CLOSE TO THE FUTURE

AQM2

Power quality analyzer. User manual

V1. 03/2026

Safety Precautions

Use instructions

Please read this manual carefully before using the device and ensure you follow the instructions below:

NOTE:

- This device must be operated and maintained by qualified personnel who have read this manual.
- Before carrying out any internal or external work, disconnect all input signals and power supplies. Ensure that:
  - The secondary terminals of the voltage transformer are not short-circuited.
  - The secondary terminals of the current transformer are not open-circuited.
- Use suitable measuring equipment to confirm that there is no voltage present on any component of the device.
- The supplied electrical parameters must be within the rated range.
- Do not touch the terminals whilst the device is in operation.
- To use the communication function, connect the equipment to a secure network.

Possible causes of failure or damage

- Operating environment outside the range
- Auxiliary voltage outside the range
- System frequency outside the range
- Input signal exceeding the maximum permitted value
- Incorrect polarity on voltage or current inputs
- Incorrect connections

Contact information

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Contents

1. Introduction

1.1. Overview

The **AQM2** is a network analyser that offers:

- Precise measurement of electrical parameters
- Energy measurement
- Power quality monitoring

It complies with the **IEC 61000-4-30 Class A standard.**

It features input/output (I/O) modules for monitoring and control, integrating easily into systems for:

- Electrical supervision
- Energy management

1.2. Features

Functions		AQM2
Display Mode	TFT	5"
Real-time Measurement	3 phase voltage	●
	3 phase current	●
	Neutral current	●
	Active power	●
	Reactive power	●
	Apparent power	●
	Power factor	●
	Frequency	●
	Demand	●
	Max/Min values	●
	Phase angle	●
Energy Metering	Bi-directional active energy	●
	Bi-directional reactive energy	●
	Four-quadrant reactive electric energy	●
	Apparent energy	●
	Bi-directional tariff energy	●

Power Quality	Voltage deviation	●
	Frequency deviation	●
	Unbalance	●
	THD	●
	Harmonic ratio(2^{nd}-51^{st})	●
	Inter-harmonic ratio	●
	Voltage flicker	●
	Rapid voltage change	●
	Voltage swell	●
	Voltage dip	●
	Voltage interruption	●
	Crest factor	●
	k-factor of current	●
	Transient capture	80μs
	ITIC/SEMI F47 curve	●
Alarms	Voltage	●
	Current	●
	Active power	●
	Reactive power	●
	Apparent power	●
	Power factor	●
	Frequency	●
Data Records	SOE log	1,024 events
	PQ event log	1,024 events
	Waveform record	1,024 events
	Data freeze	●
	EN50160 report	60 events
Input/Output	Digital input	4
	Relay output	4
Communication	RS485 interface	●
Time synchronization	IRIG-B	●
	Modbus- RTU	●
Optional Modules	FM2: 4 digital inputs	○

	FM3: 2 relay outputs	○
	FM11: RS485 port, Modbus-RTU protocol	○
	FM24: Ethernet port, Modbus-TCP, Webseve	○

[Note 1]: "-" - not available, "●"- available, "○" - optional.

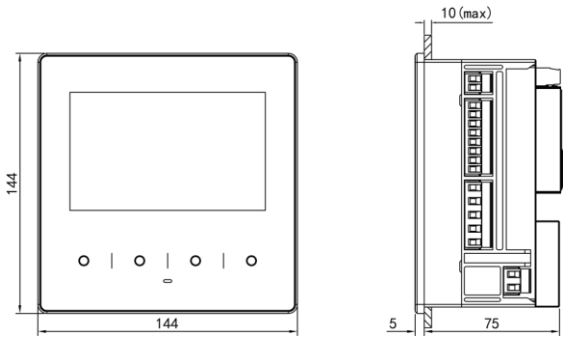
2. Technical Specification

Accuracy	
Voltage,Current	0.1%
Active Power,Reactive Power	0.2%
Power Factor	0.2%
Frequency	±0.01Hz
Active Energy	Cl. 0.2S
Reactive Energy	Cl. 2
Power Quality Parameters	IEC 61000-4-30 Cl. A
Environmental Characteristics	
Working Temperature	-25℃...+70℃
Storage Temperature	-25℃...+70℃
Relative Humidity	5%...95%RH, without condensation
Working Altitude	≤ 2000m (CAT III)
Pollution Degree	2
Mechanical Characteristics	
Dimension	144mm×144mm×80mm
Protection Degree	Front: IP54; rear housing: IP20
Safety Characteristics	
Measurement Category	300V (CAT III)
Safety	IEC 61010-1, double insulation
Auxiliary Power Supply	
Voltage	AC/DC 80V...270V
Frequency	50/60Hz ± 5Hz
Power Consumption	≤ 10VA
Voltage Input	
Rated Value	3×230/400 VAC
Starting Value	10 V
Overload	Continuous: 1.2Vn; instantaneous: 2Vn/1min
Frequency	45Hz...65Hz
Current Input	
Rated Value	3×.../1A or .../5A
Starting Value	10mA
Overload	Continuous: 2In; instantaneous: 20In/0.5s
Switching Input	
Number	4
Type	Dry contact
Relay Output	
Number	4
Contact Capacity	AC 250V/5A or DC30V/5A
Pulses of Electric Energy	
Number	1

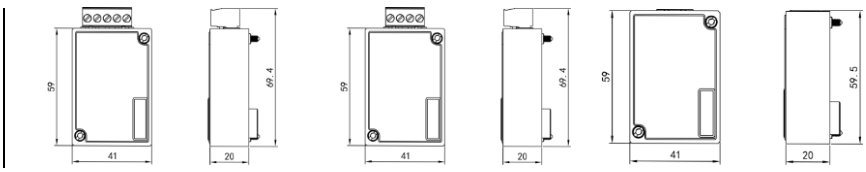
Type	Photocoupler isolation
Communication Port	
Number	1
Port	RS485
Baud rate	2.4kbps...115.2kbps
Protocol	Modbus-RTU
Real-time Clock	
Clock Drifting	≤ 0.5s/day
Terminals	
Torque	0.5N·m
Standards	
IEC 62586	Measurement of power quality in electrical supply systems
IEC 61557-12	Power measurement and monitoring devices (PMD)
IEC 61000-4-2	Electrostatic discharge immunity, Level 4
IEC 61000-4-3	Radio frequency field immunity, Level 3
IEC 61000-4-4	Immunity to fast electrical transients/bursts, Level 4
IEC 61000-4-5	Surge immunity, Level 4
IEC 61000-4-8	Power frequency magnetic field immunity, Level 4

3. Installation

3.1. Dimensions



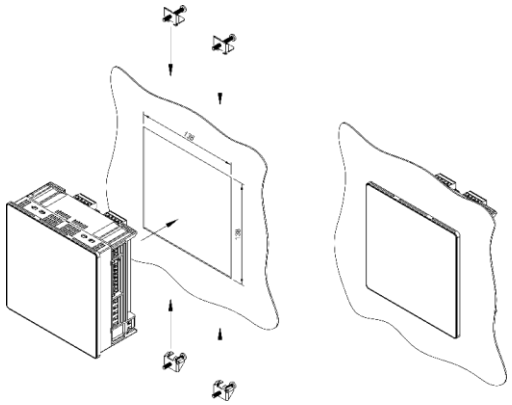
AQM2 (Dimensions in mm)



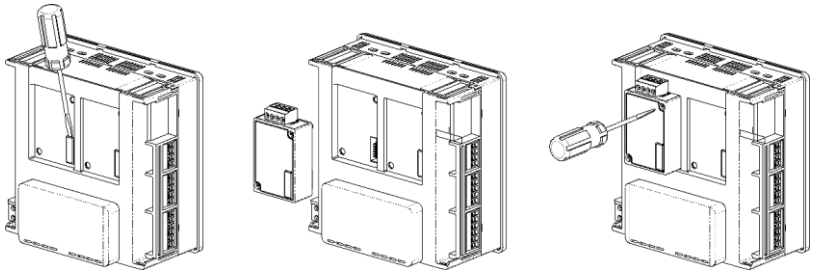
FM2 FM3, FM11 FM24

Modules (Dimensions in mm)

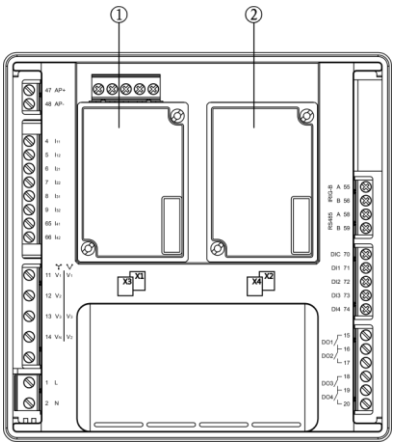
3.2. Installation



Installation Diagram. (Installation bracket screw torque 0.2~0.3N.m)



Module installation Diagram



Back-end Diagram

A maximum of 2 modules can be installed in each position.

A maximum of 1 communication module per position.

Each unit supports up to 4 modules.

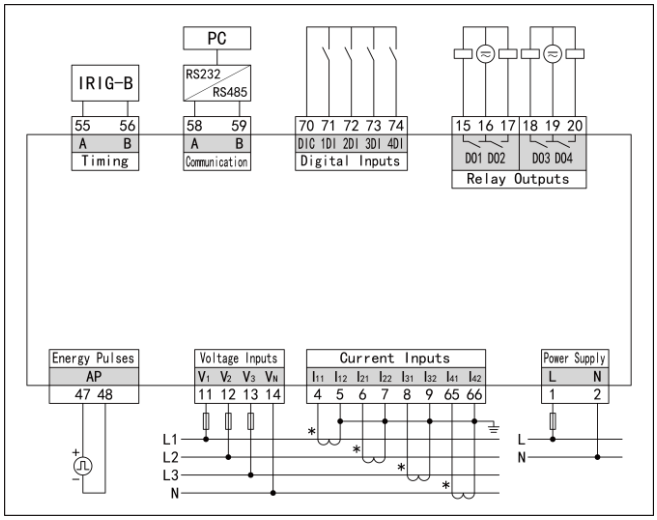
Restrictions:

FM11 and FM24 only in position ①.

