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# Rail-type Multifunction Electrical Instrument

Use and Installation Manual V1. 1

Acrel Co., Ltd.

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# 申 明

## Announcement

Please read the manual carefully before using the product. The pictures, marks and symbol in the manual belong to Acrel. The manual or part of it shall not be publicly reprinted by people outside the company without written authorization.

The manual will be continuously updated and corrected but it is inevitable to see a little discrepancy or error if compared with the real products. Please refer to the purchased real product. The latest version of the manual is available on [www.ACREL.cn](http://www.ACREL.cn) or sales channel upon request.

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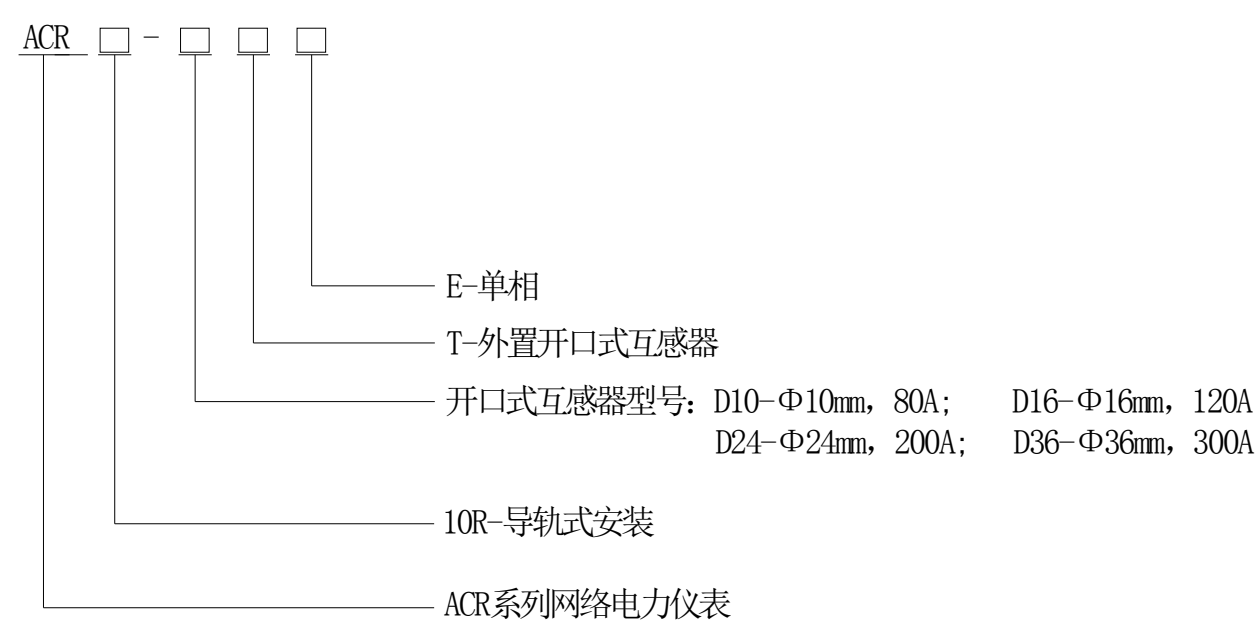
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Note: The instrument must be installed on the spot together with a complementary split-core current transformer .

## 1 Overview

The rail-type multifunction electrical instrument with external Rogowski coil and split-core current transformer is applicable for the energy-saving reconstruction project in high energy consumption industries including the smelting, iron and steel, welding and semi-conductor industry. It is also suitable for applications such as the power monitoring of grid-connected cabinet for distributed photovoltaic power cabinet and energy demand management. It boasts of no need of bus removal, easy connection and safe construction, saving reconstruction cost and raising efficiency for the user. It integrates the measurements of all electric parameters (including single-phase or three-phase current, voltage, active power, reactive power, apparent power, frequency and power factor) and comprehensive energy monitoring and examination management. Meanwhile, it also has various peripheral interfaces for the user to choose: the RS485 communication interface with MODBUS-RTU protocol can meet the need of online communication management; the interfaces with switch input and relay output can realize the remote signalling and remote control of the circuit breaker switch. It is very suitable for real-time power monitoring system with an LCD display and the panel buttons to realize the setting and control of parameters.

