SPM73 Multi-function Power Meter

User Manual

V1.0.8

ZHUHAI PILOT TECHNOLOGY CO.,LTD

Safety Precautions

 DANGERS AND WARNINGS

This equipment may only be installed by qualified professionals.

The manufacturer assumes no liability for malfunctions caused by failure to comply with the instructions in this manual.

 RISK OF ELECTRIC SHOCK, BURN, OR EXPLOSION

The equipment may only be installed and maintained by qualified personnel.

Before performing any operation on the equipment, isolate the voltage inputs and power supply, and short-circuit the secondary windings of all current transformers.

Use a suitable voltage detection device to confirm that the voltage has been disconnected.

Before energizing the equipment, restore all mechanical components, doors, and covers to their original positions.

The equipment must be supplied with the correct rated voltage during operation.

Failure to observe these precautions may result in serious injury.

We have verified the consistency between the hardware and software descriptions in this manual. However, as it is impossible to completely eliminate errors, we cannot guarantee absolute consistency. Data in this manual will be reviewed periodically, and necessary revisions will be made in new editions. Suggestions for improvement are welcome. Changes in future versions will not be announced separately.

Contents

Chapter 1 Product Overview

The SPM73 three-phase Multi-function Power Meter (hereinafter referred to as SPM73) is mainly applicable to power distribution cabinets and switchgear in high and low voltage power distribution systems below 650kV. SPM73 is equipped with an RS485 industrial bus as standard, supporting Modbus RTU/DLT645 communication protocols for networking management, which can be used for data collection, meter reading and automatic control by the background system.

The product performance meets the relevant technical requirements of Class D active energy in GB/T 17215.321-2021 and Class 0.5S reactive energy in GB/T 17215.324-2022.

The main functions of the product are as follows:

- Full electrical quantity measurement: three-phase voltage, current, active power, reactive power, apparent power, power factor, frequency, voltage-current angle, voltage/current average value
- Fundamental wave measurement: three-phase fundamental voltage, fundamental current, fundamental active power, fundamental reactive power, fundamental apparent power, fundamental power factor
- Energy measurement: bidirectional energy, phase-separated energy, four-quadrant energy, optional time-of-use energy
- Demand function: real-time demand, predicted demand, optional billing day maximum demand, monthly maximum demand
- Power quality (optional): 63rd harmonic analysis, voltage and current harmonic content rate, THD, TOHD, TEHD, zero-sequence and negative-sequence unbalance, current K-factor, voltage crest factor, current TDD
- Data recording (optional): 10-year and 12-month historical energy, billing day maximum demand, monthly maximum demand, electrical parameter maximum/minimum values, electrical parameter billing day maximum/minimum values
- Event recording (optional): 200 event records
- Operation recording (optional): 100 operation records
- Phase sequence adjustment: software adjustment of current transformer phase sequence
- Alarms: 32 types of alarms including phase voltage overvoltage/undervoltage, line voltage overvoltage/undervoltage, current overcurrent/undercurrent, frequency

overhigh/overlow, power overhigh, phase loss, phase sequence error, digital input 1-6 action, harmonic distortion rate,unbalance factor, etc.

- Up to 6 optional active or passive digital inputs
- Up to 6 optional relay outputs
- 1 optical pulse output as standard
- Up to 2 optional RS485 communications
- Up to 2 optional 4~20mA DC analog outputs
- Up to 4 optional temperature measurements
- Rated current 1A/5A configurable
- Universal for high and low voltage, compatible with 3×57.7/100V and 3×220/380V
- Supports interface visualization of individual harmonics, capacitive/inductive loads, temperature and leakage current values
- Supports flexible configuration of zero-value alarms and phase-separated alarms
- Analog output and configuration interface visualization
- Optional Ethernet port, supporting 10M/100M adaptive
- Optional 1 channel of neutral-to-ground voltage, neutral current or 1 channel of residual current

Chapter 2 Product Selection

SPM73-①-②-③	
①Model Code (Mandatory, select only one)	
E1	1x RS485
E2	2x Active DI + 2x Relay Output + 1x RS485
E3	6x Active DI + 2x Relay Output + 1x RS485
E4	6x Passive DI + 2x Relay Output + 1x RS485
E5	6x Passive DI + 6x Relay Output + neutral current + neutral-to-ground voltage + 1x Ethernet port + 2x RS485
E6	6x Passive DI + 2x Relay Output + 2x AO + 4x Temperature + 1x Residual current + 2x RS485
②Model Code (Optional)	
Q	Power Quality Analysis + TOU Energy + SOE + Max/Min function
③Model Code (Optional. If not selected, active energy accuracy is 0.5S class)	
L02	Segment LCD, Active energy accuracy is 0.2S

Selection Examples

SPM73-E5-Q-L02: Segment LCD, Active energy accuracy is 0.2S, 6x passive DI, 6 x relay output, 2x RS485, 1x neutral current, 1x neutral-to-ground voltage, 1x Ethernet, supporting power quality analysis function.

SPM73-E1: Segment LCD, Active energy accuracy is 0.5S , 1x RS485, standard full electrical quantity measurement.

Note 1: If the rated current is 1A, the L02 option is not supported.

Chapter 3 Installation and Wiring

3.1 Outline Dimensions(Unit: mm)

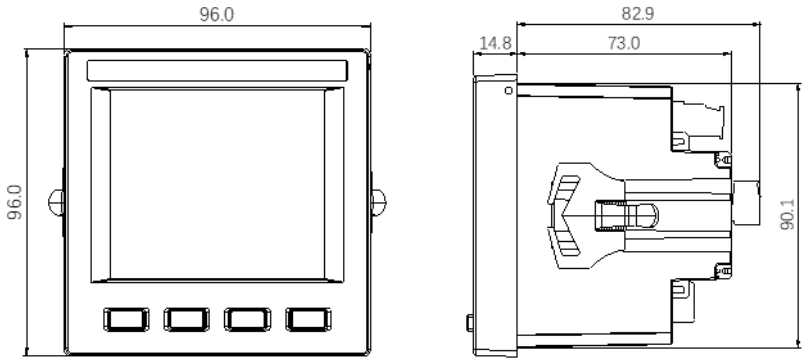


Figure 1 Outline Dimensions

3.2 Installation Diagram(Unit: mm)

Environment

SPM73 should be installed in a dry, clean location, away from heat sources and strong electromagnetic fields.

Installation Location

Typically installed in switchgear cabinets, protecting SPM73 from oil, dirt, dust, corrosive gases, or other harmful substances. Ensure convenient access for maintenance and sufficient space for wiring, terminal blocks, shorting plates, and other necessary equipment.

Installation Method

1) Install SPM73 into a 96mm x 96mm cutout.
2) Remove the mounting clips, push SPM73 from front to back into the panel cutout.
3) Slide the two mounting clips into the grooves on both sides of SPM73 and push them forward tightly, so the front ends of the clips squeeze against the switch panel, thus horizontally securing SPM73 on the switchgear body.

Installation Dimensions

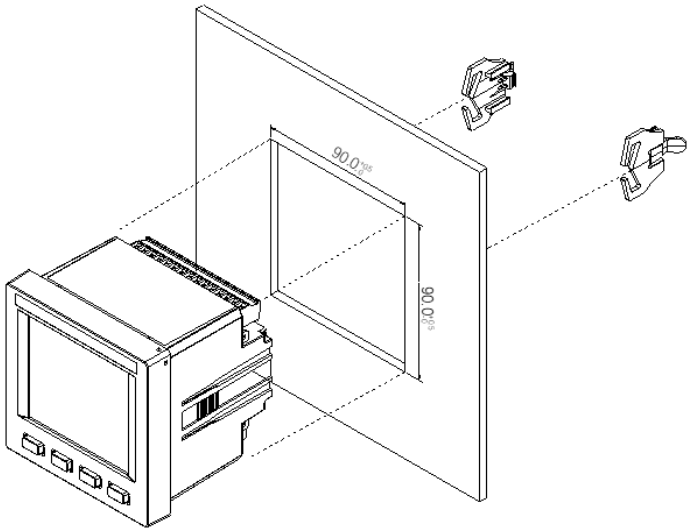


Figure 2 Installation Dimensions

3.3 Product Terminal Diagram

Note: Due to the small laser marking area for voltage and current on the back of SPM73, the actual voltage and current silkscreen is located directly above the housing. A separate rear view diagram is provided for better understanding of actual wiring.

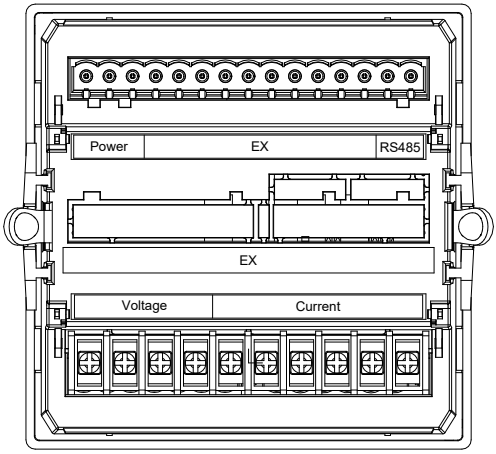


Figure 3 Terminal arrangement diagram

3.3.1 Terminal Diagram for E1

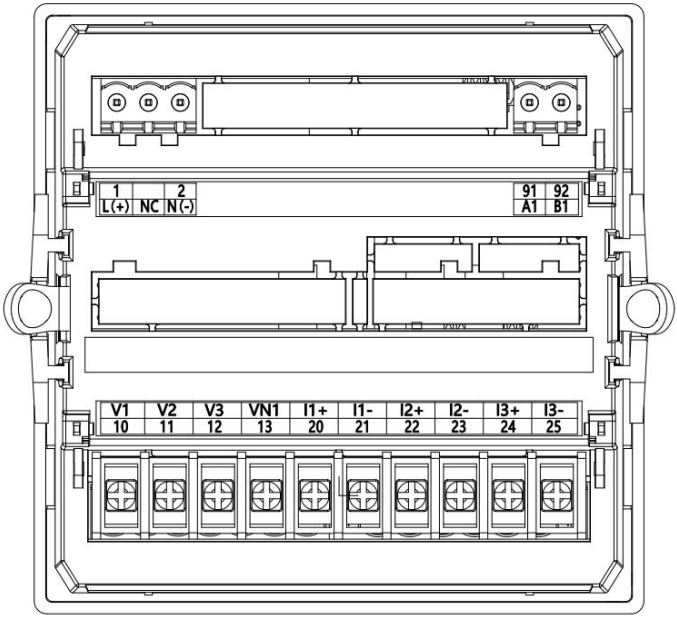


Figure 4 Terminal Diagram for E1

Description as follows:

No.	Symbol	Description	No.	Symbol	Description
1	L(+)	Power Line (Live)	2	N(-)	Power Neutral
10	V1	Phase A voltage	11	V2	Phase B voltage
12	V3	Phase C voltage	13	VN1	Neutral (Voltage N)
20	I1+	Phase A Current In	21	I1-	Phase A Current Out
22	I2+	Phase B Current In	23	I2-	Phase B Current Out
24	I3+	Phase C Current In	25	I3-	Phase C Current Out
91	A1	RS485+	92	B1	RS485-

3.3.2 Terminal Diagram for E2

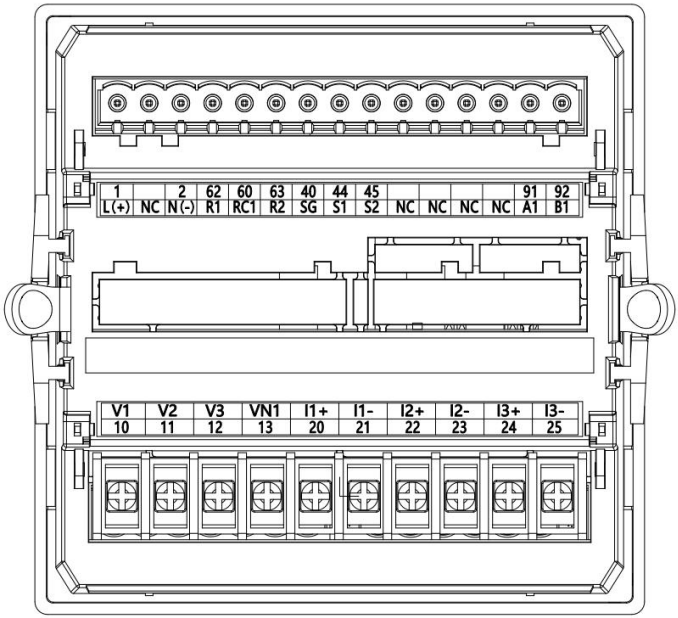


Figure 5 Terminal Diagram for E2

Description as follows:

No.	Symbol	Description	No.	Symbol	Description
1	L(+)	Power Line (Live)	2	N(-)	Power Neutral
10	V1	Phase A voltage	11	V2	Phase B voltage
12	V3	Phase C voltage	13	VN1	Neutral (Voltage N)
20	I1+	Phase A Current In	21	I1-	Phase A Current Out
22	I2+	Phase B Current In	23	I2-	Phase B Current Out
24	I3+	Phase C Current In	25	I3-	Phase C Current Out
40	SG	DI Common	44	S1	Digital Input 1
45	S2	Digital Input 2	60	RC1	Relay Output Common
62	R1	Relay Output 1	63	R2	Relay Output 2
91	A1	RS485+	92	B1	RS485-

3.3.3 Terminal Diagram for E3

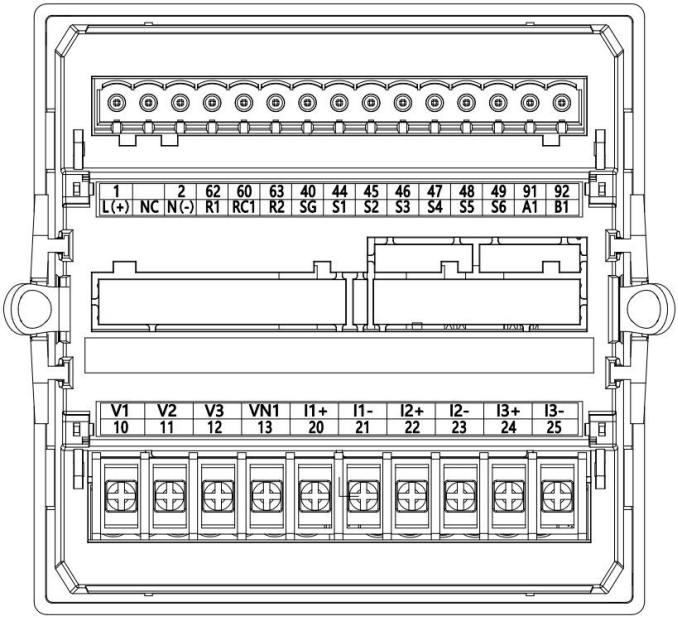


Figure 6 Terminal Diagram for E3

Description as follows:

