

# **SPM33 Multifunction Power Meter**

## **Installation & Operation Manual**

### **V1.3**

**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

<b>1. General Information.....</b>	<b>5</b>
<b>2. Order Information.....</b>	<b>6</b>
<b>3. Dimension and Installation.....</b>	<b>7</b>
3.1 Dimension.....	7
3.2 Installation.....	7
<b>4. Display and Keys-press Operation.....</b>	<b>8</b>
4.1 Display instruction.....	8
4.2 LED indicator.....	9
4.3 Keys.....	9
4.4 Real-time data display procedure.....	10
4.5 Setting menu and procedure.....	11
<b>5. Measuring Capability.....</b>	<b>14</b>
5.1 Real-time basic electrical parameters.....	14
5.1.1 Voltage.....	14
5.1.2 Current.....	15
5.1.3 Frequency.....	15

5.2 Demand value.....	16
5.3 Energy (kWh, kvarh).....	17
5.4 Harmonic parameters.....	17
5.5 Unbalance parameters.....	18
5.6 Alarm setpoint.....	18
5.6.1 Alarm action condition.....	19
5.6.2 Alarm output.....	20
<b>6. Input/output Characteristics.....</b>	<b>21</b>
6.1 Relay output.....	21
6.2 Digital input.....	22
6.3 Dual source kWh measurement .....	23
<b>7. Technical Specification.....</b>	<b>24</b>
<b>8. Communication protocol.....</b>	<b>26</b>
<b>9. Maintenance and Trouble Shooting.....</b>	<b>27</b>
<b>10. Terminals Definition.....</b>	<b>30</b>
<b>11. Typical Connection.....</b>	<b>31</b>

# 1. General Information

SPM33 Three Phase Multifunction Power Meter is designed for monitoring and displaying all kinds of electricity parameters in low voltage system below 400VAC (ph-N). It has one RS485 port and support Modbus-RTU communication protocol. .

SPM33 provide the main function as below:

- Real-time measuring data, true RMS  
(Three phase voltage, current, active power, reactive power, apparent power, power factor, frequency, active energy, reactive energy, apparent energy)
- Demand calculation  
(Demand and peak demand for 3 phase current, 3 phase active power, total active power, 3 phase reactive power, total reactive power, 3 phase apparent power, total apparent power, Max. Current, Max. Active power, Max. Reactive power, Max. Apparent power)
- 2 digital input (wet contact)
- Optional 2 relay output
- Alarm function
- 2~31th individual harmonic and THD
- One RS485, Modbus-RTU protocol

- Phase sequence adjustable.
- Optional dual-source kWh accumulation.

## 2. Order Information

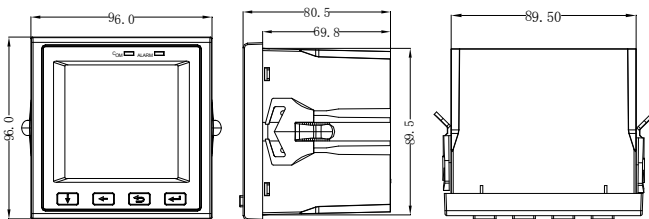
<b>SPM33 - <u>□</u> - <u>□</u></b> ①      ②	
<b>①: Optional function</b>	
<b>R</b>	Two relay output
<b>②: Rated input voltage/ current</b>	
<b>V1</b>	3×220/380V, 5A
<b>V2</b>	3×220/ 380V ,1A

Example: SPM33-R-V1, it means the device provides basic measuring function, one RS485 port, 2 digital input, 2 relay output. Rated input voltage 220/ 380V, input current 5A.