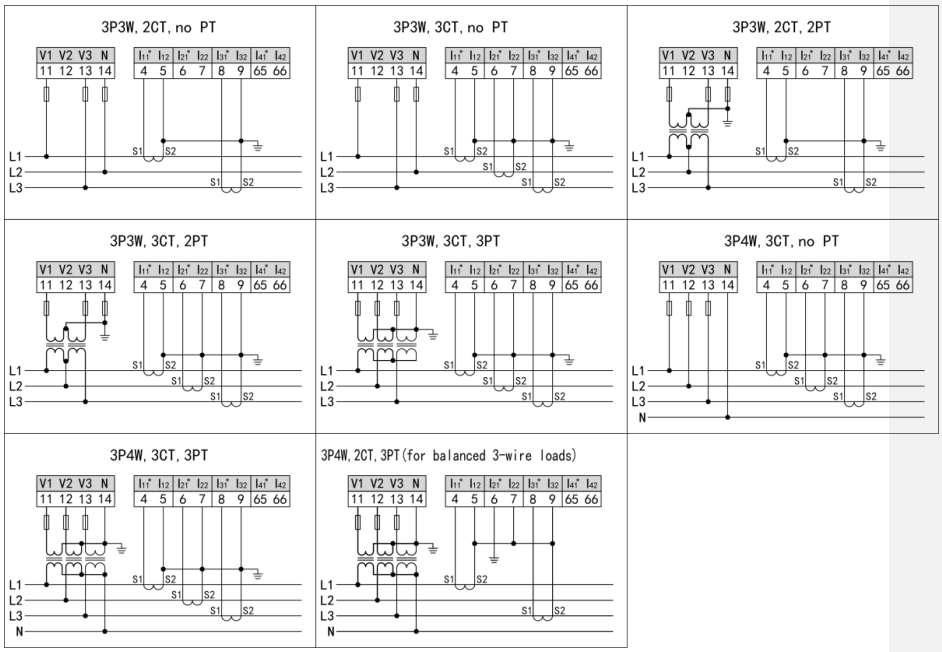
Modules can be freely combined within these conditions.

3.3. Wiring

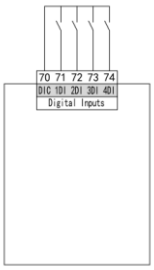
3.3.1. Typical Wiring Diagram



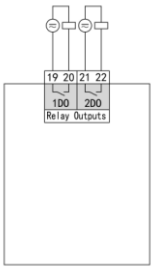
3.3.2. Voltage/Current Input Connection



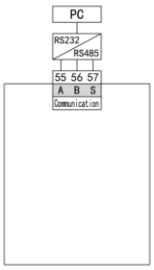
3.3.3. Module Wiring



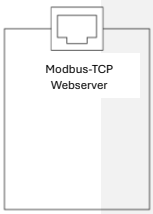
Module FM2



Module FM3



Module FM11



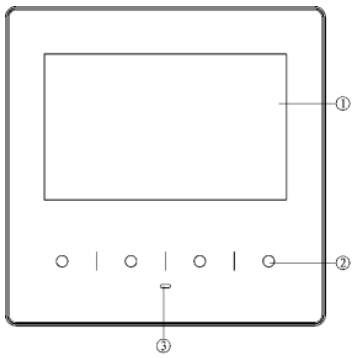
Module FM24

4. Operation

4.1. Panel

Display:

- Content indicator
- Page number
- Data window



Buttons:

- Used to configure settings

LED:

- Steady light: device powered
- Flashing: alarm active
-

Button functions

Icons	Description
▲	Increase the selected data bits.
▼	Move down the options/page down/change parameters.
◀	Move in a circular way to the left to change or display data.
▶	Move in a circular way to the right to change or display data.
Back	Return directly to the “Main Menu” page, return to the previous menu or discard modifications.
Enter	Enter the selected option.
Confirm	Confirm.
Zoom	Zoom in or out to display the image.
Edit	Edit the options.
Turn	Turn to next page.
	Invalidate the present button.

Modification methods for values:

Press “ ” to scroll through and edit the data digit, then press “ ” to increment the value of the current digit in a cyclical manner.

Entering and exiting programming mode.

Entering programming mode:

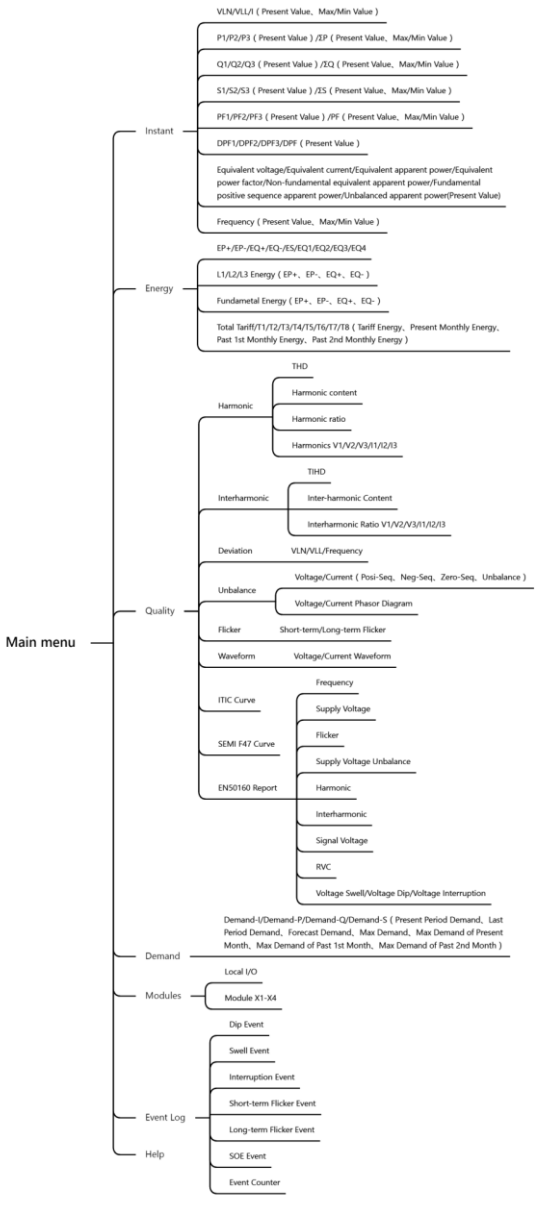
On the main interface, press “ ” and “ ” to change the selected item to “System Setup”, then press “Enter” to access the configuration interface. Normally, users can access this by selecting “User Setup”. After entering the correct programming protection password, you will enter configuration mode and can begin adjusting the parameters (the default password is 0001, and can be changed as required).

Exiting programming mode:

Once you have returned to the top-level menu of the programming interface, press the “Back” button. The device will ask if you wish to save the changes. Select “Yes” to save and return to the main menu, or “No” to exit without saving the changes and return to the main menu.

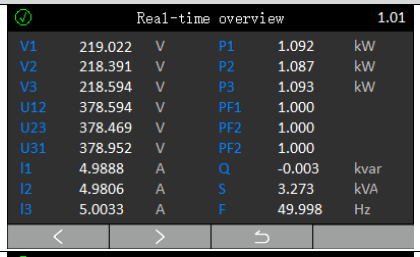
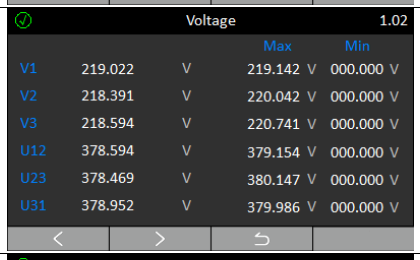
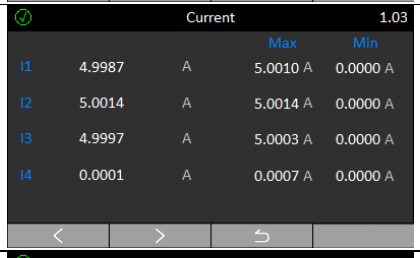
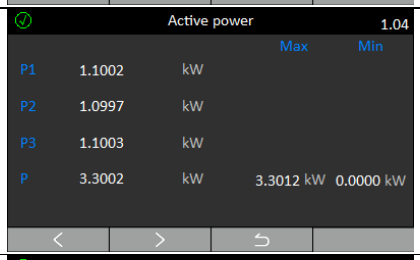
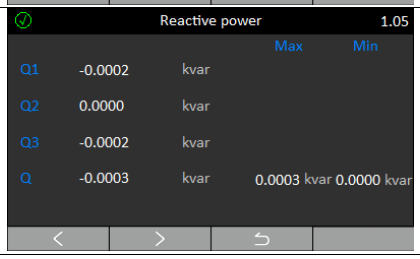
4.2. Display

