NO:13040500.0105.00

YDPQ200-A

Power Quality Analyzer Technical Specification

Guangdong Yada Electronic Co., Ltd.

DANGER AND WARNING

Read this manual carefully before installing, operating or maintaining this device and familiarize yourself with the device step by step.

This document is not an operation manual for untrained personnel. Our company shall not be liable for any problems caused by use outside its normal scope.

RISK OF ELECTRIC SHOCK, FIRE OR EXPLOSION

- **This device contains live parts with electrical hazards; operation must be carried out in strict accordance with specifications.**
- **The device must be de-energized and earthed before any maintenance or installation.**
- **All mechanical parts, doors, covers and other components shall be restored to their original positions before the device is energized.**
- **Maintenance and installation of the device shall only be performed by qualified personnel.**

Failure to observe these precautions may result in serious injury.

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Chapter 1 Product Introduction

1.1 Overview

The YDPQ200-A Online Power Quality Monitoring Device (hereinafter referred to as YDPQ200-A or the device) is a new-generation online power quality monitoring device independently developed by Guangdong Yada Electronic Co., Ltd. The device features high-precision measurement and metering functions, scheduled recording and time-of-use billing functions, as well as rich power quality monitoring functions. It complies with the latest seven national standards for power quality and the national standard for general requirements of power quality monitoring equipment, integrating harmonic analysis, waveform sampling, voltage swell/sag recording, flicker monitoring, voltage unbalance measurement, instantaneous waveform capture, event recording, measurement and control, etc. It meets the Class A standard for power quality monitoring and has accurate fault diagnosis and positioning functions. For local abnormalities or faults in the power supply and consumption system, it accurately records a large amount of waveform and event information, sensitively identifies and accurately judges potential, instantaneous or persistent local faults, ensuring the safe and reliable operation of the user's power supply and consumption system.

The YDPQ200-A device samples 1024 points per cycle with high measurement accuracy and full electrical quantity measurement. It has ultra-large capacity data storage and recording, with recorded data storable for more than half a year. It is equipped with a 5.7-inch large-screen high-resolution TFT color LCD display and an aluminum alloy high-grade metal casing with an exquisite and beautiful appearance.

The YDPQ200-A Online Power Quality Monitoring Device is manufactured in accordance with the following standards:

Table 1-1 List of Implemented Standards

Standard No.	Standard Content
GB/T 14549	Power quality - Harmonics in public supply networks
GB/T 12325	Power quality - Supply voltage deviation
GB/T 12326	Power quality - Voltage fluctuation and flicker
GB/T 15543	Power quality - Three-phase voltage unbalance in electric power systems
GB/T 15945	Power quality - Frequency deviation in power systems
GB/T 18481	Power quality - Temporary over voltage and transient over voltage
GB/T 24337	Power quality - Inter harmonics in public supply networks
GB/T 30137	Power quality - Voltage sag and short interruption
GB/T 19862	General requirements for power quality monitoring equipment
GB/T 17626.30	Electromagnetic compatibility - Testing and measurement techniques - Power quality measurement methods
GB/T 17626.7	Electromagnetic compatibility - Testing and measurement techniques - Guide for the measurement of harmonics and inter harmonics in power supply systems and connected equipment
GB/T 17626.4	Electromagnetic compatibility - Testing and measurement techniques - Electrical fast transient/burst immunity test
GB/T 17626.3	Electromagnetic compatibility - Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
GB/T 17626.2	Electromagnetic compatibility - Testing and measurement techniques - Electrostatic discharge immunity test
GB/T 17626.5	Electromagnetic compatibility - Testing and measurement techniques - Surge immunity test
GB/T 17215.322	AC electricity metering equipment - Special requirements - Part 22: Static active energy meters (Classes 0.2S and 0.5S)
GB/T 17215.302	AC electricity metering equipment - Special requirements - Part 2: Static harmonic active energy meters

Standard No.	Standard Content
GB/T 17215.324	AC electricity metering equipment - Special requirements - Part 24: Static fundamental frequency reactive energy meters (Classes 0.5S, 1S and 1)
GB/T 17215.301	AC electricity metering equipment - Special requirements - Part 1: Multi-function meters
Q/GDW 10650.2	Technical specification for power quality monitoring - Part 2: Power quality monitoring device
Q/GDW 1650.3	Technical specification for power quality monitoring - Part 3: Communication protocol between monitoring terminal and master station
IEC 61000-4-30	Power quality measurement methods
IEC 61000-4-15	Flicker meter - Functional and design specifications

1.2 Function Introduction

Table 1-2 Basic Functions

Measurement Channel	
Voltage Channels	3
Current Channels	4
Real-time Measurement	
Current	√
Phase Voltage	√
Line Voltage	√
Active Power	√
Reactive Power	√
Apparent Power	√
Power Factor	√
Frequency	√
Phase Angle	√
Electric Energy Metering	
Total Wave Energy	√
Fundamental Wave Energy	√
Harmonic Energy	Total harmonic energy, 2nd~63rd harmonic energy
Multi-tariff Energy	√
Demand Function	
Real-time Demand	√
Maximum Demand	Current, 1st~12th previous maximum demand
Time-of-Use (TOU) Function	
Time-of-Use Metering	√
Steady-State Power Quality	
Waveform Sampling Rate	1024 points/cycle
Voltage Deviation	√
Frequency Deviation	√
Three-phase Unbalance	√
Harmonics	63rd order
Interharmonics	63rd order
Voltage Fluctuation	√
Flicker Analysis	√
Rapid Voltage Change	√
Transient Power Quality	

Voltage Swell	√
Voltage Sag	√
Voltage Interruption	√
Marking Function	√
Instantaneous Power Quality	
Instantaneous Overvoltage	20μs
Sudden Change Detection	√
Power Quality Statistics and Evaluation	
Scheduled Statistical Recording	√
Over-limit Monitoring and Control	
Over-limit Monitoring	√
Waveform Recording	
Waveform Recording	√
Disturbance Recording	√
Scheduled Waveform Recording	√
RMS Value Recording	√
Event Recording	
Monitoring Events (1ms)	1024 entries, 1ms resolution
Device Log (1ms)	1024 entries, 1ms resolution
Event Counting	√
Data Recording	
Max/Min Value Recording	√
Energy Recording	√
PQDIF	√
Display	
Display Mode	5.7-inch color screen, 640×480
Real-time Data	Display of three-phase voltage, current, power, frequency and other electrical parameters
Real-time Alarm	Alarm information prompt
Device Parameters	Set relevant parameters (communication parameters such as address, baud rate, parity and product information)
Display Setting	Backlight time adjustable
Input and Output	
Digital Input (DI)	6 channels (passive contact)
Relay Output (DO)	4 channels
Energy Pulse Output (E)	2 channels
Second Pulse Output (SEC)	1 channel
PPS Time Synchronization Interface	1 channel
Communication	
RS485	2 RS485 interfaces (Modbus RTU protocol), maximum response time < 100ms
Ethernet Port	2 Ethernet ports, RJ45 interface, configurable link number, max. 10 (Modbus TCP, IEC61850 protocol)
USB Port	1 port
Communication Protocol	Modbus RTU, Modbus TCP, IEC61850 and GOOSE protocol
Clock and Timing Function	
Clock	The clock has automatic calendar calculation, timing and leap year conversion functions.
Time Synchronization	Modbus, SNTP, PPS, IRIG-B

Chapter 2 Technical Specifications

2.1 Measurement Accuracy

Parameter	Accuracy	Resolution
Voltage	±0.1%	0.001V
Current	±0.1%	0.001A
Voltage and Current Phase Angle	±0.2°	0.1°
Frequency	±0.01Hz	0.001Hz
Active Power	±0.2%	0.1W
Reactive Power	±0.2%	0.1var
Apparent Power	±0.2%	0.1VA
Power Factor	±0.5%	0.001
Voltage Deviation	±0.1%	0.01%
Frequency Deviation	±0.01Hz	0.01Hz
Three-phase Voltage Unbalance	Class A	0.01%
Three-phase Current Unbalance	Class A	0.01%
Flicker	Class A	0.001
Voltage Harmonics	Class A	0.001V
Current Harmonics	Class A	0.001A
Active Energy	Class 0.2S	0.001kWh
Reactive Energy	Class 1.0	0.001kvarh
Time Accuracy	±1ms (with external time synchronization)±1s/24h (without external time synchronization)	1ms

2.2 Environmental Conditions and Power Supply

Environmental Condition		
Storage Temperature: -40℃~+70℃		Operating Temperature: -25℃~+55℃
Humidity: 5% ~95%, no condensation		Altitude: ≤ 2000m
Working Power Supply		
Maximum Power Consumption	≤8W	Input: AC85V~AC265V, 50/60Hz;DC100V~DC330V

2.3 Voltage and Current Input

Voltage Input	
Nominal Voltage Un	57.7V/100V or 220V/380V
Accuracy Range	0.1Un~2Un
Frequency Range	42.5~57.5Hz
Power Consumption	<0.5VA/phase
Overload Capacity	2Un continuous operation, 4Un for 1s allowed
Signal Connection Mode	Direct connection, indirect connection
Current Input	
Rated Current In	5A or 1A
Accuracy Range	0.01In~1.5In
Power Consumption	<0.5VA/phase
Overload Capacity	1.5In continuous operation, 10In for 1s allowed
Signal Connection Mode	Indirect connection

Note: Voltage/current values exceeding the product's rated range may cause damage to the meter. Our company shall not be liable for accuracy changes caused by over-range operation.

2.4 Digital Input (DI)

6-channel Digital Input (DI)	
Optocoupler Isolation	6 channels
Input Type	Dry contact (with 12V internal excitation)

2.5 Relay Output (DO)

4-channel Relay Output (DO)	
Contact Type	Normally open
Contact Capacity (Resistive)	DC30V, 5A; AC250V, 5A
Operation Time	≤20ms

2.6 EC and Second Pulse Output

2-channel EC Output (Optocoupler), 1-channel Second Pulse Output	
Maximum Voltage	30VDC
Maximum Current	50mA

2.7 Communication

2 RS485 Interfaces	
Port Type: RS485, 2-wire half-duplex	Communication Protocol: Modbus RTU
Parity Bit: None/Odd/Even optional, default None	Communication Baud Rate: 4800bps, 9600bps, 19200bps, 38400bps, 115200bps optional, default 9600bps
2 Ethernet Ports	
Port Type: Ethernet, RJ45 interface	Communication Protocol: Modbus TCP, IEC61850
Communication Baud Rate	10M/100M
Link Number (Modbus TCP)	1~10 optional, default 10, shared by dual network ports
1 USB Interface	
Port Type: USB	

2.8 Electrical Characteristics

Electrical Characteristics	
Insulation Resistance: 100MΩ/500V	Dielectric Strength (Power Frequency Withstand Voltage):2kV (r.m.s), 50Hz, 1min (between voltage, current, power supply, DO and earth, each group)1kV (r.m.s), 50Hz, 1min (between DI input, RS485 port and earth, each group)
Impulse Voltage	Impulse Waveform: 1.2/50μs 500Ω5kV (between voltage, current, power supply, DO and earth, each group)2kV (between DI input, RS485 port and earth, each group)

2.9 Electromagnetic Compatibility

Electromagnetic Compatibility	
Electrical Fast Transient/Burst Immunity Test	Implemented Standard: GB/T 17626.4; IEC 61000-4-4Class: Ⅳ (2kV for other ports, 4kV for power port)
Electrostatic Discharge Immunity Test	Implemented Standard: GB/T 17626.2; IEC 61000-4-2Class: Ⅳ (8kV contact discharge, 15kV air discharge)
Surge Immunity Test	Implemented Standard: GB/T 17626.5; IEC 61000-4-5Class: Ⅳ (4kV differential mode for power and voltage ports, 4kV common mode for power/voltage ports to other ports; 2kV differential mode for RS485 port; 1kV differential mode for DI port)
Radiated, Radio-frequency, Electromagnetic Field Immunity Test	Implemented Standard: GB/T 17626.3; IEC 61000-4-3Class: Ⅲ (10V/m)
Voltage Sag and Short Interruption Immunity Test	Implemented Standard: GB/T 17626.11 and GB/T 17626.29
Immunity to Conducted Disturbances, Induced by Radio-frequency Fields	Implemented Standard: GB/T 17626.6;Class: Ⅲ (10V from 150kHz to 80MHz)
Power Frequency Magnetic Field Immunity Test	Implemented Standard: GB/T 17626.8Class: Ⅳ
Pulse Magnetic Field Immunity Test	Implemented Standard: GB/T 17626.9Class: Ⅴ (1000 A/m)
Damped Oscillatory Magnetic Field Immunity Test	Implemented Standard: GB/T 17626.10Class: Ⅴ (100 A/m)
Damped Oscillatory Wave Immunity Test	Implemented Standard: GB/T 17626.18Class: Ⅳ
Oscillatory Wave Immunity Test	Implemented Standard: GB/T 17626.12Class: Ⅳ

Chapter 3 Function Introduction

3.1 Measurement Functions

3.1.1 Basic Measurement Functions

The real-time data measurement function of the device includes total wave data measurement and fundamental wave data measurement, and the measured data can be read through display and communication. The specific measurement parameters are as follows:

1）Total Wave Data

Table 3-1 Total Wave Measurement Data and Resolution

Name	Phase A	Phase B	Phase C	Average Value	Total Value	Unit
Phase Voltage	0.001	0.001	0.001	0.001	---	V
Line Voltage	0.001	0.001	0.001	0.001	---	V
Current	0.001	0.001	0.001	0.001	---	A
Active Power	0.1	0.1	0.1	--	0.1	W
Reactive Power	0.1	0.1	0.1	--	0.1	var
Apparent Power	0.1	0.1	0.1	--	0.1	VA
Power Factor	0.001	0.001	0.001	--	0.001	--
Frequency	0.001					Hz
Neutral Current	0.001					A

Note: The average value here refers to the average of three phases A, B and C.

2）Fundamental Wave Data

Table 3-2 Fundamental Wave Measurement Data and Resolution

Name	Phase A	Phase B	Phase C	Average Value	Total Value	Unit
Phase Voltage	0.001	0.001	0.001	0.001	---	V
Line Voltage|	0.001	0.001	0.001	0.001	---	V
Current	0.001	0.001	0.001	0.001	---	A
Active Power	0.1	0.1	0.1	--	0.1	W
Reactive Power	0.1	0.1	0.1	--	0.1	var
Apparent Power	0.1	0.1	0.1	--	0.1	VA
Power Factor	0.001	0.001	0.001	--	0.001	--
Voltage Phase Angle	0.1	0.1	0.1	--	--	°
Current Phase Angle	0.1	0.1	0.1	--	--	°

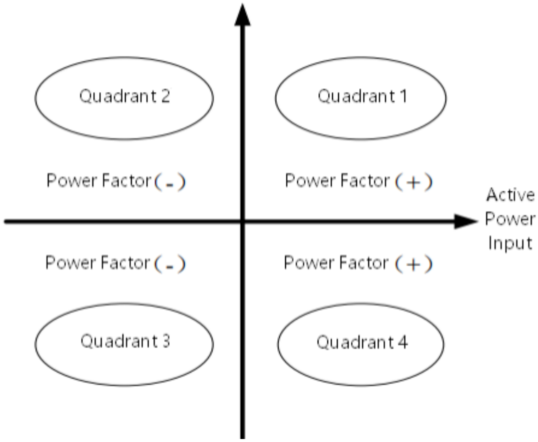
Note: The average value here refers to the average of three phases A, B and C.

3.1.2 Frequency Measurement

The frequency measurement accuracy of the device is ±0.01Hz, which meets the accuracy requirements in the range of 42.5Hz to 57.5Hz, enabling online monitoring of power system frequency. Meanwhile, over-limit alarm and recording can be set. During measurement, if the wiring mode is three-phase four-wire, phase A voltage is used as the reference; if the wiring mode is three-phase three-wire, AB line voltage is used as the reference.

3.1.3 Power Factor Definition Method

The sign of the power factor adopts the definition of IEC power factor sign, as shown in Figure 3-1.



Definition method of power factor

3.1.4 Calculation Method of Total Apparent Power

The device provides two calculation methods for total apparent power: scalar method and vector method. The method can be set through communication, and the formulas of the two calculation methods are as follows:

Vector method:

$$kVA_{total} = \sqrt{kW_{total}^2 + k\,\mathrm{var}_{total}^2}$$

Scalar method:

$$\mathrm{k}VA_{total} = kVA_a + kVA_b + kVA_\mathrm{c}$$

Notes:

1）For star connection, the user can set the vector method or scalar method to calculate the total apparent power as needed; for delta connection, there is no phase-separated power, and the vector method shall be set to calculate the total apparent power.

2）Selecting different calculation methods for total apparent power will lead to different calculation results of total power factor and cumulative results of apparent energy.

3）In the above formulas, S represents the total apparent power, P represents the total active power, Q represents the total reactive power, and kVAa/kVAb/kVAc represent the apparent power of phase A/B/C respectively.

3.2 Electric Energy Metering

3.2.1 Basic Electric Energy Metering

The YDPQ200-A device provides rich electric energy metering data for users to analyze the energy consumption of the system. The energy data provided by the device are as follows:

Table 3-3 Electric Energy Metering Data

	Forward	Reverse	Total	Four Quadrants	Combined Reactive 1	Combined Reactive 2
Total Wave Active Energy	√	√	√	--	--	--
Total Wave Reactive Energy	--	--	--	√	√	√
Total Wave Apparent Energy	√	√	--	--	--	--
Fundamental Wave Active Energy	√	√	√	--	--	--
Fundamental Wave Reactive Energy	--	--	--	√	√	√
Fundamental Wave Apparent Energy	√	√	--	--	--	--
Total Harmonic Active Energy	√	√	√	--	--	--
Total Harmonic Reactive Energy	--	--	--	√	√	√
Total Harmonic Apparent Energy	√	√	--	--	--	--
2nd~63rd Harmonic Active Energy	√	√	--	--	--	--
2nd~63rd Harmonic Reactive Energy	√	√	--	--	--	--
Note: Total wave, fundamental wave and total harmonic energy have phase-separated energy; no harmonic energy for delta connection.						

3.2.2 Energy Rollover and Clear

The maximum energy value recorded by the YDPQ200-A device is 2147483.647kWh (secondary side). When the energy exceeds the maximum value, the energy accumulates from 0 again. The energy can be cleared through the keyboard and communication.

3.2.3 Energy Pulse

The YDPQ200-A supports active energy pulse output and reactive energy pulse output.

3.3 Demand

In the power system, fees are usually charged according to the user's energy consumption (in the form of active energy) and peak power consumption level (in the form of active power). Demand is defined as the average value within a certain time interval (usually 15 minutes).

