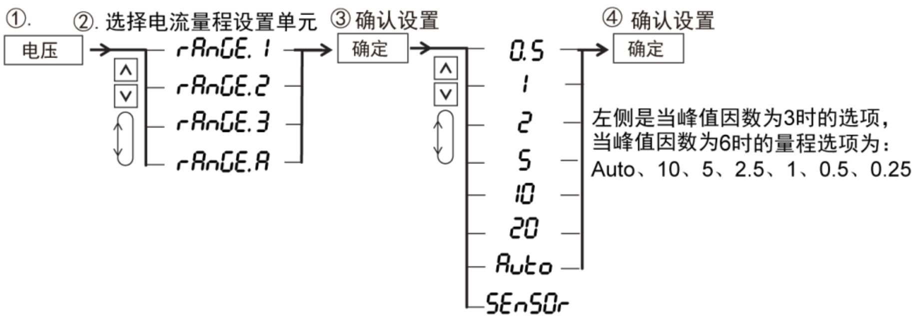

Figure 6.18 PA323 current range selection example

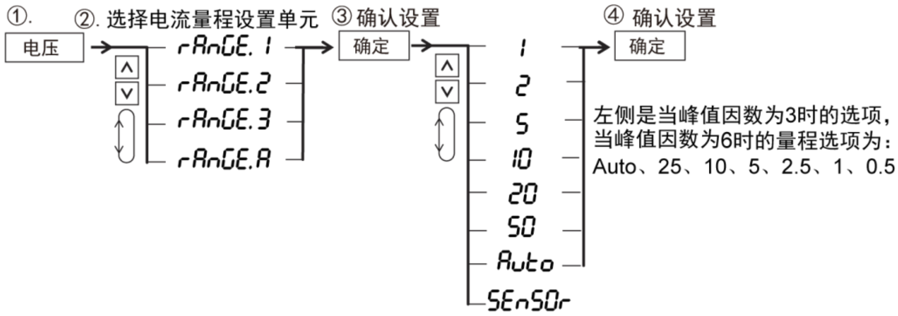

Figure 6.19 PA333H current range selection example

If only direct measurement of the input signal is required, the user must also confirm that the VT/CT ratio conversion function of the power meter is turned off. For details, see the section "Enable/Disable External VT/CT Conversion".

6.6.3 Range Configuration When Using External VT/CT (PA310/PA310H)

1. Set the direct voltage/current input range

When using the external VT/CT, the input measurement signals need to be converted to obtain the final measurement results. First. the input signal must be within the direct voltage/current input range, so the user must also first set the input range (see section Figure 6.15"), then set the external VT/CT conversion ratio, and the final measurement result is converted from the measured value of the input measurement signal and the conversion ratio.

2. Enter the external VT/CT conversion ratio setting menu

Press the SETUP key on the front panel to enter the SETUP menu (as shown in Screen A of Figure 6.20), and then press the universal keys at mark ② ofFigure 6.20 to enter the external VT/CT proportional constant setting menu "SCALE" shown in Screen B ofFigure 6.20to configure the conversion ratio. SeeFigure 6.21 for the related menu operation process.

Figure 6.20 Set external VT/CT proportional constant

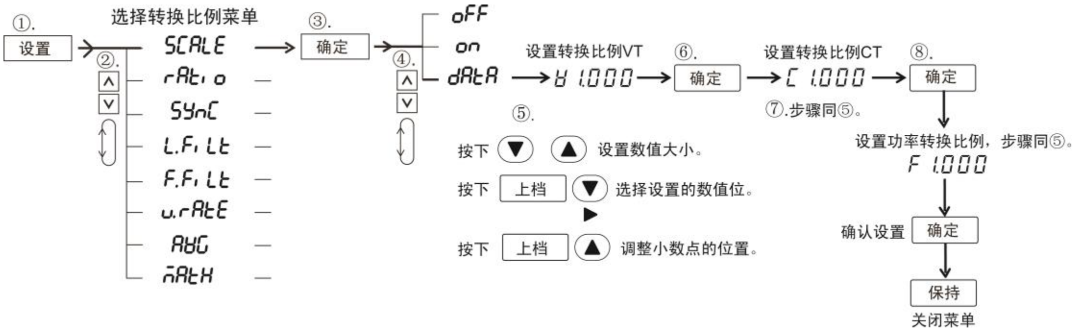

Figure 6.21 Setting process of external VT/CT proportional constant

The conversion proportional constants of voltage, current and power can be set in the "DATA" sub-menu as shown in Figure 6.21. The conversion ratio of voltage, current and power ranges from 0.001 to 9999. The user adjusts the value by moving the cursor right, moving the decimal point right, and increasing/decreasing the value by using the universal keys. The description of universal keys is as shown inFigure 6.22.

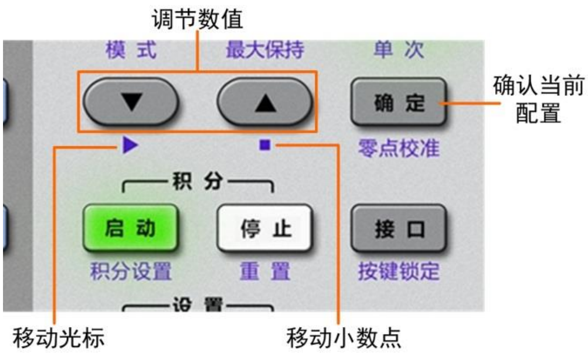

Figure 6.22 Operation description of universal keys

3. Enable/disable the external VT/CT conversion

After configuring the conversion proportion, **the user needs to make sure that the external VT/CT conversion function is enabled.** In the "SCALE" sub-menu items as shown in Figure 6.24 select "ON" to enable the external VT/CT conversion function. When the external VT/CT conversion function is enabled, the "SCALING" indicator light on the front panel will be on; select "OFF" to disable the external VT/CT conversion function, and the "SCALING" indicator light on the front panel will be off. The related menu operation process is as shown in Figure 6.23.

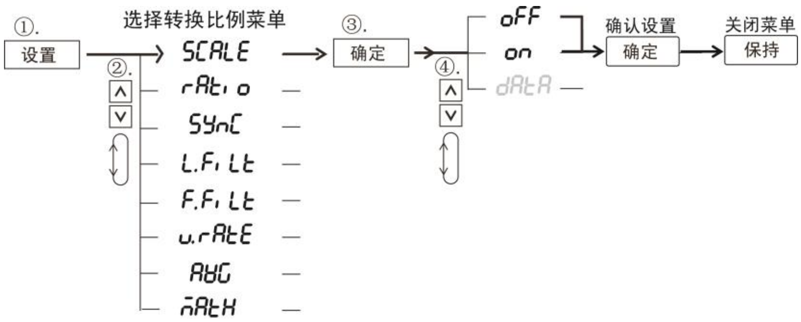

Figure 6.23Enable/disable conversion proportion function

6.6.4 Range Configuration When Using External VT/CT (PA323/PA333H)

The user needs to first select the input unit and wiring group that need to be configured with a range, see " nput unit and wiring group" for details.

1. Set the direct voltage/current input range

When using the external VT/CT, the input measurement signals need to be converted to obtain the final measurement results. First. the input signal must be within the direct voltage/current input range, so the user must also first set the input range (see "Figure 6.15" section), then set the external VT/CT conversion ratio, and the final measurement result is converted from the measured value of the input measurement signal and the conversion ratio.

2. Enter the external VT/CT conversion ratio setting menu

Press the SETUP key on the front panel to enter the SETUP menu (as shown inFigure 6.24, and then enter the external VT/CT proportional constant setting menu "SCALE" to set the conversion ratio. SeeFigure 6.25 for the related menu operation process.

Figure 6.24 Set external VT/CT proportional constant

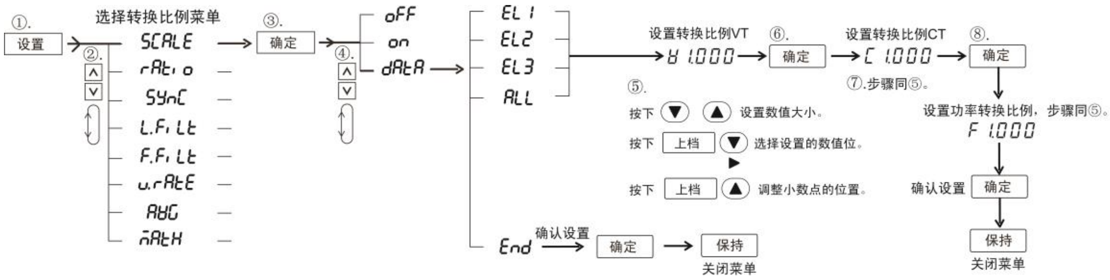

Figure 6.25 Setting process of external VT/CT proportional constant

The conversion proportional constants of voltage, current and power can be set in the "DATA" sub-menu as shown in Figure 6.25 (EL1-EL3 inFigure 6.25 corresponds to the input units 1-3, and all means selecting all input units).

The conversion ratio of voltage, current and power ranges from 0.001 to 9999. The user adjusts the value by moving the cursor right, moving the decimal point right, and increasing/decreasing the value by using the universal keys. The description of universal keys is as shown in Figure 6.25.

3. Enable/disable the external VT/CT conversion

After configuring the conversion proportion, **the user needs to make sure that the external VT/CT conversion function is enabled.** In the "SCALE" sub-menu items as shown in Figure 6.24, select "ON" to enable the external VT/CT conversion function. When the external VT/CT conversion function is enabled, the "SCALING" indicator light on the front panel will be on; select "OFF" to disable the external VT/CT conversion function, and the "SCALING" indicator light on the front panel will be off. The related menu operation process is as shown in Figure 6.25.

6.6.5 Range Configuration When Using the External Voltage-type Current Sensor

When using an external voltage-type current sensor, the measurement signal is input from the current sensor terminal. In this case, the direct current input range setting is invalid (see section "Figure 6.26"). The user must configure the range and conversion ratio of the voltage-type current sensor. Besides, the user needs to first select the input unit and wiring group that need to be configured with a range, see "Figure 6.27" for details.

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1. PA323/PA333H power meters

(1) Configure conversion ratio

Press the SETUP key on the front panel and then select the "Ratio" menu to configure the conversion ratio. The user can adjust the proportional constant in the range of 0.001 to 9999 as shown in the Screen D ofFigure 6.26The setting process of conversion proportional menu is as shown in Figure 6.27.

Figure 6.26 Proportional constant configuration menu of voltage-type current sensor

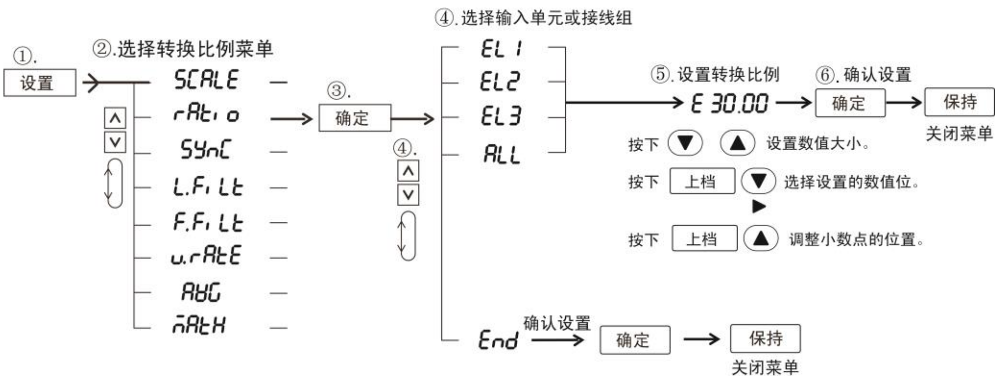

Figure 6.27 Conversion proportional menu setting process of external voltage-type current sensor

(2) Configure range

After setting the conversion range, it is required to select the range for the voltage-type current sensor. For example, if A voltage-type current sensor with A conversion ratio of 2.5mV/A is used to measure the current of 200A, the maximum output voltage of the voltage-type current sensor is 2.5mV/A × 200A = 500mV. Therefore, the user needs to select a range of at least 500mV on the power meter.

Press the CURRENT key on the front panel to enter the current range configuration menu; and then select "SENSOR" in the current range configuration menu to enter the sensor range configuration menu, as shown in Screen D of Figure 6.28. The optional range is: AUTO (auto range), 10V, 5V, 2.5V (except PA333H), 2V, 1V, 500MV (PA333H is 400MV), 200MV, 100MV, 50MV (except PA333H).

Figure 6.28 Sensor range configuration

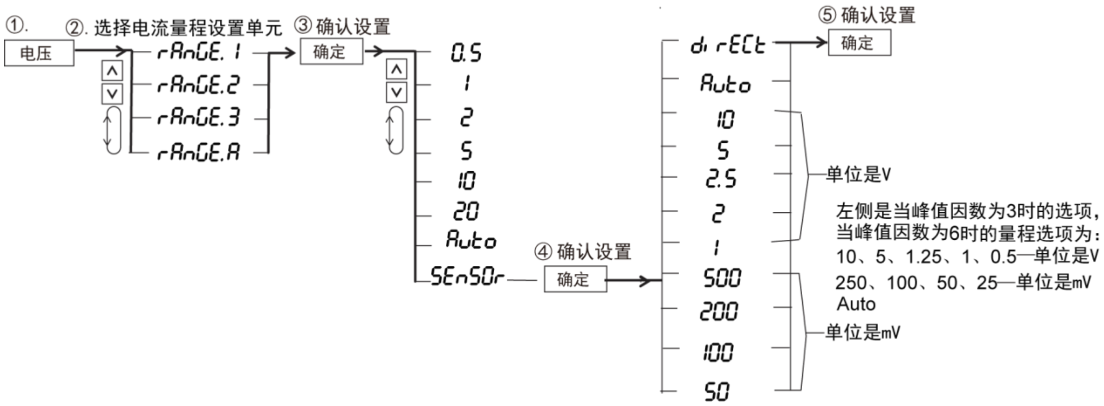

Figure 6.29 Example of selecting range for PA323 external voltage output sensor

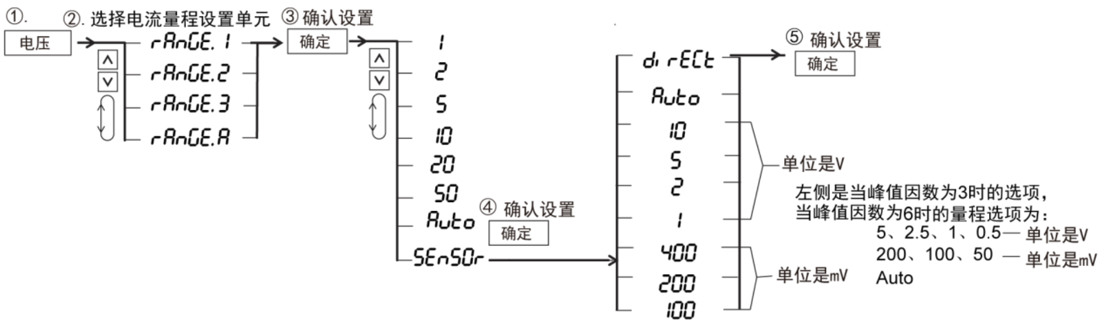

Figure 6.30 Example of selecting range for PA333H external voltage output sensor

(3) Turn off the external voltage-type current sensor

To stop using the external voltage-type current sensor, the user only needs to select the "Direct" menu from the current range menu as shown inFigure 6.29 and Figure 6.30.

2. PA310/PA310H power meters

(1) Configure conversion ratio

Press the SETUP key on the front panel and then select the "Ratio" menu to configure the conversion ratio.

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The user can adjust the proportional constant in the range of 0.001 to 9999 as shown in Figure 6.31. The setting process of conversion proportional menu is as shown in Figure 6.32.

Figure 6.31 Proportional constant configuration menu of voltage-type current sensor

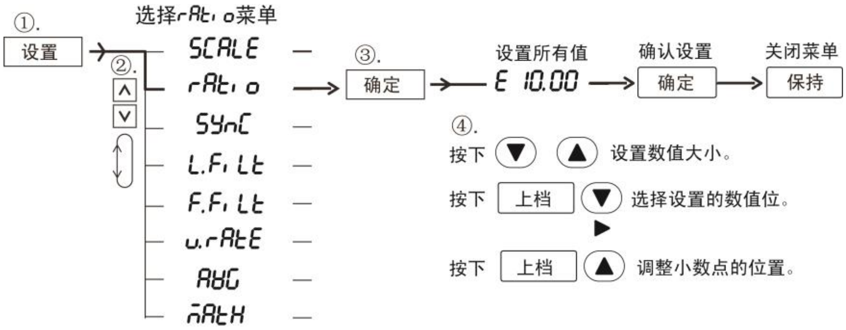

Figure 6.32 Conversion proportional menu setting process of external voltage-type current sensor

(2) Configure sensor range

After setting the conversion range, it is required to select the range for the voltage-type current sensor. For example, if A voltage-type current sensor with A conversion ratio of 2.5mV/A is used to measure the current of 200A, the maximum output voltage of the voltage-type current sensor is 2.5mV/A × 200A = 500mV. Therefore, the user needs to select a range of at least 500mV on the power meter.

Press the CURRENT key on the front panel to enter the current range configuration menu; and then select "SENSOR" in the current range configuration menu to enter the sensor range configuration menu, as shown in Screen C of Figure 6.33. The optional range is: AUTO (auto range), 10V, 5V, 2.5V, 2V, 1V, 500mV, 200mV, 100mV, 50mV.

Note: Optional range for PA310H is: AUTO (auto range), 10V, 5V, 2V, 1V, 400mV, 200mV, 100mV.

Figure 6.33 Sensor range configuration

(3) Turn off the external voltage-type current sensor

To stop using the external voltage-type current sensor, the user only needs to select other sub-menus except "SENSOR" from the current range menu as shown inFigure 6.33.

6.6.6 Range Skip

The user can make the auto range function skip the specified range. The range skip function can reduce the loss of measurement data when switching ranges one by one. The range skip function can be turned on/off by the power meter, which is convenient for users to turn on or off the function on site. The menu setting process of the range skip function is shown in Figure 6.34the rest of the settings can only be completed by sending SCPI commands to the power meter or by setting in the host computer software.