No.	Symbol	Description	No.	Symbol	Description
1	L(+)	Power Line (Live)	2	N(-)	Power Neutral
10	V1	Phase A voltage	11	V2	Phase B voltage
12	V3	Phase C voltage	13	VN1	Neutral (Voltage N)
20	I1+	Phase A Current In	21	I1-	Phase A Current Out
22	I2+	Phase B Current In	23	I2-	Phase B Current Out
24	I3+	Phase C Current In	25	I3-	Phase C Current Out
40	SG	DI Common	44	S1	Digital Input 1
45	S2	Digital Input 2	46	S3	Digital Input 3
47	S4	Digital Input 4	48	S5	Digital Input 5
48	S6	Digital Input 6	60	RC1	Relay Output Common
62	R1	Relay Output 1	63	R2	Relay Output 2
91	A2	RS485+	92	B2	RS485-

3.3.4 Terminal Diagram for E4

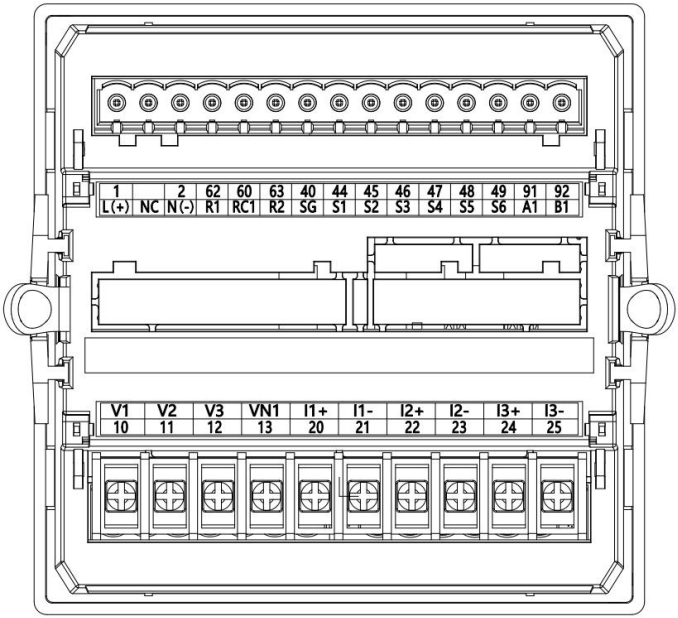


Figure 7 Terminal Diagram for E4

Description as follows:

No.	Symbol	Description	No.	Symbol	Description
1	L(+)	Power Line (Live)	2	N(-)	Power Neutral
10	V1	Phase A voltage	11	V2	Phase B voltage
12	V3	Phase C voltage	13	VN1	Neutral (Voltage N)
20	I1+	Phase A Current In	21	I1-	Phase A Current Out
22	I2+	Phase B Current In	23	I2-	Phase B Current Out
24	I3+	Phase C Current In	25	I3-	Phase C Current Out
40	SG	DI Common	44	S1	Digital Input 1
45	S2	Digital Input 2	46	S3	Digital Input 3
47	S4	Digital Input 4	48	S5	Digital Input 5
48	S6	Digital Input 6	60	RC1	Relay Output Common
62	R1	Relay Output 1	63	R2	Relay Output 2
91	A2	RS485+	92	B2	RS485-

3.3.5 Terminal Diagram for E5

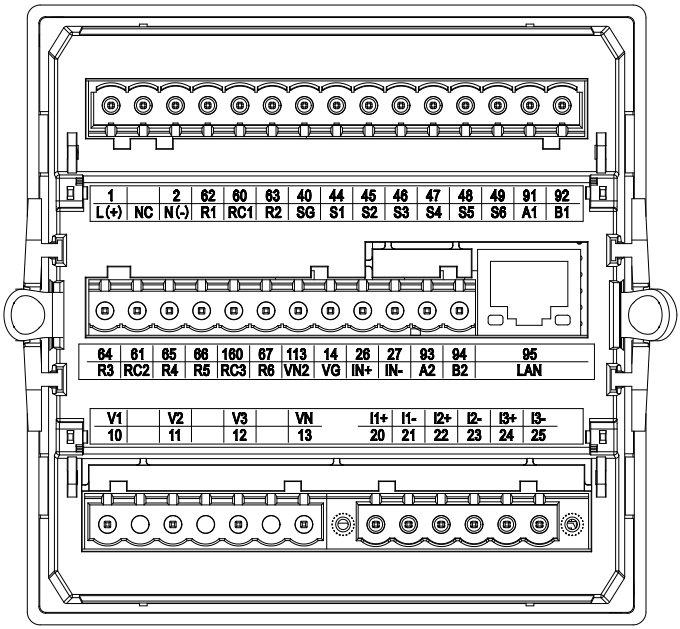


Figure 8 Terminal Diagram for E5

Description as follows:

No.	Symbol	Description	No.	Symbol	Description
1	L(+)	Power Line (Live)	2	N(-)	Power Neutral
10	V1	Phase A voltage	11	V2	Phase B voltage
12	V3	Phase C voltage	13	VN1	Neutral (Voltage N)
20	I1+	Phase A Current In	21	I1-	Phase A Current Out
22	I2+	Phase B Current In	23	I2-	Phase B Current Out
24	I3+	Phase C Current In	25	I3-	Phase C Current Out
40	SG	DI Common	44	S1	Digital Input 1
45	S2	Digital Input 2	46	S3	Digital Input 3
47	S4	Digital Input 4	48	S5	Digital Input 5
48	S6	Digital Input 6	60	RC1	Relay Output Common 1
62	R1	Relay Output 1	63	R2	Relay Output 2

91	A2	1st RS485+	92	B2	1st RS485-
No.	**Symbol**	**Description**	**No.**	**Symbol**	**Description**
64	R3	Relay Output 3	61	RC2	Relay Output Common 2
65	R4	Relay Output 4	66	R5	Relay Output 5
160	RC3	Relay Output Common 3	67	R6	Relay Output 6
113	VN2	Neutral line 2 (voltage neutral)	14	VG	Neutral-to-ground voltage
26	IN+	Neutral current In	27	IN-	Neutral current Out
93	A2	2nd RS485+	94	B2	2nd RS485-
95	LAN	Ethernet port			

3.3.6 Terminal Diagram for E6

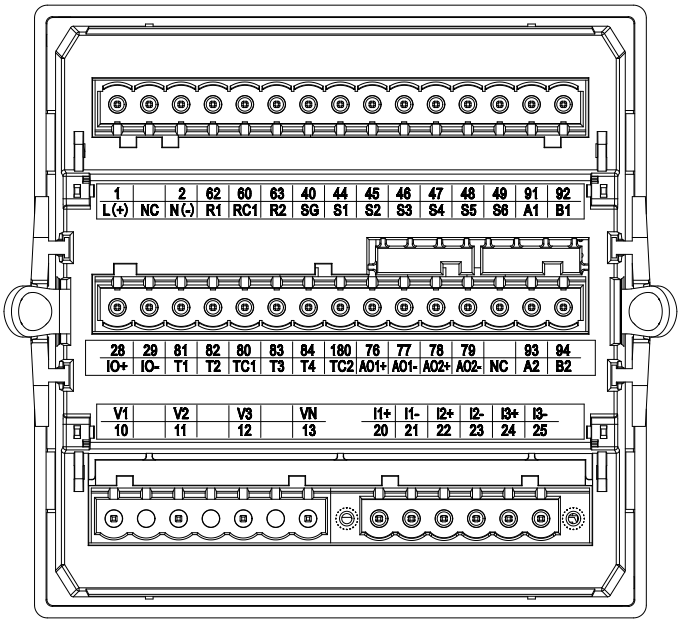


Figure 9 Terminal Diagram for E6

Description as follows:

No.	Symbol	Description	No.	Symbol	Description
1	L(+)	Power Line (Live)	2	N(-)	Power Neutral
10	V1	Phase A voltage	11	V2	Phase B voltage

12	V3	Phase C voltage	13	VN1	Neutral (Voltage N)
20	I1+	Phase A Current In	21	I1-	Phase A Current Out
22	I2+	Phase B Current In	23	I2-	Phase B Current Out
24	I3+	Phase C Current In	25	I3-	Phase C Current Out
40	SG	DI Common	44	S1	Digital Input 1
45	S2	Digital Input 2	46	S3	Digital Input 3
47	S4	Digital Input 4	48	S5	Digital Input 5
48	S6	Digital Input 6	60	RC1	Relay Output Common
62	R1	Relay Output 1	63	R2	Relay Output 2
91	A2	1st RS485+	92	B2	1st RS485-
No.	**Symbol**	**Description**	**No.**	**Symbol**	**Description**
28	IO+	Residual current In	29	IO-	Residual current Out
81	T1	Temperature sensor 1	82	T2	Temperature sensor 2
80	TC1	Temperature sensor Common 1	83	T3	Temperature sensor
84	T4	Temperature sensor 4	180	TC2	Temperature sensor Common 2
76	AO1+	1st AO+	77	AO1-	1ST AO-
78	AO2+	2ND AO+	79	AO2-	2ND AO-
93	A2	2nd RS485+	94	B2	2nd RS485-

3.4 Meter Wiring

3.4.1 Power Supply Wiring

For AC systems, connect the phase line to the L(+) terminal and the neutral line to the N(-) terminal. For DC power supplies, connect the positive pole to the L(+) terminal and the negative pole to the N(-) terminal.

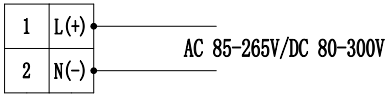


Figure 10 Power Supply Wiring Diagram

3.4.2 Voltage and Current Input Wiring

	The secondary side of a PT must not be short-circuited. The secondary side of a CT must not be open-circuited. When disconnecting the CT and monitoring circuit connection, use a shorting block to short-circuit the CT's secondary side. SPM73 is suitable for various three-phase systems. Please read this section carefully to select the appropriate wiring method. The input voltage should be within SPM73's rated voltage range.
	When wiring, pay attention to the phase sequence correspondence between voltage and current; otherwise, it will cause errors in power calculation data. Also, pay attention to the CT polarity connection; otherwise, it will cause the power calculation data to be negative.

The following illustrates typical wiring diagrams for various scenarios. Voltage Transformer is abbreviated as PT, Current Transformer as CT.

The primary side of the PT must be protected by a circuit breaker or fuse. The PT used should have a rated capacity greater than 25VA, and the secondary side of the PT should also be equipped with fuses. CTs should be connected to shorting terminals or test boxes to ensure CT wiring safety.

The excitation on the primary side of PTs and CTs will generate large voltages and currents in the secondary circuits. Therefore, necessary safety measures must be taken when installing SPM73, such as removing PT fuses and shorting CT secondary circuits.

In the wiring diagrams below, P represents the number of phase conductors, and W represents the number of live wires. For example, "3P4W" represents a three-phase four-wire system. Set the appropriate system wiring mode as described.

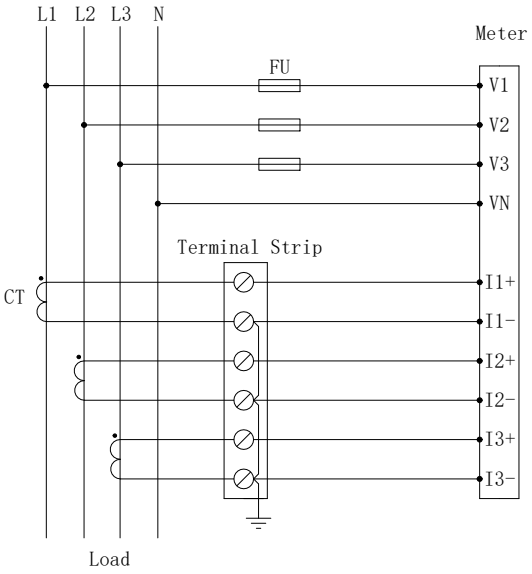


Figure 11 3P4W, No PT, 3CT

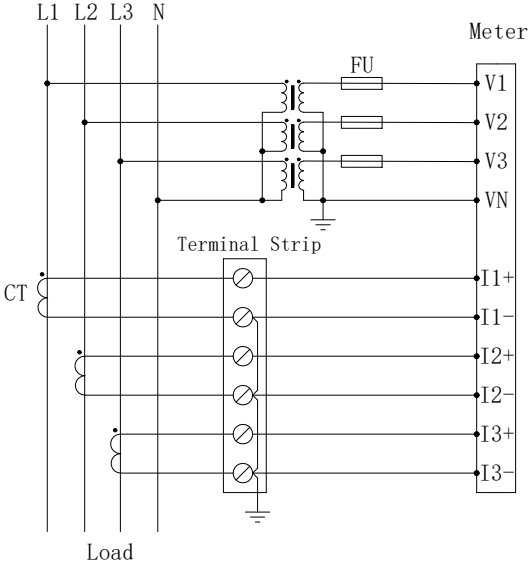


Figure 12 3P4W, 3PT, 3CT

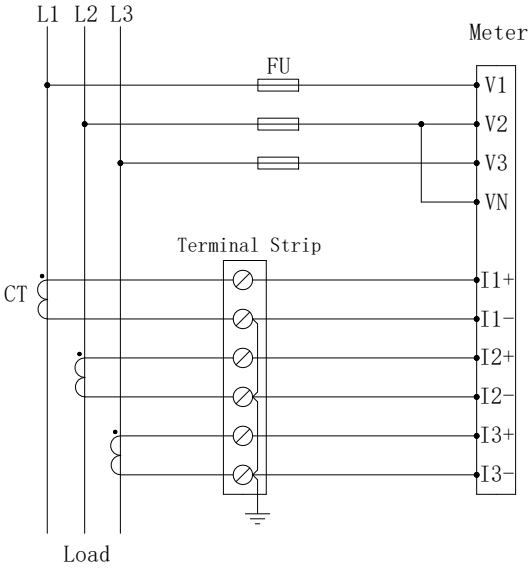


Figure 13 3P3W, No PT, 3CT

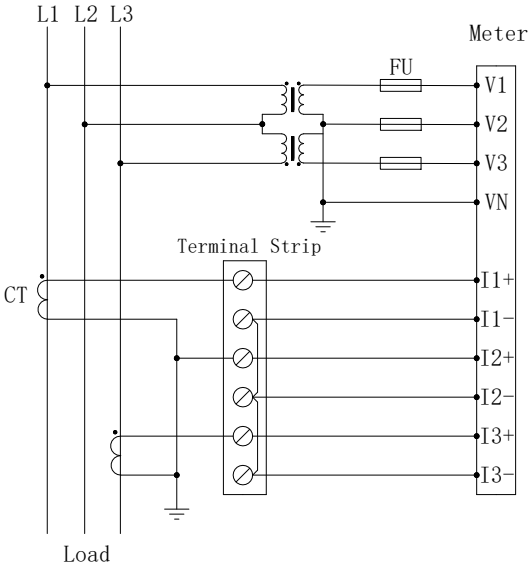


Figure 14 3P3W, 2PT, 2CT

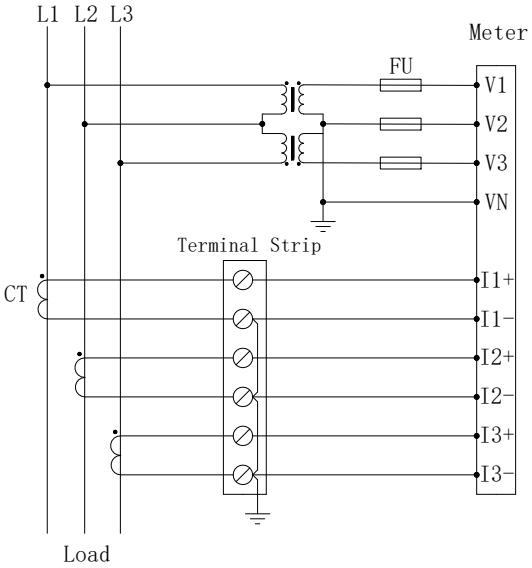


Figure 15 3P3W, 2PT, 3CT

Note:

1. For "3P3W, 2PT, 3CT" application scenarios, when the bus voltage is ⩽690VLL, it can be directly connected without PTs.
2. The wiring mode set on SPM73 must match the actual wiring mode (Wiring mode setting is described in Section 4.4); otherwise, electrical parameter measurement may be abnormal.

