Multifunction Power Meter
Model：SPM32(2020)
Installation & Operation Manual
V2.4

ZHUHAI PILOT TECHNOLOGY CO., LTD.

⚠ Danger and warning!

This device can be installed only by professionals.

The manufacturer shall not be held responsible for any accident caused by the failure to comply with the instructions in this manual.

⚠ Risks of electric shocks, burning, or explosion

- This device can be installed and maintained only by qualified people.
- Before operating the device, isolate the voltage input and power supply and short-circuit the secondary windings of all current transformers.
- Put all mechanical parts, doors, or covers in their original positions before energizing the device.
- Always supply the device with the correct working voltage during its operation.

Failure to take these preventive measures could cause damage to equipment or injuries to people

CONTENTS

1. General Information

SPM32 Three Phase Multifunction Power Meter is designed for monitoring and displaying all kinds of electricity parameters in high/ low voltage system to 650kV. It has one RS485 port and support Modbus-RTU communication protocol.

SPM32 provides the main function as below:

- Real-time measuring data, true RMS

  (Three phase voltage, current, active power, reactive power, apparent power, power factor, frequency, phase angle)

- Imp. & Exp. Energy

- Demand calculation

  (Demand and peak demand for current, three-phase active power, total active power)

- Alarm function

  (Alarm for over-voltage, under-voltage, over-current, under-current, phase lost, over-frequency, under-frequency, over power, phase error, over-total active power demand, DI1 and DI2 status change)

- Harmonic analysis: 2~63th voltage harmonic, 2~63th current harmonic, THD

- Current unbalance, Voltage unbalance, Voltage zero - sequence component, Voltage positive - sequence component, Voltage negative - sequence component.

- Three - phase voltage phase angle, Three - phase current phase

angle.

- One RS485, Modbus-RTU protocol
- Optional 2 digital input and 2 relay output
- Rated input 1A or 5A settable
- Rated voltage: compatibility 3x57.7/100V and 3x220/380V.

2. Order Information

SPM32 - ☐ - ☐	
① ②	
① : **Optional DI/ DO**	
N	Basic model (without THD, 63rd harmonic)
E	Advanced model (with THD, 63rd harmonic)
② : **Optional DI/ DO**	
S	Two Status Input (wet contact)
SR	Two Status Input (wet contact) + Two relay output

Example: SPM32-N-SR, it means the device provides basic measuring

function, one RS485 port, 2 status input (wet contact), 2 relay output.
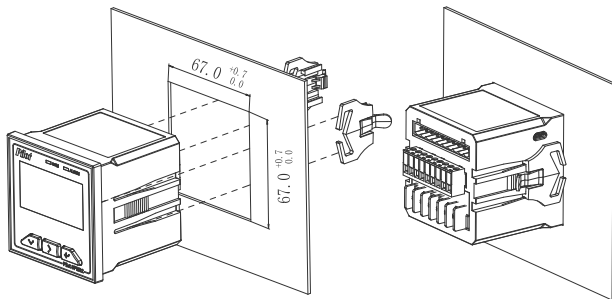
3. Dimension and Installation

3.1 Dimension

unit：mm
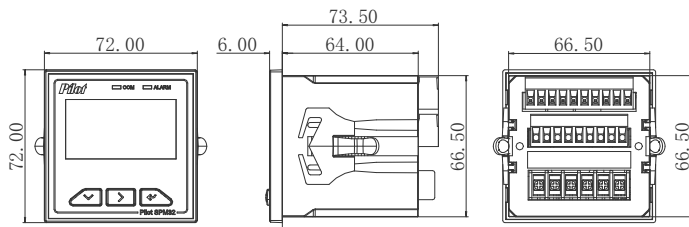
3.2 Installation

unit：mm

4. Display and Keys-press Operation

4.1 Display instruction

1: Main menu

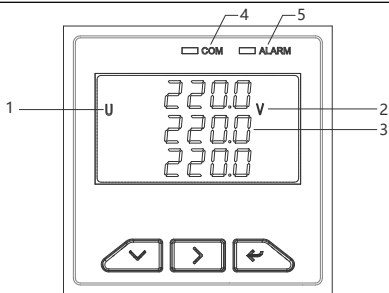2: Unit of parameter.

3: Data display area.

4:Communication indicator：

Light off when the device is

power on, flashes when

communication is OK.

5:Alarm indicator：Light off when no alarm, flashes when there is an alarm.

Description:

(1) If there is no key operation within 60s, the backlight automatically turns

off, when the backlight is lit until the button operation again.