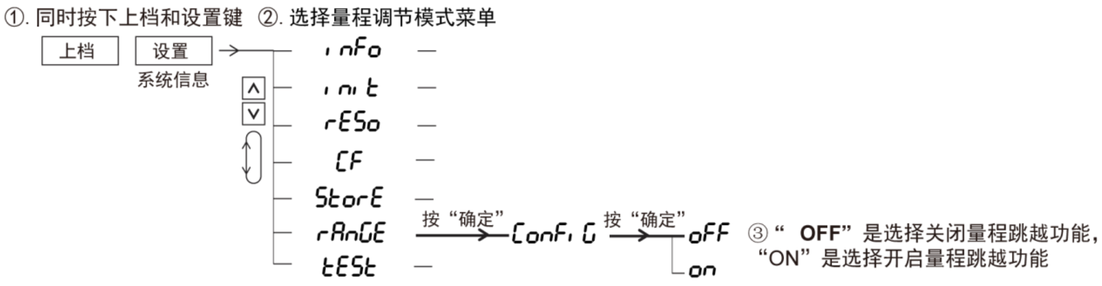

Figure 6.34 Average use function of range skip function

6.6.7 Peak Skip

When the range skip function is enabled, the user can also set to enable the peak skip function. In this way, when the peak measured value exceeds 300% of the current range, the range switch will be triggered, and the range will jump directly to the user-specified range. If the user-specified range still does not meet the measurement requirements, it will automatically switch to the appropriate range. The peak skip function is disabled by default, and the user can only send SCPI commands to the power meter or set it in the host computer software.

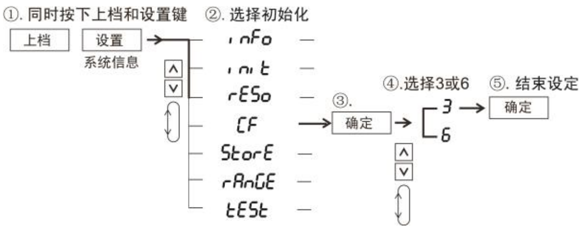

Figure 6.35 Menu operation process of peak factor selection

6.7 Select Peak Factor

The peak factor is the ratio of the wave peak value to the effective value. The setting of power meter's peak factor determines the switch between the measured range and the automatic range. See section " automatic range " for details. The user can set the peak factor of the power meter to either "3" or "6". The operation process of selecting peak factor in menu is as shown in Figure 6.35 According to the operation process, the user presses the SHIFT+SETUP key on the front panel to enter the UTILITY menu; and then selects the CF sub-menu to further select the peak factor.

Table 6.3 Parameter description

Symbol	Description
D_n	Display value of the n[th] time
M_n	Measured value of the n[th] time
D_{n-1}	Display value after the n-1[st] exponential average
$M_{n-(m-1)}$	Measured value m-1 times earlier than the measured value of n times
$M_{n-(m-2)}$	Measured value m-2 times earlier than the measured value of n times
M_{n-2}	Measured value two times earlier than the measured value of n times
M_{n-1}	Measured value one time earlier than the measured value of n times
K	Average coefficient
m	Average coefficient

6.8 Average Function

6.8.1 Introduction

When the power supply, load or low-frequency signal input changes suddenly, the sampled data may fluctuate greatly. In this case, the average function can be used to perform the average processing on the sampled data. The measurement functions that can directly support the average processing are: U, I, P, S and Q. λ, Φ, CfU and CfI can be calculated using the average value of Urms, Irms, P, S and Q. The average processing includes exponential average or moving average processing. The formula is as follows, and the description of the relevant parameters in the formula is shown in Table 6.3.

Exponential average formula

$D_n \ = D_{n-1} + (Mn - D_{n-1})/K$

Moving average formula

$D_n \ = (M_{n-(m-1)} + M_{n-(m-2)} + \ldots M_{n-2} + M_{n-1} + M_n)/m$

6.8.2 Operation Instruction

1. Operation process

The menu operation process for configuring the average function is as shown in Figure 6.36.

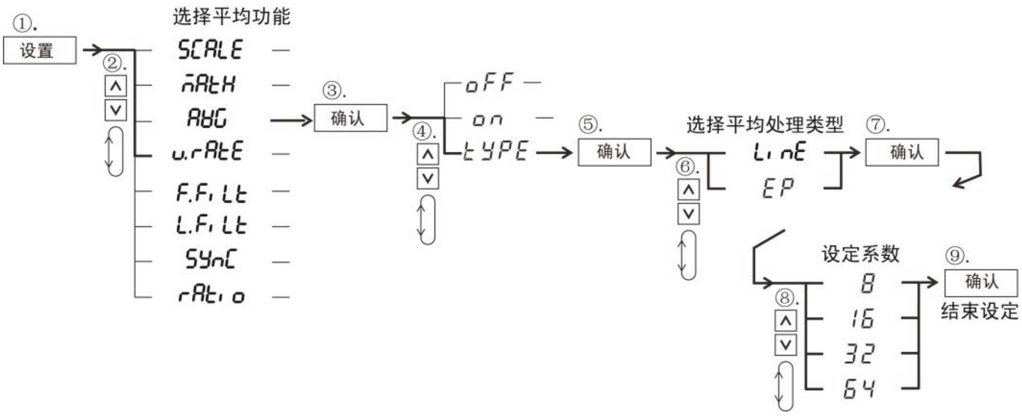

Figure 6.36 Operation process diagram

2. Enter average function menu

Press the SETUP key on the front panel and select "AVG" sub-menu in the "SETUP" menu to enter the average function menu.

3. Select average processing mode

The user selects the average processing mode from the average function menu, as shown in Figure 6.37.

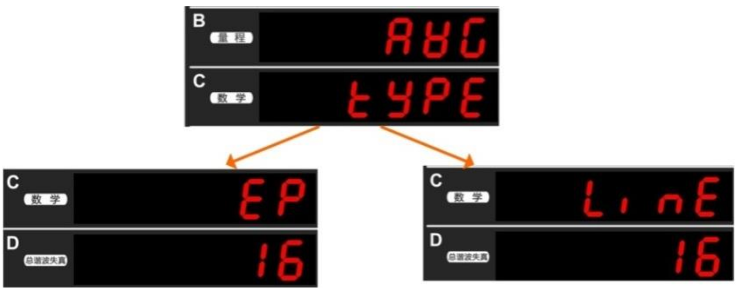

Figure 6.37 Select average processing mode

4. Select average coefficient

In Screen D, the user can use the universal keys to select the proper average coefficient, as shown in Figure 6.38. The optional average coefficients in the two average processing modes are: 8, 16, 32, 64.

Figure 6.38 Select average coefficient

5. Enable/disable average function

After configuring the average processing mode and average coefficient, the user can select "ON" in the average function menu to enable the average function, as shown in Figure 6.39.

Figure 6.39 Enable average function

6.9 Use MAX HOLD Function

When the MAX HOLD function is enabled, the max value of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), Wpk (peak power), Vpk (peak voltage) and Apk (peak current) can be obtained. The initial value of MAX HOLD function is OFF. At this time, the MAX HOLD indicator on the front panel is off; otherwise, the indicator is on. The user can directly press the MAX HOLD function key on the front panel to enable/disable the MAX HOLD function, as shown in Figure 6.40.

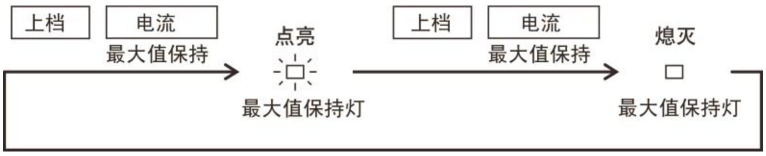

Figure 6.40 Enable/disable MAX HOLD function

6.10 Display Update Rate Settings

The user can configure the display update rate of the measurement or calculation results on the display screen. At this time, the display update rate indicator will flash according to the selected display update rate. Select a faster display update rate, which can measure the power of the load changing relatively fast; instead, select a slower display update rate to measure the power of signals with a relatively long period. The initial value of the display update rate is 0.25s, and the user can select the following display update rate: 0.1s, 0.25s, 0.5s, 1s, 2s, 5s, 10s, 20S and AUTO. The menu operation process of display update rate is as shown inFigure 6.41.

Refer to the process shown in Figure 6.41, press the SETUP key on the front panel, then select the display update rate menu and further select the desired display update rate.

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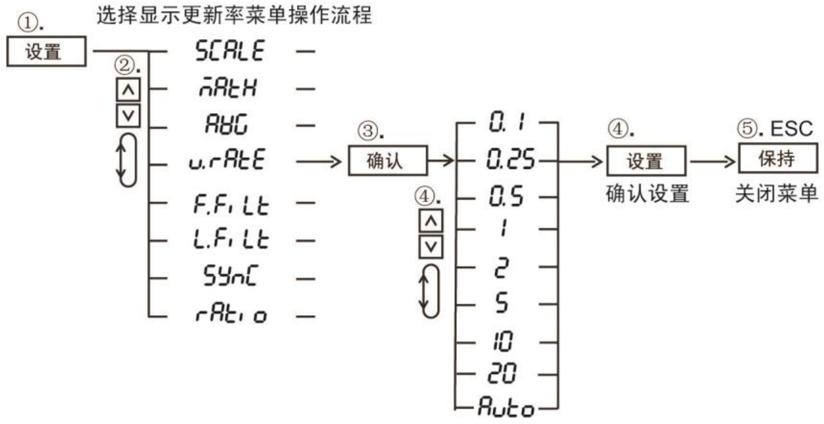

Figure 6.41 Menu operation process of display update rate

6.10.1 Auto Update Cycle

PA300 series power meters can measure frequencies as low as 0.1Hz, automatically detect the signal cycle and accurately measure it. This application has a special situation, which is similar to the power consumption measurement of inverter air conditioners. On the one hand, there is a change in signal size, and on the other hand, there is a change in signal cycle. Therefore, there is no problem with the automatic update cycle for AC signals. However, not all users measure such signals, and the automatic update period may be selected by mistake when measuring other signals. If you are measuring a DC signal or switching to the DC mode, you should also select the update rate according to the AC signal.

The following three situations are not applicable.

1. Measure the DC signal under RMS and VOLTAGE MEAN mode

If auto update rate mode is selected, the measurement data interface will prompt "LRATE" to prompt the user to switch to the desired update rate.

2. DC mode

When switching to DC mode, it is obvious that you need to see the DC composition or that you are measuring the DC signal. If the previous update cycle is automatic, it will automatically switch to the fixed 1s update rate display.

3. Synchronous source

Turn off the synchronous source automatically to switch to fixed 1s update rate.

If the voltage and current frequencies are different, the update cycle is adjusted according to the signal frequency of the synchronous source.

Note: If the update rate is automatic, the default value is 0.25s at startup.

Table 6.4 Table 6.1 Frequency measurement scope under auto range

Data Update Cycle	Frequency Measurement Scope
0.25 s	88Hz to 100kHz
0. 5 s	42Hz to 90Hz
1 s	20Hz to 45Hz
2 s	10Hz to 22Hz
5 s	0.8Hz to 10Hz
10 s	0.3Hz to 0.9Hz
20 s	0.1Hz to 0.4Hz

6.11 Display Digit Setting

The user can select the maximum display digits of V (voltage), A (current), W (active power), VA (apparent power), var (reactive power), PF (power factor), VHz (voltage frequency), AHz (current frequency) and harmonic measurement values (voltage, current, active power, power factor, harmonic components). The menu operation process of the display digit setting is shown in Figure 6.42.

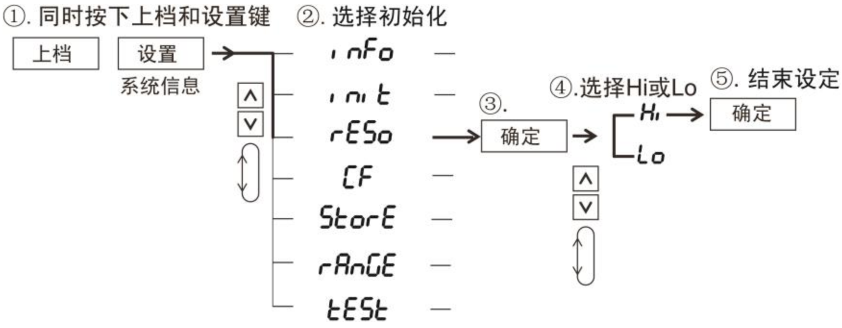

Figure 6.42 Display digit setting

As shown in Figure 6.42, the meaning of the display digits option is as follows:

- **Hi**。 The display digits are set to 5 digits (99999);
- **Lo**。 The display digits are set to 4 digits (9999).

The initial value of display digits is Hi.

7. Hold Operation and Single Measurement

7.1 Hold Operation

The user can pause measurement at each data update cycle with the hold operation and hold the current measured value.

Press the HOLD key shown in Figure 7.1 and the key indicator will be on. At this time, the measured value will be held. In hold state, press the HOLD key again, the indicator will be off and the measured value will be updated.

Figure 7.1 HOLD key and SINGLE key

7.2 Single Measurement

In hold state, the user can press the SINGLE key as shown in Figure 7.1 to preform single measurement and update the display once, and then return to hold state.

If the user wants to hold the shift state, it can press the SHIFT key twice to lock the SHIFT state; at this time, the user just needs to press the HOLD key to perform the single measurement operation. To release the shift lock state, the user can press the SHIFT key again.

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8. Power Measurement

8.1 Switch Display Measurement Function

When the display function switch keys shown inFigure 8.1 or Figure 8.2 is pressed, the measurement items in Screen A-D will be switched successively, as shown in Figure 8.3.

Figure 8.1 Display function switch keys and display area (PA310/PA310H)

Figure 8.2 Display function switch keys and display area (PA323/PA333H)

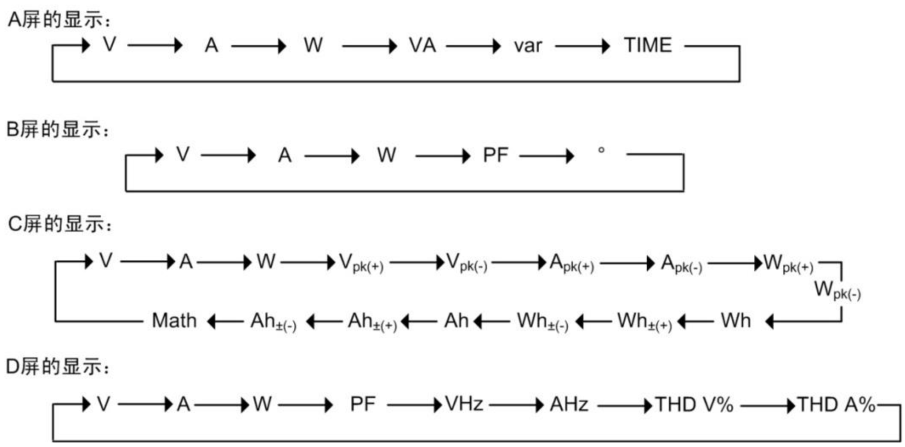

Figure 8.3 Display function switch

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In addition, attention should be paid to the following:

- Vpk, Apk, Wpk, Wh±, Ah± are all lit twice. Press the display function switch key once to display the positive value of the measured value, and press it again to display the negative value;
- Press the SHIFT key and then the display function switch key to switch the display function in reverse order as shown in Figure 8.3;
- The MATH and THD display indicators are located at the left end of screen C and screen D respectively.

8.2 Display Voltage, Current and Active Power

The user needs to first select the input unit or wiring group and then switch the measurement function displayed. The measurement display switch of voltage, current and active power is shown in Figure 8.4. V is the unit of voltage and indicates the display of the voltage measurement function; A is the unit of current and indicates the display of current measurement function. W is the unit of active power and indicates the display of active power. m, K, M are prefixes to these units. The max display value of voltage, current and active power is 99999. When selecting wiring group Σ, the measured value displayed depends on the connection mode and function displayed, as shown in the Table 8.1 (PA323 and PA333H power meters only).

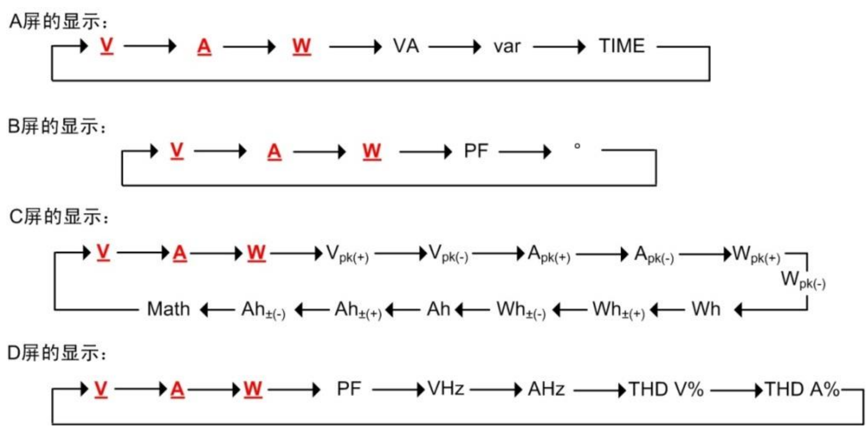

Figure 8.4 Display switching sequence of voltage, current and active power

Table 8.1 Display of corresponding measured Σ value

Wiring Mode	UΣ	IΣ	PΣ	SΣ	QΣ	Λσ	ΣΦ
1P3W	(U1 + U3) / 2	(I1 + I3) / 2	P1 + P3	S1 + S3	Q1 + Q3		
3P3W	(U1 + U3) / 2	(I1 + I3) / 2	P1 + P3	$\sqrt{3}$ (S1 + S3)/2	Q1 + Q3	PΣ/SΣ	$\cos^{-1}\lambda\Sigma$
3P4W	(U1 + U2 + U3) / 3	(I1 + I2 + I3) / 3	P1+P2+P3	S1 + S2 + S3	Q1+Q2+Q3		
3V3A	(U1 + U2 + U3) / 3	(I1 + I2 + I3) / 3	P1 + P3	$\sqrt{3}$ (S1 + S2 + S3)/3	Q1 + Q3	PΣ/SΣ	$\cos^{-1}$ (PΣ/SΣ)
P3/P1 measurement	U3	I3	P3	S3	Q3	PΣ/SΣ	$\cos^{-1}$(PΣ/SΣ)
(P1+P3)/P2 measurement	(U1+U3)/2	(I1+I3)/2	P1 + P3	$\sqrt{3}$ (S1 + S3)/2	Q1 + Q3		

8.3 Display Apparent Power, Reactive Power and Power Factor

The measurement display switch of apparent power, reactive power and power factor is as shown in Figure 8.5. VA is the unit of apparent power S and indicates the display of the apparent power measurement function; VaR is the unit of reactive power Q and indicates the display of reactive power measurement function; PF indicates the display of power factor measurement function, and the power factor has no unit. Before displaying the apparent power, reactive power and power factor, the user needs to first select the input unit or wiring group corresponding to the measured data. See Figure 6.2or the operation steps.