3.3.1 Real-time Demand

In addition to the common active demand, the device also provides real-time demand of reactive power, apparent power and three-phase current.

The real-time demand calculation mode is: sliding demand.

Table 3-4 Demand Data

Item	Unit
Phase A Current Demand	A
B-phase current demand	A
C-phase current demand	A
Forward Total Active Power Demand	W
Reverse Total Active Power Demand	W
Forward Total Reactive Power Demand	var
Reverse Total Reactive Power Demand	var
Total Apparent Power Demand	VA

3.3.2 Demand Algorithm

The demand adopts the sliding period demand algorithm, which sums the calculated values per second, takes the average value at the end of the demand calculation period, and outputs the calculation result. This method is applied to both current and power calculation. The demand calculation is performed on the whole minute and whole second. The demand period can be set to 5, 10, 15, 30, 60 minutes.

Sliding Demand: A method of measuring demand by recursive measurement at a time interval less than the demand period from any moment, and the measured demand is called sliding demand. The time interval for recursive measurement of demand in turn is called the sliding time. The sliding time is generally 1 minute, and the demand period is generally 15 minutes.

Sliding demand parameters are as follows:

Sliding Time: Optional from 1, 2, 3, 5min.

Demand Period: Optional from 5, 10, 15, 30, 60min. Meanwhile, the demand period shall be an integer multiple of 5 of the sliding sub-period (sliding time).

The above parameters can be set through the upper computer.

3.3.3 Maximum Demand

The device provides records of current and 1st~12th previous maximum demand, recording the maximum demand value and its occurrence time. The device provides the maximum demand of the following parameters:

Table 3-5 Maximum Demand Data

Item	Unit	Occurrence time
Phase A Current Demand	A	Year-Month-Day Hour:Minute:Second
Phase B Current Demand	A	Year-Month-Day Hour:Minute:Second
Phase C Current Demand	A	Year-Month-Day Hour:Minute:Second
Forward Total Active Power Demand	W	Year-Month-Day Hour:Minute:Second
Reverse Total Active Power Demand	W	Year-Month-Day Hour:Minute:Second
Forward Total Reactive Power Demand	var	Year-Month-Day Hour:Minute:Second
Reverse Total Reactive Power Demand	var	Year-Month-Day Hour:Minute:Second
Total Apparent Power Demand	VA	Year-Month-Day Hour:Minute:Second

The mode of transferring the current maximum demand to the previous maximum demand can be set through the transfer time. After transfer, the current maximum demand record is cleared, and the maximum demand value is re-statistically recorded. The transfer time can be set to: automatic transfer at the end of the month or at a fixed time (xx day xx hour) every month.

3.4 Time-of-Use (TOU) Metering Function

The YDPQ200-A device has two sets of tariff schemes, and each set of tariff scheme includes time zone setting, daily time period table setting and special day setting. In the power system, the electricity prices on working days, weekends and holidays may be different, and the electricity prices during peak load periods and off-peak periods are also different. This function is a kind of electric energy metering method provided to adapt to the peak and valley time-of-use electricity price. It can calculate and accumulate the electric energy of each time-of-use tariff according to the pre-set billing time period and tariff to realize the time-of-use metering function. In the TOU function, the time setting is based on an annual cycle. Ordinary days and special days can be set every year, with a maximum of 14 special days. A maximum of 14 time zones can be set in a year, a week can be set to 2 types: working day/weekend, and the corresponding daily time period table number can be set respectively; a maximum of 8 daily time period tables can be set, and each daily time period table divides 24 hours a day into a maximum of 14 time periods with a step of 15 minutes, each time period corresponding to a unique tariff, with a maximum of 8 tariffs. For holidays, if separate setting is required, it can be realized by setting the special day register to specify the special day date and the corresponding daily time period table.

The two sets of schemes can be independently set with multi-tariff schemes, and automatic switching can be realized by setting the switching date of the two sets of schemes.

The multi-tariff function can realize time-of-use metering of combined, forward and reverse active energy, four-quadrant and combined reactive energy, and forward and reverse apparent energy, and provide the maximum and minimum demand values of forward and reverse active, reactive and total apparent power in each tariff time period. The maximum energy rollover value of each tariff time period is 2147483.647KWh.

Table 3-6 TOU Recording Parameters

Energy	Combined, forward and reverse active energy
	Combined reactive 1, combined reactive 2, 1st quadrant, 2nd quadrant, 3rd quadrant, 4th quadrant reactive energy
	Forward and reverse apparent energy
Maximum Demand	Forward active and reactive demand
	Reverse active and reactive demand
	Total apparent demand

Parameter Range:

Billing Time Zones: 1~14 time zones, the start time of time zone 1 is January 1st and cannot be modified. The setting rule of the time zone scheme is: the date of the latter time zone shall be later than that of the previous one. Meanwhile, if the number of time zones in the time zone scheme is less than the set number of time zones, it shall be supplemented according to the last time zone.

Billing Day Types: two types of working day/weekend, and the daily time period table can be set separately.

Daily Time Period Tables: a maximum of 8 time period tables, each table can set a maximum of 14 time periods, the minimum time unit of each time period is 15 minutes, and it shall be greater than the demand period set in the device. For each daily time period table, the time period setting rule is: the time of the latter time period shall be later than that of the previous one.

Special Days: 0~14 days, each special day can independently specify the daily time period table.

Tariffs: 8 tariffs.

Time Zone Table Switching Time: automatic switching time of two sets of annual time zone tables;

Time Period Table Switching Time: automatic switching time of two sets of daily time period tables;

This function can only be set and viewed through communication.

3.5 Steady-State Power Quality Monitoring Functions

3.5.1 Harmonic and Inter harmonic Monitoring

(1) Basic Measurement

Decomposing a periodic AC quantity into Fourier series, the component with the same frequency as the power frequency is called the fundamental wave component, the component with a frequency that is an integer multiple greater than 1 of the fundamental wave component frequency is called the harmonic component, the component with a frequency that is not an integer multiple of the fundamental wave frequency is called the inter-harmonic component, and the component with a frequency lower than the fundamental wave frequency is called the sub harmonic component. When the public power grid operates ideally, the voltage frequency provided shall be single and fixed, and the voltage amplitude shall be equal to the specified value. The occurrence of harmonic voltage and harmonic current is a kind of pollution to the public power grid and will cause a certain degree of harm to electrical equipment. Therefore, it is necessary to monitor harmonics online to ensure the power supply quality.

The device samples 1024 points per cycle. At a rated frequency of 50Hz, FFT (Fast Fourier Transform) is performed with a time window of 10 cycles, and the frequency resolution is 5Hz. It can measure the harmonic components (RMS value and phase angle) and inter-harmonic components (RMS value) of each order, so as to calculate the harmonic content of each order, total harmonic distortion rate, odd harmonic distortion rate and even harmonic distortion rate.

Table 3-7 Harmonic Analysis Data

	UA/A phase	UB/B phase	UC/C phase	Sum	IA	IB	IC	I4
2nd~63rd Harmonic RMS Value	√	√	√	--	√	√	√	√
2nd~63rd Harmonic Phase Angle	√	√	√	--	√	√	√	√
2nd~63rd Harmonic Content	√	√	√	--	√	√	√	√
Total Harmonic Distortion Rate	√	√	√	--	√	√	√	√
Total Odd Harmonic Distortion Rate	√	√	√	--	√	√	√	√
Total Even Harmonic Distortion Rate	√	√	√	--	√	√	√	√
Total Harmonic RMS Value	√	√	√	--	√	√	√	√
Odd Harmonic RMS Value	√	√	√	--	√	√	√	√
Even Harmonic RMS Value	√	√	√	--	√	√	√	√
Current K Factor	--	--	--	--	√	√	√	--
Crest Factor	√	√	√	--	√	√	√	--
1st~63rd Inter harmonic RMS Value	√	√	√	--	√	√	√	--
1st~63rd Inter harmonic Content	√	√	√	--	√	√	√	--
Sub harmonic RMS Value	√	√	√	--	√	√	√	--
Sub harmonic Distortion Rate	√	√	√	--	√	√	√	--
Total Inter harmonic Distortion Rate	√	√	√	--	√	√	√	--
Total Odd Inter harmonic Distortion Rate	√	√	√	--	√	√	√	--
Total Even Inter harmonic Distortion Rate	√	√	√	--	√	√	√	--
Total Harmonic Active Power	√	√	√	√	--	--	--	--
Total Harmonic Reactive Power	√	√	√	√	--	--	--	--
Total Harmonic Apparent Power	√	√	√	√	--	--	--	--
2nd~63rd Harmonic Active Power	√	√	√	--	--	--	--	--
2nd~63rd Harmonic Reactive Power	√	√	√	--	--	--	--	--
2nd~63rd Harmonic Apparent Power	√	√	√	--	--	--	--	--
2nd~63rd Harmonic Power Factor	√	√	√	√	--	--	--	--

Note: The harmonic active power/reactive power in Table 3-7 is the primary value, and invalid for delta connection.

(2) Calculation Method

After FFT, the RMS value and phase angle of each harmonic can be obtained, so as to calculate the power factor, active power, reactive power and other parameters. The calculation formulas of parameters such as content and distortion rate are as follows:

1）Harmonic RMS Value Calculation

➢ Harmonic Group and Inter harmonic Group

The spectrum components output after DFT or FFT are shown in the following figure, with one spectrum line every 5Hz. Grouping is carried out according to the following formula, which is the sum of squares of each intermediate component between two adjacent harmonics (only intermediate components above the 2nd harmonic are used), and the root mean square value of the h-th harmonic is calculated. The RMS value of the h-th harmonic is calculated from the h-th harmonic group, the RMS value of the h-th inter harmonic is calculated from the root mean square value of the inter harmonic group between the h-th and (h+1)-th harmonics, and the inter harmonic group between the 0-th and 1st harmonics is called the sub harmonic (can be regarded as the 0-th inter harmonic).

$$\text{Harmonic:}\quad Y_{g,h} = \sqrt{\frac{1}{2}Y^2_{C,(N\times h)-N/2} + \sum_{k=(-N/2)+1}^{(N/2)-1} Y^2_{C,(N\times h)+k} + \frac{1}{2}Y^2_{C,(N\times h)+N/2}}$$

$$\text{Inter harmonic:}\quad Y_{ig,h} = \sqrt{\sum_{k=1}^{N-1} Y^2_{C,(N\times h)+k}}$$

Where:

$Y_{C,(N\times h)+k}$ is the root mean square value corresponding to the spectrum component output by DFT or FFT;

$(N\times h)+k$ is the order of the spectrum component;

$Y_{g,h}$ is the root mean square value of the harmonic group;

$Y_{ig,h}$ is the root mean square value of the inter harmonic group.

Example:

For a 50Hz system, if the frequency resolution after Fourier transform is 5Hz, then $N = \frac{50}{5} = 10$. Taking the 2nd harmonic as an example, its harmonic group starts from the $(N \times h) - \frac{N}{2} = (10 \times 2) - 5 = 15$th spectrum component, i.e., starting from 15×5=75Hz, and ends at the $(N \times h) + \frac{N}{2} = (10 \times 2) + 5 = 25$th spectrum component, i.e., ending at 25×5=125Hz, with a total of 11 spectrum lines. For the 1st inter harmonic, it starts from the (N×h)+1=(10×1)+1=11th spectrum component, i.e., starting from 11×5=55Hz, and ends at the (N×h)+(N−1)=(10×1)+(10−1)=19th spectrum component, i.e., ending at 19×5=95Hz, with a total of 9 spectrum lines.

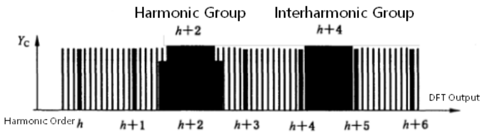


Figure 3-2 Schematic diagram of harmonic group and inter-harmonic group

- Harmonic Subgroup and Inter harmonic Central Subgroup

Fourier transform analysis assumes that the signal is steady-state. However, the voltage amplitude of the power supply system may fluctuate, which diffuses the energy of harmonic components to the spectrum of adjacent frequencies. To improve the evaluation accuracy, grouping can be carried out according to the following formula.

$$\text{Harmonic:}\quad Y_{sg,h} = \sqrt{\sum_{k=-1}^{1} Y_{C,(N\times h)+k}^2}$$

$$\text{Inter harmonic:}\quad Y_{isg,h} = \sqrt{\sum_{k=2}^{N-2} Y_{C,(N\times h)+k}^2}$$

Where:

$Y_{C,(N\times h)+k}$ is the root mean square value corresponding to the spectrum component output by DFT or FFT;

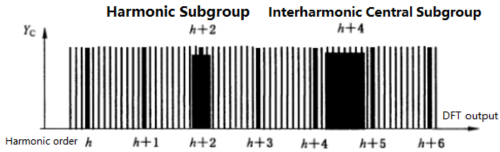
$(N \times h) + k$ is the order of the spectrum component;

$Y_{sg,h}$ is the root mean square value of the harmonic subgroup;

$Y_{isg,h}$ is the root mean square value of the inter-harmonic central subgroup.

Example:

For a 50Hz system, if the frequency resolution after Fourier transform is 5Hz, then $N = \frac{50}{5} = 10$. Taking the 2nd harmonic as an example, its harmonic subgroup starts from the (N×h)−1=(10×2)−1=19th spectrum component, i.e., starting from 19×5=95Hz, and ends at the (N×h)+1=(10×2)+1=21st spectrum component, i.e., ending at 21×5=105Hz, with a total of 3 spectrum lines. For the 1st inter harmonic, the inter harmonic central subgroup starts from the (N×h)+2=(10×1)+2=12th spectrum component, i.e., starting from 12×5=60Hz, and ends at the (N×h)+(N−2)=(10×1)+(10−2)=18th spectrum component, i.e., ending at 18×5=90Hz, with a total of 7 spectrum lines.



2）Harmonic Power Calculation

After FFT, the phase angle of each harmonic can be obtained, and then parameters such as power factor, active power, and reactive power can be calculated.

h-th harmonic relative phase angle φh= the phase angle of the h-th harmonic voltage minus the phase angle - the h-th harmonic current

h-th harmonic power factor = cos(φh)

h-th harmonic active power = UhIhcosφh

h-th harmonic reactive power = UhIhsinφh

h-th harmonic apparent power $=U_h I_h$

Total harmonic active power= $\sum_{h=2}^{63} U_h I_h \cos \varphi_h$

Total harmonic reactive power= $\sum_{h=2}^{63} U_h I_h \sin \varphi_h$

$$\text{Total harmonic apparent power} = \sqrt{\text{Total harmonic active power}^2 + \text{Total harmonic reactive power}^2}$$

$$\text{Total power factor} = \frac{\text{Total harmonic active power}}{\text{Total harmonic apparent power}}$$

3） Harmonic content and distortion rate:

$$\text{h} - \text{order harmonic ratio} = \frac{\text{h} - \text{order harmonic RMS value}}{\text{fundamental RMS value}} \times 100\%$$

$$\text{total harmonic distortion} = \left(\frac{\sqrt{\sum_{h=2}^{N} (\text{h} - \text{order harmonic RMS value})^2}}{\text{fundamental RMS value}} \right) \times 100\%$$

$$\text{subharmonic distortion} = \frac{\text{subharmonic RMS value}}{\text{fundamental RMS value}} \times 100\%$$

Notes:

1.The calculation formula of inter harmonics is the same as that of harmonics.

2.The odd harmonic distortion rate only calculates the 1st, 3rd, 5th, 7th... harmonics, and the even harmonic distortion rate only calculates the 2nd, 4th, 6th, 8th... harmonics.

4）Crest Factor

The crest factor is the ratio of the peak value of the measured quantity to the RMS value, and the crest factor of an ideal sine wave is 1.414. The device provides the crest factor of three-phase voltage and three-phase current of A, B and C, which is calculated by taking the highest sample value and root mean square value within a 10-cycle time window.

$$\text{crest factor} = \frac{|\text{Peak Value}|}{\text{RMS Value}}$$

5）K Factor

When there are harmonics in the system, the harmonic current is injected into the transformer, which increases the iron loss of the transformer, and the iron loss is greater with the increase of harmonic frequency. Therefore, high-order harmonics can cause more heating of the transformer and greater loss than low-order harmonics. At the same time, harmonic current can also cause heating of the transformer shell, outer silicon steel sheet and some fasteners. In the technical indicators of power quality, the K factor mainly reflects the influence 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 transformer eddy current loss caused by harmonic current is proportional to the square of the harmonic order. The calculation formula is:

$$k=\frac{\sum_{h=1}^{\infty} I_h^2 h^2}{\sum_{h=1}^{\infty} I_h^2}=\frac{\sum_{h=1}^{h=h_{\max}} I_h^2 h^2}{\sum_{h=1}^{h=h_{\max}} I_h^2}$$

Where, h is the harmonic order, {I}_{h} is the RMS value of the h-th harmonic current, and n is the maximum order of the harmonic current to be considered.

(3) Over-limit Events

RMS Value/Content Over-limit (one selected, content for voltage, RMS value for current)

1) Taking voltage content and current RMS value as an example, the parameters include:

2nd~63rd harmonic voltage content of phase A;

2nd~63rd harmonic voltage content of phase B;

2nd~63rd harmonic voltage content of phase C;

2nd~63rd harmonic current RMS value of phase A;

2nd~63rd harmonic current RMS value of phase B;

2nd~63rd harmonic current RMS value of phase C;

1st~63rd inter harmonic voltage content of phase A;

1st~63rd inter harmonic voltage content of phase B;

1st~63rd inter harmonic voltage content of phase C;

1st~63rd inter harmonic current RMS value of phase A;

1st~63rd inter harmonic current RMS value of phase B;

1st~63rd inter harmonic current RMS value of phase C.

2) Judgment Method (taking the 2nd harmonic voltage of phase A as an example)

Start Condition: The 2nd harmonic voltage content of Ua is greater than the "2nd harmonic voltage content operation limit value", and the duration is greater than the "2nd harmonic voltage content operation delay".

End Condition: The 2nd harmonic voltage content of Ua recovers to be less than the "2nd harmonic voltage content return limit value", and the duration is greater than the "2nd harmonic voltage content return delay".

3) Setting Parameters (taking the 2nd harmonic voltage of phase A as an example)

2nd harmonic voltage content operation limit value: default 2.00%, range 0~99.99%;

2nd harmonic voltage content operation delay: default 5s, range 1.00~99.99s;

2nd harmonic voltage content return limit value: default 1.90%, range 0~99.99%;

2nd harmonic voltage content return delay: default 5s, range 1.00~99.99s;

2nd harmonic voltage content trigger action: None/DO1/DO2/DO3/DO4.