3.4.3 RS485 Communication Wiring

SPM73 can be equipped with 1 or 2 RS485 ports. The terminals for the 1st RS485 are marked A1 and B1, for the 2nd RS485 are marked A2, B2.

The RS485 communication method allows up to 32 meters on one bus, connected to a host computer via an RS-232/RS-485 converter. Communication cables can be ordinary shielded twisted pair, with a total length not exceeding 1200 meters. The positive and negative polarities of the RS485 ports of all devices must be correctly connected. If the shielded twisted pair is long, it is recommended to connect a resistor of approximately 120Ω at the end of the bus to improve communication reliability. The communication wiring is as follows:

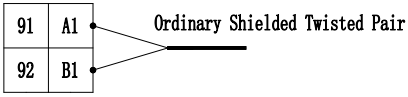


Figure 16 1st RS485 Communication Wiring

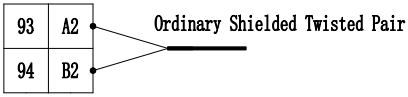


Figure 17 2nd RS485 Communication Wiring Diagram

3.4.4 Digital Input Wiring

SPM73 can be optionally equipped with up to 6 digital inputs, terminals marked S1, S2, S3, S4, S5, S6, SC, used to detect the status of external contacts.

SPM73 provides two specifications: external passive contact input and external active contact input. Users need to order according to actual requirements.

- External passive contact(Dry Contact): When the external status signal only provides position information, select passive digital input. SPM73 has an internal DC excitation source to provide the feedback signal when the contact is closed. The wiring diagram is as follows:

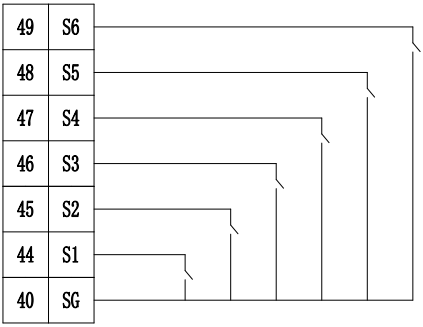


Figure 18 Passive Digital Input Wiring Diagram

- External active contact(Wet Contact): When the external status signal not only provides position information but also provides an additional feedback voltage signal, select active digital input. The wiring diagram is as follows:

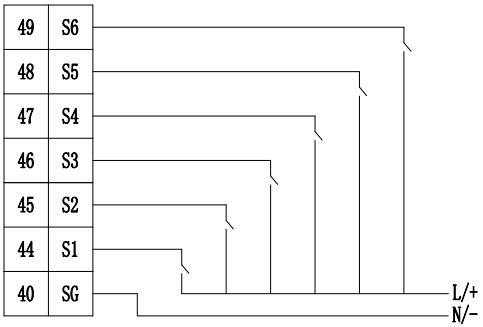


Figure 19 Active Digital Input Wiring Diagram

3.4.5 Relay Output Wiring

SPM73 can be optionally equipped with up to 6 relay outputs, terminals marked R1, R2, R3, R4, R5, R6, RC, all are Normally Open (NO) contacts. They can directly switch loads of 250VAC/5A or 30VDC/5A. If applied to 220V DC, the breaking capacity is 0.2A. If the load current is large, it is recommended to add an intermediate relay.

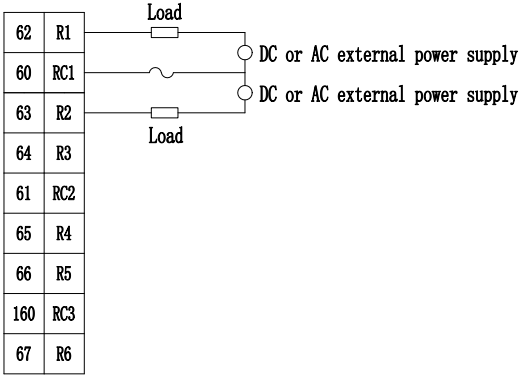


Figure 20 Relay Output Wiring Diagram

If the relay is used to control circuit breaker tripping/closing, to ensure reliability, do not connect the relay directly into the control circuit. Always add an intermediate relay in the control circuit, and use the intermediate relay contacts to trip/close the circuit breaker. Example using R1:

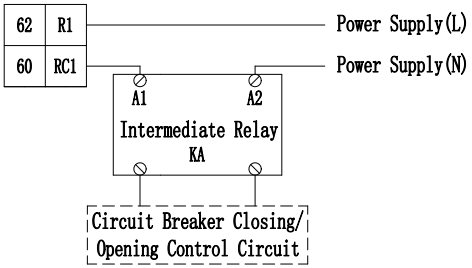


Figure 21 Relay Output Wiring Diagram (Connected to Circuit Breaker Control Circuit via Intermediate Relay)

3.4.6 Analog Output Wiring

SPM73 can be optionally equipped with 2 channels of 4-20mA analog output, terminals marked AO1+, AO1-, AO2+, AO2-. The analog output maximum load is 500 ohms, output range 4~20mA.

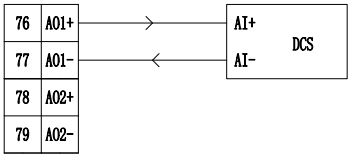


Figure 22 Analog Output Wiring Diagram

3.4.7 Temperature Sensor Wiring

SPM73 can be optionally equipped with 4 channels of temperature measurement, providing temperature monitoring from -50℃ to 150℃, which can be used to monitor cable or distribution boxes. Dimensions (mm):

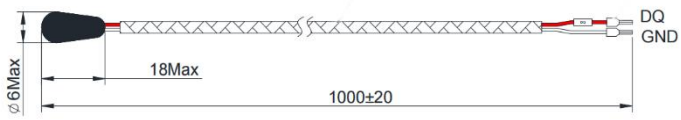


Figure 23 Temperature Sensor Dimension Diagram

Installation Instructions

Secure the temperature sensor to the cable or joint where temperature needs to be measured. The temperature sensor leads are polarized: the signal wire is red, connect to

terminals marked T1~T4 on SPM73; the GND wire is black, connect to the terminal marked TC on SPM73. Wiring as shown below:

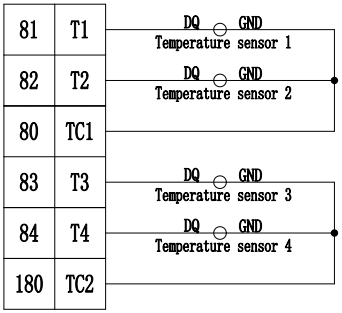


Figure 24 Temperature Sensor Wiring Diagram

Note:

1. Ensure the circuit is de-energized before connecting the sensor to any equipment to prevent electric shock.
2. Fix the probe part (black area) of the temperature sensor to the insulation layer of the measured cable with a cable tie, 2cm~3cm away from the circuit breaker contacts. Ensure the probe is at least 1cm away from the edge of the insulation layer. Ensure the probe adheres to the cable. DO NOT directly touch live metal.
3. Coil any excess temperature sensor cable and secure it with cable ties.

Chapter 4 Display and Key Operation Instructions

4.1 Panel Display

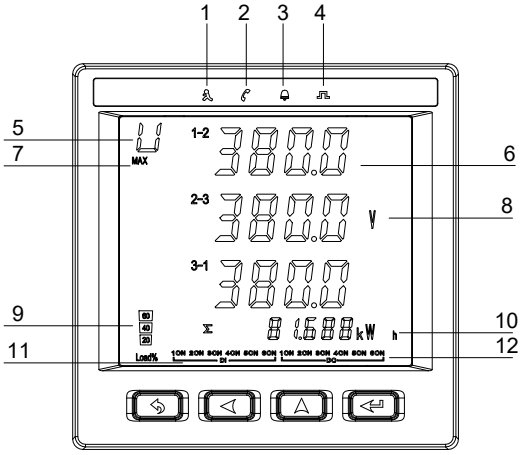


Figure 25 Panel Display Diagram

No.	Definition	No.	Definition
1	Run Indicator	2	Comm Indicator
3	Alarm Indicator	4	Pulse Indicator
5	Title Indicator	6	Main Display Area
7	Auxiliary Indicator	8	Unit Display
9	Load Status	10	Bottom Data Display
11	Digital Input Status	12	Relay Status

Note: The backlight turns off by default after 60 seconds without key operation and lights up again when a key is pressed. The backlight off time can be set via communication.

4.2 Key Description

Note: The same key may have different functions in different interfaces.

△ Main Menu Toggle / Increase Cursor Value / Long Press: Return to Previous Level

◁ Submenu Toggle / Move Cursor Left / Long Press: Return to Previous Submenu

↵ Confirm

↩ Return

4.3 Display Interface

Real-time measurement data is displayed in the form of main menus and submenus. Main menu page turn key: △ , Submenu page turn key: ◁

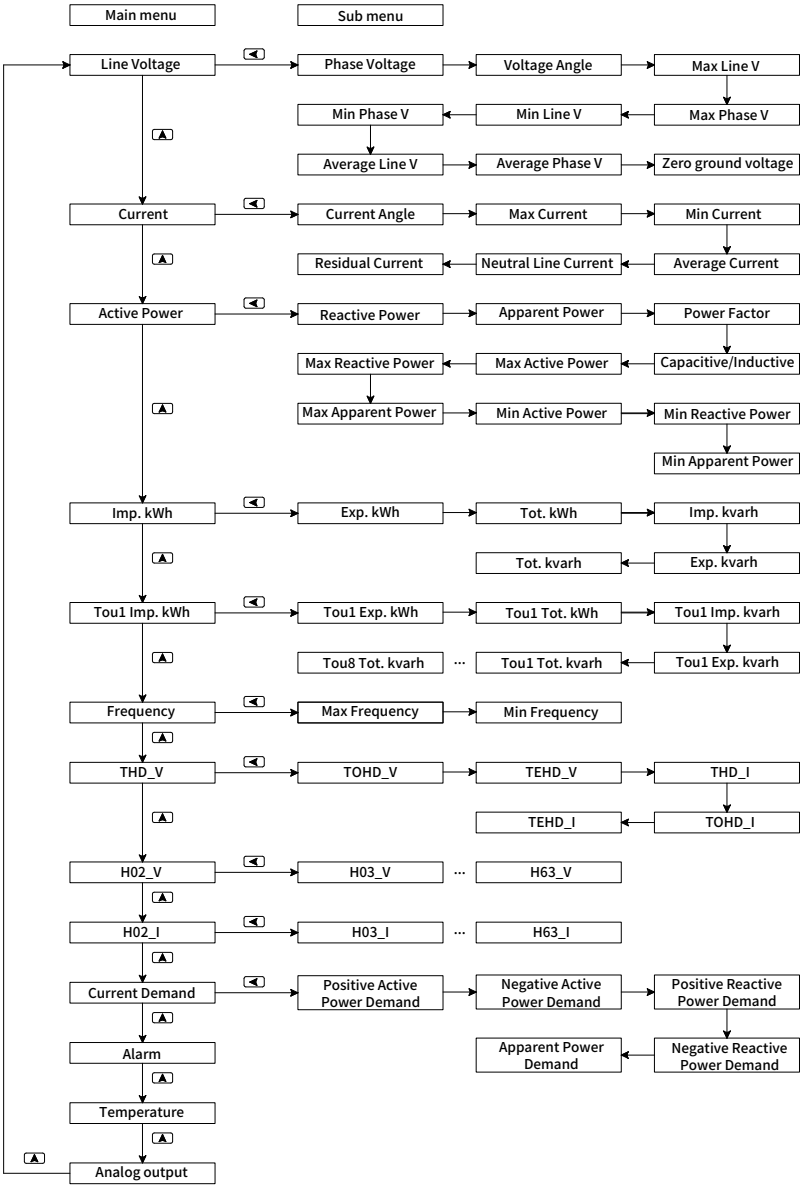
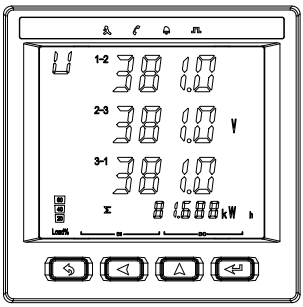
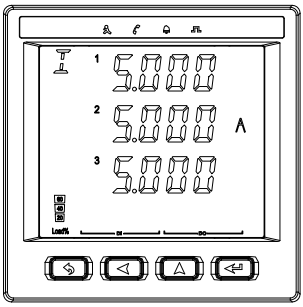
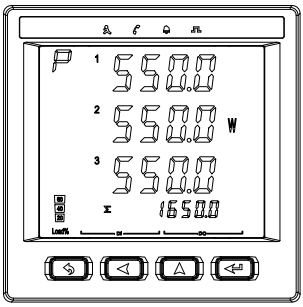


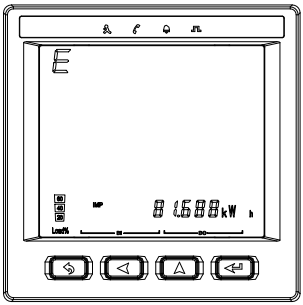
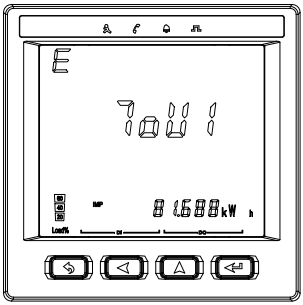
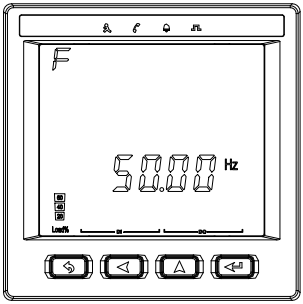
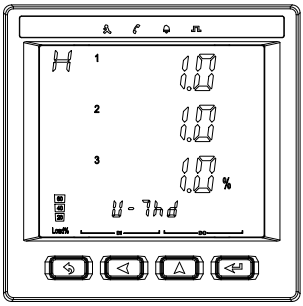
Figure 26 Measurement Data Display Interface

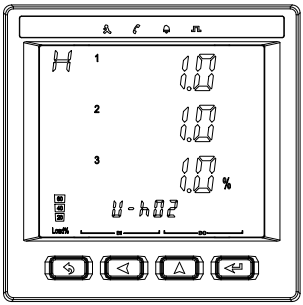
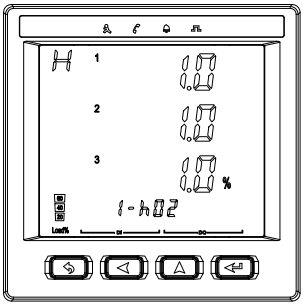
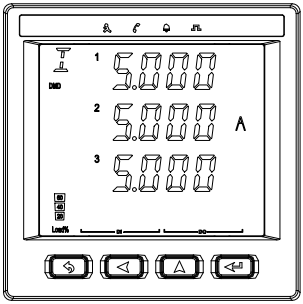
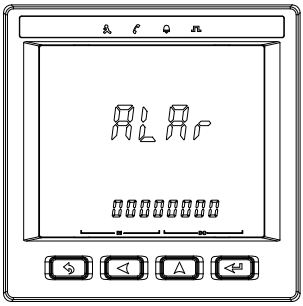
4.3.1 Main Interface