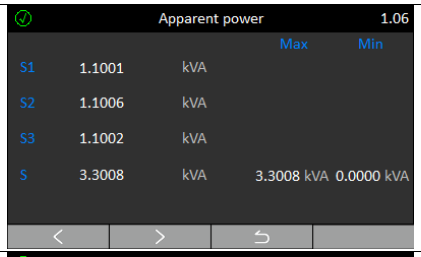
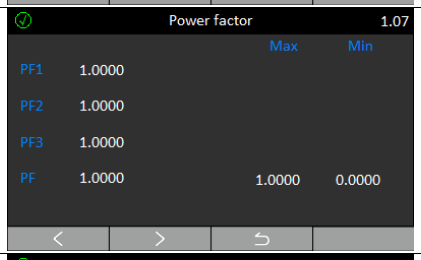
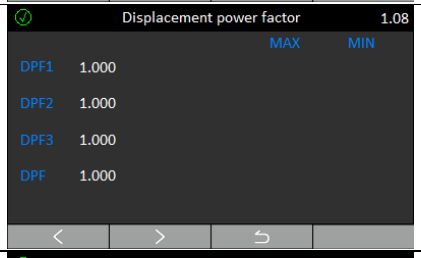
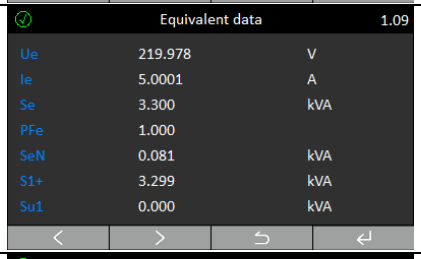
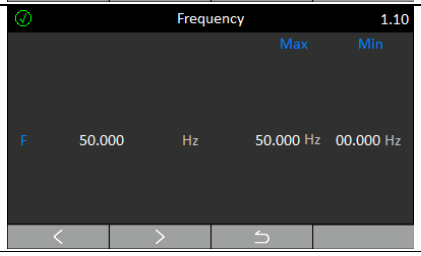
4.2.1. Display Menu



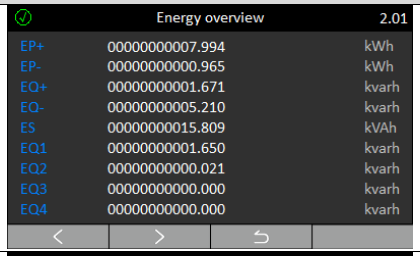
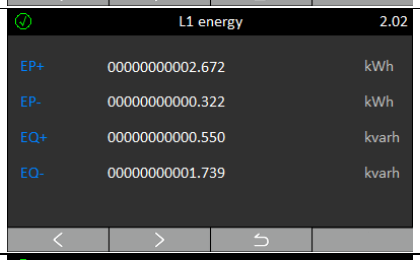
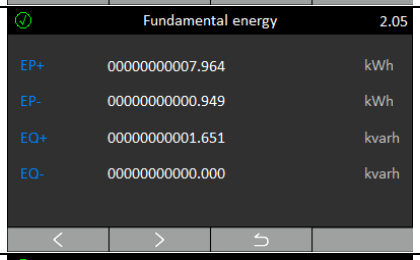
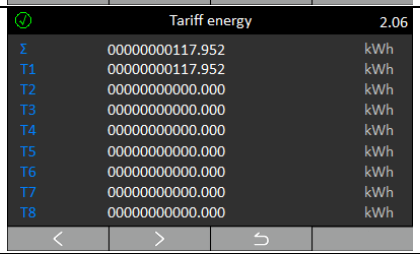
4.2.2. Display Features

4.2.2.1. Real-time measurement

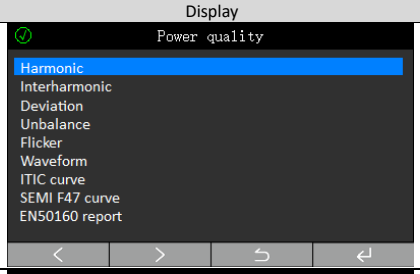
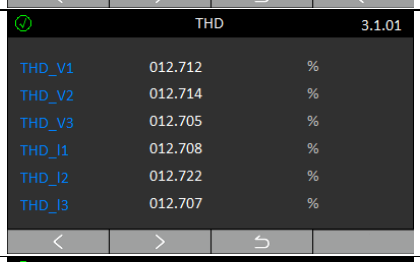
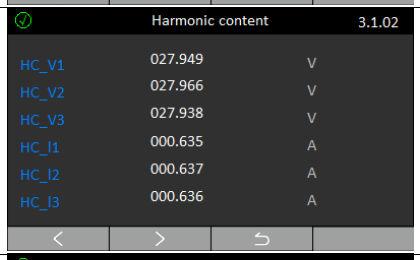
No.	Display	Description
1		Real-time measurement overview
2		Voltage Phase to neutral voltage V1=219.022V V2=218.391V V3=218.594V Phase to phase voltage U12=378.594V U23=378.469V U31=378.952V
3		Current I1=4.9987A I2=5.0014A I3=4.9997A Neutral current I4=0.0001A
4		Active power P1 =1.1002kW P2=1.0997kW P3=1.1003kW P= 3.3002kW
5		Reactive power Q1=-0.002kvar Q2=0.000kvar Q3=-0.002kvar Q =-0.003kvar

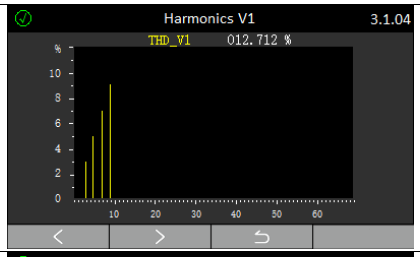
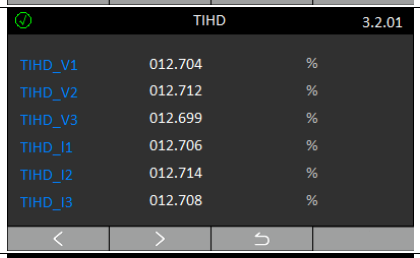
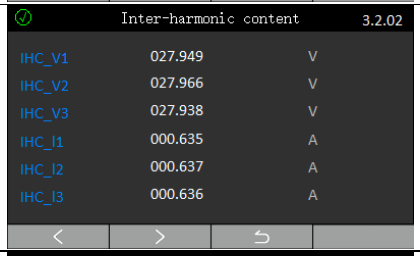
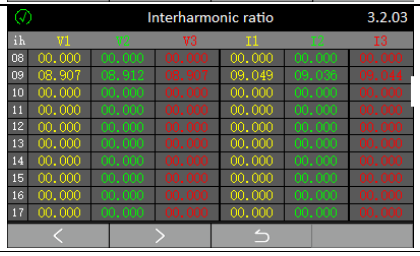
6		Apparent power S1=1.1001kVA S2=1.1006kVA S3=1.1002kVA S=3.3008kVA
7		Power factor PF1=1.000 PF2=1.000 PF3=1.000 PF=1.000
8		Displacement power factor DPF1=1.000 DPF2=1.000 DPF3=1.000 DPF=1.000
9		Equivalent data Equivalent voltage Ue=219.978V Equivalent current Ie= 5.0001A Equivalent apparent power Se=3.300kVA Equivalent power factor PFe=1.000 Non-fundamental equivalent apparent power SeN=0.081kVA Fundamental positive sequence apparent power S1+=3.299kVA Unbalanced apparent power Su1=0.000kVA
10		Frequency F=50.000Hz

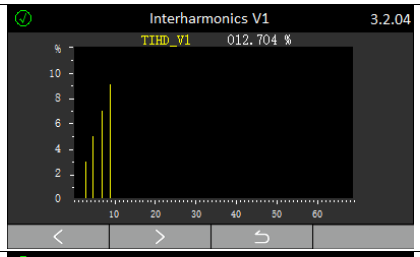
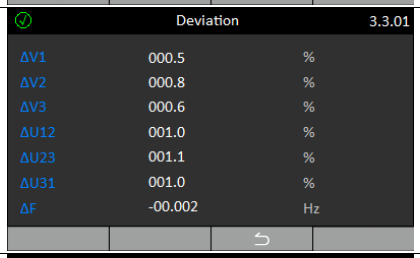
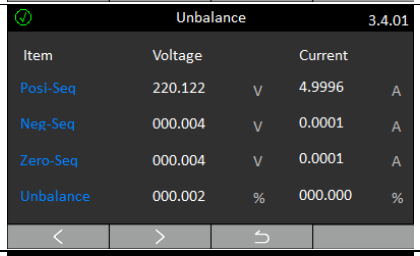
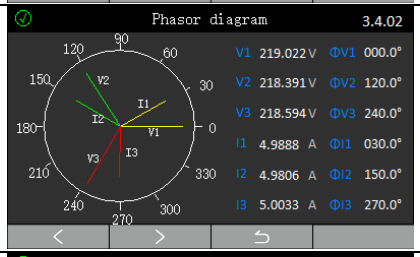
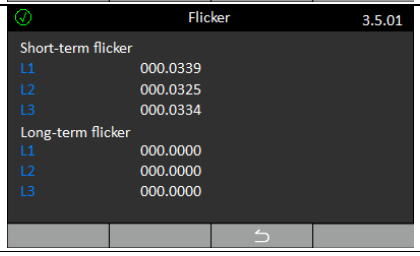
4.2.2.2. Energy metering

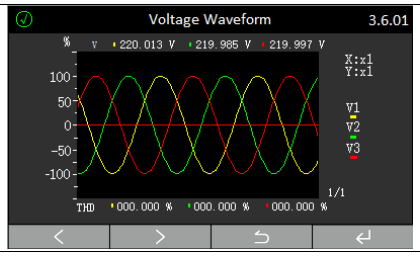
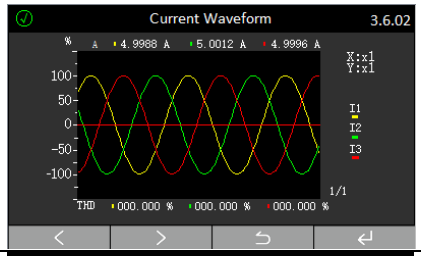
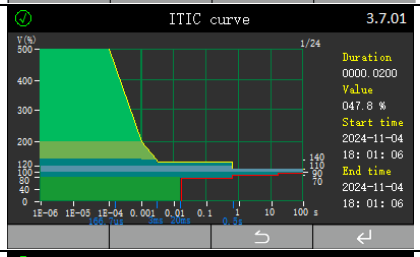
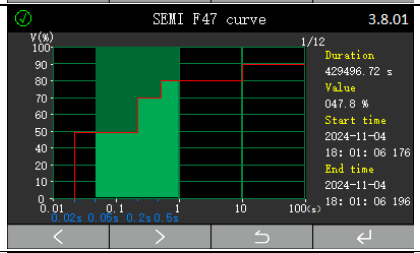
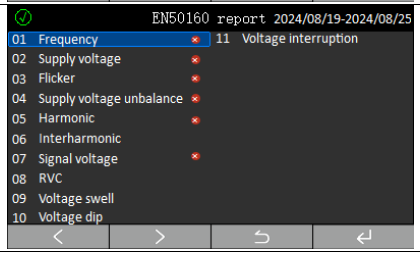
No.	Display	Description
1		Energy overview
2		L1 energy Import active energy EP+ = 2.672kWh Export active energy EP- = 0.322kWh Import reactive energy EP+ = 4.284kvarh Export reactive energy EP- = 1.814kvarh
3		Fundamental energy Fundamental import active energy EP+ =7.964kWh Fundamental export active energy EP- = 0.949kWh Fundamental import reactive energy EQ+ = 1.651kvarh Fundamental export reactive energy EQ- = 0.000kvarh
4		Tariff energy 8 tariffs energy