### 3. Dimension and Installation

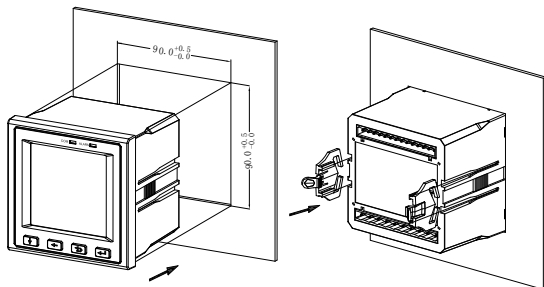
#### 3.1 Dimension

unit : mm



#### 3.2 Installation

unit : mm



## 4. Display and Keys-press Operation

### 4.1 Display instruction

1: Prompt of the currently displayed page.

2: Prompt display page number.

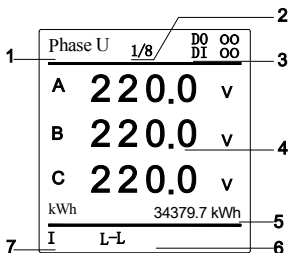
3: Status prompt of DI/DO.

4: Data display area.

5: Energy display area.

6: The sub-menu prompt

7: Prompt of next menu



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.

(2) Status prompt of DI/DO displays the current status of DI / DO ,each circle represents a DI or DO signal, when DI signal or relay is closed, the corresponding circle is solid; conversely, was hollow.

For example: ● means relay close on, ○ means relay OFF

## 4.2 LED indicator

LED	Description
COM	Always light on when the device is power on.  Flashes once per second when communication is OK.  Light off when the device is power off.
ALARM	Flashes when there is an alarm,  Light off when no alarm

## 4.3 Keys

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



Sibling menu switch / move the cursor to the right



Switching sibling menu to submenu / move the cursor to the left



Exit

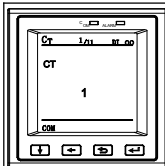


Enter the menu / confirm

## 4.4 Real-time data display procedure

Power on	⌵	
Line voltage	⌵	Phase voltage
	⌵	
Current	⌵	
	⌵	
Active power	⌵	Reactive power
	⌵	Apparent power
	⌵	Power factor
	⌵	
Active energy	⌵	Reactive energy
	⌵	Grid active energy
	⌵	Grid reactive energy
	⌵	Gen active energy
	⌵	Gen reactive energy
	⌵	
Frequency	⌵	
	⌵	
THD voltage	⌵	THD current
	⌵	2nd~31th harmonic of V1, V2, V3
	⌵	2nd~31th harmonic of I1, I1, I3
	⌵	
Demand current	⌵	Max. demand current
	⌵	Demand P, Max. demand P
	⌵	Demand Q, Max. demand Q
	⌵	Demand S, Max. demand S
	⌵	
Alarm record	⌵	

