SFERE720
Multifunction Power Meter

User Manual

JIANGSU SFERE ELECTRIC CO., LTD.

TABLE OF CONTENTS

1. Safety Precautions

The manufacturer shall not be held responsible for failure to comply with the instructions in this manual.
The equipment must be installed and serviced only by qualified personnel.
Never work alone.
Prior to any work on or in the equipment,isolate the voltage inputs and auxiliary power supplies， short the secondary of all CT, but never short the secondary of PT.
Always use a properly rated voltage sensing device to conform that all power is off.

Risk of damaging device

- The voltage of the auxiliary power supply is beyond the rated range.
- The frequency of the power distribution system is beyond the rated range.
- The input polarity of the voltage or the current is wired improperly.

2. Product description

2.1 Overview

SFERE720 is equipped with electrical variable measurement, energy metering and power quality analysis functions. SFERE720 also can be extended with I/O modules for monitoring and controlling equipment at field, realizing system integration with different smart electricity distribution system and energy management system, and sharing monitoring data and energy data.

2.2 Extend modules

Sfere720 has two extension interfaces for connecting modules and expand functions. Please take attention to the following points when connecting modules to Sfere720.

a）Two modules for one interface at most, and four modules for Sfere720 at most;

b）Only one communication module can be connected to one interface. The communication modules are FM7, FM9 and FM10. Two interfaces should be

connected with different communication modules;

c）The arrangement of modules can be set according to user's requirements in compliance with a) and b). For example, four FM2 modules, two FM2 modules + one FM3 module + one FM10 module, or one FM2 module + one FM6 module + one FM11 module.

Module type	Description
FM1	2 AC digital input
FM2	4 digital inputs
FM3	2 relay outputs
FM4	2 analog inputs：mA
FM5	2 analog inputs：PT100
FM6	2 analog outputs：mA
FM7	Ethernet :Modbus/TCP
FM8	DB9, Profibus-DP
FM9	WIFI :Modbus/TCP
FM10	GPRS: Modbus/TCP, SMS
FM11	RS485, Modbus-RTU

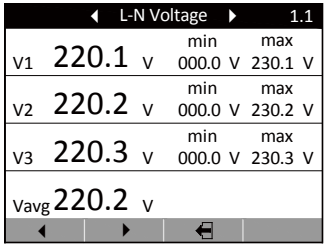
2.3 Measurement

The following list shows variables which can be measured by Sfere720 including relative variables calculated from basic electrical parameters.

Measurement variable	Instant	Max	Min	Demand	Sum	Unit
V1/V2/V3	●	●	●	—	—	[V,kV]
V12/V23/V31	●	●	●	—	—	[V,kV]
I1/I2/I3	●	●	●	●	—	[A,kA]
F	●	●	●	—	—	[Hz]
P1/P2/P3	●	—	—	—	—	[kW,MW,GW]
P	●	●	●	●	—	[kW,MW,GW]
Q1/Q2/Q3	●	—	—	—	—	[kvar,Mvar,Gvar]
Q	●	●	●	●	—	[kvar,Mvar,Gvar]

S1/S2/S3	●	—	—	—	—	[kVA,MVA,GVA]
S	●	●	●	●	—	[kVA,MVA,GVA]
PF1/PF2/PF3	●	—	—	—	—	—
PF	●	●	●	—	—	—
EP+/EP-	—	—	—	—	●	[kWh,MWh,GWh]
EQ1/EQ2/EQ3/EQ4	—	—	—	—	●	[kvarh,Mvarh,Gvarh]
THDV1/THDV2/THDV3	●	—	—	—	—	[%]
THDI1/THDI2/THDI3	●	—	—	—	—	[%]
Harmonic RMS-U (1～63th)	●	—	—	—	—	[%]
Harmonic RMS-I (1～63th)	●	—	—	—	—	[%]
Unbalance-U	●	—	—	—	—	[%]
Unbalance-I	●	—	—	—	—	[%]

2.4 Real-time measurement



Left picture shows three phase instantaneous voltage, average voltage, max. voltage and min. voltage. Click ◀ or ▶ to check other pages, press ↩ to return to main interface.

2.5 Energy metering and tariff meter reading

This meter has excellent energy metering functions as follows:

·Total bi-direction active and reactive energy metering

·Phase separated bi-direction active and reactive energy metering

·Fundamental energy metering;

·Four-qradrant reactive energy metering;

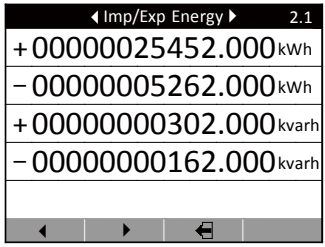
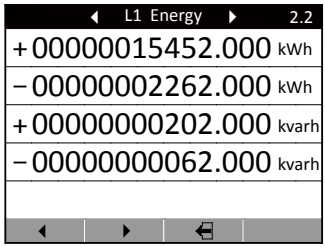
·Apparent energy metering;

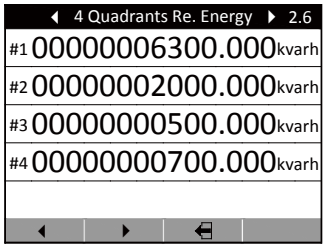
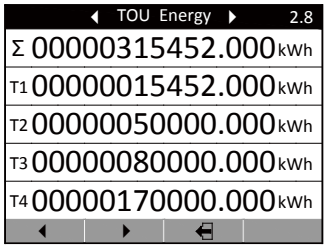
·Tariff energy metering

The meter shows primary value. Primary value is equal to the secondary value multiplied by voltage or current transformer ratio. Secondary value is the reference to all of the energy. The smallest resolution ratio of secondary value is 1Wh or 1varh. The smallest resolution ratio of energy shown on meter is 0.01kWh or 0.01kvarh.