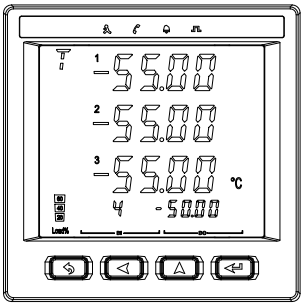
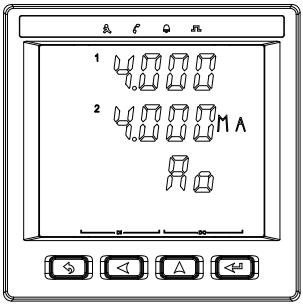
Default electrical parameter display menu - Line Voltage - Press the "Main Menu Page Turn Key (Up Arrow Key)" to cycle through queries for Current, Active Power, Import Active Energy, Frequency, Voltage THD, Current Demand, Alarm;

Main interface as follows:

Name	Diagram	Note
Line Voltage		
Current		
Active Power		

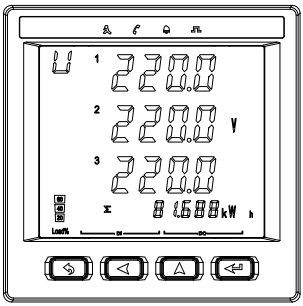
Imp. kWh		
TOU1 Imp. kWh		
Frequency		
Voltage THD		

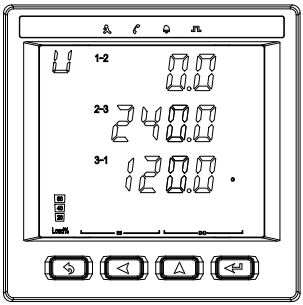
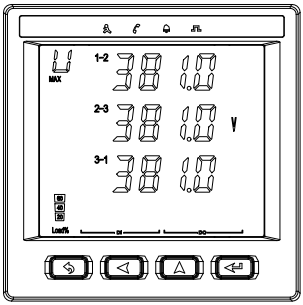
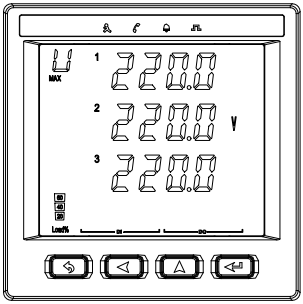
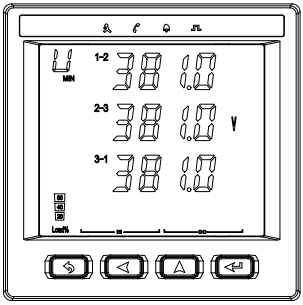
Voltage Various harmonics		
Current Various harmonics		
Current Demand		
Alarm		

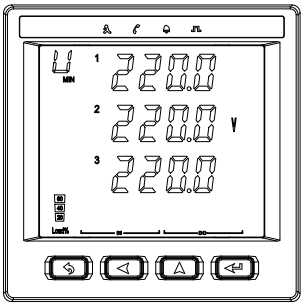
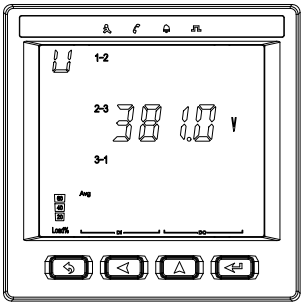
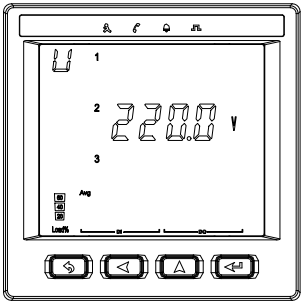
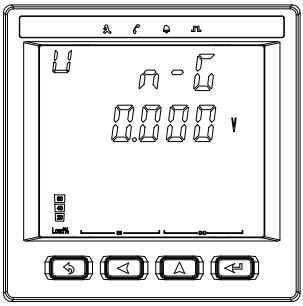
Temperature		Display when E6 is selected
Analog output		Display when E6 is selected

Note: If the user has not selected [Alarm, Max/Min, TOU Energy, Temperature, Analog Output, Ethernet Function], the corresponding interface will not be displayed.

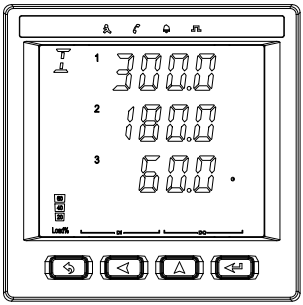
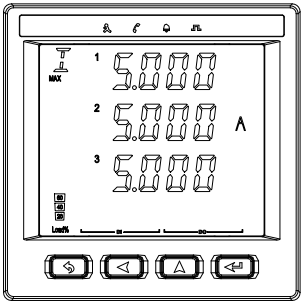
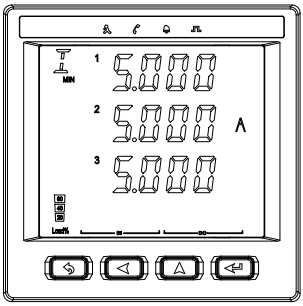
4.3.2 Voltage Related Submenu Display Interface

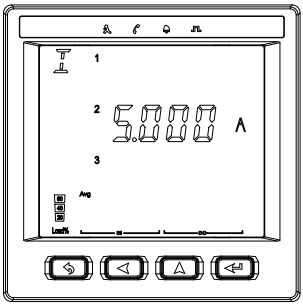
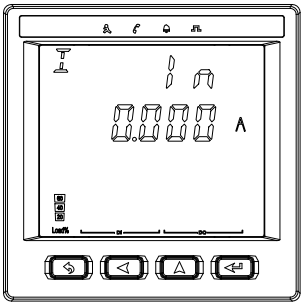
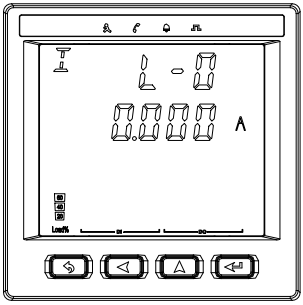
Name	Diagram	Note
Phase Voltage		

Voltage Angle		Fixed 1 decimal place Unit °
Max Line Voltage		
Max Phase Voltage		
Min Line Voltage		

Min Phase Voltage		
Average Line Voltage		
Average Phase Voltage		
Neutral-to-ground voltage		Displayed when E5 is selected

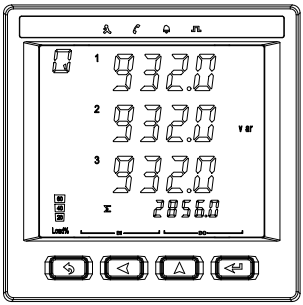
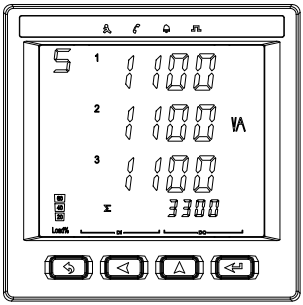
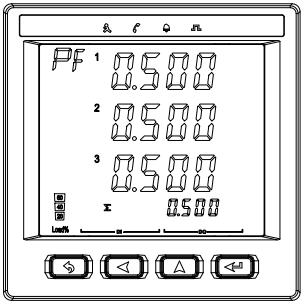
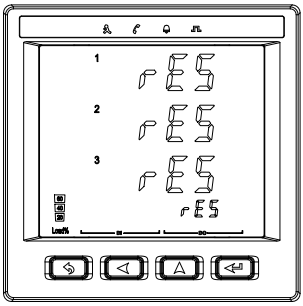
4.3.3 Current Related Submenu Display Interface

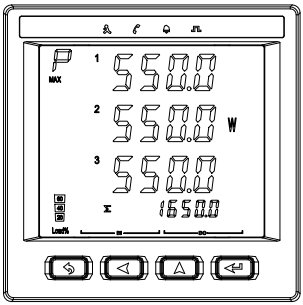
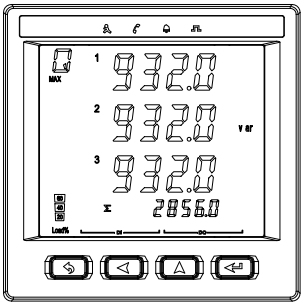
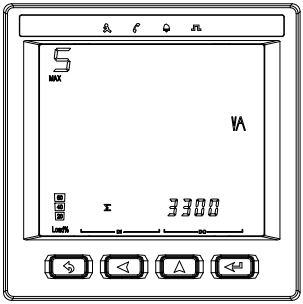
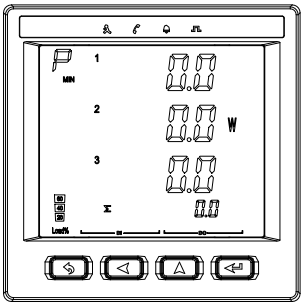
Name	Diagram	Note
Current Angle		Fixed 1 decimal place Unit °
Max Current		
Min Current		

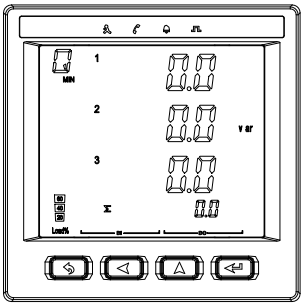
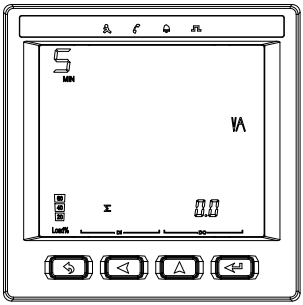
Average Current		
Neutral Line Current		Displayed when E5 is selected
Residual Current		Displayed when E6 is selected

4.3.4 Power Related Submenu Display Interface

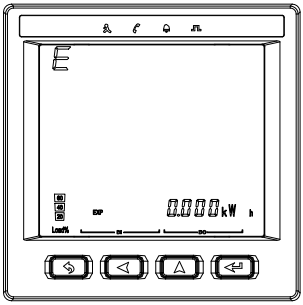
Name	Diagram	Note

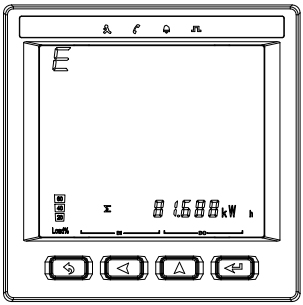
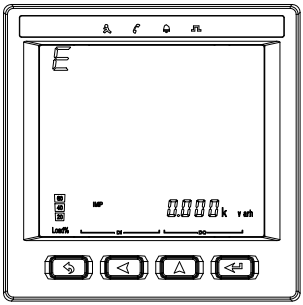
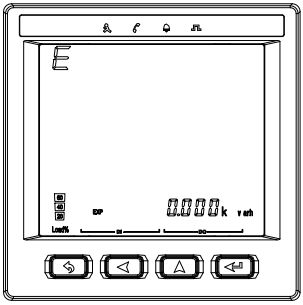
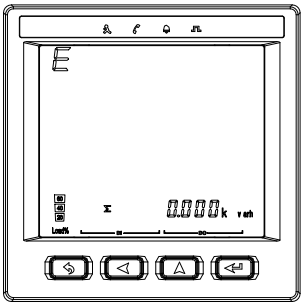
Reactive Power		
Apparent Power		
Power Factor		
Load capacitive/inductive		

Max Active Power		
Max Reactive Power		
Max Apparent Power		
Min Active Power		

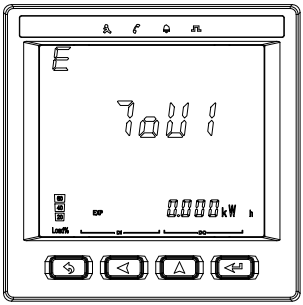
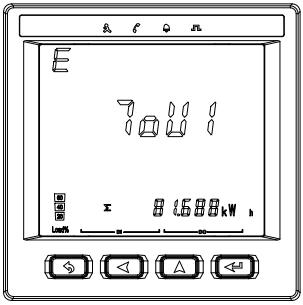
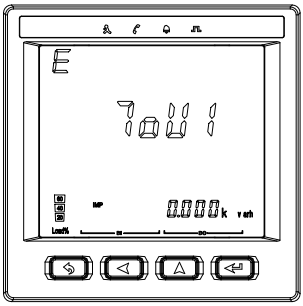
Min Reactive Power		
Min Apparent Power		

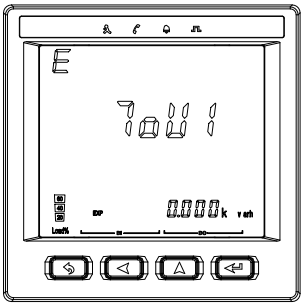
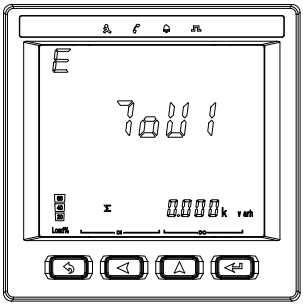
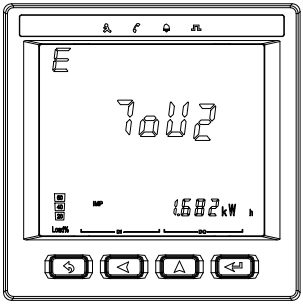
4.3.5 Energy Related Submenu Display Interface

Name	Diagram	Note
Exp. kWh		

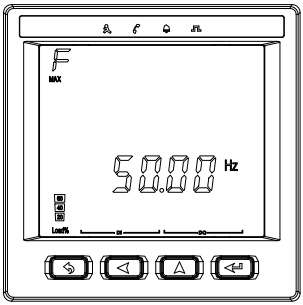
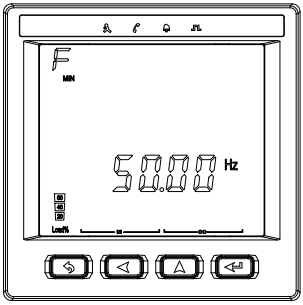
Total kWh		
Imp. kvarh		
Exp. kvarh		
Total kvarh		

4.3.6 TOU Energy Related Submenu Display Interface

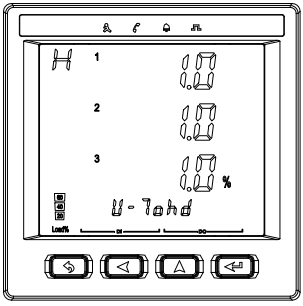
Name	Diagram	Note
TOU1 Exp. kWh		
TOU1 total kWh		
TOU1 Imp. kvarh		

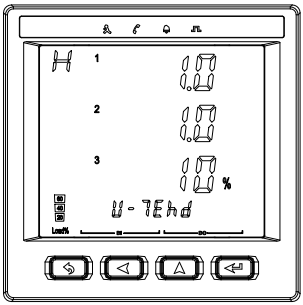
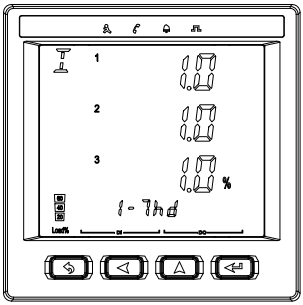
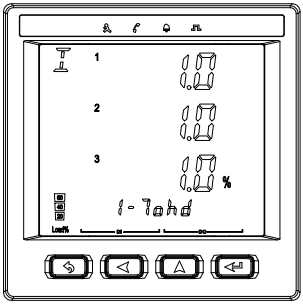
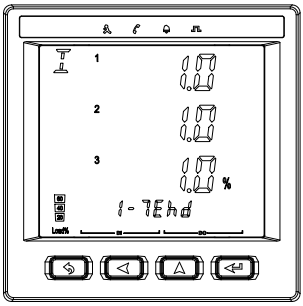
TOU1 Exp. kvarh		
TOU1 total kvarh		
TOU2 Imp. kvarh		
.....		