4.2 Keys
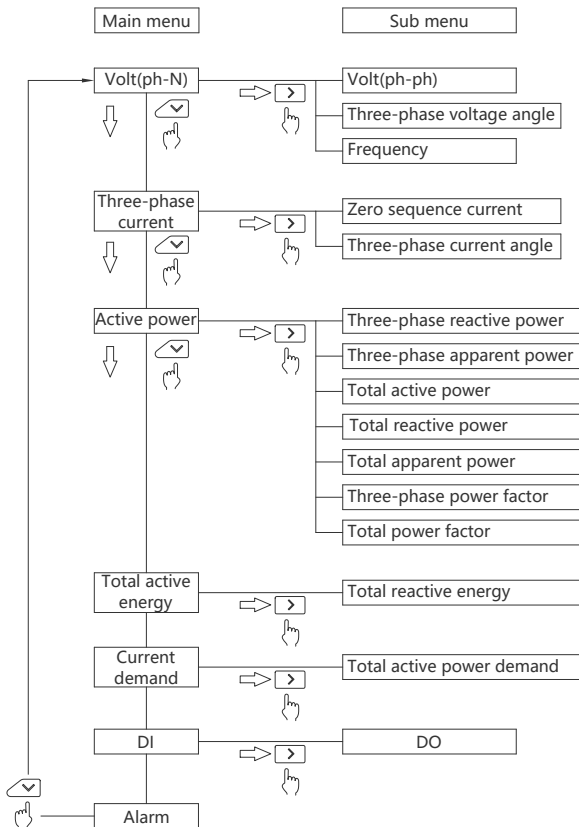
Note: In a different interface, the same keys have different functions.

$\boxed{\vee}$ Sibling menu switch / decrease the value

$\boxed{>}$ Switching sibling menu to submenu / move the cursor to right

$\boxed{\hookleftarrow}$ Confirm/ Exit

4.3 Real-time data display procedure

Main menu		Sub menu

Volt(ph-N) → ⟶ `>`
- Volt(ph-ph)
- Three-phase voltage angle
- Frequency

Three-phase current → ⟶ `>`
- Zero sequence current
- Three-phase current angle

Active power → ⟶ `>`
- Three-phase reactive power
- Three-phase apparent power
- Total active power
- Total reactive power
- Total apparent power
- Three-phase power factor
- Total power factor

Total active energy → ⟶ `>`
- Total reactive energy

Current demand → ⟶ `>`
- Total active power demand

DI → ⟶ `>`
- DO

Alarm

4.4 Setting menu and procedure

| ■Parameter setting	1. Password: Press the ⏎ key to enter the password page, parameters can be set only after entering the correct password. Default password: 01, super password: 99.
Setting menu	
1. Password	
2. PT primary	
3. PT secondary	
4. CT primary	
5. CT secondary	
6. Wiring mode	

1. Password: Press the ⏎ key to enter the password page, parameters can be set only after entering the correct password. Default password: 01, super password: 99.

```
┌─────────────────┐
│   ▭ COM  ▭ ALARM │
│      PASS        │
│       00         │
│  ⌄   >   ⏎       │
└─────────────────┘
```

2. PT primary: Press the ⏎ key to enter the PT primary page, can set the PT primary side line voltage value.

Range: 0.10~650.00 kV.

Setting menu:
7. Com. address
8. Com. baud rate
9. Clear energy
10. Clear demand
11. Demo mode
12. Demand mode
13. Demand interval
14. Demand sub-interval (slip)
15. Version (view only)

```
┌─────────────────┐
│   ▭ COM  ▭ ALARM │
│     P7- 1ᵗᵥ      │
│      0.38        │
│  ⌄   >   ⏎       │
└─────────────────┘
```
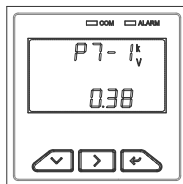
3. PT secondary: Press the ⏎ key to enter the PT secondary page, set the PT secondary side line voltage value.

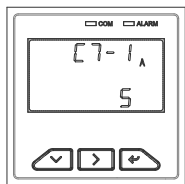Range: 100~400V (ph-ph).

```
  □ COM   □ ALARM
    P7-2 v
     380
  [ ∨ ][ › ][ ⏎ ]
```
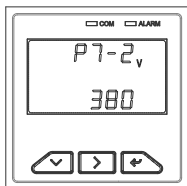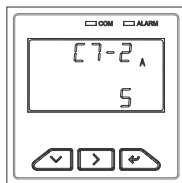
4. CT primary: Press the ⏎ key to enter the CT primary page, can set the CT primary value.