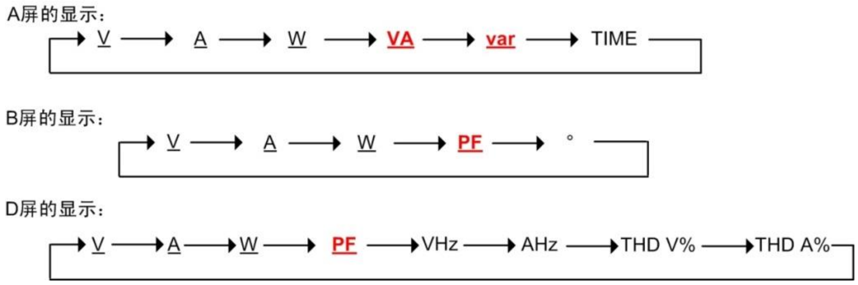

Figure 8.5 Display apparent power, reactive power and power factor

The max display value of apparent power and reactive power is 99999; and the display range of power factor is –1.0000-1.0000. The prefixes for apparent power and reactive power units are m, k, and M.

8.4 Display of Phase Angle and Frequency

The user can display the phase angle, voltage frequency and current frequency, as shown in Figure 8.6 "°" is the unit of phase angle and indicates the display of the phase angle measurement function; V Hz indicates the display of voltage frequency measurement function; and A Hz indicates the display of current frequency measurement function. K, M are prefixes to frequency unit. Before displaying the phase angle and frequency, the user needs to first select the input unit or wiring group corresponding to the measured data. See Figure 6.2for the operation steps.

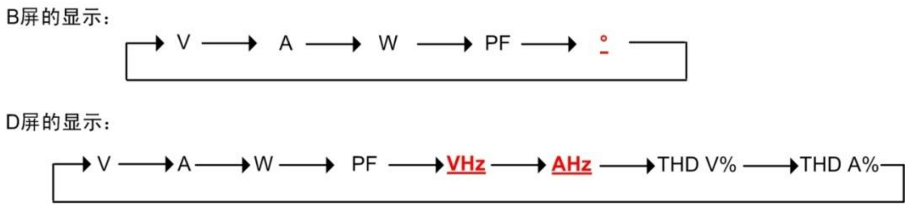

Figure 8.6 Display of phase angle and frequency

Display range of phase angle: G180 to d180 ((G indicates lag, d indicates lead); the maximum value of frequency display: 99999. The frequency measurement range is affected by the data update cycle, seeTable 8.2for details.

Table 8.2 Frequency measurement range

Data Update Cycle	Frequency Measurement Scope	
	PA310/PA310H/PA333H	PA323
0.1 s	25Hz to 300kHz	25Hz to 100kHz
0.25 s	10Hz to 300kHz	10Hz to 100kHz
0.5 s	5Hz to 300kHz	5Hz to 100kHz

续上表

Data Update Cycle	Frequency Measurement Scope	
	PA310/PA310H/PA333H	PA323
1 s	2.5Hz to 300kHz	2.5Hz to 100kHz
2 s	1.5Hz to 300kHz	1.5Hz to 100kHz
5 s	0.5Hz to 300kHz	0.5Hz to 100kHz
10s	0.2Hz to 300kHz	0.2Hz to 100kHz
20s	0.1Hz to 300kHz	0.1Hz to 100kHz
Auto	0.1Hz to 300kHz	0.1Hz to 100kHz

8.5 Display Peak Value

The user can display the peak voltage Vpk, peak current Apk and peak power Wpk, as shown in Figure 8.7:

- Vpk indicates the display of peak voltage measurement function, Vpk+ indicates the display of maximum voltage, and Vpk- indicates the display of minimum voltage;
- Apk indicates the display of peak current measurement function, Apk+ indicates the display of maximum current, and Apk- indicates the display of minimum current;
- Wpk indicates the display of peak power measurement function, Wpk+ indicates the display of maximum power, and Wpk- indicates the display of minimum power;
- V is the unit of peak voltage, A is the unit of peak current, and W is the unit of peak power. m, K, M are prefixes to these units.

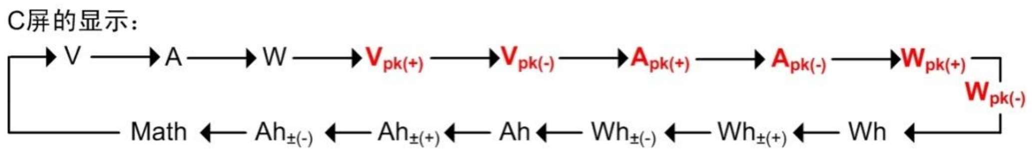

Figure 8.7 Display peak value

The max display peak value is 99999. Before displaying the phase angle and frequency, the user needs to first select the input unit or wiring group corresponding to the measured data. See Figure 8.7 for the operation steps.

8.6 Total Harmonic Distortion

The user can display the voltage total harmonic distortion (THD V%) and current total harmonic distortion (THD A%) in Screen D, as shown in Figure 8.8Figure 9.1:

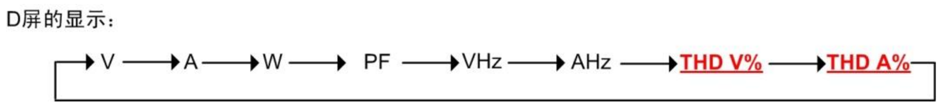

Figure 8.8 Total harmonic distortion

9. Mathematical Operation

9.1 MATH Menu

The user can select various operations to be performed under the MATH menu and display the results of the operations. The MATH menu access steps and content of PA323/PA333H power meters are shown in Figure 9.1 and of PA310 power meter is shown in Figure 9.2The description of operational formulas in the menu is as shown in Table 9.1

Table 9.1 Description of operational formula

功率计里显示的运算算式	算式说明
CFi	电流峰值因数计算，其后的数字是功率计输入单元的编号，例如 CFi 1 即为输入单元 1 的电流峰值因数
CFu	电压峰值因数计算
EFFi	效率计算
AUP	积分平均有功功率
A^2/b	A^2/B
A/b^2	A/B^2
A/b	A/B
A*b	A×B
A-b	A－B
A+b	A＋B

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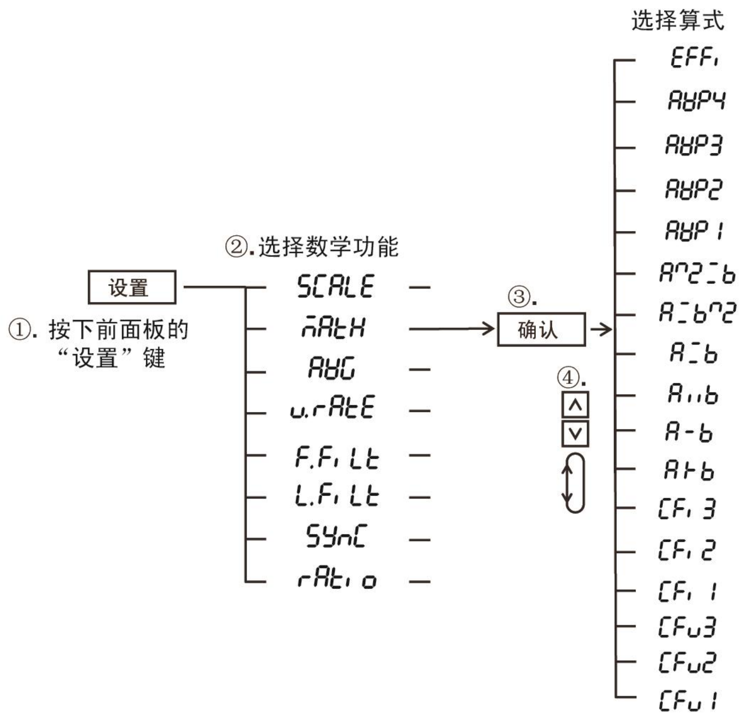

Figure 9.1 MATH menu (PA323/PA333H)

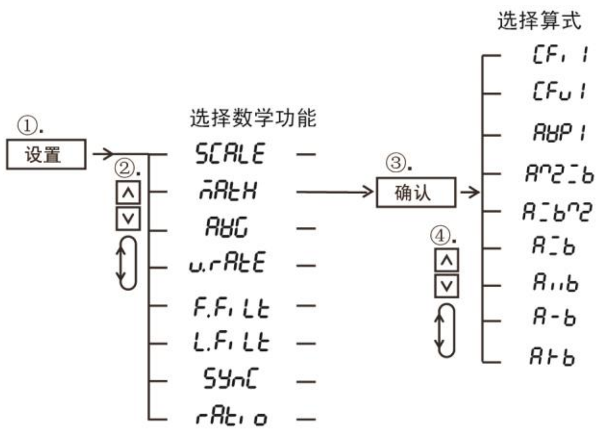

Figure 9.2 MATH menu (PA310/PA310H)

9.2 Efficiency Calculation

PA323 and PA333H power meters can display the results of efficiency measurement (PA310/PA310H power meters are not supported).

The efficiency calculation diagram of PA323/PA333H power meters is as shown in Figure 9.3. The input unit 2 measures the effective power of the primary side of the inverter, and the input unit 1 and 3 measure the effective power of the secondary side of the inverter. The efficiency calculation formula is as follows:

$$\text{Efficiency} = \frac{P1+P3}{P2} \times 100\ (\%)$$

Figure 9.3 Efficiency calculation description of PA323/PA333H power meters

It should be noted that if the denominator of the efficiency calculation formula is less than 0.0001% of the rated range, the efficiency measurement results will show as "ERROR".

9.3 Peak Factor Calculation

The peak factor is equal to the peak value/effective value. The instrument can calculate the peak factor of the measured signal and display it on the Screen C. The menu operation process of PA323/PA333H power meters is shown in Figure 9.4 and of PA310/PA310H power meters is shown in Figure 9.5. If the operation is correct, the peak factor calculation results will appear on Screen C of the front panel, and the "MATH" indicator on screen C will be on, as shown in Figure 9.6.

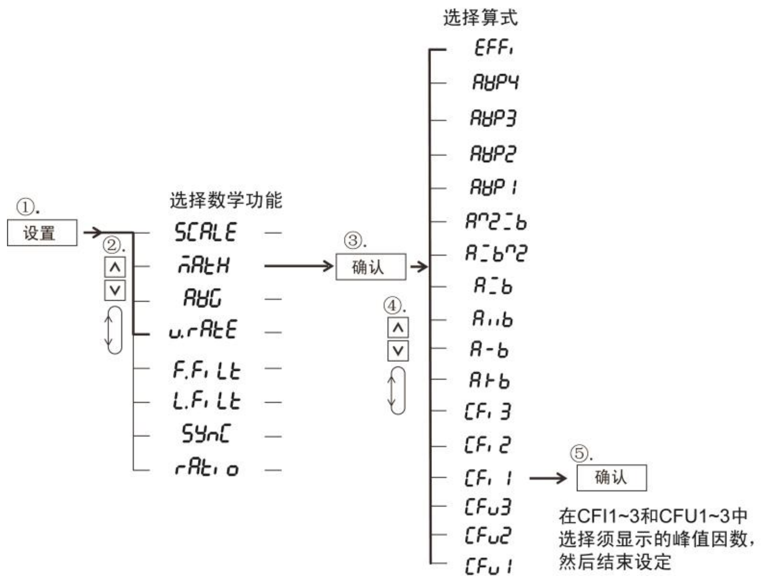

Figure 9.4 Calculation of peak factor (PA323/PA333H)

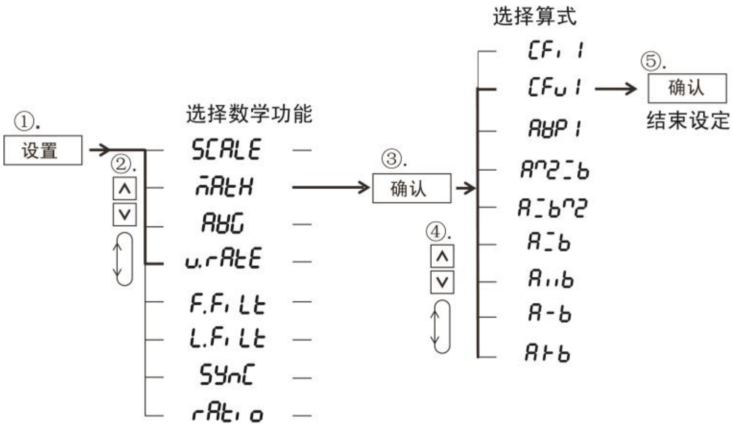

Figure 9.5 Calculation of peak factor (PA310/PA310H)

Figure 9.6 Peak factor display

The calculation method and display value of peak factor:

- CF u1: Display the calculation result of dividing U1 peak value by U1RMS value;
- CF U2: Display the calculation result of dividing U2 peak value by U2RMS value (PA323/PA333H only);
- CF u3: Display the calculation result of U3 peak value divided by U3rms value (PA323/PA333H);
- CF i1: Display the calculation result of dividing I1 peak value by I1RMS value;
- CF i2: Display the calculation result of dividing I2 peak value by I2RMS value (PA323/PA333H only);
- CF i3: Display the calculation result of I3 peak value divided by I3rms value (PA323/PA333H).

9.4 Integral Average Active Power

The power meter can calculate the average active power during the integration period and display the calculation result. The calculation formula of the average integral active power is shown below.

$$\text{Average active power during integration (W)} = \frac{\text{瓦时（Wh）}}{\text{积分时间 (h)}}$$

For PA323/PA333H power meters, according to the menu operation process shown in Figure 9.7 (the menu operation process of PA310/PA310H power meters is shown inFigure 9.8), press the SETUP key on the front panel, then select the average integral active power formula in the MATH menu, and the average integral active power measurement value will be displayed on the Screen C.

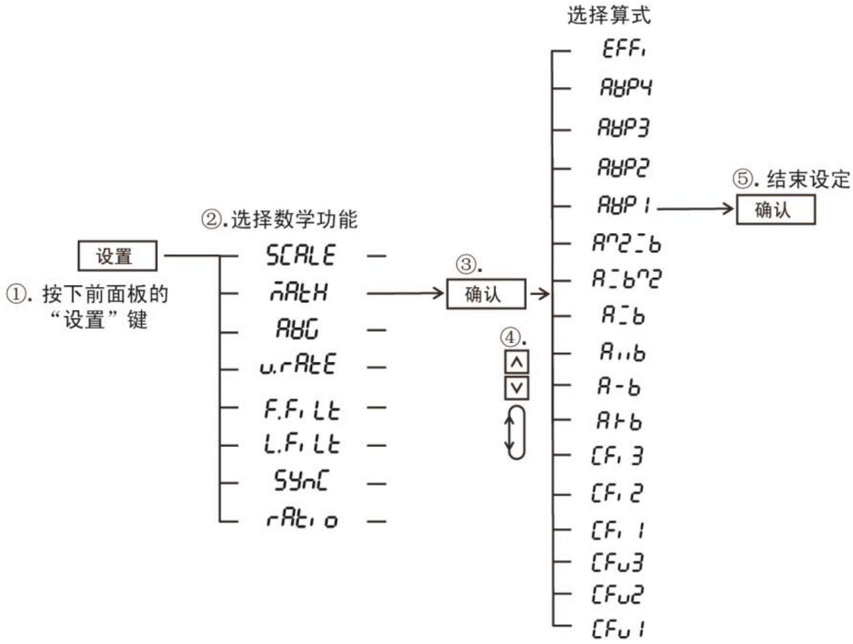

Figure 9.7 Average integral active power calculation (PA323/PA333H)

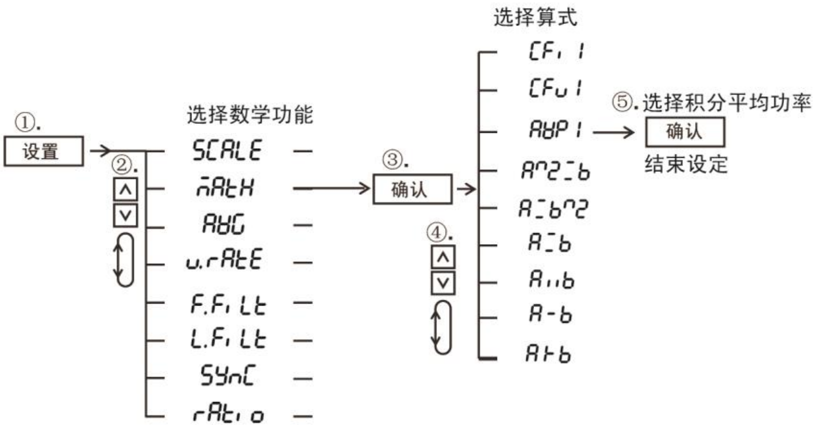

Figure 9.8 Average integral active power calculation (PA310/PA310H)

9.5 Four Arithmetic Operations

The user can perform four arithmetic operations on the display values of Screens A and B on the front panel, and display the calculation results on Screen C. At this time, the "MATH" indicator on Screen C will light up. The description of the four arithmetic formulas displayed on the front panel is shown in Figure 9.11. The menu operation process of four arithmetic operations for PA323/PA333H power meters is shown in Figure 9.9, and of PA310/PA310H power meters is shown in Figure 9.10.

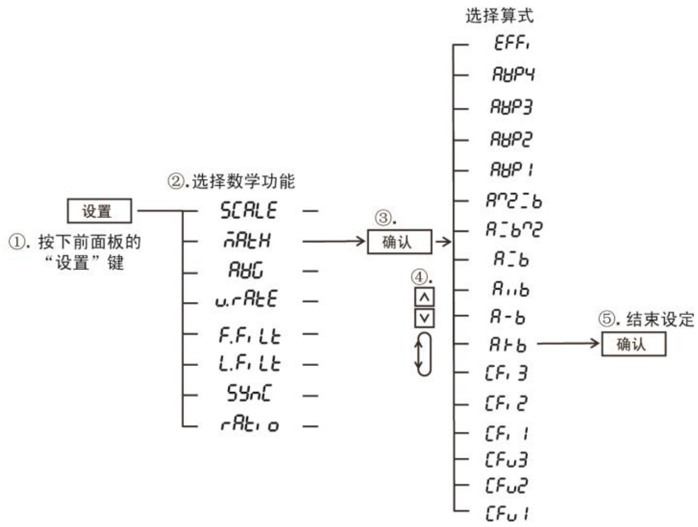

Figure 9.9 Menu operation process (PA323/PA333H)

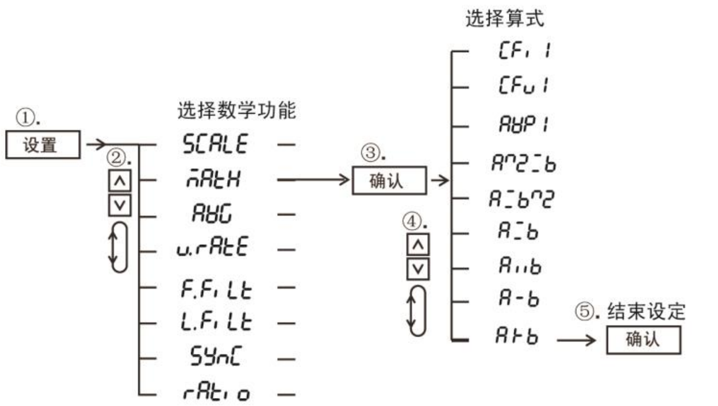

Figure 9.10 Menu operation process (PA310/PA310H)

According to the menu operation process shown in Figure 9.9, press the SETUP key on the front panel, select the MATH menu, and then select the desired formula. After confirming the formula selection, press the Fc key on the front panel to switch to the Screen C to switch its display function to mathematical operation. At this time, the display data on Screen C is shown in Figure 9.11which is equal to Screen A data + Screen B data.