The storage range of energy is secondary energy 4294967295 Wh, and the display range of energy is primary energy 99999999999 kWh (99.9 billion). The data will not exceed the range if the meter is in its mean time between failures. User can clear the energy data after entering correct password.

Tariff energy: the meter has two sets of tariffs with four kinds of rates in twelve time zones. It starts energy metering in one time zone according to digital input status.

	Left picture shows bi-direction active/reactive energy. EP+= 25452kWh， EP- = 5262kWh， EQ+ = 302kvarh， EQ- = 162kvarh。
	Left picture shows Phase A bi-direction active/reactive energy. EP+= 15452kWh， EP- = 2262kWh， EQ+ = 202kvarh， EQ- = 62kvarh。

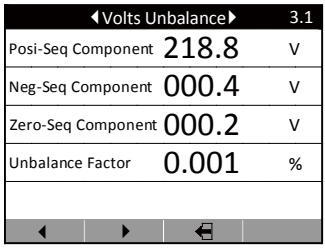
	Left picture shows four quadrant ractive energy. First quadrant Q1 = 6300kvarh， Second quadrant Q2 = 2000kvarh， Third quadrant Q3 = 500kvarh， Fourth quadrant Q4 = 700kvarh。
	Left picture shows import active energy in different time zones. Total active energy (Σ) 315452kWh Energy of tariff 1 (T1) 15452kWh Energy of tariff 2 (T2) 50000kWh Energy of tariff 3 (T3) 80000kWh Energy of tariff 4 (T4) 170000kWh

2.6 Energy quality

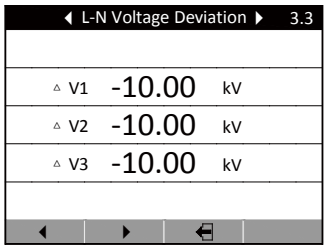
Sfere720 can monitor and analyze power quality of gird and measure the following variables:

Three phase voltage and current sequence component and unbalance

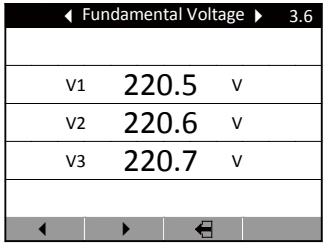
Electrical variables in three phase system can be divided into positive sequence component, negative sequence component and zero sequence component according to symmetrical component method. If electric system is in normal operation mode, the ratio between negative sequence component RMS value and positive sequence component RMS value is defined as three phase unbalance of an electrical variable.

	Left picture shows three phase voltage and current sequence component and unbalance.

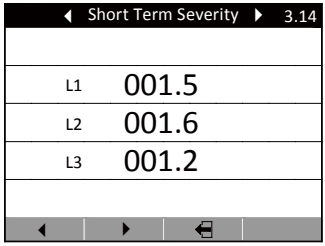
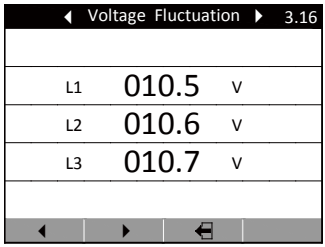
Phase voltage, line voltage and frequency deviation.

	Left picture shows three phase voltage deviation.

Fundamental wave voltage/ current, harmonic voltage/current, fundamental wave active power/reactive power/apparent power, fundamental wave power factor.

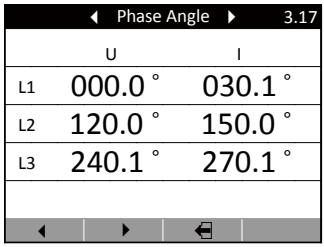
	Left picture shows three phase voltage fundamental wave content.

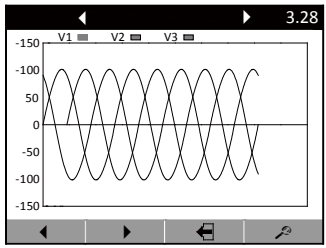
Voltage short-term flicker, long-term flicker and fluctuation

	Left picture shows voltage short-term flicker value.
	Left picture shows voltage fluctuation value.

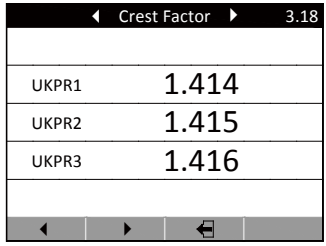
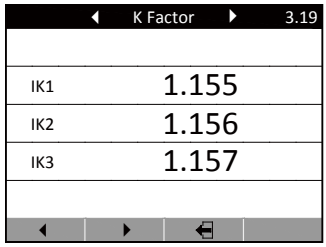
Voltage and current phase angle

Sfere720 shows three phase voltage and current phase angles. Phase A voltage angle is defaulted as 0°. Other phase angles are shown phase difference relative to Phase A voltage. Unit: °

	Left picture shows three phase voltage and current phase angles.

	Left picture shows three phase voltage waveform.

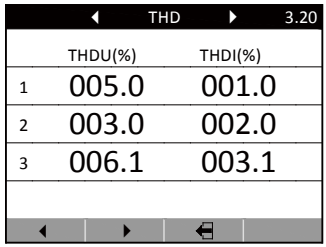
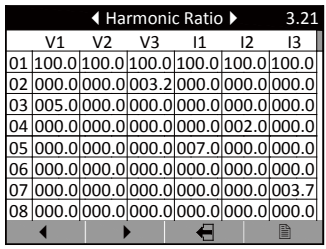
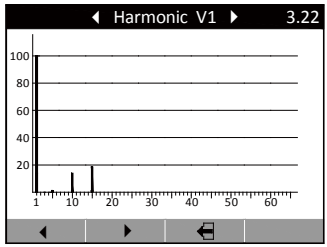
Voltage crest factor, current K factor

	Left picture shows three phase voltage crest factor.
	Left picture shows current K factor.