Range:1~9999A.

```
  □ COM   □ ALARM
    C7- 1 A
      5
  [ ∨ ][ › ][ ⏎ ]
```

5. CT secondary: Press the ⏎ key to enter the CT secondary page, can   set the CT secondary value. Range:1A or 5A.

```
  □ COM   □ ALARM
    C7-2 A
      5
  [ ∨ ][ › ][ ⏎ ]
```

6. Wiring mode: Press the ⏎ key to enter the wiring mode page. Range: 4Y (3P4W) or 3D (3P3W)

```
  □ COM   □ ALARM
    rodE
     4Y
  [ ∨ ][ › ][ ⏎ ]
```
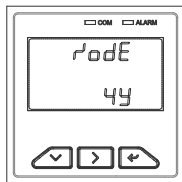
7. Com. address: Press the ⏎ key to enter the Com. address page. Range: 1~247.

```
  □ COM   □ ALARM
    Adr
      1
  [ ∨ ][ › ][ ⏎ ]
```
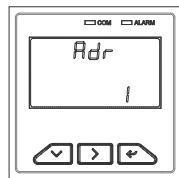
8. Com. baud rate: Press the ⏎ key to enter the Com. baud rate page.

Range: 4800/ 9600/ 19200bps.
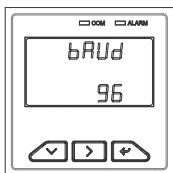
note: 96 means 9600bps.

9. Clear energy: Press the ⏎ key to enter the clear energy page, select "Yes" and press the ⏎ key to clear energy.

10. Clear demand: Press the ⏎ key to enter the clear demand page, select "Yes" and press the ⏎ key to clear demand.
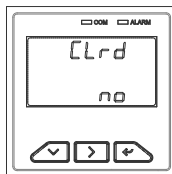
11. Demo mode: Press the ⏎ key to enter the demo mode page, select "Yes" and press the ⏎ key to start the demo mode, select "No" and press the ⏎ key to close the demo mode.
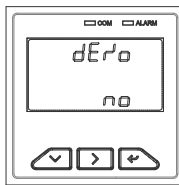
12. Demand mode: Press the ⏎ key to enter the demand mode.

Range: 0 - Fixed mode,

1 - Slip mode.

Default: Fixed mode.

9
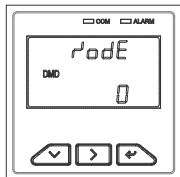
13. Demand interval: Press the ⏎ key to enter the demand interval page. Range: 5 mins, 10 mins, 15 mins, 30mins, 60mins. Default: 15 mins.
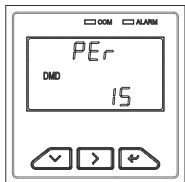
14. Demand sub-interval (slip): Press the ⏎ key to enter the demand sub-interval page. Range: 1 min, 2 mins, 3 mins, 4mins.
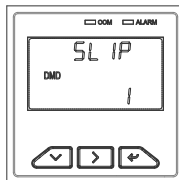
15. Version (view only): Press the ⏎ key to enter the version page.
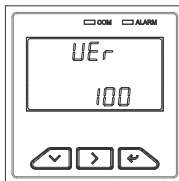
Remark

1. Input super password "99", the device will display the original password.

2. In 3-phase 3-wire mode, the device displays total power only (total P, total Q, total PF). Per phase power value will be 0.

3. The optional relay function only can be set via Modbus communication

4. In case the programmed data is invalid, the setting is not successful. The device restores the original parameters.

5. There is no description in this manual for other customized function.

5. Measuring Capability

5.1 Voltage

SPM32 maximum measurement for phase voltage is 400V (PT secondary).
In 3-phase 3-wire system, maximum measurement for line voltage is 500V
(PT secondary). Users should be noted this to prevent internal measuring
circuit saturation, avoid inaccurate measurements.

The device support 3-phase 3-wire and 3-phase 4 mode. Users can set the
Wiring Mode by keys or communication.

Note: After change the wiring mode, users must clear energy value to 0.

5.2 Current

SPM32 must be connected by CT to measure current. CT secondary rated
output required to meet the input requirements of SPM32 rated current (5A
or 1A). When using an external CT, wiring should prevent open, otherwise
it will generate a higher voltage in the secondary role. In the primary
excitation effect, causing no casualties or damage to equipment.

Measuring range: 0 ~ 6.5 A (CT secondary).

CT primary setting range: 1~9999A

Users should be noted above range to prevent internal measuring circuit
saturation, avoid inaccurate measurements.