4)Recording Parameters (taking the 2nd harmonic voltage of phase A as an example)

Occurrence time of over-limit, operation value of the 2nd harmonic voltage content of phase A;

End time of over-limit, return value of the 2nd harmonic voltage content of phase A, maximum value of the 2nd harmonic voltage content of phase A during over-limit, over-limit duration.

5) The over-limit principle of other parameters is the same as above, and the corresponding content fixed value or RMS value fixed value can be set independently for each harmonic.

Distortion Rate Over-limit

1）The parameters include:

Total harmonic distortion rate of three-phase voltage of A, B and C; total odd harmonic distortion rate of three-phase voltage of A, B and C; total even harmonic distortion rate of three-phase voltage of A, B and C;

Total harmonic distortion rate of three-phase current of A, B and C; total odd harmonic distortion rate of three-phase current of A, B and C; total even harmonic distortion rate of three-phase current of A, B and C;

Total inter harmonic distortion rate of three-phase voltage of A, B and C; total odd inter harmonic distortion rate of three-phase voltage of A, B and C; total even inter harmonic distortion rate of three-phase voltage of A, B and C;

Total inter harmonic distortion rate of three-phase current of A, B and C; total odd inter harmonic distortion rate of three-phase current of A, B and C; total even inter harmonic distortion rate of three-phase current of A, B and C.

2）Judgment Method (taking the total harmonic distortion rate of phase A voltage as an example)

Start Condition: The total harmonic distortion rate of phase A voltage is greater than the "voltage total harmonic distortion rate operation limit value", and the duration is greater than the "voltage total harmonic distortion rate operation delay".

End Condition: The total harmonic distortion rate of phase A voltage recovers to be less than the "voltage total harmonic distortion rate return limit value", and the duration is greater than the "voltage total harmonic distortion rate return delay".

3）Setting Parameters (taking the total harmonic distortion rate of phase A voltage as an example)

Voltage total harmonic distortion rate operation limit value: default 2.00%, range 0~99.99%;

Voltage total harmonic distortion rate operation delay: default 5s, range 1.00~99.99s;

Voltage total harmonic distortion rate return limit value: default 1.90%, range 0~99.99%;

Voltage total harmonic distortion rate return delay: default 5s, range 1.00~99.99s;

Voltage total harmonic distortion rate trigger action: None/DO1/DO2/DO3/DO4.

4）Recording Parameters (taking the total harmonic distortion rate of phase A voltage as an example)

Occurrence time of over-limit, operation value of the total harmonic distortion rate of phase A voltage;

End time of over-limit, return value of the total harmonic distortion rate of phase A voltage, maximum value of the total harmonic distortion rate of phase A voltage during over-limit, over-limit duration.

5）The over-limit principle of other parameters is the same as above, and the corresponding fixed values can be set independently for the total/odd/even harmonics of voltage and current.

3.5.2 Voltage Deviation

The percentage of the difference between the actual voltage at a point and the nominal system voltage to the nominal system voltage during the operation of the power supply system is called the voltage deviation at that point. The voltage deviation is divided into upper voltage deviation and lower voltage deviation. The mathematical expression is:

Voltage Deviation:

$$\text{Voltage deviation} = \frac{\text{Actual voltage} - \text{System nominal electric}}{\text{System nominal voltage}} \times 100\%$$

Upper Voltage Deviation:

$$Uover(\%) = \frac{\sqrt{\dfrac{\sum_{i=1}^{n} U_{rms-over,i}^{2}}{n}} - U_{din}}{U_{din}} \times 100\%$$

Where $U_{rms-over,i}$ *is the effective value of the ith 10-cycle wave.*

$$U_{rms-200ms,i} < U_{din}, \text{则}, \quad U_{rms-over,i} = U_{din}$$
$$U_{rms-200ms,i} \geq U_{din}, \text{则}, \quad U_{rms-over,i} = U_{rms-200ms,i}$$

Voltage lower deviation:

$$U_{under}(\%) = \frac{U_{din} - \sqrt{\frac{\sum_{i=1}^{n} U_{rms-under,i}^{2}}{n}}}{U_{din}} \times 100\%$$

Where is the effective value of the the i 10-cycle wave.

$$U_{rms-200ms,i} > U_{din}, \text{则}, \quad U_{rms-under,i} = U_{din}$$
$$U_{rms-200ms,i} \leq U_{din}, \text{则}, \quad U_{rms-under,i} = U_{din}$$

The sum of the absolute values of the positive and negative deviations of the power supply voltage of 35kV and above shall not exceed 10% of the nominal voltage.

The voltage deviation of three-phase power supply of 20kV and below is ±7% of the nominal voltage.

The voltage deviation of single-phase power supply of 220V is +7% and -10% of the nominal voltage.

The basic measurement time window for the device to obtain the voltage RMS value is 10 cycles, and each measurement time window is close and non-overlapping. The average value of the voltage RMS value is continuously measured and calculated, and finally the power supply voltage deviation value is obtained.

The voltage measurement accuracy of the device is ±0.1%, which can realize online monitoring of voltage deviation, and can set over-limit alarm and event recording functions at the same time.

Table 3-8 Voltage Deviation Data

Measured Value	**Unit**	**Measured Value**	**Unit**
Ua Upper Voltage Deviation	0.01%	Uab Upper Voltage Deviation	0.01%
Ub Upper Voltage Deviation	0.01%	Ubc Upper Voltage Deviation	0.01%
Uc Upper Voltage Deviation	0.01%	Uca Upper Voltage Deviation	0.01%
Ua Lower Voltage Deviation	0.01%	Uab Lower Voltage Deviation	0.01%
Ub Lower Voltage Deviation	0.01%	Ubc Lower Voltage Deviation	0.01%
Uc Lower Voltage Deviation	0.01%	Uca Lower Voltage Deviation	0.01%

Voltage Deviation Over Upper Limit

(1) Classification of Voltage Deviation Over Upper Limit: including 6 types of Ua/Ub/Uc/Uab/Ubc/Uca.

(2) Judgment Method

Precondition: When the actual voltage is greater than the nominal system voltage, the lower voltage deviation is 0, and the upper voltage deviation can be calculated.

Start Condition: The upper voltage deviation is greater than the "voltage deviation upper limit operation limit value", and the duration is greater than the "voltage deviation upper limit operation delay".

End Condition: The upper voltage deviation recovers to be less than the "voltage deviation upper limit return limit value", and the duration is greater than the "voltage deviation upper limit return delay".

(3) Setting Parameters

Voltage deviation upper limit operation limit value: default 7.00%, range 0~99.99%;

Voltage deviation upper limit operation delay: default 5.00s, range 1.00~99.99s;

Voltage deviation upper limit return limit value: default 6.65%, range 0~99.99%;

Voltage deviation upper limit return delay: default 5.00s, range 1.00~99.99s;

Voltage deviation upper limit trigger action type: None/DO1/DO2/DO3/DO4.

Note: The return limit value is generally set to 0.95 times the operation limit value, the same for other events below.

(4) Recording Parameters (taking Ua as an example)

Occurrence time of Ua voltage deviation over upper limit, operation value of Ua upper voltage deviation;

End time of Ua voltage deviation over upper limit, return value of Ua upper voltage deviation, maximum value of Ua upper voltage deviation during over-limit, over-limit duration.

(5) The same for Ub, Uc, Uab, Ubc, Uca.

Voltage Deviation Over Lower Limit

(1) Classification of Voltage Deviation Over Lower Limit: including 6 types of Ua/Ub/Uc/Uab/Ubc/Uca.

(2) Judgment Method

Precondition: When the actual voltage is less than the nominal system voltage, the upper voltage deviation is 0, and the lower voltage deviation can be calculated.

Start Condition: The lower voltage deviation is greater than the "voltage deviation lower limit operation limit value", and the duration is greater than the "voltage deviation lower limit operation delay".

End Condition: The lower voltage deviation recovers to be less than the "voltage deviation lower limit return limit value", and the duration is greater than the "voltage deviation lower limit return delay".

(3) Setting Parameters

Voltage deviation lower limit operation limit value: default 7.00%, range 0~99.99%;

Voltage deviation lower limit operation delay: default 5.00s, range 1.00~99.99s;

Voltage deviation lower limit return limit value: default 6.65%, range 0~99.99%;

Voltage deviation lower limit return delay: default 5.00s, range 1.00~99.99s;

Voltage deviation lower limit trigger action type: None/DO1/DO2/DO3/DO4.

(4) Recording Parameters (taking Ua as an example)

Occurrence time of Ua voltage deviation over lower limit, operation value of Ua lower voltage deviation;

End time of Ua voltage deviation over lower limit, return value of Ua lower voltage deviation, maximum value of Ua lower voltage deviation during over-limit, over-limit duration.

(5) The judgment for Ub, Uc, Uab, Ubc, Uca is the same as above.

3.5.3 Frequency Deviation

The difference between the actual value and the nominal value of the system frequency under the normal operation condition of the power system is called the frequency deviation. The mathematical expression is:

Frequency Deviation = Actual Frequency − Nominal Frequency

The frequency deviation limit under the normal operation condition of the power system is ±0.2Hz. When the system capacity is small, the deviation limit can be relaxed to ±0.5Hz. The frequency variation caused by impact load shall not exceed ±0.2Hz.

The frequency measurement accuracy of the device is ±0.005Hz, which can realize online monitoring of frequency deviation, and can set over-limit alarm and event recording functions at the same time.

➢ Frequency Deviation Over Upper Limit

(1) Judgment Method

Precondition: When the actual frequency is greater than the nominal frequency, the frequency deviation is positive.

Start Condition: The frequency deviation is greater than the "frequency deviation upper limit operation limit value" (positive value), and the duration is greater than the "frequency deviation upper limit operation delay".

End Condition: The frequency deviation recovers to be less than the "frequency deviation upper limit return limit value" (positive value), and the duration is greater than the "frequency deviation upper limit return delay".

(2) Setting Parameters

Frequency deviation upper limit operation limit value: default 0.20Hz, range 0.01~9.99Hz;

Frequency deviation upper limit operation delay: default 5.00s, range 1.00~99.99s;

Frequency deviation upper limit return limit value: default 0.19Hz, range 0.01~9.99Hz;

Frequency deviation upper limit return delay: default 5.00s, range 1.00~99.99s;

Frequency deviation upper limit trigger action type: None/Waveform Recording/DO1/DO2/DO3/DO4.

(3) Recording Parameters

Occurrence time of frequency deviation over upper limit, operation value of frequency deviation (+);

End time of frequency deviation over upper limit, return value of frequency deviation (+), maximum value of frequency deviation (+) during over-limit, over-limit duration.

➢ Frequency Deviation Over Lower Limit

(1) Judgment Method

Precondition: When the actual frequency is less than the nominal frequency, the frequency deviation is negative.

Start Condition: The frequency deviation is less than the "frequency deviation lower limit operation limit value" (negative value), and the duration is greater than the "frequency deviation lower limit operation delay".

End Condition: The frequency deviation recovers to be greater than the "frequency deviation lower limit return limit value" (negative value), and the duration is greater than the "frequency deviation lower limit return delay".

(2) Setting Parameters

Frequency deviation lower limit operation limit value: default -0.20Hz, range -0.01~ -9.99Hz;

Frequency deviation lower limit operation delay: default 5.00s, range 0~99.99s;

Frequency deviation lower limit return limit value: default -0.19Hz, range -0.01~ -9.99Hz;

Frequency deviation lower limit return delay: default 5.00s, range 1.00~99.99s;

Frequency deviation lower limit trigger action type: None/DO1/DO2/DO3/DO4.

(3) Recording Parameters

Occurrence time of frequency deviation over lower limit, operation value of frequency deviation (-); end time of frequency deviation over lower limit, return value of frequency deviation (-), minimum value of frequency deviation (-) during over-limit, over-limit duration.

3.5.4 Unbalance and Sequence Component Measurement

In an ideal power supply system, the three-phase voltages or currents should have equal amplitudes and 120° phase differences. Deviations from this ideal state result in unbalance, reducing power utilization efficiency. For example, unbalanced loads cause asymmetric operation of generators and large motors, generating negative sequence components that induce overheating, increased losses, and shortened equipment lifespan.

To analyze three-phase system unbalance, voltages are decomposed using the symmetrical component method (the same algorithm applies to currents):

$$\text{method of symmetrical components}\begin{cases} \text{negative-sequence component} & \dot{U}_0 = \frac{1}{3}(\dot{U}_a + \dot{U}_b + \dot{U}_c) \\ \text{positive-sequence component} & \dot{U}_1 = \frac{1}{3}(\dot{U}_a + a\dot{U}_b + a^2\dot{U}_c) \\ \text{zero-sequence component} & \dot{U}_2 = \frac{1}{3}(\dot{U}_a + a^2\dot{U}_b + a\dot{U}_c) \end{cases}$$

The device measures positive/negative/zero sequence voltages and currents. Under three-phase symmetry, only the positive sequence component exists (negative and zero sequence components = 0). Unbalance is quantified by the unbalance factor, defined as the percentage of the RMS value of the negative/zero sequence fundamental component to the positive sequence fundamental component:

（1）Voltage and Current Negative Sequence Unbalance Factor

$$u_2 = \frac{\text{Voltage negative sequence division}}{\text{Voltage positive sequence division}} \times 100\% \qquad i_2 = \frac{\text{Current negative sequence division}}{\text{Current positive sequence division}} \times 100\%$$

（2）Voltage and Current Zero Sequence Unbalance Factor

$$u_0 = \frac{\text{Voltage zero sequence division}}{\text{Voltage positive sequence division}} \times 100\% \qquad i_0 = \frac{\text{Current zero sequence division}}{\text{Current positive sequence division}} \times 100\%$$

During normal operation of the power grid, the negative-sequence voltage imbalance should not exceed 2%, and it should not exceed 4% for short periods.

The allowable value of negative-sequence voltage imbalance caused by each user connected to the point of common coupling is generally 1.3%, with a short-term limit of no more than 2.6%.

This device is capable of measuring positive-sequence voltage, negative-sequence voltage, zero-sequence voltage, positive-sequence current, negative-sequence current, and zero-sequence current. It also calculates the negative-sequence imbalance and zero-sequence imbalance of voltage and current separately. The basic measurement time window is 10 cycles, as shown in the table below.

Table 3-9 Three-phase unbalance measurement parameters

Measured Value (RMS)	Unit	Resolution
Positive Sequence Voltage U_1	V	0.001 V
Negative Sequence Voltage U_2	V	0.001 V
Zero Sequence Voltage U_0	V	0.001 V
Positive Sequence Current I_1	A	0.001 A
Negative Sequence Current I_2	A	0.001 A
Zero Sequence Current I_0	A	0.001 A
Voltage Negative Sequence Unbalance Factor	%	0.01%
Voltage Zero Sequence Unbalance Factor	%	0.01%
Current Negative Sequence Unbalance Factor	%	0.01%
Current Zero Sequence Unbalance Factor	%	0.01%

➢ Unbalance Factor Exceeding Upper Limit

（1）**Unbalance Classification**: Voltage Negative Sequence / Voltage Zero Sequence / Current Negative Sequence / Current Zero Sequence (4 types)

（2）**Judgment Method (Taking Voltage Negative Sequence as Example)**

Normal Condition: Unbalance factor = 0

Start Condition: Voltage negative sequence unbalance factor exceeds the "voltage negative sequence unbalance operation threshold" and persists for longer than the "voltage negative sequence unbalance operation delay".

End Condition: Voltage negative sequence unbalance factor returns to below the "voltage negative sequence unbalance return threshold" and persists for longer than the "voltage negative sequence unbalance return delay".

（3）**Setting Parameters (Taking Voltage Negative Sequence as Example)**

Voltage negative sequence unbalance operation threshold: Default 2.00%, Range 0~99.99%

Voltage negative sequence unbalance operation delay: Default 5.00s, Range 1.00~99.99s

Voltage negative sequence unbalance return threshold: Default 1.90%, Range 0~99.99%

Voltage negative sequence unbalance return delay: Default 5.00s, Range 1.00~99.99s

Voltage negative sequence unbalance trigger action: None/DO1/DO2/DO3/DO4

4) Recording Parameters (Taking Voltage Negative Sequence as an Example)

Record the occurrence time of the voltage negative sequence unbalance out-of-limit and the operating value of the voltage negative sequence unbalance; also record the end time of the voltage negative sequence unbalance out-of-limit, the reset value of the voltage negative sequence unbalance, the maximum value of the voltage negative sequence unbalance during the out-of-limit period, and the duration of the out-of-limit.

5) The principles for the voltage zero sequence, current negative sequence, and current zero sequence are the same as above, and the corresponding setting values can be independently configured for each.

3.5.5 Voltage Fluctuation

In an ideal power system, the supply voltage should operate stably according to specified parameters. However, in practical processes, due to various external influences, it is often difficult to meet this requirement. A series of variations or continuous changes in the effective value of voltage is called voltage fluctuation. The voltage variation value is the difference between two extreme values of the effective voltage, often expressed as a percentage of the nominal voltage. The number of voltage variations per unit time is called the frequency of voltage variation. The calculation formula for voltage fluctuation is as follows:

$$\text{Voltage variation}\ d = \frac{\Delta U}{U_N} = \frac{U_{max} - U_{min}}{U_N} \times 100\%$$

$$\text{Voltage fluctuation frequency}\ r = \frac{\text{Number of voltage fluctuations}}{\text{Runtime}}$$

The device provides data related to voltage fluctuations, as shown in the table below:

Table 3-10 Voltage fluctuation measurement data

Name	Unit	Resolution
Ua Voltage Fluctuation	%	0.01%
Ub Voltage Fluctuation	%	0.01%
Uc Voltage Fluctuation	%	0.01%
Ua Voltage Fluctuation Frequency	Times/10 minutes	1
Ub Voltage Fluctuation Frequency	Times/10 minutes	1
Uc Voltage Fluctuation Frequency	Times/10 minutes	1

Note: The voltage fluctuation and variation frequency are refreshed every 10 minutes.

3.5.6 Voltage Flicker

Flicker generally refers to the perception of people towards the brightness changes of incandescent lamps, including the impact and harm of voltage fluctuations on electrical equipment. However, voltage fluctuations cannot be used to replace flicker, as flicker is the subjective visual perception of people towards illumination fluctuations. A statistical value that measures the intensity of flicker within a short period of time (several minutes) is called the short-time flicker value P_{st}, and the basic recording period for short-time flicker is 10 minutes. Based on the short-time flicker value, a value that reflects the intensity of flicker over a long period of time (several hours) is calculated, which is called the long-time flicker value P_{lt}, and the basic recording period for long-time flicker is 2 hours.

The main determining factors of flicker are as follows.

（1）The amplitude, frequency, and waveform of power supply voltage fluctuations.

（2）Lighting device. It has the greatest impact on the illuminance waveform of incandescent lamps, and is related to the wattage and rated voltage of the incandescent lamps.

