AX9L Series

AX9L Series One Phase Inteligent Energy Meter User Manual

This series meters are widely applied to control system, SCADA system and energy management system, transformer substation automation,distributing net automation, residence community electrical power monitor, industrial automation, intelligent construction, intelligent switchboard, switch cabinet,ect. It is easy to install and maintain, simple connection, programmable setting parameters on meters or computer.

Features:

- Measurement items: single-phase voltage/current/active power/reactive power/apparent power/frequency/power factor, etc., a total of 13 electrical parameters.
- 2 switch inputs and 2 switch outputs (four switch inputs can be ordered)
- True effective value measurement.
- With RS485 digital interface, using Modbus RTU communication protocol.
- With recording function of forward active energy and reverse active energy, which can record the consumed and emitted electric energy respectively.

⚠ Warning

An accident may happen and product may be damaged if the operation does not comply with the instruction.

KKDS9L-A02ET01-A/0-20230901

Isolation withstand voltage	Power supply and RS485 interface, DI interface, ≥DC 2000V
Insulation	Input, output, power supply to the housing> 5MΩ
Dimensions	96W×96H×61.5L（mm）
Weight	0.5kg

I. Model

AX9 L-□ -□ □ □

- RS485 port: 18: with RS485 communication 10: without RS485
- Alarm output: C: 2 alarms output A: without alarm function
- Output: R: relay output Blank: no output
- Signal input: W: full-function measurement
- Display: L: LCD display
- Dimensions: 9: 96H×96W×61.5L（mm）
- AX series single phase power meter

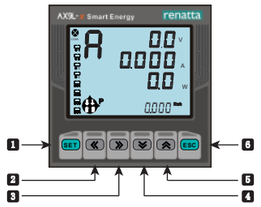
II. Model Indication

Model	Measure parameters	RS485 port	DI	DO
AX9L-W-A10	Measure parameters	No	2	No
AX9L-W-A18	Measure parameters	with RS485	2	No
AX9L-W-RC10	Measure parameters	No	2	2
AX9L-W-RC18	Measure parameters	with RS485	2	2

III. Main Technical parameters

Connection	1 phase 2 wire
Voltage Range	AC 0～280V
Voltage overload	Continuous:1.2 times Instantaneous:2 times/10S
Voltage consumption	<1VA
Voltage impedance	≥300KΩ
Voltage accuracy	RMS measurement, accuracy class 0.5
Current range	AC 0.025～5A
Current overload	Continuous:1.2 times Instantaneous:10 times/10S
Current consumption	<0.4VA
Current impendance	<20mΩ
Current accuracy	RMS measurement, accuracy class 0.5
Frequency	45～60Hz、 accuracy 0.01Hz
Power	Active power, reactive power, apparent power, accuracy class 0.5
Energy	Active energy class 1, reactive energy class 2
Display	LCD display (optional blue backlight, default white backlight)
Power supply	AC/DC 100～240V （85～265V）
Power consumption	≤5VA
Output port	RS-485，MODBUS-RTU protocol
DI input	2 DI（dry contact）
Alarm output	2 DO, 250VAC/3A or 30VDC/5A (optional, please contact the sales before order)
Operating temperature	Temp: -10～50℃ Hum: <85% RH; no corrosive gas; altitude ≤2500m
Storage temperature	-40～70℃

IV. Panel Indication

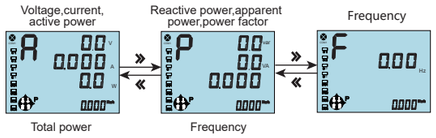


Item	Symbol	Name	Function	
1	SET	Set key	△Press this key for 5s to enter the menu	△To confirm the modified menu value
2	«	Left key	△Shift menu and move data position	△To shift measure interface outside the menu
3	»	Right key	△Shift menu and move data position	△To shift measure interface outside the menu
4	˅	Decrease key	△Enter data modification in menu operation	△To shift energy page outside the menu
5	˄	Increase key	△Enter data modification in menu operation	△To shift energy page outside the menu
6	ESC	Return key	△For backspace in menu operation	△Back to previous menu