4.2.2.3. Power quality

No.	Display	Description
1		Power quality overview
2		Total harmonic distortion(THD)
3		Harmonic content
4		Harmonic ratio
5		Harmonic ratio

6		Harmonic bar
7		Total Inter-harmonic distortion
8		Inter-harmonic content
9		Inter-harmonic ratio
10		Inter-harmonic ratio

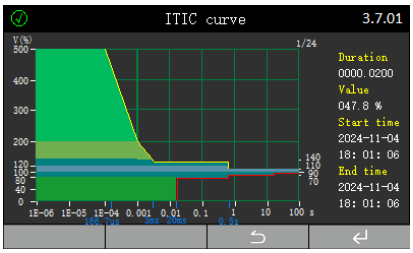
11		Inter-harmonic bar
12		Voltage deviation Frequency deviation
13		Unbalance
14		Phasor diagram
15		Flicker

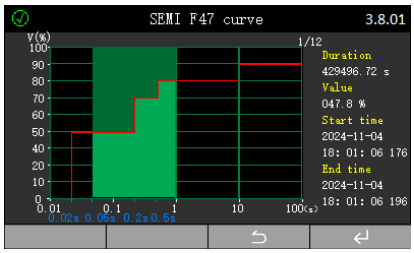
16		Voltage waveform
17		Current waveform
18		ITIC curve
19		SEMI F47 curve
20		EN50160 report

ITIC/SEMI F47 Curves

The ITIC and SEMI F47 curves specify the ability of equipment to withstand power supply's voltage disturbances. Their significance lies in being the benchmarks for assessing the tolerance of power equipment to voltage interference and voltage disturbances in power supply systems.

For the ITIC curve interface displayed by the device, the horizontal axis represents the duration of transient voltage event, and the vertical axis represents the voltage percentage (relative to nominal voltage). The upper curve represents the tolerance of equipment to voltage swells, and the lower curve represents the tolerance of equipment to voltage dips. The area between them represents the normal running range. As shown in the figure below, this interface shows the amplitude-duration distribution of a single transient event.

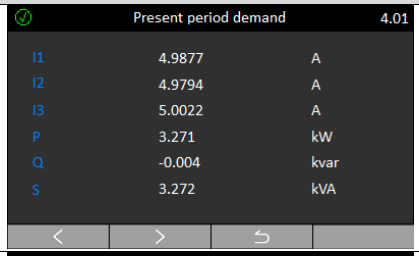
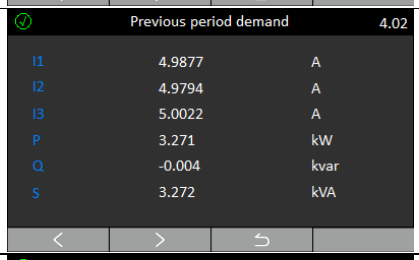
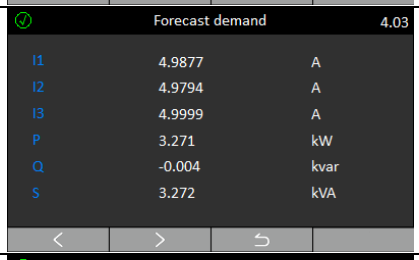
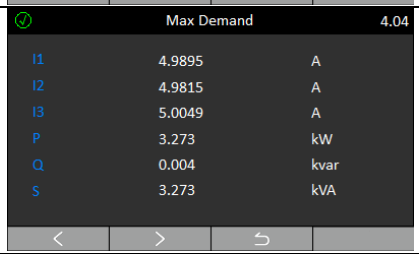




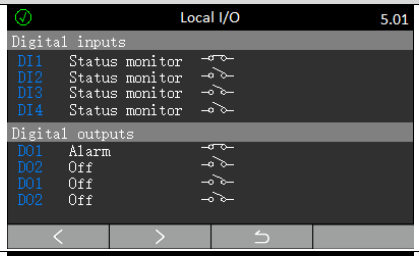
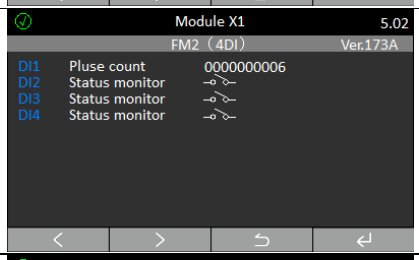
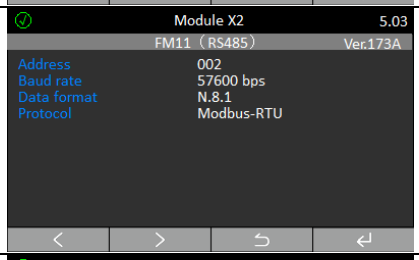
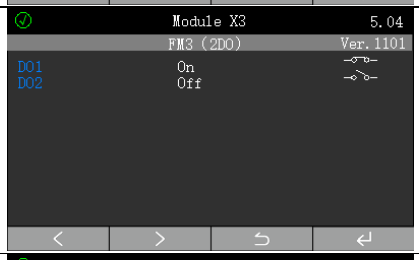
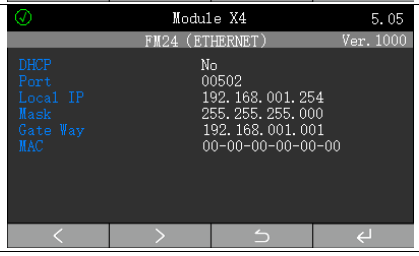
For the SEMI F47 curve interface displayed by the device, the horizontal axis represents the duration of transient voltage event, and the vertical axis represents the voltage percentage (relative to nominal voltage). The specification stipulates the tolerance time of equipment to voltage dips. The area above red solid line represents that the equipment must ensure normal continuous running under such interference.

The equipment can run 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 shows the amplitude-duration distribution of a single transient event.

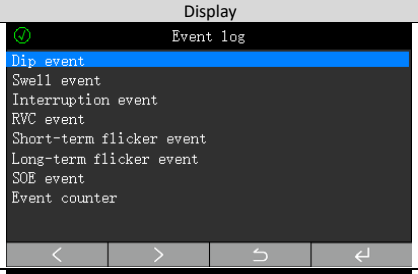
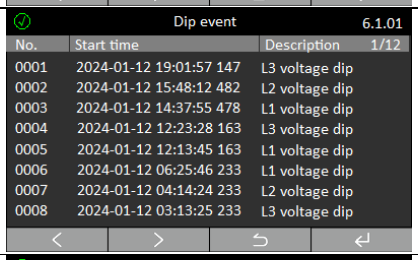
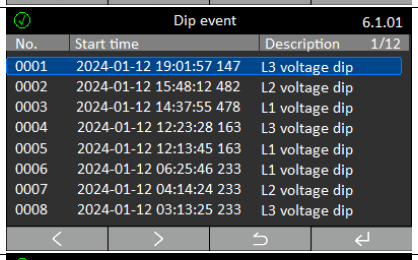
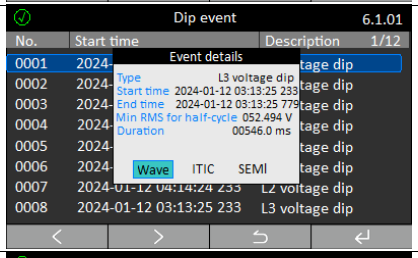
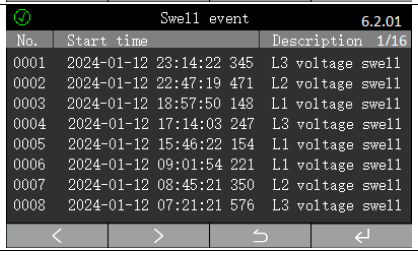
4.2.2.4. Demand

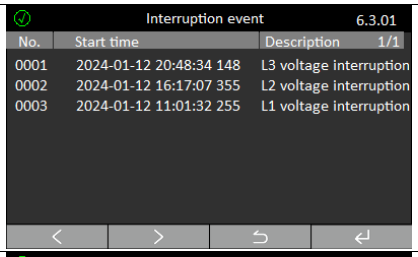
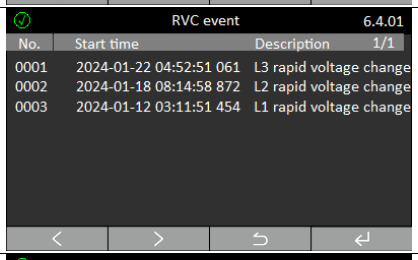
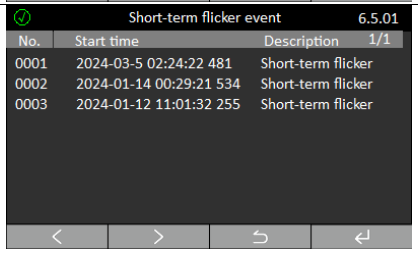
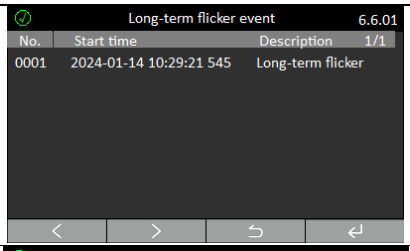
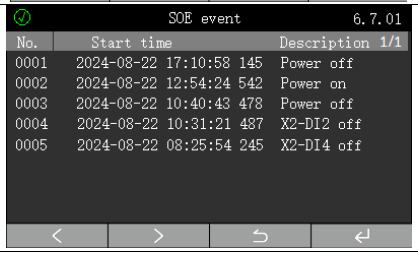
No.	Display	Description
1		Present period demand I1=4.9877A I2=4.9794A I3=5.0022A P=3.271kW Q=-0.004kvar S=3.272kVA
2		Previous period demand I1=4.9877A I2=4.9794A I3=5.0022A P=3.271kW Q=-0.004kvar S=3.272kVA
3		Forecast demand I1=4.9877A I2=4.9794A I3=4.9999A P=3.271kW Q=-0.004kvar S=3.272kVA
4		Max demand I1=4.9895A I2=4.9815A I3=5.0049A P=3.273kW Q=-0.024kvar S=3.273kVA