（3）People's subjective perception of flicker. Due to differences in people's visual perception, a sampling survey of observers' perception of flicker is necessary.

➢ Principle of flicker meter

This device refers to the recommended model of the IEC flicker meter, simulating the process of light-eye-brain, thereby calculating parameters such as short-term flicker value and long-term flicker value.

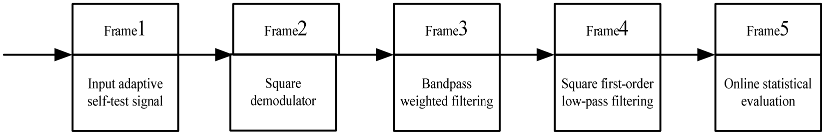


Figure 3-2 Simplified block diagram of the IEC flicker meter model

Box 1: Voltage adaptation, and generation of standard modulated waves for self-checking.

Box 2: The role of the analog lamp. Square processing of voltage signals.

Box 3: Simulating the frequency selection characteristics of the human eye. The bandpass weighted filter reflects the sensitivity of humans to changes in illuminance under voltage fluctuations of tungsten filament lamps at different frequencies, with a passband of 0.05Hz~35Hz (the maximum detection range of human perception to illuminance fluctuations). This function can be composed of three filters connected in series:

（1）A first-order high-pass filter with a cutoff frequency of 0.05Hz, which suppresses DC components

$$H(z) = \frac{0.9996(1 - z^{-1})}{1 - 0.9992z^{-1}}$$

（2）A sixth-order Butterworth low-pass filter with a cutoff frequency of 35Hz, which removes the 2-fold mains frequency (100Hz) component. For a 120V 60Hz system, a filter with a cutoff frequency of 42Hz should be selected. Combined with (1), it can demodulate the amplitude modulated wave reflecting voltage fluctuations.

$$H(z) = \frac{\sum_{k=0}^{6} b_k z^{-k}}{1 + \sum_{k=1}^{6} a_k z^{-k}}$$

Where:

$a_1 =- 3.8807$；$a_2 = 6.5355$；$a_3 =- 6.0495$；$a_4 = 3.2276$；$a_5 =- 0.9374$；$a_6 = 0.1155$；

$b_0 = 0.0002$；$b_1 = 0.0010$；$b_2 = 0.0026$；$b_3 = 0.0034$；$b_4 = 0.0026$；$b_5 = 0.0010$；$b_6 = 0.0002$。

（3）Visibility-weighted filter, which simulates the frequency selection characteristics of the human eye. In practice, it approximates the visibility curve with a transfer function F(s) at a detection rate of 50%.

$$F(s) = \frac{k\omega_1 s}{s^2 + 2\lambda s + \omega_1^2} \times \frac{1 + \frac{s}{\omega_2}}{\left(1 + \frac{s}{\omega_3}\right)\left(1 + \frac{s}{\omega_4}\right)}$$

parameter	230V lamp	120V lamp
k	1.74802	1.6357
λ	$2\pi \times 4.05981$	$2\pi \times 4.167375$
ω_1	$2\pi \times 9.15494$	$2\pi \times 9.077169$
ω_2	$2\pi \times 2.27979$	$2\pi \times 2.939902$
ω_3	$2\pi \times 1.22535$	$2\pi \times 1.394468$
ω_4	$2\pi \times 21.9$	$2\pi \times 17.31512$

Taking a 230V lamp as an example, F(s) is converted from the frequency domain to the z-domain using the bilinear transformation method, as shown below:

$$s = \frac{2}{T}\frac{1 - z^{-1}}{1 + z^{-1}}$$

$$H(z) = \frac{\sum_{k=0}^{4} b_k z^{-k}}{1 + \sum_{k=1}^{4} a_k z^{-k}}$$

Where:

T represents the sampling period;

$a_1 =- 3.548754$；$a_2 = 4.714548$；$a_3 =- 2.776010$；$a_4 = 0.610325$；

$b_0 = 0.009351$；$b_1 = 0.000329$；$b_2 =- 0.018373$；$b_3 =- 0.000329$；$b_4 = 0.009022$。

Correction factor: Adjust the short-term flicker value or long-term flicker value based on different system parameters.

For a 220V, 50Hz system, the result of a 230V, 50Hz system should be multiplied by a correction factor of 0.97;

For a 100V, 50Hz system, the result of a 120V, 50Hz system should be multiplied by a correction factor of 0.90;

For a 100V, 60Hz system, the results of a 120V, 60Hz system should be multiplied by a correction factor of 0.90.

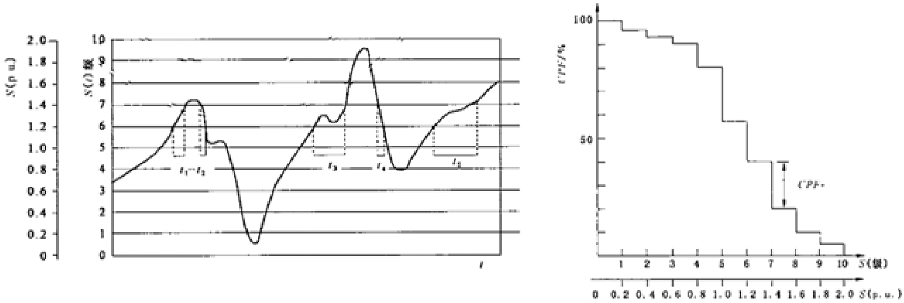
Box 4: Simulating human brain neural responses and memory effects to vision. It includes a squarer and a low-pass filter with a time constant of 300ms, which are used to simulate the transient nonlinear response and memory effect of the lamp-eye-brain pathway to changes in light intensity. The output $S(t)$ reflects the instantaneous flicker perception level of human vision to voltage fluctuations.

（1）Square calculation, simulating the nonlinear process of human brain neurons responding to visual stimuli.

（2）Smoothing and averaging, simulating the human brain memory effect, is achieved by a first-order low-pass filter with a time constant of 300ms.

$$H(z)=\frac{0.26471(1+z^{-1})}{1-0.99170z^{-1}}$$

Box 5: Analyze the input S(t) value using the Cumulative Probability Function (CPF) method, where the horizontal axis represents the measured quantity, and the vertical axis represents the percentage of time during which this quantity exceeds the corresponding horizontal axis value within the total measurement period. Statistics are typically compiled over a 10-minute period, and the actual number of levels for the instrument should be no less than 64.



（a）S(t) curve （b） CPF curve

Figure 3-3 Example of generating CPF curve from S(t)

- calculation formula

$$P_{st}=\sqrt{0.0314P_{0.1}+0.0525P_1+0.0657P_3+0.28P_{10}+0.08P_{50}}$$

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

$$\text{Short term severity }\ P_{st}=\sqrt{0.0314P_{0.1}+0.0525P_1+0.0657P_3+0.28P_{10}+0.08P_{50}}$$

$$\text{Loog term severity }\ P_{lt}=\sqrt[3]{\frac{1}{12}\sum_{j=1}^{12}\left(P_{stj}\right)^3}$$

- Where:

$P_{0.1}$、P_1、P_3、P_{10}、P_{50} The values on the CPF curve correspond to the times when it equals 0.1%, 1%, 3%, 10%, and 50%, respectively;S(t)

P_{stj} It is the j-th short-time flicker value within 2 hours.

- smoothing

To prevent errors caused by abrupt values, the following smoothing process can be applied. However, the storage time constant of 300ms ensures that $P_{0.1}$there will be no abrupt changes, so $P_{0.1}$no further processing is necessary.

$$P_{1s}=\frac{(P_{0.7}+P_1+P_{1.5})}{3}$$

$$P_{3s}=\frac{(P_{2.2}+P_3+P_4)}{3}$$

$$P_{10s}=\frac{(P_6+P_8+P_{10}+P_{13}+P_{17})}{5}$$

$$P_{50s}=\frac{(P_{30}+P_{50}+P_{80})}{3}$$

- Grader

The value of P_{st}a specific percentage point required for calculation $P_k$generally does not correspond to a single grade exactly. The accuracy can be improved according to the following methods.

（1） Linear interpolation method

$$P_k = \frac{F_s}{N}\left(n - \frac{y_k - y_n}{y_{n-1} - y_n}\right)$$

Where:

Fs represents the range of the classifier, which is the value range of S(t);

N represents the number of equal grades;

$\frac{F_s}{N}$The width of each level;

y_nIt corresponds to the percentage probability value of level n;

y_kThe corresponding percentages, such as P_k0.1%, 1%, 3%, 10%, and 50%;

P_kFall between the n-1 level and the n level.

（2）Nonlinear interpolation method

When linear interpolation fails to provide sufficient accuracy, nonlinear interpolation should be employed.

$$P_k = \frac{F_s}{N}\left(n - 1 + \frac{1}{2H_2}\left(H_1 - \sqrt{H_3}\right)\right)$$

Where:

$H_1 = \frac{3}{2}y_{n-1} - 2y_n + \frac{1}{2}y_{n+1}$;

$H_2 = \frac{1}{2}y_{n-1} - y_n + \frac{1}{2}y_{n+1}$;

$H_3 = H_1^2 - 4H_2(y_{n-1} - 2y_k)$;

（3）Pseudo-zero truncation

When $P_k$located within the first level interval, the interpolation method may not perform well between the zero point of the first level and its upper endpoint. One method to reduce error is to provide a pseudo-zero intercept value.

$$y_0 = (3y_1 - 3y_2 + y_3)$$

（4）Nonlinear classification

Gradual changes in the width of the grade interval can make the grading device more effective and accurate, and can also avoid false zero extension, such as logarithmic grading and linear interpolation.

➢ Measurement data

Table 3-11 Flicker Measurement Data

Name	Unit	Resolution
Ua Short-time Flicker Value	--	0.001
Ub Short-time Flicker Value	--	0.001
Uc Short-time Flicker Value	--	0.001
Ua Long-duration Flicker Value	--	0.001
Ub Long-time Flicker Value	--	0.001
Uc Long-term Flicker Value	--	0.001

➢ Flicker exceeds the limit

（1）Flicker classification: including short-term flicker values and long-term flicker values of phase A, phase B, and phase C

（2）Judgment method (taking short-term flicker of phase A as an example)

Initial condition: The short-term flicker value of Phase A exceeds the "short-term flicker limit".

P_{lt}	
≤110 kV	>110 kV
1	0.8

Figure 3-6: Recommended flicker limits according to national standards

（3）Set parameters

Short-term flicker limit: default value 1, range 0~99.99;

Long-term flicker limit: default 1, range 0~99.99;

Flicker trigger action: None/DO1/DO2/DO3/DO4.

（4）Record parameters (taking short-term flicker of Phase A as an example)

Flicker threshold crossing time, A-phase short-term flicker action value.

（5）Other parameters are the same as above, and the short-term flicker limit and long-term flicker limit can be set independently.

3.5.7 Rapid voltage variation

Voltage variations or fluctuations in the distribution network caused by changes in the operating current of electrical equipment may lead to the phenomenon of lighting flickering. Rapid voltage variations refer to the rapid transition of RMS voltage between two steady states (within the limits of the temporary rise and fall thresholds).

The YDPQ200-A device provides a function to capture rapid voltage variations. Rapid voltage variations reflect the changes in voltage amplitude between two steady states in terms of effective voltage values. Rapid voltage variations are captured based on stable voltage tolerance, stabilization time, the minimum step size detected, and the minimum change rate (%/s). Figure 4-2 explains this. When the voltage change exceeds the threshold for temporary voltage dips and surges, it is considered as a temporary dip or surge, rather than a rapid voltage variation. According to the definition of rapid voltage variations in Norwegian FoL, rapid voltage variations are detected through voltage steps (Vstep), maximum voltage change (Vmax), and voltage change rate. Rapid voltage variations are considered to have occurred when both the voltage step (Vstep) and voltage change rate are greater than the limit values, and the voltage change does not exceed the transient threshold. Rapid voltage variation events are stored in PQ events, recording the voltage step change, change duration, and the maximum voltage change Vmax relative to the nominal voltage.

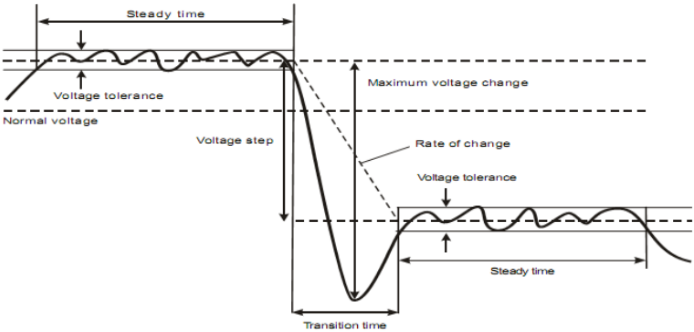


Figure 3-4 Rapid voltage variation

voltage tolerance

(1) To determine whether the voltage reaches the steady-state limit within a certain period of time, the voltage tolerance is generally expressed as a percentage of the rated voltage.

$$\text{Steady state voltage tolerance}=\frac{\text{maximum allowable voltage fluctuation in steady state}}{\text{Rated voltage}}\times 100\%$$

Steady time

(2) The duration of time after the voltage enters a steady state is called the steady-state time.

Voltage step

(3) In a rapid voltage fluctuation, the difference between the previous steady-state value and the current steady-state value is referred to as a voltage step, typically expressed as a percentage of the rated voltage.

$$\text{Voltage step}=\frac{|\text{pre steady state value - current steady state value}|}{\text{Rated voltage}}\times 100\%$$

Transition time

(4) The transition time of rapid voltage variation refers to the time period between the moment when the previous steady state is left and the moment when the subsequent steady state is entered.

Rate of change

(5) The rate of voltage change is equal to the ratio of voltage step to transition time, representing the magnitude of voltage change per unit time.

$$\text{Voltage change rate}=\frac{\text{voltage step}}{\text{transition time}}\ (\%/\text{s})$$

Maximum voltage change

(6) During the entire process of a voltage variation, the maximum change in voltage relative to the previous steady-state value, expressed as a percentage of the rated voltage, is referred to as the maximum voltage variation. The end is marked by the establishment of a new steady state or the end of the observation period.

$$Maximumvoltagevariation = \frac{\max\left(|\text{pre steady state value - new voltage value 1}|,\ |\text{pre steady state value - new voltage value 2}|\ldots\ldots\right)}{\text{Rated voltage}} \times 100\%$$

Steady voltage

(7) If the fluctuation of the effective voltage value within the steady time remains within the voltage tolerance range, it is considered as a voltage steady state. That is, during the steady time, the following condition is met:

$$\frac{ABS(U_{\max} - U_{\min})}{U_n} < \delta$$

Where $U_{\max}$, $U_{\min}$ is the maximum and minimum value of the effective voltage during steady time, U_n is the rated voltage, δ and is the voltage tolerance

(8) Capture conditions for rapid voltage fluctuations

- The voltage step exceeds the voltage step parameter value / the maximum voltage change exceeds the voltage step parameter value (based on different detection modes)
- The voltage change rate is greater than the voltage change rate parameter value
- During rapid voltage fluctuations, the voltage value should not exceed the transient threshold; otherwise, it is considered that a transient voltage rise or fall event has occurred.
- Rapid voltage fluctuations can trigger two outputs simultaneously, including DO output, waveform recording, disturbance recording, and effective value recording.

(9) The parameter settings are as follows:

- Join/Leave: Join/Leave, default is Leave;
- Threshold: 0.2% to 10% of rated voltage, default 5%;
- Hysteresis: 0.1% to 5% of rated voltage, default 2.5%;
- Trigger parameters: DO outlet, waveform recording, disturbance recording, effective value recording;
- Setting method: The device panel and the upper computer software can be used for setting through communication.

3.6 Transient Power Quality Monitoring Functions

3.6.1 Voltage dips, spikes, and interruptions

The phenomenon where the voltage at a certain point in the power system temporarily rises to between 110% and 180% of the nominal voltage and returns to normal after a brief duration is called voltage sag. When the effective value of the power frequency voltage at a certain point suddenly drops to 10% to 90% of the nominal voltage and returns to normal after a brief duration, it is referred to as voltage sag. When the effective value of the power frequency voltage at a certain point suddenly drops below 10% of the nominal voltage and returns to normal after a brief duration, it is called short interruption. The duration of transient events is usually between 10ms and 1min. The minimum value of the root-mean-square voltage recorded during a voltage sag or short interruption is called residual voltage. Correspondingly, the maximum value of the effective voltage measured on any channel during a voltage sag is called maximum sag voltage. The depth is the difference between the nominal voltage and the residual voltage or the maximum sag voltage, expressed as a percentage of the nominal voltage. The hysteresis voltage is the difference between the starting voltage threshold and the ending voltage threshold.

The specific functions of this device for voltage sag and swell, as well as short-term voltage interruptions, are as follows:

- Each phase voltage can trigger events such as voltage dips/swells and interruptions;
- Record detailed data such as the occurrence time, duration, and depth of each voltage sag/swell and interruption;

The parameter settings related to the transient state of this device are as follows:

- Activation/Deactivation: The transient state can be set to be activated or deactivated, with activation as the default;
- Transient reference voltage: rated voltage/sliding reference voltage, default rated voltage;
- Voltage transient rise limit: default 110%, range 110% to 200%;

- Voltage sag limit: default 90%, range 10% to 90%;
- Voltage interruption limit: default 10%, range 1-10%;
- Transient hysteresis value: default 2%, range 0.5% to 10%;
- Trigger action type: DO output, waveform recording, disturbance recording, effective value recording.
- Setting method: The device panel can be set through communication with the host computer software.

3.6.2 Voltage Event Marking

The YDPQ200-A device provides voltage event marking functionality. When voltage sag, swell, or interruption events occur, the device marks the measurement results of frequency, flicker, voltage amplitude, imbalance, and harmonics at the time of the voltage event. The purpose of marking is to avoid the impact of transient events when evaluating the pass rate of voltage fluctuation and flicker, accurately assessing the flicker value; to effectively avoid calculating voltage interruption events when evaluating the voltage pass rate, accurately assessing the supply voltage amplitude; and to effectively avoid analytical and computational errors of instruments and unreasonable measurement results when evaluating the harmonic pass rate, accurately assessing the harmonic level.

3.7 Instantaneous Power Quality Monitoring Functions

Due to the rapid changes in transient events, to indicate the occurrence of a transient alarm event, the alarm status word will be restored after a delay of 1 minute after the transient alarm occurs, rather than immediately restoring it based on the actual status.

3.7.1 Instantaneous Over-voltage Capture

The YDPQ200-A device exhibits strong transient capture capability, capable of capturing voltage transients shorter than 0.5 cycles:

A）Capable of capturing sub-cycle transients as short as 20μs;

B）Each time a transient is captured, waveform recording and disturbance recording can be triggered;

C）Record detailed data such as the occurrence time, depth, and duration of each voltage transient.