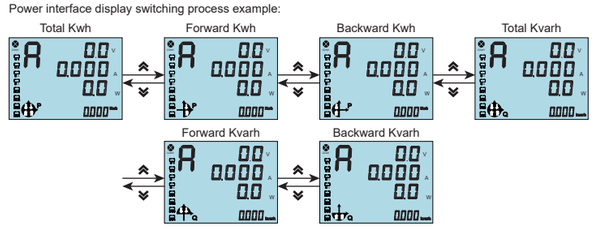
Indication of checking the measured value and meter working status :

1. In the measurement state, press the button " « / » " to switch and display single-phase voltage, current, active power, reactive power, power factor, apparent power, frequency and other screens.
2. Press the button " ˄ / ˅ " to increase or decrease the total active energy (algebraic sum), forward active energy, reverse active energy, total reactive energy (algebraic sum), forward reactive energy, reverse Reactive energy switching display.
3. DO1 and DO2 are used as alarm output status indicators in the alarm mode, and as switch output status indicators in the switch “remote control” mode.
4. S1, S2, S3, and S4 are the status indicators of the switch "remote signal" input, and the default is 2-way switch input.
5. When COM flashes, it means that it is communicating.
6. P (kWh) represents the total active electric energy (it is the algebraic sum of forward active electric energy and reverse active electric energy); Q (kvarh) represents the total reactive electric energy (it is the algebraic sum of forward reactive electric energy and reverse reactive electric energy)

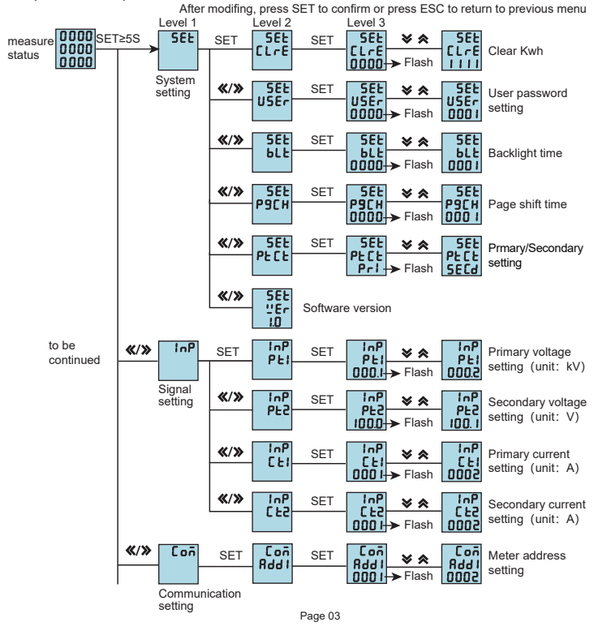
Illustration for measure interface switch procedure:

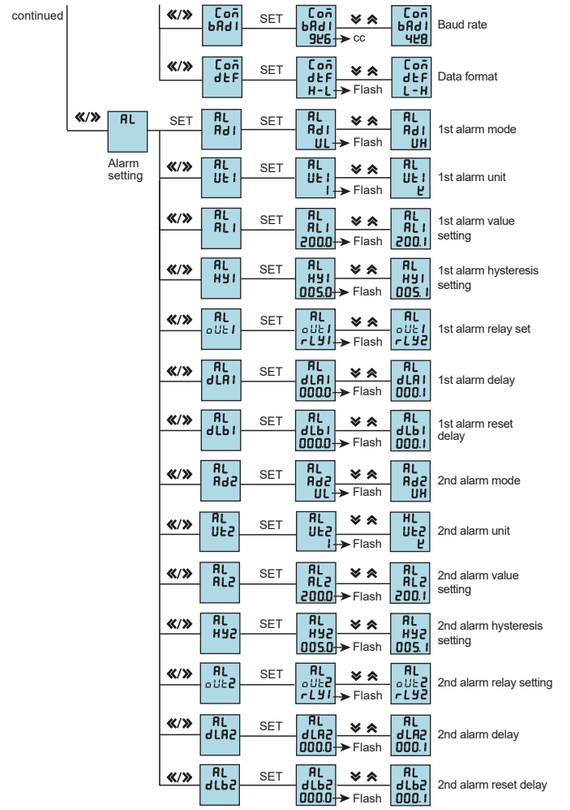


Power interface display switching process example:



