712

APView400
Power Quality Analyzer

User's Manual V1.4

Acrel CO.,LTD

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1 Introduction

1.1 Overview

The APView400 utilizes a high-performance multi-core platform and an embedded operating system. It adheres to the measurement methods for power quality indices specified in IEC 61000-4-30, integrating functions such as harmonic analysis, waveform sampling, voltage sag/swell/interruption detection, flicker monitoring, voltage unbalance monitoring,demand,TOU, event recording, and measurement control.

The device meets Class A national standards in terms of measurement method standardization, parameter accuracy, clock synchronization, and event alarm functionality. It is suitable for power quality monitoring in 35kV and below power supply systems and is widely used in industries such as semiconductor, petrochemical, steel, hospitals, data centers, and transportation buildings, as well as in new energy power generation systems like photovoltaic, energy storage, and wind power.

1.2 Features

1.2.1 High-performance hardware platform

The device employs a multi-core heterogeneous SoC as its central chip, with dual Arm cores based on an asymmetric processor architecture. Arm1 is equipped with an embedded Linux operating system, tasked with executing communication, storage, statistics, analysis, and other functions. Arm2 operates bare-metal, dedicated to high-real-time tasks such as sampling and computation. The device samples at a rate of 1024 points per cycle and utilizes a 32GB solid-state Class A storage component for program and data storage, with all chips selected to meet wide-temperature industrial-grade specifications. The device is integrated with a large 800*480 dot matrix color LCD, enabling on-site viewing of events, waveforms, and other data.

1.2.2 Various interfaces available

- 4 channels of AC voltage
- 4 channels of AC current
- 5 DO,5 DI
- 2 RS485, support the Modbus-RTU protocol and IRIG-B
- 2 Ethernet port, support Modbus-TCP、IEC61850 MMS、FTP and device update
- 1 USB,used for device update

1.2.3 Reliability

Both hardware and software of this device have continuous and comprehensive self-test function and good anti-interference capacity. This device has been certified in a number of EMC tests like electric fast transient, electrostatic discharge and surge anti-interference and complied with the relevant standards.

1.3 Functions

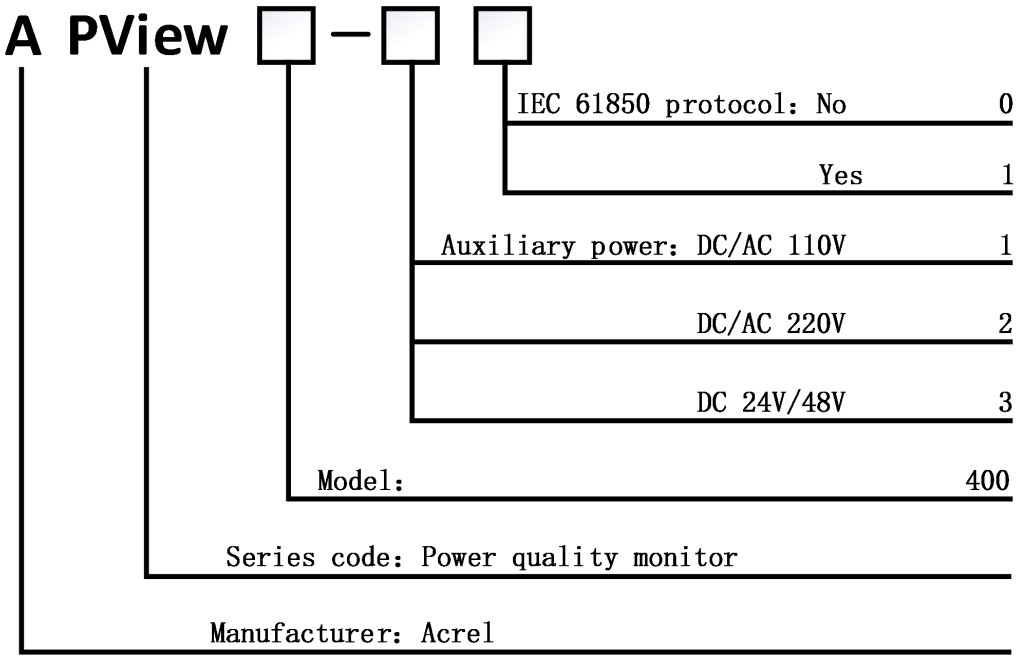
Table 1.1 Functions

Meter	RMS voltage and current		√
	Frequency		√
	Fundamental phase angle and vector diagram		√
	Real-time voltage and current waveform		√
	P、Q、S、PF		√
	Ep+、Ep-、Eq+、Eq-		√
	Demand(real-time,max)		√
	Multi-rate energy(TOU)		√
Steady	Voltage and Current sequence components		√
	Current and voltage unbalance		√
	Voltage deviation		√
	Frequency deviation		√
	Harmonics (2^{nd} -63^{rd})	Harmonic voltage/current RMS	√
		Harmonic voltage/current ratio	√
		Total harmonic distortion(THD) of voltage/current	√
		Total demand distortion(TDD) of current	√
		Harmonic voltage/current phase angle	√
		Crest factor	√
		K-factor	√
		Odd harmonic distortion	√
		Even harmonic distortion	√
		Harmonic energy	√
		Harmonic power	√
	Interharmonics (0.5^{th} to 62.5^{th})	Interharmonic voltage/current RMS	√
		Interharmonic voltage/current ratio	√
	Higher harmonics	2.5kHz～8.9kHz	√
	Voltage flicker (short-term flicker & long-term flicker)		√
	Voltage fluctuation		√
	Rapid voltage change		√
	DC component		√
Temporary	Voltage interruption		√
	Voltage dip		√
	Voltage swell		√

	Inrush current		√
Transient	Transient voltage		√
	Transient current		√
Events	Temporary events	Trigger the threshold of temporary events	√
	Steady events	Trigger the threshold of steady events	√
	Log	Record the daily operation and running conditions	√
Fault record	Event triggered	Settable waveform periods	√
	Manual trigger	Settable sampling point	√
	Timed trigger	Settable sampling point	√
	Host trigger	Settable sampling point (supported by IEC61850)	√
Communication	IEC61850		■
	Modbus-RTU		√
	Modbus-TCP		√
	WebServer		√
Timing	SNTP , GPS timing(IRIG-B)		√

Note: √- standard function, ■- option.

1.4 Type



1.5 Overview

1.5.1 Front Panel

The panel is a 5" color LCD that graphically indicates the main power quality indexes in real time. The built-in clock can be set. The monitoring parameters can be set and modified. A user can also assign a password and perform other actions.

1.5.2 Memory

It is allowed to save monitoring data in real time. The 1min-data (e.g. maximum value, minimum value, average value, 95% probability value and RMS) can be saved for a maximum of 90 days. The memory will be updated in accordance with the principle of "first-in-first-out".

It can save 5000 steady events , 5000 temporary events , and 2000 fault waveforms.

1.5.3 Communication

There are 2 RS485 serial communication ports that support Modbus-RTU protocol and IRIG-B. There are 2 Ethernet ports that support Modbus-TCP, IEC61850 MMS and FTP .

1.5.4 Alarm

The alarm will be triggered to the user-set threshold of power quality indexes in steady, temporary and transient states. When an alarm is triggered, this device will record the event and trigger recording.

1.5.5 Waveform Recorder

Each alarm event can be recorded. There are three more triggering modes, i.e. manual recording, timed recording and host-triggered recording. The periods of waveform can be set up to 1024 point every time (51.2kHz).

1.5.6 PQDIF

The recorded data is saved in PQDIF format, including the fault waveforms and steady data within 2h. Steady-state data contains every 1 minute of "maximum value", "minimum value", "average value", "RM " and "95% probability value" recorded in 2h. The record of fault data and steady data can be viewed by the tool software. The data of "maximum value", "minimum value", "average value", "RMS" and "95% probability value" in 1min will be recorded for one data point. All these data points in 2h will be saved in a file. The trend of changes can be observed by the tool software.

1.5.7 Web Server

The device includes Web Sever function which supports user login access with different user levels.Users of different levels log in using different 8-digit passwords, namely "Visitor", "Administrator", and "Debugger", and the password for the Visitor is "00000000". Users can directly connect to the device through a browser to view power quality data in real time and set device parameters.

Connection method:

1. Connect this device to your computer with the network cable.
2. Check the IP address of connected Ethernet port via "System→Communication", e.g. 172.22.60.99.
3. Allocate the same network segment for your computer IP and the device IP.
4. Open the browser on your computer, input the IP address in the address bar as shown in Fig. 1.1.and press Enter.

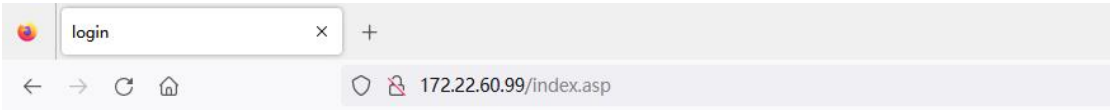


Fig. 1.1 Enter the IP address in the address bar of your browser

The user login screen appears.The user selects his/her identity and input a login password on the user login screen as illustrated in Fig. 1.2.



Fig. 1.2 Web server Log-in Screen

After login, the function menu appears on the left and the device information and data are shown on the right side as illustrated in Fig. 1.3.

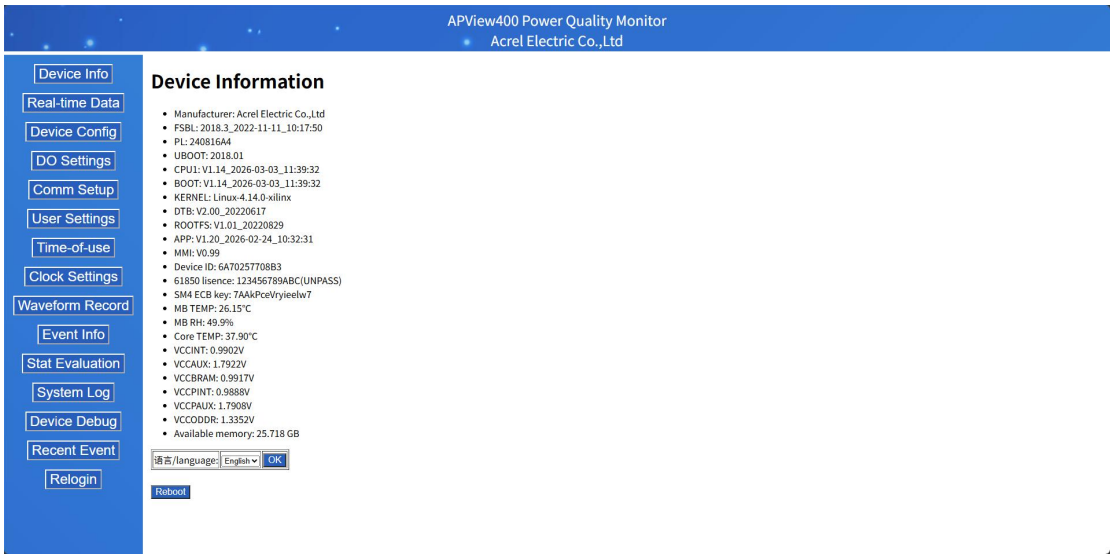


Fig. 1.3 Product Information Screen

View of real-time data. Click "Real-time Data" on the left menu once. Then the real-time data will be indicated on the right.

"Generate EXCEL". Generate a spreadsheet (.xls) according to the real-time data. Click the file name to open it or save it.

"Basic data", "Power", "Energy", "Harmonic" and others: Make a switch to check other data as shown in Fig. 1.4.

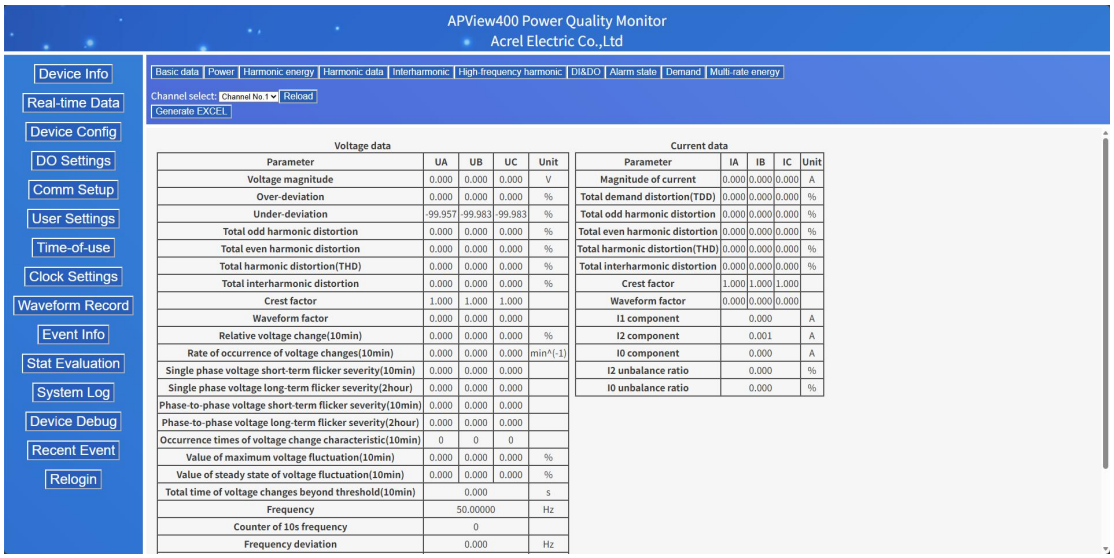


Fig. 1.4 Basic Data Screen

Waveform Record. Click "Wave Record" on the left and select the corresponding Events to check the recorded waveform.

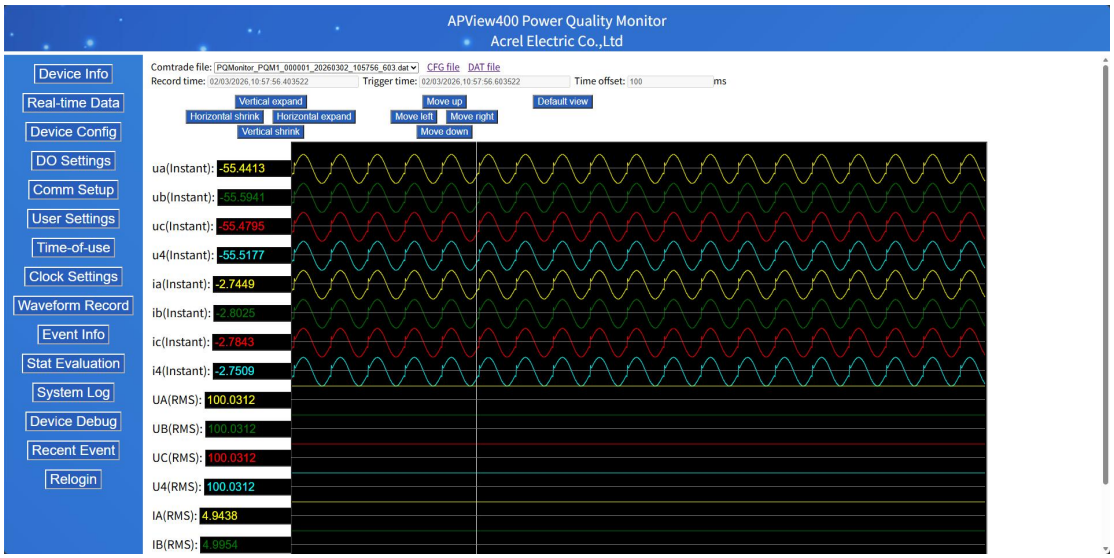


Fig. 1.5 Waveform Screen

2 Technical parameter

2.1 Power supply

Rated: AC/DC220, AC/DC110V or DC24V/48V

Permissible deviation: -20%-+20%

Power consumption:≤15W

2.2 AC current

Rated: 5A

Input method: Current transformer input

Measuring range: 0-1.2In

Power consumption: ≤0.5VA (single phase)

Overload capacity: 1.2In, continuous working

20 times for 1 second

2.3 AC voltage

Input mode: Voltage transformer input or direct connect

Rated: 57.74/100,220V/380V

Measuring range: 0-1.2Un

Power consumption:≤0.5VA (single phase)

Overload capacity: 1.2Un, continuous working

4 times for 1seconds

2.4 Digital input

Rated voltage: AC/DC220V, AC/DC110V or DC24V/48V

Input mode: Passive contacts, external power supply required

2.5 Digital output

Mechanical service life: ≥10000

Output mode: Passive contacts

Switching capacity: ≤4000W or ≤384VA

On-state current: ≥16A(AC250V/DC24V) in the continuous mode

≥30A for a short term (200ms)

2.6 Communication port

2.6.1 Ethernet

Speed: 10/100M, adaptive

Type: 10/100Base—T

Compatible with TCP/IP, FTP protocol

2.6.2 RS485 port

Speed: 300-57600bps

With the optical isolation

2.7 Accuracy

Basic functions			Accuracy
Meter	RMS Voltage		±0.1%U_N
	RMS Current		0.01I_N ~ 0.05I_N : ±1% >0.05I_N : ±0.5%
	P , Q, S		P:±0.2%, Q:±0.5%
	Power factor		±0.5%
	Ep+ ,Ep- ,Eq+ ,Eq-		Ep Class 0.2 ,Eq Class 0.5
Steady	Voltage deviation		0.1%
	Frequency deviation		±0.001Hz
	Three-phase unbalance	Voltage unbalance	±0.05%
		Current unbalance	±1%
	Harmonics(2nd -63rd)	Harmonic voltage RMS	U_{hN}≥1%U_N： ±5%
			U_{hN}<1%U_N： ±0.05%
		Harmonic current RMS	I_{hN}≥3%I_N： ±5%
			I_{hN}<3%I_N： ±0.15%.
	Interharmonics (0.5th to 62.5th)	Interharmonic voltage RMS	U_{hN}≥1%U_N： ±5%
			U_{hN}<1%U_N： ±0.05%
		Interharmonic current RMS	I_{hN}≥3%I_N： ±5%
			I_{hN}<3%I_N： ±0.15%
	Higher harmonics		2.5kHz～8.9kHz
	Voltage flicker		±2%
	Voltage fluctuation		±0.2%U_N
	Rapid voltage change		±0.2%U_N
	Manual/Timed recording		Settable sampling points/cycle
Temporary	Event type	Voltage dip	Amplitude error: <±0.2%; time error: <±20ms

		Voltage swell	Amplitude error: <±0.2%; time error: <±20ms
		Voltage interruption	Amplitude error: <±0.2%; time error: <±20ms
		Inrush current	Amplitude error: <±0.2%; Time error: <±20ms
	Temporary event record		1024 points/ cycle
Transient	Transient voltage		20us
	Transient voltage		20us
Timing	IRIG-B		Absolute timing accuracy: ±1ms; Clock accuracy: ±1s/24h
	SNTP		Absolute timing accuracy: ±1ms; Clock accuracy: ±1s/24h

Note 1: In the table, U_N is the rated voltage and I_N is the rated current; U_{InN} is the voltage set value, and I_{InN} is the current set value.

Formula for voltage RMS error: $\frac{U-U_{InN}}{U_N} \times 100\%$; Formula for current RMS $\frac{I-I_{InN}}{I_{InN}} \times 100\%$.

Note 2: In the table, U_h is the actual measured value of the h (inter)harmonic voltage; U_{hn} is the set value of the h (inter)harmonic voltage.

While the U_{hN}<1%U_N, the formula for (inter)harmonic voltage RMS error is $\frac{U_h-U_{hN}}{U_N} \times 100\%$;

While the U_{hN}≥1%U_N, the formula for (inter)harmonic voltage RMS error is $\frac{U_h-U_{hN}}{U_{hN}} \times 100\%$.

Note 3: In the table, I_h is the actual measured value of the h (inter)harmonic current; I_{hn} is the set value of the h (inter)harmonic current.