The parameter settings related to transient state for YDPQ200-A are as follows:

Activation/Deactivation: Instantaneous activation or deactivation can be set, with deactivation as the default;

- Transient capture limit: default 0.35, range 0.05~5 times rated voltage;
- Trigger parameters: waveform recording, disturbance recording, effective value recording;
- Setting method: The device panel and the upper computer software through communication.

3.7.2 Sudden Change Detection

The device provides voltage and current mutation detection functions for monitoring voltage and current parameter mutation faults during operation and triggering quick response actions. The activation and deactivation of voltage and current mutation functions, as well as the action limits, can be set according to actual needs. Mutation event actions are recorded in monitoring events, including the occurrence time, action phase, and mutation change value. It is also possible to set triggers for DO actions, waveform recording, disturbance recording, and effective value recording. Triggered events are also recorded in monitoring events. The relevant setting parameters are as follows:

- Join/Leave: Join/Leave, default is Leave.
- Voltage mutation limit (ΔU): default 100V, range 0.57~100.00V
- Current jump limit (ΔI): default 5A, range 0.10~5.00A
- Trigger action: DO output, waveform recording, disturbance recording, effective value recording;
- Setting method: The device panel can be set through communication with the host computer software.

3.8 Power Quality Statistical Functions

3.8.1 Scheduled Statistical Recording

The YDPQ200-A device boasts an exceptional statistical timing recording function. It can perform statistical calculations on real-time measured 3s values at preset intervals and record the statistical values, including the maximum, minimum, average, and 95% probability values within the interval. The statistical data is stored in PQDIF format with a fixed interval of 3 minutes. It can store statistical data for 90 days, and the data is not lost in case of power failure. The data storage method employs a circular recording approach, overwriting the oldest recorded data when the storage is full.

3.9 Over-Limit Monitoring and Control Functions

3.9.1 Over-Limit Monitoring

This device provides an over-limit monitoring function for measurement parameters, which determines whether various electrical quantities exceed the set limits. An over-limit condition can trigger an alarm and SOE event recording. Specific setting values can be configured, and they can only be set through communication via the host computer software. The relevant parameters are listed in the table below:

Table 3-12: Monitoring Parameters with Fixed Value Out-of-Limit

Category	Objects under off-limit monitoring
Voltage deviation	Voltage deviation
Frequency deviation	Frequency deviation
Current out of limit	Ia、Ib、Ic
Power exceeding the limit	$P_{total,}$ Pa, Pb, Pc
Power factor out of limit	PFTotal, $_{PFa}$, PFb, PFc
Three-phase unbalance	Voltage negative-sequence imbalance, voltage zero-sequence imbalance, current negative-sequence imbalance, current zero-sequence imbalance
Harmonic	Total harmonic distortion rate of voltage, total harmonic distortion rate of current, even-order harmonic distortion rate of voltage, even-order harmonic distortion rate of current, odd-order harmonic distortion rate of voltage, odd-order harmonic distortion rate of current, 2nd to 63rd order voltage harmonic content, and 2nd to 63rd order current harmonic effective value
Inter-harmonic	Total voltage inter-harmonic distortion rate, total current inter-harmonic distortion rate, even-order voltage inter-harmonic distortion rate, even-order current inter-harmonic distortion rate, odd-order voltage inter-harmonic distortion rate, odd-order current inter-harmonic distortion rate,
Flicker	Short-term flicker value, long-term flicker value

（1） Action value and return value:

When exceeding the upper limit, if the measured value is greater than the action upper limit, an out-of-limit action is triggered; if it is less than the action reset value, the out-of-limit status is returned;

When the measurement value is below the lower limit, it triggers an off-limit action. When it exceeds the action reset value, the off-limit status returns to normal.

（2）Action delay: The setting range is 1.00~99.99s.

When the measured parameter exceeds the limit and the duration is greater than the action delay, the relay will actuate.

（3）Return delay: The setting range is 1.00~99.99s.

When the measured parameter returns to normal and the duration exceeds the return delay, the relay returns.

（4）All out-of-limit actions and returns will trigger SOE records, and the triggering of DO alarm outputs can be set.

（5）The delay time for timing overrun must be set in steps of 1 second.

3.10 Event Recording (SOE)

The YDPQ200-A device can sequentially record various events generated by the device, including the time, type, duration, and typical values of these events, with a time resolution of 1ms. The recorded data will not be lost during power outages, and when the recording is full, it will overwrite from the earliest event. All event records can be read and cleared through the display panel and communication port.

The event logs of the YDPQ200-A device include monitoring events, device logs, device self-inspection, and event counts. Among them, the monitoring events and device logs can store up to 1024 records each.

3.10.1 Monitoring Events

The monitoring events include the following:

Table 3-13 Monitoring Event Record

Event category	Event description	Eigenvalue
Out-of-limit event	xx (monitoring object) exceeds the upper limit	Occurrence time; action value End time; return value; maximum/minimum value; duration
	xx (monitoring object) has exceeded the lower limit	
Transient event	Temporary rise in A/B/C phase voltage trigger	Occurrence time; action value End time; return value; maximum/minimum value; duration
	A/B/C phase voltage trigger sag	Occurrence time; action value End time; return value; maximum/minimum value; duration
	Short-term interruption triggered by A/B/C phase voltage	Time of occurrence; action value End time; return value; maximum/minimum value; duration
Rapid voltage fluctuation	A/B/C phase voltage triggers rapid voltage fluctuations	Occurrence time; action value End time; return value; maximum/minimum value; duration
transient disturbance	A/B/C phase voltage trigger transient	Time of occurrence; action value End time; return value; maximum/minimum value; duration
Waveform recording event	Manually trigger waveform recording	Occurrence time
Disturbance recording event	Manually trigger disturbance recording	Occurrence time
Mutation variable	A-phase/B-phase/C-phase voltage mutation	Occurrence time; action value End time; return value; maximum/minimum value; duration
	A-phase/B-phase/C-phase current mutation	Occurrence time; action value End time; return value; maximum/minimum value; duration

3.10.2 Device Log

The device log contains the following records:

After the operation and maintenance personnel modify the parameters set by the device, the device will automatically record this event, including the content and time of the operation. These records cannot be modified and will not be lost in case of power failure. Together with off-limit events, transient event records, fault wave records, etc., they serve as the basis for accident analysis.

The device log contains the following content:

- Power-on/off records
- Modify system parameters
- Time calibration
- Clear operation
- Switch to TOU (Time-of-Use) rate plan
- Device self-check information

3.10.3 Event Counting

The YDPQ200-A device provides an event counting function. When a corresponding new event occurs, the counter increments by 1, allowing for the statistics of the occurrence frequency of various events. This includes separate counting for power quality events such as voltage swells, sags, interruptions, transients, rapid voltage variations, voltage jumps, and current jumps, as well as the total count of all monitored events.

The maximum number of events that can be recorded is 2^{32} times. When the count reaches the maximum, any subsequent events will be reset to 0 and the count will start again.

Each event counter can be reset through the panel and communication methods respectively.

Table 3-14 Event Count

Serial number	Event counting category
1	voltage swell
2	voltage sag
3	voltage interruption
4	Voltage transient
5	Rapid voltage fluctuation
6	voltage mutation
7	Current surge
8	Total number of events

3.11 Data Recording Functions

3.11.1 Max/Min Value Recording

The device can record the extreme values of real-time measurements, including the data of maximum/minimum values and the time of occurrence.

Record the maximum and minimum values of the following quantities:

- Three-phase current, average current
- Three-phase phase voltage and average phase voltage
- Three-phase line voltage and average line voltage
- Three-phase active power/three-phase reactive power/three-phase apparent power

3.11.2 Electric energy recording function

The YDPQ200-A device is equipped with an electric energy recording function, providing electric energy records of total electric energy-related parameters. The device offers two types of electric energy records based on the recording period: the first type (hourly freezing) records the real-time value of electric energy, while the second type records the real-time value of electric energy on a daily basis (daily freezing). The relevant electric energy parameters include: total active electric energy, total forward active electric energy, total reverse active electric energy, total reactive electric energy, total forward reactive electric energy, and total reverse reactive electric energy.

The recording periods for two types of electric energy data can be set. The first type can store 254 records, while the second type can store 90 records. Each record is stored in non-volatile memory with date and time stamps, ensuring that it is retained even in the event of a power loss. A circular storage method is employed, meaning that when the records are full, the oldest data is overwritten. The electric energy recording data can be reset to zero. The relevant parameter settings are as follows:

Whole-point freezing cycle: Select-able from 15, 30, and 60 minutes (default is 60 minutes).

Daily freeze cycle: Any time within the day can be set (default is 00:00).

The above parameters can be set through the host computer.

3.11.3 PQDIF

The YDPQ200-A device boasts a 16GB memory capacity. It stores regular data in the standard PQDIF format and records data in the COMTRADE format. In the absence of communication, it can retain all data for approximately half a year. The data stored in the PQDIF format includes the following:

Table 3-15 Data Content Stored in PQDIF

<table>
<tr><th>Parameter</th><th>Instructions</th><th>Phase sequence</th><th>Period</th></tr>
<tr><td>Frequency</td><td>Frequency</td><td></td><td>3 seconds</td></tr>
<tr><td rowspan="2">RMS voltage</td><td>Phase voltage</td><td>A、B、C</td><td rowspan="8">150 cycles</td></tr>
<tr><td>Line voltage</td><td>AB,BC,CA</td></tr>
<tr><td>RMS current</td><td>Current</td><td>A、B、C</td></tr>
<tr><td rowspan="2">Voltage deviation</td><td>Phase voltage deviation</td><td>A、B、C</td></tr>
<tr><td>Line voltage deviation</td><td>AB、BC、CA</td></tr>
<tr><td>Fundamental effective value</td><td>Voltage, current</td><td>A、B、C</td></tr>
<tr><td>Unbalance degree</td><td>Voltage, current</td><td>Negative and zero sequence</td></tr>
</table>

Order component	Voltage, current	Positive, negative, and zero sequence	
Harmonic voltage	Total distortion rate, total odd harmonic distortion rate, total even harmonic distortion rate 2nd to 25th harmonic voltage content ratio	A、B、C	
harmonic current	Total distortion rate, total odd harmonic distortion rate, total even harmonic distortion rate 2nd to 25th harmonic current content ratio	A、B、C	
Inter-harmonic voltage	Total distortion rate, 1-25th harmonic voltage content rate	A、B、C	
Inter-harmonic current	Total distortion rate, 1st -25th harmonic current content rate	A、B、C	
Total power	P/Q/S/PF	A, B, C, Total	
Fundamental power	P/Q/S/DF	A, B, C, Total	
Total harmonic power	THP/ THQ/ THS	A, B, C, Total	
Flicker	Pst	A、B、C	10 minutes
	Plt	A、B、C	2hours
Event	Monitor events		N/A
	Waveform event (waveform record, disturbance record)		

3.12 Waveform Recording Functions

3.12.1 Waveform Recording

The YDPQ200-A device features waveform recording capabilities, which can be triggered by transient disturbances, rapid voltage fluctuations, sudden voltage/current changes, and communication conditions. The recorded data is stored in both COMTRADE and PQDIF formats and remains intact even in the event of a power loss.

The device can store 128 pieces of wave recording data, with cyclic storage. When the wave recording is full, new wave recording data will overwrite the oldest data. The wave recording data, marked with date and time, is stored in the device's file system, and the wave recording graphics can be read and displayed through a monitoring computer.

Waveform recording can be divided into three stages, encompassing the recording of wave-forms during three time periods: before the event trigger, during the event duration, and after the event ends. The waveform recordings for each period are illustrated in the figure below:

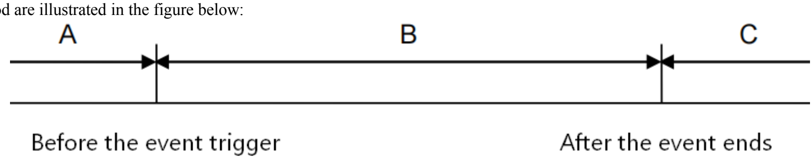


Figure 3-5 Waveform Record Segmentation

The waveform recording format and the number of cycles before triggering the recording can be set. The setting range is shown in the table below:

Table 3-16 Waveform recording parameters

Sampling Rate	Record the Total Number of Cycles (A+B+C)	Triggering Pre-cycle Number Setting range (A)	Set Range of Post-completion cycle number (C)
1024 points/cycle	10 cycles	2~4 cycles can be set	2~4 cycles can be set
512 points/cycle	20 cycles	The wave frequency can be set between 2 and 4 cycles	2~4 cycles can be set
256 points/cycle	40 cycles	2~4 cycles can be set	2~4 cycles can be set
128 points/cycle	80 cycles	The frequency can be set between 2 and 4 cycles	2~4 cycles can be set

Note:

The waveform recording time automatically adjusts based on the duration of the event:

1）When the "duration of the event" is less than or equal to the maximum number of cycles that can be recorded in Segment B, the total length of the recorded waveform is "the cycles before triggering + the cycles during the event + the cycles after ending";

2）When the "duration of the event" exceeds the maximum number of cycles that can be recorded in Segment B, the total length of the recorded waveform shall be the total number of cycles recorded;

3）Trigger the wave recording manually, and record the wave based on the length of the maximum number of cycles recorded.

3.12.2 Perturbation Record

The YDPQ200-A device provides a disturbance recording function, capable of recording at least one complete fault process. It divides the fault event into six stages and records the wave-forms during various time periods before and after the fault initiation, during the fault duration, and at the end of the fault. The waveform records for each stage are shown in the figure below

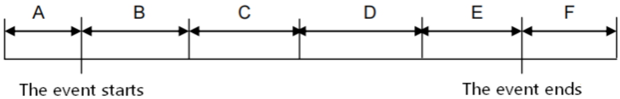


Figure 3-6 Transient Waveform Recording Segmentation

The data recorded during various time periods before, during, and after the event are described as follows:

Table 3-17 Disturbance Recording Event Time Period

Event time period	**Record description**	**Record time**	**Sampling rate**
Time period A	Record the waveform data before the system event starts	5~10 cycles	512 points/cycle
Time slot B	Record the waveform data in the initial stage after the system event starts	25~30 cycles	512 points/cycle
Time slot C	Record the raw waveform data since the start of the system event	0~150 cycles	16 points/cycle
Time period D	Record the peak value data of the system event duration in cycles	0~18000 cycles	1 point/cycle
Time slot E	Record the waveform data before the end of all events in the system	2 cycles	512 points/cycle
Time period F	Record the waveform data after all events in the system have ended	13 cycles	512 points/cycle

Note:

The recording time for time slots C and D varies automatically based on the duration of the event:

1） If the duration of Segment C is less than 150 cycles, then Segment D is 0;

2） If Section C is recorded for 150 cycles, start recording Section D;

3） When the D segment reaches 18,000 cycles, data recording for the D segment will cease; after a duration exceeding 10 minutes, data recording for the E and F segments will continue.

4） Manually trigger the disturbance recording, and record the length of all six time periods.

Record the wave forms of disturbance data Ua/Ub/Uc, Ia/Ib/Ic.

- It can be caused by transient disturbance, instantaneous disturbance, rapid voltage fluctuation, and voltage/current mutation;
- Provide the function of recording communication trigger disturbances;
- The trigger pre-cycle count can be set between 5 and 10 cycles;
- Setting method: It can be set through the device panel or via communication with the host computer software.

The system can store up to 128 pieces of disturbance record data internally. When the records are full and a new disturbance record event occurs, the latest disturbance record data will overwrite the oldest data. The disturbance record file is stored in a COMTRADE-like fault recording format, ensuring that it is not lost in the event of a power failure.

3.12.3 Timed Wave Recording

The YDPQ200-A device features a scheduled wave recording function, which enables waveform data acquisition in accordance with the preset time intervals and the number of records, following the waveform recording format. Users have the option to enable or disable this function, and it is disabled by default.

Set the starting time and interval for scheduled waveform recording. From the set time, the device will generate a waveform record at regular intervals. Each time the scheduled waveform recording is triggered, the device will report an "Scheduled Triggered Waveform Record" event.

When the number of triggered scheduled waveform recordings reaches the set recording limit, the scheduled waveform recording will stop, and no more waveform records will be triggered at regular intervals.

The parameter settings related to scheduled wave recording include:

- Join/Leave: Join/Leave, default is Leave;
- Start time: XX year XX month XX day, set the start date and time;
- Waveform recording interval: 10~1440 minutes, configurable, default 60 minutes;
- Number of recorded wave forms: 1~10000, configurable, default is 1;
- Setting method: Settings are made through communication by the host computer software.

3.12.4 Effective Value Record

The YDPQ200-A device is capable of providing an effective value recording function that meets the following requirements:

- It can be triggered by transient disturbance, instantaneous disturbance, rapid voltage variation, voltage/current mutation, and communication conditions;
- Provide the function of recording effective values triggered by communication;
- Each record costs 7200 points;
- The trigger point can be set between 100 and 500 points;
- Number of real-time quantity recording channels: 1~8, default is 8 (Ua, Ub, Uc, Ia, Ib, Ic, Freq., Freq. Dev.);
- Sampling interval: 0.5 Hz to 60 Hz;
- It can be set through communication by the host computer software.

Table 3-18 Real-time quantity recording objects

NO.	Record object	Remark
1	Phase voltage (Ua, Ub, Uc)	The minimum period is half a cycle
2	Line voltage (Uab, Ubc, Uca)	
3	Current (Ia, Ib, Ic, I4)	
4	Frequency (Freq.), Frequency Deviation (Freq. Dev.)	The minimum cycle is 1 cycle. If such a channel is selected and the interval is set to 0.5 cycles, the sampled values will be the same every 2 times
5	Three-phase active power (Pa, Pb, Pc)	
6	Three-phase reactive power (Qa, Qb, Qc)	
7	Three-phase apparent power (Sa, Sb, Sc)	
8	Three-phase total power factor (PFa, PFb, PFc)	

The device can store up to 128 pieces of valid value record data internally. When the limit is exceeded, the oldest data is overwritten with the latest high-speed record data. The valid value record files are stored in a COMTRADE-like fault recording manner, ensuring that they are not lost in the event of a power failure.

3.13 ITIC /SEMI F47 curve

The ITIC and SEMI F47 curves specify the required capability of equipment to withstand voltage disturbances in the power supply. Their significance lies in serving as benchmarks for evaluating the tolerance of power equipment to voltage interference and assessing the level of voltage disturbances in power supply systems.