V. Operation Sequence





Ⅶ. Output function

1. Remote control function: 4 S1-S4 is used to remote control electric switch status. Two DO1, DO2 function be used to control electric devices; when using this function, alarm mode should be setted as “0”, otherwise, DO1, DO2 control function is written via RS485 interface.
2. Communication function (please refer to Communication protocol)
3. Alarm function, after the meter is powered on and run steady > 5S, alarm begin to work.(Please refer to table 1)

Table 1: Comparison table of alarm output power parameters

No.	Parameters	Switch output (low alarm) code	Switch output (high alarm) code
1	U(Voltage)	1 (UL)	2 (UH)
2	A(Current)	3 (AL)	4 (BH)
3	P(Active Power)	5 (PL)	6 (PH)
4	Q(Reactive Power)	7 (QL)	8 (QH)
5	S(Aprarent Power)	9 (SL)	10 (SH)
6	PF (Power factor)	11 (PFL)	12 (PFH)
7	F (Frequency)	13 (FL)	14 (FH)
8	EP （Total active energy)	15 (EPL)	16 (EPH)
9	EQ （Total reactive energy)	17 (EqL)	18 (EqH)

Ⅷ. Communication protocol

1. The instrument conforms to the MODBUS-RTU communication protocol, adopts RS485 half-duplex communication, and performs 16-bit CRC verification on the data, and the instrument does not return any verification errors.

1.1 All RS485 communication should follow the master-slave mode. In this way, information and data are transferred between a single master station and up to 32 slave stations (monitoring devices);

1.2 The master station will initialize and control all the information transmitted on the RS485 communication;

1.3 In any case, communication cannot be started from a slave station;

1.4 All communication over RS485 happens in a "packetized" way. A data packet is a communication frame, and a packet can contain up to 128 bytes;

1.5 The master station sends a request, and the slave station sends a response;

1.6 In any case, the slave station can only respond to one request from the master station;

2. Data frame format:

Start not	Date not	Check bit	Stop bit
1	8	None, even, odd parity (programmable)	1

Ⅶ. Menu Modification Illustration

Uder user menu status

1. Press the "SET" key for more than 5 seconds. If the user has set a password, a password input box will pop up. Enter the correct password to enter the user menu and modify the corresponding parameters.
2. If currently the primary menu is displayed, press "SET" to enter the secondary menu, and press the " « " and " » " keys to change the menu sub-items.
3. If the current menu is level 2 or level 3, press the "ESC" key to return to the previous display.
4. If the current level 3 is displayed, press the " ˅ " and " ˄ " keys to flash the numbers, press the " « " and " » " keys to shift, and press the " ˅ " and " ˄ " keys to adjust the value; when flashing Press "SET" to save the set value; press "ESC" to return to the second-level menu without saving the set value.
5. After modification, press the confirmation key "SET" for more than 5 seconds or directly press "ESC" to exit the user menu and return to the measurement state.