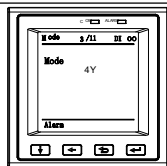
## 4.5 Setting menu and procedure



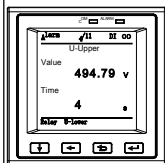
1. CT ratio



2. Comm add, baudrate



3. Wiring mode



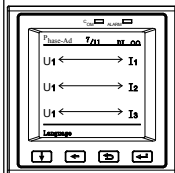
4. Alarm value, time



5. Relay setting



6. Clear energy, demand



7. Phase adjust



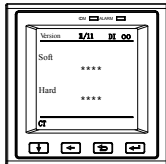
8. Language



9. DEMO



10. Password



11. Version (view only)

## Setting procedure

Setting	Default password: 01												
CT ratio	Range: 1~10000. For example: CT spec. 200/ 5A, set CT ratio= 40												
Communication address and Baudrate	Address: 1~247. Baudrate: 4800, 9600 or 19200bps												
Wiring mode	3D: 3-phase 3-wire 4Y: 3-phase 4-wire												
Alarm value and Action time (Range: 0~120s)	<table><tr><td>Voltage upper and lower limit</td><td>Range: 110.0~500.00V</td></tr><tr><td>Current upper and lower limit</td><td>Range: 1.0~60000.0A</td></tr><tr><td>Active power upper limit</td><td>Range: 0.1~4000.0KW</td></tr><tr><td>Frequency upper and lower limit</td><td>Range: 45.00~65.00Hz</td></tr><tr><td>Phase loss alarm (ON or OFF)</td><td><b>Note:</b></td></tr><tr><td>DI1 OFF alarm (ON or OFF)</td><td>Upper limit must be &gt; lower limit Value 0 means unable alarm</td></tr></table>	Voltage upper and lower limit	Range: 110.0~500.00V	Current upper and lower limit	Range: 1.0~60000.0A	Active power upper limit	Range: 0.1~4000.0KW	Frequency upper and lower limit	Range: 45.00~65.00Hz	Phase loss alarm (ON or OFF)	<b>Note:</b>	DI1 OFF alarm (ON or OFF)	Upper limit must be > lower limit Value 0 means unable alarm
Voltage upper and lower limit	Range: 110.0~500.00V												
Current upper and lower limit	Range: 1.0~60000.0A												
Active power upper limit	Range: 0.1~4000.0KW												
Frequency upper and lower limit	Range: 45.00~65.00Hz												
Phase loss alarm (ON or OFF)	<b>Note:</b>												
DI1 OFF alarm (ON or OFF)	Upper limit must be > lower limit Value 0 means unable alarm												
Relay 1, Relay 2	Mode : Remote control or Alarm Release time : 0~120s Object : All, Voltage, Current, Fre, Power, U-Lose, DI1 OFF.												
Clear Energy Clear Demand													
Phase sequence adjust													
Language	Chinese or English												
DEMO	Select "Yes" to display dummy value, "No" to display normal value.												
Password	Default password: 01												
Version No.	Software and hardware version ( can not set)												

## Remark

1. Input super password “33”, 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. If the devices don't have optional relay function, there is no setting relay menu
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 Real-time basic electrical parameters

SPM33 measures basic parameters: voltage, current, power, and frequency etc.

Real-time metering	Measuring range
<b>Current</b>	
Single phase	0 ~ 65,000A
Zero sequence	0 ~ 65,000A
Unbalance (%)	0 ~ 100%
<b>Voltage</b>	
Line-line	0 ~ 650V
Line-neutral	0 ~ 400V
Unbalance (%)	0 ~ 100%
<b>Active power/Reactive power /Apparent power</b>	
Single phase	0 ~ ± 26MW/var/VA
Total	0 ~ ± 78MW/var/VA
<b>Power factor</b>	
Single phase	-1.000 ~ +1.000
Total	-1.000 ~ +1.000
<b>Frequency</b>	
35 ~ 65Hz	35 ~ 65Hz

#### 5.1.1 Voltage

SPM33 maximum measurement for phase voltage is 400V. In 3-phase 3-wire system, maximum measurement for line voltage is 500V. 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**

### 5.1.2 Current

SPM33 must be connected by CT to measure current. CT secondary rated output required to meet the input requirements of SPM33 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.

Overload: 120% of the rated input.

Measuring range: 0 ~ 65kA.

CT ratio setting range: 1~10000

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

### 5.1.3 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 measure frequency signal from Line 1 voltage input. In case Line 1 voltage loss, it measures from Line 3 voltage input. In case both Line 1 & 3 loss, it measures from Line 2 voltage input.

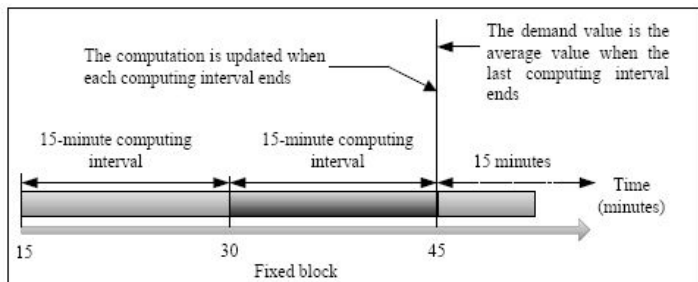
## 5.2 Demand value

Demand value is accumulated value during a specified period divided by the length of that period. SPM33 adopts Fix Block to calculate the demand. Fix interval is 15 minutes.