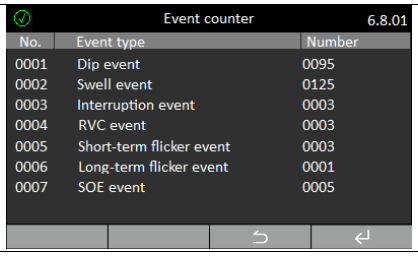
4.2.2.5. Modules

No.	Display	Description
1		Local I/O
2		Expansion module FM2
3		Expansion module FM3
4		Expansion module FM11
5		Expansion module FM24

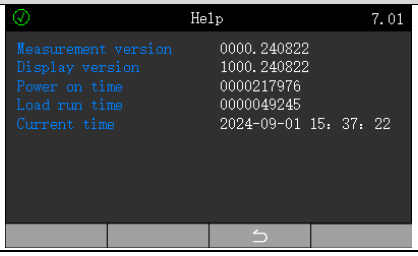
4.2.2.6. SOE logs

No.	Display	Description
1		SOE logs overview
2		Dip event logs
3		Dip event logs
4		Dip event logs
5		Swell event logs

6		Interruption event logs
7		RVC event logs
8		Short term flicker event logs
9		Long term flicker event logs
10		SOE logs

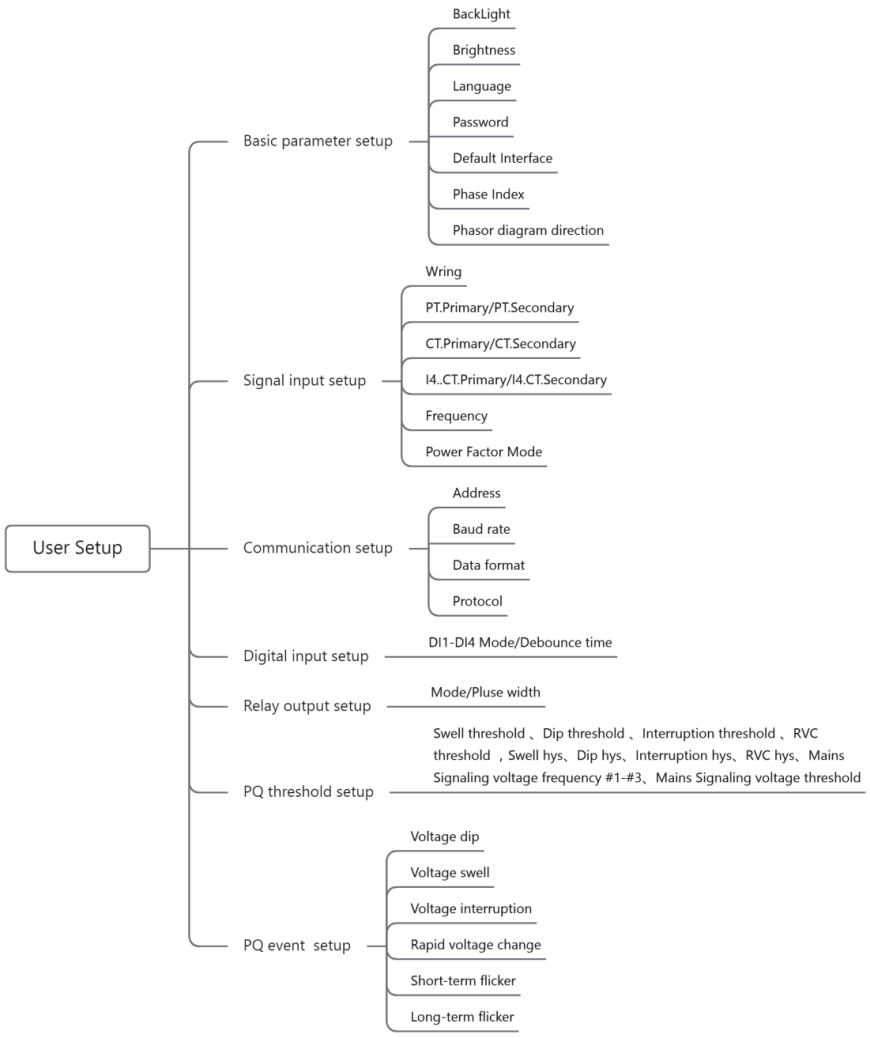
11		Event counter

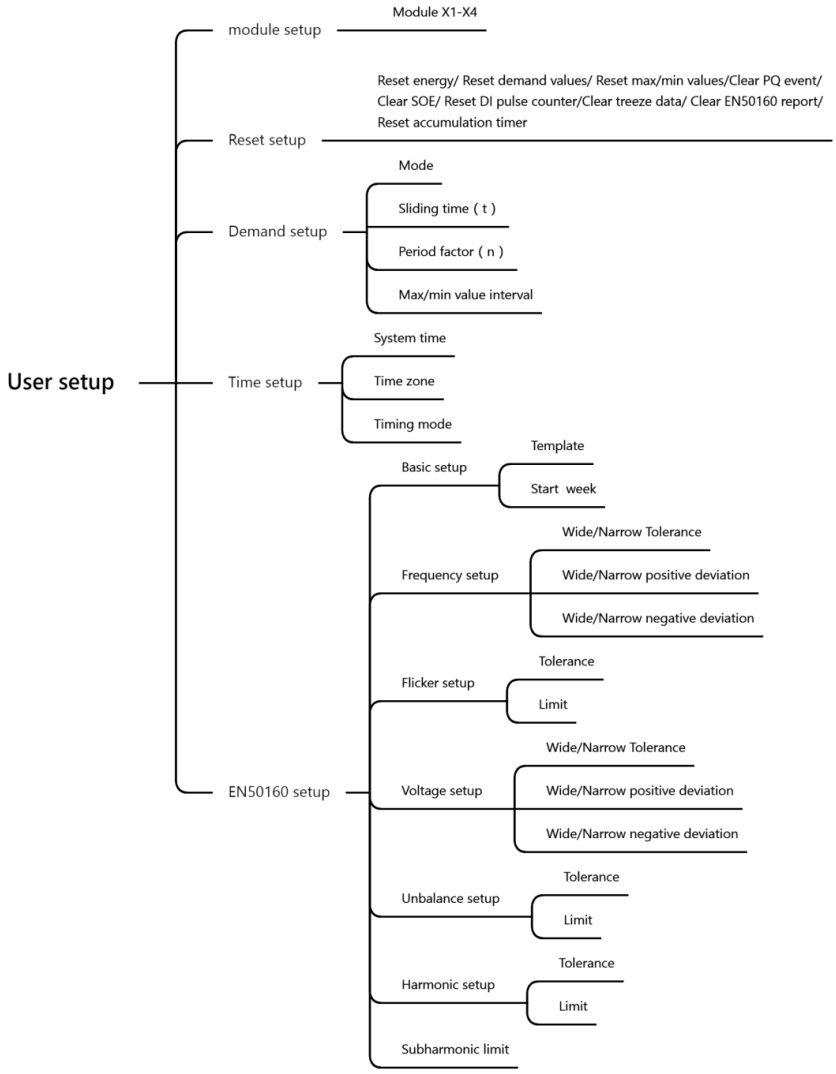
4.2.2.7.Help

No.	Display	Description
1		Help

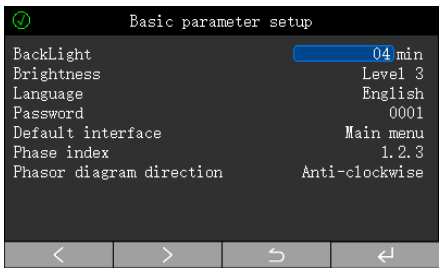
4.3. Setup

4.3.1. Setup menu



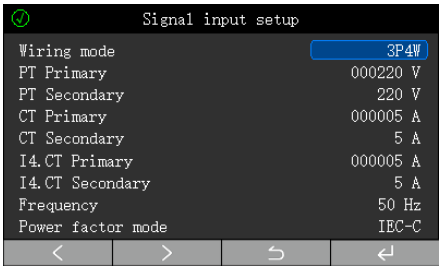

User setup
module setup
Module X1-X4
Reset setup
Reset energy/ Reset demand values/ Reset max/min values/Clear PQ event/ Clear SOE/ Reset DI pulse counter/Clear treeze data/ Clear EN50160 report/ Reset accumulation timer
Demand setup
Mode
Sliding time (t)
Period factor (n)
Max/min value interval
Time setup
System time
Time zone
Timing mode
EN50160 setup
Basic setup
Template
Start week
Frequency setup
Wide/Narrow Tolerance
Wide/Narrow positive deviation
Wide/Narrow negative deviation
Flicker setup
Tolerance
Limit
Voltage setup
Wide/Narrow Tolerance
Wide/Narrow positive deviation
Wide/Narrow negative deviation
Unbalance setup
Tolerance
Limit
Harmonic setup
Tolerance
Limit
Subharmonic limit