The YDPQ200-A device displays the ITIC curve interface, where the horizontal axis represents the duration of voltage transient events and the vertical axis represents the percentage of voltage (relative to the nominal voltage). The upper curve represents the equipment's resistance to voltage swells, while the lower curve represents its resistance to voltage dips. The middle area of the curve indicates the normal operating range. As shown in the figure below, this interface displays the distribution of amplitude-duration for a single transient event.

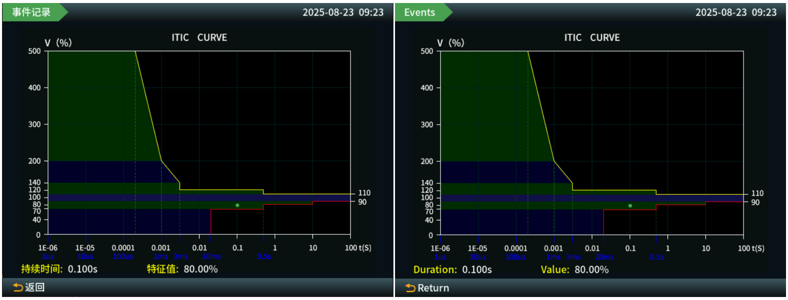


Figure 3-7 ITIC Voltage Tolerance Curve

The SEMI F47 curve interface displayed on the device has the horizontal axis representing the duration of voltage transient events and the vertical axis indicating the percentage of voltage (relative to the nominal voltage). The specifications define the tolerance time of the equipment to voltage dips, and the area above the red solid line represents the condition under which the equipment must ensure normal continuous operation. The equipment can operate continuously for 0.02s at 0% of the nominal value, 0.2s at 50% of the nominal value, 0.5s at 70% of the nominal value, 1s at 80% of the nominal value, and 10s at 90% of the nominal value. As shown in the figure below, this interface displays the distribution of amplitude-duration for a single transient event.

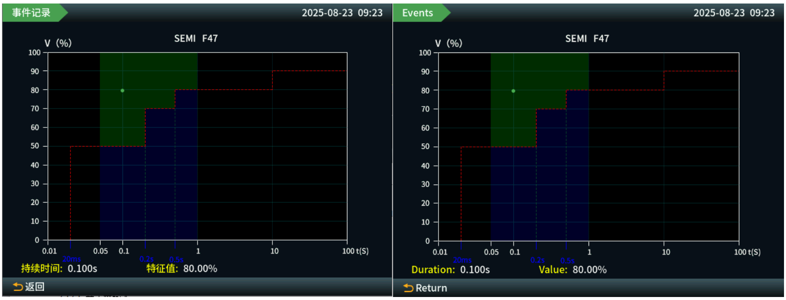


Figure 3-8 SEMI F47 curve

3.14 Input and Output Functions

3.14.1 Switching Value Input

The device provides six optocoupler switch inputs and a built-in 12V excitation power supply, including 6 digital input (DI) channels.

DI function

Used to detect the status of external passive contacts.

The real-time status of switch input can be observed through liquid crystal display or communication.

3.14.2 Switching Value Output

The device provides 4 relay outputs (DO), which can be used for alarm output.

The relay provided by the device has the following control modes: remote control, fixed value overrun, transient disturbance, voltage transient disturbance, and fast voltage change trigger.

- There are 2 types of DO output modes: level type and pulse type, which can be set through the host computer. The pulse width setting range is 0.1~300.0 seconds, with a step size of 0.1 seconds.
- The action of exceeding the set value limit can trigger the relay action. When the limit is returned, the relay returns.
- Transient disturbance/instantaneous disturbance/rapid voltage fluctuation triggers relay action.

3.14.3 Electric Energy Pulse Output

The YDPQ200-A device provides 2 electrical energy pulse outputs, EC1 and EC2, which can only be used for contact pulse output.

3.14.4 Second Pulse Output

The YDPQ200-A device provides 1 second pulse output, which can only be used for contact pulse output.

3.15 Communication Function

The YDPQ200-A device provides 2 Ethernet interfaces, supporting Mod-bus TCP, IEC61850 protocol, and GOOSE protocol; and 2 RS485 interfaces, supporting Mod-bus RTU protocol.

The device can be integrated into various power monitoring networks. The host computer software can read and display all measured parameters, status information, data records, etc. through any of the above communication ports. Additionally, it can configure the device and receive remote control instructions from the host computer.

3.15.1 RS-485 Communication

The RS-485 communication interface supports the MODBUS communication protocol, with baud rates of 4800 bps, 9600 bps, 19200 bps, 38400 bps, and 115200 bps being select-able, and the parity bit can be set.

3.15.2 Ethernet Communication

The Ethernet interface adopts a standard RJ45 connector, with a communication rate that is adaptive to both 10M and 100M. It supports Mod-bus TCP and IEC 61850 communication protocols.

3.16 Clock Function

3.16.1 Clock

The device incorporates a built-in hardware clock circuit with temperature compensation function; within the temperature range of -25 to +60℃, the clock accuracy should be ≤ ±1s/d; at the reference temperature (23℃), the clock accuracy is ≤ ±0.5s/d. The clock features automatic calendar calculation, timing, and leap year automatic conversion functions.

3.16.2 Time Synchronization Function

The device can be set to select the following clock sources: internal clock source (RTC), PPS timing, IRIG-B timing signal, and SNTP network clock source. Software timing is performed through the Modbus protocol and is not affected by the device clock source settings.

When using IRIG-B timing, PPS differential timing, or SNTP network timing, the device clock source needs to be set to the corresponding value. If there is no clock synchronization device in the operating environment, the clock source should be set to RTC (the device's internal clock) to ensure the accuracy of the system's timekeeping. After timing via IRIG-B or PPS differential, the clock source will automatically switch to RTC.

The IRIG-B code timing interface multiplexes the RS485-1 interface. Before using the IRIG-B code for timing, set the clock source to IRIG-B.

The timing interface is as follows:

Table 3-19 IRIG-B timing interface

Time synchronization		Corresponding wiring terminal	Parameters that need to be set
IRIG-B code timing	P+	RS485-1A	"Clock source" is set to IRIG-B
	P-	RS485-1B	

(1) PPS time synchronization

(2) The PPS (Pulse Per Second) pulse timing method supports both second pulse and minute pulse timing, and the device only supports external second pulse signals. Since PPS pulse synchronization only includes edge signals of whole minutes/seconds and cannot provide specific values of hours/minutes/seconds, it should be used in conjunction with software timing in practical applications to achieve precise clock synchronization across the entire station, with an error within ±1ms.

When using PPS for time synchronization, it is necessary to first set the time source parameter to PPS mode.

(2) IRIG-B time synchronization

The IRIG-B time synchronization method can accurately parse the year/month/day/hour/minute/second information from the input signal, achieving microsecond-level timing accuracy without the need for other timing methods. Since the actual received IRIG-B signal may be a non-standard signal with time zone information, the system provides an IRIG-B correction parameter to adjust the clock of the input IRIG-B.

When using IRIG-B for time synchronization, it is necessary to first set the time source parameter to IRIG-B mode.

(3) SNTP time synchronization

SNTP network time synchronization involves the device automatically obtaining high-precision time from a network time server. For SNTP broadcast time synchronization, it is also required that the time difference between the device and the timing source be within 5 minutes (uni-cast time synchronization does not have this limitation).

The device supports both SNTP uni-cast and broadcast as time synchronization methods

➢ SNTP uni-cast time synchronization: The device will proactively connect to the server for time synchronization at preset intervals.

The parameters that need to be set to implement SNTP uni-cast time synchronization are:

●Clock source: SNTP;

●SNTP time interval: 10 minutes to 1440 minutes (24 hours);

●SNTP server address: IP address of the network time server;

➢ SNTP broadcast time synchronization:

The parameters that need to be set to implement SNTP broadcast time synchronization are:

➢ Clock source: SNTP：

(4) SNTP broadcast flag: 0: Disable SNTP broadcast time synchronization; 1: Enable SNTP broadcast time synchronization

➢ Mod-bus communication time synchronization：

(5) Mod-bus communication time synchronization involves the host computer synchronizing the device through the Mod-bus protocol.

3.17 USB Function

3.17.1 USB Upgrade Program

This device is equipped with a USB interface, supporting program upgrades via a USB flash drive. You can store the latest files in the root directory of the USB flash drive, and after inserting it into the device, you can complete the upgrade with one click in the system settings.

Note:

1）Please use a USB flash drive formatted with FAT32 or exFAT. NTFS format is not supported.

2）During the upgrade process, a progress bar will be displayed on the device screen. Please keep the device powered on and do not disconnect the power.

3）After the upgrade is completed, the device will automatically restart. Please verify the new program version number after the restart to confirm that the upgrade has been successful.

4）It is recommended to perform the upgrade operation when the system is idle and there are no important tasks running.

Chapter 4: Usage and Operation

This device utilizes a TFT color LCD screen with a resolution of 640×480 and an RGB color mode. The user interface is menu-driven, making operation convenient and straightforward.

4.1 Keyboard definition

The front panel keyboard consists of six buttons, namely "Up", "Down", "Left", "Right", "Confirm", and "Return". Their specific functions are as follows:

Button	pattern	Functional Description
Up key	▲	Move the cursor up; when setting data, increment the data by one.
Down key	▼	Move the cursor downwards; when setting data, subtract one from the data.
Left button	◀	Move the cursor to the left; or turn the page to the left.
Right-click	▶	Move the cursor to the right; or turn the page to the right.
Confirm button	↵	Enter the next level menu; or confirm the input value.
Back button	⮌	Return to the previous menu; or cancel the input value.

4.2 Definition of Pulse Lamp

The front panel of this device features three dual-color LED lights, defined as follows:

Operation light (RUN): When the device is powered on, the red LED illuminates, indicating that it is in the initialization phase. After successful initialization, the device enters the normal operation state, with the green LED constantly lit and the red LED extinguished. If initialization fails or an exception occurs during operation, the red LED illuminates and the green LED is extinguished.

Communication light: When the device's communication is functioning normally, the green LED light is constantly on and the red light is off. Conversely, if the communication is abnormal, the green light is off and the red light is on.

Alarm light ERROR: When the device detects an alarm event, the red light will be on and the green light will be off. Conversely, if the red light is off, the green light will be on.

4.3 Menu Description

The device is powered on and initiates the initialization interface. Upon completion, it enters the main menu page. The main menu displays nine primary menus, including "Measure", "Waveform", "Energy", "Demand", "TOU", "P.Q.", "Event", "Status", and "Settings", as shown above.

Table 4-1 Overview of Menu Contents

Primary Menu	Sub-menu
Measure	Phasor
	RMS
	Fundamental
	Maximum
	Minimum
Wave-for	Voltage waveform
	Current waveform
P.Q.	Harmonics

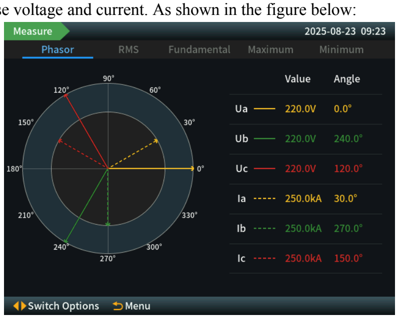
	Inter harm.
	Deviation
	Unbalance
	Flicker
Energy	RMS Energy
	Fund.Energy
	Harm.Energy
Demand	Real-Time Dem.
	Max. Dem.
TOU	TOU Energy
	TOU Demand
Events	SOE Log
	Dev. Log
	PQ Countters
Status	Alarms
	Status
Settings	Basic
	Comm.
	PQ
	wave Record
	Clock
	Maintenance
	Device info
	Site info.

4.3.1 Basic Measurement

The "Basic Measurement" menu contains 5 sub-menus: Vector Graph, Full Wave Data, Fundamental Wave Data, Maximum Value, and Minimum Value. The sub-menu pages can be switched using the up"◀"、 and down"▶" arrow keys.

（1）Vector graphic

The "Vector Graph" interface displays the vector diagrams of three-phase voltage and current, as well as the amplitude and phase angle of the three-phase voltage and current. As shown in the figure below:



（2）Full-wave data

The "RMS" interface displays basic measurements such as real-time voltage, current, active power, reactive power, power factor, frequency, and phase angle, as shown in the figure below:

	A/AB	B/BC	C/CA	Total/Avg
Uln	282.842V	141.421V	70.710V	0.000V
Ull	0.000V	0.000V	0.000V	0.000V
I	0.000A	0.000A	0.000A	0.000A
U Angle	-	-	-	-
I Angle	-	-	-	-
PF	0.500	0.000	0.000	0.000
P	0.0000kW	0.0000kW	0.0000kW	0.0000kW
Q	0.0000kvar	0.0000kvar	0.0000kvar	0.0000kvar
S	0.0000kVA	0.0000kVA	0.0000kVA	0.0000kVA

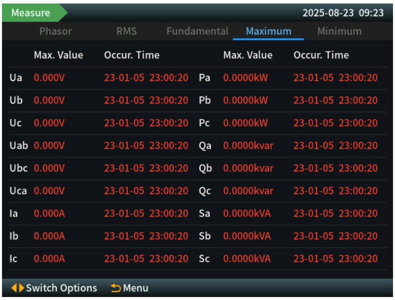
(3) Fundamental wave data

The "Fundamental" interface displays fundamental wave measurements such as fundamental wave voltage, fundamental wave current, fundamental wave active power, fundamental wave reactive power, and fundamental wave power factor, as shown in the figure below:

	A/AB	B/BC	C/CA	Total/Avg
Uln	220.000V	220.000V	220.000V	0.000V
Ull	220.000V	220.000V	0.000V	0.000V
I	250.000kA	250.000kA	250.000kA	0.000A
U Angle	0.00°	240.00°	120.00°	-
I Angle	30.00°	270.00°	150.00°	-
PF	0.000	0.000	0.000	0.000
P	54.5000MW	0.0000kW	0.0000kW	0.0000kW
Q	0.0000kvar	0.0000kvar	0.0000kvar	0.0000kvar
S	0.0000kVA	0.0000kVA	0.0000kVA	0.0000kVA

(4) Maximum

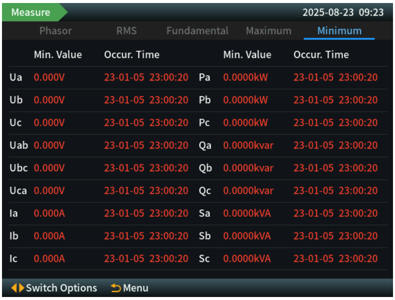
The "Maximum" interface displays the maximum values and occurrence times of three-phase phase voltage, line voltage, three-phase current, and power, as shown in the figure below:



	Max. Value	Occur. Time		Max. Value	Occur. Time
Ua	0.000V	23-01-05 23:00:20	Pa	0.0000kW	23-01-05 23:00:20
Ub	0.000V	23-01-05 23:00:20	Pb	0.0000kW	23-01-05 23:00:20
Uc	0.000V	23-01-05 23:00:20	Pc	0.0000kW	23-01-05 23:00:20
Uab	0.000V	23-01-05 23:00:20	Qa	0.0000kvar	23-01-05 23:00:20
Ubc	0.000V	23-01-05 23:00:20	Qb	0.0000kvar	23-01-05 23:00:20
Uca	0.000V	23-01-05 23:00:20	Qc	0.0000kvar	23-01-05 23:00:20
Ia	0.000A	23-01-05 23:00:20	Sa	0.0000kVA	23-01-05 23:00:20
Ib	0.000A	23-01-05 23:00:20	Sb	0.0000kVA	23-01-05 23:00:20
Ic	0.000A	23-01-05 23:00:20	Sc	0.0000kVA	23-01-05 23:00:20

(5) Minimum

The "Minimum" interface displays the maximum values and occurrence times of three-phase phase voltage, line voltage, three-phase current, and power, as shown in the figure below:



4.3.2 Waveform display

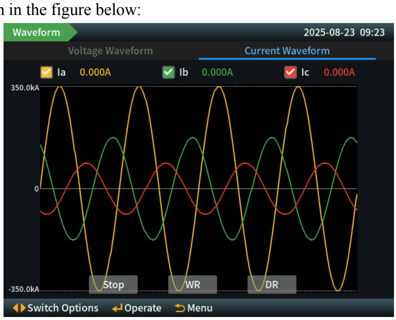
The "Waveform" menu includes two sub-menus: Voltage Waveform and Current Waveform. You can switch between sub-menu pages using the "◀" and "▶" arrow keys. By clicking on "Record Waveform" and "Disturbance Record", you can enable manual waveform recording and manual disturbance triggering.

（1）Voltage waveform

The "Voltage Waveform" interface displays the real-time waveform of three-phase voltage. You can select any waveform channel using the arrow keys, and clicking the pause/refresh button can toggle between dynamic waveform display and stopping it. as shown in the figure below

（2）Current waveform

The "Current Waveform" interface displays the real-time waveform of three-phase current. You can select any waveform channel using the arrow keys, and clicking the pause/refresh button can toggle between dynamic waveform display and stopping it. As shown in the figure below:

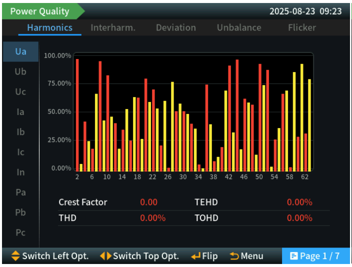


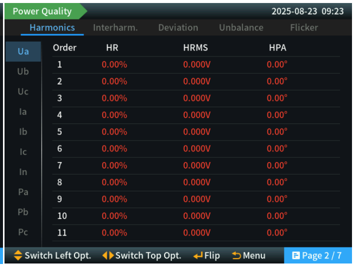
4.3.3 Power Quality

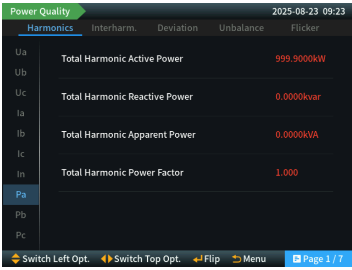
The "P.Q." menu includes five sub-menus: Harmonics, Inter harm, Deviation, Unbalance, and Flicker. Sub-menu pages can be switched using the "◀ " and "▶" arrow keys.