Menu structure and function description

No	Level 1	Level 2	Level 3	Description
1	SEt System setting	Clear energy CLrE	0000	Enter 1111 to clear the power, enter 1234 to factory settings
		User password USEr	0000	User password modification, factory default is "0000", no password
		Backlight time bLt	0000	Backlight off delay time, the unit is "second", The screen does not turn off when the value is "0"
		Page time PGCH	0000	Measure the page turning time, the unit is "second". No page turning when the value is "0" .
		Primary, Secondary selection PtCt	SECd/Pri	Value "SECD": display secondary measured energy, Value "PRI": display primary measured energy
		Software version VEr	1.1	Software version number, cannot be modified
2	InP Signal setting	Voltage ratio Pt1	0.1-500.0	Primary measured voltage, unit：KV
		Voltage ratio Pt2	0.1-999.9	Secondary measured voltage, unit：V
		Current ratio Ct1	1-9999	Primary measured current, unit：A
		Current ratio Ct2	0.1-999.9	Secondary measured current, unit：A
3	Con Communi-cation setting	Address Add1	1-247	Meter address range
		Baud rate brd1	1k2/2k4/4k8 9k6/19k2	Baud rate 1k2 means 1200, 2k4 means 2400, 4k8 means 4800, 9k6 means 9600, 19k2 means 19200
		Data order dtF1	H-L/L-H	Data order: high register first or low register first
4	AL Alarm setting	Alarm type Ad1	1-18	When the value is DO, it is the remote control mode, otherwise it is the alarm mode. Refer to "Table 1"
		Alarm value unit Ut1	1/K/M	1: means international standard unit, K: means 1000 times of the IS unit, M: means 1000000 times of the IS unit
		Alarm action value AL1	0-999.	The first channel alarm value setting (the unit is the standard display unit)
		Alarm hysteresis HY1	0-999.9	The first channel alarm hysteresis value setting (the unit is the standard display unit)
		Alarm relay selection oUt1	rLY1/rLY2	1st alarm relay output selection (can only be set when the alarm mode is not DO)
		Action delay dLA1	0-9.9	Action delay time, unit: S
		Alarm end time dLb1	0-9.9	Action reset time, unit: S
		For the parameter setting method of the second channel alarm, please refer to the first channel.		

3. Communication frame format illustration

Content	Bytes	Illustration	
Slave address	1	Valid slave address range is 1-247	
Function code	1	0X03	Read one or more current register values
		0X06	Write the specified value into an internal register
		0X10	Write the specified value into multiple internal registers
Data address	2	The location where the data area is stored when the slave executes a valid command. Different variables occupy different numbers of registers, some address variables occupy two registers, 4 bytes of data, some variables occupy one register, 2 bytes of data, please use according to the actual situation.	
Data length	2	Length of data to be read or written	
Data	Changeable	The slave station returns the response data or the data to be written by the master station.	
CRC check code	2	MODBUS-RTU mode adopts 16-bit CRC check. The sending device should perform CRC16 calculation on each data in the package, and store the final result in the inspection field. The receiving device should also perform CRC16 calculation on each data in the package (except the check field), and compare the result with the check field. Only identical packages will be accepted.	

4. Communication abnormal handling

If the master station sends an illegal data packet or the master station requests an invalid data register, abnormal data response will be generated. This abnormal data response consists of slave station address, function code, fault code and check field. When the high bit position of the function code field is 1, it means that the data frame at this time is an abnormal response.

According to MODBUS communication requirements, abnormal response function code = request function code + 0x80; when abnormal response, set the highest position of the function number to 1. For example: the function number requested by the master is 0x04, and the function number returned by the slave corresponds to 0x84.

The following table explains the meaning of the abnormal codes:

Error code	Name	Illustration
0X01	Function code error	Meter received the unsupported function number
0X02	Variable address errod	The data location specified by the host is out of range of the meter or an illegal register operation was received
0X03	Data value out of bounds	The data value sent by the host exceeds the corresponding data range of the meter or the data structure is incomplete
0X04	Frame length error	The length of the function code and the communication frame is inconsistent

5. Communication frame delay

There should be an appropriate delay between the two frame requests of the master station for the slave station to respond to. When the communication baud rate is 9600, in order to ensure that the correct response is received, it is recommended to reserve a 300mS delay between the two frame requests. When the baud rate decreases, the communication delay should increase appropriately.

IX. Communication frame format illustration

1. Function code "03": read multiple register input

Example: The host reads UA (phase A voltage), assuming that the measured voltage of phase A is 220.0V. The address code of UA is 0x4000, because UA is a fixed-point number (4 bytes), occupying 2 data registers, and the hexadecimal data corresponding to 220.0V is: 0x0000898 (2200).