While the I_{hN}<3%I_N, the formula for (inter)harmonic voltage RMS error is $\frac{I_h-I_{hN}}{I_N} \times 100\%$;

While the I_{hN}≥3%I_N, the formula for (inter)harmonic voltage RMS error is $\frac{I_h-I_{hN}}{I_{hN}} \times 100\%$.

2.8 Reference standard

IEC 61000-4-30 Power quality measurement methods

IEC 61000-4-15 Flickermeter—Functional and design specifications

IEC 61000-4-2 Electromagnetic compatibility— Testing and measurement techniques—Electrostatic discharge immunity test

IEC 61000-4-3 Electromagnetic compatibility— Testing and measurement techniques—Radiated, radio-frequency, electromagnetic field immunity test

IEC 61000-4-4 Electromagnetic compatibility— Testing and measurement techniques— Electrical fast transient/burst immunity test

IEC 61000-4-5 Electromagnetic compatibility— Testing and measurement techniques—Surge immunity

test

IEC 60068-2-1 Environmental testing for electric and electronic products— Part 2: Test methods— Tests A: Cold

IEC 60068-2-2 Environmental testing for electric and electronic products— Part 2: Test methods— Tests B: Dry heat

IEC 60068-2-4 Environmental testing for electric and electronic products— Part 2: Test methods— Test Db: Damp heat, cyclic (12h + 2h cycle)

IEC 60068-2-6 Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)

IEC 60068-2-27 Environmental testing - Part 2-27: Tests - Test Ea and guidance: Shock

IEC 60068-2-30 Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)

IEC 60529 Degrees of protection provided by enclosure (IP code)

IEC 60255-1 Measuring relays and protection equipment - Part 1: Common requirements

IEC 60255-2-27 Measuring relays and protection equipment - Part 27: Product safety requirements

IEC 60255-2-1 Measuring relays and protection equipment - Part 1: Common requirements

IEC 60255-21-1 Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section One: Vibration tests (sinusoidal)

IEC 60255-21-2 Electrical relays - Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment - Section Two: Shock and bump tests

2.9 Working conditions

Normal working temperature: -10℃-+55℃

Storage temperature: -30℃-+80℃

Relative humidity: 5%-95%

Atmospheric pressure: 86kPa-106kPa

Altitude: ≤2500m

Degree of protection: IP51

2.10 Safety features

2.10.1 Insulating properties

Pass the Insulating properties test at 2KV and 50Hz for 1min without breakdown or flashover.

2.10.2 Insulation resistance

Measure the insulation resistance by a megohmmeter with an open-circuit voltage of 500V. The insulation resistance of circuit at different levels shall not be less than 20MΩ under normal atmospheric conditions.

2.10.3 Impulse voltage

Conduct the short-term impulse voltage test among the power input circuit, the AC input circuit and the digital output circuit and between such circuits and the ground at the standard lightning wave of 1.2/50μs and an open-circuit voltage of 5kV under normal atmospheric conditions.

2.10.4 Damp and heat resistance

Conduct the steady-state damp and heat test at +40℃±2℃ and (93±3)％RH for 48h in compliance with the provisions of IEC 60068-2-30:2005. During the last 2 hours before the end of the test, measure the insulation resistance and the dielectric strength between the exposed non-conductive metal parts and enclosures of all external live circuits, and between the circuits which are not electrically connected with a 500VDC megohmmeter. Such insulation resistance shall be no less than 1.5MΩ and the dielectric strength shall not be less than 75% of the dielectric strength test voltage.

2.11 EMC and mechanical properties

2.11.1 EMC performance

Test Name	Standard	Level
Electrostatic Discharge Immunity Test	IEC 61000-4-2:2008	Class IV
Radiated, Radio-Frequency, Electromagnetic Field Immunity Test	IEC 61000-4-3:2010	Class III
Electrical Fast Transient/Burst Immunity Test	IEC 61000-4-4:2012	Class III
Surge Immunity Test	IEC 61000-4-5:2005	Class III
Immunity to Conducted Disturbances, Induced by Radio-Frequency Fields	IEC 61000-4-6:2013	Class III
Power Frequency Magnetic Field Immunity Test	IEC 61000-4-8:2001	Class IV
Voltage Dips, Short Interruptions and Voltage Variations Immunity Tests	IEC 61000-4-11:2004	Pass

Oscillatory Waves Immunity	IEC 61000-4-12:2016	Class IV
Voltage Dips, Short Interruptions and Voltage Variations on D.C. Input Power Port Immunity Tests	IEC 61000-4-29:2000	Pass

2.11.2 Mechanical vibration

The device can pass the vibration endurance test specified in "IEC 60068-2-6 Environmental testing - Part 2-6: Tests - Test Fc: Vibration (sinusoidal)".

2.11.3 Mechanical shock

The device can pass the shock response test specified in "IEC 60068-2-27:2008:Environmental testing - Part 2: Test methods - Test Ea and guidance: Shock.".

3 Mechanical structure and installation

3.1 Hole size and installation method

The embedded installation is adopted for this device. First, drill holes on the panel of a distribution cabinet as shown in Fig. 3.1. Second, place this device into these holes until the panel of device is against the panel of the distribution cabinet as shown in Fig. 3.2. Finally,install the mounting slide bars,then insert screws and tighten them to fix this device.

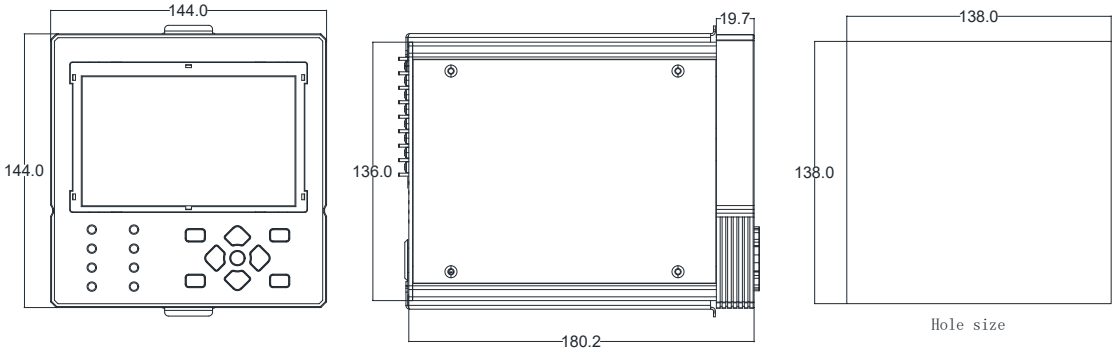


Fig. 3.1 Outline and size diagram

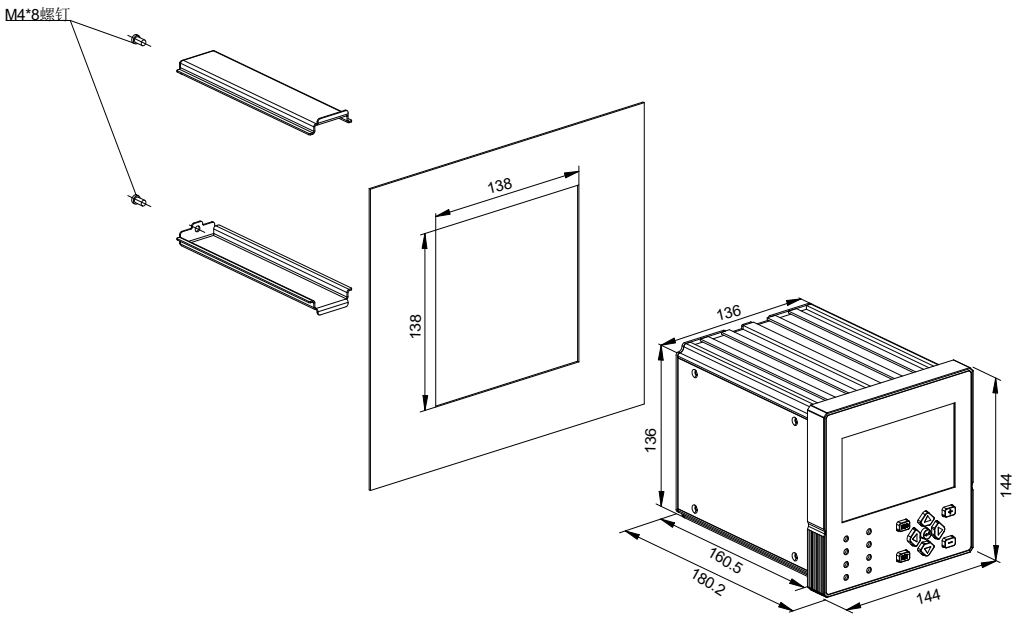


Fig. 3.2 Installation diagram

3.2 Back terminals

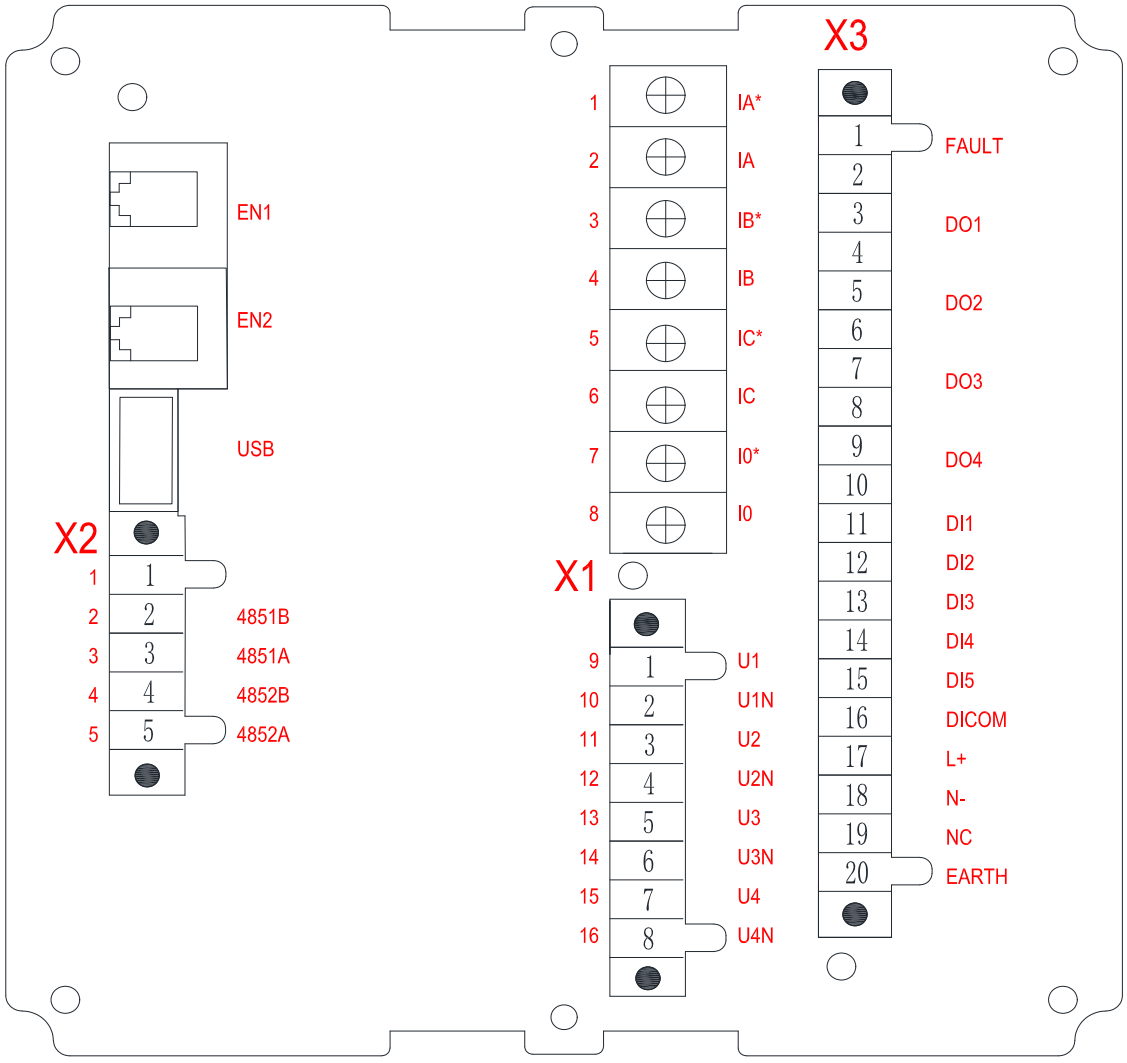


Fig. 3.3 Back terminals

Terminal	Description
X1	3 current inputs: X1.1~X1.6 3 voltage inputs: X1.9~X1.14 Spare current input: X1.7~X1.8 Spare voltage input: X1.15~X1.16
X2	The 1st RS485 port (485A1, 485B1) The 2nd RS485 port (485A2, 485B2) Both support IRIG-B protocol
X3	Digital inputs (X3.11~X3.15, common terminal X3.16) Digital outputs (abnormal signal X3.1-X3.2, customizable normally open contacts X3.3-X3.10) Auxiliary power supply (X3.17~X3.18) Ground (X3.20)**(Please ensure grounding during installation)**
EN	2 Ethernet ports
USB	USB maintenance port

3.3 Wiring

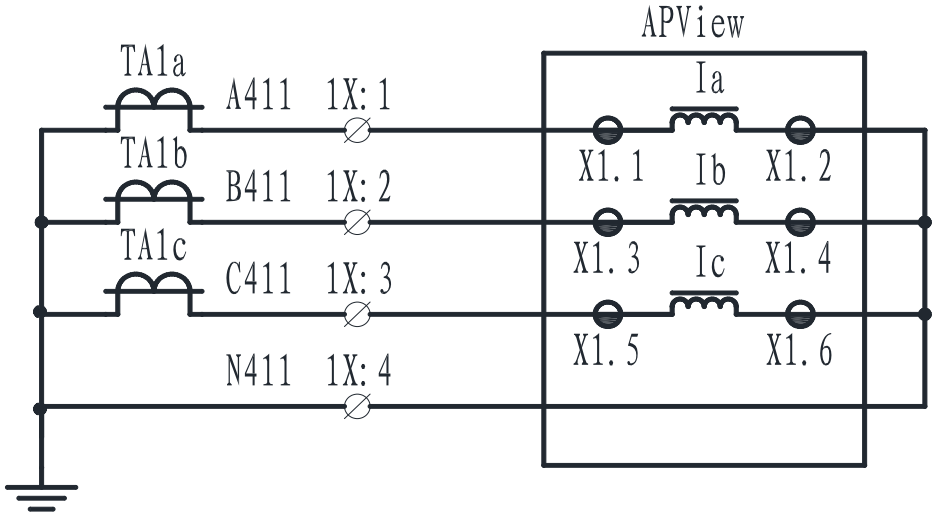


Fig. 3.5 3CT Current wiring

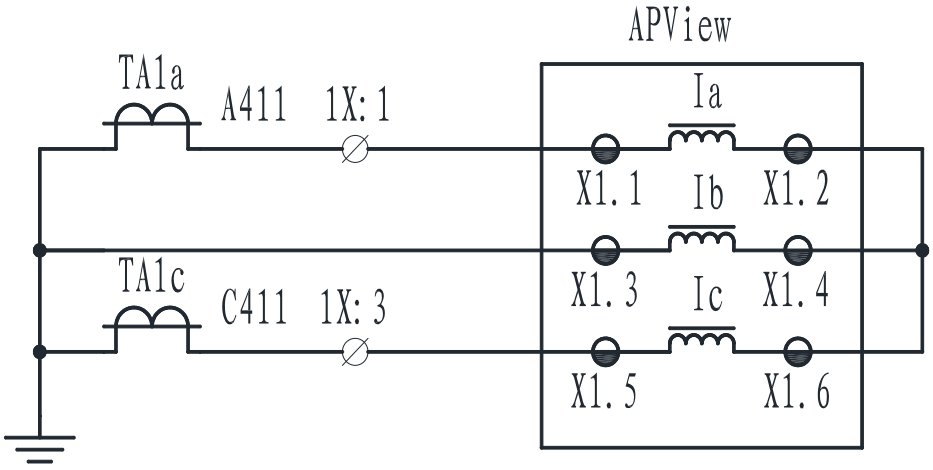


Fig. 3.6 2CT Current wiring

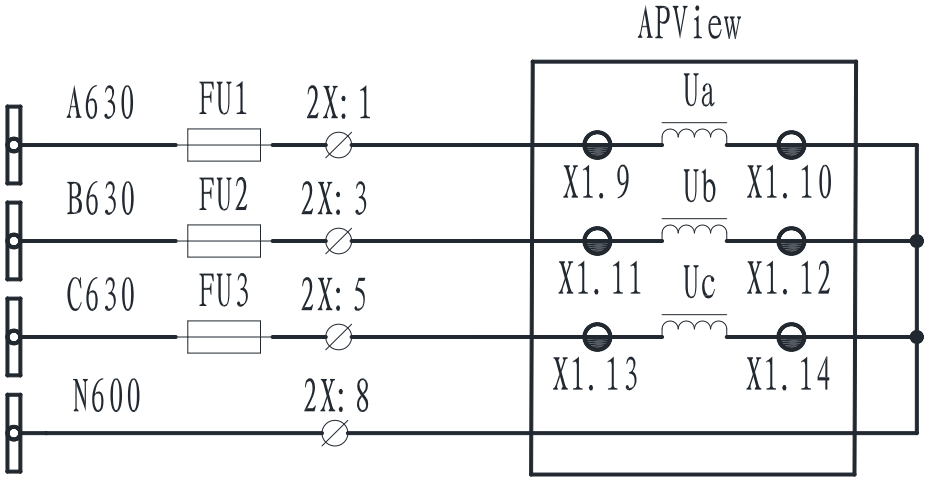


Fig. 3.7 3PT Voltage wiring

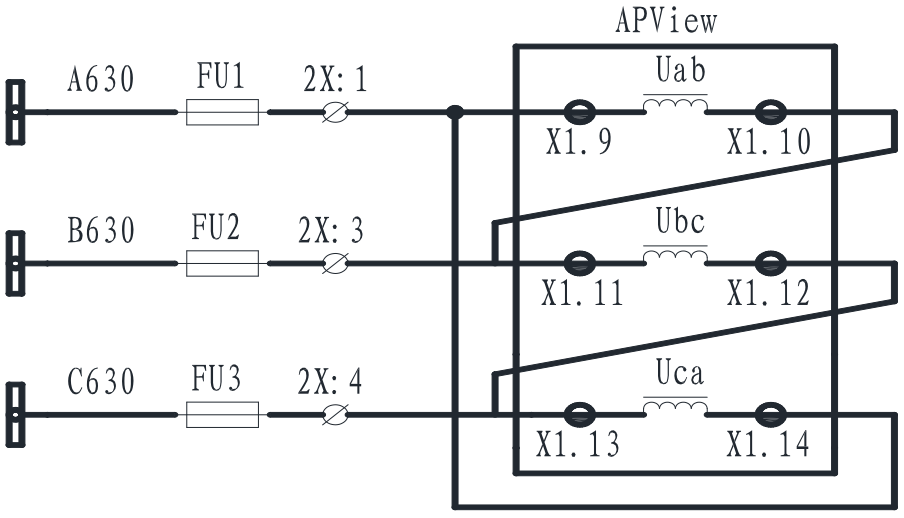


Fig. 3.8 2PT Voltage wiring

3.4 Ground

In order to ensure the safety of this device and its operators, the casing shall be connected to the grounding grid of substation or power plant reliably. For reliable operation at a workplace exposed to strong electromagnetic interference, isolation, filtering and safety measures have been incorporated into this device. However, the effect of these measures depends on the correct grounding of this device. Therefore, grounding is crucial. Grounding port X3.20 (label: EARTH) is provided at terminal X3, which must be reliably grounded with a 4mm² or bigger grounding conductor (yellow-green).