4.3.2. Basic parameter setup

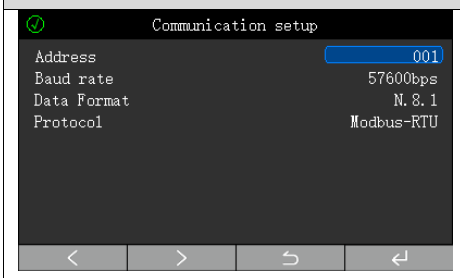
Display	Menu1	Menu2
	BackLight	01... 99min 00 - always on
	Brightness	Level 1...Level5
	Language	English
	Password	0000...9999
	Default interface	Main menu Instant overview Voltage Current Active power Reactive power Apparent power Power factor Frequency Energy overview L1/L2/L3 energy Fundamental energy Tariff energy Present monthly energy THD Harmonic content Harmonic ratio Inter-harmonic content Inter-harmonic ratio Deviation Unbalance Phasor diagram Flicker Voltage Waveform Current Waveform Present demand

		Last demand Predicted demand Max demand Max demand of present month Digital I/O Module X1...X4 About
	Phase index	a.b.c
	Phasor diagram direction	Clock wise / Anti clock wise

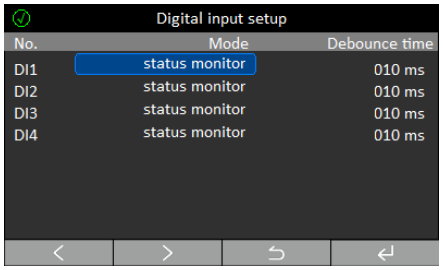
4.3.3. Signal Input Setup

Display	Menu1	Menu2
	Wiring mode	3P3W/3P4W
	PT Primary	1...999999V
	PT Secondary	1...600V
	CT Primary	1...999999A
	CT Secondary	1...6A
	I4. CT Primary	1...999999A
	I4.CT Secondary	1...6A
	Frequency	50Hz/60Hz
	Power factor mode	IEC-C/IEEE-C/IEC-P

4.3.4. Communication Setup

Pantalla	Menu1	Menu2
	Slave Address	1...247
	Baud rate	2400 bps... 115200 bps
	Data format	E81, O81, N81, N82
	Protocol	Modbus-RTU

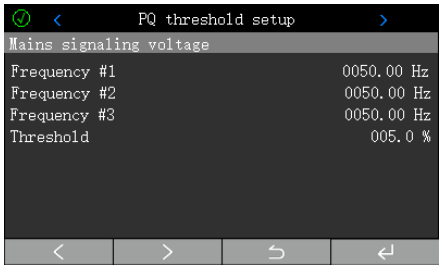
4.3.5. Digital Input Setup

Pantalla	Menu1	Menu2
	Mode	Status monitor/ Pulse counting
	Debounce time	10...1000ms

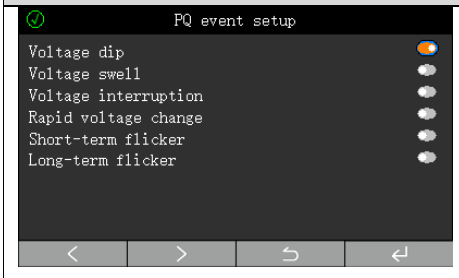
4.3.6. Relay Output Setup

Display	Menu1	Menu2
	Mode	Off/On/Alarm
	Pulse width	0.1...999.9s

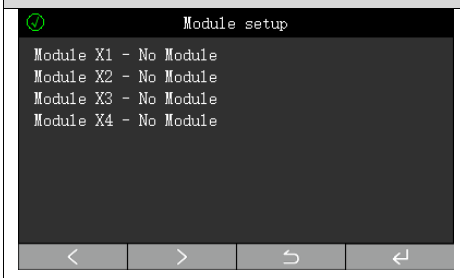
4.3.7. Power quality threshold setup

Display	Menu1	Menu2
	Swell threshold	100...180%
	Dip threshold	0...-100%
	Interruption threshold	0...100%
	RVC threshold	1...6%
	Swell hysteresis	0...10%
	Dip hysteresis	0...10%
	Interruption hysteresis	0...10%
	RVC hysteresis	0...3%
	Mains signaling voltage frequency	50.0...2575.0Hz
	Mains signaling voltage threshold	0.3...1 00%

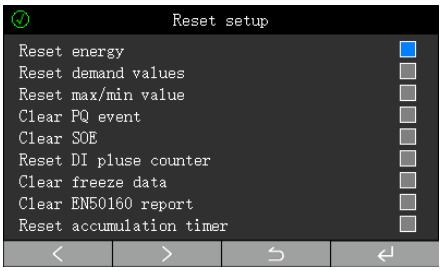
4.3.8. PQ event setup

Display	Menu1	Menu2
	Swell	Enable/Disable
	Dip	Enable/Disable
	Interruptiont	Enable/Disable
	RVC	Enable/Disable
	Short term flicker	Enable/Disable
	Long term flicker	Enable/Disable

4.3.9. Module setup

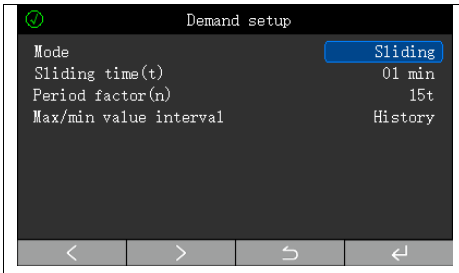
Display	Menu1
	Module setup

4.3.10. Reset setup

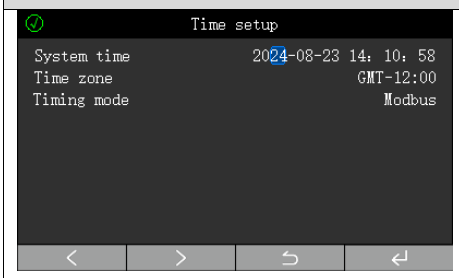
Pantalla	Menu1	Menu2
	Reset energy values	Enable/Disable
	Reset demand values	Enable/Disable
	Reset max/min values	Enable/Disable
	Clear PQ event logs	Enable/Disable
	Clear SOE logs	Enable/Disable
	Reset DI pulse counter	Enable/Disable
	Clear freeze data	Enable/Disable
	Clear EN50160 report	Enable/Disable
	Reset accumulation timer	Enable/Disable

4.3.11. Demand setup

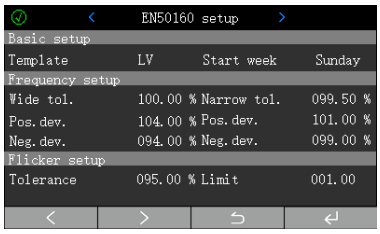
Display	Menu1	Menu2
	Mode	Sliding block/Fixed block
	Sliding time	1min...60 min

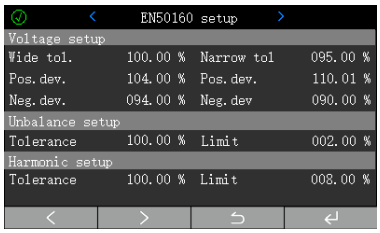
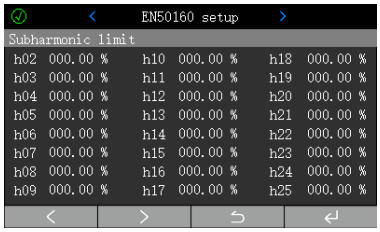
	Period factor	1t...30 t
	Max/min interval	Historic /1/5/15/30/60/1440 min

4.3.12. Time setup

Pantalla	Menu1	Menu2
	System time	Year/Month/day/hour/ minute/second
	Time zone	GMT-12:00 ...GMT+13
	Timing mode	Modbus/IRIG-B/Web /NTP

4.3.13. EN50160 Setup

Pantalla	Menu1	Menu2	Menu3
	Basic update	Template	LV/MV/HV
		Start week	Monday...Sunday
	Frequency setup	Wide/Narrow Tolerance	0...100%
		Wide/Narrow positive deviation	0...200%
		Wide/Narrow negative deviation	0...100%
	Flicker setup	Tolerance	0...100%
		Limit	0...100
	Voltage setup	Wide/Narrow Tolerance	0...100%
		Wide/Narrow positive deviation	0...200%

<table>
<tr><td rowspan="4"> 
</td><td rowspan="2"></td><td>Wide/Narrow negative deviation</td><td>0...100%</td></tr>
<tr><td rowspan="2">Unbalance setup</td><td>Tolerance</td><td>0...100%</td></tr>
<tr><td>Limit</td><td>0...100%</td></tr>
<tr><td>Harmonics setup</td><td>Tolerance</td><td>0-100%</td></tr>
<tr><td> 
</td><td>THD limit setup</td><td>Limit</td><td>0-100%</td></tr>
<tr><td></td><td>Subharmonic limit</td><td colspan="2">0...200%</td></tr>
</table>

5. Functions

5.1. Real-time measurements

The device can measure the full electric parameters of power grid.

Measurement		Phase	Total	Max	Min	Average	Demand
Voltage	Phase voltage	●	—	●	●	●	—
	Line voltage	●	—	—	—	●	—
	Fundamental voltage	●	—	—	—	—	—
Current	Current	●	—	●	●	●	●
	Neutral current	—	●	●	●	—	—
	Fundamental current	●	—	—	—	—	—
Power	Active power	●	●	●	●	●	●
	Reactive power	●	●	●	●	●	●
	Apparent power	●	●	●	●	●	●
Power factor		●	●	●	●	—	—
Frequency		—	●	●	●	—	—

5.2. Energy metering

The device can measure different types of energy, specifically:

- Bidirectional active/reactive energy
- Fundamental active/reactive energy
- Reactive energy in four quadrants
- Apparent energy
- Energy by tariff

The device allows to configure 8 daily tariffs, weekly tariffs or 12 time-of-use tariffs, as well as up to 90 variable public holidays.