SPM33 provides the following demand data and measuring ranges:

Demand reading	Measuring range
<b>Demand current</b>	
Per phase current	0 ~ 65,000A
Max. peak demand	0 ~ 65,000A
<b>Demand active power/ reactive power/ apparent power</b>	
Per phase power	0 ~ ± 26MW/ MVAR/ MVA
Total power	0 ~ ± 78MW MVAR/ MVA
Max. peak of per phase	0 ~ ± 26MW/ MVAR/ MVA
Max. peak of total	0 ~ ± 78MW/ MVAR/ MVA

The figure below describes demand calculation:



### 5.3 Energy (kWh, kvarh)

SPM33 accumulates energy parameters: imp. kWh, exp. kWh, imp. kvarh, exp. kvarh. If the value reaches to maximum ( 99,999,999.9 kWh), it will automatically turn over, and re-start accumulate from 0.

### 5.4 Harmonic parameters

SPM33 measures voltage and current harmonic up to 31<sup>st</sup>, 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:

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

$i$  : 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 31 here.

**【Attention】** : Each harmonic and THD can be checked through display or

communication.

## 5.5 Unbalance parameters

SPM33 can measure current unbalance, the unbalance is calculated:

$$X_{unbal} = (X_{max} - X_{min}) / X_{max} \times 100\%$$

$X_{unbal}$  — The unbalance of the voltage or current

$X_{max}$  — Maximum value of the three-phase voltage or current

$X_{min}$  — Minimum value of the three-phase voltage or current

## 5.6 Alarm setpoint

SPM33 with user definable valued system which can monitor the electrical parameters of the instrument and set the action. When an alarm event occurs, the instrument panel ALARM light will flash, meanwhile, the display can be switched to the alarm interface to see the type of alarm events, or read the type of alarm through communication, after the elimination of alarm events, ALARM light will destroy, warning interface will appear as "no."

The object of the alarm type as below:

Object	Alarm triggered	remark
The upper limit of voltage	Max. 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	110V <Min. voltage < Lower limit	



voltage	In 3P4W, the value is voltage ph-N In 3P3W, the values is voltage ph-ph	
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 ( $\neq 0$ ) < 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 ( $\neq 0$ ) < Lower limit	
The upper limit of power	Total active power (primary) > Upper limit	Setting value to 0 means unable alarm.
Voltage phase loss	In 3P4W, any one phase or 2 phase voltage <110V In 3P3W, any one phase or 2 phase voltage < 190V	Select ON/OFF
DI 1 switch off	Digital input 1 channel switch position OFF	Select ON/OFF

### 5.6.1 Alarm action condition

SPM33 generated alarm condition: the setting object meet the action conditions, and need to meet the time requirements in order to be really activated.

Throughout the delay period, if the object is within the return limits, then the alarm setpoint is not activated. If the delay time is 0, it means that once the monitoring object exceeds the limit, the alarm setpoint generated immediately. There is a fixed value or more objects is active, the alarm is generated. After the alarm is generated, all the setting object if returned within the limit, the alarm will disappear.

### 5.6.2 Alarm output

When the alarm occurs, the ALARM lights will flash, meanwhile, the LCD panel will pop up warning dialog box, then press key  to switch to the alarm interface to view the type of event alarms, press key  to return to the current interface. If don't press key within 5s, alarm box will disappear. Alarms type can also be read through communication. If the alarm associated relays, the relay generates action. Once the alarm disappears, the ALARM light will be off, the alarm interface will be displayed "no" at this time. If the alarm associated relays, the relay will be reset.

## 5. Input/output Characteristics

### 5.1 Relay output

SPM33 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.

SPM33 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, 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 the relay acts, it can return to the state after N times (N is set reset time, can be set by the panel and communications, N = 0, the relay can't reset, that is, relay will not restore to original state).