Figure 9.11 Display of four arithmetic operation results

It should be noted that the Screen C displays as many valid numbers as possible. In Figure 9.11, for example, Screen C shows 188.24 instead of 0.188.

10. Integrator Function

10.1 Introduction

The user can integrate the active power and current. The integrator can not only display the measured integral value (Wh or Ah) and integral time, but also other measured value (or operation value); since the integral value can be displayed by polarity, the positive integral power consumed by the load (Wh+) and the negative integral power returned to the power supply (Wh-) can be displayed separately; in DC mode, the positive and negative current integral value can also be displayed separately (Ah+, Ah-).

10.1.1 Displayable Integrator Function

The integrator functions that can be displayed include: Wh: display the sum of positive and negative watt-hours, Wh±: display watt-hours by polarity, Ah: display the sum of ampere-hours, Ah±: display the sum of ampere-hours or display ampere-hours by polarity, see Table 10.1 for details.

Table 10.1 Display of integral value

Display Function	Measurement Mode	Display Content
Wh	RMS, VOLTAGE MEAN, DC	Sum of positive and negative watt-hours
Wh±[1]	RMS, VOLTAGE MEAN, DC	Positive watt-hours
Wh±[1]	RMS, VOLTAGE MEAN, DC	Negative watt-hours
Ah	RMS, VOLTAGE MEAN	Sum of ampere-hours
	DC	Sum of positive and negative ampere-hours
Ah±[2]	RMS, VOLTAGE MEAN	Sum of ampere-hours (Ah)
	DC	Positive ampere-hours
Ah±[2]	RMS, VOLTAGE MEAN	Display -0
	DC	Negative ampere-hours

[1] When selecting the Wh function, press the display function switch button once or twice and the display function will always display Wh±. Press once to display positive watt-hours; and press twice to display negative watt-hours. The negative value is displayed with "-".

[2] When selecting the Ah function, press the display function switch button once or twice and the display function will always display Ah±. Press once to display positive ampere-hours; and press twice to display negative ampere-hours. The negative value is displayed with "-".

10.1.2 Display of Integral Value

The integral value is usually displayed at a resolution of 99999 (in mWh or mAh, 999999). When the integral count reaches 100,000, the decimal point position will automatically move. For example, 9.9999mWh plus 0.0001 mWh will be displayed as "10.000mWh".

The max reading of integral value is: 99999 when the integral value is positive (the unit is MWh or MAh, 999999), and -99999 when the integral value is negative; the maximum value of the integral time is 10000.

When the integral value reaches the max integral value or 10,000 hours, the integrator will stop and the instrument will maintain the display of the current integral result.

10.1.3 Integral Mode

The integrator function has many modes, including: manual mode, normal mode and continuous mode.

1. Manual mode

In manual mode, the integrator runs from starting to stopping; but it will stop when it reaches the max integral time or max/min integral value and maintain the current integral time and value display, as shown in Figure 10.1 Press STOP key or reach the max integral value and Figure 10.2 Press STOP key or reach the max integral time

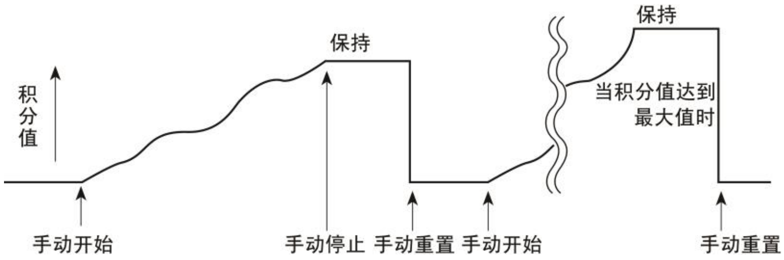

Figure 10.1 Press STOP key or reach the max integral value

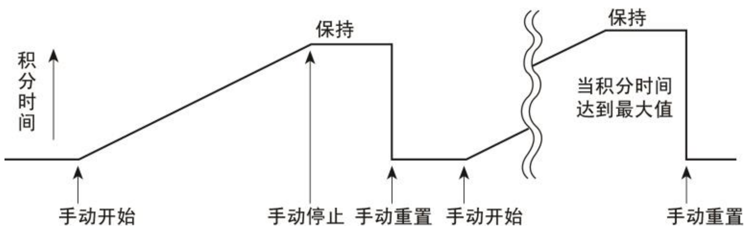

Figure 10.2 Press STOP key or reach the max integral time

2. Normal mode

The integral time is set by a timer for integration. When the set time is over, or when the integral value reaches the max/min displayed integral value, the integrator will stop and maintain the current integral time and value display.

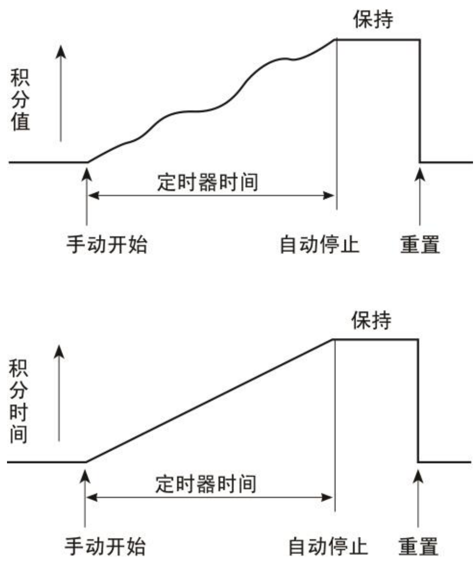

Figure 10.3 Normal mode diagram

3. Continuous mode

The integral time is set by a timer for integration. After the set time is over, it will automatically reset and restart integration until the STOP key is pressed. When the integral value reaches the max/min display value, the display of the integral time and value will be maintained, as shown in Figure 10.4 Continuous mode.

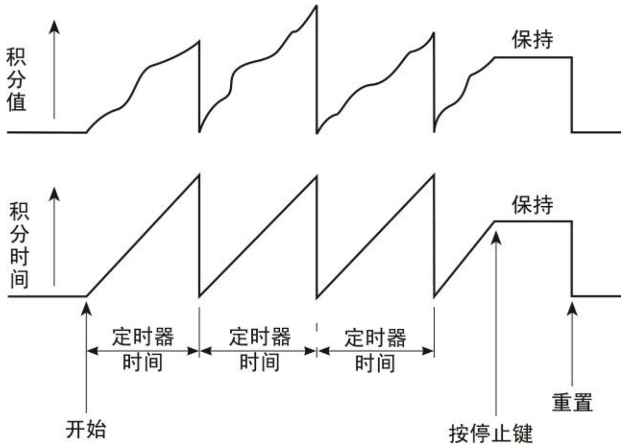

Figure 10.4 Continuous mode

4. Comparison of integral modes

The comparison of three integral modes are as shown in Table 10.2.

Table 10.2 Integrator function

<table>
<tr><th>Integral Mode</th><th>Integral Start Condition</th><th>Integral Stop Condition</th><th>Integral Hold</th><th>Repeat</th></tr>
<tr><td rowspan="3">Manual mode</td><td rowspan="3">Press the START key to start integration</td><td>Press the STOP key to stop integration</td><td rowspan="8">Hold the integral value and time at the time of stopping until the RESET key is pressed</td><td rowspan="3">—</td></tr>
<tr><td>The integrator stops when the max/min integral value is reached
Note: The min value is negative</td></tr>
<tr><td>The integrator stops when the max integral time is reached</td></tr>
<tr><td rowspan="2">Normal mode</td><td rowspan="2">Press the START key to start integration</td><td>The integrator stops when the integral time reaches the set time of timer</td><td rowspan="2">—</td></tr>
<tr><td>The integrator stops when the max/min integral value is reached
Note: The min value is negative</td></tr>
<tr><td rowspan="3">Continuous mode</td><td>Press the START key to start integration</td><td>The integrator stops when the max/min integral value is reached
Note: The min value is negative</td><td rowspan="3">The integrator restarts when the timer is timeout</td></tr>
<tr><td rowspan="2">When the integral time reaches the set time of timer, it will automatically reset the integral value and time and integrate again</td><td>The integrator stops when the max/min integral value is reached
Note: The min value is negative</td></tr>
<tr><td>Press the STOP key to stop integration</td></tr>
</table>

10.1.4 Integral Method

The formula of integral operation is shown in Table 10.3. In power integral and current integral, if the measurement mode is DC, the instantaneous value of power and current is integrated. When the measurement mode is set to RMS, the current value measured during each data update cycle is integrated.

Table 10.3 Integral method

Power integral		$\sum_{i=1}^{n} Ui \times Ii$
Current integral	RMS, VOLTAGE MEAN	$\sum_{I=1}^{N} I_I$
	DC	$\sum_{i=1}^{n} i_i$

Note: Ui and Ii are the instantaneous value of voltage and current, respectively, and n is the number of samples. I_I is the current measured in each data update cycle, and N is the number of data update.

10.2 Operation Instruction

The user needs to first set the integral mode and then further configure the relevant parameters.

10.2.1 Set Integral Mode

Before setting integral mode, it is required to stop current integration and reset the integrator. The menu operation process of integral mode setting is as shown in Figure 10.5.

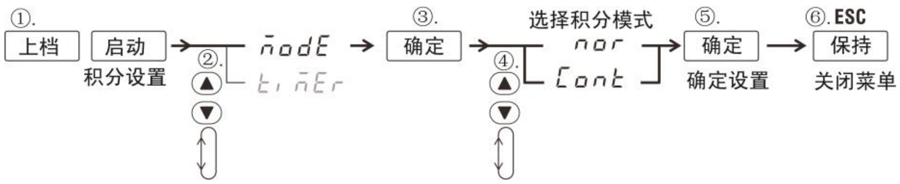

Figure 10.5 Set integral mode

According to the menu operation process as shown in Figure 10.5, press the SHIFT key on the front panel, and then the START key to enter the integral setting menu; select the Mode menu item and then select the integral mode.

10.2.2 Set Integral Range

The PA300 series high-precision power meters adopt the leading measurement and control technology, which can automatically and quickly switch the range in integral mode, enabling continuous and accurate integral measurement. This function supports not only watt-hour integral (+/-Wh), but also ampere-hour integral (+/-Ah). The integral is the result of calculation after collecting voltage and current data. Therefore, the integral range is directly determined by the voltage/current range, and the user needs to configure the voltage/current range first. For details, see the section "Figure 10.6".

10.2.3 Set Integral Timer

The menu operation process of integral timer setting is as shown in Figure 10.6.

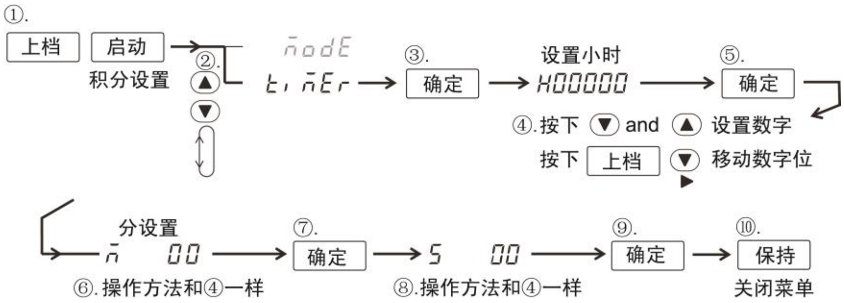

Figure 10.6 Menu operation process for setting integral timer

10.2.4 Integrator Operation

1. Display integral function

Taking the PA323/PA333H power meters as an example, as shown in Figure 10.7, press the display function switch key Fa on Screen A and select "TIME" to display the integral time. Press the display function switch key Fc on Screen C and select Wh/Wh± and Ah/Ah± to display the corresponding measurement result. The operation method of PA310/PA310H power meters is the same.

Figure 10.7 Display integral function (PA323/PA333H)

2. Start integration

Press the START key and the corresponding indicator will be on. The integral value and time will be displayed on Screens C and A, respectively.

3. Stop integration

Press the STOP key, the START indicator will be off, the STOP indicator will be on and the display will stop at the last displayed integral value and time. The measured value cannot be integrated for a period of time after the integration stop action takes effect.

4. Reset integral

After the integral function stops, if the function needs to be started again, it is required to reset the integrator.

Press the RESET key (SHIFT+STOP (RESET) key combination) and the STOP indicator will be off. Both Screens A and C display horizontal lines, as shown in Figure 10.8.

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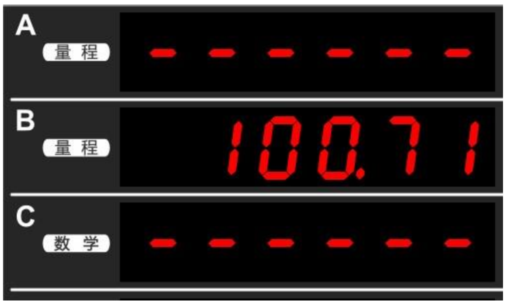

Figure 10.8 Reset integrator

5. Hold/cancel hold

Press the HOLD key and the HOLD indicator will be on. The displayed value will be held. Although the displayed value cannot be updated in hold state, the instrument continues to integrate. After the hold state is released, the integral result (integral value and time) when the hold state is released is displayed.

Press the HOLD key in hold state, the HOLD indicator will be off and the display results will be displayed. In addition, in hold state, each time the SINGLE key (SHIFT+STOP (SINGLE) key combination) is pressed, the display result will be updated.

10.3 Operation Limit During Integration

When the integral function is running, the limits on the related operations are described below.

Table 10.4 Table 10.4 Operation limits during integration

Operation Function	Reset Integration	During Integration	Pause Integration
Measurement mode setting	Operation available	Operation unavailable	Operation unavailable
Range configuration			
Range conversion ratio configuration			
Peak factor selection			
Measurement synchronous source setting			
PLL source setting			
Input filter setting			
Data update rate setting			
Average function			
Hold operation	Operation available	Operation available	Operation available
Single measurement operation			
Display measurement operation			
Max hold			
Display digit setting			
Integral mode setting	Operation available	Operation unavailable	Operation unavailable
Integral timer setting	Operation available	Operation unavailable	Operation unavailable
Start integration operation	Operation available	Operation unavailable	Operation available
Stop integration operation	Operation unavailable	Operation available	Operation unavailable
Reset integration operation	Operation available	Operation unavailable	Operation available
Harmonics measurement display on/off	Operation available	Operation available	Operation available
PLL source selection for harmonics measurement	Operation available	Operation unavailable	Operation unavailable
Number of harmonics measurement	Operation available	Operation unavailable	Operation unavailable
THD calculation formula selection	Operation available	Operation unavailable	Operation unavailable

Continued

Operation Function	Reset Integration	During Integration	Pause Integration
Storage operation	Operation available	Operation available	Operation available
Zero adjustment	Operation available	Operation unavailable	Operation unavailable

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11. Harmonics Measurement

11.1 Introduction

The harmonics measurement function of this product fully conforms to the international standard IEC61000-4-7:2002 of harmonic measurement. According to the fundamental frequency, voltage, current and power can be measured up to 50 harmonics respectively, whether it is the total harmonic distortion rate (THD), or the fundamental component, the harmonic content of each measurement, phase difference, and containing rate. In addition, the upper limit of harmonics analysis times can be set freely between 2 and 50 times. Even when the upper limit of the THD operation times is specified, the operation can be carried out according to this set value.

Note: The IEC61000-4-7:2002 standard strictly specifies the harmonics calculation methods, such as time window, synchronization, window function, etc., and specifies the performance of standard measurement instruments.

11.1.1 Harmonics Measurement Function

The user can enable the harmonics measurement function to measure and display the parameters of voltage, current and active power harmonic components of the input unit, including:

- The voltage, current, and active power of each harmonic. Up to the 50 times of harmonics can be measured;
- Harmonic distortion rate of each harmonic;
- The phase angle of each harmonic with respect to the fundamental wave;
- The voltage rms value, current rms value, active power rms value and total harmonic distortion (THD) of the fundamental wave.

11.1.2 Display of Harmonics Measurement Result

The harmonics measurement results are displayed on Screens A, B, C and D, respectively.

1. Display of Screen A

In harmonics measurement mode, if the display function of harmonics measurement data is enabled, the user can press the display switch key Fa and the indicator of Screen A will be off. Screen A displays the times of current harmonics measurement times, as shown inFigure 11.1. At this time, the user can set the times of harmonics measurement to be displayed through the "▲" and "▼" keys on the front panel (note that you must exit the range adjustment mode at this time).

Figure 11.1 Harmonic order displayed on Screen A

In harmonics measurement mode, the user can also press the Fa key to light up the V, A and W functional indicators, so as to display the RMS value (operation value) of voltage, current and active power of total harmonics.

2. Display of Screen B

The harmonics measurement function that can be displayed on screen B are shown inFigure 11.2 and Table 11.1 Harmonics function

Symbol	Description
V	Measured voltage value of specified times of harmonics on Screen B
A	Measured current value of specified times of harmonics on Screen B
W	Measured active power value of specified times of harmonics on Screen B
V%	Harmonic distortion factor of specified times of harmonics voltage on Screen B
A%	Harmonic distortion factor of specified times of harmonics current on Screen B
W%	Active power harmonic distortion factor of specified times of harmonics on Screen B

Continued

Symbol	Description
V deg	When the specified times on Screen B is 1 (fundamental harmonic): It displays the phase angle of primary voltage and current When the specified times on Screen B is 2-50: It displays the phase angle of each voltage from 2 to 50 times and primary voltage
A deg	When the specified times on Screen B is 1 (fundamental harmonic): It displays the phase angle of primary voltage and current When the specified times on Screen B is 2-50: It displays the phase angle of each current from 2 to 50 times and primary current

Figure 11.2 Display of Screen B

3. Display of Screen C

The display function of Screen C is shown in Table 11.1.