Sfere720 can measure harmonic content of grid. The detailed functions are as follows:

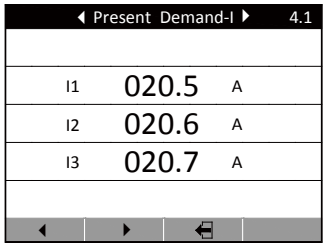
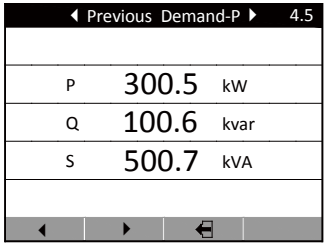
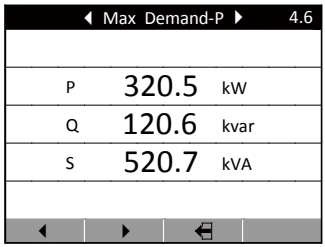
■Measuring 2nd to 63rd harmonics;

■Showing voltage and current bar graph.

<table>
<tr>
<td> 
</td>
<td>Left picture shows three phase voltage and current THD.</td>
</tr>
<tr>
<td> 
</td>
<td>Left picture shows three phase voltage and current subharmonics content.</td>
</tr>
<tr>
<td> 
</td>
<td>Left picture shows voltage subharmonics bar graph.</td>
</tr>
</table>

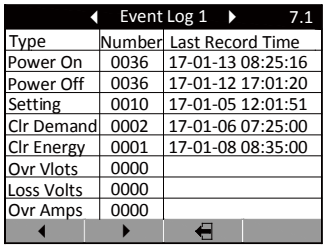
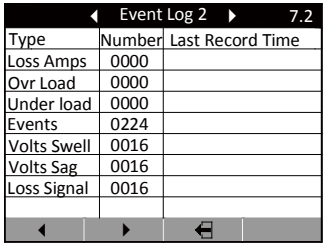
2.7 Demand record

Sfere720 has six independent demand recording channels to measure and record max. demand, present demand and previous demand of three phase current, total active power, total reactive power and total apparent power.

	Left picture shows present demand of three-phase current.
	Left picture shows three-phase total active power, reactive power, apparent power in last cycle.
	Left picture shows max. demand of three-phase total active power, reactive power and apparent power.

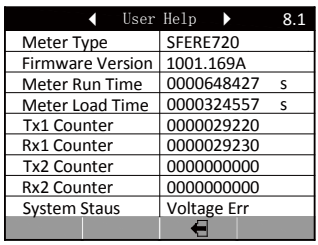
2.8 Event record

Event record includes the total times and lastest occurrence time of power on record, parameter modification record, over current record and so on.

	Left picture shows event record 1.
	Left picture shows event record 2.

2.9 Help information

The page shows software version and module status.

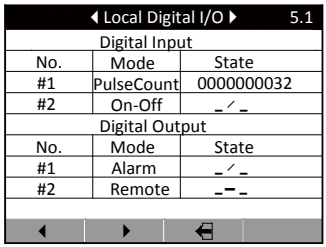
	Left picture shows user help information. The last column shown present status of system. “OK” means the system operates normally. “Voltage Err” means there is voltage fault.

2.10 Extend module

Sfere720 has two extension interfaces for connecting modules and expand functions.

2.10.1 Digital input and relay output of Sfere720

Sfere720 has two digital inputs and two relay outputs.



Left picture shows digital input and relay output information of Sfere720.

2.10.2 Digital input（FM1, FM2）

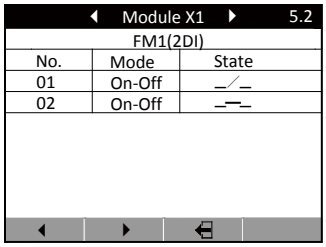
FM1 module has digital input adopting wet contact mode to measure AC 220V signal.

FM2 module has digital input adopting dry contact mode which gets power supply from inside of meter and with no need for external power supply.

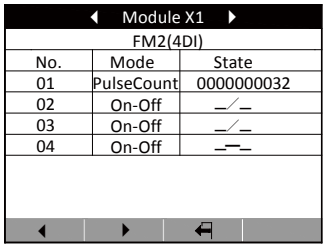
Digital input supports two working modes:

Status monitoring: the meter receives the status of terminal node and shows it on the window. It also shows the newest status immediately when the status of terminal node changes.

Pulse counting: the meter receives and counts up the number of pulses from terminals. It adds by one when it receives one pulse.



Left picture shows working modes of two digitals inputs are synchronous demand and status monitoring. No. 2 digital input receives signal.



Left pictures shows workings modes of four digital inputs. No. 1 digital input is in pulse counting mode, and the pulse number is 32; No. 2, No. 3 and No. 4 digital inputs are in status monitoring mode, No.4 digital input has signal input.

2.10.3 Relay output（FM3）

Sfere720 has two relay outputs. FM3 module is used to add more relay outputs to meter.

Sfere720 relay outputs have two working modes: remote control and off-limit alarm.

FM3 module relay outputs have two working modes: remote control and off-limit alarm. Working mode, alarm item and alarm range of each relay output can be set in programming.

As for detailed information about relay output setting, please refer to Appendix 2.

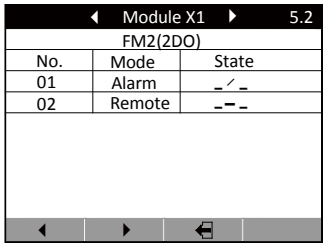
Notice:

Remote control

If user needs to remotely control relay output, please set the working mode as “Remote”. Set delay as electrical level mode or set delay time as N * 100ms.