5.3 Frequency

In different wiring mode, the device measures the frequency from different

channel.

In 3-phase 3-wire, it measures frequency signal from Line 1-2

In 3-phase 4-wire, it measures frequency signal from Line 1 voltage input.

In case Line 1 voltage loss, it measures from Line 2 voltage input. In case both Line 1 & 2 loss, it measures from Line 3 voltage input.

5.4 Power

SPM32 calculates per phase and total active power/ reactive power/ apparent power/ power factor.

Power measuring range: 0 ~ ± 9999MW/Mvar/MVA (per phase & total)

If value over 9999MW/Mvar/MVA, LCD will show "OVER".

Power factor measuring range: -1.000 ~ +1.000 (per phase & total)

The active power/ reactive power/ power factor is signed value

LCD shows symbol "L" for inductive load and symbol "C" for capacitive load.

Note
When wiring, users should pay attention to the phase sequence of voltage and current. Otherwise, it may cause wrong measuring data. Besides, it is necessary to connect the CTs terminals correctly; otherwise there will be negative power value.

5.5 Demand value

Demand value is accumulated value during a specified period divided by the length of that period.

SPM32 adopts 2 modes to calculate the demand: Fixed Block mode and Slip Block mode.

Users can set demand interval as 5mins, 10mins, 15mins, 30mins or 60mins.

In Fixed Block mode, users just need to set the interval.

In Slip Block mode, users should set interval and sub-interval.

Below is the setting range for the 2 intervals.

Optional Demand Interval (period), unit: mins	Programmable Sub-interval (slip), unit: mins
5	1
10	1 or 2
15	1 or 3
30	1, 2 or 3
60	1, 2, 3 or 4

SPM32 provides real-time demand data and peak demand for current (per phase) / active power (per phase and total). User can read the demand from LCD and communication, and can clear demand data to 0.

Below figure is explain for Fixed Block mode:

The computation is updated when each computing interval ends

The demand value is the average value when the last computing interval ends

15-minute computing interval | 15-minute computing interval | 15 minutes

15   30   45

Time (minutes)

Fixed block
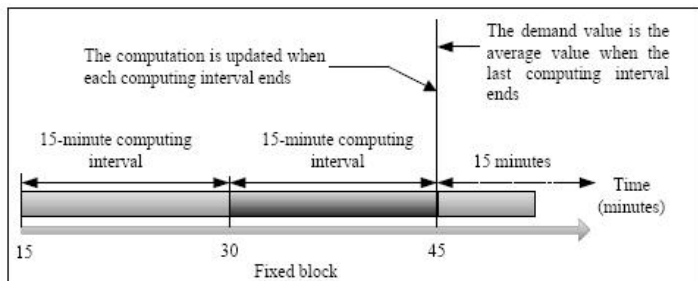
5.6 Energy (kWh, kvarh)

SPM32 accumulates energy parameters: imp. kWh, exp. kWh, imp. kvarh,

exp. kvarh and kVAh. If the value reaches to maximum (99,999,999.9

kWh), it will automatically turn over, and re-start accumulate from 0.

5.7 Harmonic parameters

SPM32 measures voltage and current harmonic up to 63st, and calculates THD.

The data of harmonics are given according to the percentage of

fundamental harmonics and have one digit after the decimal point. That is

to say, when the value of the fundamental harmonic is fixed at 1000, it is

100.0% of the effective value of the fundamental harmonic; others are by

analogy.

THD refers to the total of higher harmonics except fundamental harmonics,

and it is calculated according to the following formula:

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

i : Harmonic order.

X_i : Percentage of the effective value of each harmonic to that of the fundamental harmonic.

n : Highest harmonic order, which should be 63 here.

5.8 Unbalance parameters

SPM32 can measure the amplitude of the positive sequence, negative sequence and zero sequence components of voltage and current, and calculate the voltage and current imbalance.

The unbalance is calculated:

Uunbal= (Voltage negative sequence component / Voltage positive sequence component) x100%

Iunbal= (Current negative sequence component / Current positive sequence component) x100%

5.9 Alarm setpoint

SPM32 with user definable valued system which can monitor the electrical parameters of the instrument and set the action.