Table 11.1 Display of Screen C

Symbol	Description
V	Display the total effective value of the voltage from 1 to 50 harmonics
A	Display the total effective value of the current from 1 to 50 harmonics
W	Display the total effective value of the active power from 1 to 50 harmonics

Figure 11.3Display of Screen C

4. Display of Screen D

The display function of Screen D is shown in Table 11.2.

Table 11.2 Display of Screen D

Symbol	Description
V, A, W	Display the total effective value of the voltage, current and power from 1 to 50 harmonics
PF	Display the power factor of fundamental harmonic
V Hz	Display the voltage fundamental frequency
A Hz	Display the current fundamental frequency
THD V%	Display the THD of voltage
THD A%	Display the THD of current

Figure 11.4 Display of Screen D

11.2 Operation Instruction

11.2.1 Select Harmonics Measurement Mode

The user can select the harmonics measurement mode as normal or IEC mode. In different measurement modes, the time window and the number of FFT calculation points for the measurement will be different:

Normal: A fixed 1024 points are used for FFT calculation, and the time window is adjusted with the fundamental frequency. The measurement method is shown in Table 11.3.

Table 11.3 Select harmonics measurement mode

Fundamental Frequency	Sampling Rate	Window Width
10Hz ~ 75Hz	f×1024	1
75Hz ~ 150Hz	f×512	2
150Hz ~ 300Hz	f×256	4
300Hz ~ 600Hz	f×128	8
600Hz ~ 1200Hz	f×64	16

IEC mode (measure according to IEC61000-4-7: 2002 standard): The time window of 200ms is used for FFT calculation, and the maximum number of THD calculation is 40. The measurement method is shown in Table 11.4 Select harmonics measurement mode

Signal System	Sampling Rate	Window Width
50Hz system	f×512	10
60Hz system	f×512	12

The menu operation process for selecting harmonics measurement mode is as shown inFigure 11.5.

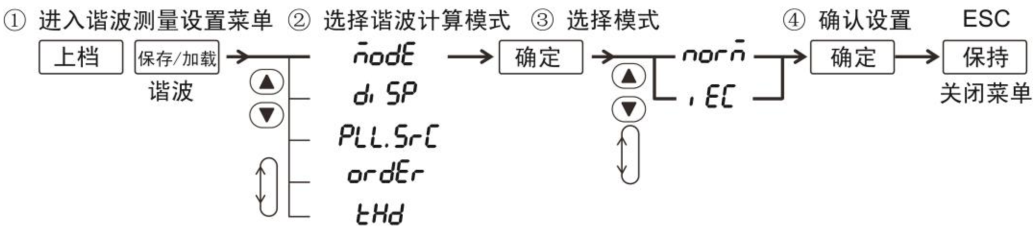

Figure 11.5 Select harmonics calculation mode

11.2.2 Enable/Disable Harmonics Measurement Display

The user can enable/disable harmonics measurement display. When the function is enabled, it will display the harmonics measurement data and the harmonics function indicator will be on; when the function is disabled, it will display normal measurement data and the indicator will be off. Refer to Figure 11.6 for the menu operation process.

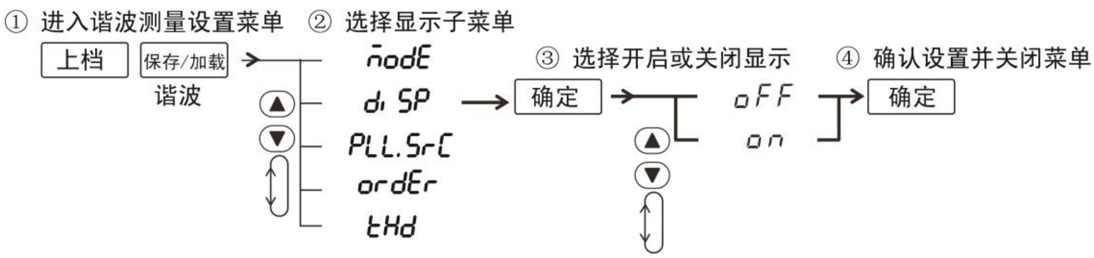

Figure 11.6 Operation process of enabling/disabling harmonics measurement display

11.2.3 Select PLL Source

During harmonics measurement, it is required to select the PLL source to determine the fundamental frequency, which is the benchmark for harmonics measurement. The PLL source is U by default. When selecting the PLL source, the period of PLL source signal used must be same with the signal period of harmonics measurement to be performed. Besides, the user should select input signal with less distortion as the

PLL source signal to ensure the stability of harmonics measurement. The menu operation process of PLL source selection for PA323/PA333H power meters is shown in Figure 11.7 and of PA310/PA310H power meters is shown in Figure 11.8.

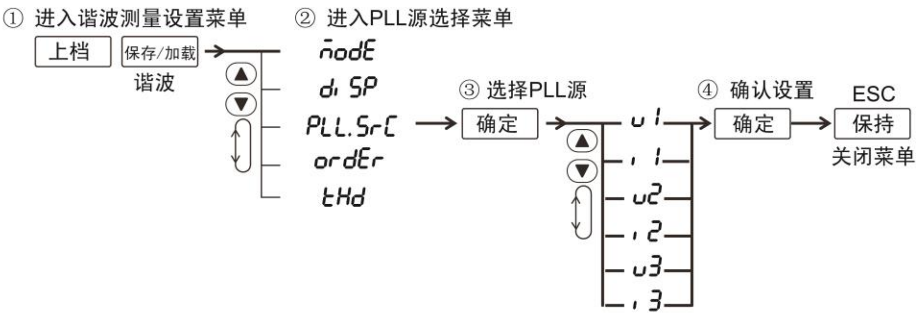

Figure 11.7 PLL source selection (PA323/PA333H power meters)

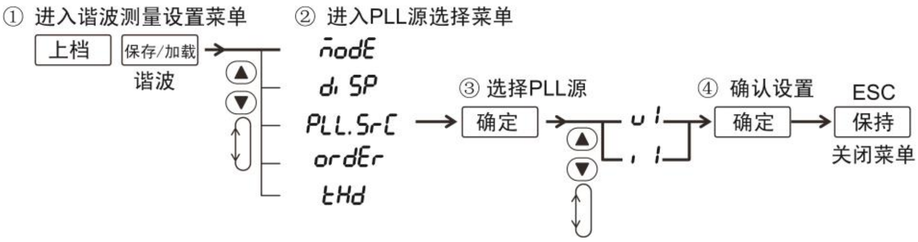

Figure 11.8 PLL source selection (PA310/PA310H power meters)

11.2.4 Select Harmonic Order

The user can specify the upper limit of the harmonics measurement times, with the range of 1-50 times. However, it should be noted that the range of the harmonic order depends on the fundamental frequency. This is because the upper limit of the harmonic order depends on the fundamental frequency: when the fundamental frequency is 50Hz, the upper limit of the harmonic order is 50; when the fundamental frequency is 1.2kHz, the upper limit of the harmonic order is 4. The menu operation process of harmonic order editing is shown in Figure 11.9.

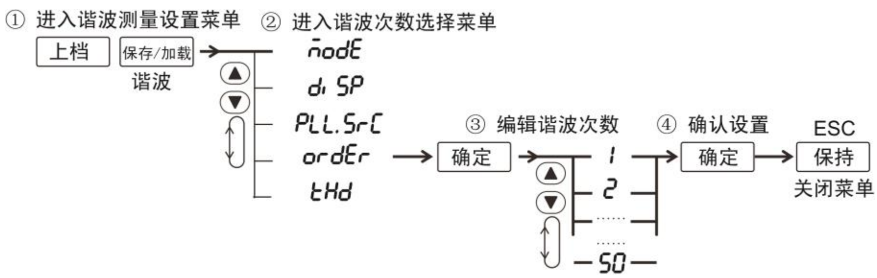

Figure 11.9 Edit harmonics order

11.2.5 THD Calculation Formula Selection

The harmonics distortion factor calculation formulas can be selected by the user are as follows (here, the upper limit of the harmonic order of 50 is taken as an example. If the upper limit of the harmonic order is not 50, the actual upper limit shall prevail):

- IEC: Calculate the ratio of the rms value of the 2nd to 50th harmonic components to the rms value of the fundamental wave. The calculation formula is detailed in Formula 11.1.

- CSA: Calculate the ratio of the rms value of the 2nd to 50th harmonic components to the 1st to 50th harmonics. The calculation formula is detailed in Formula 11.2.

$$\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right]/C_1$$

Formula 11.1 THD calculation formula of IEC

$$\left[\sqrt{\sum_{k=2}^{n}(C_k)^2}\right]/\left[\sqrt{\sum_{k=1}^{n}(C_k)^2}\right]$$

Formula 11.2 THD calculation formula of CSA

Note: C1: Fundamental components, Ck: Fundamental and harmonic components, k: analysis times, n: max analysis times. This value depends on the fundamental frequency of the PLL source.

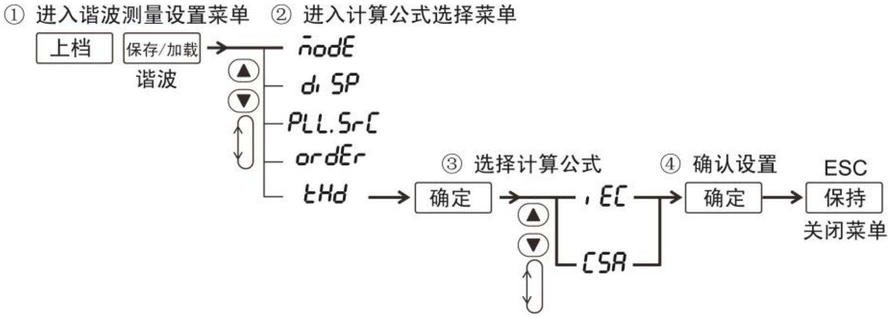

Figure 11.10 Calculation formula selection

12. Store and Load Function

12.1 Introduction

PA300 series high-precision power meters have the functions of storage/loading measurement data and configuring parameters.

In the production line or some special applications, multiple power meters need to be set to unified configuration parameters, and manual setting is extremely tedious and error-prone. With the configuration parameter storage/loading function of PA300 series high-precision power meters, the possibility of user setting errors can be reduced and work efficiency can be improved.

The PA300 series high-precision power meters are equipped with a USB-Host interface (standard), which can be connected to external mobile storage such as U disks to store voltage, current, power, harmonics and other measurement data for a long time; at the same time, the saved measurement data can be imported into the PC-side analysis software for further data display and analysis.

12.2 Operation Instruction

12.2.1 Storage/Loading of Set Parameters

1. Storage operation

The user can store set parameters to the internal storage and external USB storage through the storage function of the instrument. The current set parameters that can be saved are: range, measurement mode, measurement synchronous source, scale setting, average function setting, input filter setting, max hold setting, calculation setting, display digit setting, data update cycle, peak factor, integrator setting, harmonics setting, storage setting, communication setting, etc. This instrument can use four storage files (File1, File2, File3, File4) to store the set parameters. The description of storage menu operation process is shown in Figure 12.1.

Figure 12.1 Storage menu operation process

In addition, it should be noted that when operating the storage file as shown in Figure 12.1, the Screen D will prompt the various states of the storage operation simultaneously, as shown in Figure 12.2.

Figure 12.2 Storage file status prompt

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2. Loading operation

The user can restore the set parameters stored in internal storage or external USB storage to the function settings through the loading function of the instrument and start the measurement based on this setting. The menu operation process description of the loading function is shown in Figure 12.3

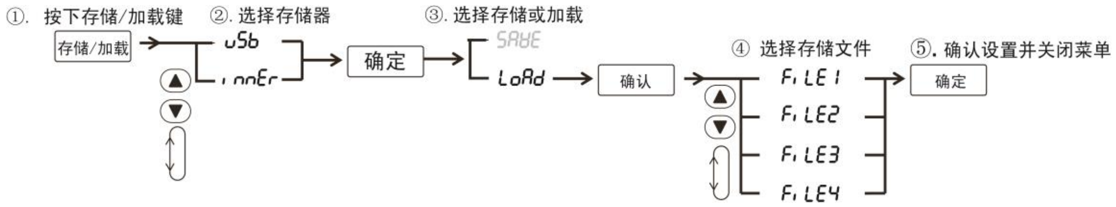

Figure 12.3 Loading menu operation process

Press the SAVE/LOAD key on the front panel to enter the storage/loading menu for selection.

Figure 12.4 Key operation process

In loading operation, Screen D also displays the state of the selected storage file, as show Figure 12.5

Figure 12.5 Storage state display of loading operation

12.2.2 Storage of Measurement Data

1. Introduction

PA300 series high-precision power meters can save measurement data to the external memory (cannot save to the internal memory), the stored measurement items are all the measurement items that can be displayed, including the measurement items under normal mode and harmonic mode; the measurement items to be stored must be set by the software of the upper computer. The measurement data is stored in cvs format, and the file can be opened and edited by Excel and other software on the upper computer.

PA323 and PA333H power meters are taken as examples to explain the generation and naming of files. The power meter generates files and folders in the format of "PA330_Data_year month day/H_hour/PA330_minutes

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and seconds. CSV". For example, if the file is stored at 9:2:55 on April 22, 2014, the folders PA330_Data_20140422, H_09 and the file Pa330_0255.csv are generated, and the file storage path is: PA330_Data_20140422/H_09/Pa330_0255.csv. Similarly, the naming format of the PA310 power meter file generation is "PA310_Data_year month day/H_hour/Pa310_minutes and seconds.csv"; the file generation naming format of the PA310H power meter is PA310H_Data_20140422/H_09/Pa310H_0255.csv.

Note: Only when the created data storage file is full, the power meter will create a new data storage file.

2. Operation process

The user needs to first set the data storage interval before starting the measurement data storage function.

(1) Turn on/off storage

Before setting the storage interval, the measurement data storage function must be turned off. The operation process is shown in Figure 12.6:

- ON: Select ON and press SET key to start storage. The storage indicator flashes in the storage process;
- OFF: Select OFF and press SET key to stop storage. The storage indicator will be off.

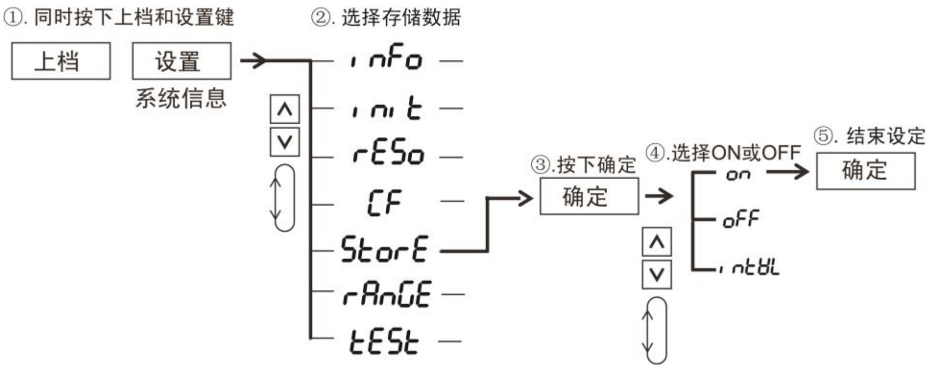

Figure 12.6 Operation process of selecting OFF or ON

(2) Set storage interval

The user can set the storage interval in the range of 00.00.00 (0 hour, 00 minute, 00 second) to 99.59.59 (99 hours, 59 minutes, 59 seconds); the initial value is 1s. The storage interval setting process is shown in Figure 12.7

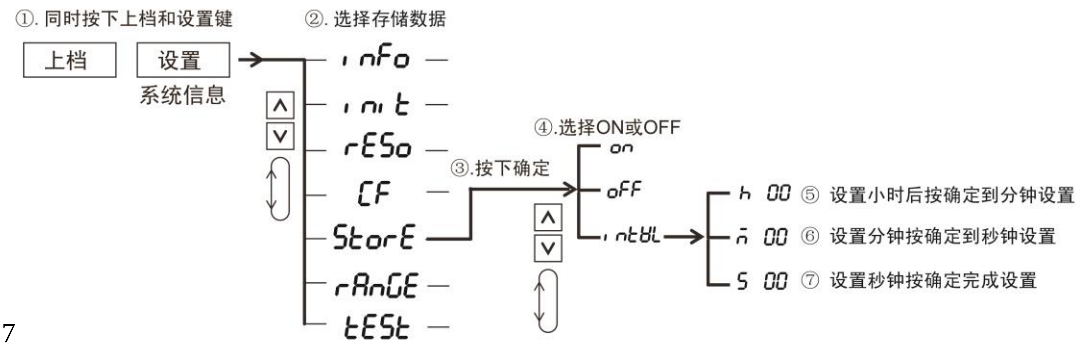

Figure 12.7 Set storage interval process

12.2.3 Precautions

The data storage function should pay attention to the following precautions:

- For harmonics measurement items, the user can specify the corresponding harmonic order for each measurement item. For example, only the measurement data of the first, third, and 29th harmonics of the voltage are stored. When the harmonics mode is turned off, if the user specifies to store the harmonic measurement items at this time, the result obtained is meaningless;

- When storing data, if HOLD key is pressed to select the hold function, the measurement operation will be temporarily held, and the held data will be stored at this time;
- When the MAX HOLD function is enabled, the measurement data stored is the max value currently held.

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13. System Auxiliary Settings

13.1 View System Information

The user can view the instrument information, and the relevant menu operation process is shownFigure 13.1.

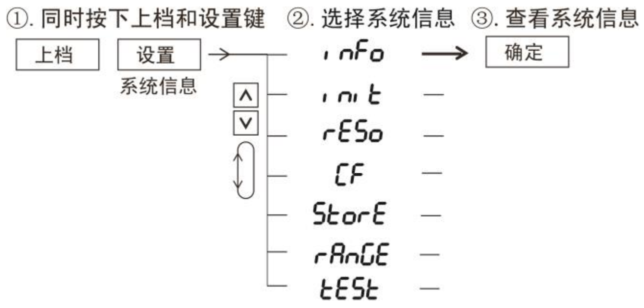

Figure 13.1 Operation process of system information view menu

The system information can be viewed is as shown in Figure 13.3Table 13.1 and Figure 13.2 Also, when Figure 13.2 is displayed, press the "▼" key on the front panel to view the sequence number, as shown in Figure 13.3Table 13.1 System information

Position	Meaning
Screen A	Model
Screen B	Hardware version
Screen C	Software firmware version
Screen D	Calibration date

Figure 13.2 System information display (take the PA310 power meter as an example)

Figure 13.3 Sequence number (take PA310 power meter as an example)

13.2 Initialize Setting Information

The user can initialize the setting information of each menu item, and the menu operation process is shown in Figure 13.4 According to the process shown in Figure 13.5, the user can press the SETUP and SHIFT keys on the front panel to open the system information menu; then select the init menu to configure whether to perform initialization.