The format of the message sent by the host: (high word first as default)

Host sends	Bytes	Message sent	Message sent
Slave address	1	01	Send to slave with address 01
Function code	1	03	Send to slave with address 01
Start address	2	0x4000	Start address
Data length	2	0x0002	Read 2 registers (total 4 bytes)
CRC code	2	0XD1CB	The CRC code is calculated by the host

The message format returned by the slave response:

Slave response	Bytes	Returned messeges	Remarks
Slave address	1	01	From slave 01
Function code	1	03	Read register
Words read	1	04	2 registers total 4 bytes
Register data	1	0x00	The high high bytes of the content for memory at address 0x4000
	1	0x00	The high bytes of the content for memory at address 0x4000
	1	0x08	The low byte of the content for memory at address 0x4000
	1	0x98	The low low byte of the content for memory at address 0x4000
CRC code	2	0xFC59	The CRC code is calculated by the slave

2. Function code "06": write single register

Example: The host writes fixed-point numbers to the 1st alarm mode AD1. Assume that the address code of AD1 is 0x4900, because AD1 is a fixed-point number, occupying 1 data register, and the decimal 11 corresponds to 0X000B.

The message format sent by the host:

Host sends	Byes	Message sent	Example
Slave address	1	01	Send to slave 01
Function code	1	06	Write single register
Start address	1	0x49	Register address high byte to write
	1	0x00	Register address low byte to write
Data to be written	1	0x00	Data high byte
	1	0x0B	Data low byte
CRC code	2	0xDE51	CRC code calculated by the host

The message format returned after the slave responds correctly:

Host sends	Bytes	Send messege	Example
Slave address	1	01	Send to slave 01
Function code	1	06	Write single register
Start address	1	0x49	Register address high byte to write
	1	0x00	Register address low byte to write
Data to be written	1	0x00	Data high byte
	1	0x0B	Data low byte
CRC code	2	0xDE51	CRC code calculated by the host

3. Function code "10": write multiple registers

Example: The host writes fixed-point numbers to the 1st alarm mode AD1. Assume that the address code of AD1 is 0x4900, because AD1 is a fixed-point number, occupying 1 data register, and the decimal 11 corresponds to 0X000B.

The message format sent by the host:

Host sends	Bytes	Send messege	Example
Slave address	1	01	Send to slave 01
Function code	1	10	Write multiplex register
Start address	1	0x49	Start address high byte for the register to be written
	1	0x00	Start address low byte for the register to be written
Data word length to be written	1	0x00	High byte of the word length for the written data
	1	0x01	Low byte of the word length for the written data
Byte length of the data to be written	1	0x02	The byte length of the data (total 1 byte)
Data to be written	1	0x00	data high byte
	1	0x0B	data low byte
CRC code	2	0x3F53	CRC code calculated by the host

The message format returned after the slave responds correctly:

Slave response	Bytes	Send messege	Example
Slave address	1	01	From slave 01
Function code	1	10	Write multiplex register
Start address	2	0x4900	The starting address is 0000
Save data word length	2	0x0002	Save 2 word length data
CRC code	2	0X1795	The CRC code is calculated by the slave

4. The calculation method of CRC code is:

4.1 Preset a 16-bit register as hexadecimal FFFF (that is, all 1); this register is called CRC register;

4.2 XOR the first 8-bit binary data (the first byte of the communication information frame) with the lower 8 bits of the 16-bit CRC register, and put the result in the CRC register;

4.3 Shift the content of the CRC register to the right by one bit (towards the lower bit), fill the highest bit with 0, and check the shifted out bit after the right shift;

4.4 If the shifted out bit is 0: repeat step 3 (shift right one bit again); if the shifted out bit is 1: XOR the CRC register with the polynomial A001 (1010 0000 0000 0001);

4.5 Repeat steps 3 and 4 until the right shift is 8 times, so that the entire 8-bit data has been processed;

4.6 Repeat steps 2 to 5 to process the next byte of the communication information frame;

4.7 After all the bytes of the communication information frame are calculated according to the above steps, exchange the high and low bytes of the 16-bit CRC register;

4.8 The finally obtained CRC register content is: CRC code.

Attachment: CRC calculation C language source code

```
unsigned int GET_CRC(unsigned char * buf,unsigned charnum)
{
        unsigned  chari,j;
        unsigned int    WCRC    =       0xffff;
        for(i=0;i<num;i++)
        {
                WCRC  ^=        (unsigned int)(buf[i]);     //      Cyclic redundancy check
                  for(j=0;j<8;j++)
                  {
                        if(WCRC&1)
                        {
                                WCRC                    >>=     1;
                                WCRC                    ^=      0XA001;
                        }
                        else
                        WCRC                    >>=     1;
                  }
        }
        return(WCRC);                   //      Obtain CRC check code
}
```