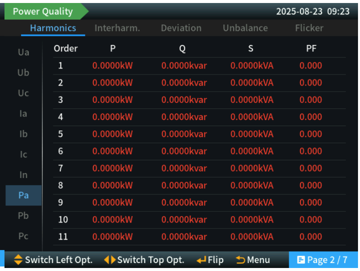
(1) Harmonic wave

The "Harmonics" interface displays bar graphs of voltage and current harmonics from 1st to 63rd order, total harmonic distortion rate, total odd and even harmonic distortion rates, crest factor and K factor, three-phase total harmonic active/reactive/apparent power, and total harmonic power factor. On the voltage and current harmonic bar graph interface, the content rate, effective value, and phase angle of each harmonic order can be viewed by pressing the "Confirm" button. On the three-phase harmonic power interface, the list of sub-harmonic power can be viewed by pressing the "Confirm" button. As shown in the figure below:



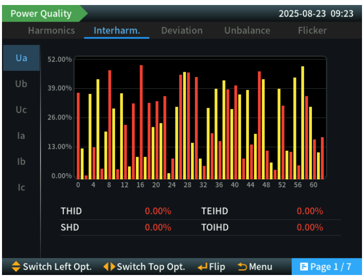


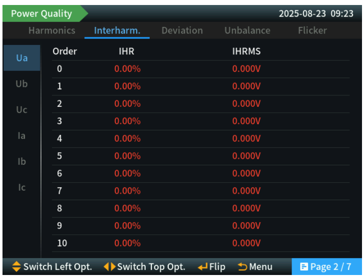




(2) Inter harmonics

The "Inter harmonics" interface displays a bar graph of voltage and current inter harmonics from 0 to 62 times, as well as the total inter harmonic distortion rate, and the total odd and even inter harmonic distortion rates. By clicking the "Confirm" button, you can view the content rate and effective value of each order of inter harmonics. As shown in the figure below:





（3）Deviation

The "Deviation" interface displays the upper/lower deviations of phase voltage and line voltage, as well as frequency deviation. As shown in the figure below:

（4）Unbalance degree

The "Unbalance" interface displays the positive-sequence, negative-sequence, and zero-sequence voltage and current values, as well as the unbalance degrees of negative-sequence and zero-sequence voltage and current. As shown in the figure below:

（5）Flicker

The "Flicker" interface displays short-term flicker, long-term flicker, voltage fluctuation, and variation frequency of three-phase voltage, as shown in the figure below:

4.3.4 Electric Energy Metering

The " Energy" menu includes three sub-menus: RMS Energy, Fund. Energy, and Harm Energy. Sub-menu pages can be switched using the "◀" and " "▶arrow keys.

(1) Full-wave Electric Energy

The "RMS Energy" interface displays three-phase split-phase full-wave electric energy and total full-wave electric energy, including combined active power, forward and reverse active power, combined reactive power, four-quadrant reactive power, and forward and reverse apparent power. As shown in the figure below:

	Total	Phase A	Phase B	Phase C
P Comb.	0.000kWh	0.000kWh	0.000kWh	0.000kWh
P Positive	0.000kWh	0.000kWh	0.000kWh	0.000kWh
P Negative	0.000kWh	0.000kWh	0.000kWh	0.000kWh
Q Comb. 1	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Comb. 2	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 1	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 2	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 3	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 4	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
S Positive	0.000kVAh	0.000kVAh	0.000kVAh	0.000kVAh
S Negative	0.000kVAh	0.000kVAh	0.000kVAh	0.000kVAh

（2）Fundamental Wave Electric Energy

The "Fund. Energy" interface displays the three-phase split-phase fundamental electric energy and total fundamental electric energy, including combined active power, forward and reverse active power, combined reactive power, four-quadrant reactive power, and forward and reverse apparent power. As shown in the figure below:

	Total	Phase A	Phase B	Phase C
P Comb.	0.000kWh	0.000kWh	0.000kWh	0.000kWh
P Positive	0.000kWh	0.000kWh	0.000kWh	0.000kWh
P Negative	0.000kWh	0.000kWh	0.000kWh	0.000kWh
Q Comb. 1	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Comb. 2	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 1	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 2	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 3	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 4	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
S Positive	0.000kVAh	0.000kVAh	0.000kVAh	0.000kVAh
S Negative	0.000kVAh	0.000kVAh	0.000kVAh	0.000kVAh

（3）Harmonic Electric Energy

The "Harm. Energy" interface displays three-phase split-phase harmonic energy and total harmonic energy, including combined active power, forward and reverse active power, combined reactive power, four-quadrant reactive power, and forward and reverse apparent power. By pressing the "▲" and "▼" buttons, you can view the harmonic energy of each order for forward and reverse active power, as well as forward and reverse reactive power. As shown in the figure below:

	Total	Phase A	Phase B	Phase C
P Comb.	0.000kWh	0.000kWh	0.000kWh	0.000kWh
P Positive	0.000kWh	0.000kWh	0.000kWh	0.000kWh
P Negative	0.000kWh	0.000kWh	0.000kWh	0.000kWh
Q Comb. 1	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Comb. 2	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 1	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 2	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 3	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
Q Quad. 4	0.000kvarh	0.000kvarh	0.000kvarh	0.000kvarh
S Positive	0.000kVAh	0.000kVAh	0.000kVAh	0.000kVAh
S Negative	0.000kVAh	0.000kVAh	0.000kVAh	0.000kVAh

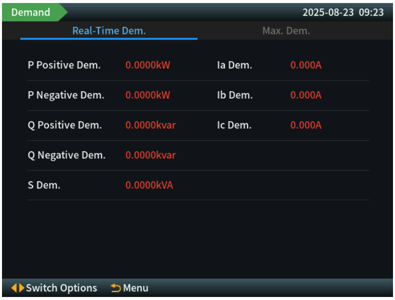
Order	P Positive	P Negative	Q Positive	Q Negative
2	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
3	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
4	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
5	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
6	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
7	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
8	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
9	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
10	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
11	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh
12	0.000kWh	0.000kWh	0.000kvarh	0.000kvarh

4.3.5 Demand Statistics

The " Demand" interface includes two tertiary menus: Real-Time Dem. and Max. Dem.; users can switch between the two menus using the "◄" and "►" arrow keys.

（1）Real-time Demand

The "Real-time Demand." interface displays the real-time demand of forward and reverse total active power, forward and reverse total reactive power, total apparent power, and three-phase current.



（2）Maximum Demand

The "Max. Dem." interface displays the maximum demand and corresponding time stamps for forward and reverse total active power, forward and reverse total reactive power, total apparent power, and three-phase current.

4.3.6 Time-based Billing

The "TOU" menu includes two sub-menus: TOU Energy and TOU Demand. You can switch between sub menu pages using the " ◀ " and " ▶ " arrow keys. The current rate, current operating period, and daily period meter number are displayed simultaneously.

(1) TOU Energy

The "TOU Energy" interface displays full-wave energy for eight rates, including combined active power, forward and reverse active power, combined reactive power, four-quadrant reactive power, and forward and reverse apparent power. Pages can be turned using the "▲" "▼and " " buttons, as shown in the following figure:

（3）TOU Demand

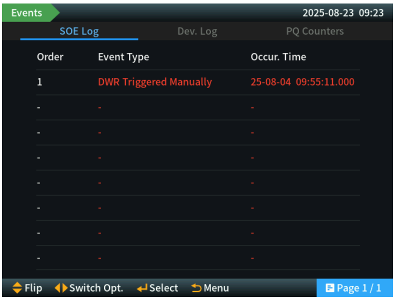
The "TOU Demand" interface displays the maximum demand for eight rates, including forward active power, reverse active power, forward reactive power, reverse reactive power, and total apparent demand. You can page through using the " ▲" and " ▼" buttons, as shown in the following figure:

4.3.7 Event Recording

The "Events" menu comprises three sub-menus: "SOE Log", "Dev. Log", and "PQ Counters". You can switch between these sub-menus using the arrow keys, and press the "Confirm" key to enter a sub-menu. As shown in the figure below:

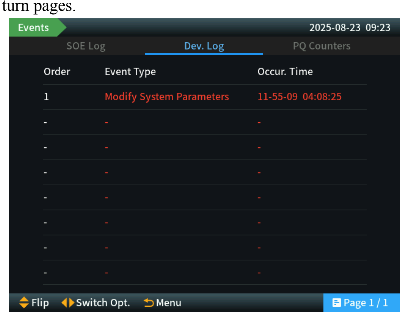
(1) Monitoring events

The "SOE Log" interface displays various events that have occurred on the device along with their trigger times, with a maximum capacity of displaying up to 1024 records. The " ▲" and " ▼" buttons allow the cursor to be moved to switch between sequentially occurring events, with the latest event displayed at the top. The "Confirm" button allows for the viewing of detailed event information, including the event name, occurrence time, and feature value (displayed as primary side value), etc. The “◀” and “▶”buttons can be used to directly turn pages. Pressing the "Back" button returns to the previous menu level.



(2) Device Log

The "Dev. Log" interface records the operation records and operation time on the device, with the latest event at the top. Pressing "◀" and "▶" can turn pages.



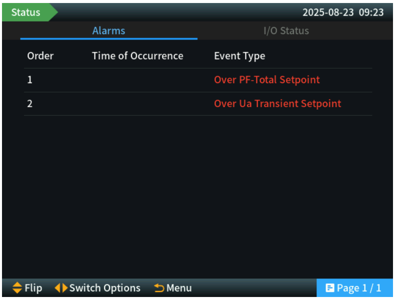
(3) Event Counting

The "PQ Counters" interface displays the statistical count of transient events

4.3.8 Meter Status

The "Status" menu primarily displays the current real-time alarms and I/O status of the meter. Users can switch between sub menus using "◀" and "▶", and press the "Confirm" button to enter a sub-menu. As shown in the figure below:

（1）Real-time alerts



（2） I/O Status

4.3.9 Parameter Setting

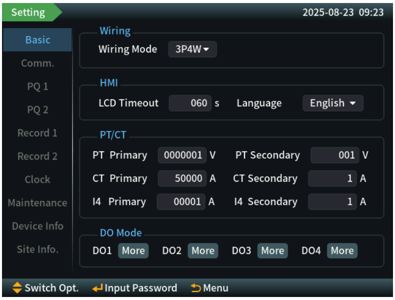
Before normal use of the YDPQ200-A device, it is necessary to set the device's operating parameters and display menu content. The operating parameters of the device determine how it connects with the measurement circuit, measures system data, and operates in a networked manner. In the parameter settings of the device, many settings are made by selecting some list options. When selecting, you can use the arrow keys to highlight the item you want to select, and then press the "Confirm" key to confirm. When modifying any parameter settings, you need to enter a user password. The factory default password is "000002".

The "Setting" menu is divided into 10 sub-menus, including Basic, Comm., PQ 1, PQ 2, Record 1, Record 2, Clock, Maintenance, Device Info, and Site Info.

（1）Basic Parameters

The " Basic" interface displays basic setting parameters, including wiring mode, LCD Timeout, language, PT/CT,, language, DO mode settings, etc.

As shown in the figure below:

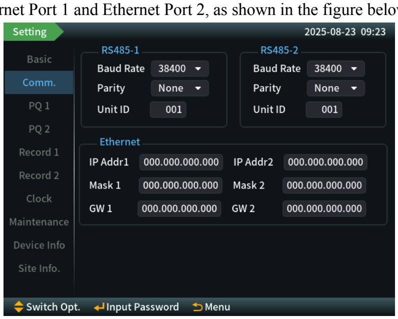


The basic parameter settings are as follows:

Category	Set Parameters	Default Value	Function or Setting Range
Wiring	Wiring Mode	Three-phase four-wire	Three-phase four-wire/three-phase three-wire
HMI	LCD Timeout	60S	0~300S (0 indicates constant on)
	Language	Chinese	Chinese/English
PT parameter	PT Primary	1V	1~1000000V
	PT Secondary	1V	1~380V
CT parameters	CT Primary	1A	1~50000A
	CT Secondary	1A	1~5A
I4CT parameters	I4 Primary	1A	1~50000A
	I4 Secondary	1A	1~5A
DO mode	DO1	Power quality alarm correlation	Remote control/DI1~DI6 alarm correlation/power quality alarm correlation
	DO2	Power quality alarm correlation	Remote control/DI1~DI6 alarm correlation/power quality alarm correlation
	DO3	Power quality alarm correlation	Remote control/DI1~DI6 alarm correlation/power quality alarm correlation
	DO4	Power quality alarm correlation	Remote control/DI1~DI6 alarm correlation/power quality alarm correlation

（2）Communication Settings

The "Comm." interface displays the communication parameters for RS485-1 and RS485-2 ports, as well as the communication parameters for Ethernet Port 1 and Ethernet Port 2, as shown in the figure below:

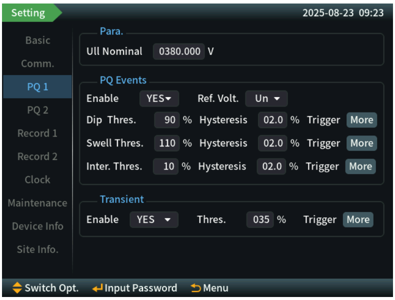


The communication parameter settings are as follows:

Category	Setting Parameters	Default Value	Function or Setting Range
RS485-1	Baud rate	9600	4800/9600 /19200/38400/115200bps
	Parity	Nothing	None/Odd/Even
	Unit ID	1	Device ID number: 1~247. In the same communication link, each device should have a unique ID number
RS485-2	Baud rate	9600	4800/9600 /19200/38400/115200bps
	Parity	Nothing	None/Odd/Even
	Unit ID	1	Device ID number: 1~247. In the same communication link, each device should have a unique ID number
Ethernet port 1	IP address	192.168.0.101	The network parameter settings must meet the following requirements: 1） The IP address and sub-net mask cannot be 0 (a gateway of 0 indicates the absence of a gateway) 2）The highest byte value range for IP addresses and gateways is 1~223 3）The IP address and gateway cannot be 127.x.x.x 4）At least one IP address of the 1/2 port needs to be set on the same network segment as the gateway, otherwise the parameter saving will fail. 5）The network ID cannot be 0, nor can it consist entirely of 1s (in binary) 6）The host ID cannot be 0, nor can it be all 1s (in binary) for the IP address 2
	mask	255.255.255.0	
	GW	192.168.0.1	
Ethernet port 2	IP address	192.168.0.102	
	mask	255.255.255.0	
	GW	192.168.0.2	

（3）Power quality parameter 1

The "PQ 1" interface displays the settings for transient and instantaneous related parameters, as shown in the figure below:

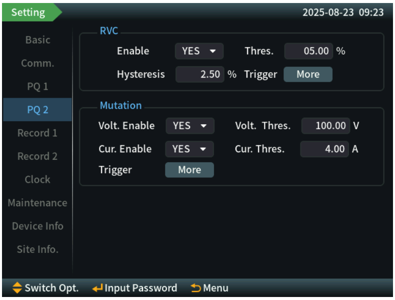


The transient parameter settings are as follows:

Category	Setting Parameters	Default Value	Function or Setting Range
Parameter	Ull Nominal	381.051	
PQ Events	Enable	YES	YES/NO
	Reference voltage	Rated voltage	Rated voltage (Un)/sliding reference voltage
	Dip Thres.	90%	10%～90%
	Hysteresis	2%	0.5%～10%
	Trigger	Waveform recording	None / DO1~4 / WFR / DWR / RMSR
	Swell Thress	110%	110%~200%
	Hysteresis	2%	0.5~10%
	Trigger	Waveform recording	None / DO1~4 / WFR / DWR / RMSR
	Inter.Thres	10%	1~10%
	Hysteresis	2%	0.5~10%
	Trigger	Waveform recording	None / DO1~4 / WFR / DWR / RMSR
transient	Enable	NO	YES/NO
	Thres.	35%	5%~500%
	Transient trigger	Waveform recording	None / DO1~4 / WFR / DWR / RMSR

（4）Power Quality Parameters 2

The "Power Quality Parameter 2" interface displays the settings for RVC and mutation-related parameters, as shown in the figure below:



The settings for the RVC (Rapid Voltage Change) parameter and the sudden change parameter are as follows:

Category	Set parameters	Default value	Function or setting range
Rapid voltage fluctuation	Enable	NO	YES/NO
	Thres.	5%	（0.2%～10%）Un
	Hysteresis	2.5%	（0.1%~5%）Un
	Trigger	Waveform recording	None / DO1~4 / WFR / DWR / RMSR
Sudden change	Volt. Enable	NO	YES/NO
	Volt. Thres	100	0.57~100V
	Cur. Enable	NO	YES/NO
	Cur. Thres	5	0.10~5A
	Trigger	waveform recording	None / DO1~4 / WFR / DWR / RMSR

（5）Waveform Record 1

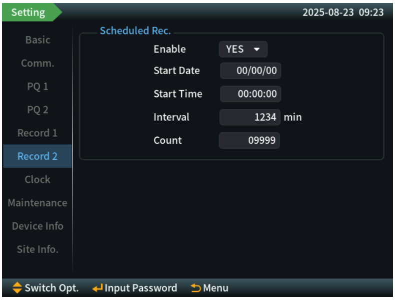
The "Waveform Record 1" interface displays the settings for parameters such as waveform records, disturbance records, and effective value records, as shown in the figure below:

The waveform recording parameter settings are as follows:

Category	**Set parameters**	**Default value**	**Function or setting range**
Waveform recording	WFR	1024×10	1024 points/cycle × 10 cycles 512 points/cycles × 20 cycles 256 points/cycles × 40 cycles 128 points/cycles × 80 cycles
	Pre -TC	4	2~4
	Post-TC	4	2~4
Disturbance record	Pre-TC	5	5~10
Effective value record	Pre-TS	100	100~500
	Interval	2.5 cycles	0.5 cycles to 60 cycles
	Channel 1	Ua	Ua / Ub / Uc / Uab / Ubc / Uca Ia / Ib / Ic / I4 Frequency / Frequency deviation Pa / Pb / Pc Qa / Qb / Qc Sa / Sb / Sc PFa / PFb / PFc 空 Empty
	Channel 2	Ub	
	Channel 3	Uc	
	Channel 4	Ia	
	Channel 5	Ib	
	Channel 6	Ic	
	Channel 7	frequency	
	Channel 8	frequency deviation	

（6）Waveform Record 2

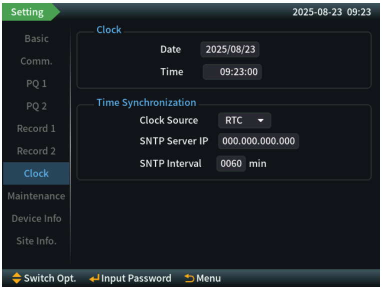
The "Record 2" interface allows for the setting of parameters for scheduled waveform recording, including activation/deactivation, start date, start time, interval time, and recording frequency, as shown in the figure below:



The settings for the scheduled wave recording parameters are as follows:

Category	Set parameters	Default value	Function or setting range
Scheduled wave recording	Enable	NO	YES/NO
	Start date	25/04/01	Year (00~99)/Month (1~12)/Day (1~31)
	Startup time	00:00:00	Hour (00~23): Minute (00~59): Second (00~59)
	interval (minutes)	60	1~1440min
	count	1	1~10000

（7）Time Settings



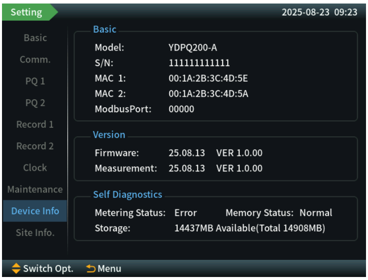
Category	Set parameters	Default value	Function or setting range
Clock	Date	Nothing	Year (2000~2099) / Month (1~12) / Day (1~31)
	Time	Nothing	Hour (00~23): Minute (00~59): Second (00~59)
Time synchronization	Clock Source	RTC	RTC/SNTP/IRIG-B/PPS
	SNTP Server IP	203.107.6.88	0.0.0.0~255.255.255.255
	SNTP Interval	60min	10~1440min

（8）Device Operation

Category	Setting Parameters	Default Value	Function or Setting Range
Change password	New password	000002	000000~999999
	Confirm Password	000002	000000~999999
Clear operation	All Events	--	Second confirmation
	All Demands	--	Second confirmation
	Energy	--	Second confirmation
	PQ Counters	--	Second confirmation
USB operation	Update Program	--	Upgrade program
	Update Meter		Upgrade Meter

（9）Device Information

The "Device Information" interface displays basic device information, version information, and self-check information. Among them, basic information can be set through communication and viewed through display; self-check information can display the metering status and storage card storage status. As shown in the figure below:



Category	Display Parameters
Basic Information	Model
	Serial number
	MAC address 1
	MAC address 2
	Mod-bus port
Version Information	Firmware
	Measurement
Self-check information	Measurement Status
	Memory status
	Storage

（10）Monitoring point information

The "Monitoring Point Information" interface displays substation information and monitoring point information, which can be modified through the host computer software. As shown in the figure below:

Category	Display Parameters
Substation Information	Power supply company
	County Power Supply Company
	Substation
	Voltage level of substation
Monitoring Point Information	Bus-bar name
	Name of monitoring point
	Voltage level of monitoring point
	ID Asset management ID
	ID Monitoring network management ID
	Commissioning Date
	Minimum short-circuit capacity
	Power supply equipment capacity
	User agreement capacity

Chapter 5: Installation

5.1 Installation Precautions and Preparation

Please Read Before starting the operation

This chapter contains important safety precautions that must be followed before installing, servicing, or maintaining electrical equipment. Carefully read and follow the safety precautions below.