5.9.1The alarm object and type

Object	Alarm triggered	remark
The upper limit of voltage	Max. primary voltage > Upper limit In 3P4W, the value is voltage ph-N In 3P3W, the values is voltage ph-ph	Setting value to 0 means unable alarm.
The lower limit of voltage	Min. primary voltage < Lower limit In 3P4W, the value is voltage ph-N In 3P3W, the values is voltage ph-ph	Setting value to 0 means unable alarm.
The upper limit of current	Max. primary current > Upper limit	Setting value to 0 means unable alarm.
The lower limit of current	Min. primary current (≠0) < Lower limit	
The upper limit of frequency	Metering frequency >Upper limit	Setting value to 0 means unable alarm.
The lower limit of frequency	Metering frequency (≠0) < Lower limit	
The upper limit of power	Total active power (primary) > Upper limit	Setting value to 0 means unable alarm.
Voltage phase loss	Any one phase or 2 phase voltage (secondary) <10V	Select ON/OFF
DI 1 switch off	Digital input 1 channel switch position	Select ON/OFF

	From ON to OFF	
The upper limit of demand power	Demand Ptot (primary) > Upper limit	Setting value to 0 means unable alarm.
Phase error	3 phase voltage >= 80% of rated input, meanwhile the absolute value of three phase voltage angle difference > 10°	Setting value to 0 means unable alarm.
DI 2 switch off	Digital input 2 channel switch position From ON to OFF	Select ON/OFF

5.9.2 Setpoint delay time

Alarm condition: When the monitoring object exceeds the limitation, the delay duration time also is required to active the alarm. Throughout the delay time, if the object is within the return limits, then the alarm setpoint is not activated.

The unit of delay time is seconds (s), setting range: 0~120 (s).

If the delay time is 0, it means that once the monitoring object exceeds the limit, the alarm setpoint generated immediately.

Users want to set alarm for over-current and over-voltage, trigger condition: voltage is higher than 240V for 80s or current is higher than 200A for 10s, then Relay 1 trigger alarm.

The correct setting as below:

Setting alarm object	Setting value
Voltage upper limit	240V
Over-voltage delay time	80s
Current upper limit	200A
Over-current delay time	10s
Relay 1 mode	Alarm
Relay 1 object	All

5.9.3 Alarm output

When the alarm event occurs, users can check the alarm event from LCD or communication. If the alarm associated one relay, the relay will trigger. Once the alarm disappears, the ALARM LED will be off, and the associated relay will restore.

Note: If no require for alarm function, users can keep all setpoint value to be 0,

5.9.4 Alarm information on LCD

When the alarm event occurs, the ALARM LED will flash. Users can press the keys to check the alarm information on LCD. The alarm information is displayed as a four-digit hexadecimal value, users need to convert the hexadecimal value to binary. Each binary bit represents an alarm type. If value is 1, it means alarm. If value is 0, it means no alarm.

Digit place	Binary digit	Alarm parameter
---X	Bit0	Over-voltage
	Bit1	Under-voltage
	Bit2	Over-current
	Bit3	Under-current
--X-	Bit4	Over-frequency
	Bit5	Under-frequency
	Bit6	Over-power
	Bit7	Phase loss
-X--	Bit8	DI 1 switch off
	Bit9	Over-Demand Ptot
	Bit10	Phase error
	Bit11	DI 2 switch off
X---	Bit12	reserved
	Bit13	reserved
	Bit14	reserved
	Bit15	reserved

For example:

On SPM32 LCD, it shows alarm information: 0D05,

then, convert it to binary is 为"0000 1101 0000 0101", it means there are 5

alarm events: Over-voltage, Over-current, DI 1 switch off , Phase error, DI2

switch off.

If the alarm associated one relay, the relay will trigger. Once the alarm disappears, the ALARM LED will be off, and the associated relay will restore.

On the LCD, it shows alarm information "0000".

5.10 Load run statistics

SPM32 supports accumulate the Load power on hour (LOH), Load run hour (LRH) .

Load power on hour (LOH) is counted when total active power (P) >0.

Load run hour (LRH) is counted when total active power (P) > setpoint.

5.12 Load impedance

SPM32 measures 3 phase load impedance and total load impedance. The load impedance is judged by the active power (P) and reactive power (Q).

When P=0, Q=0, it is resistive impedance

when P>0 and Q>0, it is inductive impedance;

when P<0 and Q<0, it is inductive impedance;

when P<0 and Q>0, it is capacitive impedance;

When P>0 and Q<0, it is capacitive impedance.

6. Input/output Characteristics

6.1 Relay output

SPM32 provides optional two relay output, relay specification is 250Vac/5A. It can be used with the instrument's alarm setpoint system, to monitor relative electrical parameters whether there is exceed limit, and thus output breaker reasonable action (Please refer to the chapter of the alarm setpoint for more details).

Or, the relay can be set to remote control mode. Users can remote control the relay according to project requirement.