4.3.7 Frequency Related Submenu Display Interface

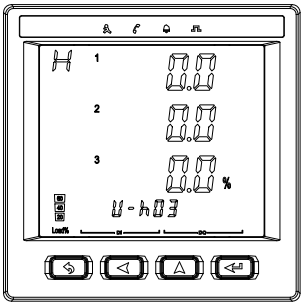
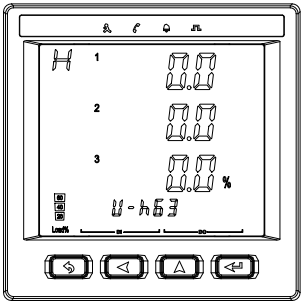
Name	Diagram	Note
Max Frequency		
Min Frequency		

4.3.8 Harmonic Related Submenu Display Interface

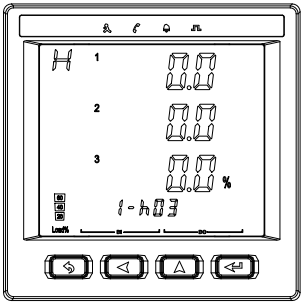
Name	Diagram	Note
Voltage TOHD		

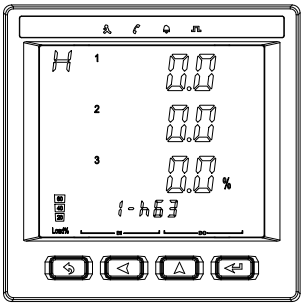
Voltage TEHD		
Current THD		
Current TOHD		
Current TEHD		

4.3.9 Voltage Individual Harmonic-related Submenu Display Interface

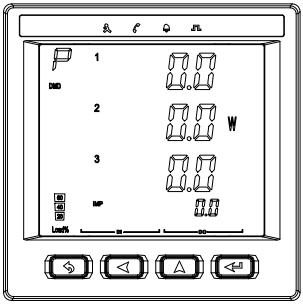
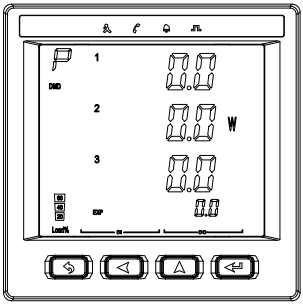
Name	Diagram	Note
3rd voltage harmonic		
...		
63rd voltage harmonic		

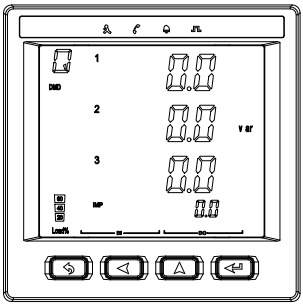
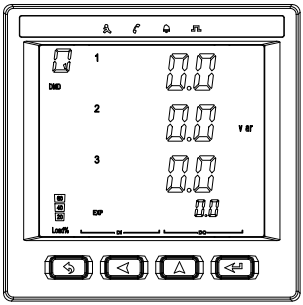
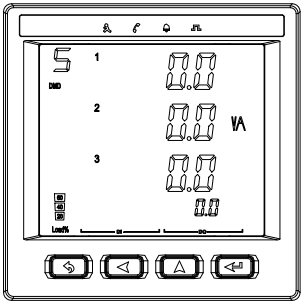
4.3.10 Current Individual Harmonic-related Submenu Display Interface

Name	Diagram	Note
3rd current harmonic		
...		

63rd current harmonic		

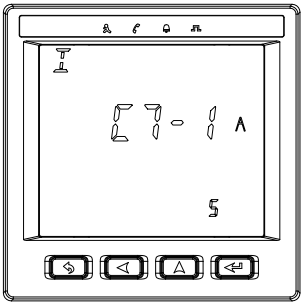
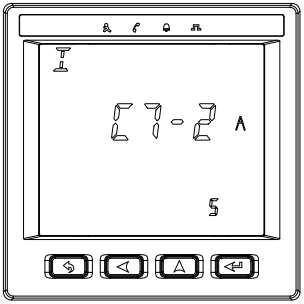
4.3.11 Demand Related Submenu Display Interface

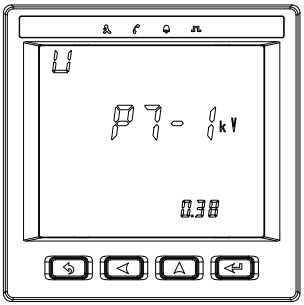
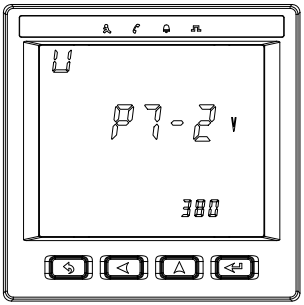
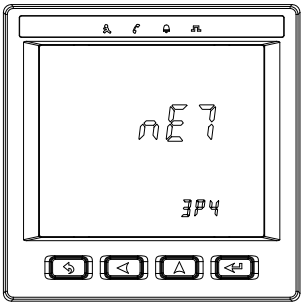
Name	Diagram	Note
Positive active power demand		
Negative active power demand		

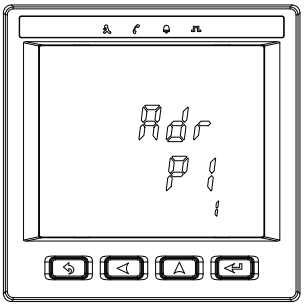
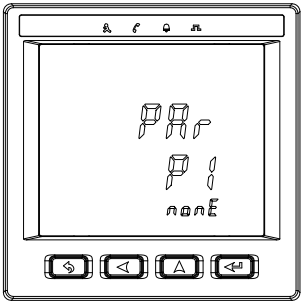
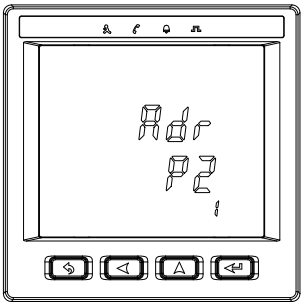
Positive reactive power demand		
Negative reactive power demand		
Apparent power demand		

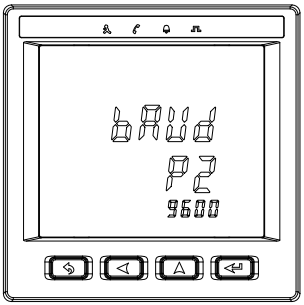
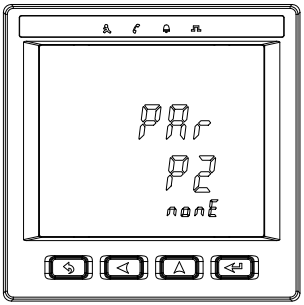
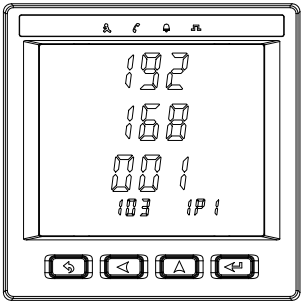
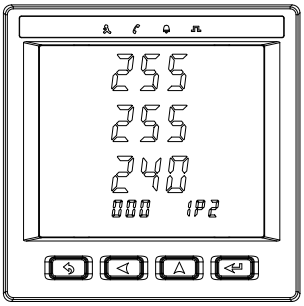
4.4 Setting Interface

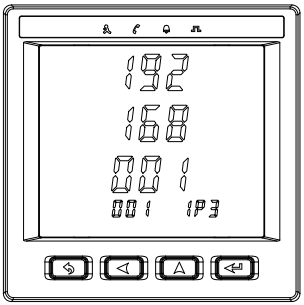
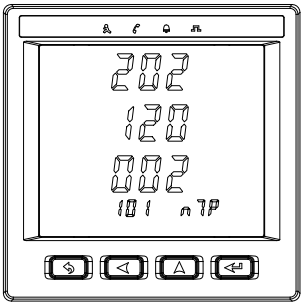
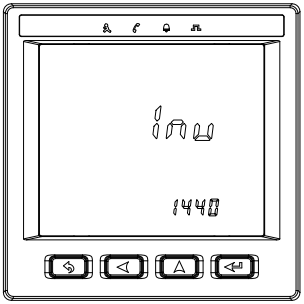
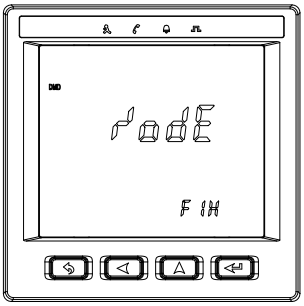
4.4.1 Setting Menu

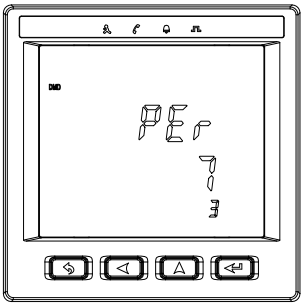
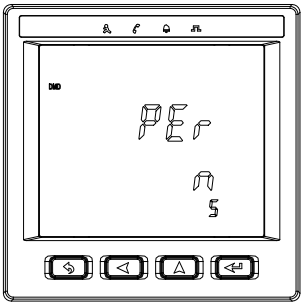
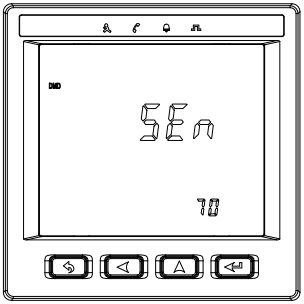
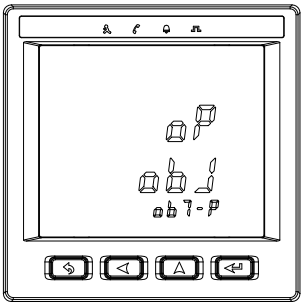
Menu	Diagram	Note
Enter Password		Password required before parameter settings (Default: 01)
CT Primary		Setting Range: 1~50000A
CT Secondary		Setting Range: 1A or 5A

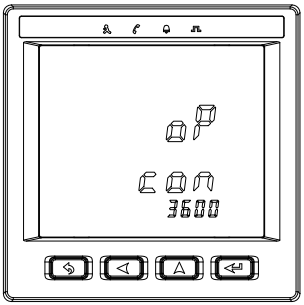
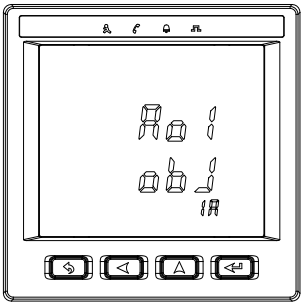
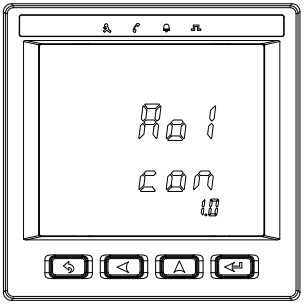
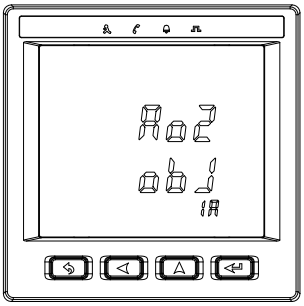
PT Primary		Setting Range: 0.10~650.00, Unit: kV
PT Secondary		Setting Range: 100~400, Unit: V
Wiring Mode		Can be set: 3P4 (3-phase 4-wire), 3P3 (3-phase 3-wire), 1P-A (Single-phase - Phase A), Factory default 3P4 (3-phase 4-wire) Meter wiring mode must match actual wiring, else measurement may be abnormal.

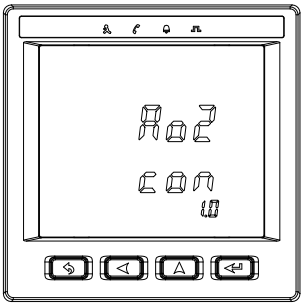
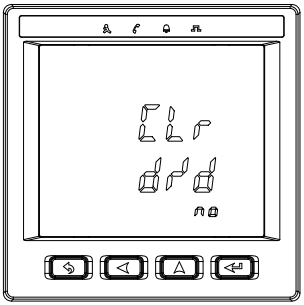
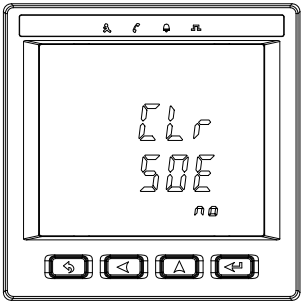
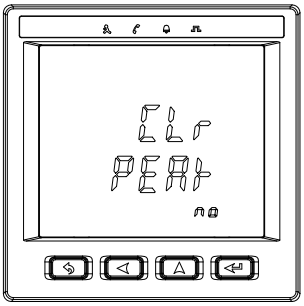
Comm1 Address		Setting Range: 1~247
Comm1 Baud Rate		Can be set: 4800, 9600, 19200
Comm1 Parity		Can be set: none(No Parity), odd(Odd Parity), even (Even Parity)
Comm2 Address		Setting Range: 1~247

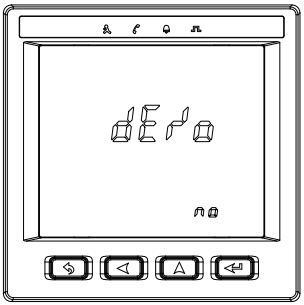
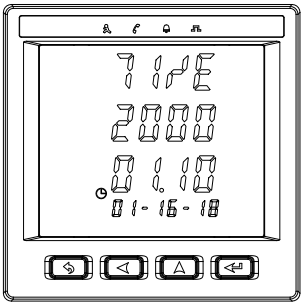
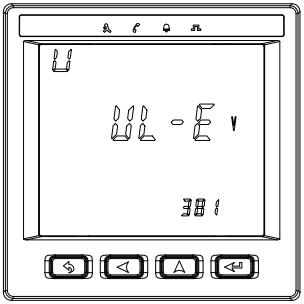
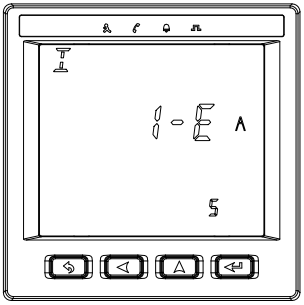
Comm2 Baud Rate		Can be set: 4800, 9600, 19200
Comm2 Parity		Can be set: none(No Parity), odd(Odd Parity), even (Even Parity)
IP1		
IP2		