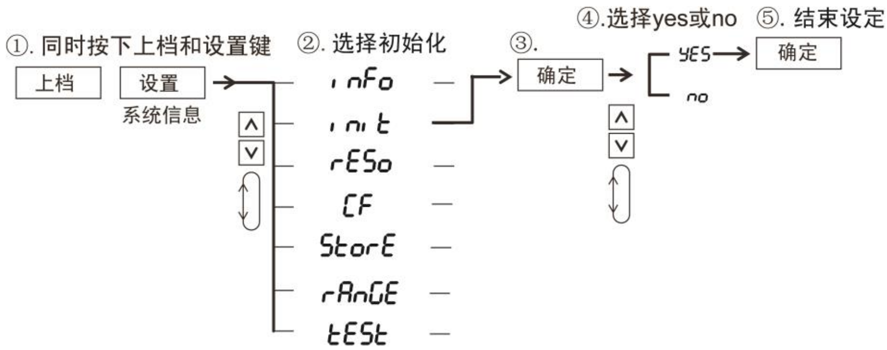

Figure 13.4 Initialization process

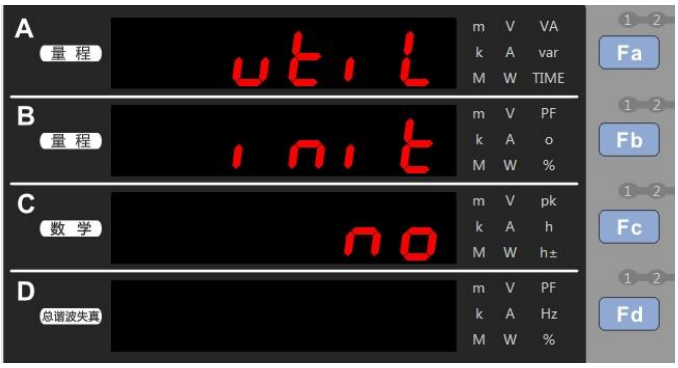

Figure 13.5 Key operation process

13.3 Zero Adjustment

In order to meet the specifications of this instrument, the user can create a state where the input signal is zero in the internal circuit of the instrument, and set the current level to zero, which is zero adjustment. Zero adjustment is required in the following conditions:

- For accurate measurement, the instrument must be warmed up for more than half an hour before performing zero adjustment;
- If the measurement mode, range, and input filter settings are not changed for a long time, the zero level of the instrument may change due to changes in the surrounding environment. At this time, the instrument also needs to be zeroed.

To perform the zero adjustment operation, the user just need to first press the SHIFT key; and then press the SET key.

13.4 Key Lock

The PA300 series high-precision power meters support the key lock function, which is a combination of the SHIFT and INTERFACE keys. By setting the key lock, the operation keys on the front panel can be disabled (except for the power key: ON/OFF, and related keys to turn off key lock). When the key lock function is valid, the key lock indicator will be on; when the key lock function is invalid, the key lock indicator will be off. The related key combination of the key lock and the key lock indicator are shown in Figure 13.5 (take PA310 as an example).

Figure 13.6 Key lock function (PA310)

13.5 Self-check

13.5.1 Introduction

The user can check the storage, keys and LED to observe whether these components are working normally:

- **Storage test.** The storage test item is to check the internal storage of the instrument. After testing, the following information will appear:
  - — 1-4 OK
  - — 2-4 OK
  - — 3-4 OK
  - — 4-4 OK
- **Panel key test.** In the test, the user can press the keys on the front panel, and then observe whether the key information displayed on the instrument corresponds to the keys. To exit the test, the user needs to press the SHIFT key twice;
- **LED test.** The test is used to check whether the function indicator on the front panel is normal. When the SET key is pressed to perform LED test, all function indicators and key indicators on the front panel will be on and then off; to exit the LED test, the user needs to press the SHIFT key once.

13.5.2 Operation Instruction

1. Storage self-check

The menu operation process of storage self-check is shown in Figure 13.7.

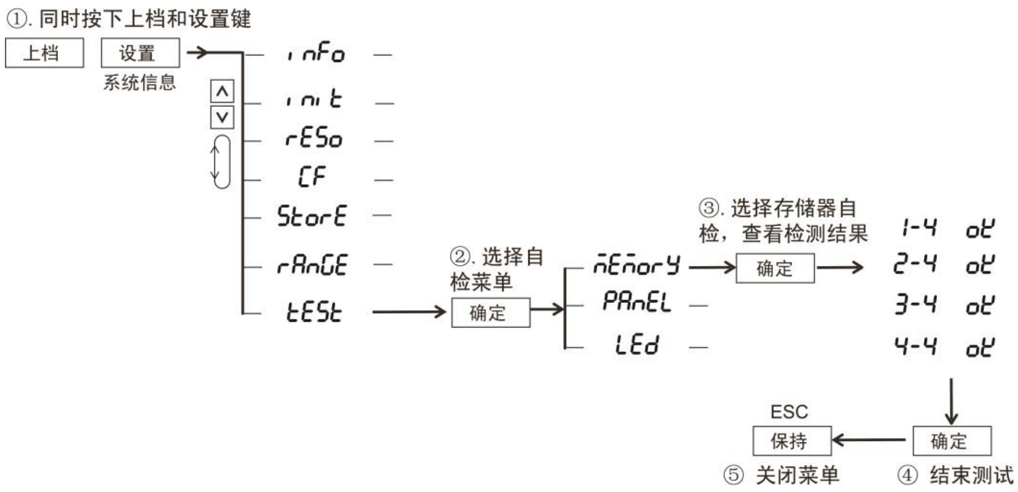

Figure 13.7 Menu operation process of storage self-check

2. Panel key test

The menu operation process of panel key test is as shown in Figure 13.8.

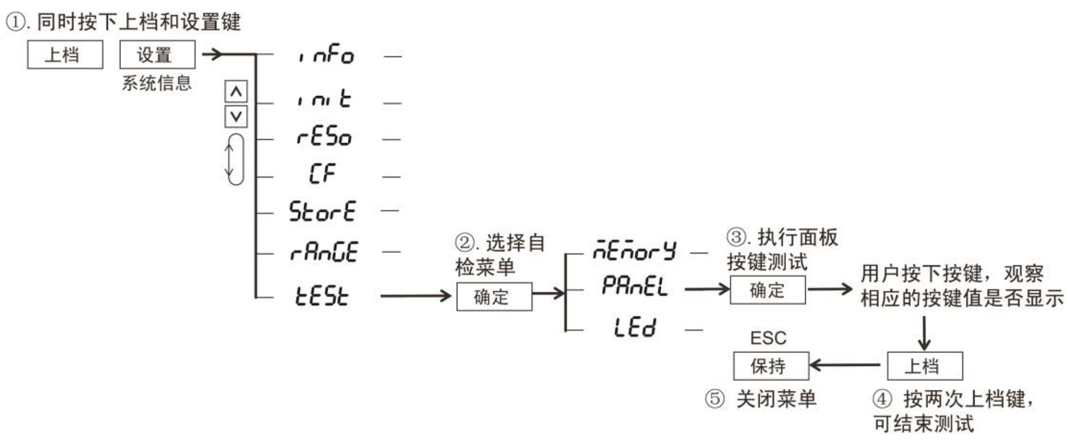

Figure 13.8 Panel key test

3. LED test

The menu operation process of LED test is as shown in Figure 13.9.

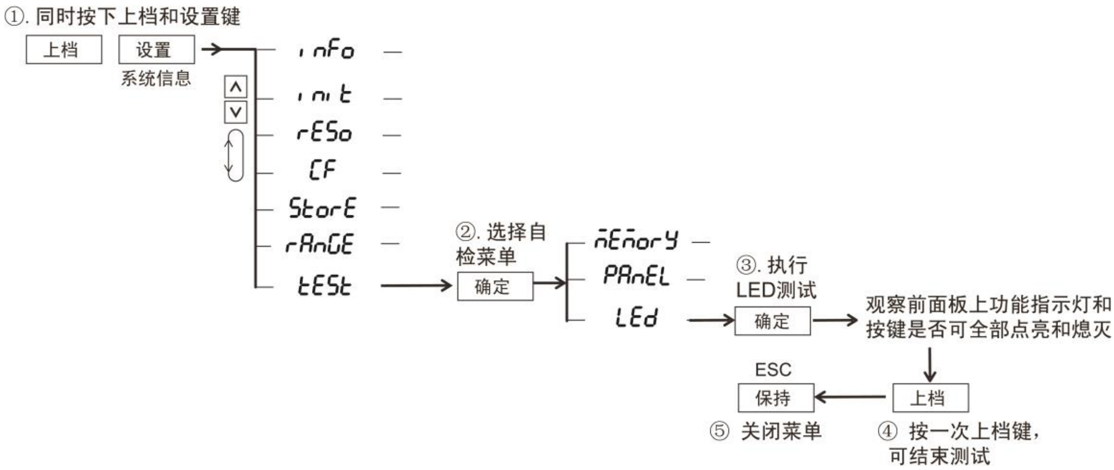

Figure 13.9 LED test

13.6 Firmware Update

The user can download the upgrade firmware of PA300 series high-precision power meters from the official website of Guangzhou Zhiyuan Electronics to upgrade the firmware of power meter. After downloading, the user unzips the upgrade firmware; copies the unzipped firmware folder to the root directory of USB flash disk (the disk must be in FAT file format, such as FAT16, FAT32, etc.); inserts the disk to the power meter; and then restarts the power meter to upgrade the firmware of the power meter, as shown in Table 13.2.

Table 13.2 Firmware upgrade

SN	Display	Description
①		Insert the USB flash disk, power on and restart the power meter, and it will display BOOT, indicating that the internal Bootloader program of the power meter is running
②		Then Screen A displays UPDATE, indicating that the firmware is upgrading

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Continued

SN	Display	Description
③		Screen B displays APP, indicating that the currently upgraded component is the application within the power meter, and Screen C displays the upgrade progress as a percentage
④		Screen C displays 100, indicating that the application has been upgraded
⑤		Screen C displays END, indicating that all upgrade operations have been completed. At the same time, the power meter beams once per second and the Screen D flashes with a dotted line, prompting the user to pull out the USB flash disk and restart the power meter again. At this time, the firmware upgrade operation completes

14. Error Warning

Table 14.1 Error warning

Item	Error Condition	Error Warning
Voltage V	The measured voltage exceeds the current range by 140%	--OL-
Current A	The measured current exceeds the current range by 140%	--OL--
Active power P	The RMS value of the voltage or current exceeds the current range by 140%	--OL--
Apparent power S	The RMS value of the voltage or current exceeds the current range by 140%	--OF--
Reactive power Q	The RMS value of the voltage or current exceeds the current range by 140%	--OF--
Power factor PF	The RMS value of the voltage or current exceeds the current range by 140%	--OF--
	The measured voltage or current is less than 0.5% of current range (cf=6,1%)	Error
	The power factor is greater than 2.001 or less than -2.001	Error
Angle Deg	The RMS value of the voltage or current exceeds the current range by 140%	--OF--
	The measured voltage or current is less than 0.5% of current range (cf=6,1%)	Error
	The power factor is greater than 2.001 or less than -2.001	Error
Peak factor	The RMS value of voltage or current is less than 0.5% of current range (cf=6,1%)	Error
MATH	The value of operation B is less than 0.00001% of the current range of operation B	Error
Display overflow	When the display digits are 4, the maximum display value exceeds 9999; When the number of display digits is 5, the maximum display value exceeds 99999	--OF--
The sum function of PA300 series high-precision power meters ∑	All channels generate an Error message	Error
	One channel generates an "OF" error	--OF-
	One channel generates an "OL" error	--OL-

Note: "------" indicates that no data can be displayed, "--oF--" indicates calculation overflow, and "--oL--" indicates that the range is exceeded.

15. Functional Parameters

15.1 Input Parameters

Table 15.1 Input parameters

Input Parameter	Parameter Description		
Input terminal type	Voltage	Plug-in safety terminal (banana jack)	
	Current	Direct input	Large terminal
		Sensor input	Safety BNC interface
Input type	Voltage	Float input, resistance divider input	
	Current	Float input, shunt input	
Measurement range	Voltage	PA310/PA323：15V, 30V, 60V, 150V, 300V, 600V PA310H/PA333H：15V, 30V, 60V, 150V, 300V, 600V, 1000V	
	Current	PA310	5mA, 10mA, 20mA, 50mA, 100mA, 200mA, 0.5A, 1A, 2A, 5A, 10A, 20A
		PA323	0.5A, 1A, 2A, 5A, 10A, 20A
		PA310H/PA333H	1A, 2A, 5A, 10A, 20A, 50A
		Sensor input PA310/PA323	50mV, 100mV, 200mV, 500mV, 1V, 2V, 2.5V, 5V, 10V
		Sensor input PA310H/PA333H	100mV, 200mV, 400mV, 1V, 2V, 5V, 10V
Input impedance	Voltage	Input resistance: 2MΩ, input capacitance: 13pF (parallel mode with resistor)	
	Current	Direct input range (PA310) 5mA-200mA	Input resistance: About 505mΩ Input inductance: 0.1μH
		Direct input range (PA310/PA323) 0.5A~20A	Input resistance: About 5mΩ Input inductance: 0.1μH
		Direct input range （PA310H/PA333H） 1A~50A	Input resistance: About 2mΩ Input inductance: 0.1μH
		Sensor input	Input resistance: 100kΩ (2.5V-10V) Input resistance: 20kΩ (50mV-2V)
Continuous max allowable input value	Voltage	1.5kV peak value and 1kV voltage effective value, whichever is smaller	
	Current	Direct input range (PA310) 5mA-200mA	30A peak value and 20A effective value, whichever is smaller
		Direct input range (PA310/PA323) 0.5A~20A	100A peak value and 30A effective value, whichever is smaller
		Direct input range （PA310H/PA333H） 1A~50A	150A peak value and 50A effective value, whichever is smaller
		Sensor input	The peak value does not exceed 5 times the rated range value

Continued

Input Parameter	Parameter Description		
Max instantaneous allowable input value (1s)	Voltage	2kV peak value and 1.5kV voltage effective value, whichever is smaller	
	Current	Direct input range (PA310) 5mA-200mA	30A peak value and 20A effective current value, whichever is smaller
		Direct input range (PA310/PA323) 0.5A~20A	150A peak value and 40A effective current value, whichever is smaller
		Direct input range （PA310H/PA333H） 1A~50A	150A peak value and 50A effective value, whichever is smaller
		Sensor input	The peak value does not exceed 10 times the rated range
Input bandwidth	PA310/PA310H/PA333H：DC，0.1Hz~300kHz PA323：DC，0.1Hz~100kHz		
Max continuous common-mode voltage	PA310/PA323：600Vrms，CAT Ⅱ PA310H/PA333H：1000Vrms，CAT Ⅱ		
Line filter	OFF is optional, and the cut-off frequency is 500Hz		
Frequency filter	OFF is optional, and the cut-off frequency is 500Hz		
Digital filter	OFF is optional, only the PA310/PA310H power meters support cut-off frequencies of 5.5kHz, 9kHz and 10kHz		
Range	The range of each input unit can be set separately		
A/D converter	The voltage and current inputs are converted simultaneously. Resolution: 16-bit, max conversion rate: 5μs		

Note: Configuration mode of peak factor 3: The peak factor of 1000V range is 1.5, the maximum effective value is 1000V, and the maximum peak value is 1500V;

Configuration mode of peak factor 6: The peak factor of 500V range is 3, the maximum effective value is 500V, and the maximum peak value is 1500V.

15.2 Voltage and Current Precision

Table 15.2 Voltage and current precision

Item	Specification	
Measurement conditions	Temperature	23±5℃, humidity: 30 ~ 75%RH
	Input waveform	Sine wave, peak factor: 3, common-mode voltage: 0V
	Scaling function	OFF, display digits: 5 digits
	Frequency filter	Turn on to measure voltage or current equal to or less than 200Hz
	After full preheating	
	After zero level compensation or measurement range change	
Precision (The following precision is the sum of the reading error and range error) * f in the reading error formula is the frequency of the input signal, with the unit of kHz	PA310, PA310H, PA323, PA333H (voltage/current)	
	DC	±(0.1% of the reading + 0.2% of the range)
	0.5Hz ≤f＜45Hz	±(0.1% of the reading + 0.2% of the range)
	45Hz ≤ f ≤ 66Hz	±(0.1% of the reading + 0.05% of the range)
	66Hz＜f ≤ 1kHz	±(0.1% of the reading + 0.2% of the range)
	1kHz＜f ≤ 10kHz	±{(0.07×f)% of the reading + 0.3% of the range}
	10kHz＜f ≤ 100kHz	±(0.5% of the reading + 0.5% of the range)±[{0.04×(f-10)}% of the reading]
Input range	Rated range of voltage or current: 1-130% (max display is 140%) (the max display for 1000V, 500V, 50A range is 100%)	

Continued

Item	Specification	
Frequency range	**Data Update Cycle**	**Bandwidth**
	0.1s	DC, 25Hz ≤ f ≤300kHz
	0.25s	DC, 10Hz ≤ f ≤ 300kHz
	0.5s	DC, 5Hz ≤ f ≤300kHz
	1s	DC, 2.5Hz ≤ f ≤300kHz
	2s	DC, 1.5Hz ≤ f ≤ 300kHz
	5s	DC, 0.5Hz ≤ f ≤300kHz
	10s	DC, 0.2Hz ≤ f ≤300kHz
	20s	DC, 0.1Hz ≤ f ≤300kHz
	Auto	DC, 0.1Hz ≤ f ≤300kHz
When the line filter is turned on	45-66Hz: Increase the reading by 0.2% <45Hz: Increase the reading by 0.5%	
Temperature coefficient	5~18℃ or 28~40℃L: Increase ±reading by 0.03%/℃	
Precision at peak factor 6	2 times the measurement range error at peak factor 3	

Note: The upper limit of measurement at each frequency end of PA323 is 100kHz, as shown in Table 8.2.

The influence of temperature change after zero level compensation or measurement range change

Increase the range by 0.02%/℃ on the DC voltage precision, and the following value on the DC current precision.

PA310 (5mA/10mA/20mA/50mA/100mA/200mA range): 5μA/℃

PA310/PA323 (0.5A/1A/2A/5A/10A/20A range): 500μA/℃

PA333H/PA310H (1A/2A/5A/10A/20A/50A range): 1.25mA/℃

External current sensor input (2.5V~10V): 1mV/℃

External current sensor input (50mV~2V): 50μV/℃

Waveform display data, Upk and Ipk precision

Increase the following value based on above precision (reference value). The effective input range is within 300% of the ±range (within 600% of the ±range at peak factor 6).