3.5 Power supply

This device can work at the rating of AC/DC110V, AC/DC220V or DC24V/48V within an operating range of 80% to 120%. Before powering on this device, check the nameplate on the side and ensure that the actual power supply matches the nominal range of this device to prevent damages to this device.The power supply must be stable to prevent the device from shutting down due to power failure, which may lead to unrecorded faults.

3.6 Analog input

The current input terminals of device shall be connected to the AC current circuit of the distribution board or cabinet with a color-labeled wire of min. 2.5mm² reliably crimped. The fixing screws of terminals shall be provided with spring washers and tightened to prevent open circuit. The voltage input terminals of device shall also be connected to the AC voltage circuit of the distribution board or cabinet with a color-labeled wire of min. 1.5mm² reliably crimped.

3.7 Communication port

This device is equipped with 10/100M Ethernet ports EN1 and EN2 (with phase switching function) using RJ45 interface. There are two RS485 serial communication ports(with the IRIG-B synchronization function), i.e. 4851B/1A and 4852B/2A, within the range of 300 to 57600bps. And the communication connection is made through a shielded twisted pair to improve reliability.

4 Human Machine Interface(HMI)

The HMI of this device include a LCD, LEDs and buttons. The 5" color LCD with a resolution of 800*480 shows metering, power quality, events, parameters, system setup, Debug and other data.

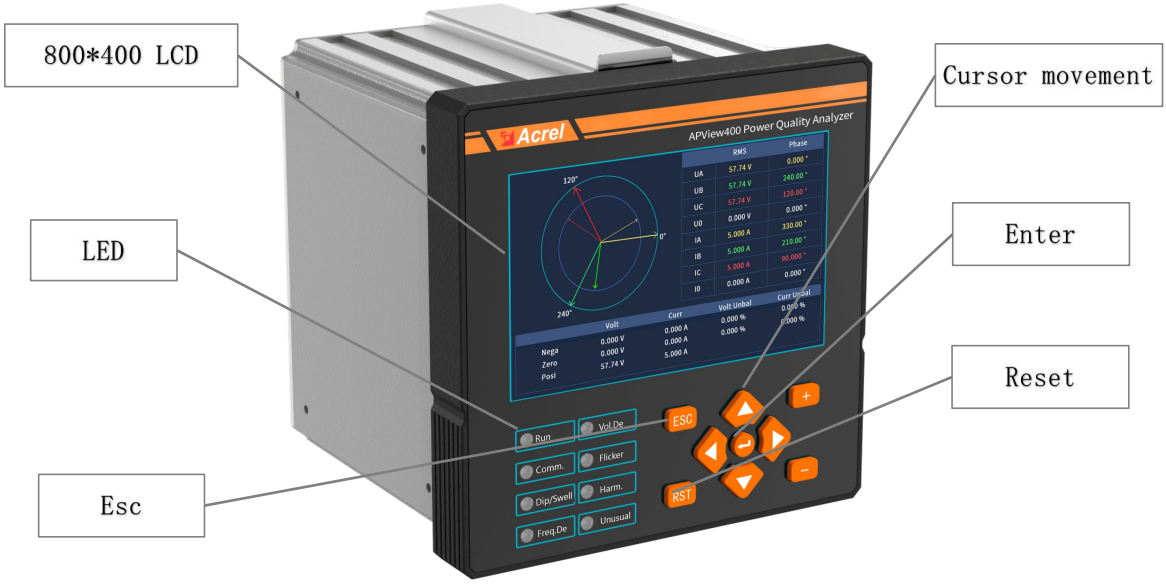


Fig. 4.1 Front Panel

4.1 Buttons

Table 4.1 Function Description of Buttons

Button	Main functions	Button	Main functions
▲	Move selection up or increase value	◀	Move selection left or scroll to previous page
▼	Move selection down or decrease value	▶	Move selection right or scroll to next page
ESC	Escape	+	Move the vertical cursor right on the waveform graph
RST	Reset	—	Move the vertical cursor left on the waveform graph
↵	Enter		

4.2 LED

LED indicate the running conditions, communication conditions and power quality indexes.

Table 4.2 Function Description of LED

Name	Color	Meaning
Run	Green	Flash when this device is running
Communication	Green	Flash during communication
Dip/Swell	Red	Voltage swell, dip, interruption and transient voltage/ current
Frequency deviation	Red	Power frequency beyond the limit
Voltage deviation	Red	Voltage RMS beyond the limit,Negative sequence voltage unbalance
Flicker	Red	Voltage flicker beyond the limit
Harmonic	Red	Total voltage/current harmonics beyond the limit, Each harmonic beyond the limit, Odd/ even voltage harmonics beyond the limit
Unusual	Red	Abnormal running

4.3 Quick navigation

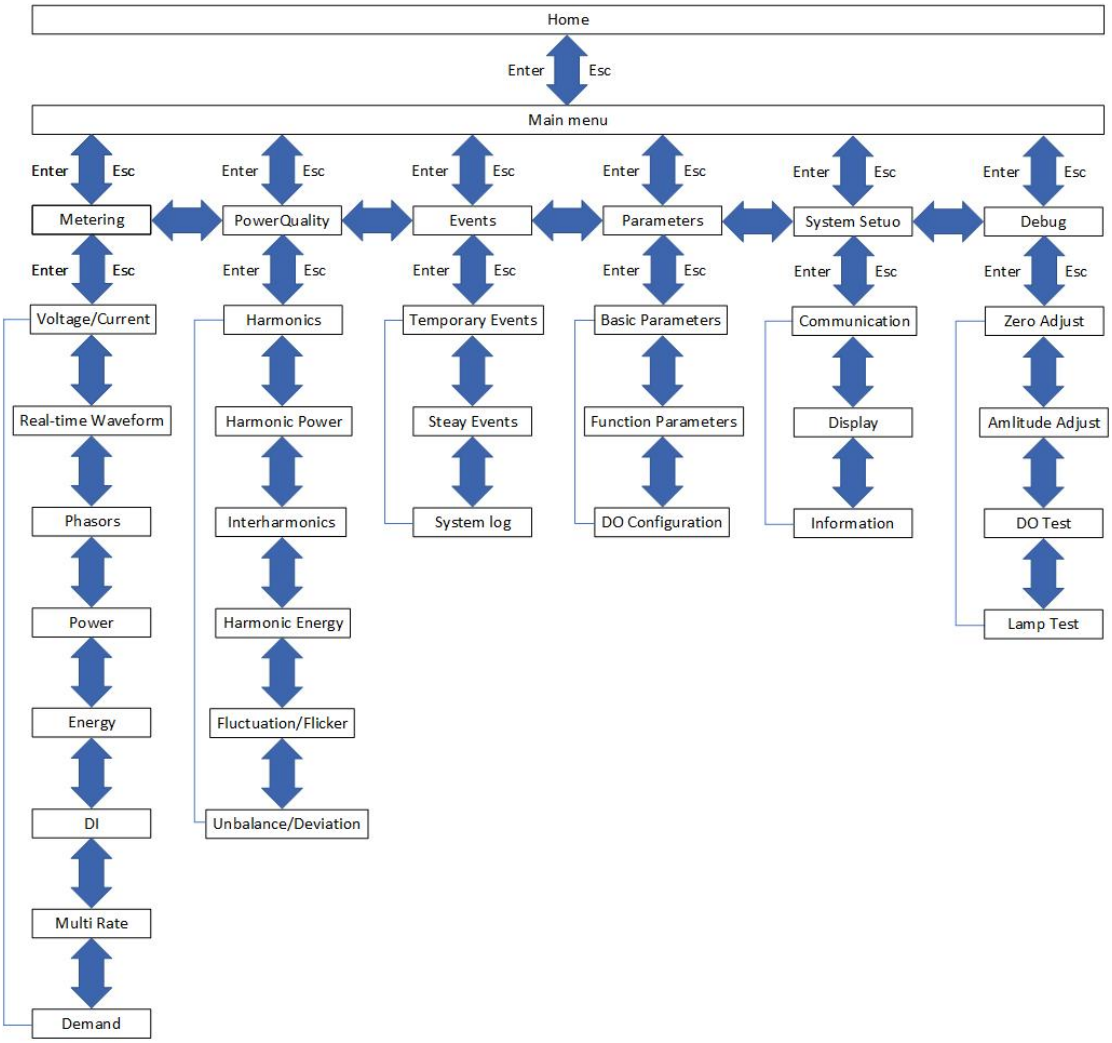


Fig. 4.2 Quick navigation

4.4 Operation instructions

4.4.1 Home

After it is powered on, this device opens Home automatically. Home mainly shows the real-time RMS voltage/ current and phase angles, channel frequency, number of dip/swell events, number of steady events and time. The number of events at the right side is the number of unviewed events, which can be cleared after entering the "Event" menu.



Fig. 4.3 Home

4.4.2 Main menu

The main menu is divided into six submenus, namely "Metering", "Power quality", "Events", "Parameters", "System Setup" and "Debug". When a submenu is selected, a blue select box will appear and be highlighted, and the the selected submenu items will be displayed in the "Preview" on the right. Then, press "↵" to enter the submenu.

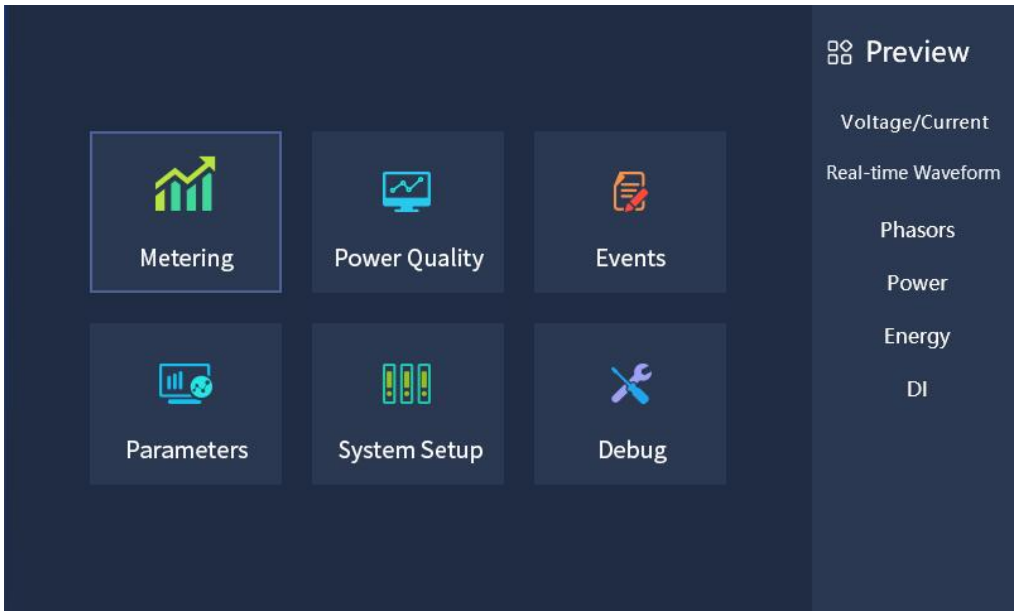


Fig. 4.4 Main Menu

4.4.3 Metering

Select "Metering" on main menu and enter "Metering" submenu. Submenu "Metering" provides six screens, i.e. "Voltage/current", "Real-time waveform", "Phasors", "Power", "Energy", "DI", “Multi rate”, ”Demand”.

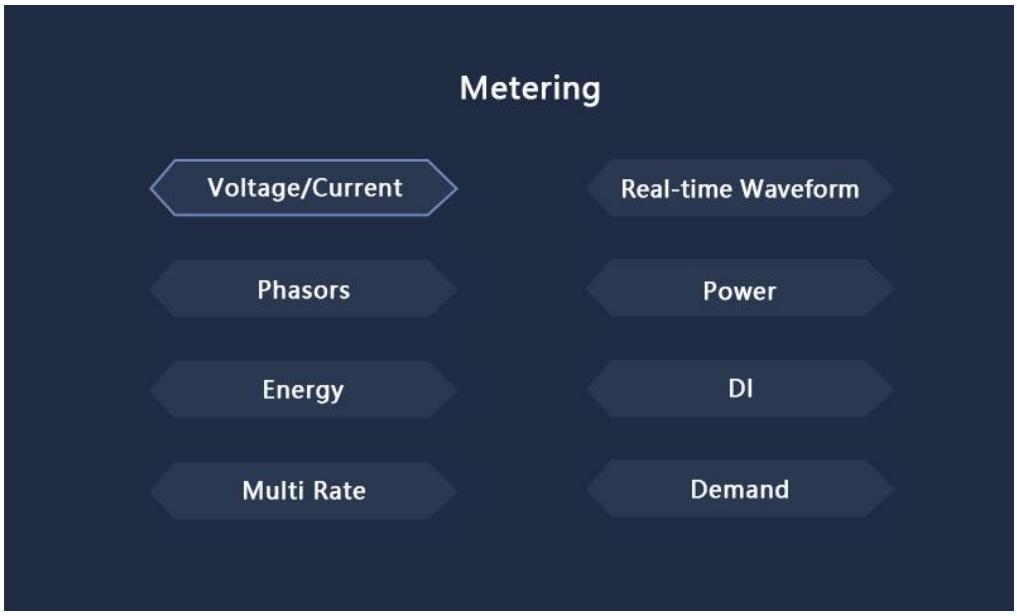


Fig. 4.5 Metering

4.3.3.1 Metering - Voltage/Current

Screen "Voltage/current" will show the primary and second values of voltage/current,as well as phase angles in last 3s.

(Note 1. All phase angles of this device are based on the fundamental phase angle of the phase-A voltage.)

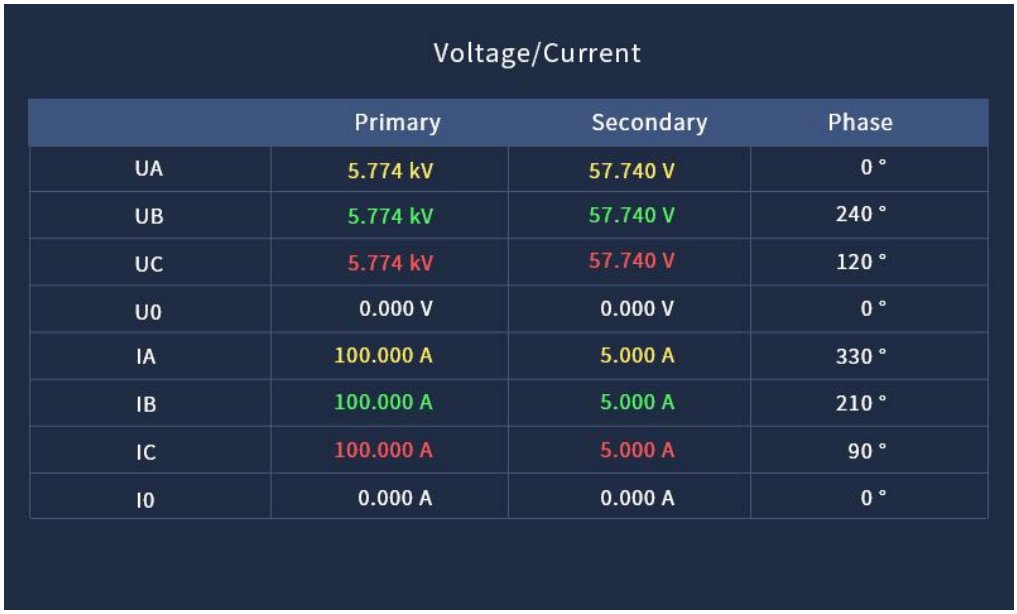


Fig. 4.6 Voltage & current

4.4.3.2 Metering –Real-time waveform

Screen "Real-time waveform" will mainly show the waveform of real-time sampling value. Press "+" or "-" to select a channel and "▲" or "▼" to select a channel. The selected one will turn white. Yellow, green and red indicate phase A, B and C respectively and blue indicates the zero sequence.

Press "◀" or "▶" to select the operation area; press "▲" or "▼" to select the displayed channel. Yellow, green and red indicate phase A, B and C respectively and blue indicates the zero sequence. Press "+" and "-" keys to move the waveform cursor.

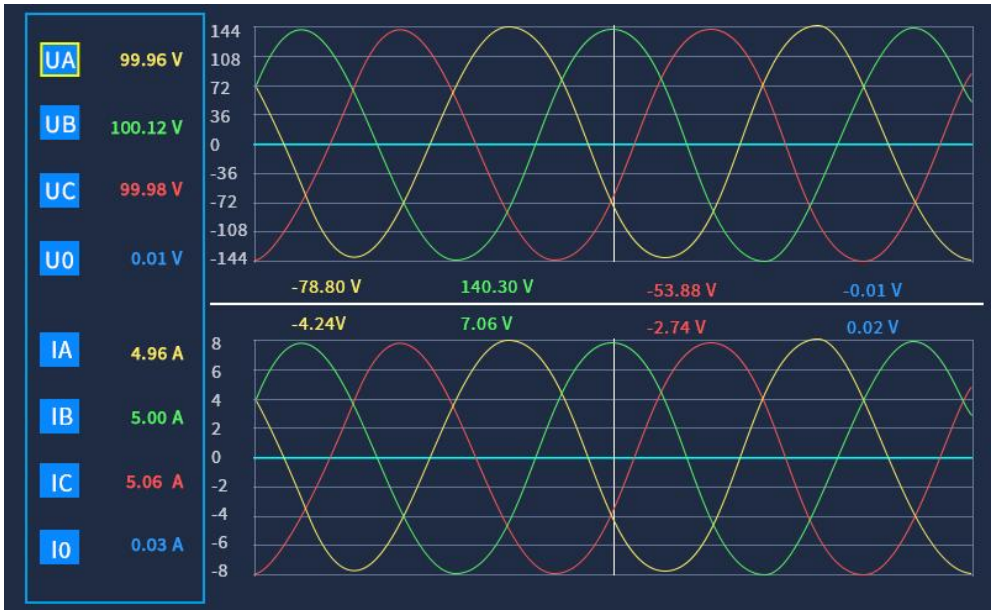


Fig. 4.7 Real-time Waveform

4.4.3.3 Metering – Phasors

Screen "Phasors" will show the vector diagram of the voltage and current, and negative/ zero/ positive sequence voltage and current as well as the negative/ zero sequence voltage/ current unbalance.

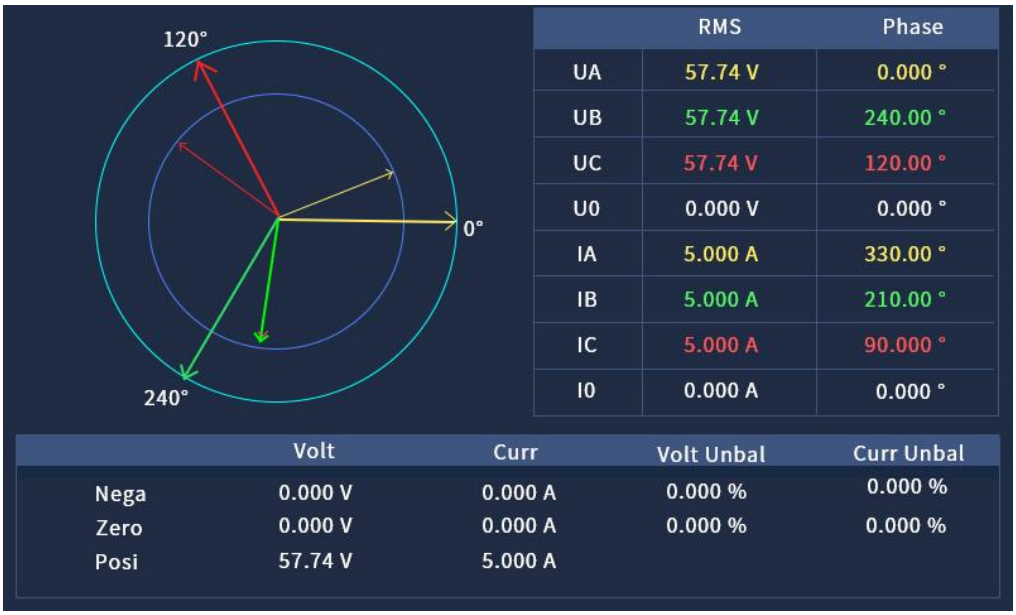


Fig. 4.8 Phasors

4.4.3.4 Metering – Power

Screen "Power" will show active/reactive power, power factor, apparent power, fundamental active power.