Silencer: If users select relays, relay 1 in alarm mode, have a mute button function simulation, when an alarm occurs, the relay 1 will have action, under the alarm menu interface if press the "mute" button, relay 1 will be reset. After the reset, if there is a new alarm generation, Relay 1 will re-action again.

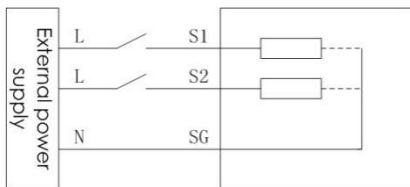
**Note: Relay 2 without this mute function.**

## 6.2 Digital input

SPM33 provides 2-way nodes configurable input, applied to monitoring circuit breaker position signal, switch position signals and other status information.

SPM33 provides active status node, which need an external power source. 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, SPM33 LCD corresponding

status input channel is ON, internal set to 1.

When the external node is turned off, SPM33 LCD corresponding status input channel is OFF, internal set to 0.

### **6.3 Dual source kWh measurement**

DI 1 is defined as special function (register 40207), as dual source kWh measurement function

After enable this function:

If DI 1 with status OFF, the device add energy value to Grid area (register 40052-40063), on the display will show Grid. And the value also will add to register 40026-40037.

If DI 1 with status ON, the device add total energy value to Generator area (register 40064-40075), on the display will show Gen. And the value also will add to register 40026-40037.

Customer can query total energy, Grid energy and Gen energy from the page of kWh (Active/ Reactive)

## 7. Technical Specification

<b>Aux. power supply</b>	AC 85~265V DC 100~300V
<b>Rated input current</b>	5A or 1A
<b>Rated input voltage</b>	3×220/380V 35Hz~65Hz
<b>Status input</b>	Rated voltage 220V, 2 channel active status input. Lower than 60V is open, higher than 140V is closed. Max. input is 300V.
<b>Relay output</b>	Rated contact capacity: AC 250V/5A or DC 30V/5A
<b>Power Consumption</b>	≤ 2W/5VA
<b>Operating environment</b>	Operating temperature: -10℃ ~ +55℃ Limit operating temperature: -25℃ ~ +55℃ Storage temperature: -40℃ ~ +70℃ Humidity: 5% ~ 95% RH, non-condensing
<b>Power frequency withstand voltage</b>	2KVAC
<b>Insulation resistance</b>	≥ 100MΩ
<b>Impulse voltage</b>	6KV
<b>IP index</b>	Front panel: IP52, case: IP20
<b>Certificate</b>	CE, Standard IEC61010-1: 2010

Parameter	Range	Accuracy
voltage	10%~150% of rating	0.5%
current	1%~120% of rating	0.5%
Power factor	-1.000~1.000	1.0%
Active energy	0~99999999.9	1.0% or 0.5%
Reactive energy	0~99999999.9	2.0%
Active power	Per phase: 0 ~ ± 26MW Total: 0 ~ ± 78MW	0.5%
Reactive power Apparent power	Per phase: 0 ~ ± 26Mvar/VA Total: 0 ~ ± 78Mvar/VA	1.0%
Unbalance	0%~100%	1.0%
Harmonic	0%~100%	Class B
Standard		
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	CISPR22 : 2006 (GB 9254-2008)	Pass
Voltage dips, short interruptions immunity test	IEC61000-4-11:2004 (GB/T17626.11-2008)	Pass
Power frequency	GB/T 17215.211-2006	Rated insulation

withstand voltage		voltage $\leq$ 300V , The test voltage 2000V。 Rated insulation voltage $\leq$ 60V , The test voltage 1000V。 Leakage current $\cong$ 10mA。
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## 8. Communication protocol