Voltage input: $1.5\times\sqrt{15/\text{量程}}$ % of the range

Direct current input range:

PA310(5mA/10mA/20mA/50mA/100mA/200mA range): $3\times\sqrt{0.005/\text{量程}}$ % of the range

PA310/PA323(0.5A/1A/2A/5A/10A/20A range): $3\times\sqrt{0.5/\text{量程}}$ %

PA333H /PA310H(1A/2A/5A/10A/20A/50A range): $3\times\sqrt{1.25/\text{量程}}$%

Input range of external current sensor:

(2.5V~10V): $3\times\sqrt{2.5/\text{量程}}$ % of the range

(50mV~2V): $3\times\sqrt{0.05/\text{量程}}$ % of the range

Spontaneous heating effect due to voltage input

Increase reading by 0.0000001xU^2% on AC voltage precision.

Increase reading by 0.0000001 ×U^2%+ range by 0.0000001 ×U^2% on DC current precision. U is the voltage reading (V).

Even if the voltage input is reduced, the effect of spontaneous heating will continue until the temperature of the input resistance drops.

Spontaneous heating effect due to current input

PA310/PA323:

Increase reading by 0.00013 x I^2% on AC current precision.

Increase reading by 0.00013 ×I^2%+0.004 ×I^2mA(0.5A/1A/2A/5A/10A/20A range) or 0.00013 ×I^2% +0.00004 ×I^2mA(5mA/10mA/20mA/50mA/100mA/200mA range) on DC current precision.

I is the current reading (A).

PA310H/PA333H:

Increase reading by 0.00013 ×I^2% +0.002 ×I^2mA on DC current precision. I is the current reading (A).

Even if the current input is reduced, the effect of spontaneous heating will continue until the temperature of the shunt resistance drops.

Precision change due to data update cycle

When the data update rate is 100ms, increase reading by 0.05% on the precision of 0.5Hz-1kHz.

15.3 Active Power Precision

Table 15.3 Active power precision

<table>
<tr><th>Item</th><th colspan="2">Specification</th></tr>
<tr><td>Measurement requirements</td><td colspan="2">Same as voltage and current conditions, power factor is 1</td></tr>
<tr><td rowspan="7">Precision
(The following precision is the sum of the reading error and range error)
Note: f in the reading error formula is the frequency of the input signal, with the unit of kHz</td><td colspan="2">PA310, PA310H, PA323, PA333H</td></tr>
<tr><td>DC</td><td>±(0.1% of the reading + 0.2% of the range)</td></tr>
<tr><td>0.5Hz ≤ f ＜45Hz</td><td>±(0.3% of the reading + 0.2% of the range)</td></tr>
<tr><td>45Hz ≤ f ≤ 66Hz</td><td>±(0.1% of the reading + 0.05% of the range)</td></tr>
<tr><td>66Hz ＜ f ≤ 1kHz</td><td>±(0.2% of the reading + 0.2% of the range)</td></tr>
<tr><td>1kHz ＜f ≤ 10kHz</td><td>±(0.1% of the reading + 0.3% of the range)±[{0.067 ×(f-1)}% of the reading]</td></tr>
<tr><td>10kHz＜f ≤ 100kHz</td><td>±(0.5% of the reading + 0.5% of the range)±[{0.07 ×(f-10)}% of the reading]</td></tr>
<tr><td>Influence of power factor</td><td colspan="2">When the power factor (λ)=0 (S: Apparent power)
• 45Hz ≤ f ≤ 66Hz: 0.2% of ±S
• Max 100kHz: ±{(0.2+0.2× f)% of S}, the reference value
f is the frequency of the input signal, with the unit of kHz
When 0<λ<1 (Ø: Phase angle of voltage and current)
(power reading) ×[(power reading error %)+(power range error %) ×(power range/apparent power display value) + {tanØ ×(influence when λ=0)%}]</td></tr>
<tr><td>When the line filter is turned on</td><td colspan="2">45-66Hz: Increase the reading by 0.3%
<45Hz: Increase the reading by 1%.</td></tr>
<tr><td>Temperature coefficient</td><td colspan="2">Same temperature coefficient as voltage and current</td></tr>
<tr><td>Precision at peak factor 6</td><td colspan="2">2 times the measurement range error at peak factor 3</td></tr>
<tr><td>Precision of apparent power S</td><td colspan="2">Voltage precision + current precision</td></tr>
</table>

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Continued

Item	Specification
Reactive power precision Q	Apparent power precision + ($\sqrt{1.0004-\lambda^2}$ - $\sqrt{1-\lambda^2}$)×100% of the range
Precision of power factor λ	±[(λ–λ/1.0002)+|cosØ-cos{Ø+sin^{-1}((λ=0, the influence of power factor %)/100)}|]±1 bit. Voltage and current are rated ranges, and Ø is the phase difference of voltage and current
Precision of phase difference Ø	±[|Ø-cos-1(λ/1.0002)|+sin^{-1}((λ=0, the influence of power factor %)/100)]deg±1 bit Voltage and current are rated ranges

The influence of temperature change after zero level compensation or measurement range change

Add the voltage and current influence of the following instruments to the DC power precision.

DC voltage precision: 0.02%/℃ of the range

DC current precision:

PA310 (5mA/10mA/20mA/50mA/100mA/200mA range): 5μA/℃

PA310/PA323 (0.5A/1A/2A/5A/10A/20A range): 500μA/℃

PA333H/PA310H (1A/2A/5A/10A/20A/50A range): 1.25mA/℃

External current sensor input (2.5V~10V): 1mV/℃

External current sensor input (50mV~2V): 50μV/℃

Spontaneous heating effect due to voltage input

Increase reading by 0.0000001xU^2% on AC power precision.

Increase reading by 0.0000001×U^2%+ range by 0.0000001×U^2% on DC power precision. U is the voltage reading (V).

Even if the voltage input is reduced, the effect of spontaneous heating will continue until the temperature of the input resistance drops.

Spontaneous heating effect due to current input

PA310/PA323:

Increase reading by 0.00013 x I^2% on AC power precision.

Increase reading by 0.00013×I^2% +0.004×I^2mA(0.5A/1A/2A/5A/10A/20A range) of the range or 0.00013×I^2% +0.00004×I^2mA(5mA/10mA/20mA/50mA/100mA/200mA range) on DC power precision. I is the current reading (A).

PA310H/PA333H:

Increase reading by 0.00013 x I^2% on AC power precision.

Increase reading by 0.00013×I 2 % +0.002×I 2 mA on DC power precision. I is the current reading (A).

Even if the current input is reduced, the effect of spontaneous heating will continue until the temperature of the shunt resistance drops.

Precision change due to data update cycle

When the data update rate is 100ms, increase reading by 0.05% on the precision of 0.5Hz-1kHz.

15.4 Voltage, Current and Active Power Measurement

Table 15.4 Voltage, current and active power measurement

Item	Specification
Measurement method	Digital sampling method
Peak factor	3 or 6

Continued

Item	Specification
Wiring method	**PA310, PA310H (single channel):** 1P2W **PA323/PA333H (three channels)**: 1P2W, 1P3W, 3P3W, 3P4W, 3V3A, 1I1O and 1I3O are optional
Range switch	Manual range or auto range
Auto range	**Range upshift** The range upshifts when any of the following conditions is met: ● Urms or Irms exceeds 130% of the currently set range ● Peak factor 3: The Upk and Ipk value of the input signal exceed 300% of the currently set range ● Peak factor 6: The Upk and Ipk value of the input signal exceed 600% of the currently set range When using PA300 series high-precision power timers, if any input unit meets the above conditions, the range will be upshifted next time the measured value is updated **Range downshift** The range downshifts when all the following conditions are met: ● Urms or Irms is equal to or less than 30% of the currently set range ● Urms or Irms is equal to or less than 125% of the currently set range ● Peak factor 3: The Upk and Ipk value of the input signal is equal to or less than 300% of the next shift of range ● Peak factor 6: The Upk and Ipk value of the input signal is equal to or less than 600% of the next shift of range If all input units meet the above conditions, the range will be downshifted next time the measured value is updated
Switch display mode	RMS (RMS value of voltage and current), VOLTAGE MEAN (rectified average value calibrated to voltage effective value), DC (simple average value of voltage and current) are optional
Measurement synchronous source	The voltage, current of the signal, or the entire interval of the data update cycle can be selected as the synchronous source during measurement
Line filter	OFF or ON (cut-off frequency of 500Hz)
Peak measurement	Measure the peak value (max, min) of voltage, current or power from sampled instantaneous voltage, instantaneous current, or instantaneous power
Zero level compensation	Remove internal offset

15.5 Frequency Measurement

Table 15.5 Frequency measurement

Item	Specification	
Measurement items	Can measure the voltage or current frequency input to the setting unit **PA323/PA333H (3-input type)** Voltage (U1)/current (I1) of input unit 1, voltage (U2)/current (I2) of input unit 2, voltage (U3)/current (I3) of input unit 3 are optional	
Method	Reciprocal method	
Frequency measurement scope	Update cycle changes according to the following data	
	Data Update Cycle	**Measurement Scope**
	0.1s	25Hz≤f≤300kHz

Continued

Frequency Measurement Scope	Data Update Cycle	Measurement Scope
Frequency measurement scope	0.25s	10Hz≤f≤300kHz
	0.5s	5Hz≤f≤300kHz
	1s	2.5Hz≤f≤300kHz
	2s	1.5Hz≤f≤300kHz
	5s	0.5Hz≤f≤300kHz
	10s	0.2Hz≤f≤300kHz
	20s	0.1Hz≤f≤300kHz
	Auto	0.1Hz≤f≤300kHz
Frequency filter	OFF or ON (cut-off frequency of 500Hz)	
Precision	Precision: ±(0.06% or the reading) Note: When the peak factor is 3, it is required that the input signal level is equal to or greater than 30% of the measurement range (60% when the peak factor is 6); in addition, the frequency filter must be turned on when the measurement voltage or current is less than or equal to 200Hz	

Note: The upper limit of measurement at each frequency end of PA323 is 100kHz, as shown in Table 8.2

15.6 Operation

Table 15.6 Operational function parameters

Item		Specification					
Operational formula for apparent power (S), reactive power (Q), power factor (λ) and phase angle (Ø). i is the number of input unit							
		1P3W	3P3W	3V3A	3P4W	1I1O	1I3O
UΣ[V]		(U1+U3)/2		(U1+U2+U3)/3		U3	(U1+U3)/2
IΣ[A]		(I1+I3)/2		(I1+I2+I3)/3		I3	(I1+I3)/2
PΣ[W]		P1+P3			P1+P2+P3	P3	P1+P3
SΣ[VA]	Si=Ui×Ii	S1+S3	$\sqrt{3}$ (S1+S3)/2	$\sqrt{3}$ (S1+S2+S3)/3	S1+S2+S3	S3	$\sqrt{3}$ (S1+S3)/2
QΣ[var]	Qi= $\sqrt{Si^2 - Pi^2}$	Q1+Q3			Q1+Q2+Q3	Q3	Q1+Q3
λΣ	Λi=Pi/Si	PΣ/SΣ					
Ø[°]	Øi=cos^{-1}(Pi/Si)	cos^{-1} (PΣ/SΣ)					
On PA310/PA310H/PA323/PA333H power meters, S, Q, λ and Ø are calculated from the measured values of voltage, current and active power. Therefore, when a distorted signal is input, these values may be slightly different from other measurement instruments based on different measurement principles: ● If the voltage or current is less than 0.5% of the rated range (when the peak factor is 6, less than or equal to 1%), S or Q displays 0, and λ and Ø display error ● When the current leads the voltage, the Q value in the Q[var] operation is calculated with the minus sign (-); when the current lags the voltage, the plus sign (+) is used. QΣ may be negative because the Q value of each unit is signed							
D(LEAD)/G(LAG) Lead and lag phase detection (D (lead) and G (lag) of phase angle Ø)		Under the following conditions, the lead and lag of the input voltage and current can be correctly detected: ● Sine wave ● When the measured value is greater than or equal to 50% of the measurement range (at peak					

Continued

Item	Specification
D(LEAD)/G(LAG) Lead and lag phase detection (D (lead) and G (lag) of phase angle Ø)	● factor 6, greater than or equal to 100%) ● Frequency: 20Hz-2kHz Phase difference: ±(5°-175°)
Scale	When the output of external sensor VT and CT is input to the instrument, the sensor conversion ratio shall be set: VT ratio, CT ratio and power coefficient ● Valid digit: Set automatically according to the valid digit of voltage and current range ● Set range: 0.001-9999
Average	Select the following two methods: exponential average method and moving average method Choose from 8, 16, 32, and 64 an exponentially averaged attenuation constant or a moving average constant
Efficiency	PA323/PA333H can calculate the efficiency
Peak factor	Calculate the peak factors of voltage and current (peak/RMS value)
Four arithmetic operations	There are 6 types of four arithmetic operations (A+B, A-B, A×B, A/B, A^2/B, A/B^2).
Average active power during integration	Calculate the average active power during integration

15.7 Integrator

Table 15.7 Integrator

Item	Specification
Mode	Manual, normal and repeat integral mode are optional
Timer	Stop integration automatically by setting a timer Setting range: 0h00m00s-10000h00m00s (0h00m00s is automatically set to manual integral mode)
Count overflow	WP：999999MWh/-99999MWh q：999999MAh/-99999MAh When the integral time reaches the max integral time of 10000 hours, or when the integral value reaches the max value that can be displayed (999999 or -99999), the integral time and value are maintained and the integration is stopped
Precision	±(power precision (or current precision)+0.1% of the reading) (fixed range) Note: Under auto range mode, the measurement is not performed when the range changes. The first measured value after the range change and the non-measurement period will be appended
Range setting	The integrator has auto range or fixed range. For details of range switch, refer to the voltage, current and active power measurement
Effective frequency range of integrator	Active power: DC-45kHz Current: When the measurement mode is RMS: DC, the lower limit frequency determined by the data update cycle - 45kHz; when the measurement mode is VOLTAGE MEAN: DC, the lower limit frequency determined by the data update cycle - 45kHz When the measurement mode is DC: DC - 45kHz
Timer precision	±0.02%

15.8 Harmonics Measurement

Table 15.8 Harmonics measurement

Measurement items	All installed units
Method	PLL synchronization method
Frequency range	The fundamental frequency of PLL source is in the range of 10Hz-1.2kHz
PLL source	Select the voltage or current of each input unit Input level At peak factor 3, greater than or equal to 50% of the rated range

	At peak factor 6, greater than or equal to 100% of the rated range When the fundamental frequency is less than or equal to 200Hz, the frequency filter must be turned on
FFT data word length	1024/5120/6144
Window function	Rectangle

15.9 Conventional Harmonic Sampling

Table 15.9 Conventional harmonic sampling

Fundamental Frequency	Sampling Rate	Window Width	Analysis Times Upper Limit
10Hz ≤ Fundamental frequency < 75Hz	f×1024	1	50
75Hz ≤ Fundamental frequency < 150Hz	f×512	2	32
150Hz ≤ Fundamental frequency＜300Hz	f×256	4	16
300Hz ≤ Fundamental frequency < 600Hz	f×128	8	8
600Hz ≤ Fundamental frequency ≤1200Hz	f×64	16	4
Note 1: Can reduce the upper limit of analysis times			

15.10 IEC61000-4-7 Harmonics Sampling

Table 15.10 IEC61000-4-7 harmonics sampling

Fundamental Frequency	Sampling Rate	Window Width	Analysis Times Upper Limit
50Hz	f×512	10	50
60Hz	f×512	12	50

15.11 Harmonics Precision

Table 15.11 Power meter precision when the line filter is turned off (indicator ± (% reading +% range))

Frequency	Voltage	Current	Power
10Hz ≤ f<45Hz	0.15% +0.35%	0.15% +0.35%	0.15%+0.50%
45Hz ≤ f ≤ 440Hz	0.15% +0.35%	0.15%+0.35%	0.25%+0.50%
440Hz<f ≤ 1kHz	0.20% +0.35%	0.20% +0.35%	0.40%+0.50%
1kHz<f ≤ 2.5kHz	0.80% +0.45%	0.80% +0.45%	1.56%+0.60%
2.5kHz<f ≤ 5kHz	3.05%+0.45%	3.05% +0.45%	5.77%+0.60%

The following instructions apply to Table 15.11:

- When the peak factor is 3;
- When λ (power factor)=1;
- Power exceeding 1.2kHz is the reference value;
- For the direct current range, increase the current accuracy by 10μA, and increase the power accuracy by (10μA/direct current range)×100% of the range;
- For the external current sensor range, increase the current accuracy by 100μV, and increase the power accuracy by (100μV/ external current sensor rated range) ×100% of the range;
- For harmonics input, increase ({n/(m+1)}/50)% of the nth harmonic reading on the (n+m) and (n-m) harmonics of voltage and current, and increase ({n/(m+1)}/25)% of the nth harmonic reading on the (n+m) and (n-m) harmonics of power;
- Increase (n/500) of the reading on the nth harmonic of voltage and current, and increase (n/250)% of

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the reading on power;

- Precision at peak factor 6: same as the precision of double range at peak factor 3;
- The precision guarantee range of frequency, voltage and current is the same as that of conventional measurement. If the amplitude of the high-frequency component is large, it may have an influence of about 1% on the specific harmonic. This influence depends on the size of the frequency component; therefore, if the frequency component is smaller than the rated range, there will be no problem.