SPM32 provides two relay operation modes. The action of relay is different in these two modes. The default control mode of this product is remote control. Users can modify to alarm control through panel relay setting or through communication.

◆ Remote control (external) - The relay is controlled by a PC or PLC by using commands through communication.

◆ Alarm Control (internal) - If there is an alarm generated, the relay on the action, you can refer to specific alarm setpoint alarm.

◆ When setting as Alarm mode, Alarm Subject including All, Voltage, Current, Frequency, Total active power, Voltage Phase lose, or DI 1 off, Demand power etc

Once the relay has been in the remote control mode, even if the alarms generated, it will not act, the relay mode must be set to alarm mode, then

can operate the alarm action.

Reset (effective only under remote mode): When receive a command from PC or PLC, the relay will act. The relay will keep on the position until to reset time.

When reset time is 0, it means no reset.

6.2 Digital input

SPM32 provides 2-way nodes configurable input, applied to monitoring circuit breaker position signal, switch position signals and other status information.

SPM32 provides active status node, which need an external power source (176V~300V). The following 2-way status input as example to introduce this wiring mode.

◇External active node wiring diagram is shown as below：
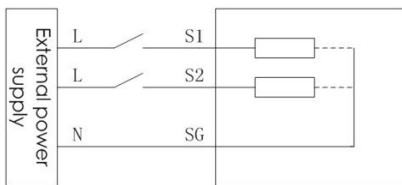
In general, when the external node is closed on, SPM32 LCD corresponding status input channel is ON (●), internal set to 1.

When the external node is turned off, SPM32 LCD corresponding status input channel is OFF (○), internal set to 0.

7. Technical Specification

Aux. power supply	AC 85~265V or DC 100~300V
Rated input current	5(6)A 、1(1.2)A
Rated input voltage	3×57.7/100V、3×220/380V, 40Hz~70Hz
Status input	Rated voltage 220V, 2 channel active status input. Lower than 60V is open, higher than 178V is closed. Max. input is 300V.
Relay output	Rated contact capacity: AC 250V/5A or DC 30V/5A
Power Consumption	≤ 2W/4VA
Operating environment	Operating temperature: -20℃ ~ +55℃ Limit operating temperature: -25℃ ~ +70℃ Storage temperature: -40℃ ~ +80℃ Humidity: 5% ~ 95% RH, non-condensing
Power frequency withstand voltage	4kVAC
Insulation resistance	≥ 100MΩ
Impulse voltage	6kV
IP index	Front panel: IP54
Certificate	CE, Standard IEC61010-1: 2010

Parameter	Range	Accuracy
Direct connection voltage	10V~400V(phase voltage) 10V~500V(line voltage)	0.2%
Primary side voltage	≤650kV	
Direct connection current	5mA~6.5A	0.2%
Primary side current	≤9999A	
Frequency	40Hz~70Hz	0.1%
Power factor	-1.000~1.000	0.5%
Active energy	0~99999999.9	class 0.5S
Reactive energy	0~99999999.9	class 2.0
Active power	Per phase/Total: 0 ~ ± 9999MW	0.5%
Reactive power	Per phase/Total: 0 ~ ± 9999Mvar	1.0%
Unbalance	0%~100%	1.0%
Harmonic	0%~100%	Class B

Item	Standard	Class
Electrostatic Discharge Immunity Test	IEC61000-4-2:2001 (GB/T17626.2-2006)	Level 4
Radiated immunity test	IEC61000-4-3:2002 (GB/T17626.3-2006)	Level 4
Electrical fast transient/burst immunity test	IEC61000-4-4:2006 (GB/T17626.4-2008)	Level 4
Surge immunity test	IEC61000-4-5:2005 (GB/T17626.5-2008)	Level 4
RF field immunity induced mass	IEC61000-4-6:2006 (GB/T17626.6-2008)	Level 3
Radiated emissions limit	GB 4824-2013 (CISPR11：2010)	class B
Voltage dips, short interruptions immunity test	IEC61000-4-11:2004 (GB/T17626.11-2008)	Pass

8. Communication protocol

(Please refer to SPM32 Modbus Communication Protocol & Register List)

9. Maintenance and Trouble Shooting

Possible problem	Possible cause	Possible solution
There is no display on device after impose power supply.	The power supply fails to be imposed on the meter.	Check if the correct working voltage has been imposed on the L/+ and N/- terminals of the meter. Check if the fuse for the control power supply has been burnt down.
The measured value is not correct or does not conform to the expectation.	The voltage measurement is not correct.	Check if the neutral point has been connected reliably. Check if the measured voltage matches the rated parameter of the meter. Check if the PT ratio has been set correctly.
	The current measurement is not correct.	Check if the measured current matches the rated parameter of the meter. Check if the CT ratio has been set correctly.
	The power measurement is not correct.	Check if the measurement mode has been set correctly. Check if the phase sequence corresponding to the voltage and the current is correct. Check if the current terminals of the same name are wrong.