(Please refer to SPM33 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.	<p>Check if the correct working voltage has been imposed on the L/+ and N/- terminals of the meter.</p> <p>Check if the fuse for the control power supply has been burnt down.</p>
The measured value is not correct or does not conform to the expectation.	The voltage measurement is not correct.	<p>Check if the neutral point has been connected reliably.</p> <p>Check if the measured voltage matches the rated parameter of the meter.</p> <p>Check if the PT ratio has been set correctly.</p>
	The current	Check if the measured current

	<p>measurement is not correct.</p>	<p>matches the rated parameter of the meter.</p> <p>Check if the CT ratio has been set correctly.</p>
	<p>The power measurement is not correct.</p>	<p>Check if the measurement mode has been set correctly.</p> <p>Check if the phase sequence corresponding to the voltage and the current is correct.</p> <p>Check if the current terminals of the same name are wrong.</p>
<p>The digital input status no changing.</p>	<p>The voltage relating to digital input is not correct.</p>	<p>Check if the types of external nodes match the rated parameters of the meter.</p> <p>Check if the external connection is correct.</p>
<p>The relay output status no changing.</p>	<p>The relay does not receive the control command.</p>	<p>Check if the communication link is correct.</p>

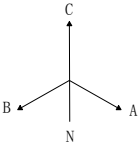
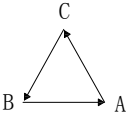
	The control mode of relay is not correct.	Check if the current relay is under the correct mode.
There is no communication between the upper end device and the meter	The communication baud rate of the meter is not correct.	Check if the communication baud rate of the meter is consistent with its definition.
	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

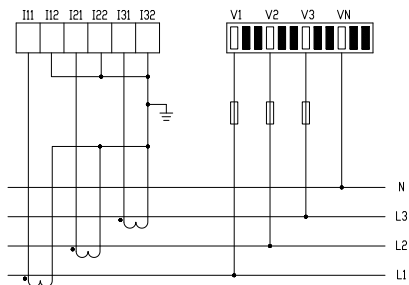
No.	Def.	Instruction	No.	Def.	Instruction
1	L/+	Positive pole of power supply	13	485+	RS485 positive pole
2	NC	Null	14	SHLD	RS485 shield
3	N/-	Negative pole of power supply	15	VA	Phase A voltage
4	NC	Null	16	VB	Phase B voltage
5	S1	Status input 1	17	VC	Phase C voltage
6	S2	Status input 2	18	VN	Neutral line
7	SG	Status input public GND	19	I11	Phase A current incoming line
8	RL1	Relay 1 output 1	20	I12	Phase A current outgoing line
9	RLN1	Relay 1 Output 2	21	I21	Phase B current incoming line
10	RL2	Relay 2 Output 1	22	I22	Phase B current outgoing line
11	RLN2	Relay 2 Output 2	23	I31	Phase C current incoming line
12	485-	RS485 negative pole	24	I32	Phase C current outgoing line

## 11. Typical Connection

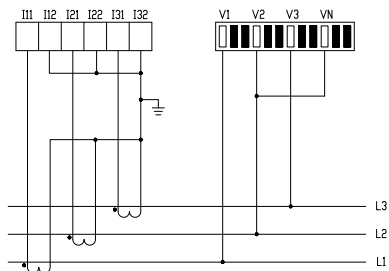
SPM33 supports multiple connection modes of measurement, the following methods were used icons explained.

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

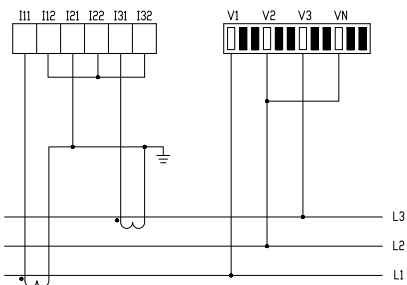
### ■ 3-phase 4-wire system



■ 3-phase 4-wire system, 3CT



■ 3-phase 3-wire system, 2CT



SPM33 typical wiring diagrams, comprehensive electrical parameters measuring under 3-phase 4-wire mode, with digital status inputs and one RS485 communication function:

**Notice:**

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

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