15.12 Display

Table 15.12 Display

Item	Specification	
Display type	7 segments of LED	
Simultaneous display	4 items	
Max display	During normal measurement	
Display item	When the display digit is 5	When the display digit is 4
U, I, P, S, Q	99999	9999
λ	1.0000 ~ -1.0000	1.000 ~ -1.000
Ø	G180.0 ~ d180.0	G180.0 ~ d180.0
fU, fI	99999	9999
WP, WP±, q, q± ● The unit is MWh or MAh ● The unit is not MWh or MAh	999999 (-99999 is negative watt-hour and negative ampere-hour -99999	999999 -99999
TIME		
Integral time	display instruction	Display resolution
0-99 hours 59 minutes 59 seconds	0.00.00 ~ 99.59.59	1s
100 hours - 9999 hours 59 minutes 59 seconds	100.00 ~ 9999.59	1 min
10,000 hours	10000	1h
Efficiency (only for PA323 and PA333)	100.00 ~ 999.99(%)	100.0 ~ 999.9(%)
Peak factor	99999	9999
Four arithmetic operations	99999	9999
Average active power	99999	9999
Peak voltage	99999	9999
Peak current	99999	9999
Peak power	99999	9999
Max display (display range)	During harmonics measurement	
Display item	Display digit is 5	Display digit is 4
U, I, P	99999	9999
λ	1.0000 ~ -1.0000	1.000 ~ -1.000
Uhdf, Ihdf, Phdf	0.000 ~ 99.999% ~ 100.00 ~ 999.99%	0.00 ~ 99.99% ~100.0 ~ 999.9%

续上表

Item	Specification	
Uthd, Ithd	0.000 ~ 99.999% ~ 100.00 ~ 999.99%	0.00 ~ 99.99% ~100.0 ~ 999.9%
ØU, ØI		
The phase angle between primary fundamental current and primary fundamental voltage		
	G180.0 ~ D180.0	G180.0 ~ D180.0
The phase angle of the secondary and higher harmonics relative to the primary fundamental voltage		
	-180.0 ~ 180.0	-180.0 ~ 180.0
The phase angle of the secondary and higher harmonics relative to the primary fundamental current		
	-180.0 ~ 180.0	-180.0 ~ 180.0
Unit symbol	m, k, M, V, A, W, VA, var, °, Hz, h±, TIME, %	
Display digit	5 or 4 is optional	
Data Update Cycle	0.1s, 0.25s, 0.5s, 1s, 2s, 5s, 10s, 20S and AUTO are optional	
Response time	Max 2 times the data update cycle (the time required for the display value to reach the final precision state when the rated range changes from 0 to 100% or from 100% to 0)	
Auto range monitor	The indicator flashes when the input signal meets the auto range switch conditions	
Outrange monitor	If "-- oL --" is displayed under the following conditions, it indicates that the measured value exceeds 140% of the rated range	
Hold	Hold display value	
Single update	Under hold state, the display value is updated every time the SINGLE key is pressed	
MAX HOLD	Hold U, I, P, S, Q, U±pk, I±pk, P±pk	

15.13 External Current Sensor Input

Table 15.13 External current sensor input

	Measurement Range
Peak factor 3	PA310 /PA323：50mV/100mV/200mV/500mV/1V/2V/2.5V/5V/10V PA310H/PA333H：100mV/200mV/400mVv/1V/2V/5V/10V
Peak factor 6	PA310/PA323：25 mV/50 mV/100 mV/250 mV/500 mV/1V/1.25 V/2.5V/5V PA310H/PA333H：50mV/100mV/200mV/500mV/1V/2.5V/5V

15.14 GPIB Interface

Table 15.14 GPIB interface

Applicable device	National Instruments Corporation ● PCI-GPIB or PCI-GPIB, PCIe-GPIB or PCIe-GPIB+ ● PCMCIA-GPIB or PCMCIA-GPIB+ (Windows Vista or Windows 7 not supported) ● GPIB-USB-HS uses NI-488.2M Ver. 2.8.1 or later driver
Electrical and mechanical specifications	Conform to IEEE St'd 488-1978(JIS C 1901-1987

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15.15 Serial Interface

Table 15.15 Serial interface

Interface type	D-Sub 9-pin (plug)
Electrical specifications	Conform to EIA-574 (EIA-232(RS-232) 9-pin standard)
Baud rate	1200, 2400, 4800, 9600, 19200, 115200 are available

15.16 USB Interface

Table 15.16 USB interface

Number of port	1
Interface	Type B interface (socket)
Electrical and mechanical specifications	Compliance with USB Rev. 2.0 standard
Transmission mode	HS (high speed; 480Mbps) and FS (full speed; 12Mbps)
Supported protocol	Custom protocols
PC system requirements	Equipped with USB port, running English or Chinese version of Windows 7 (32-bit/64-bit) WindowsVista(32-bit) or Windows XP (32-bit, SP2 or update version)

15.17 Ethernet Interface

Table 15.17 Ethernet interface

Number of port	1
Interface type	RJ-45 interface
Electrical and mechanical specifications	Conform to IEEE802.3 standard
Transmission system	Ethernet (100BASE-TX, 10BASE-T)
Transmission rate	Max 100Mbps
Communication protocol	TCP/IP
Supported service	DHCP, remote control

15.18 Common Features

Table 15.18 Common features

Display parameter	Parameter description
Rated supply voltage	100VAC ~ 240VAC
Preheating time	≥ 30 min
Working environment	Full precision 5℃-40℃, 20% R.H.-80%R.H., non-condensing
Storage temperature	-25℃-60℃, 20% R.H.-80%R.H., non-condensing
Rated supply frequency	50/60Hz
Allowable range of supply frequency	48Hz ~ 63Hz
Max power consumption	PA310/PA310H: 50VA; PA323/PA333H: 70VA

15.19 Model and Suffix Code

Table 15.19 Model and suffix code

Model	Channel Number	Description
PA310/PA310H	Single-input unit type	GPIB, USB-Host, USB-Device, RS-232 interface and external sensor interface (standard)
PA323/PA333H	3-input unit type	GPIB, USB-Host, USB-Device, RS-232 interface and external sensor interface (standard)

15.20 AC/DC current Sensor/Transformer (optional)

Table 15.1 AC/DC current sensor/transformer

Product Type	Model	Image	Current	Precision	Bandwidth	Scaling	Interface Type
AC/DC current clamp	CA (PAC22)		1400Apk	±1.5%, ±2%	DC-10kHz	10mV/A 1mV/A	BNC interface
AC current clamp	CA(D36N)		3000Arms	±0.5%	30Hz≤f ≤5kHz	1mA/A	φ4mm female banana jack
AC current clamp	CA(C117)		1000Arms	±0.3% of rgd	30Hz≤f ≤5kHz	1mV/A	Banana plug
AC current clamp	ZY (CTS500)		500Arms	±0.3%	45Hz-5kHz	1mV/A	BNC interface
AC current clamp	ZY(CTS5)		5Arms	±0.3%	45Hz-5kHz	10mV/A	BNC interface
AC current clamp	ZY (CTS6000)		6000Arms	±1.0%	10Hz≤f≤20kHz	50mV/A 5mV/A 0.5mV/A	BNC interface
Current transformer	YX-CTS200		200Arms	±0.3%	45Hz-5kHz	10mV/A 1mV/A	BNC interface

Note: D36N combined with TL1000 measurement line
C117 combined with TA1004 adaptor

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16. Mechanical Dimension Drawings

16.1 Mechanical Dimension Drawings of PA310/PA310H Power Meters (unit: mm)

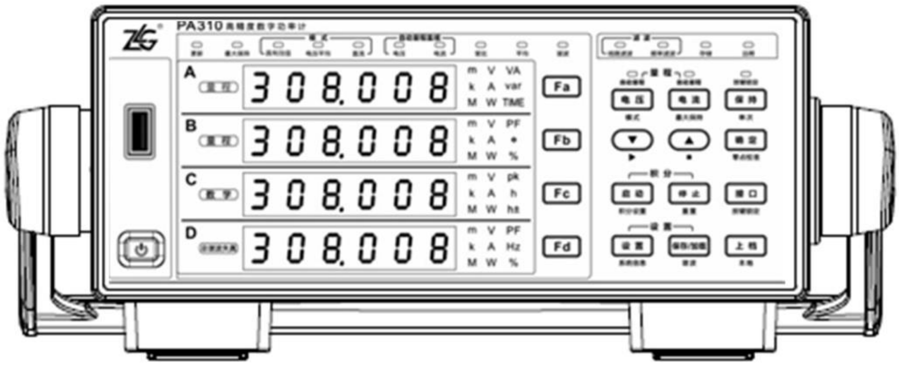

Figure 16.1 Mechanical dimension drawing of PA310 power meter (front view)

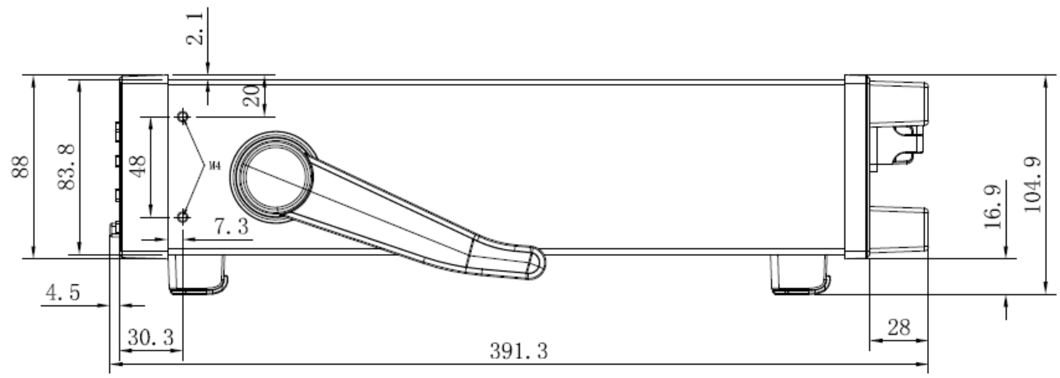

Figure 16.2 Mechanical dimension drawing of PA310 power meter (side view)

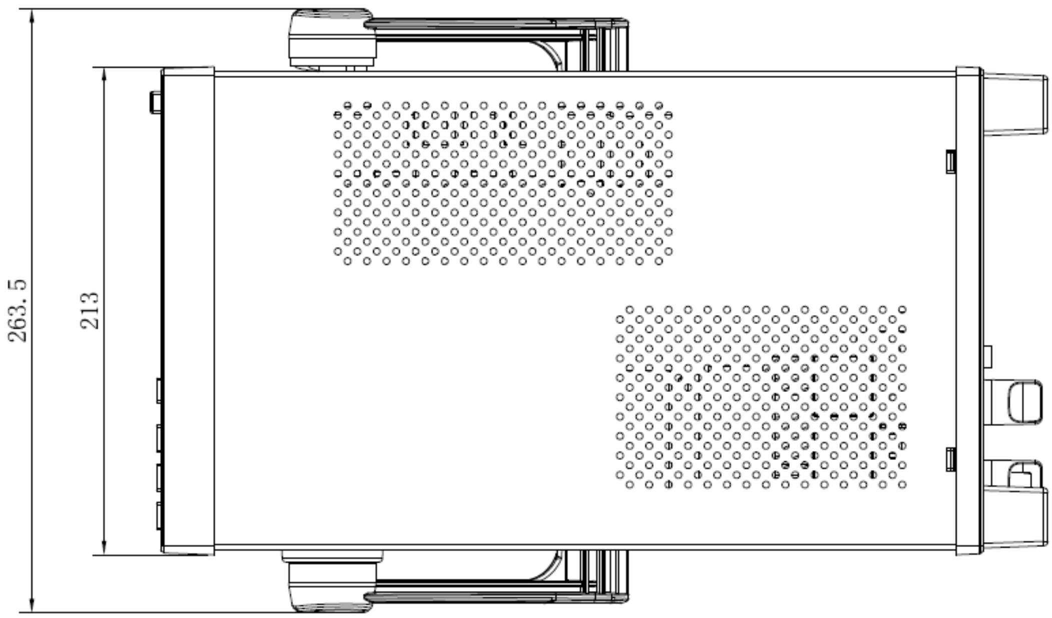

Figure 16.3 Mechanical dimension drawing of PA310 power meter (top view)

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Note: The front and side dimension drawings of PA310H and PA310 are the same, but the PVC model is different.

16.2 Mechanical Dimension Drawings of PA323/PA333H Power Meters (unit: mm)

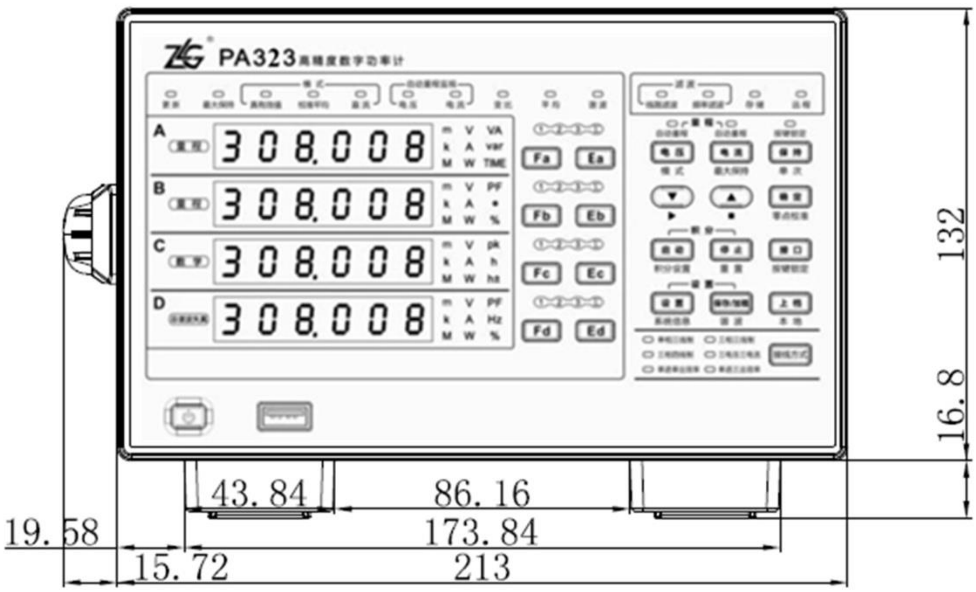

Figure 16.4 Mechanical dimension drawing of PA323 power meter (front view)

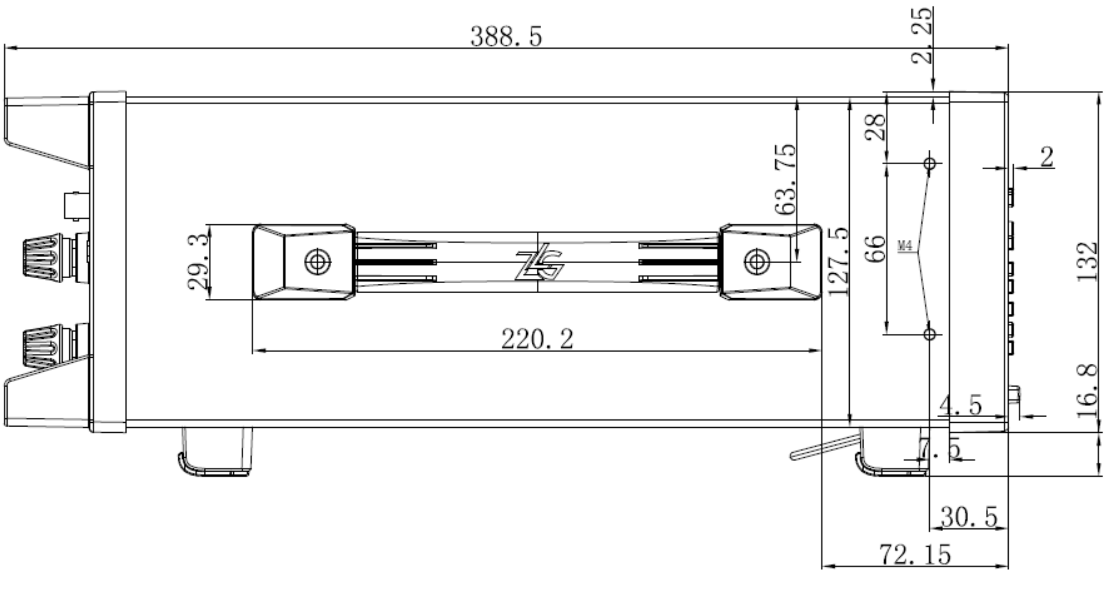

Figure 16.5 Mechanical dimension drawing of PA323 power meter (side view)

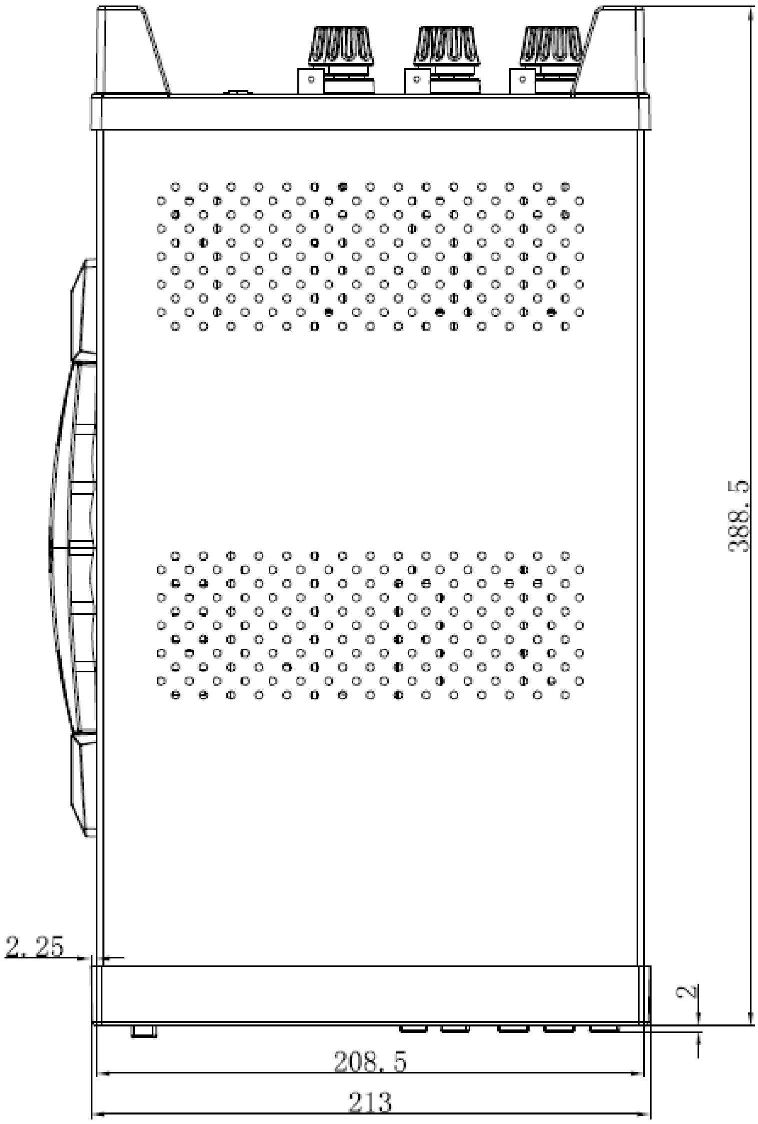

Figure 16.6 Mechanical dimension drawing of PA323 power meter (top view)

Note: The front and side dimension drawings of PA333H and PA323 are the same, but the PVC model is different.

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17. Accessories

Table 17.1 Accessories (optional)

Model	Brand	Specification and Model
Test wire	MC TL1000	Safety test wire. Safety level: 600 V, CAT III ~ 1000 V, CAT II / 32 A, with the wire length of 1.5m
Test connector	MC TA1002	Large alligator clip, with Φ4mm safety socket, rated voltage of 1000V and the max current of 32A
	MC TA1003	Φ4mm safety plug, stackable, test wire can be connected by screws, with rated voltage of 1000V
	MC TA1004	Safety BNC male banana socket adapter, with Φ4mm safety socket, and rated voltage of 1000V

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