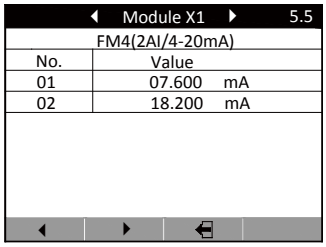
Off-limit alarm

Set relay output as “Alarm” mode, “Mode” is used to select an electrical variable, “Delay” is used to set alarm delay time, “Value” is used to set alarm limit value, “Reset” is used to set alarm recovery threshold value for electrical variable.

	Left picture shows FM2 status information. No. 1 is in off-limit alarm mode, No. 2 is in remote control mode.

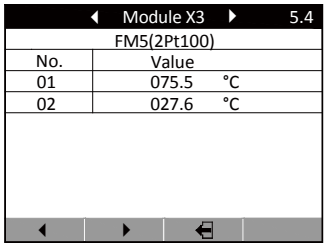
2.10.4 Analog input module（FM4）

FM4 module is used to measure 4~20mA signal. The measurement display page is shown as follows,

	Left picture shows DC analog input value. No. 1 input 7.6mA, No. 2 input 18.2mA.

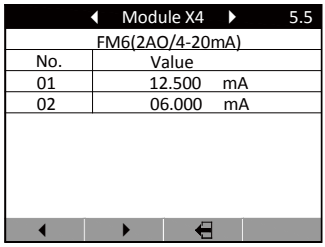
2.10.5 Analog input module（FM5）

FM5 module is used to measure PT100 signal. The measurement display page is shown as follows,

	Left picture shows PT100 input value. No.1 input temperature is 75.5℃, No.2 input temperature is 27.6℃.

2.10.6 Analog output module（FM6）

Analog output module can transfer instantenous electrical variables to DC current signal output. If analog output module is conneted to meter, the corresponding display page will be shown on meter. Current value shown in the page is theoretical output value in present status. Analog output item and range can be set through meter.



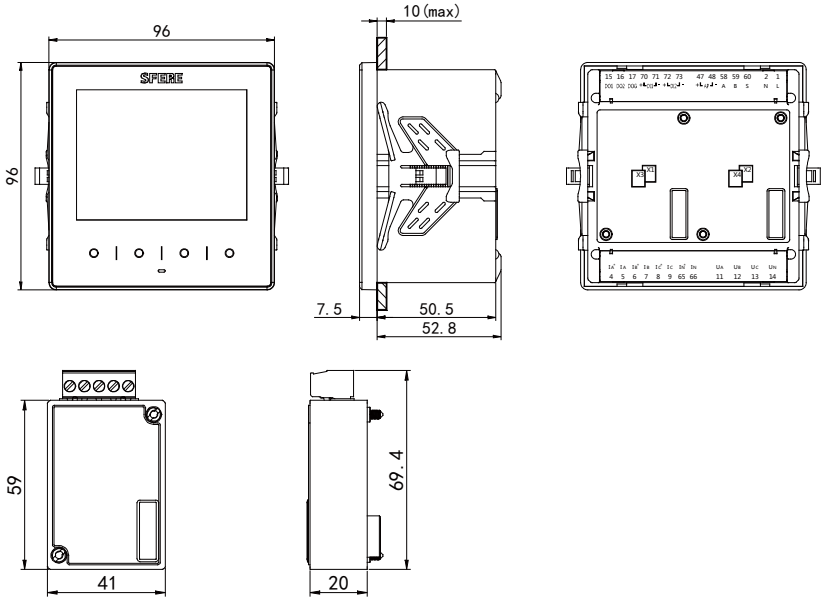
Left picture shown analog output theoretical value. No. 1 output 12.5mA, No. 2 output 6mA.

2.11 Communication

Sfere720 has digital communication interface. User can read meter status and measured value or do programming and setting parameters through the communication interface. Sfere720 is defaulted to be equipped with one RS-485 communication interface adopting Modbus-RTU protocol. Communication should be connected with shielded twisted pair line. One busbar can be connected with 32 meters at most. Starting and ending terminal of busbar should be connected with terminal resistance.

3 Installation and wiring

3.1 Outline dimension



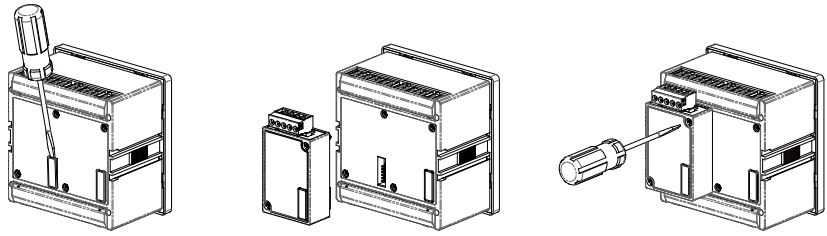
3.2 Installation method

1) Choose a right place on the fixed distribution cabinet for cutout by size 91×91mm;

2) Take off the supporting clips of the meter;