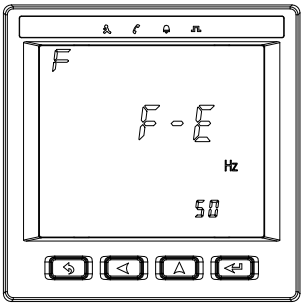
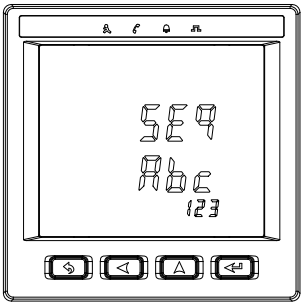
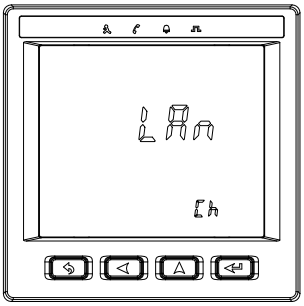
IP3		
NTP IP		
NTP timing interval		
Demand Mode		Can be set: FIX (Fixed Mode), SLIP (Sliding Mode), Factory default Fixed Mode

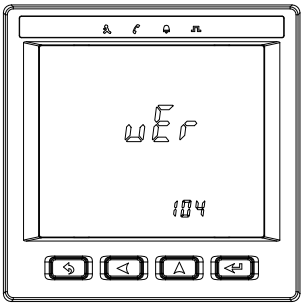
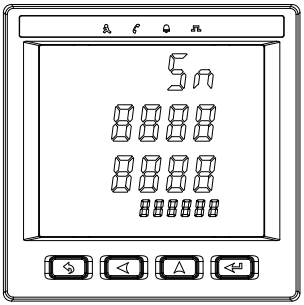
Demand Subinterval		Can be set: 1min-5min, Factory default 3min
Num of Subintervals		Can be set: 1-15, Factory default 5
Predictive Demand Sensitivity		Can be set: 70-99, Factory default 70
Optical Pulse Mode		Can be set: OUT-p (Active Pulse Output), OUT-q (Reactive Pulse Output), PPS (Second Pulse Output). Factory default OUT-p

Optical Pulse Constant		Can be set: 100, 1000, 3200, 3600, 5000, 6400, 12800. Factory default 3600
Analog output 1 object		
Analog output 1 Constant		
Analog output 2 object		

Analog output 2 Constant		
Clear Demand		Select "YES" and press ⏎ to clear demand.
Clear SOE		Select "YES" and press ⏎ to clear SOE records.
Clear Max/Min		Select "YES" and press ⏎ to clear max/min values.

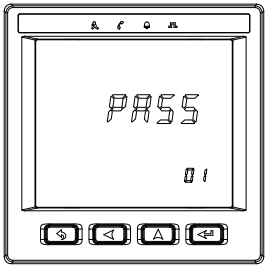
DEMO Mode		Select "YES" and press ⏎ Enters DEMO test interface, sets real-time parameters to specific values for communication debugging/data viewing.
Time Setting		Set meter date and time.
Rated line voltage		
Rated current		

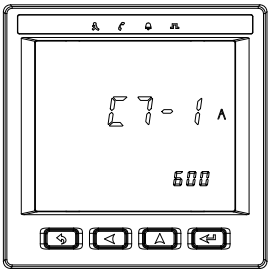
Rated frequency		
Phase sequence adjustment		Can set the current channel numbers 1, 2, 3 corresponding to phases A, B, C, and adjust the phase sequence of the current channel corresponding to the voltage according to the on-site wiring
Modify password		Setting range: 0-99
Modify Language		Can be set: En (English), Ch (Chinese)

Version		View the software version of SPM73
SN		View the SN code of SPM73

4.4.2 Operation Example

Assume the field wiring is 3P4W, rated voltage is 3*220/380V, and the field CT is 600:5. Since SPM73 factory default wiring mode is 3P4W and secondary current is 5A, only the CT primary value needs to be set to 600 according to the site requirement. Operation as follows:

Operation Steps	Diagram
1. Press and release the ⏎ key quickly to enter the configuration parameter view interface. Press ⏎ again quickly to prepare to enter the password. The units digit "0" flashes. Since the tens digit is 0, no modification is needed (initial password is 01). Press △ until the units digit value is modified to 1. Press the confirm key ⏎ , as shown in the diagram. 2. After entering the password, the CT Primary editing page is entered, and the units digit of the CT value	

flashes. Press [△] to modify the units digit to 0. 3. Press [◁] to move the cursor to the hundreds place. The hundreds digit flashes. Press [△] to modify the hundreds digit to 6. 4. Similarly, modify the other digits to 0. After modification, press the confirm key [↵] .	

Note:

1) The default parameter configuration password is 01.
2) When SPM73 operates in 3P3W mode, active power, reactive power, and power factor only display the total values.
3) If the set value exceeds the range, the original value is restored. Press the return key when the cursor is flashing to cancel parameter setting.
4) Some display pages require specific models.
5) Other customized functions are not described in this manual.

Chapter 5 Measurement Performance

5.1 Basic Electrical Parameters

SPM73 provides real-time three-phase full electrical parameter measurement data, accessible via the panel display or communication query.

Table 5-1 Basic Measurement Parameters

Type	Description	1	2	3	Total	Average
Voltage	Phase Voltage	√	√	√		√
	Line Voltage	√	√	√		√
Current	Current	√	√	√		√
Power	Active Power	√	√	√	√	
	Reactive Power	√	√	√	√	
	Apparent Power	√	√	√	√	
Power Factor	Power Factor	√	√	√	√	
Frequency	Frequency	√				

Note: In Delta wiring mode, per-phase line voltage, active power, reactive power, apparent power, and power factor are meaningless.

5.1.1 Voltage

SPM73 can be directly connected to 400/690VAC Wye systems. Users should note this during design to prevent saturation of the internal measurement circuit, leading to inaccurate measurement or even damage. If the monitored system voltage exceeds 400/690V, voltage transformers (PTs) must be used to proportionally reduce the voltage to within SPM73's allowable input range. SPM73 allows setting PT parameters; the maximum measurable primary phase voltage is 650kV.

For correct use of SPM73, PT selection is important (if PTs are used). Select PT parameters according to the following requirements:

- Wye System: PT primary rating should equal the system phase voltage rating, or slightly higher.
- Delta System: PT primary rating should equal the system line voltage rating.
- For both Wye and Delta systems, the PT secondary rating must be within the rated voltage input range.

The PT's rated load capacity must be greater than the sum of all loads from SPM73 and other equipment connected in parallel to the PT. PT accuracy directly affects SPM73's measurement accuracy. It is recommended that users select PTs with accuracy matching the chosen meter's accuracy class.

5.1.2 Current

This meter must use current transformers (CTs) to measure phase currents. The transformation ratio parameters of the three-phase CTs are set uniformly, so the transformation ratios of the three-phase CTs must be the same. The CT secondary rated output needs to conform to SPM73's current input requirements (5A or 1A).

SPM73's current measurement channels can directly accept currents from 0~6.5A. The maximum measurable primary current is 50000A. Users should note this during design to prevent saturation of the internal measurement circuit, leading to inaccurate measurement.

CT accuracy also affects this meter's measurement accuracy. It is recommended that users select CTs with accuracy matching the chosen meter's accuracy class.

Additionally, inconsistent phase angle errors between PTs and CTs can also affect the measurement accuracy of power, energy, etc.

5.1.3 Frequency

When SPM73 operates in different measurement modes, the acquisition channel for frequency measurement differs. In Delta mode, frequency calculation priority order is U12, U23. In Wye mode, frequency calculation priority order is U1, U2, U3.

5.1.4 Power

SPM73 calculates three-phase active power, reactive power, apparent power, power factor, total active power, total reactive power, total apparent power, and total power factor.

Active power, reactive power, and power factor are signed. SPM73 uses the symbols 、  to distinguish the capacitive/inductive nature of the load. Users should note this when querying active power, reactive power, and power factor.

The SPM73 measures power factor sign according to IEC standards. The following diagram illustrates the definitions:

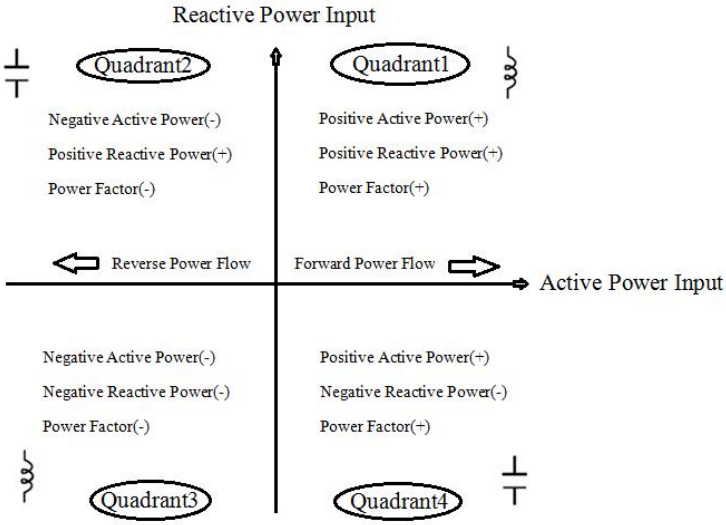


Figure 27 Power Factor Definition Method

5.2 Energy Metering

SPM73 provides rich energy metering data for users to analyze system energy consumption. The energy data provided by SPM73 is as follows.

Table 5-2 Energy Metering Data

	Forward	Reverse	Net	Total
Full-wave Active En.	√	√	√	√
Full-wave Reactive En.	√	√	√	√
Full-wave Apparent En.				√

5.2.1 Combined Energy

SPM73 supports various real-time combined energy types, as shown below.

Table 5-3 Combined Energy

Energy Type	DLT645 Max Range	Storage & Modbus Range
Combined Import Act. En.	999999.99 kWh	99999999.999 kWh
Combined Export Act. En.	999999.99 kWh	99999999.999 kWh
Combined Import React. En.	999999.99 kvarh	99999999.999 kvarh
Combined Export React. En.	999999.99 kvarh	99999999.999 kvarh

Combined active energy is the sum of the per-phase (per-line) energy. After accumulating to the full range, it rolls over to zero and starts accumulating again. If energy rollover occurs within a statistical period, users can calculate the energy consumption within the period using: Rollover value + Range - Previous Energy = Consumption in this period.

*** Note:**

Since Combined Energy = Phase A Energy + Phase B Energy + Phase C Energy

Therefore, combined energy will roll over before per-phase energy. In this case, the displayed or communicated energy may seem inconsistent with the algebraic sum of per-phase energies. This is normal. Use the calculation formula described above for rollover.

The maximum energy statistics value is 99999999.999 (100 million kWh). SPM73 supports both Modbus RTU and DLT645 protocols. The DLT645 standard protocol defines a maximum combined energy representation range of 999999.99 (1 million kWh). Therefore, the actual DLT645 energy read value is Total Energy modulo 1,000,000.

*** Example:**

When SPM73 displays energy as 10230002.2kWh, the display panel and Modbus read 10230002.2kWh. But the DLT645 energy reading is 10230002.2 % 1000000 = 230002.2kWh.

5.2.2 Per-Phase Energy

SPM73 supports various real-time per-phase energy types. As shown below:

Table 5-4 Per-Phase Energy

Energy Type	DLT645 Max Range	Storage & Modbus Range
Per-Phase Import Act. En.	999999.99 kWh	99999999.999 kWh
Per-Phase Export Act. En.	999999.99 kWh	99999999.999 kWh
Per-Phase Import React. En.	999999.99 kvarh	99999999.999 kvarh
Per-Phase Export React. En.	999999.99 kvarh	99999999.999 kvarh

Per-phase energy accumulates to the full range and then rolls over to zero, starting accumulation again. If rollover occurs within a statistical period, users can calculate consumption within the period using: Rollover value + Range - Previous Energy = Consumption in this period.

5.2.3 Four-Quadrant Energy

SPM73 provides four-quadrant energy data, viewable via communication. Four-quadrant energy essentially divides energy into four parts for metering: Forward Inductive (Q1), Reverse Capacitive (Q2), Reverse Inductive (Q3), Forward Capacitive (Q4). Active Energy (Absorbed) = Forward Active Energy, Active Energy (Delivered) = Reverse Active Energy, Reactive (Inductive) = Q1 + Q3 Reactive Energy, Reactive (Capacitive) = Q2 + Q4 Reactive Energy. Forward active energy is the energy consumed by the user; reverse active energy is generated energy; reactive energy is not used for billing.

5.2.4 Time-of-Use (TOU) Energy

SPM73 can be configured with two TOU schemes. The scheme can be switched automatically based on set times. Each TOU scheme includes day type settings, billing season settings, day tariff table settings, and special day settings. In power systems, electricity prices may differ on weekdays, weekends, holidays, and during peak/non-peak load periods. This function provides an energy metering method to adapt to time-of-use electricity pricing needs, calculating and accumulating energy for different time-of-use rates based on predefined billing periods and tariffs.

In the TOU function, time settings are annual. Each year can have ordinary days and special days; up to 90 special days can be set. Up to 12 billing seasons can be set per year. A week can be set to 4 day types (Billing Day Type 1,2,3,4), each corresponding to a day tariff table number. Up to 20 day tariff tables can be set. Each day tariff table divides a 24-hour day into up to 12 periods with a step of 15 minutes. Each period corresponds to a unique tariff; up to 8 tariffs can be set. For holidays requiring separate settings, they can be specified via special day registers indicating the date and corresponding day tariff table.

The TOU function enables time-based metering of forward/reverse active/reactive energy. The maximum accumulation per tariff period is 99999999.999kWh.

Parameter ranges are as follows:

Billing Seasons: 1~12 billing seasons. Billing Season 1 start date is January 1st (fixed). If set to 0xFFFF or another non-existent date, it is considered invalid. If a date in the billing season scheme is set to 0xFFFF, all dates after that billing season should be set to 0xFFFF. The rule for setting the billing season scheme is: the start date of a later billing season should be later than the previous one, unless subsequent seasons are all set to 0xFFFF.

Billing Day Types: 4 types (Billing Day Type 1,2,3,4). Each can be set with a different day tariff table.

Day Tariff Tables: Up to 20 day tariff tables. Each table can set up to 12 periods. The minimum time unit per period is 15 minutes. If the value is 0, it means the day tariff table used in that billing season is Day Tariff Table 1, effective from the start date of this billing season to the start date of the next billing season. If the next billing season start date is set to 0xFFFF, it is effective from the start date of this billing season to the end of the year. For each day tariff table, the period setting rule is: a later period time should be after the previous one, unless subsequent periods are all set to 0xFFFF.

Special Days: 0~90. Each special day can specify a day tariff table individually.

Tariffs: 8 tariffs.

Parameters related to this function can only be set and viewed via communication.

Example:

If a user's daily energy metering is divided into 8 time periods as per the table below:

Period	Start Time	Tariff Segment
Period 1#	0:00	1
Period 2#	3:00	2
Period 3#	6:00	4
Period 4#	9:00	3
Period 5#	12:00	1
Period 6#	15:00	4
Period 7#	18:00	2
Period 8#	21:00	3

Period 1# start time is 0:00, end time 3:00, tariff segment 1; Period 2# start time 3:00, end time 6:00, tariff segment 2; and so on. Period 8# start time is 21:00, end time 0:00, tariff segment 3.