The digital input status no changing.	The voltage relating to digital input is not correct.	Check if the types of external nodes match the rated parameters of the meter. Check if the external connection is correct.
The relay output status no changing.	The relay does not receive the control command.	Check if the communication link is correct.
	The control mode of relay is not correct.	Check if the current relay is under the correct mode.
There is no communication between the upper end device and the meter	The communication baud rate of the meter is not correct.	Check if the communication baud rate of the meter is consistent with its definition.
	The communication link has not been connected to the terminal resistor.	Check if the 120-Ohm resistor has been connected.
	The communication link suffers interference.	Check if the communication-shielding layer has been earthed effectively.
	The communication line is interrupted.	Check if the communication cable has been disconnected.
	The communication baud rate of the meter is not correct.	Check if the communication baud rate of the meter is consistent with its definition.

10. Terminals Definition

Terminals of basic unit

No.	Def.	Instruction	No.	Def.	Instruction
1	I3-	Phase C current outgoing line	2	I3+	Phase C current incoming line
3	I2-	Phase B current outgoing line	4	I2+	Phase B current incoming line
5	I1-	Phase A current outgoing line	6	I1+	Phase A current incoming line
7	NC	Null	8	SHLD	RS485 shield
9	485-	RS485 negative pole	10	485+	RS485 positive pole
12	V1	Phase A voltage	13	V2	Phase B voltage
14	V3	Phase C voltage	15	VN	Neutral line
16	N/-	Negative pole of power supply	17	L/+	Positive pole of power supply

Terminals of 2DI module (Optional)
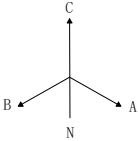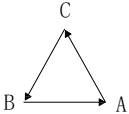
No.	Def.	Instruction	No.	Def.	Instruction
18	SG	Status input public GND	19	S1	Status input 1
20	S2	Status input 2	21	NC	Null

Terminals of 2DI+2DO module (Optional)

No.	Def.	Instruction	No.	Def.	Instruction
18	SG	Status input public GND	19	S1	Status input 1
20	S2	Status input 2	21	NC	Null
22	NC	Null	23	RLN2	Relay 2 Output 2
24	RL2	Relay 2 output 1	25	RLN1	Relay 1 Output 2
26	RL1	Relay 1 output 1			

11. Typical Connection

SPM32 supports multiple connection modes of measurement, the following

methods were used icons explained.

3-phase 4-wire system	3-phase3-wire system

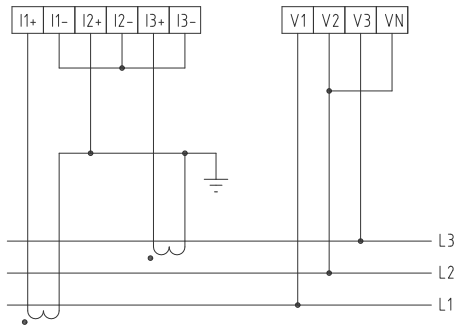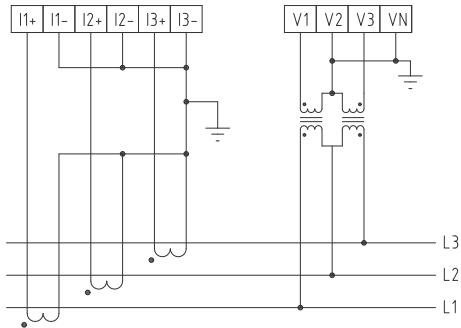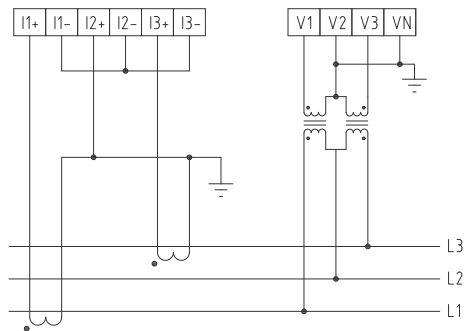■ 3-phase 4-wire system, no PT, 3CT
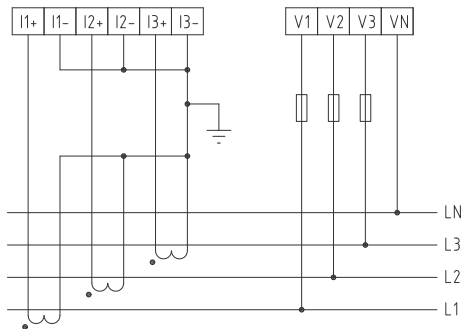
■ 3-phase 4-wire system, 3PT, 3CT
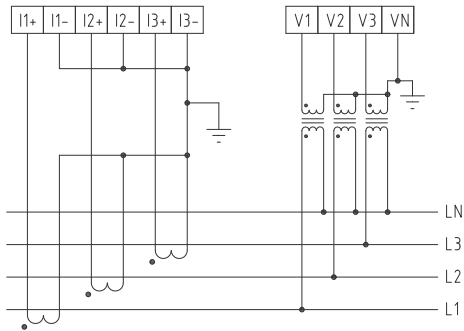
■ 3-phase 3-wire system, no PT, 3CT