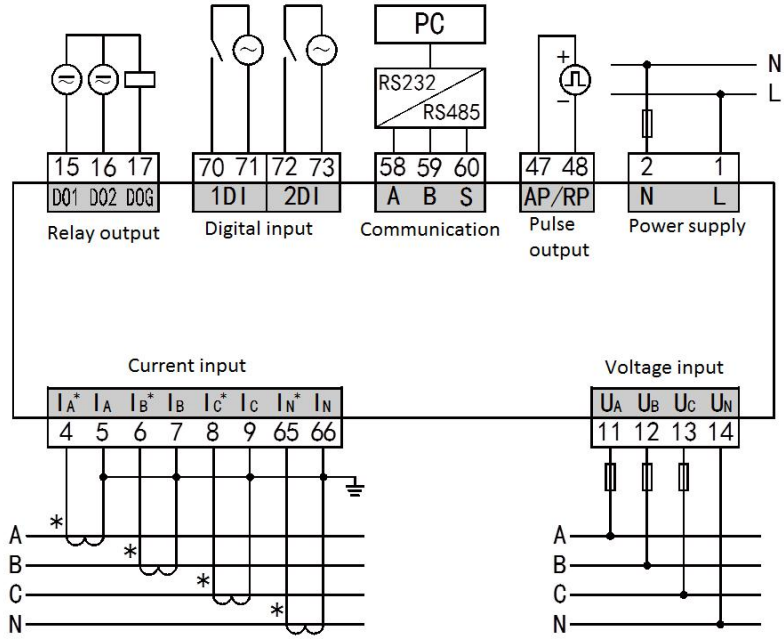
3) Insert the meter into the cutout;

4) Insert and push the supporting clips to fix the meter.



3.3 Wiring

Typical wiring

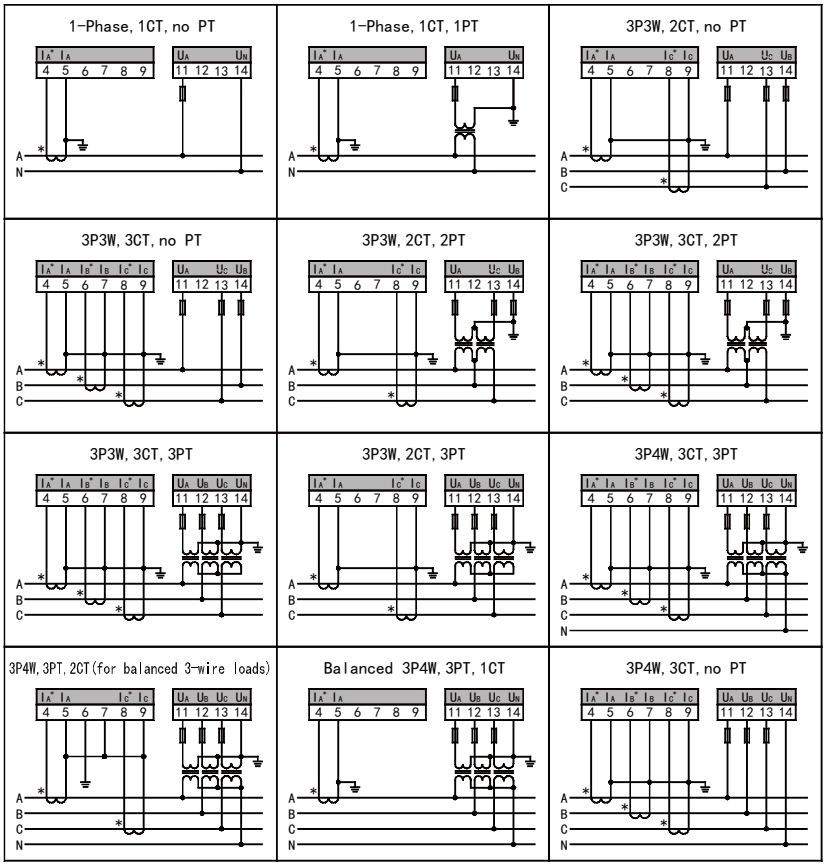


Note:

Auxiliary power supply：AC/DC (80～270)V

Rated current of fuse：0.5A

3.4 Signal wiring diagram



Wiring instruction:

(a) External wiring method must be the same with the inner wiring method of the meter. Otherwise the measured data will be incorrect.

(b) Voltage and current signals must be AC signals. Please do not connection DC signals to input terminals.

(c) Voltage input: make sure the input voltage in not higher than the rated voltage of the meter, otherwise, please connect external PT to the meter. If external PT is adopted, the accuracy of meter will depend on the accuracy of

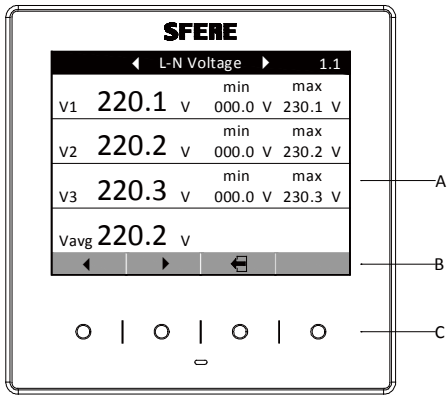
external PT. Please make sure the accuracy of external PT is equal to or better than that of meter. For your convenient maintenance, please adopt wiring terminal row.

(d) Current input: make sure the input current in not higher than the rated current of the meter, otherwise, please connect external CT to the meter. If external CT is adopted, the accuracy of meter will depend on the accuracy of external CT. Please make sure the accuracy of external CT is equal to or better than that of meter. If there is more than one meter connected to the CT, please connect them in serial. Before removing the current input wires of the meters, make sure to cut off the first loop of CT or short connect its second loop. For your convenient maintenance, please adopt wring terminal row.

(e) Make sure voltage and current of three phases corresponding to each other, that means the phase sequence and direction are same. Otherwise, the numbers and signals will be incorrect (power and energy).

4. Operation

4.1 Panel description



A: Display window B. Function indication for keys C: Touch type keys

5 Setting

5.1 Signs for keys and corresponding functions

User can set parameters for meter through keys.