If the TOU metering start time is not a zero moment, refer to the following example.

Example:

If a customer's daily energy metering is divided into 5 periods as per the table below:

Period	Start Time	Tariff
Period 1#	6:00	1
Period 2#	10:00	2

Period 3#	12:00	1
Period 4#	14:00	3
Period 5#	20:00	4

Period 1# start time is 6:00, end time 10:00, tariff 1; Period 2# start time 10:00, end time 12:00, tariff 2; and so on. Period 5# start time is 20:00, end time next day 6:00, tariff 4. Energy for the same tariff is combined.

5.2.5 Historical Energy

SPM73 provides monthly historical energy for the last 12 months and yearly historical energy for the last 10 years. The saved data is total active energy.

5.3 Demand

5.3.1 Real-Time Demand

Demand refers to the value obtained by dividing the accumulated electrical parameters within a time period by the length of the time period.

SPM73 provides two demand modes: fixed mode and sliding mode. The demand cycle length has two parameters: sub-cycle (1-5 minutes) and number of sub-cycles (1-15). In either mode, the demand cycle can be set. In fixed mode, the demand cycle is sub-cycle * number of sub-cycles. For example, if the sub-cycle is set to 5 minutes and the number of sub-cycles is 6, the demand cycle is 30 minutes. In sliding mode, the sliding cycle is sub-cycle * number of sub-cycles, and the sliding window size is the sub-cycle time. For example, if the sub-cycle is 1 minute and the number of sub-cycles is 15, the sliding cycle is 15 minutes and the sliding window is 1 minute.

SPM73 provides demand calculation for 15 electrical parameters including three-phase current, three-phase and total active power, three-phase and total reactive power, three-phase and total apparent power, as well as demand maximum value recording. The demand value can be viewed through display or communication, and a demand maximum value recording clearing operation is provided.

The following diagram illustrates the fixed demand calculation method:

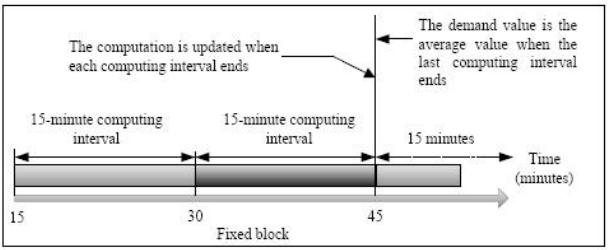


Figure 28 Fixed Demand Calculation Method

5.3.2 Predicted Demand

SPM73 provides a predicted demand function. Ordinary demand outputs the demand only at the end of the demand calculation sub-cycle, while for predicted demand, the demand at the end of the demand calculation sub-cycle is predicted according to the current value. Since SPM73 performs demand calculation once per second, the predicted demand is updated once per second.

5.3.3 Maximum Demand

SPM73 provides the maximum demand function for the current billing day and the previous billing day, recording the maximum demand values for the current billing day and the previous billing day.

The maximum demand values for the current billing day and the previous billing day can only be obtained through Modbus RTU communication and cannot be viewed through the LCD panel temporarily. Once the time crosses the billing day, the maximum demand value of the current billing day will be recorded as the maximum demand value of the previous billing day, and then the maximum demand value of the current billing day will be cleared to zero and the maximum demand value of the current cycle will be recalculated. Definition of billing day transfer time: the data transfer boundary time can be set to any time between the 1st and 28th of each month, and the default value is zero o'clock on the 1st of each month.

5.4 Power Quality

5.4.1 Harmonics

SPM73 can measure complete 63rd harmonic voltage and current content

(voltage/current harmonic ratio), total odd harmonic distortion (TOHD), total even harmonic distortion (TEHD), and total harmonic distortion (THD).

Harmonic data is given as a percentage of the fundamental, with one decimal place. The fundamental value is fixed at 1000, representing 100.0% of the fundamental RMS value. Others follow similarly!

Total Harmonic Distortion (THD) refers to the sum of all higher harmonics except the fundamental, calculated as follows:

$$THD = \sqrt{\sum_{i=2}^{i=n} X_i^2}$$

Where:

i represents the harmonic order

X_i represents the percentage of each harmonic RMS value relative to the fundamental RMS value

n represents the highest harmonic order, here it should be 63

5.4.2 Unbalance

In an ideal three-phase power supply system, ABC phase voltages and currents have equal magnitude and are 120° out of phase, which is the balanced state. When the actual system deviates from this, unbalance problems arise, leading to reduced power utilization efficiency.

SPM73 can measure the positive, negative, and zero sequence magnitudes of voltage and current, and calculate and analyze the voltage and current negative and zero sequence unbalance.

Voltage and Current Negative Sequence Unbalance formulas:

Uunbal = (Voltage Negative Sequence Component / Voltage Positive Sequence Component) x 100%

Iunbal = (Current Negative Sequence Component / Current Positive Sequence Component) x 100%

5.4.3 Current K-Factor

In power quality technical indicators, K-factor primarily reflects the impact of harmonic frequencies caused by non-linear loads on transformer losses. The K-factor definition

assumes that the eddy current losses in transformers caused by harmonic currents are proportional to the square of the harmonic order. Calculation formula:

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

Where: h is the harmonic order, I_h is the RMS value of the h th harmonic current。 $h_{\max}$ is the highest harmonic current order to be considered.

5.4.4 Voltage Crest Factor

SPM73 provides the voltage crest factor, viewable via communication. The crest factor is the ratio of the peak voltage of a waveform to its RMS value. For most electronic equipment, the crest factor is 1.414 (1.414 is the ratio of peak to RMS for a sine wave).

5.4.5 Current TDD

SPM73 provides three-phase current TDD (Total Demand Distortion), viewable via communication. Current TDD is the ratio of the square root of the sum of the squares of the harmonic current RMS values to the rated current.

5.5 Alarm Function

SPM73 has the functions of digital input alarm, voltage phase loss alarm, voltage phase sequence error alarm and electrical parameter over-limit alarm, and the alarm supports associated relay output. The over-limit alarm function can separately configure the monitoring object, monitoring mode, action threshold, return threshold, action time, return time and associated action outlet. When an alarm event occurs, the ALARM light on SPM73 panel will be on. If the relay action is configured, the relevant relay outlet will be closed (when the relay is in local mode). At the same time, the display can be switched to the alarm page to view the alarm event type, or the alarm type can be read through communication. After the alarm event is eliminated, the ALARM light will be off, and the relay outlet will return.

Note: Due to the large number of alarm parameters, panel setting is not supported, and it

can only be set through communication. Our company can provide communication setting software for free.

5.5.1 Alarm Object Types and Alarm Action Values

The analog setting value system can monitor common electrical parameters in the power grid, as shown in the following table:

Type	Alarm Description
DI 1-6	DI state changes, while meeting the delay condition. Alarm mode can be set to one of: Open to Close, Close to Open, ,alarm when open, and alarm when closed.
Voltage Phase Loss	One or two phases of voltage are below the phase loss threshold, corresponding phase current is 0, while meeting the delay condition.
Phase Sequence Error	Three-phase voltage must be ≥ set threshold, the absolute value of the phase angle difference between phases > 10°, while meeting the delay condition.
Phase voltage over-limit	The maximum value of the three-phase voltage is less than/greater than the set action threshold, and the delay condition is met.
	The minimum value of the three-phase voltage is less than/greater than the set action threshold, and the delay condition is met.
	The average value of the three-phase voltage is less than/greater than the set action threshold, and the delay condition is met.
	The voltage of any one phase of the three-phase is less than/greater than the set action threshold, and the delay condition is met.
Line voltage over-limit	The maximum value of the three-line voltage is less than/greater than the set action threshold, and the delay condition is met.
	The minimum value of the three-line voltage is less than/greater than the set action threshold, and the delay condition is met.
	The average value of the three-line voltage is less than/greater than the set action threshold, and the delay condition is met.
	The voltage of any one of the three-line is less than/greater than the set action threshold, and the delay condition is met.
Current	The maximum value of the three-phase current is less than/greater than

over-limit	the set action threshold, and the delay condition is met.
	The minimum value of the three-phase current is less than/greater than the set action threshold, and the delay condition is met.
	The average value of the three-phase current is less than/greater than the set action threshold, and the delay condition is met.
	The current of any one phase of the three-phase is less than/greater than the set action threshold, and the delay condition is met.
Frequency over-limit	The frequency is less than/greater than the set action threshold, and the delay condition is met.
Power over-limit	The total active power value is less than/greater than the set action threshold, and the delay condition is met.
	The total active power value of any one phase of the three-phase is less than/greater than the set action threshold, and the delay condition is met.
Harmonic distortion rate	The voltage/current harmonic distortion rate is less than/greater than the set action threshold, and the delay condition is met.
Unbalance factor	The voltage/current unbalance factor is less than/greater than the set action threshold, and the delay condition is met.
Neutral-to-ground voltage	The neutral-to-ground voltage is less than/greater than the set action threshold, and the delay condition is met.
Neutral current	The Neutral current is less than/greater than the set action threshold, and the delay condition is met.
Residual current	The residual current is less than/greater than the set action threshold, and the delay condition is met.
Temperature	Temperature 1-4 are less than/greater than the set action threshold, and the delay condition is met.

Notes:

1. For phase voltage, line voltage, current, power, frequency, harmonic distortion rate, and unbalance factor alarms, objects can be configured, and a maximum of 10 groups of alarm object configurations are supported.
2. The electrical parameters related to over-limit alarms are all primary side values.

5.5.2 Threshold Action Conditions

After the threshold object meets the action condition, it must also meet the time requirement to be truly activated. If the threshold object returns within the limit during the entire delay period, the threshold is not activated. After the alarm is triggered, when the monitored value is less than the alarm return value and the duration meets the return delay time, the alarm automatically resets. The action delay unit is seconds, range 0~100. Setting to 0 means the threshold channel activates immediately upon the monitored object exceeding the limit.

If the user wants to monitor the phase voltage upper limit simultaneously, assuming the alarm should trigger Relay 1 if the voltage continuously exceeds 240V for 80 seconds, and the alarm should return immediately when the voltage is below 230V. Set as follows:

Setting Item	Setting Value
Monitoring Object	Phase Voltage
Monitoring Mode	Over Upper Limit
Action Threshold	240V
Return Threshold	230V
Action Time	80s
Return Time	0s
Associated Action	RO1 Action

The threshold exceedance trigger mode can be set to Over Upper Limit or Over Lower Limit. The judgment logic is explained below:

Figure 29 illustrates the Over Upper Limit scenario, using relay action triggered by exceedance as an example. When the measured parameter exceeds the upper action limit and the duration exceeds the action delay time, the exceedance triggers relay action. When the measured parameter is less than the return value and the duration meets the return delay time, the relay returns.

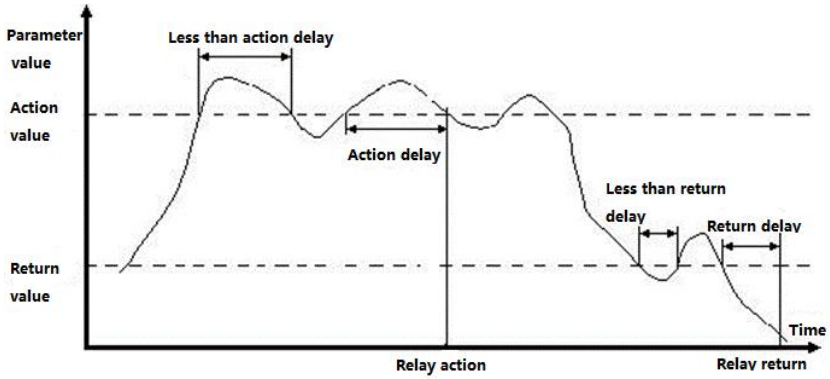


Figure 29 Over Upper Limit

Figure 30 illustrates the Over Lower Limit scenario, using relay action triggered by exceedance as an example. When the measured parameter falls below the lower action limit and the duration exceeds the action delay time, the exceedance triggers relay action. When the measured parameter is greater than the return value and the duration meets the return delay time, the relay returns.

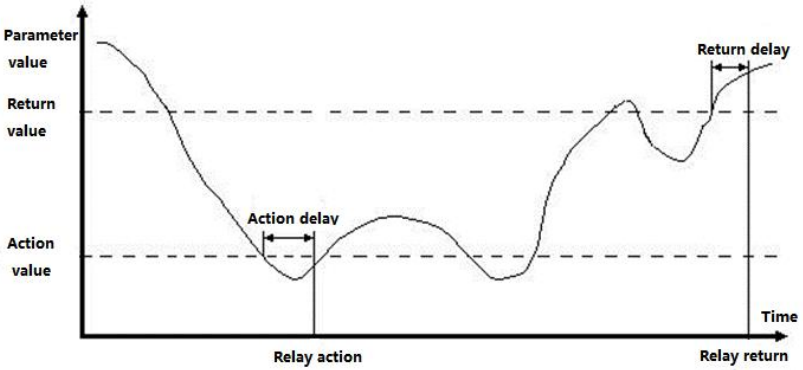


Figure 30 Over Lower Limit

Note: An alarm is generated if any one phase triggers the alarm condition; all three phases must return simultaneously for the alarm to clear. For Over Lower Limit alarms, when the monitored object value is 0, it is not considered an alarm by default. If 0 value needs to be judged, it can be enabled by modifying the alarm configuration. When Over Lower Limit alarm is enabled to judge 0 values, after enabling the related over-limit alarm, a non-zero value

must be detected first before the lower limit judgment starts.

5.5.3 Alarm Output

When an alarm occurs, the alarm event type can be viewed via SPM73 panel and communication. If the alarm occurs and the relay's action object is associated with this alarm type, the relay will operate. If the alarm condition disappears, the alarm indication disappears, and the associated relay resets.

5.5.4 Alarm Display

When an alarm occurs, the ALARM light on SPM73 panel will illuminate. At this time, the alarm page can be accessed via keys to view the alarm event type. The generated alarm type parameter is displayed as a four-digit hexadecimal number on the alarm interface. This value needs to be converted to binary. Each bit in the binary representation indicates an alarm type. The bit is 1 if the alarm is present, 0 if not. Find the alarm type using the list below:

Display Bit	Binary Bit	Alarm Type	Display Bit	Binary Bit	Alarm Type
---X	Bit0	DI 1	---X	Bit10	Object 1 alarm
	Bit1	DI 2		Bit11	Object 2 alarm
	Bit2	DI 3		Bit12	Object 3 alarm
	Bit3	DI 4		Bit13	Object 4 alarm
	Bit4	DI 5		Bit14	Object 5 alarm
	Bit5	DI 6		Bit15	Object 6 alarm
--X-	Bit6	Voltage Phase Loss		Bit16	Object 7 alarm
	Bit7	Voltage Phase Seq. Err		Bit17	Object 7 alarm
				Bit18	Object 9 alarm
				Bit19	Object 10 alarm

If the panel displays an alarm value of "0004 1014", converted to binary is "0000 0000 0000 0100 0000 0000 0001 0100". Checking the table shows that Object 3 alarm, Voltage Phase Loss, and Digital Input 3 Action alarms are present.