Fig. 4.9 Power

4.4.3.5 Metering – Energy

Screen "Energy" will show forward active energy EP+, forward reactive energy EQ+, reverse active energy EP-, reverse reactive energy EQ-, apparent energy ES and other related data.



Fig. 4.10 Energy

4.4.3.6 Metering – DI

Screen "DI" will show the state of digital inputs. "CLOSE" indicates the existence of input while "OPEN" indicates lack of input.

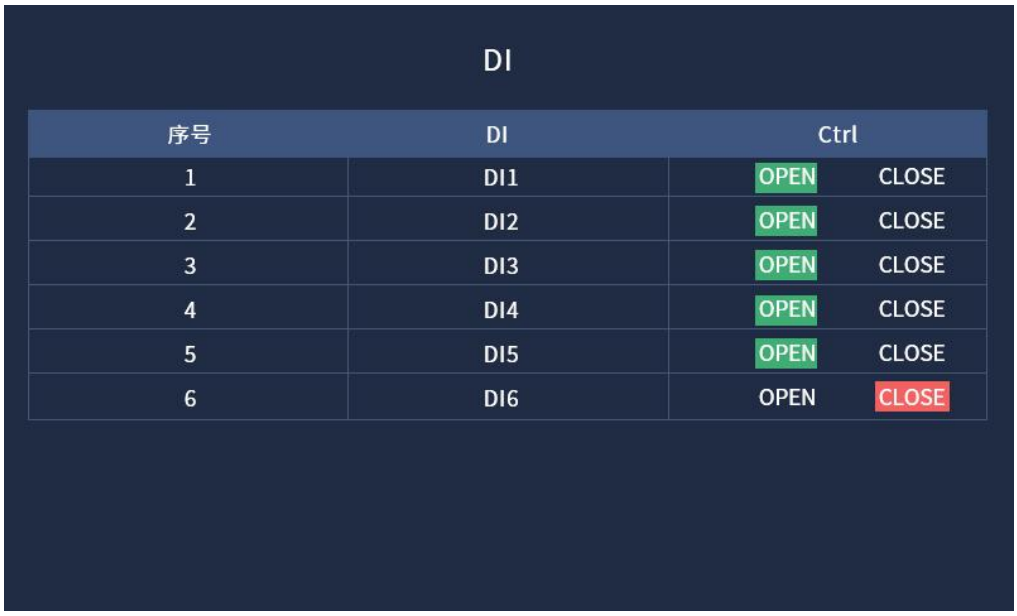


Fig. 4.11 DI

4.4.3.7 Metering – Multi Rate

Screen “Multi Rate” displays the cumulative energy and incremental energy of various types of energy data under different rates.

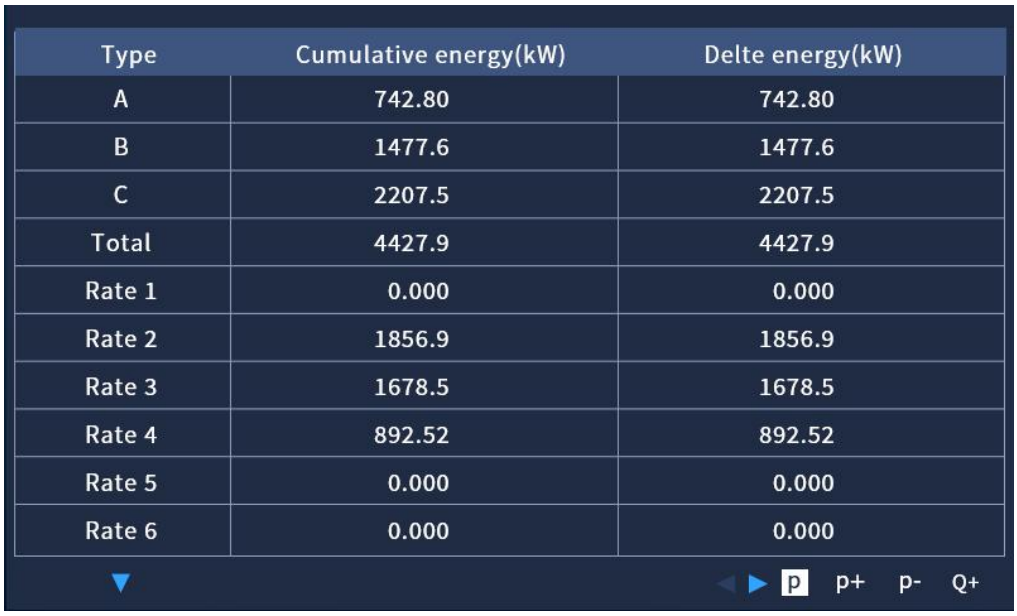


Fig. 4.12 Multi Rate

4.4.3.8 Metering – Demand

Screen “Demand” displays the real-time demand and maximum demand in different rates.



Type	Realtime(kW)	Maximum(kW)	Time
A	100.97	104.94	2025-10-16 16:15
B	201.09	212.39	2025-10-16 16:05
C	300.41	312.56	2025-10-16 17:05
Total	602.47	629.72	2025-10-16 16:05
Rate 1	0.000	0.000	-
Rate 2	602.47	602.82	2025-10-17 11:25
Rate 3	0.000	602.62	2025-10-17 10:33
Rate 4	0.000	629.72	2025-10-16 16:05
Rate 5	0.000	0.000	-
Rate 6	0.000	0.000	-

Fig. 4.13 Demand

4.4.4 Power quality

Select "Power quality" on main menu and enter "Power quality" submenu. Submenu "Metering" provides six screens, i.e. "Harmonics", "Harmonic power", "Interharmonics", "Harmonic Energy", "Fluctuation/ Flicker" and "Unbalance/ Deviation".



Fig. 4.14 Power Quality

4.4.4.1 Power Quality - Harmonics

Screen "Harmonics" will show the harmonics in two forms, chart and table. The chart describes the harmonic distortion and the order of harmonics of the selected channel graphically. The table lists the RMS, ratio and phase angle of the 1st to 63rd harmonics of the selected channel. To make a switch, press use left and right buttons to switch between

the graph and the table, press “◀” or “▶”. In the form of table, press "↵ " to enter the selected channel, and press "▲" or "▼" to scroll through 1st to 63rd harmonic data.

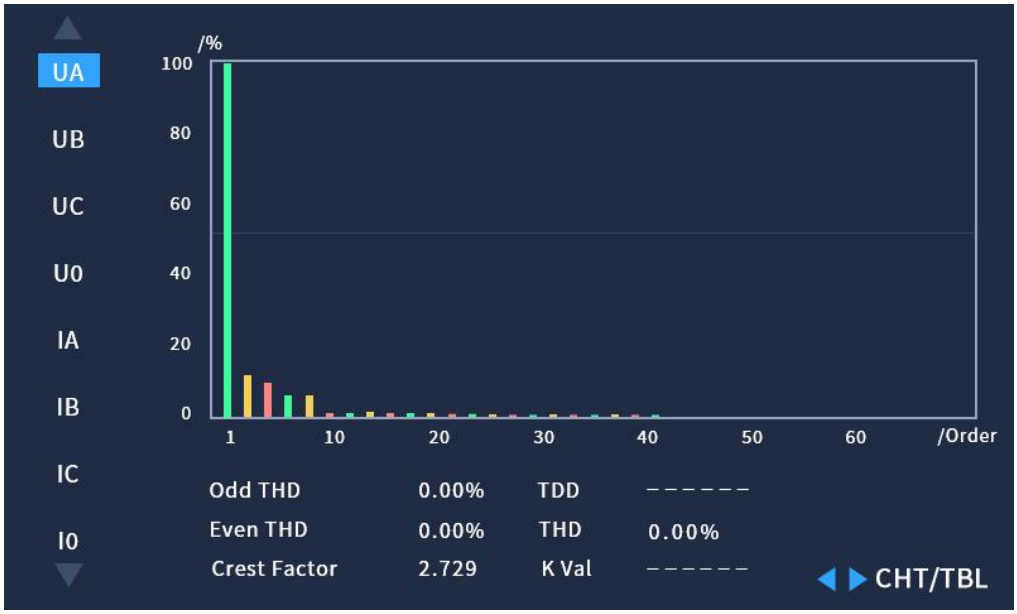


Fig. 4.15 Harmonics Chart

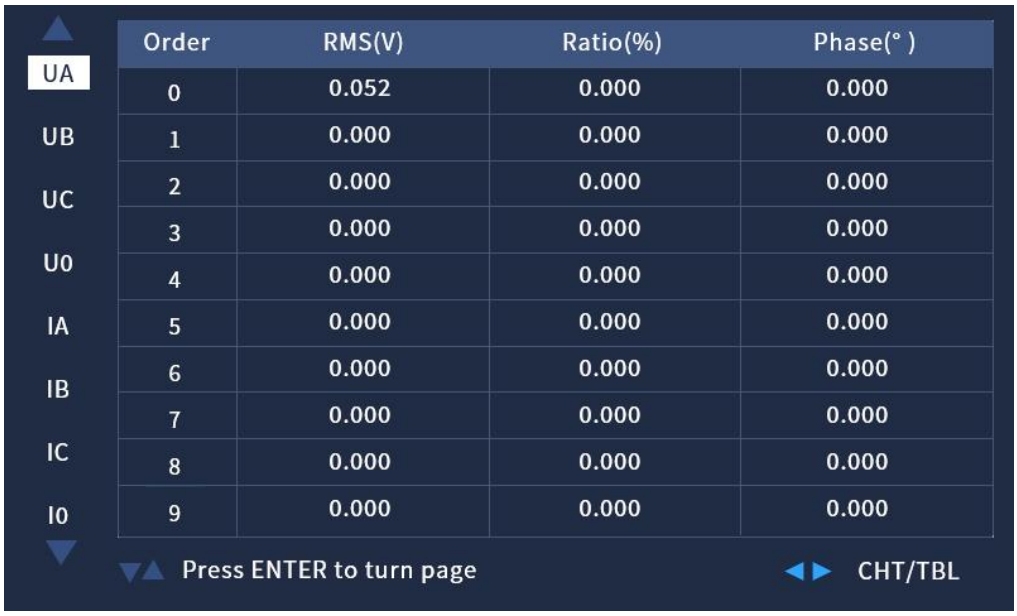


Table 4.16 Harmonics Table

4.4.4.2 Power Quality – Harmonic power

Screen "Harmonic power" will show 1st to 63rd harmonic power of phases A, B and C. Such data includes the active harmonic power, the reactive harmonic power, the apparent harmonic power and the harmonic power factor. Each page lists 10 harmonic power values. Press "↵ " to scroll through 1st to 63rd harmonics. To check the active harmonic power, the reactive harmonic power, the apparent harmonic power and the harmonic power factor, press “◀” or “▶”.



Order	A (kW)	B (kW)	C (kW)
1	61.704	43086	43086
2	0.000	0.0671	0.0661
3	0.000	0.0042	1.0042
4	-0.000	41.895	41.895
5	-0.082	0.0122	0.0122
6	-0.000	9.5645	10.716
7	-0.001	0.0059	0.0059
8	-0.000	0.0003	0.0042
9	-0.001	0.7740	0.3788
10	-0.000	0.0024	0.0014

Fig. 4.17 Harmonic Power

4.4.4.3 Power Quality – Interharmonics

Screen "Interharmonics" will show the RMS and ratios of 0.5th to 62.5th Interharmonics.Press "↵ " to enter the selected channel, and press "▲" or "▼" to scroll through 0.5th to 62.5th Interharmonics data.



Order	RMS(V)	Ratio(%)
0.5	0.000	0.000
1.5	0.000	0.000
2.5	0.000	0.000
3.5	0.000	0.000
4.5	0.000	0.000
5.5	0.000	0.000
6.5	0.000	0.000
7.5	0.000	0.000
8.5	0.000	0.000
9.5	0.000	0.000

Fig. 4.18 Interharmonics

4.4.4.4 Power Quality – Harmonic Energy

Screen "Harmonic Energy" will show 1st to 63rd harmonic energy. To check the apparent energy ES, the active energy EP, the reactive energy EQ, the forward active energy P+, the reverse active energy P-, the forward reactive energy Q+, the reverse reactive energy Q-, the reactive energy of the 1st quadrant Q1, the reactive energy of the 2nd quadrant Q2 , the reactive energy of the 3rd quadrant Q3 and the reactive energy of

the 4th quadrant Q4, press“◀” or “▶”. Each page lists 10 harmonics data. Press "↵ " to scroll through 1st to 63rd harmonics.



Order	A (kVA · h)	B (kVA · h)	C (kVA · h)
1	43086	43086	43086
2	0.0456	0.0671	0.0661
3	0.0042	0.0042	1.0042
4	41.895	41.895	41.895
5	0.0122	0.0122	0.0122
6	9.5645	9.5645	10.716
7	0.0059	0.0059	0.0059
8	0.0003	0.0003	0.0042
9	0.7400	0.7740	0.3788
10	0.0020	0.0024	0.0014

Fig. 4.19 Harmonic Energy

4.4.4.5 Power Quality – Fluctuation/ Flicker

Screen "Fluctuation/ Flicker" will show the voltage fluctuation and the voltage flicker of three phases.



	Fluctuation		Flicker	
	Rate (cnt/min)	Value (%s)	Pst(10m)	Plt(2h)
UA	0.000	0.000	0.000	0.000
UB	0.000	0.000	0.000	0.000
UC	0.000	0.000	0.000	0.000
U0	---	---	---	---

Fig. 4.20 Fluctuation/ Flicker

4.4.4.6 Power Quality – Unbalance/ Deviation

Screen "Unbalance/Deviation" will show maximum/minimum voltage deviation, frequency deviation, positive/negative/zero sequence voltage amplitude, positive/ negative/zero sequence current amplitude, negative/zero sequence voltage unbalance and negative/zero sequence current unbalance of phases A, B and C.

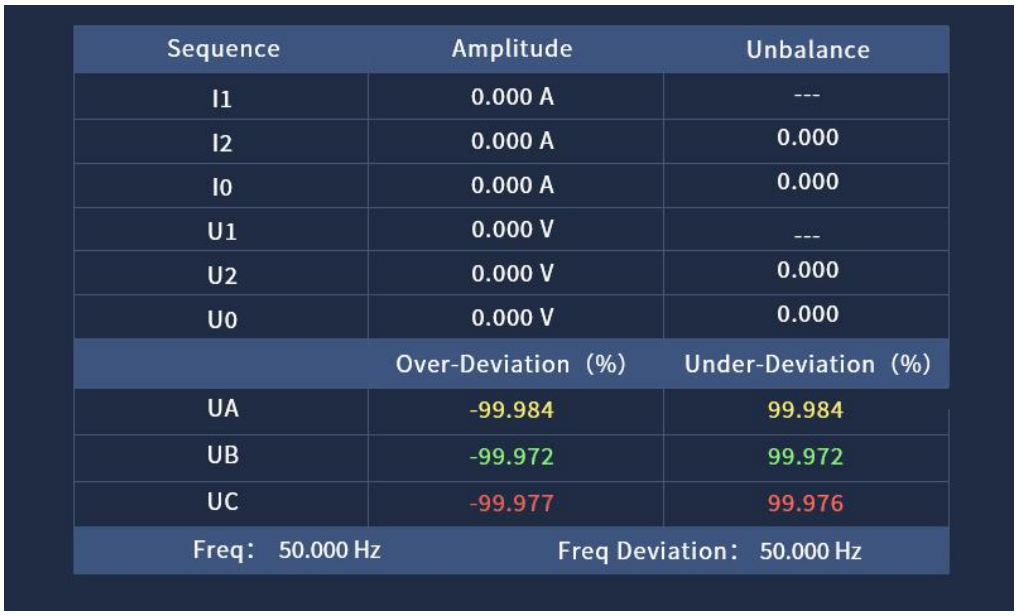


Fig. 4.21 Unbalance/ Deviation

4.4.5 Events

Select "Events" on main menu and enter "Events" submenu. Submenu "Events" provides three screens, i.e. "Dip/Swell", "Steady Events" and "System Log".

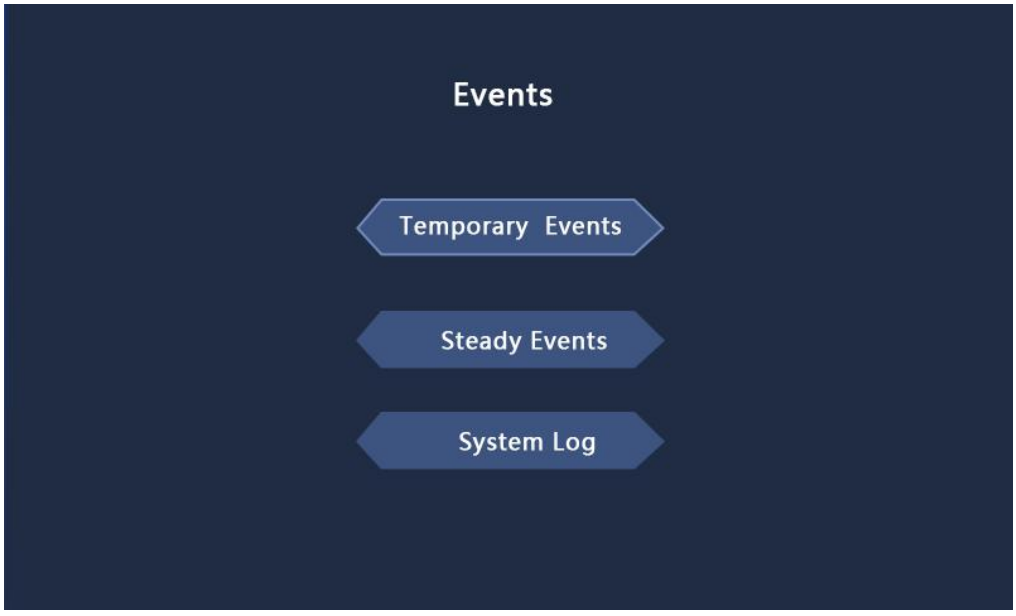


Fig. 4.22 Events

4.4.5.1 Power Quality – Dip/Swell

Screen "Dip/Swell" will show temporary event types, i.e. voltage swell, voltage dip, voltage interruption, and inrush current and two transient event types, i.e. transient voltage and transient current.

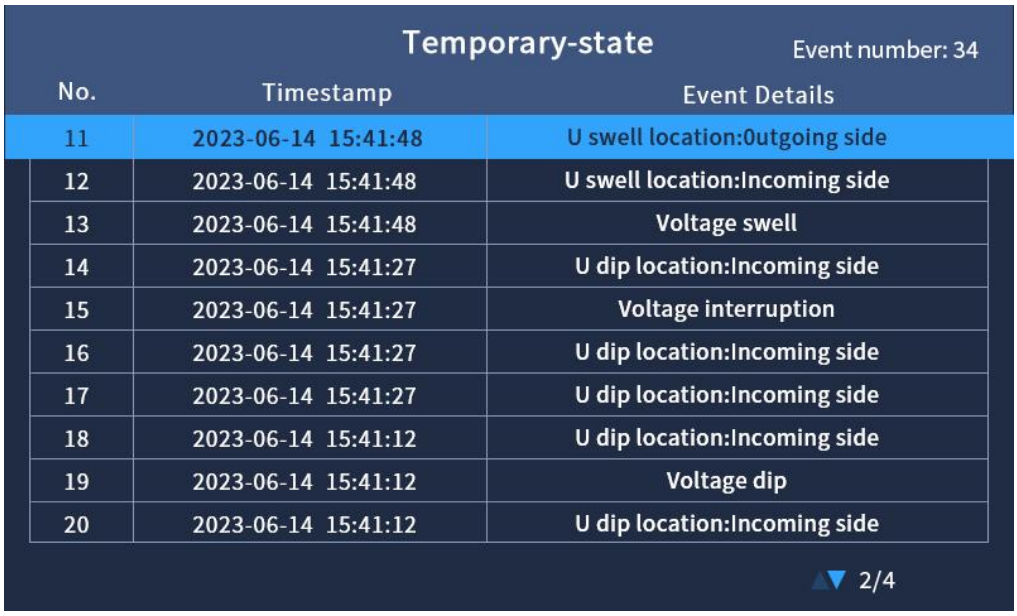


Fig. 4.23 Dip/Swell

Press "▲" or "▼" to select an event and press "↵ " to check the event details.