When the switchover time is reached, or when the year/month registers for the change are set directly to 0xFFFF, the current tariff will be replaced by the backup tariff and the switchover time register will be cleared (the device will always operate on the current tariff).

The following energy values are recorded per tariff:

- Current total energy / T1 / T2 / T3 / T4 / T5 / T6 / T7 / T8
- Total energy / T1 / T2 / T3 / T4 / T5 / T6 / T7 / T8 for the current month
- Total historical energy / T1 / T2 / T3 / T4 / T5 / T6 / T7 / T8 from 1 to 12 months prior

5.3. Demand

The device can provide:

- Current period demand
- Previous period demand
- Peak demand
- Peak demand for the current month
- Peak demand for the previous month
- Peak demand for the last 2 months

It offers two calculation methods:

- Sliding window
- Fixed window

The relevant settings can be configured via communication.
The device can measure basic demand values, including:

- 6 fixed values: (I1, I2, I3, P, Q, S)
- 10 optional values (see communication manual)

Demand can be calculated using two methods: sliding window and fixed window. The time parameters involved are:

- t: sliding time (minutes)
- T: calculation period or interval (minutes)

Sliding block demand:
Every t minutes, the average demand value over the last T minutes is calculated, evaluated, recorded and the automatic monthly demand reading is taken.

Fixed block demand:
Every T minutes, the average demand over the last T minutes is calculated, evaluated, recorded, and the monthly demand reading is taken automatically.

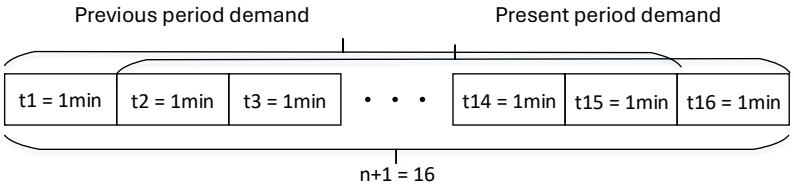
5.3.1. Sliding Block Demand

The settings relating to the sliding calculation are as follows:

- **Mode**: Sliding block
- **Sliding time (t):** "1" minute
- **Period factor (n):** Set to "15"

The calculation method is shown in Figure 5.2.1.1:

- **Demand for the previous period** = (dmdt1 + dmdt2 + … + dmdt14 + dmdt15) / 15
- **Demand for the current period** = (dmdt2 + dmdt3 + … + dmdt15 + dmdt16) / 15



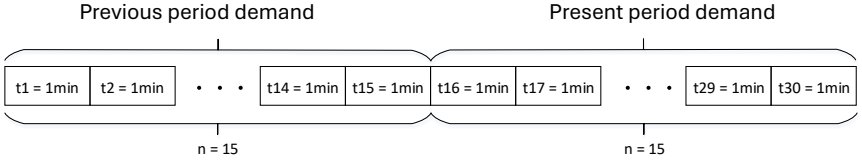
5.3.2. Fixed Block Demand

The settings for the fixed-block calculation are as follows:

- **Mode**: Fixed block
- **Sliding time (t):** "1" minute
- **Period factor (n):** "15"

The calculation method is shown in Figure 5.2.2.1:

- **Demand for the previous period** = (dmdt1 + dmdt2 + … + dmdt14 + dmdt15) / 15
- **Demand for the current period** = (dmdt16 + dmdt17 + … + dmdt29 + dmdt30) / 15



5.4. Max/Min Values

The device provides two types of maximum and minimum values: interval values and historical values. When the interval time is set to “0”, these are historical values; when it is not “0”, these are interval values. For example, if the interval is set to 15 minutes and the current time is 12:20, the values displayed by the device correspond to the period from 12:00 to 12:15.

The device provides basic maximum and minimum data, including:

- 15 fixed maximum values
- 15 fixed minimum values
- 34 programmable values

5.5. Power Quality

5.5.1. Power Quality

The device can monitor and analyse the quality of the power grid, including the following parameters:

- Voltage deviation
- Frequency deviation
- Harmonics
- Interharmonics
- Unbalance
- Flicker
- Surges (swell)
- Voltage dips
- Outages
- Rapid voltage changes

5.5.2. Fundamental Wave Analysis

The device can provide the following fundamental data:

- Split-phase fundamental phase/line voltage
- Split-phase fundamental current
- Split-phase/total fundamental active power
- Split-phase/total fundamental reactive power
- Split-phase/total fundamental apparent power
- Split-phase/total fundamental power factor

5.5.3. Crest Factor

The device calculates the crest factor by analyzing a complete voltage and current cycle to provide crest factors of three-phase voltage and current:

Crest factor = Peak value / r.m.s value

5.5.4. K Factor

The device calculates the k-factor based on the calculated harmonic data of current to provide k-factor of three-phase current:

$$k = \frac{\sum_{h=2}^{h=h_{max}} I_h^2 h^2}{I_{th}^2}$$

Where **h** refers to the harmonic order, **Ih** represents the harmonic distortion value for the hth-order current harmonic, and **Ith** represents the total harmonic distortion value. The device is capable of measuring harmonics from the 2nd to the 51st order; therefore, **hmax = 51.**

5.5.5. Voltage Deviation

Changes in the running mode of power supply and distribution system and slow variations in load will cause the voltage at various points of the system to change accordingly. The difference between voltage at each point and rated voltage is known as voltage deviation, which is usually expressed as a percentage. The calculation method is as follows:

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

ΔU - voltage deviation

U - actual voltage

U_N - rated voltage

5.5.6. Frequency Deviation

Frequency deviation refers to the difference between actual value and nominal value of system frequency under normal running conditions in the power system. The calculation method is as follows:

Frequency deviation = Actual frequency - Nominal frequency

5.5.7. Harmonic and Inter-harmonic

Harmonics
Perform Fourier series decomposition on the periodic alternating quantity to obtain components with frequencies that are integer multiples of the fundamental frequency higher than 1.

Inter-harmonics
Perform Fourier series decomposition on the periodic alternating quantity to obtain components with frequencies that are not equal to integer multiples of the fundamental frequency higher tan 1.

The device provides the following harmonic data:

- Split-phase 2nd ... 51st voltage/current harmonic ratio
- voltage/current THD
- voltage/current harmonics content
- Split-phase harmonic active power
- Split-phase harmonic reactive power
- Split-phase 1st ... 50st inter-harmonic ratio of voltage/current
- Voltage/current inter-harmonics content

5.5.8. Unbalance

For four-wire three-phase systems, the device calculates the voltage and current imbalance based on the calculated positive and negative sequence components.

$$\mathrm{Unb2} = \frac{\mathrm{U2}}{\mathrm{U1}} \times 100$$

$$\mathrm{Unb0} = \frac{\mathrm{U0}}{\mathrm{U1}} \times 100$$

$$\mathrm{Inb2} = \frac{\mathrm{I2}}{\mathrm{I1}} \times 100$$

$$\mathrm{Inb0} = \frac{\mathrm{I0}}{\mathrm{I1}} \times 100$$

For three-phase, three-wire systems, the device calculates the voltage and current imbalance based on the maximum and average voltage and current values.

$$Unb = \frac{\max(U - Uavg)}{Uavg} \times 100$$

$$Inb = \frac{\max(I - Iavg)}{Iavg} \times 100$$

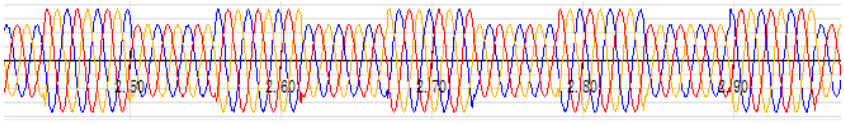
The device also simultaneously provides the real and imaginary components of the fundamental voltage and current waveforms.

5.5.9. Voltage Flicker

The human visual response to unstable lighting caused by voltage fluctuations (lamp flickering) is known as flicker. In other words, **flicker** reflects the impact of lighting flickering due to voltage variations on human visual perception.

The device provides short-term and long-term flicker values along with timestamps. Specifically:

- The update cycle for short-term flicker is **10 minutes**
- The update cycle for long-term flicker is **2 hours**



Waveform Screenshot of Voltage Flicker

5.5.10. Voltage Swell, dip and Interruption

Swell: Under standard frequency conditions, the root mean square (RMS) value of the voltage rises to between 1.1 and 1.8 times the nominal voltage.

Dip: Under standard frequency conditions, the root mean square (RMS) value of the voltage drops to between 0.1 and 0.9 times the nominal voltage.

Voltage interruption: Under standard industrial frequency conditions, the root mean square (RMS) value of the voltage falls below 0.1 times the nominal voltage for a period not exceeding 1 minute.

The device offers the following functions:

- Overvoltage, dip and interruption events per phase
- Start and end times, duration and extreme values of the events
- Waveform records of the events

The device allows the following parameters to be configured:

- Event triggering
- Selection and configuration of event data sources
- Configuration of event thresholds, hysteresis and detection duration

Voltage dip: Under standard frequency conditions, the rms voltage drops to between 0.1 and 0.9 times the nominal voltage.

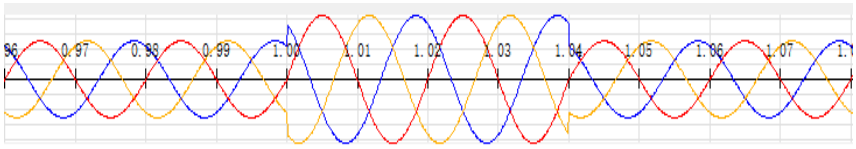
Voltage interruption: Under standard frequency conditions, the rms voltage falls below 0.1 times the nominal voltage for a period not exceeding 1 minute.