3. Power meter communication address mapping (the data read by single-phase meter communication is read according to phase A, and the power is read according to total power)

Single-phase/three-phase smart power meter address definition							
Read-only power parameter communication list							
No.	Com address	Parameter	Register	Data bytes	Read/write	Unit	Remark
1	**0 x 4000**	**Phase voltage A**	**2**	**long**	**R**	**0.1V**	**single phase voltage**
2	0 x 4002	**Phase voltage** B	2	long	R	0.1V	
3	0 x 4004	**Phase voltage** C	2	long	R	0.1V	
4	0 x 4006	Line voltage AB	2	long	R	0.1V	
5	0 x 4008	Line voltage BC	2	long	R	0.1V	
6	0 x 400a	Line voltage CA	2	long	R	0.1V	
7	**0 x 400c**	**Phase current A**	**2**	**long**	**R**	**0.001A**	**single phase current**
8	0 x 400e	Phase current B	2	long	R	0.001A	
9	0 x 4010	Phase current C	2	long	R	0.001A	
10	0 x 4012	Active power A	2	long	R	0.1W	
11	0 x 4014	Active power B	2	long	R	0.1W	
12	0 x 4016	Active power C	2	long	R	0.1W	
13	**0 x 4018**	Total active power	**2**	**long**	**R**	**0.1W**	**single phase active power**
14	0 x 401a	Reactive power A	2	long	R	0.1var	
15	0 x 401c	Reactive power B	2	long	R	0.1var	
16	0 x 401e	Reactive power C	2	long	R	0.1var	
17	**0 x 4020**	**Total reactive power**	**2**	**long**	**R**	**0.1var**	**single phase reactive power**
18	0 x 4022	Aparent power A	2	long	R	0.1VA	
19	0 x 4024	Aparent power B	2	long	R	0.1VA	
20	0 x 4026	Aparent power C	2	long	R	0.1VA	
21	**0 x 4028**	**Total aparent power**	**2**	**long**	**R**	**0.1VA**	
22	0 x 402a	Power factor A	2	long	R	0.001	
23	0 x 402c	Power factor B	2	long	R	0.001	
24	0 x 402e	Power factor C	2	long	R	0.001	
25	**0 x 4030**	Total Power factor	**2**	**long**	**R**	**0.001**	**single phase power factor**
26	0 x 4032	Frequency	2	long	R	0.01HZ	
27	**0 x 4034**	**Active energy**	**2**	**long**	**R**	**0.01kWh**	**single phase active energy**
28	**0 x 4036**	**Reactive energy**	**2**	**long**	**R**	**0.01kvarh**	**single phase reactive energy**
29	0 x 4038	Forward active energy	2	long	R	0.01kWh	
30	0 x 403a	Backward active energy	2	long	R	0.01kWh	
31	0 x 403c	Forward reactive energy	2	long	R	0.01kvarh	
32	0 x 403e	Backward reactive energy	2	long	R	0.01kvarh	

Extension reserved							
System setting parameter list							
1	0 x 4800	Wiring	1	short	R		Table 1
2	0 x 4801	Voltage ratio PT1	1	short	R/W	0.1kV	Fixed decimal point
3	0 x 4802	Voltage ratio PT2	1	short	R/W	0.1V	
4	0 x 4803	Current ratio CT1	1	short	R/W	1A	
5	0 x 4804	Current ratio CT2	1	short	R/W	0.1A	Fixed decimal point
6	0 x 4805	Communication address 1	1	short	R/W		
7	0 x 4806	Baud rate 1	1	short	R/W		Table 2
8	0 x 4807	Data format 1	1	short	R/W		
9	0 x 4808	Communication address 2	1	short	R/W		Backup
10	0 x 4809	Baud rate 2	1	short	R/W		
11	0 x 480a	Data format 2	1	short	R/W		
12	0 x 480b	DO	1	short	R		Table 4
13	0 x 480c	DI	1	short	R		Table 5
14	0 x 480d	Remote input	1	short	R/W		Table 6
Extension reserved							
Alarm communication parameter list							
1	0 x 4900	1st alarm mode	1	short	R/W	No decimal point	
2	0 x 4901	1st alarm unit	1	short	R/W		Table 3
3	0 x 4902	1st alarm value	1	short	R/W	0.1	Fixed decimal point
4	0 x 4903	1st alarm hysteresis value	1	short	R/W	0.1	
5	0 x 4904	1st alarm output mode	1	short	R	No decimal point	
6	0 x 4905	1st channel action delay	1	short	R/W	0.1s	Fixed decimal point
7	0 x 4906	1st channel cut off delay	1	short	R/W	0.1s	
Please read the second or more alarm communication addresses from the end of the first address							
Extension reserved							