As shown in Fig. 4.24(a), the voltage dip event is recorded, and the waveform of the event can be viewed by pressing the "↵ " as shown in Fig. 4.24(b).

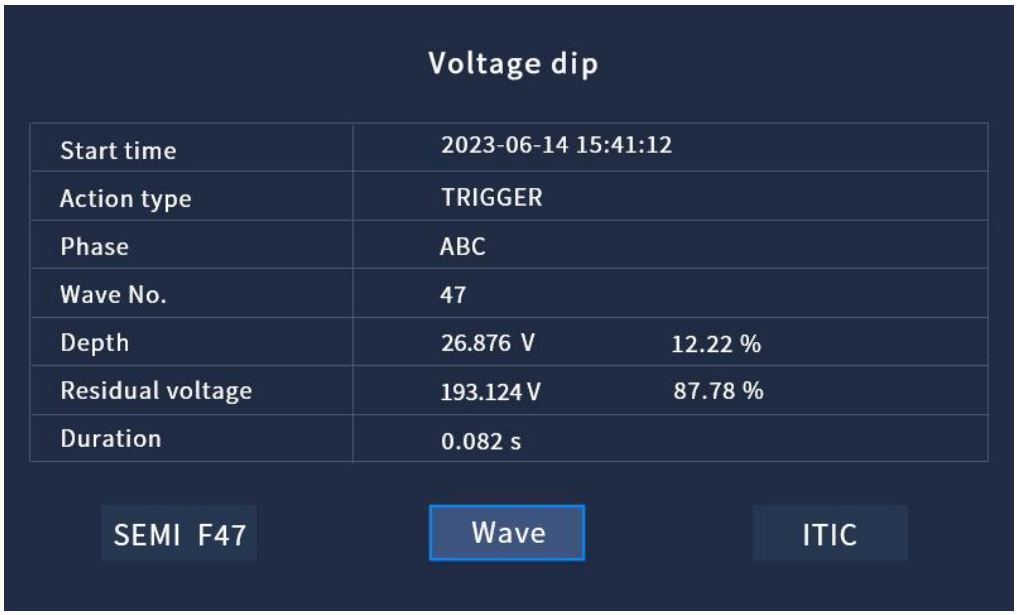


Fig. 4.24(a) Voltage dip

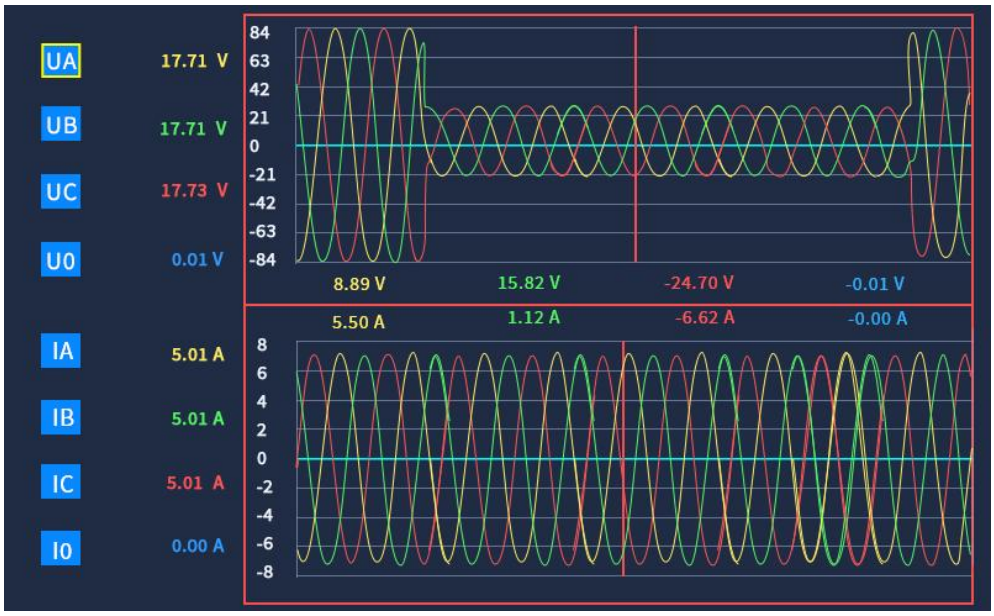


Fig. 4.24(b) Voltage dip waveform

As shown in Fig. 4.25(a), the voltage swell event is recorded, and the waveform of the event can be viewed by pressing the "↲ " as shown in Fig. 4.25(b).



Fig. 4.25(a) Voltage swell

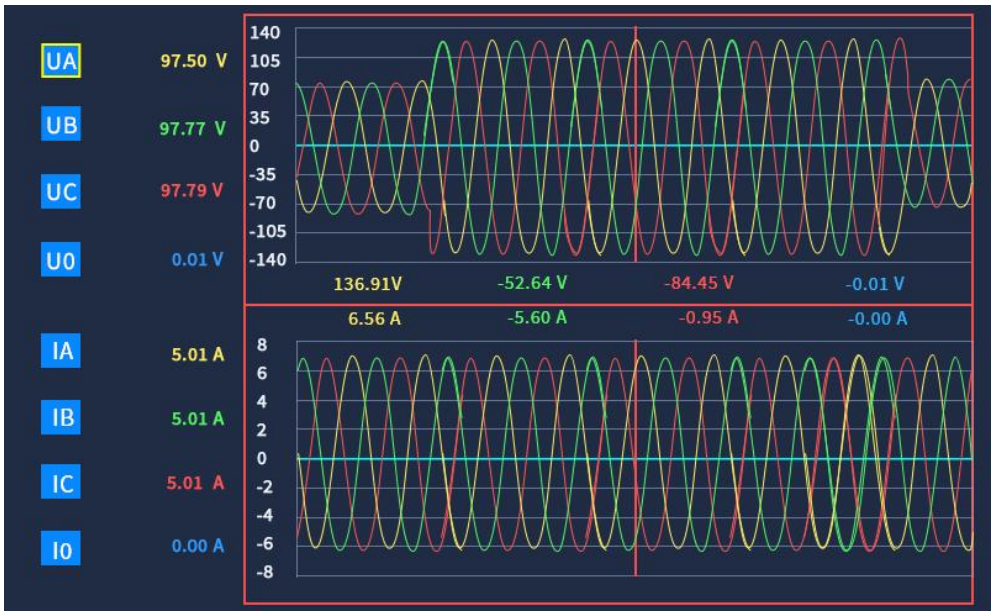


Fig. 4.25(b) Voltage swell waveform

4.4.5.1.1 Dip/Swell-Dip location

The dip/swell location function can help to troubleshoot the location of voltage dip/swell and formulate a power quality governance plan to solve the related power quality problems. Figure 4.26 shows the configuration scheme of the power supply system, and the APView power quality monitoring device is configured at the incoming line of each demarcation point and the outgoing line of the important loop to realize the function of positioning the source of voltage dip.

The device can use the equivalent impedance method to discriminate the position of impedance mutation by the waveform, measurement and other data during the accident, and determine that the voltage dip/swell source is located on the incoming side or outgoing side. As shown in Figure 4.27(a)-(b), the voltage dip/swell positioning interface are recorded, respectively.

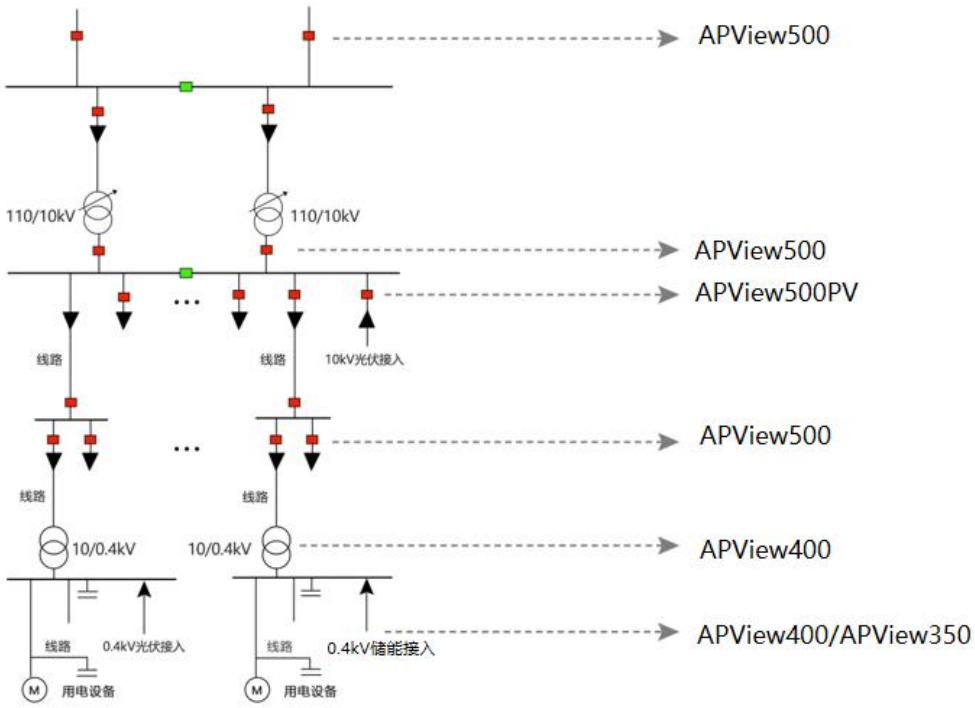


Fig. 4.26 APView configuration

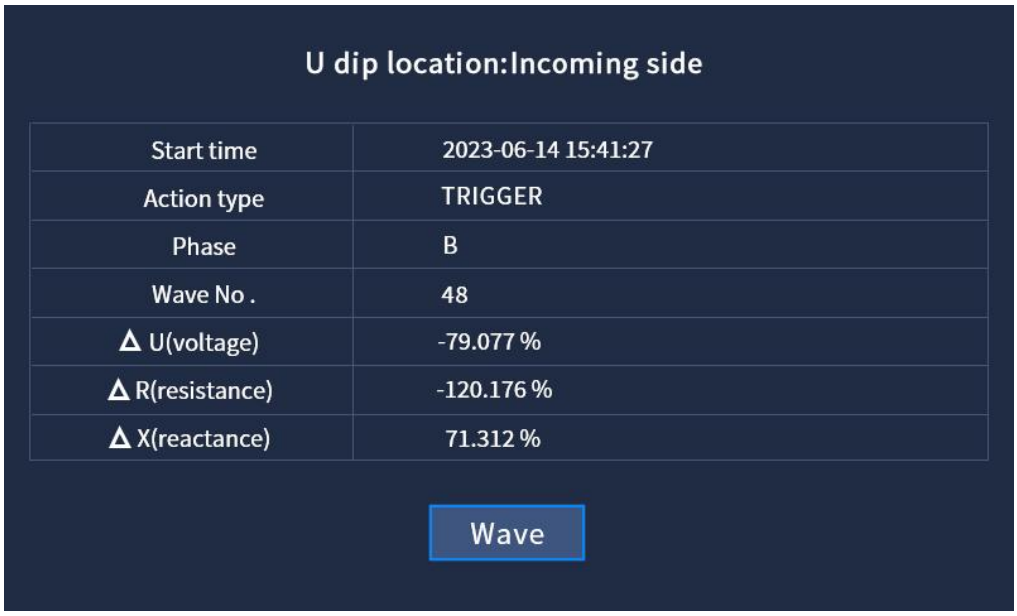


Fig. 4.27(a) Voltage dip location:incoming side

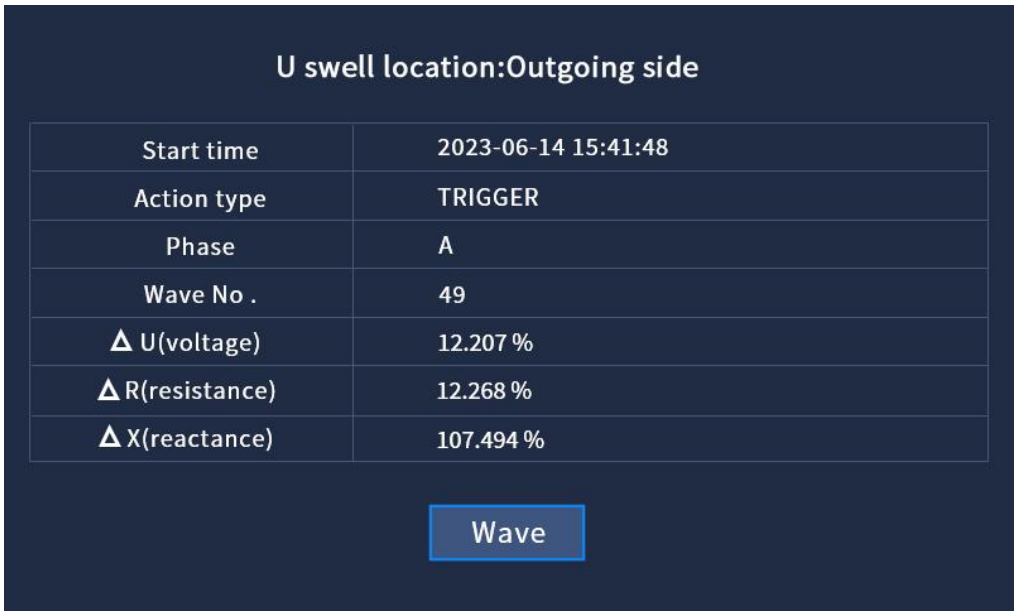


Fig. 4.27(b) Voltage swell location:Outgoing side

4.4.5.1.2 Dip/Swell-ITIC and SEMI F47 Curves

The device has ITIC and SEMI F47 curves for tolerance analysis of power quality temporary changes, and ITIC curves and SEMI F47 curves can be viewed on the LCD interface of the device. ITIC curve is mainly for voltage dip,swell and interruption analysis, suitable for IT and other industries; The SEMI F47 curve is mainly for voltage dip and interruption analysis, and is suitable for semiconductor and other industries. Figure 4.28(a) and 4.28(b) show the ITIC and SEMI F47 curves corresponding to voltage dip respectively.

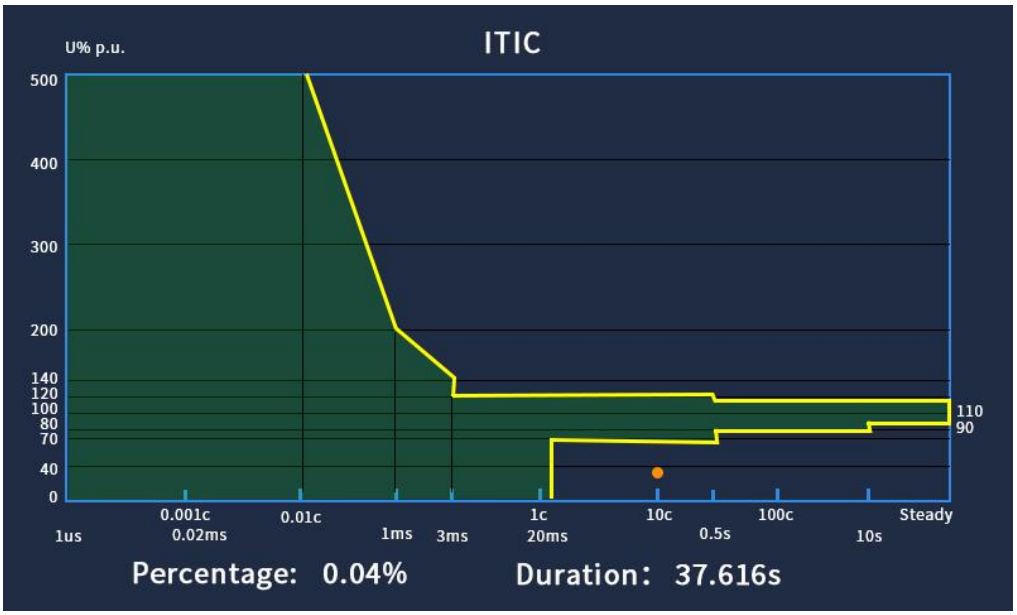


Fig. 4.28(a) ITIC Curves

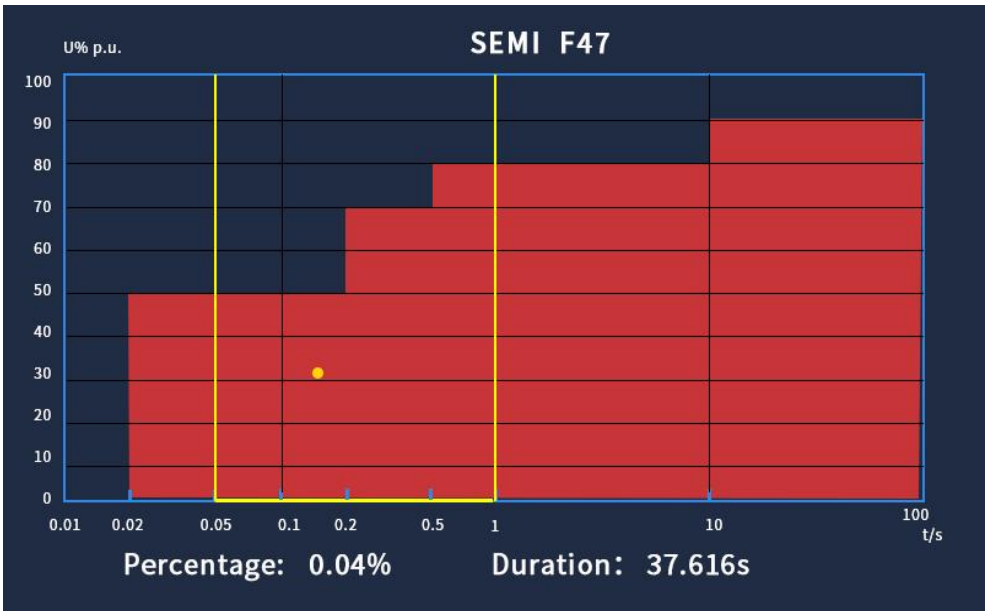


Fig. 4.28(b) SEMI F47 Curves

4.4.5.2 Power Quality – Steady Events

Screen "Steady Events" will show steady events such as voltage deviation, frequency deviation, voltage fluctuation and flicker, harmonics/ Interharmonics and unbalance. To check these data shown in Fig. 4.29, follow the steps as described in 4.4.5.1.