If the alarm is associated with a relay, the relay operates. Once the alarm disappears, the

panel ALARM light turns off, the alarm page displays "0000 0000", and the relay resets.

SPM73 supports light effect shielding for a certain alarm, that is, when the preset alarm is triggered, only the alarm status is displayed on the panel, but the alarm light flashes.

5.6 SOE Event Recording

To facilitate customer analysis of various faults in the power system, SPM73 provides up to 200 SOE (Sequence of Events) records, viewable via communication.

If viewed via communication, the time inside SPM73 is recorded in UNIX time format, with a resolution of 1ms. UNIX time is the total number of seconds since January 1, 1970, 00:00:00 UTC.

After an event occurs, if analyzed using the software provided by our company, the following format information can be obtained:

Event No.	Event UTC Time	Event ms Time	Event Type
0	2024-11-01 11:08:46	961	1: RO1 open

5.7 Max/Min Values

SPM73 records the maximum/minimum values of three-phase phase voltage, three-phase line voltage, three-phase current, three-phase and total active power, three-phase and total reactive power, three-phase and total apparent power, and frequency. Active and reactive power are judged as signed numbers. For example: If the real-time active power of Phase A is -100W, and the historical minimum is -50, then -100W is recorded as the minimum active power for Phase A, and the current system time is recorded.

SPM73 provides the maximum/minimum value function for the current billing day and the previous billing day, recording the maximum/minimum values for the current billing day and the previous billing day.

The maximum/minimum values for the current billing day and the previous billing day can only be obtained through Modbus RTU communication and cannot be viewed through the LCD panel temporarily. Once the time crosses the billing day, the maximum/minimum value of the current billing day will be recorded as the maximum/minimum value of the previous billing day, and then the maximum/minimum value of the current billing day will be cleared to zero and the maximum/minimum value of the current cycle will be recalculated. Definition of billing day transfer time: the data transfer boundary time can be set to any time between the

1st and 28th of each month, and the default value is zero o'clock on the 1st of each month.

SPM73 also provides a function to clear the max/min values of real-time quantities.

5.8 System Runtime

SPM73 provides three time recording functions: Load Running Hours (LRH), Load On Hours (LOH), and Device Running Hours (DRH), in units of 0.1 hours.

- Load Running Hours (LRH): Time when the absolute value of total active power is greater than a set threshold. This threshold can be set.
- Load On Hours (LOH): Time when total active power is not zero.
- Device Running Hours (DRH): Time SPM73 has been running.

5.9 Load Impedance

SPM73 provides three-phase load impedance and total load impedance detection functions. Load impedance is determined by active power (P) and reactive power (Q).

- If P=0 or Q=0, it is resistive.
- If P>0 and Q>0, it is inductive impedance.
- If P<0 and Q<0, it is inductive impedance.
- If P<0 and Q>0, it is capacitive impedance.
- If P>0 and Q<0, it is capacitive impedance.

5.10 Phase Sequence Adjustment

Accurate measurement and energy statistics of SPM73 are based on the correct matching of voltage and current phase sequences, e.g., V1 must match I1. However, in retrofit projects, one application scenario, older sites may have mislabeled or incorrectly wired cables, or installation personnel errors may lead to mismatched CT phase sequences during installation. The traditional approach is to rewire. However, some sites cannot be powered down again for rewiring, or are remote, making re-entry for adjustment difficult. SPM73 provides a phase sequence adjustment function, allowing the voltage-current phase matching relationship to be modified via the display panel or remote configuration software, greatly reducing maintenance costs. Adjustable phase sequence combinations:

Voltage Sequence	Programmable Current Sequence	Description

V1	I1, I2, I3,	V1 can be software-configured to match I1/I2/I3
V2	I1, I2, I3,	V2 can be software-configured to match I1/I2/I3
V3	I1, I2, I3,	V3 can be software-configured to match I1/I2/I3

Example: If the field wiring is wrong, configure the adjustment as follows:

Incorrect Wiring	Corresponding Adjustment
Voltage A -> CT for B Phase	V1 -> I2 Current Channel
Voltage B -> CT for A Phase	V2 -> I1 Current Channel
Voltage C -> CT for C Phase	V3 -> I3 Current Channel

Chapter 6 Input/Output Characteristics

6.1 Relay Output

SPM73 can be optionally equipped with 6 relays, used in conjunction with SPM73's threshold alarm system to monitor whether related electrical parameters exceed limits and output reasonable relay actions (detailed in the Threshold Alarm chapter description). Alternatively, the relay can be set to remote mode, allowing the customer to control the relay as needed. For special requirements, please specify when ordering.

SPM73 provides two relay action modes, differing based on the control mode. The relay control mode is set to remote control by default. Users can change it to alarm control via communication:

- Remote Control (External): The relay is controlled by commands from a PC or PLC via communication.
- Local Control (Internal): The relay operates if the monitoring object configured for it generates an alarm.

When the relay is in remote control mode, even if the monitored object generates an alarm, it will not operate. It must be set to local control mode for alarm-based operation.

Reset (Return) Time (valid only in remote mode): The relay is activated by a command from a PC or PLC. The relay remains activated until the reset time ends. A reset time of 0 means no reset.

6.2 Digital Input

SPM73 provides optional digital inputs for up to 6 active or passive channels, suitable for monitoring circuit breaker position signals, disconnector position signals, and other status information.

When an external contact closes, the corresponding digital input on SPM73 LCD displays "ON", and the internal status information is set to 1. When the external contact opens, "ON" is not displayed, and the internal status information is set to 0.

6.3 Pulse Output

SPM73 comes standard with one optical pulse output and provides an optional electrical pulse output function for energy metering. The pulse can be configured as active

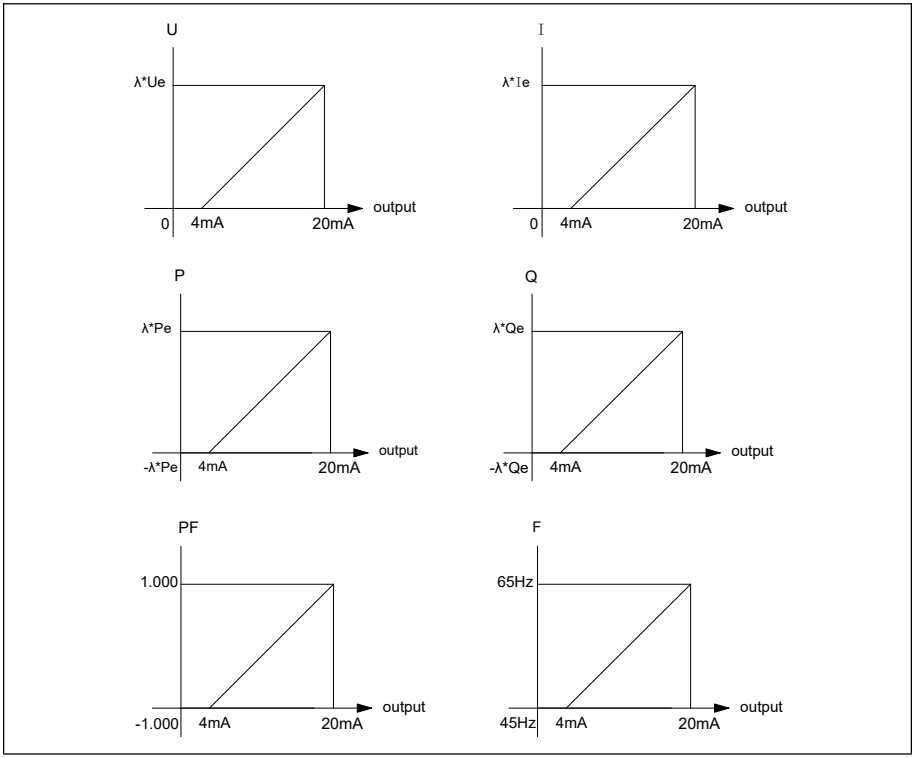
pulse output, reactive pulse output, or (for electrical pulse only) second pulse output (PPS) mode. The pulse constant can be set to one of: 100, 1000, 3200, 3600, 5000, 6400, 12800. The pulse width is 40ms by default.

6.4 Analog Output

SPM73 can be optionally equipped with 2 analog output, range 4~20mA.

Analog output channels can be defined to be associated with parameters such as three-phase phase voltage, three-phase line voltage, three-phase current, total active power, total reactive power, total power factor, frequency, etc.

The following figure shows the analog output characteristic curve, with amplification factor λ:



Description:

$$P = \frac{(P_\lambda - 12)}{8} \times P_e \times \lambda \times CT \times PT$$

Where:

P_λ is the measured analog value, unit mA;

$P_e$is the corresponding rated power value, unit W/var;

λ is the amplification factor for the corresponding channel, range 1.0 to 10.0, default 1.0

In 3P4W/3P3W mode:

$$Pe = Ue * Ie * \sqrt{3}$$

In Single-Phase mode:

$$Pe = Ue * Ie$$

U_e is SPM73 rated phase voltage;

I_e is SPM73 rated current

The analog output can be associated with any item in the table below:

Category	Association Options
Voltage	Phase A Voltage , Phase B Voltage , Phase C Voltage
	AB Line Voltage , BC Line Voltage , CA Line Voltage
Current	Phase A Current, Phase B Current, Phase CCurrent
Active Power	Total Active Power
Reactive Power	Total Reactive Power
Power Factor	Total Power Factor
Frequency	System Frequency

Example:If the customer needs to monitor Phase A voltage (AO object) and set the amplification factor to 1, then when the input Phase A voltage is 176V (rated 220V), the analog AO output will be 16.8mA. The configuration is as follows:

Setting Item	Setting Value
Analog Output Assoc. Obj.	Phase A Voltage
Analog Output Amp. Factor	1

Analog Output Algorithm:

$$U_A = \frac{(U_\lambda - 4)}{16} \times U_e \times \lambda \times PT$$

$$AO = 4 + \frac{16 \times U_A}{U_e \times \lambda \times PT}$$

U_e is Meter Rated Phase Voltage

U_A is Meter Input Phase A Voltage

λ is Amplification Factor for the Channel

Note:

1. When the analog output object is Frequency or Total Power Factor, it is not affected by the amplification factor, i.e., it defaults to 1.0x regardless of the setting.
2. In analog output calculation, the rated voltage Ue used is the PT secondary value set by the user.

Chapter 7 Technical Specifications

Parameter	Range / Performance	Accuracy	Resolution
Rated Operating Parameters			
Power Supply	Supply Voltage: AC 85~265V/DC 100~300V Power Consumption: ≤2W		
Rated Current	5A/1A		
Nominal Voltage	3x57.7/100V, 3x220/380V 40Hz~65Hz		
Active Digital Input	Rated Operation 220V, Lower than 88V is open, higher than 154V is closed.		
Passive Digital Input	SPM73 provides DC24V power supply		
Relay Output Contact Rating	AC 250V/5A or DC 30V/5A		
Measurement Parameters			
Direct Voltage Input	Phase V: 20V~400V Line V: 20V~690V	0.1%	0.01V
Primary Voltage	Max 650kV		
Direct Current Input	5mA~6.5A	0.1% (L02) 0.2% (L05)	0.001A
Primary Current	Max 50000A		
Frequency	40~65Hz	0.1%	0.01Hz
Power Factor	-1.000 ~ +1.000	0.2%	0.001
Active Energy	0~99999999.999kWh	Class D(L02) Class C(L05)	0.001kWh
Reactive Energy	0~99999999.999kvarh	Class 0.5S(L02) Class 1(L05)	0.001kvarh
Active Power	-2,147,483,648W~ 2,147,483,647W	0.2%(L02) 0.5%(L05)	0.1W
Reactive Power	-2,147,483,648var~ 2,147,483,647var	0.5%(L02) 1%(L05)	0.1var
Apparent Power	0~4,294,967,295VA	0.2%(L02) 0.5%(L05)	0.1VA
Unbalance	0%~100%	0.5%	
Harmonic Ratio	0%~100%	Class B	
Analog Output	4~20mA, max load 500Ω	±0.5%FS (@25℃)	

Environmental Conditions			
Normal Operating Temp.	-25℃ ~ +60℃		
Extreme Operating Temp.	-40℃ ~ +75℃		
Storage Temp.	-40℃ ~ +75℃		
Relative Humidity	5%～95% (non-condensing)		
Atmospheric Pressure	70 kPa ~ 106 kPa		
Altitude	<2000m		
Enclosure Protection	IP52 (Front Panel)		
Test Items	**Standard Basis**	**Severity Level**	
Insulation Performance			
Insulation Resistance	GB/T 13729-2019	≥100MΩ	
Power Frequency Withstand Voltage	GB/T 4793.1-2007 (IEC 61010.1:2001)	3000VAC	
Impulse Voltage	GB/T 4793.1-2007 (IEC 61010.1:2001)	6000V	
EMC Performance			
ESD Immunity Test	GB/T 17626.2-2018 (IEC61000-4-2:2008)	Level 4	
RF EM Field Rad. Immunity Test	GB/T 17626.3-2023 (IEC61000-4-3:2020)	Level 3	
Electrical Fast Transient/Burst Immunity Test	GB/T 17626.4-2018 (IEC61000-4-4:2012)	Level 4	
Surge Immunity Test	GB/T 17626.5-2019 (IEC61000-4-5:2014)	Level 4	
Conducted RF Immunity Test	GB/T 17626.6-2017 (IEC61000-4-6:2006)	Level 3	
EM Emission Limits	GB 4824-2019 (CISPR11:2024)	Class B	
Voltage Dips, Sags, Interruptions Immunity Test	GB/T 17626.11-2023 (IEC61000-4-11:2020)	Compliant	

Chapter 8 Maintenance and Troubleshooting

Possible Problem	Possible Cause	Possible Solution
No display after applying control power	Power not applied to device	Check if correct operating voltage is applied to L/+ and N/- terminals. Check if control power fuse is blown.
Incorrect measurement or not as expected	Voltage measurement incorrect	Check neutral connection reliability. Check if measured voltage matches device rated parameters. Check PT parameter settings are correct.
	Current measurement incorrect	Check if measured current matches device rated parameters. Check CT parameter settings are correct.
	Power measurement incorrect	Check if measurement mode setting is correct. Check voltage and current phase sequence correspondence is correct. Check if CT polarity is wrong.
DI status not changing	DI operating voltage incorrect	Check if external contact type matches device rated parameters. Check external wiring is correct.
Relay not operating	No control command received	Check communication link is correct.
	Relay operating mode incorrect	Check if current relay is in the correct mode.
Host computer cannot communicate with device	Device baud rate incorrect	Check device baud rate matches defined value.
	Comm link missing terminator	Check if 120Ω resistor is added.
	Comm link interference	Check communication shield is properly grounded.
	Communication line broken	Check communication cable is disconnected.
	Device baud rate incorrect	Check device baud rate matches defined value.

Notice:

- PILOT reserves the right to modify this manual without prior notice if there is anything needed to change.
- Marketing email: marketing@pmac.com.cn
- Technical support: systemtech@pmac.com.cn

珠海派诺科技股份有限公司
ZHUHAI PILOT TECHNOLOGY CO.,LTD.

Address: No.15, Keji 6th Road, Science and Technology Innovation Coast, High-tech Zone, Zhuhai

Postcode: 519085

Tel: 400-878-6678

Fax: 0756-3629600 3629670