The device offers the following functions:

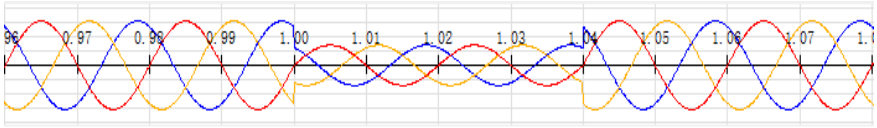
- Overvoltage, dip and interruption events per phase
- Start and end times, duration and extreme values of events
- Waveform records of events

The device allows the following parameters to be configured:

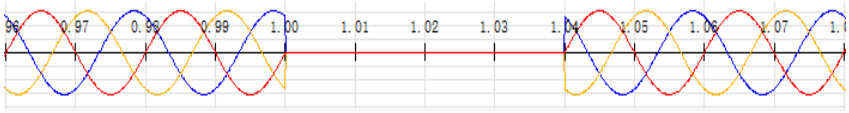
- Event triggering
- Selection and configuration of event data sources
- Configuration of event thresholds, hysteresis and detection duration



Waveform Screenshot of Voltage Swell



Waveform Screenshot of Voltage dip



Waveform Screenshot of Voltage Interruption

5.5.11. Rapid Voltage Change

Rapid voltage change refers to a rapid transition in the effective value of voltage between two stable voltage states, with the maximum change in effective voltage value not exceeding the threshold for voltage swell or dip.

The device provides the following functions:

- Rapid change events of split-phase/total voltage
- Occurrence and end time, duration, **ΔUmax** and **ΔUss** of rapid voltage change event
- Waveform recordings during a rapid voltage change event

The device provides the following relevant parameter Setup:

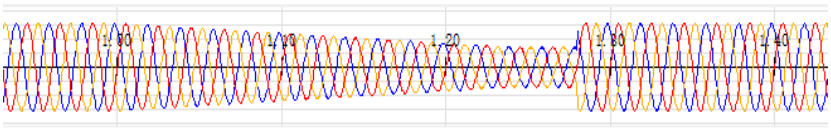
- Event judgment enable setting
- Event judgment threshold and hysteresis setting

△Umax: It refers to the maximum absolute value of difference between the last Uavg before an RVC event starts and any Urms during the event. For a multiphase system, it refers to maximum value among △Umax of all phases.

△Uss: It refers to the absolute value of difference between the last Uavg before an event starts and the first Uavg after the event ends. For a multiphase system, the maximum value among all phases is taken.

Uavg: It refers to the arithmetic mean of 100 consecutive Urms.

Urms: It refers to the effective value of voltage half-wave.



Waveform Screenshot of Rapid Voltage Change

5.6. Alarm

The device can provide independent alarms with configurable activation, limit, hysteresis and delay settings. When an alarm is triggered, the value of the corresponding entry in the communication address table will be updated accordingly.

Alarm parameters include voltage, current, power, THD, etc.

Alarm activation conditions:

1. The relevant alarm is enabled.

2. The value is greater than the threshold for upper limit alarms; or less than the threshold for lower limit alarms.

3. The duration exceeds the set delay time.

Alarm deactivation conditions:

- The value is below the threshold minus the hysteresis for upper limit alarms.
- The value is above the threshold plus the hysteresis for lower limit alarms.

Alarm item:

LN-Voltage	2^{nd}... 51^{st} current harmonic ratio
LL-Voltage	2^{nd}... 51^{st} voltage harmonic content
Current	2^{nd}... 51^{st} current harmonic content
N-phase Current	1^{st}... 50^{st} voltage inter-harmonic ratio
Total Apparent Power	1^{st}... 50^{st} current inter-harmonic content

Tabla con formato

Total Active Power	DI1 ON
Total Reactive Power	DI1 OFF
Total Power Factor	DI2 ON
Zero-sequence voltage unbalance	DI2 OFF
Negative-sequence voltage unbalance	DI3 ON
Zero-sequence current unbalance	DI3 OFF
Negative-sequence current unbalance	DI4 ON
Fundamental Voltage	DI4 OFF
Fundamental Current	X1-DI1 ON
Voltage Deviation	X1-DI1 OFF
Frequency	X1-DI2 ON
Frequency Deviation	X1-DI2 OFF
THD-V	X1-DI3 ON
TOHD-V	X1-DI3 OFF
TEHD-V	X1-DI4 ON
THD-I	X1-DI4 OFF
TOHD-I	X2-DI1 ON
TEHD-I	X2-DI1 OFF
TIHD-V	X2-DI2 ON
TOIHD-V	X2-DI2 OFF
TEIHD-V	X2-DI3 ON
TIHD-I	X2-DI3 OFF
TOIHD-I	X2-DI4 ON
TEIHD-I	X2-DI4 OFF
HC_V	X3-DI1 ON
HC_I	X3-DI1 OFF
IHC_V	X3-DI2 ON
IHC_I	X3-DI2 OFF
Present demand-P	X3-DI3 ON
Present demand-Q	X3-DI3 OFF
Present demand-S	X3-DI4 ON
Present demand-PF	X3-DI4 OFF
Forecast demand-P	X4-DI1 ON
Forecast demand-Q	X4-DI1 OFF
Forecast demand-S	X4-DI2 ON
Forecast demand-PF	X4-DI2 OFF
Short-term flicker	X4-DI3 ON
Long-term flicker	X4-DI3 OFF
Rapid voltage change	X4-DI4 ON
2^{nd} ... 51^{st} voltage harmonic ratio	X4-DI4 OFF

5.7. Event Log

The device provides 1,024 data records for querying, where each record can be divided into two parts i.e., event + occurrence time. The event is divided into a high byte (event classification) and a low byte (specific event), as shown in the following table:

High byte	Event Classification	Low byte	Specific Events
0x00	No event	—	—
0x01	Power on/off event	0x00	Power off
		0x01	Power on
0x02	Over-limit start event	—	See communication manual
0x03	Over-limit end event	—	
0x04	DI event	0x00	DI1 ON
		0x01	DI1 OFF
		0x02	DI2 ON
		0x03	DI2 OFF
		0x04	DI3 ON
		0x05	DI3 OFF
		0x06	DI4 ON
		0x07	DI4 OFF
		0x08	X1-DI1 ON
		0x09	X1-DI1 OFF
		0x0A	X1-DI2 ON
		0x0B	X1-DI2 OFF
		0x0C	X1-DI3 ON
		0x0D	X1-DI3 OFF
		0x0E	X1-DI4 ON
		0x0F	X1-DI4 OFF
		0x10	X2-DI1 ON
		0x11	X2-DI1 OFF
		0x12	X2-DI2 ON
		0x13	X2-DI2 OFF
		0x14	X2-DI3 ON
		0x15	X2-DI3 OFF
		0x16	X2-DI4 ON
		0x17	X2-DI4 OFF
		0x18	X3-DI1 ON
		0x19	X3-DI1 OFF
		0x1A	X3-DI2 ON
		0x1B	X3-DI2 OFF
		0x1C	X3-DI3 ON
		0x1D	X3-DI3 OFF
		0x1E	X3-DI4 ON

		0x1F	X3-DI4 OFF
		0x20	X4-DI1 ON
		0x21	X4-DI1 OFF
		0x22	X4-DI2 ON
		0x23	X4-DI2 OFF
		0x24	X4-DI3 ON
		0x25	X4-DI3 OFF
		0x26	X4-DI4 ON
		0x27	X4-DI4 OFF
0x05	DO event	0x00	DO1 ON
		0x01	DO1 OFF
		0x02	DO2 ON
		0x03	DO2 OFF
		0x04	DO3 ON
		0x05	DO3 OFF
		0x06	DO4 ON
		0x07	DO4 OFF
		0x08	X1- DO1 ON
		0x09	X1- DO1 OFF
		0x0A	X1- DO2 ON
		0x0B	X1- DO2 OFF
		0x0C	X2- DO1 ON
		0x0D	X2- DO1 OFF
		0x0E	X2- DO2 ON
		0x0F	X2- DO2 OFF
		0x10	X3- DO1 ON
		0x11	X3- DO1 OFF
		0x12	X3- DO2 ON
		0x13	X3- DO2 OFF
		0x14	X4- DO1 ON
		0x15	X4- DO1 OFF
		0x16	X4- DO2 ON
		0x17	X4- DO2 OFF

0x06	Meter operation event	0x00	Setup change
		0x01	Reset energy values
		0x02	Reset demand values
		0x03	Reset max/min values
		0x05	Clear SOE logs
		0x07	Reset DI pulse counter
		0x09	Reset running timer
		0x0A	Clear PQ event
		0x0B	Clear EN50160 report
		0x0C	Clear freeze data
		0xFF	Clear all records

5.8. Data Freezing

The device allows data to be frozen, including:

- 5 fixed data points (imported active energy, exported active energy, imported reactive energy, exported reactive energy and apparent energy)
- 20 optional data points

The freezing interval can be set to: 1 min, 5 min, 15 min, 30 min, 60 min or 1440 min.

5.9. Address Mapping

The device has **60 registers** whose addresses can be programmed.

For example, if the master system wishes to read the values of the following in a single frame:

- Phase V1 voltage
- Phase V2 voltage
- Phase V3 voltage
- Average phase voltage

It can be configured as follows:

- Custom setting 1/2 → “0x0006” / “0x0007” (V1 address)
- Custom setting 3/4 → “0x0008” / “0x0009” (V2 address)
- Custom setting 5/6 → “0x000A” / “0x000B” (V3 address)
- Custom setting 7/8 → “0x000C” / “0x000D” (average voltage address)

Once the configuration is complete, the master system can read 8 addresses directly from **0x6D00** to obtain all this data in a single frame.

5.10. Digital Input

The digital input module adopts the dry contact mode. Since it is equipped with an built-in power source, the device can be used to monitor the state of the circuit breaker, accumulate the pulses of energy without external power source.

5.11. Relay Output

The relay output allows you to select three modes:

- OFF mode
- Alarm mode
- Remote control mode

5.12. Expansion Modules

- FM2: 4 digital inputs
- FM3: 2 relay outputs
- FM11: RS485, Modbus-RTU
- FM24: BACnet/IP communication

The device supports expansion modules, including **FM2, FM3, FM11 y FM24**.