Sign	Function
▲	Add number at selected bit
▼	Move downward, switch to next page, change parameter
◀	Move left to change or show data/ switch data bit
▶	Move right to change or show data
⏎	Return to Main interface directly, return to upper level menu/cancel modification
→	Enter selected item
↵	Confirm
🔍	Zoom display image
✎	Edit
📄	Next page
	Ineffective key

The method of changing numbers

Click ◀ to select a bit, click ▲ to add number at selected bit

Enter and exit programming status

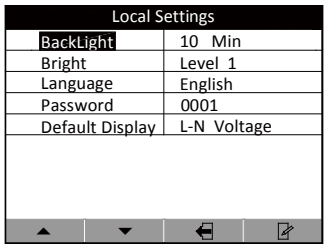
Enter programming mode: Click ◀ or ▶ to select "System setting" in main interface, and then click → to enter programming interface. Select "User" and input correct password to enter parameter setting mode. (Programming password is defaulted as 0001 in factory. User can change the password.).

Exit programming mode: return to first level of menu at first, and then click  . The meter will indicate whether to save modified data or not at this step. If “Yes” is selected, the meter will save modified data and return to main interface; if “No” is selected, the meter will cancel modified data and return to main interface.

5.2 Programming and setting menu

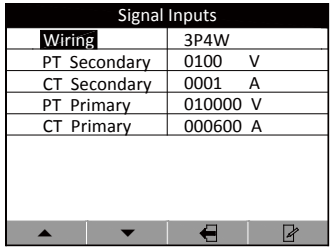
Programming and setting menu adopts hierarchical mode.

5.2.1 Basic parameter setting



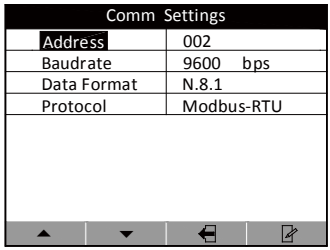
Backlight	00s-99 min 00-backlight constant on
Bright	1-5
Language	English
Password	0001-9999
Default display	Set first display interface after power on. This interface can be set as U, I, P, E, THD, Waveform, Demand and Max/Min

5.2.2 Signal input setting



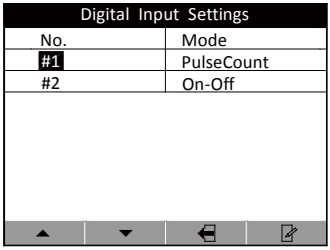
Wiring method	1P2W,3P3W,3P4W
PT secondary value	0-690V
CT secondary value	0-6A
PT primary value	0-999999V
CT primary value	0-999999A

5.2.3 Communication setting



Address	1~247
Baud rate	1200~38400bps
Check mode	E81,O81,N81,N82
Communication protocol	Modbus-RTU

5.2.4 Digital input setting

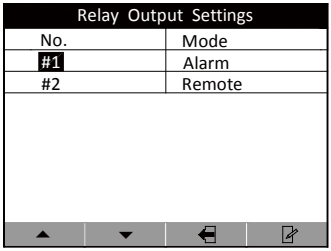


There are two working modes of digital input.

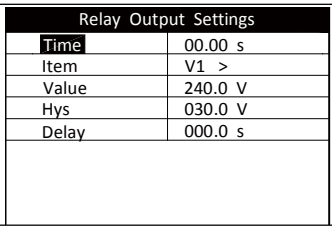
Pulse counting

Status monitoring

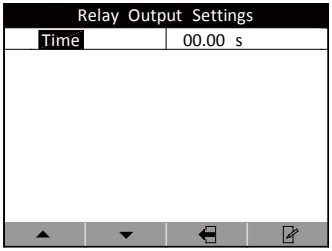
5.2.5 Relay output setting



There are two working modes of relay output which are remote communication and alarm.



Alarm output Settings	
Time	Pulse width: (0~9999)×100ms
Item	See following list
Value	Limit value
Hys	Hysteresis value

	Delay	Delay time: (0~9999)×100ms
	Remote control output mode	
	Time	0-99.99s

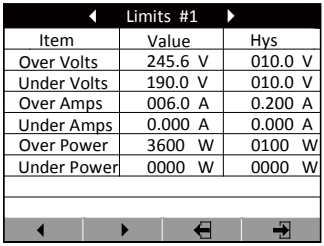
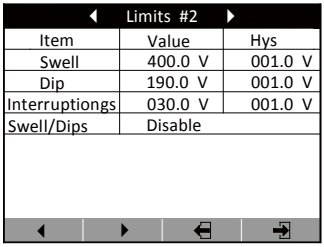
Electrical variables for alarm are shown in the following list:

Item	Format	Instruction
OFF		Off
DI	0/1	Digital input linkage of selected channel,the relay output copy the state of the digital input
THDi <	xx.xx%	Current harmonic distortion rate low alarm
THDi >		Current harmonic distortion rate high alarm
THDv <		Voltage harmonic distortion rate low alarm
THDv >		Voltage harmonic distortion rate high alarm
Iunb <	xxx.x %	Current unbalance low alarm
Iunb >		Current unbalance high alarm
Vunb <		Voltage unbalance low alarm
Vunb >		Voltage unbalance high alarm
F <	xx.xx Hz	Grid frequency low alarm
F >		Grid frequency high alarm
PF <	x.xxx	Total power factor low alarm
PF >		Total power factor high alarm
S <	xxxx _VA	Total apparent power low alarm
S >		Total apparent power high alarm
Q <	xxxx _var	Total reactive power low alarm