Table 1: Connection

Communication address	Value	Display characters	Illustration
0X4800	0	3-4	3 phase 4 wire
	1	3-3	3 phase 3 wire

Table 2 : communication baud rate

Communication address	Value	Display characters	Illustration
0X4805	0	1.2K	Baud rate 1200bps
	1	2.4K	Baud rate 2400bps
	2	4.8K	Baud rate 4800bps
	3	9.6K	Baud rate 9600bps
	4	19.2K	Baud rate 19200bps

Table 3: Alarm and transmitter unit

Communication address	Value	Display characters	Illustration
0X4901、0X4908 0X4A01、0X4A05	0	1	Unit : 1
	1	K	Unit : K
	2	M	Unit : M

Table 4: Alarm output status indication

Communication address	Bit number	Alarm	Illustration
0X480B	BIT2-BIT15	unused	unused
	BIT1	Alarm 2	0：Alarm did not act;
			1：Alarm acted;
	BIT0	Alarm 1	0：Alarm did not act;
			1：Alarm acted;

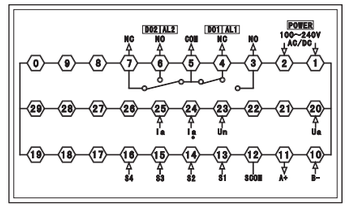
Table 5 : DI input status indication

Communication address	Bit number	Alarm	Illustration
0X480C	BIT4-BIT15	unused	unused
	BIT3	DI input 4	0：Disconnect;
			1：Connect;
	BIT2	DI input3	0：Disconnect;
			1：Connect;
	BIT1	DI input2	0：Disconnect;
			1：Connect;
	BIT0	DI input1	0：Disconnect;
			1：Connect;

Table 6 : Illustration for remote control output commands

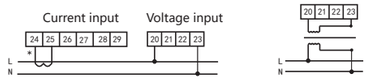
Communication address	Bit number	Alarm	Illustration
0X480D	BIT2-BIT15	unused	unused
	BIT1	DO 2	0：disconnect relay;
			1：connect relay;
	BIT0	DO 1	0：disconnect relay;
			1：connect relay;

■ Connection



If any changes, please subject to the connection drawing the meter.

Connection drawing:



Current input via CT Voltage direct input Voltage input via PT

Illustrate:
A. Voltage input: The input voltage should not be higher than the rated input voltage of the product, otherwise PT should be considered.
B. Current input: The standard rated input current is 5A. If it is greater than 5A, an external CT should be used. If the CT used is connected to other instruments, the wiring should be connected in series.
C. Make sure that the input voltage and current are corresponding, the phase sequence is consistent, and the direction is consistent, otherwise there will be numerical and sign errors (power and energy).
D.Meter wiring, the input network Link set in the meter programming, should be consistent with the wiring of all measured loads, otherwise the voltage or power measured by the meter will be inaccurate.

Remarks:
1. Do not connect the power cord wrongly.
2. Pay attention to the phase sequence of the voltage signal input.
3. The current signal input should be connected according to the terminal with the same name marked on the wiring diagram.
4. The wiring method should be consistent with the setting of the user menu "LIN".
5. It is recommended to isolate the power supply of the instrument from the main test line, so as not to cause the leakage switch to operate incorrectly.
6. The electric energy measurement is designed as the secondary measurement method, please multiply the corresponding PT and CT values by yourself when calculating the electric energy.

■ Dimensions (Unit: mm)