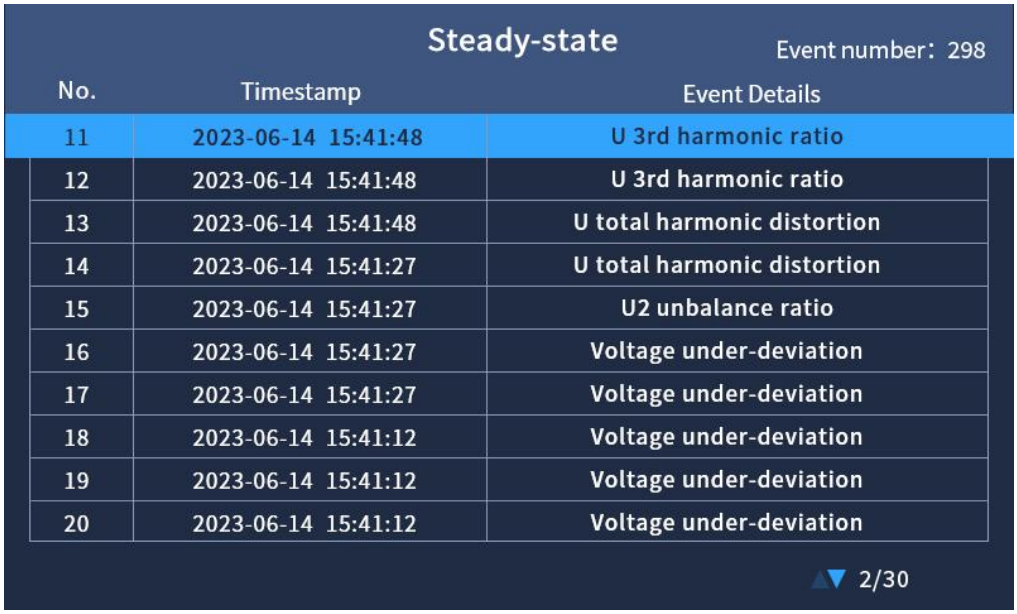


Fig. 4.29 Steady Events

Press "▲" or "▼" to select an event and press "↵ " to check the event details as shown in Fig. 4.30.Users can view the waveform recorded for the selected event with "↵ ".

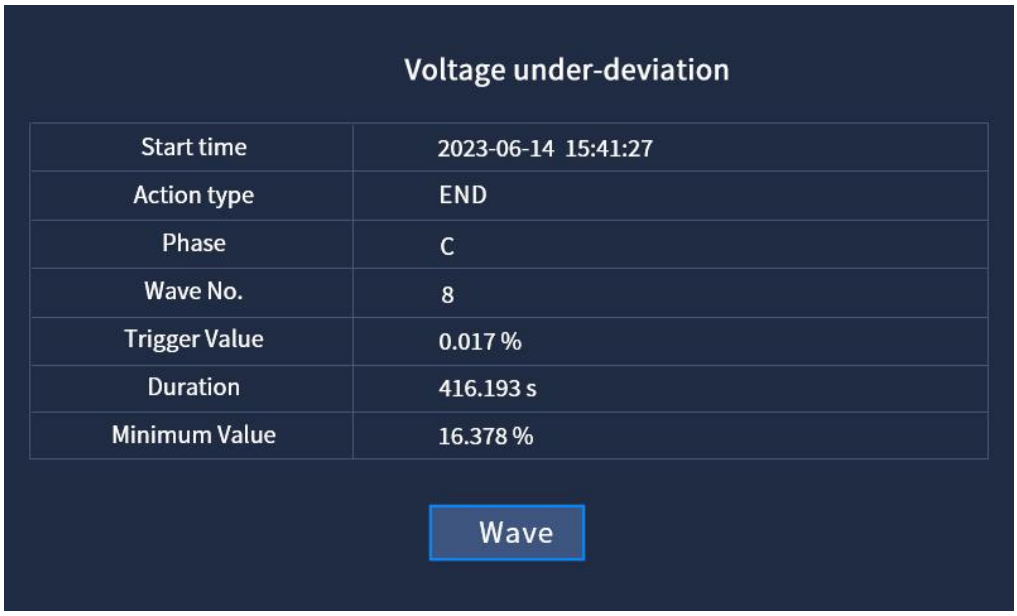


Fig. 4.30 Voltage under-deviation

4.4.5.3 Power Quality - System Log

Screen "System Log" will show the device parameters, modification of parameters, modification of system parameters and abnormal running.

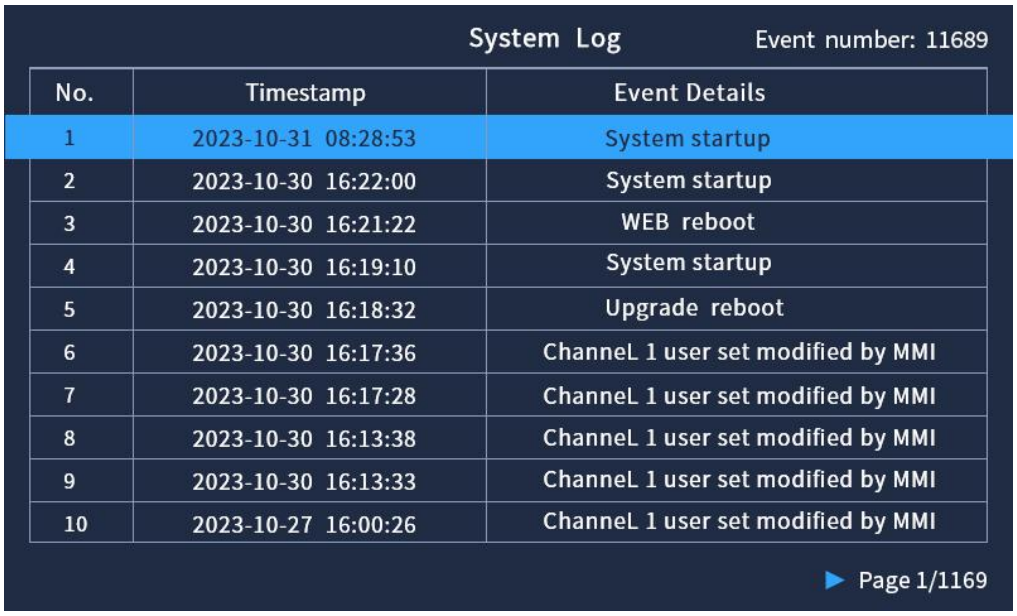


Fig. 4.31 System Log

4.4.6 Parameters

Screen "Parameters" is encrypted with a password (0008).

Select "Parameters" on main menu and enter "Parameters" submenu. "Parameters" provides three screens, i.e. "Basic Parameters", "Function Parameters" and "DO Configuration".

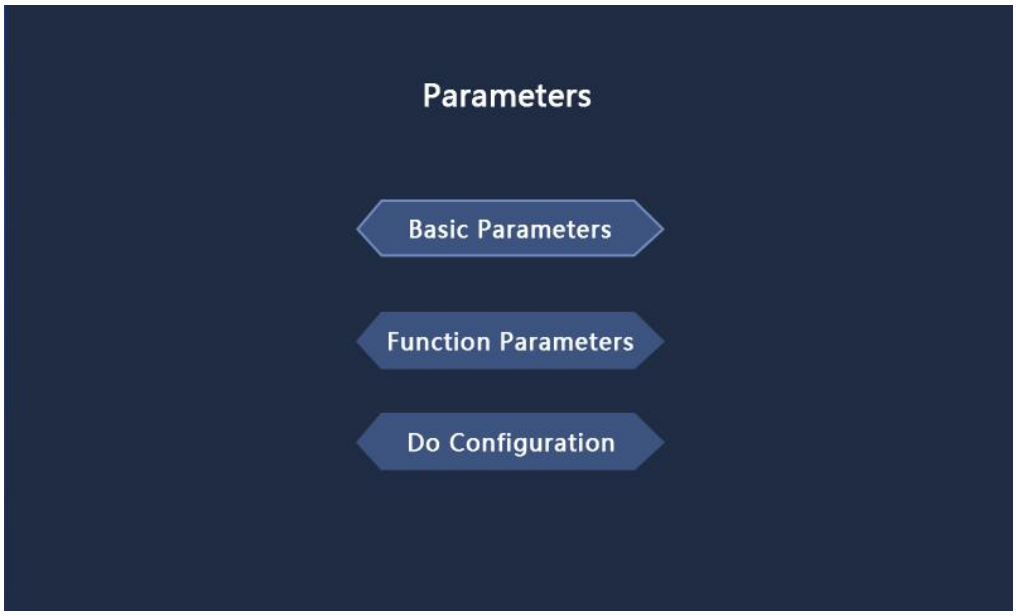
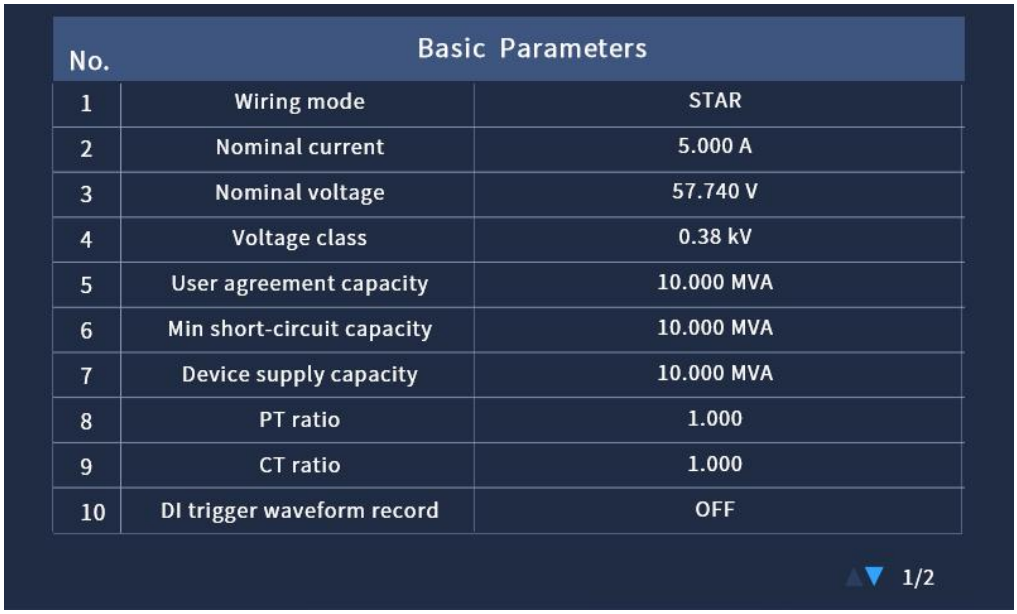


Fig. 4.32 Parameters

4.4.6.1 Parameters – Basic Parameters

Screen "Basic Parameters" is used by users to set parameters according to the power distribution system for this device. It will show some data such as "Wiring mode", "Nominal current" and "Nominal voltage".Users shall set these parameters according to actual conditions.Please refer to Chapter Five "Parameter set" for the specific setting method.

Press "↵" to modify data and "▲" or "▼" to change parameters. When "Esc" is pressed after the parameter setting, a message will be shown, asking "save or not". To save the modification, input the password (0008). Then a message will indicate that modification is saved successfully. If a wrong password is input, a message will be shown, asking "Whether to re-enter".



No.	Basic Parameters	
1	Wiring mode	STAR
2	Nominal current	5.000 A
3	Nominal voltage	57.740 V
4	Voltage class	0.38 kV
5	User agreement capacity	10.000 MVA
6	Min short-circuit capacity	10.000 MVA
7	Device supply capacity	10.000 MVA
8	PT ratio	1.000
9	CT ratio	1.000
10	DI trigger waveform record	OFF

▲▼ 1/2

Fig. 4.33 Basic Parameters

4.4.6.2 Parameters – Function Parameters

Screen "Function Parameters" is used for setting of various power quality indexes and function control, showing maximum and minimum values of voltage, frequency and other data. These parameters can be set as described in 4.4.6.1 and protected by a default password (0008).

All functions are set “ON” and the settings comply with power quality standards relating to the power quality before delivery of this device. However, they can be modified if required.

Example 1: Frequency deviation. It is necessary to set "Max frequency" and "Min frequency"and enable "Frequency deviation". When the actual frequency is above the maximum value or below the minimum value, the frequency deviation alarm will be activated. The "Frequency deviation" event will generate and the wave recording will work. Meanwhile, the corresponding digital output is closed and the frequency deviation LED on the panel turns bright. Press “RST” to reset the digital output and the LED when the frequency becomes normal.

Example 2: Voltage dip. It is necessary to set the "Voltage dip threshold" to be 90% and enable the "Temporary voltage". Term "90%" means 90% of the nominal voltage. If the actual voltage is below 90% of the nominal voltage and then increases to the normal level in 1min, the voltage dip will be activated, the "Voltage dip" event will generate and the wave recording will work. Meanwhile, the corresponding digital output is closed and the Dip/Swell LED on the panel turns bright. Press “RST” to reset this device at the end of voltage dip event.

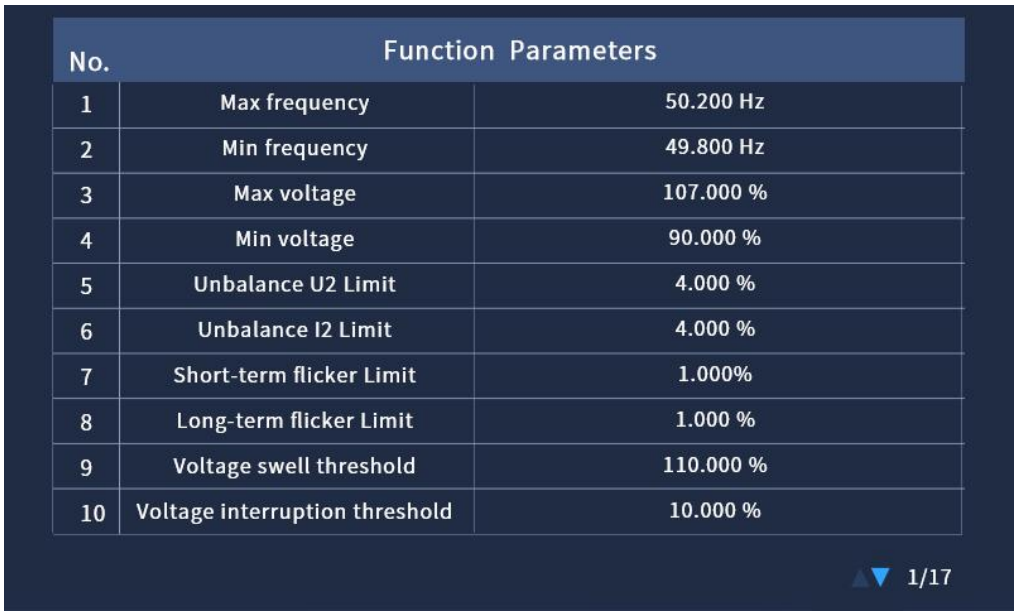


Fig. 4.34 Function Parameters

4.4.6.3 Parameters – DO Configuration

Screen "DO Configuration" is used to set relay outputs corresponding to power quality alarms. Any one or combination of DO1 to DO3 can be set for an alarm. Every DO can be set to 0, A, B or C. "0" indicates a off output, "A" indicates a bistable output, "B" indicates a monostable output and "C" indicates a impulsive output. To confirm the DO configuration, see Fig. 4.35.

For example, the "temporary voltage" relates to relay number A00C. Letter "A" relates to 1st relay output DO1 and letter "C" relates to 4th relay output DO4, indicating that both DO1 and DO4are alarm outputs of "Voltage Swell", DO1 is attribute A (bistable) and DO4 is attribute C (impulsive).

Default settings: (see description of terminal X3 on the back for DO outputs)

Table 4.3 Factory Default

Function	DO configuration	DO attribute	Function	DO configuration	DO attribute
Voltage swell	DO1	Bistable	Voltage flicker	DO1	Bistable
Voltage dip	DO1	Bistable	Voltage harmonic	DO2	Bistable
Voltage interruption	DO1	Bistable	Current harmonic	DO2	Bistable
Transient volt	DO2	Bistable	Voltage DC	DO3	Bistable
Transient curr	DO2	Bistable	Current DC	DO3	Bistable
Frequency deviation	DO3	Bistable	Rapid voltage change	DO4	Bistable
Voltage deviation	DO3	Bistable	Inrush current	DO1	Bistable
Voltage unbalance	DO4	Bistable	Mains signalling	DO1	Bistable
Current unbalance	DO4	Bistable			

Note 1. One DO can be related to several functions and one function can be allocated with more than one DO.

Note 2. A DO may permit several output states. In other words, a DO can be set for different alarms and its output attribute may be bistable, monostable or impulsive. For example, DO1 is attribute A for temporary voltage while it is attribute B or C for transient voltage.

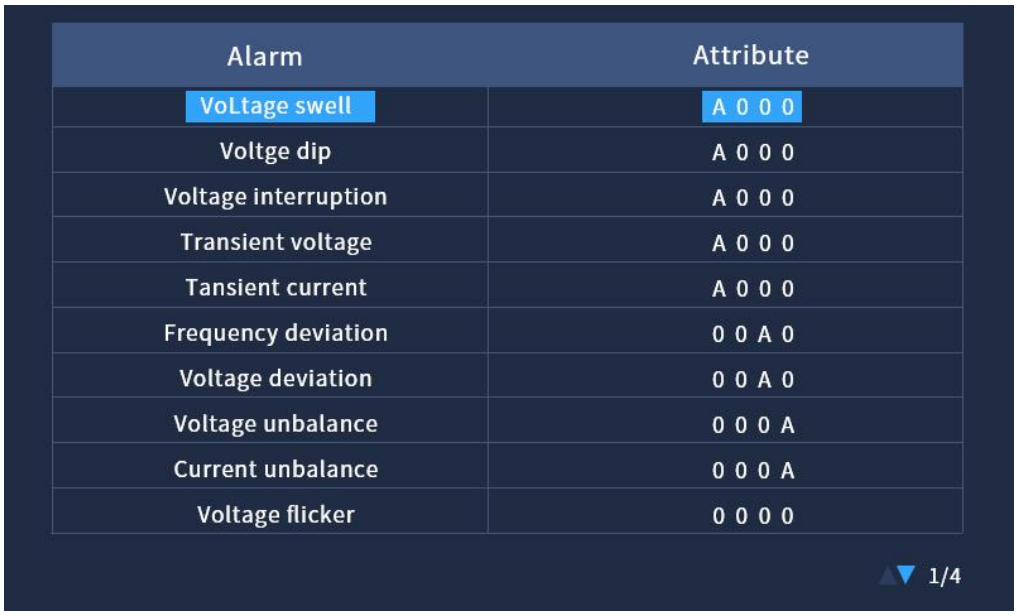


Fig. 4.35 DO Configuration

All relay functions are off by default. Press "↵" to select the desired function and make the configuration with ◀ or ▶ as shown in Fig. 4.36(a) and Fig. 4.36(b).