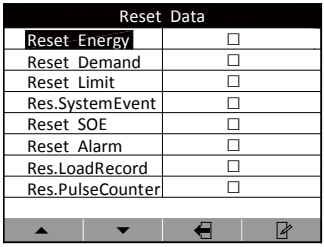
Q >		Total reactive power high alarm
P <	xxxx _W	Total active power low alarm
P >		Total active power high alarm
Io <	x.xxx _A	Zero-sequence current low alarm
Io >		Zero-sequence current high alarm
Iavg >		Current average value low alarm
Iavg <		Current average value high alarm
I <		One of three phases currents low alarm
I >		One of three phases currents high alarm
I3 <		I3 currents low alarm
I3 >		I3 currents high alarm
I2 <		I2 currents low alarm
I2 >		I2 currents high alarm
I1 <		I1 currents low alarm
I1 >		I1 currents high alarm
Vllavg <	xxx.x _V	Line voltage average value low alarm
Vllavg >		Line voltage average value high alarm
Vlnavg <		Phase voltage average value low alarm
Vlnavg >		Phase voltage average value high alarm
Vll <		One of three line-voltages low alarm
Vll >		One of three line-voltages high alarm
V31 <		V31 voltages low alarm
V31 >		V31 voltages high alarm
V23 <		V23 voltages low alarm
V23 >		V23 voltages high alarm
V12 <		V12 voltages low alarm
V12 >		V12 voltages high alarm
Vln <		One of three phases voltages low alarm
Vln >		One of three phases voltages high alarm

V3 <		V3 voltages low alarm
V3 >		V3 voltages high alarm
V2 <		V2 voltages low alarm
V2 >		V2 voltages high alarm
V1 <		V1 voltages low alarm
V1 >		V1 voltages high alarm

5.2.6 Limit value setting

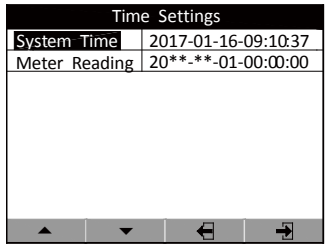
	Used to set off-limit alarm for voltage, current and power.
	Used to set voltage swell, sag and interruption.

5.2.7 Clear synchronous setting



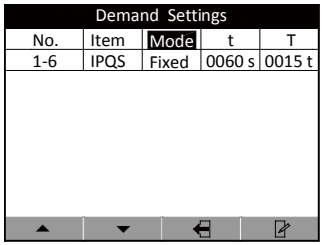
Parameters of energy, demand, Max./Min. value and Event are cleared in this interface. If the parameters are cleared, the relative value will be zero and not be reset; If energy is cleared, a piece of energy clearance SOE is made.

5.2.8 Time setting and meter reading time



System time	Setup real-time-clock
Meter reading time	

5.2.9 Demand setting

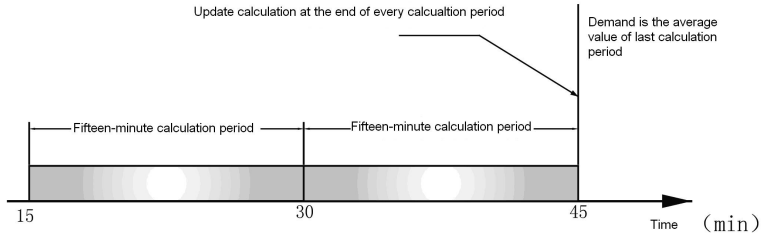


No.	1-6
Item	I1,I2,I3,P,Q,S
Mode	Slip/Fixed
t	Update time
T	T=n*t,

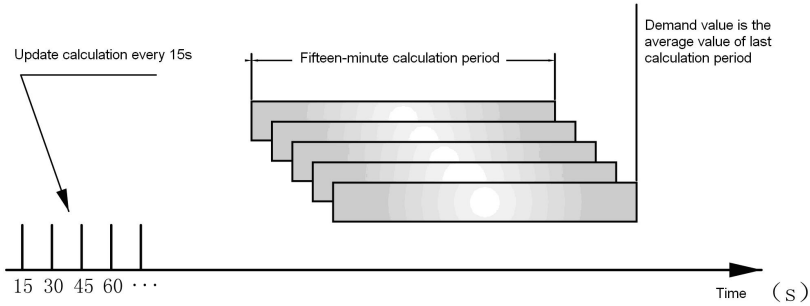
There are two demand measurement modes which are slip and fixed. The relative time parameters are set as t (updating time) and T (time zone).

Slip: meter calculates average demand during latest T minutes every t seconds, tests and records the value, automatically reads the demand every month；

Fixed: meter calculates average demand during latest T minutes after T minutes, tests and records the value, automatically reads the demand every month.



Fixed mode



Slip mode

Note: calculation method in upper pictures takes 15min as example.

5.2.10 Monthly tariff setting

Month Tariffs			
Month	Day Type	Month	Day Type
01	#2	07	#1
02	#1	08	#1
03	#1	09	#1
04	#1	10	#1
05	#2	11	#1
06	#1	12	#1

Sfere720 has two sets of daily tariffs. One month can be selected to follow one set of daily tariffs. Daily tariffs can be set in daily tariff page.

5.2.11 Daily tariff setting

#1 Day Tariffs					
No.	Time	Tariffs	No.	Time	Tariffs
01	00:00	T2	07	00:00	T1
02	08:00	T1	08	00:00	T1
03	20:00	T3	09	00:00	T1
04	22:00	T4	10	00:00	T1
05	00:00	T1	11	00:00	T1
06	00:00	T1	12	00:00	T1

Sfere720 has two sets of daily tariffs. 24 hours in a day are divided into 12 twelve zone. Each time zone can be selected with one from fours kinds of tariffs.

5.2.12 Extend module setting

Analog output setting

X4 Anolog Output				
No.	Item	Mode	DS	FS
01	V1	4-20mA	0000	3800
02	I1	4-20mA	0000	5000

Item	See following list
Mode	4~20mA
Zero point	Zero scale
Full scale point	Full scale

Note: zero scale and full scale points of analog output range should be set correctly, or there will be deviation. As for data format and unit, please reder to the following list.