■ 3-phase 3-wire system, no PT, 2CT

| I1+ | I1− | I2+ | I2− | I3+ | I3− |

| V1 | V2 | V3 | VN |

L3
L2
L1

■ 3-phase 3-wire system, 2PT, 3CT
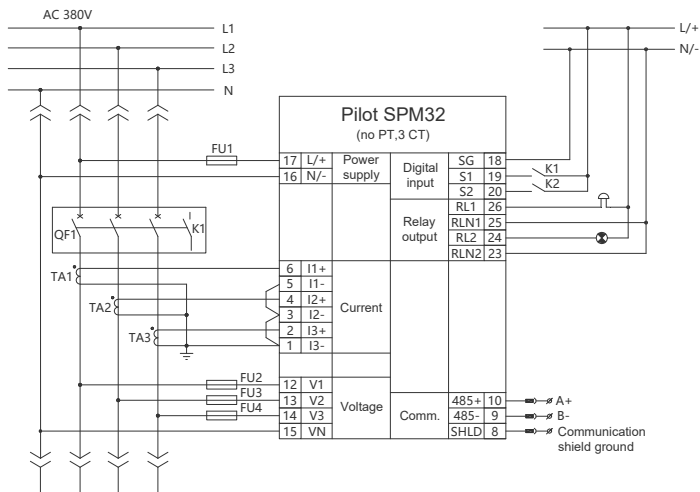

| I1+ | I1− | I2+ | I2− | I3+ | I3− |

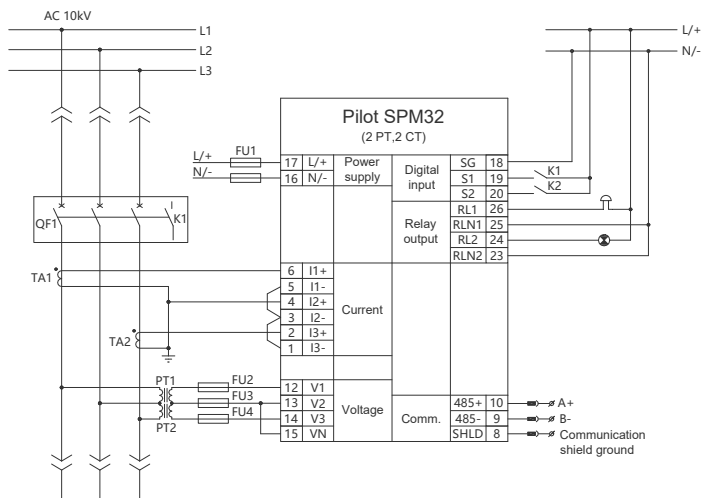| V1 | V2 | V3 | VN |

L3
L2
L1
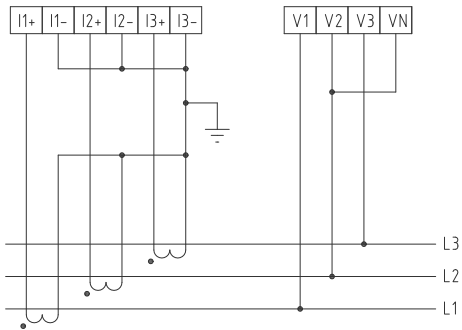
■ 3-phase 3-wire system, 2PT, 2CT

■ Typical wiring: 3-phase 4-wire system

■ Typical wiring: 3-phase 3-wire system

Notice:

PILOT reserves the right to modify this manual without prior notice in view of

continued improvement