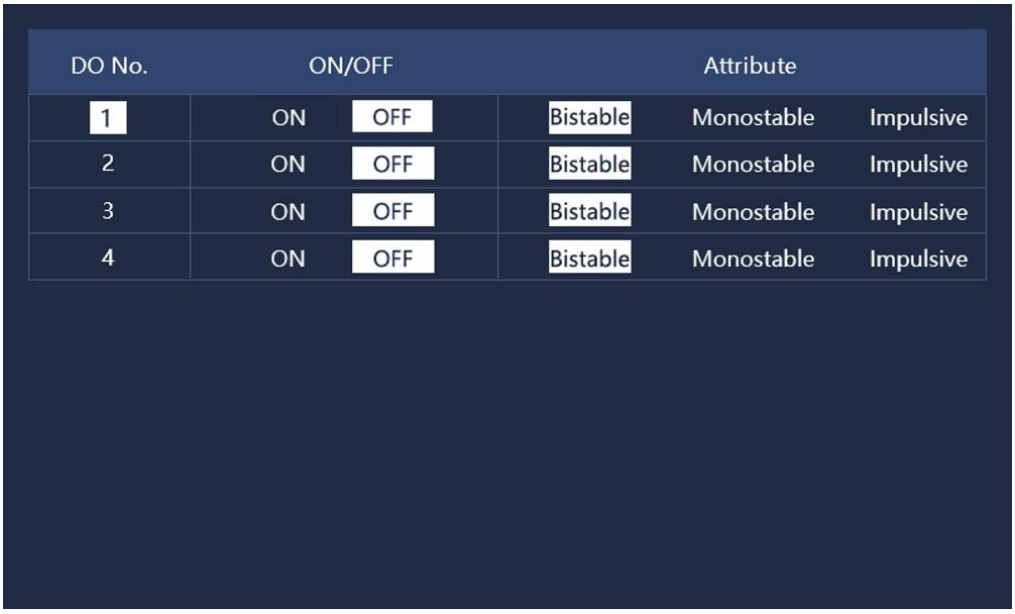


Fig. 4.36(a) Relay Setting

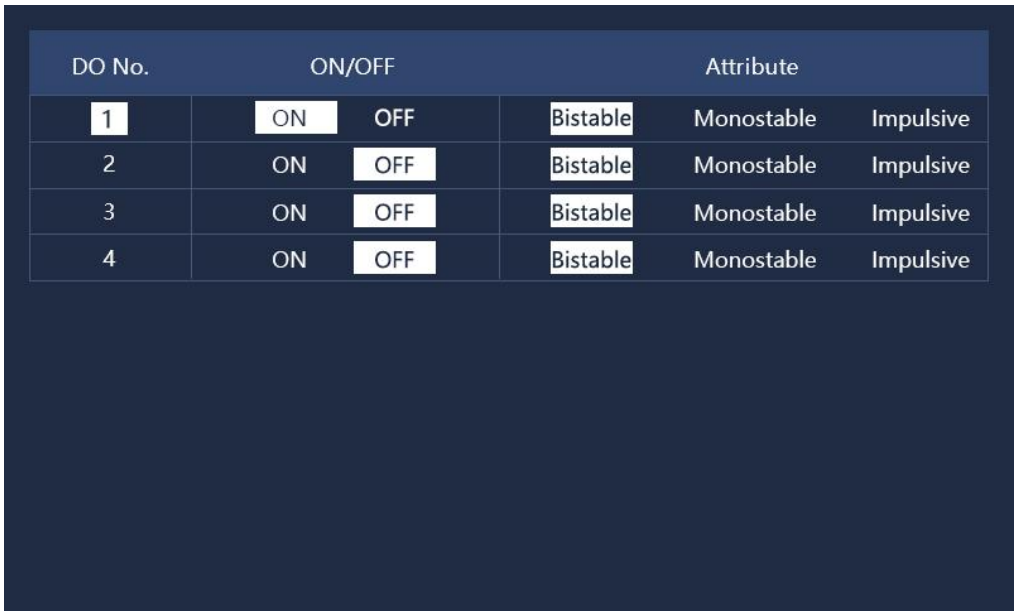


Fig. 4.36(b) Relay Setting

4.4.7 System Setup

Screen "System Setup" is encrypted with a password (0008).

Select "System Setup" on main menu and open submenu "System Setup" with button "↵". Submenu "System Setup" provides three screens, i.e. "Communication", "Display" and "Information".

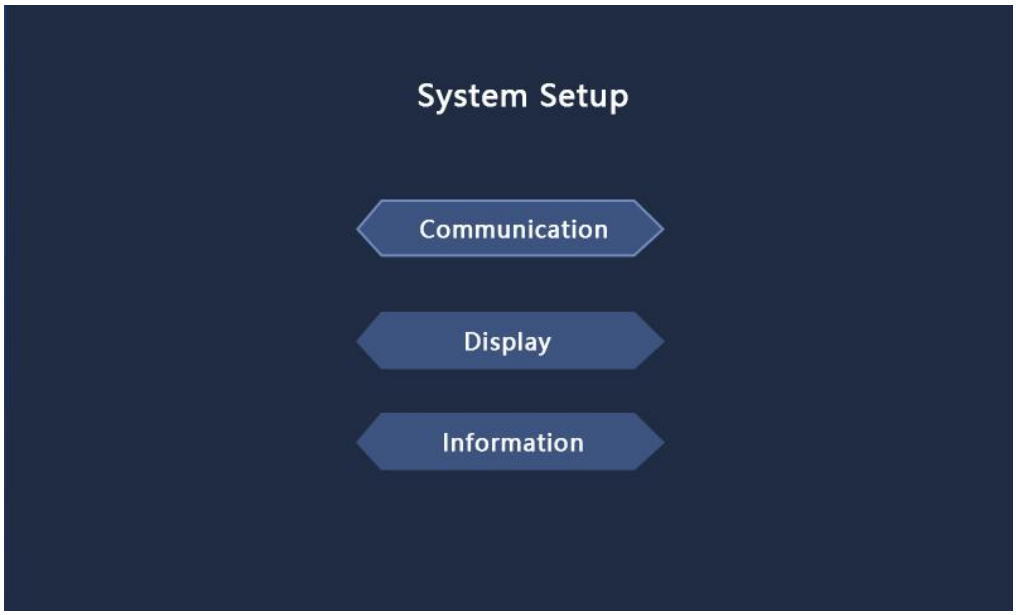


Fig. 4.37 System Setup

4.4.7.1 System Setup – Communication

Screen "Communication" is used to configure Ethernet communication and RS485 serial communication parameters.

Default: IP address of Ethernet 1: 172.22.60.99

IP address of Ethernet 2: 172.23.60.99

(Note: The IP address of different Ethernet network interfaces cannot be set in the same network segment and the modbus interface is 8080 by default)

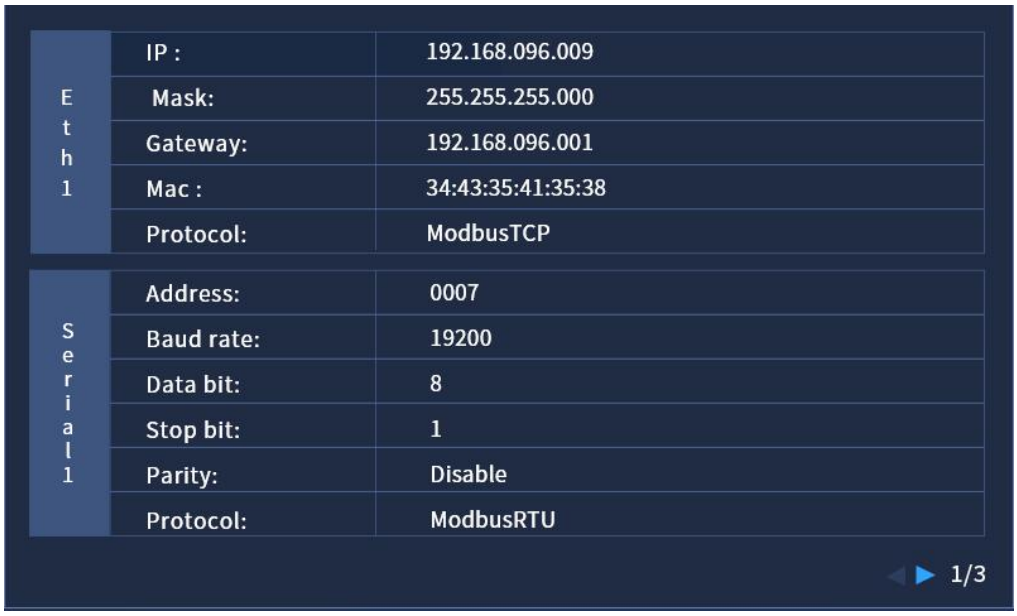


Fig. 4.38 Communication setup

4.4.7.2 System Setup – Display

Screen "Display" indicates language, contrast (0-99),backlight time (10-999s) and system time. It is encrypted with a password (0008).

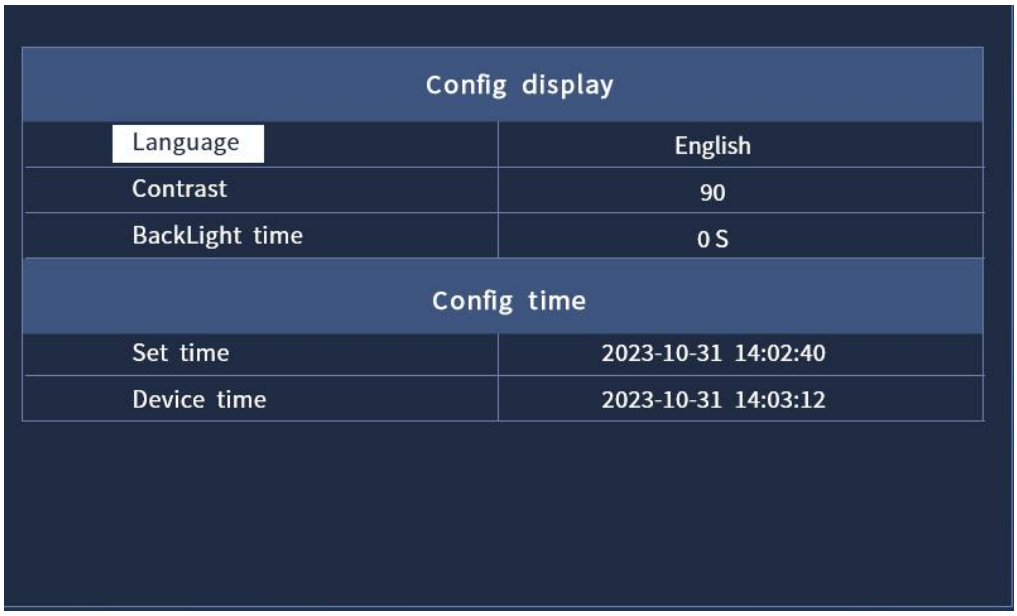


Fig. 4.39 Display setup

4.4.7.3 System Setup – Information

Screen "Information" contains the information on the current version of this product.

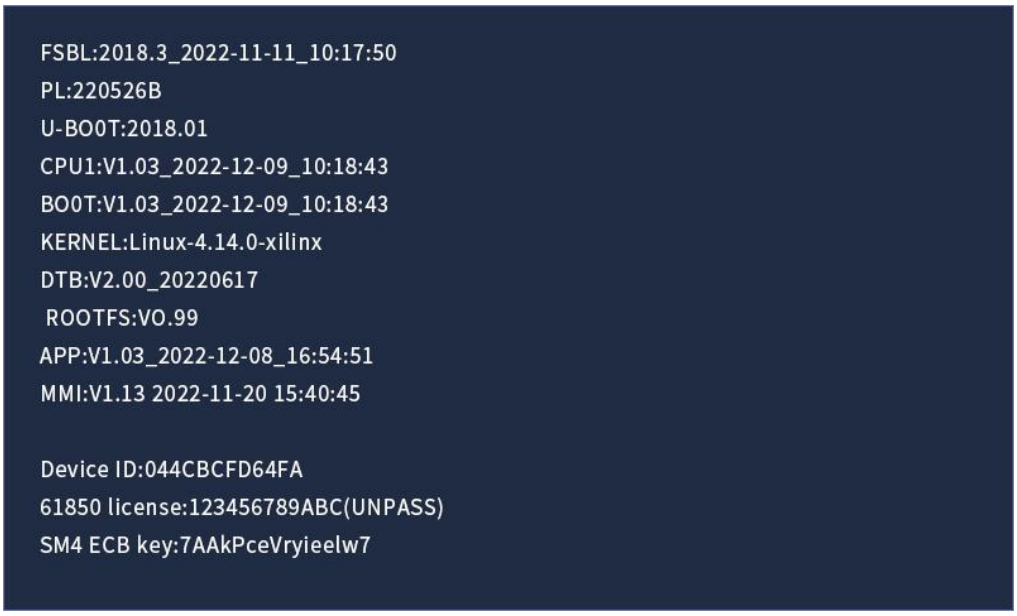


Fig. 4.40 Information

4.4.8 Debug

Select "Debug" on main menu and open submenu "Debug". Submenu "Debug" provides four screens, i.e. "Zero Adjust", "Amplitude Adjust", "DO Test" and "Lamp Test".

It is used to test the hardware function. Please contact the manufacturer before debugging.



Fig. 4.41 Debug

5 Parameter set

5.1 Parameter setting guide

***Note: In the following table, " ■ " indicates the parameters that must be set according to the site conditions, and "□" indicates the parameters that are not necessary to be set, which can be set according to the actual needs.**

Basic Parameters		
Parameters	**Description**	
Wiring mode	Set it according to the actual wiring method “STAR” indicates 3PT wires and “DELTA” indicates 2PT wires.	■
Nominal current	As the secondary rated current of CTs, it may be 5A or 1A. **(For example, for a 150/5 current transformer, it should be set to 5A.)**	
Nominal voltage	**3P4W Mode**:Configured for secondary phase voltage. For example, the rated secondary phase voltage is 57.74 V for medium/high voltage applications; when directly connected to a 0.38 kV low-voltage system, the rated phase voltage is 220 V. **3P3W Mode**:Configured for secondary line voltage. For example, the rated secondary line voltage is 100 V for medium/high voltage applications; when directly connected to a 0.38 kV low-voltage system, the rated line voltage is 380 V.	
Voltage class	It indicates the voltage class of the primary system to this product and may be 0.38kV, 6kV, 10kV, 20kV, 35kV, 66kV or other setting.	
User agreement capacity	Input the parameter according to actual conditions.If any value is unknown, follow defaults.	
Min short-circuit capacity		
Device supply capacity		
PT ratio	Voltage transformer ratio, the PT ratio = primary voltage / secondary voltage. **(For example, if the voltage transformer specification is 10/0.1 kV, then the PT turns ratio**	■

	is 100.)	
CT ratio	Current transformer ratio, the CT ratio = primary current / secondary current. **(For example, if the current transformer specification is 800/5, then the CT ratio is 160.)**	
DI trigger waveform record	Select the corresponding DI to trigger recording waveform.	
Timing waveform rcd start time	When the "Timing waveform rcd start time" is reached, the device starts waveform recording, and the number of recording cycles = "Waveform cnt before event" + "Waveform cnt after event". If multiple timed waveform recordings are required, the recording will be triggered again according to the "Timing waveform rcd time span" until the "Timing waveform rcd cnt" ends.	
Timing waveform rcd cnt		
Timing waveform rcd time span		
Waveform rcd duration		☐
Sample cnt per cycle	The number of sampling points per cycle can be selected from 64 to 1024 points per cycle.	
Waveform cnt before event	The default value is 10. The number of recorded cycles before the fault is triggered and before the fault returns.	
Waveform cnt after event	The default value is 10. The number of recorded cycles after the fault is triggered and after the fault returns.	

Detailed Explanation of Recording Cycle:

The upper limit of the recording cycle is closely related to the number of sampling points per cycle. The specific correspondence is as follows:：

- When the number of sampling points is 1024 points/cycle, the upper limit of the recording cycle is 40 cycles;
- When the number of sampling points is 512 points/cycle, the upper limit of the recording cycle is 80 cycles;
- When the number of sampling points is 256 points/cycle, the upper limit of the recording cycle is 160 cycles;
- When the number of sampling points is 128 points/cycle, the upper limit of the recording cycle is 320 cycles;

- When the number of sampling points is 64 points/cycle, the upper limit of the recording cycle is 350 cycles;

"Waveform cnt before event" and "Waveform cnt after event" are 10 respectively by default. The "Sample cnt per cycle " is 1024.

- Record 40 cycles for dip/swell events:

  Record 10 cycles before the start of the fault and 10 cycles after the start of the fault.

  Record 10 cycles before the end of the fault and 10 cycles after the end of the fault.

- Record 20 cycles for steady events:

  A steady fault consists of an “START” event and a “END” event.

  Record 10 cycles before the start of the faults and 10 cycles after the start of the fault in the “START” event;

  Record 10 cycles before the end of the fault and 10 cycles after the end of the fault in the “END” event.

Example: "Waveform cnt before event" is 15. "Waveform cnt after event" is 6."Sample cnt per cycle " is 1024.

- Record 40 cycles for dip/swell events:

  Record 15 cycles before the start of the fault and 5 cycles after the start of the fault.

  Record 14 cycles before the end of the fault and 6 cycles after the end of the fault.

- Record 20 cycles for steady events:

  Record 20 cycles for steady events:

  A steady fault consists of an “START” event and a “END” event.

  Record 15 cycles before the start of the faults and 5 cycles after the start of the fault in the “START” event;

  Record 14 cycles before the end of the fault and 6 cycles after the end of the fault in the “END” event.

5.2 Parameter list

	No.	Parameter	Unit
Basic Parameters	1	Wiring mode	0-STAR (3PT) 1-DELTA (2PT) 2-DC (DC)
	2	Nominal current	A
	3	Nominal voltage	V
	4	Voltage class	kV
	5	User agreement capacity	MVA
	6	Min short-circuit capacity	MVA
	7	Device supply capacity	MVA

	8	PT ratio	
	9	CT ratio	
	10	DI trigger waveform record	0-OFF 1-DI_1 2-DI_2 3-DI_3 4-DI_4 5-DI_5
	11	Timing waveform rcd start time	D/M/Y, hour: minute: second
	12	Timing waveform rcd cnt	Number
	13	Timing waveform rcd time span	s
	14	Waveform rcd duration	s
	15	Sample cnt per cycle	0-32 points 1-64 points 2-128 points 3-256 points 4-512 points 5-1024 points
	16	Waveform cnt before event	Cycle
	17	Waveform cnt after event	Cycle
Function Parameters	18	Max frequency	Hz
	19	Min frequency	Hz
	20	Max voltage	%
	21	Min voltage	%
	22	Unbalance U2 limit	%
	23	Unbalance I2 limit	%
	24	Short-term flicker limit	%
	25	Long-term flicker limit	%
	26	Voltage swell threshold	%
	27	Voltage interruption threshold	%
	28	voltage dip threshold	%
	29	Voltage swell hysteresis	%
	30	Voltage interruption hysteresis	%
	31	voltage dip hysteresis	%
	32	Transient current threshold	%
	33	Transient voltage threshold	%
	34	Voltage THD threshold	%
	35	Current THD threshold	%
	36	Total odd harmonic U threshold	%
	37	Total even harmonic U threshold	%
	38	Voltage DC ratio limit	%
	39	Current DC ratio limit	%
	40	RVC limit	%

	41	RVC hysteresis	%
	42	Inrush current limit	%
	43	Inrush current hysteresis	%
	44	Mains signalling freq	Hz
	45	Mains signalling limit	%
	46	Mains signalling duration	s
	47	Voltage 2nd harmonic limit	%
	... ...	... ...	%
	108	Voltage 63rd harmonic limit	%
	109	Current 2nd harmonic limit	A
	... ...	... ...	A
	170	Current 63rd harmonic limit	A
	171	Temporary voltage	0- OFF 1- ON
	172	Transient voltage	0- OFF 1- ON
	173	Transient current	0- OFF 1- ON
	174	Frequency deviation	0- OFF 1- ON
	175	Voltage deviation	0- OFF 1- ON
	176	Voltage unbalance	0- OFF 1- ON
	177	Current unbalance	0- OFF 1- ON
	178	Long-term flicker	0- OFF 1- ON
	179	Short-term flicker	0- OFF 1- ON
	180	Voltage THD rate	0- OFF 1- ON
	181	Current THD rate	0- OFF 1- ON
	182	Total odd harmonic voltage	0- OFF 1- ON
	183	Total even harmonic voltage	0- OFF 1- ON
	184	Harmonic voltage ratio	0- OFF 1- ON
	185	Harmonic current	0- OFF 1- ON
	186	Voltage DC ratio	0- OFF

			1- ON
	187	Current DC component	0- OFF 1- ON
	188	Rapid voltage change	0- OFF 1- ON
	189	Inrush current	0- OFF 1- ON
	190	Mains signalling	0- OFF 1- ON

6 Technical instructions

6.1 Voltage deviation。

Definition: relative deviation of actual working voltage to the nominal voltage, represented in %.

Formula：

$$Voltage\ deviation(\%) = \frac{Actual\ voltage - Nominal\ voltage}{Nominal\ voltage} \times 100\%$$

Debugging method：

1. Enable function "Voltage deviation".
2. Set "max voltage" to be 110% and "min voltage" to be 90%.
3. Supply the nominal voltage to the voltage input terminal of device for 12s (to determine the running stability with electricity).
4. Increase the voltage above the "max voltage" (i.e. 110% of the nominal voltage) and hold it for more than 1min, which will result in the "Deviation over voltage" event. It is similar to the "Voltage under-deviation" event. (If the voltage above the max voltage lasts for less than 1min, it will be determined as voltage swell.)