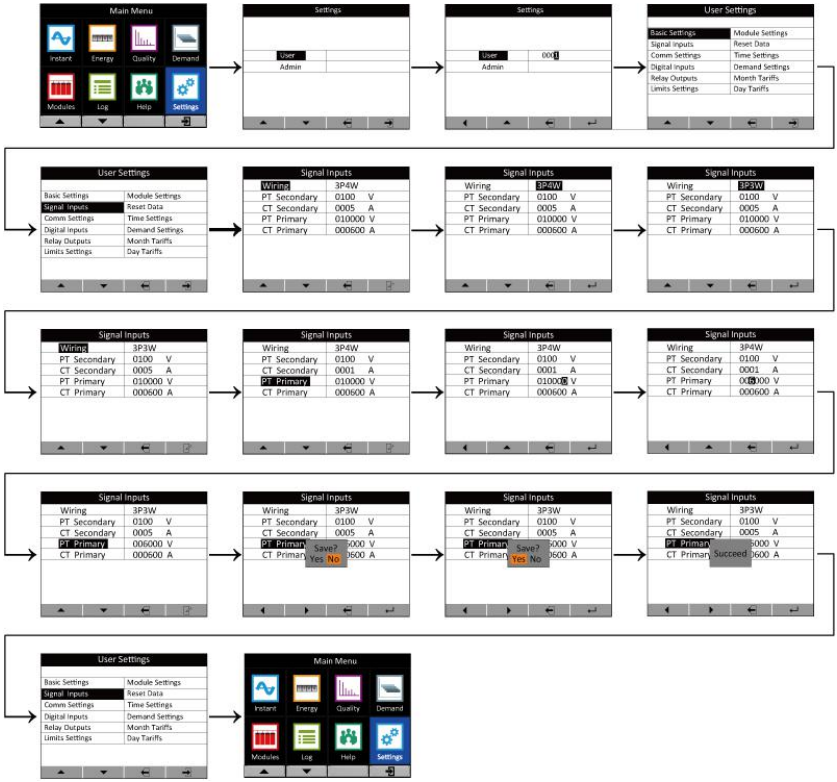
Analog output table

Item	Format	Instruction
OFF		Off
V1	xxx.x __V	Voltage
V2		
V3		
V12		
V23		
V31		
I1	x.xxx __A	Current
I2		
I3		
In		
P1	x.xxx __W	Active Power
P2		
P3		
P		
Q1	x.xxx __var	Reactive Power
Q2		
Q3		
Q		
S1	x.xxx __VA	Apprent Power
S2		
S3		
S		
PF1	x.xxx	Power Factor
PF2		
PF3		
PF		

F	xx.xx Hz	Frequency

5.3 Example for programming operation

Suppose the wiring method of meter is three phase four wire, input voltage range is 380V, direct voltage input mode and primary voltage is 380V, change the wiring method to be three phase three wire, change input voltage range to be 100V and change primary voltage to be 6000V, the programming operation process is as follows,



6. Communication

Meter is defaulted to be equipped with one communication, RS-485 interface, Modbus-RTU protocol. It also can be extended with one communication by connecting with a module.

7. Technical specifications

Electric Characteristics			
Accuracy	Voltage and current		0.2%
	Power,Power Factor		0.2%
	Frequency		±0.01Hz
	Active power		IEC62053-22, class 0.2S
	Reactive power		IEC62053-23, class 2
Data update rate			1s
Input	Wiring mode		1P2W、3P3W、3P4W
	Voltage	Rated value	400 VAC L-N (690 VAC L-L)
		Overload	1.2Vln
		Impedance	>1MΩ
	Current	Rated value	1A or 5A
		Overload	Continuous: 1.2In
			Instantaneous: 10In/5s
		burden	<0.1VA
		Rated value	<20mΩ
	Grid frequency		(45～65)Hz
Auxiliary supply	Working range		AC/DC（80～270）V
	consumption		≤ 10VA
Energy pulse output			1 photocouple outputs, pulse width (80±20%) ms

Digital input		AC220V input, isolation：2000VAC
Relay output		Contact rated at AC 250V/5A or DC 30V/5A
		Isolation： 2500VAC
Communications		
RS485 port		Modbus-RTU , 2-wire,up to 38400bps
Mechanical Characteristics		
IP index	IP65（front panel）and IP20（meter body）	
Dimensions	96×96×55mm	
Environmental Characteristics		
Operating temperature		(-10～60)℃
Storage temperature		(-25～70)℃
Relative humidity		(5～95)% (no gel)
Insulation		IEC 61010-1
Electromagnetic Compatibility		
Immunity to electrostatic discharge		IEC 61000-4-2-Level III
Immunity to radio-frequency field		IEC 61000-4-3- Level III
Immunity to electrical fast transients/bursts		IEC 61000-4-4- Level Ⅳ
Immunity to impulse waves		IEC 61000-4-5- Level Ⅳ
Immunity to conducted disturbances		IEC 61000-4-6- Level III
Immunity to power frequency magnetic fields		IEC 61000-4-8- Level III
Immunity to voltage dips and short interruptions		IEC 61000-4-11- Level III
Module		

FM1	2 AC digital input
FM2	4 digital inputs
FM3	2 relay outputs
FM4	2 analog inputs：mA
FM5	2 analog inputs：PT100
FM6	2 analog outputs：mA
FM7	RJ45, Modbus/TCP
FM8	DB9, Profibus-DP
FM9	WIFI: Modbus/TCP
FM10	GPRS: Modbus/TCP, SMS
FM11	RS485, Modbus-RTU