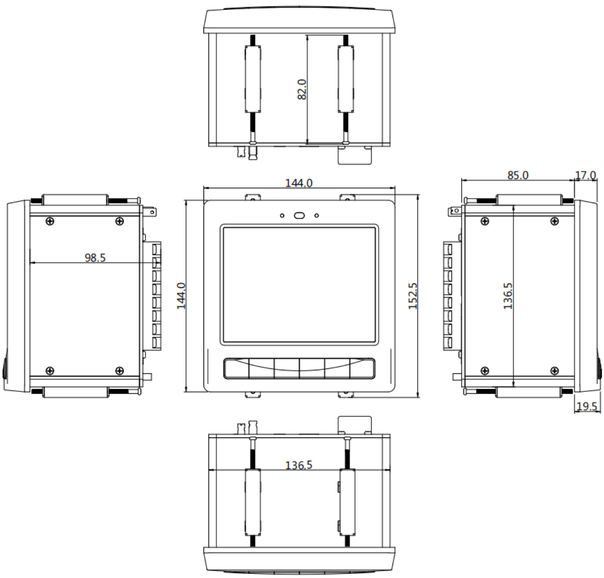
There is a risk of electric shock, burnout, or explosion, so only qualified operators are authorized to install this equipment. This work should be carried out after reading the entire instruction manual. Before conducting installation, inspection, testing, or maintenance, all power connections should be disconnected. Please follow the wiring instructions in the manual to connect the wires, and carefully verify that the wiring is correct after completion. Aware of the potential dangers, staff members need to wear protective equipment and carefully check whether the work wiring and installation are correct. When installing or removing instruments, please confirm that the power supply, signal source to be measured, and related power sources have been completely disconnected.

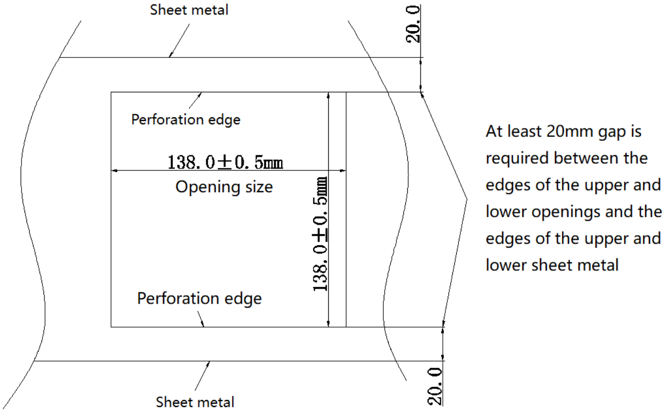
5.2 Installation Information

5.2.1 Installation Environment and Location

The device should be installed in a dry, clean location, away from heat sources and strong electromagnetic fields, and protected from direct sunlight. It is typically installed in a switch cabinet, which shields the device from oil, dirt, dust, corrosive gases, or other harmful substances. During installation, attention should be paid to ensuring easy maintenance and sufficient space for placing relevant wires, terminal blocks, shorting boards, and other necessary equipment.

5.2.2 Installation Dimensions (unit: mm; tolerance: ±0.5)

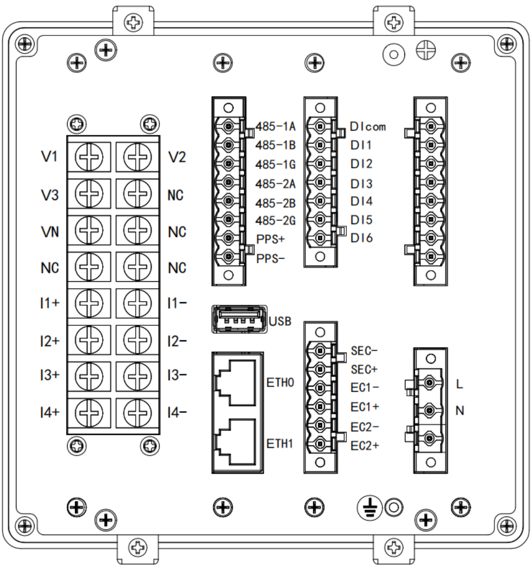




Note: Overall Dimensions: Length * Width * Height (excluding terminals): (144±0.5)mm×(144±0.5)mm×(85±0.5)mm

Length * width * height (including terminals): (144±0.5)mm×(144±0.5)mm×(118±1)mm
Hole size: (138±0.5)mm×(138±0.5)mm

5.3 Terminal Definition



Terminal definition	Note	Terminal definition	Note
V1	A phase voltage input	DIcom	Switching input common terminal
V2	B phase voltage input	DI1	First channel switch input
V3	C phase voltage input	DI2	Second channel switch input
NC	Reserve	DI3	Third channel switch input
VN	Neutral line voltage input	DI4	Fourth channel switch input
NC	reserve	DI5	Fifth channel switch input
I1+	A phase current flows in	DI6	Sixth channel switch input
I1-	A phase current flows out	SEC+/SEC-	Millisecond pulse port
I2+	B-phase current inflow	EC1+/EC1-	Active energy pulse port
I2-	B-phase current outflow	EC2+/EC2-	Reactive energy pulse port
I3+	C-phase current inflow	DO1+/DO1-	First relay output
I3-	C-phase current outflow	DO2+/DO2-	Second relay output
I4+	Zero line current inflow	DO3+/DO3-	Third relay output
I4-	Zero line current flowing out	DO4+/DO4-	Fourth relay output
485-1A/1B/1G	RS485 interface 1	L/+	AC power live wire/DC power positive pole
485-2A/2B/2G	RS485 interface 2	N/-	AC power neutral line/DC power negative pole
PPS+/PPS-	PPS timing interface	USB	
ETH0	Network communication RJ45 interface 1	⏚	For the shell grounding terminal, please ensure it is grounded and in good contact.
ETH1	Network communication RJ45 interface 2		

5.4 Wiring diagram

（1）The secondary side of the PT cannot be short-circuited;

（2）The secondary side of the CT cannot be open-circuited. When disconnecting the CT from the monitoring circuit, short-circuit the secondary side of the CT;

（3）The device is suitable for various three-phase systems. Please read this section carefully to select the appropriate wiring method;

（4）The voltage received should be within the rated voltage range of the device;

（5）The primary side of the PT must be protected by a circuit breaker or a fuse. If the rated capacity of the PT used is greater than 25VA, a fuse should also be installed on the secondary side of the PT;

（6）The excitation on the primary side of PT and CT will generate significant voltage and current in the secondary side circuits of PT and CT. Therefore, it is essential to take necessary safety measures when installing instruments, such as removing the fuse of PT and short-circuiting the secondary side of CT;

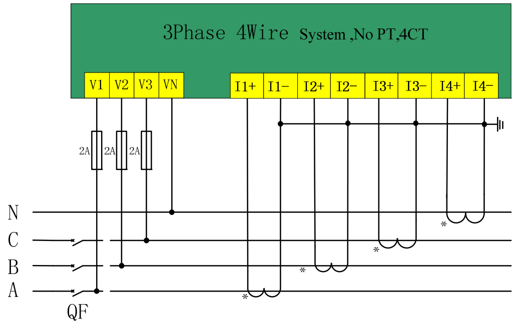
5.4.1 Power Supply

When used in an AC system, connect the phase line to the L/+ terminal and the neutral line to the N/- terminal; the power supply range is AC85V~265V, 50Hz/60Hz.

When used in a DC system, connect the positive pole to the L/+ terminal and the negative pole to the N/- terminal; the power supply range is DC100V~330V

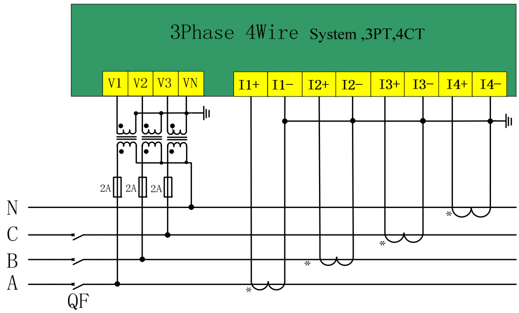
5.4.2 Voltage and Current

(1) Three-wire and four-wire connection method (without PT, 4CT)



The wiring method of the device should be set to "three-phase four-wire", with corresponding current transformation ratio set

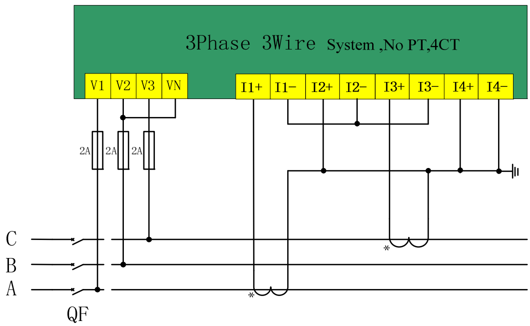
（2）Three-wire and four-wire connection method (3PT, 4CT)



The wiring method of the device should be set to "three-phase four-wire", with corresponding voltage transformation ratio and current transformation ratio set

(3) Three-phase three-wire (without PT, 2CT)

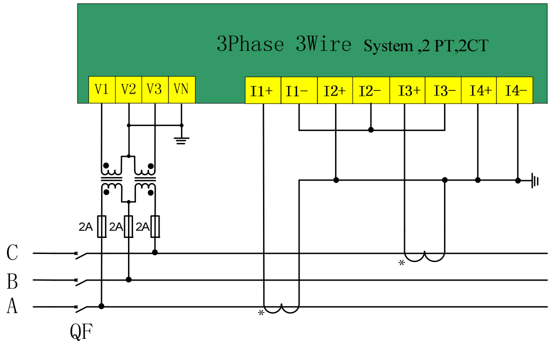
When the measurement circuit is a three-phase three-wire system, the wiring diagram is shown below, and the wiring mode of the device should be set to "three-wire star type".



The wiring method of the device should be set to "three-phase three-wire" and the corresponding current transformation ratio should be set

(4) Three-phase three-wire (2PT, 2CT)

When the measurement circuit adopts a three-wire angular connection method, the wiring diagram is shown below, and the wiring mode of the device should be set to "angular connection".

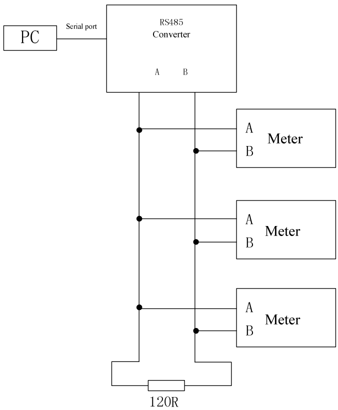


The wiring method of the device should be set to "three-phase four-wire", with corresponding voltage transformation ratio and current transformation ratio set

5.4.3 Communication

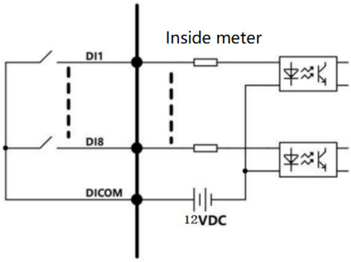
RS-485 communication port, with terminals labeled A and B.

The RS-485 communication method allows up to 32 instruments to be connected on one bus, which is then linked to the host computer via an RS-485 converter. The communication cable can be a standard shielded twisted pair, with a total length not exceeding 1200 meters. The positive and negative polarities of the RS-485 ports of each device must be connected correctly. If the shielded twisted pair is long, it is recommended to connect a resistor of approximately 120Ω at its end to enhance communication reliability.



5.4.4 Switch Input

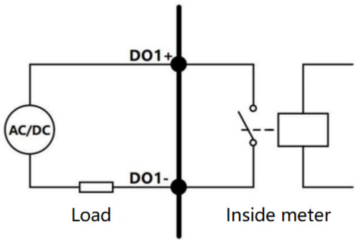
The device provides 6 optocoupler DI inputs and a built-in 12V excitation power supply, which can be connected to switching signals. The wiring diagram is shown below:



DI wiring diagram

5.4.5 Relay output

The instrument provides 4-channel relay output, labeled as DO1+/-~DO4+/-. All 4 channels feature normally open contacts. The wiring for DO output is shown in the figure below:



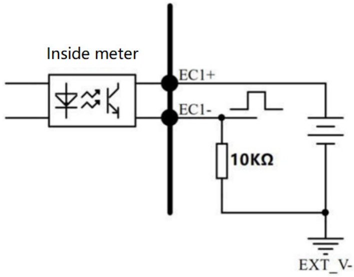
Relay output wiring diagram

5.4.6 Pulse Terminal Wiring

The instrument provides two-channel EC output function, with terminals marked as EC1+/- and EC2+/-, which can be used as outputs for other alarm functions. When in use, connect EC+ to the positive terminal of the external DC power supply, and connect EC- to the load and then to the negative terminal of the external DC power supply. The schematic diagram of EC output wiring is as follows:

The device provides two pulse outputs: EC1+, EC1-, and EC2+, EC2-. EC1+, EC1- are for active energy pulse output; EC2+, EC2- are for reactive energy pulse output,

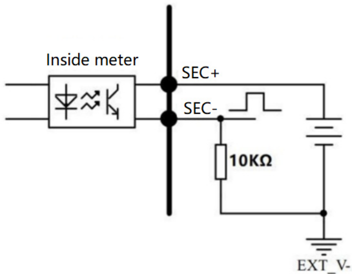
Active/reactive pulse output, primarily used for accurate testing of active/reactive electrical energy, with a pulse width of 80ms±20ms; the electrical pulse is output after being photoelectrically isolated.



EC output wiring (taking EC1 as an example, EC2 is similar)

5.4.7 Wiring of second pulse terminal

The instrument provides a one-way second signal output function, with the terminal marked as SEC+/-. When in use, SEC+ is connected to the positive terminal of the external DC power supply, and SEC- is connected to the load and then to the negative terminal of the external DC power supply. The schematic diagram of SEC output wiring is as follows:



The second pulse output is primarily used for clock accuracy testing.

5.4.8 PPS Wiring

The terminals are marked with + and -. When performing PPS timing, connect the + terminal (signal) of the PPS timing device to +, and connect the - terminal (ground) to -.

Chapter 6 Maintenance and Troubleshooting

6.1 Troubleshooting

Possible Issues	PossibleReasons	Possible Solutions
No display after power-on	The power supply failed to be connected to the device	Check whether the correct operating voltage is applied to the L/+ and N/- terminals of the device
The measurement data is inaccurate or displayed as 0 after adding a signal	The voltage measurement is incorrect	Check whether the voltage signal is correctly connected to the device Check whether the voltage measurement signal falls within the measurement range of the device Check whether the PT transformation ratio parameter is set correctly
	The current measurement is inaccurate	Check whether the current signal is correctly connected to the device Check whether the current measurement signal is within the measurement range of the device Check whether the CT transformation ratio parameters are set correctly
	The power measurement is inaccurate	Check whether the measurement mode setting is correct Check whether the voltage and current correspond to the correct phase sequence Check whether the current direction is correct
The switch state remains unchanged	Switch input error	Check whether the equipment is equipped with switch input function Check whether the external wiring is correct
The relay does not operate	No control command received	Check whether the relevant settings are correct (in which mode) If it is about communication control, check whether the communication is successful
	No relay function	Check whether the equipment is equipped with relay function
The host computer cannot communicate with the device	Communication wiring error	Check whether the communication cable of the device is properly connected
	The communication parameters are incorrect	Check whether the mailing address is correct Check whether the communication baud rate is correct Check whether the communication check digit is correct

Possible Issues	PossibleReasons	Possible Solutions
	The communication link is affected	Check if there are devices with the same parameters on the same communication link Check whether the communication shielding layer is properly grounded Check if the communication cable is disconnected

Note: If there are any unresolved issues, please contact YADA's after-sales service department in a timely manner.

Chapter 7 Quality Assurance

7.1 Quality Assurance

All new instruments sold to users are covered by a free quality assurance for malfunctions caused by design, materials, and workmanship, within 12 months after being powered on or 18 months after receipt. If the product is confirmed to meet the aforementioned warranty conditions, our company will be responsible for free repairs.

7.2 Quality Limitations

The following issues with the device are not covered by the free warranty:

■Damage caused by incorrect installation, use, or storage.

■Abnormal operation and application conditions beyond the product specifications.

■Instruments repaired by institutions or individuals not authorized by our company.

■Instruments that have exceeded the free warranty period.

Note: The above pictures are for reference only. The actual product is subject to the actual product.

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