6.2 Frequency deviation

Definition: difference between the actual frequency and nominal frequency

Formula:

$$\text{Frequency deviation} = \text{Actual frequency} - \text{Nominal frequency}$$

Debugging method：

1. Enable function "Frequency deviation".
2. Set "Max frequency" to be 50.10Hz and "Min frequency" to be 49.9Hz.
3. Supply a 3-phase nominal voltage of 50Hz to the voltage input terminal for 12s (to determine the running stability with electricity). Increase the frequency above

the "Max frequency", which will result in the "Deviation over frequency" event. It is similar to the "Deviation under frequency" event.

6.3 Harmonics

Definition: frequency components greater than one integer multiple of the fundamental frequency after cyclical AC voltage/current are decomposed by Fourier series

Causes. Harmonics are mainly caused by the nonlinear characteristics of power systems or loads. The electronic equipment in power system is the main source of harmonics. Other sources include loads that generate electric arcs and electrical equipment operating in a ferromagnetic nonlinear state. Such equipment and loads, which are often represented as harmonic current sources, will supply harmonic current to the power system. The degree of harmonic distortion can be described by the harmonic spectral range as well as the amplitude and phase angle of each harmonic component. Alternatively, it can be represented by a single quantity, namely the total harmonic distortion (THD).

Hazards. The harmonic current that is generated by nonlinear loads will result in the harmonic voltage in the power system. Harmonic current and voltage may cause overheating of rotating equipment, transformers and live wires and burning of fuses.

Debugging method：

1. Enable "Harmonic current" or "Harmonic voltage ratio".
2. Set the harmonic parameters and input the harmonic current or voltage.
3. An alarm will be triggered if the harmonics exceeds the parameters.

6.3.1 Total harmonic distortion(THD)

Total harmonic distortion THD: Ratio of the RMS value of harmonic components to the RMS of fundamental component in cyclical AC voltage/current, represented in %. The waveform distortion indicates the waveform deviation from the sine wave caused by the nonlinear characteristics of voltage and current of some electrical equipment. There are five main types of waveform distortion, i.e. DC bias, harmonics, Interharmonics, voltage gap and noise (suspended).

The symbol of total harmonic distortion of voltage is $\mathrm{THD_u}$ and the symbol of total harmonic distortion of current is $\mathrm{THD_i}$.

Formula:

$$\mathrm{THD_u} = \frac{\sqrt{\sum_{\mathrm{h=2}}^{\infty}(U_h)^2}}{U_l} \times 100\%, THD_i = \frac{\sqrt{\sum_{h=2}^{\infty}(I_h)^2}}{\mathrm{I_1}} \times 100\%$$

In the formula：

$\mathrm{U_h}$ — Harmonic voltage of order h (RMS)

$\mathrm{U_l}$ —Fundamental voltage (RMS)

$\mathrm{I_h}$ —Harmonic current of order h (RMS)

$\mathrm{I_l}$ —Fundamental current (RMS)

6.3.2 K-factor

K-factor. Among the technical indexes of power quality, the K-factor mainly reflects the effect of the frequency of harmonics caused by nonlinear loads on transformer loss.The definition of the K-factor is mainly based on the assumption that the eddy current loss of transformer caused by harmonic currents are proportional to the square of the number of harmonics.

Formula:

$$K = \frac{\sum_{h=1}^{\mathrm{h}=h_{\max}} I_h{}^2 h^2}{\sum_{h=1}^{\mathrm{h}=h_{\max}} I_h{}^2}$$

In the formula：

h —The order of harmonics

$\mathrm{I_h}$ —RMS of harmonic current of order h

$\mathrm{h_{max}}$ —The maximum order of calculated harmonic current, 63

6.3.3 Crest factor

Crest factor: The crest factor is the ratio of the wave peak value to the RMS. The crest factor of standard sine wave is 1.414.

Formula:

$$Crestfactor = \frac{\mathrm{Peak}\ value}{RMS}$$

6.3.4 Total demand distortion(TDD)

Total demand distortion TDD: the ratio of the RMS of harmonic current of harmonic components up to 50 cycles (excluding Interharmonics) to the maximum demand load current, represented in %.

Formula:

$$\mathrm{TDD} = \frac{\sqrt{\sum_{\mathrm{h}=2}^{\infty} \mathrm{I}_{\mathrm{h}}^{2}}}{I_L} \times 100\%$$

In the formula：

I_{h} —Harmonic current component

h —Order of harmonics

I_{L} —Max demand load current

6.4 Interharmonics

Definition: frequency components other than integer multiples of the fundamental frequency after cyclical AC voltage/current are decomposed by Fourier series

Causes. It is often caused by great voltage fluctuations or impact nonlinear loads. All nonlinear wave loads generate Interharmonics, including electric arc furnaces, electric welding machines, various frequency converters, synchronous cascade speed controls and induction motors. And the power line carrier signals are also a kind of Interharmonics.

6.5 Unbalance

Unbalance: the RMS ratio of the negative sequence or zero sequence fundamental component of voltage/ current to the positive sequence fundamental component, indicating the degree of unbalance among three phases in a 3-phase power system, represented in %.

Formula:

$$\varepsilon_{U2} = \frac{U_2}{U_1} \times 100\%, \varepsilon_{U0} = \frac{U_0}{U_1} \times 100\%$$

In the formula：

U_{1} — RMS of positive sequence component of 3-phase voltage

U_{2} —RMS of negative sequence component of 3-phase voltage

U_{0} —RMS of zero sequence component of 3-phase voltage

(Change the “U” to “I”, it is the I Unbalance.)

Causes. 3-phase unbalance refers to the amplitude inconsistency of phase voltage (current) in a 3-phase system or deviation of phase difference from 120 °. Such unbalance may occur under conditions including but not limited to:

- Unbalanced load distribution among phases
- Higher harmonics

- Poor connection of wiring terminals or cables
- External conditions, such as open circuit caused by improper construction
- Long distance overhead transmission and distribution lines without transposition

Hazards. The main hazards of voltage unbalance include the easy overheating of motors and transformers and vibration of rotating equipment.

6.6 Voltage fluctuation and flicker

6.6.1 Voltage fluctuation

Voltage fluctuation: a series of changes or continuous changes in the RMS (effective value) of fundamental voltage. Voltage change d and rate of occurrence of voltage changes r are used to measure the degree and speed of voltage fluctuation. It is a phenomenon describing a series of rapid changes or continuous changes in the RMS of voltage. The period of change is longer than the frequency cycle (20ms). During voltage fluctuations, the RMS of voltage is generally within the permissible range of the voltage.

Formula:

$$\mathrm{d} = \frac{\Delta U}{U_N} \times 100\%$$

In the formula：

$\Delta \mathrm{U}$ —Difference between two adjacent peak voltages on the RMS curve of voltage

$\mathrm{U_N}$ —Nominal voltage

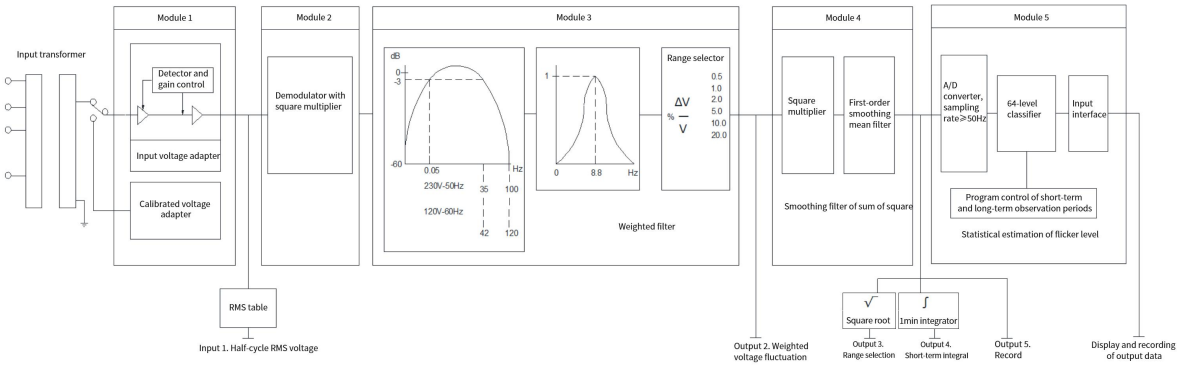
Causes. Any cyclical change of loads, particularly the reactive component, causes voltage fluctuations. Changes in light intensity as a result of voltage fluctuation are called "flicker". Regarding transmission and distribution systems, arc furnaces and variable frequency governors are the most common causes of voltage fluctuations. In addition, wind turbines connected to the power grid also generate voltage fluctuations when they run continuously or make a switchover.

6.6.2 Voltage flicker

Flicker: visual perception caused by unstable light

Short-term flicker Pst: a statistical value of the flicker intensity over a short period of time (e.g. several minutes). Basically, the short-time flicker is recorded every 10 min.

The following figure illustrates how to calculate the short-term flicker:



Long-term flicker Plt: a statistical value that is derived from short-term flicker Pst and reflects the flicker intensity over a long period of time (several hours). Basically, the long-time flicker is recorded every 2h.

Formula:

$$P_{lt} = \sqrt[3]{\frac{1}{12}\sum_{j=1}^{12}(P_{stj})^3}$$

In the formula：

P_{stj}—Short-term flicker of period j within 2h

Hazards. Flicker reflects the effect of light flickering on the human visual perception, which is an undesirable consequence of voltage fluctuations. For example, when an incandescent lamp works at 8.8Hz and a voltage fluctuation equal to 0.25% of power frequency voltage, its user will feel visual discomfort and fatigue.

Debugging method：

1. Enable the control of "Long-term flicker" and "Short-term flicker".
2. Set both "Short-term flicker limit" and "Long-term flicker limit" to be 1.
3. Apply a standard power quality source to send the flicker signal Pst =2. The "Short-term flicker" will be activated in 10 minutes and the "Long-term flicker" will be activated in 2 hours.

6.7 Voltage swell, dip and interruption

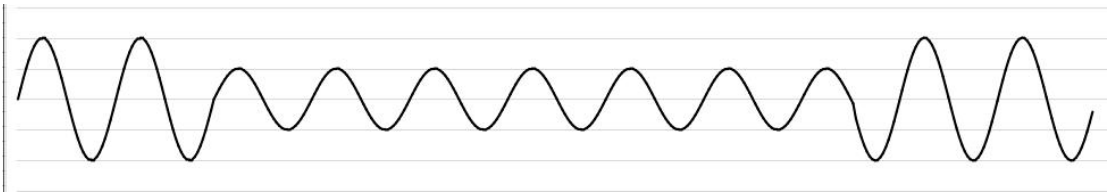
6.7.1 Voltage dip

Voltage dip: It is a phenomenon that the RMS voltage in a power system suddenly reduces to 0.1p.u. to 0.9p.u. and returns to normal in a short period from 10ms to 1min.

Causes. Voltage dip is usually related to system faults. In addition, starting of large-capacity induction motors or no-load excitation of transformers may also be causes.

When a large-capacityinduction motor starts, it may result in voltage dips. When a motor starts, it will generate a current 6 to 10 times than the rated value. Under the effect of system impedance, it will cause voltage dips. If a transformer is connected to the power grid without load, it may generate a large impact current because of flux saturation and remanence and thus result in voltage dips.

Hazards. Electrical loads are very sensitive to voltage dips, including but not limited to precision manufacturing equipment, computers, frequency converter, microelectronic devices and automatic speed governors. voltage dip with the amplitude of 85% to 90% of the normal voltage may make equipment shut down if it lasts for 16ms. The following figure illustrates the waveform of voltage dip:



6.7.2 Voltage interruption

Short-term interruption: It is a phenomenon that the RMS voltage in a power system suddenly reduces below 0.1p.u. and returns to normal in a short period from 10ms to 1min.

Causes. Power system faults, equipment malfunctions and control failures can cause short-term interruptions. Short-term interruptions are measured by the duration of RMS voltage below 10% of the nominal value. The duration of a system fault is determined by the working time of the corresponding protective device or the duration of a special event.

Hazards. voltage interruption may affect electronic and lighting equipment and further cause misoperation or shutdown. In some cases, electronic equipment may be damaged when the voltage is suddenly restored from a voltage interruption. The following figure illustrates the waveform of voltage interruption:

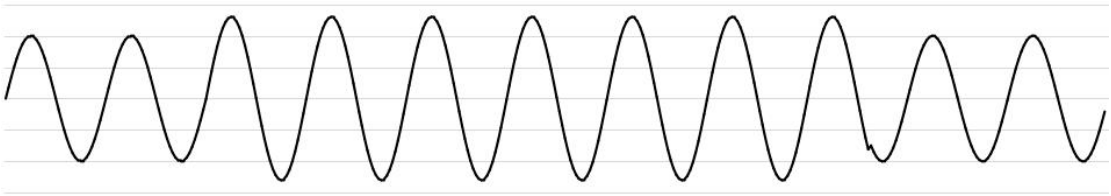


6.7.3 Voltage swell

Voltage swell: It is a phenomenon that the RMS voltage of in a power system suddenly increases to 1.1p.u. to 1.8 p.u. and returns to normal in a short period from 10ms to 1min.

Causes. When an single-phase earth fault occurs in a power system without the earthed neutral point, the voltage of other phases will rise. Voltage swell may also be caused by removal of large-capacity loads, load shedding or operation of large-capacity capacitor bank.

Hazards. Voltage swell may damage the insulation and reduce the life of electric equipment. It may also damage compact surge protection devices such as varistors and avalanche diodes when surge voltage exceeds the maximum rated operating voltage. The following figure illustrates the waveform of voltage swell:



Debugging method：

1. Enable the control of "Temporary voltage".
2. Set the "Voltage dip" to be 90%. Meaning of 90% is 90%* Nominal voltage.
3. Supply the nominal voltage of a 3-phase 50Hz system to the voltage input terminal for 12s (to determine the running stability with electricity).
4. Reduce the voltage below 90% of the nominal voltage and return to the normal voltage in 1min.
5. It will trigger the function "Voltage dip". The "Voltage dip event" will generate and the waveform recorder will work. Meanwhile, the corresponding alarm output is closed and the lamp on the panel turns bright. Press RST to OFF this product after the voltage dip event.

6.8 Transient current and voltage

Transients. They are changes in voltage or current under steady conditions, lasting for a few cycles. In general, they include sudden and unipolar change (mainly positive or negative), or suddent and bipolar change (positive and negative) in voltage or current under steady conditions.

Causes. Transient overvoltages caused by lightning or switching operations may make various equipment fail or damage the insulation.

Hazards. The high amplitude and rapid rise of transient overvoltage cause insulation breakdown in electrical equipment like rotating motors, transformers, capacitors, cables, current transformers, voltage transformers and switches. When circuits exposed to transients are led to semiconductor devices such as integrated circuits, it will damage electronic devices easily. The following figure illustrates the waveform of transients:



6.9 Energy measurement

6.9.1 Energy measurement

The device is equipped with detailed energy data. The data types of the energy contained in the device are as shown in table 6.1.

Table 6.1 Type of energy

Total	Three-phase total	Active energy(EP) Positive active energy(EP+) Negative active energy(EP-) Reactive energy(EQ) Positive reactive energy(EQ+) Negative reactive energy(EQ-) 4-quardrant reactive energy(EQ1~EQ4) Capacitive reactive energy(EQC) Inductive reactive energy(EQL) Apparent energy(ES) Apparent energy(ES+) Apparent energy(ES-)
	Single-phase	
Fundamental	Single-phase	
2nd~63rd harmonic	Single-phase	

6.9.2 Time of use(TOU)

- 8 independent multi-rate schedules.
  Support manual switch and timing switch
- 8 season schedules (refer to table 6.2)
  up to 16 seasons for one season schedule.
- 8 time schedules. (refer to table 6.3)
  Up to16 time periods can be set for one time schedule
  Up to 63 rates can be set.
- Separate settings for workdays, weekends, special days, other days
  8 special day schedule, max 32 days per schedule
  8 other day schedule, max 32 days per schedule

Table 6.2 The season schedule settings

Start date	Time schedule	Description
03-01	Schedule A	The multi-rate energy is calculated using time schedule A from March 1 to June 1.
06-01	Schedule B	The multi-rate energy is calculated using time schedule B from June 1 to September 1.
09-01	Schedule C	The multi-rate energy is calculated using time schedule C from September 1 to December 1.
12-01	Schedule D	The multi-rate energy is calculated using time schedule B from December 1 to March 1.

T

able 6.3 The time schedule settings

	Start time	Weekday	Weekend	Special day	Other day	Description
Time schedule A	0:00	rate3	rate3	rate3	rate3	From 0:00 to 3:00,the energy is calculated using rate3
	3:00	rate2	rate2	rate2	rate2	From 3:00 to 7:00,the energy is calculated using rate2
	7:00	rate3	rate3	rate3	rate3	From 7:00 to 11:00,the energy is calculated using rate3
	11:00	rate2	rate2	rate2	rate2	From 11:00 to 12:00,the energy is calculated using rate2
	12:00	rate1	rate1	rate1	rate1	From 12:00 to 15:00,the energy is calculated using rate1
	15:00	rate3	rate3	rate3	rate3	From 15:00 to 16:00,the energy is calculated using rate3
	16:00	rate4	rate4	rate4	rate4	From 16:00 to 00:00,the energy is calculated using rate4

6.9.3 Delta energy

The device is equipped with delta energy, which can record the energy variation under different rates over a period of time.

The delta energy is auto-reset to zero on the 1st of each month, with the previous month’s data stored. Users can query historical monthly multi-rate energy on the web.

The data of delta energy includes:

- Combination Active Energy
- Positive Active Energy
- Negative Active Energy
- Positive Reactive Energy
- Negative Reactive Energy
- Inductive Reactive Energy
- Capacitive Reactive Energy
- Four-Quadrant Energy
- Positive Apparent Energy
- Negative Apparent Energy

- Related Energy
- Positive Fundamental Active Energy
- Negative Fundamental Active Energy
- Positive Harmonic Active Energy
- Negative Harmonic Active Energy
- Copper Loss Active Energy Compensation Amount
- Copper Loss Reactive Energy Compensation Amount
- Iron Loss Active Energy Compensation Amount
- Iron Loss Reactive Energy Compensation Amount

6.10 Demand

The device is equipped with real-time demand and maximum demand functions.Demand refers to the average power value measured within a specified time period.

Real-time demand: The average power value within the demand period immediately preceding the current time.

(Example: Assuming the demand period is 15 minutes and the current time is 15:54:24, the real-time demand displays the average power value during the time period from 15:39:00 to 15:54:00.)

Maximum demand: The device can store the maximum demand value for each month with recorded time.

(Example: "Maximum demand_2025.10" records the maximum demand values of different power types during the period from 2025_10_01 to 2025_10_31.)

Tbale 6.4 Demand date

Demand Type	Positive/Negative active power	Positive/Negative reactive power	Inductive/Capacitive reactive power	Four-Quadrant reactive power	Positive/Negative apparent power
Single-phase	√	√	√	√	√
Three-phase total	√	√	√	√	√
Rate 1	√	√	√	√	√
...	...	...	...	...	...
Rate63	√	√	√	√	√

Headquarters: Acrel Co., Ltd.

Trade Company: Acrel E-Business(Shanghai)Co., Ltd.

Address: No.253 Yulv Road, Jiading District, Shanghai, China

TEL.: 0086-21-69156352

Web-site: www.acrel-electric.com

E-mail: sales@acrel-electric.com

Postcode: 201801

Manufacturer: Jiangsu Acrel Electrical Manufacturing Co., Ltd.

Address: No.5 Dongmeng Road, Dongmeng industrial Park, Nanzha Street, Jiangyin City, Jiangsu Province, China

TEL./Fax: 0086-510-86179970

Web-site: www.jsacrel.com

E-mail: sales@email.acrel.cn

Postcode: 214405