2. Product Specifications



E-单相	E-Single-phase
T-外置开口式互感器	T-External open current transformer
开口式互感器型号	Open current transformer model:
10R-导轨式安装	IOR-Rail-type installation
ACR 系列网络电力仪表	ACR series grid electrical instruments

Product Function

Model		ACR10R-DxxTE
Function		
Measurement Parameters	Single-phase current	■
	Single-phase voltage	■
	Single-phase (active power, reactive power, power factor)	■
	Three-phase (active energy, reactive energy)	■

Note:1. “■” refers to standard function, the standard configuration for above instruments is 1 channel RS485 communication.

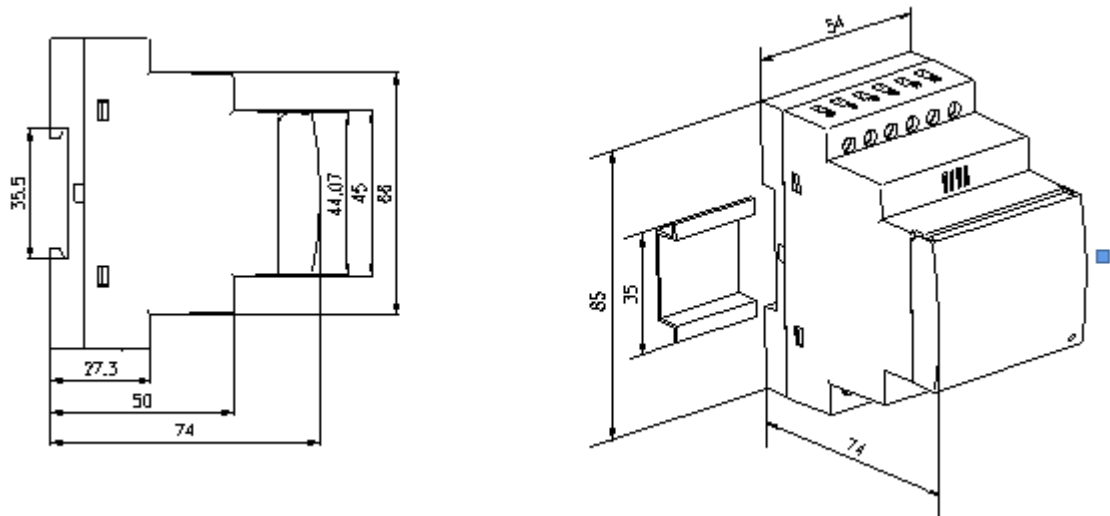
#### -4 Technical Parameters

Technical parameters		Indicators
Input	Grid	Single-phase,
	Frequency	45~65Hz
	Voltage	Rated voltage: AC 100V, 400V
		Overload: 1.2 times the rated voltage(continuous); 2 times the rated voltage lasting for 1 second
		Power consumption: less than 0.2VA
	Current	Rated current: 10A, 20A, 40A, 80A, 120A, 200A etc. (for details see product specifications)
		Overload: 1.2 times the rated current(continuous);10 times the rated current lasting for 1 second
		Power consumption: less than 0.2VA
Output	Communication	RS485 interface, Modbus-RTU
	Display	LCD
Measurement precision		Voltage: 0.2 level, current, power Active energy: 0.5 level, 0.01Hz frequency, Reactive energy: 1 level
Power supply		AC85~265V or DC100~350V; power consumption ≤10VA
Safety	Power frequency withstand voltage	AC2kV 1 min between power supply // current input//voltage input and communication AC2kV 1 min between each pair of combinations among power supply, current input and voltage input.

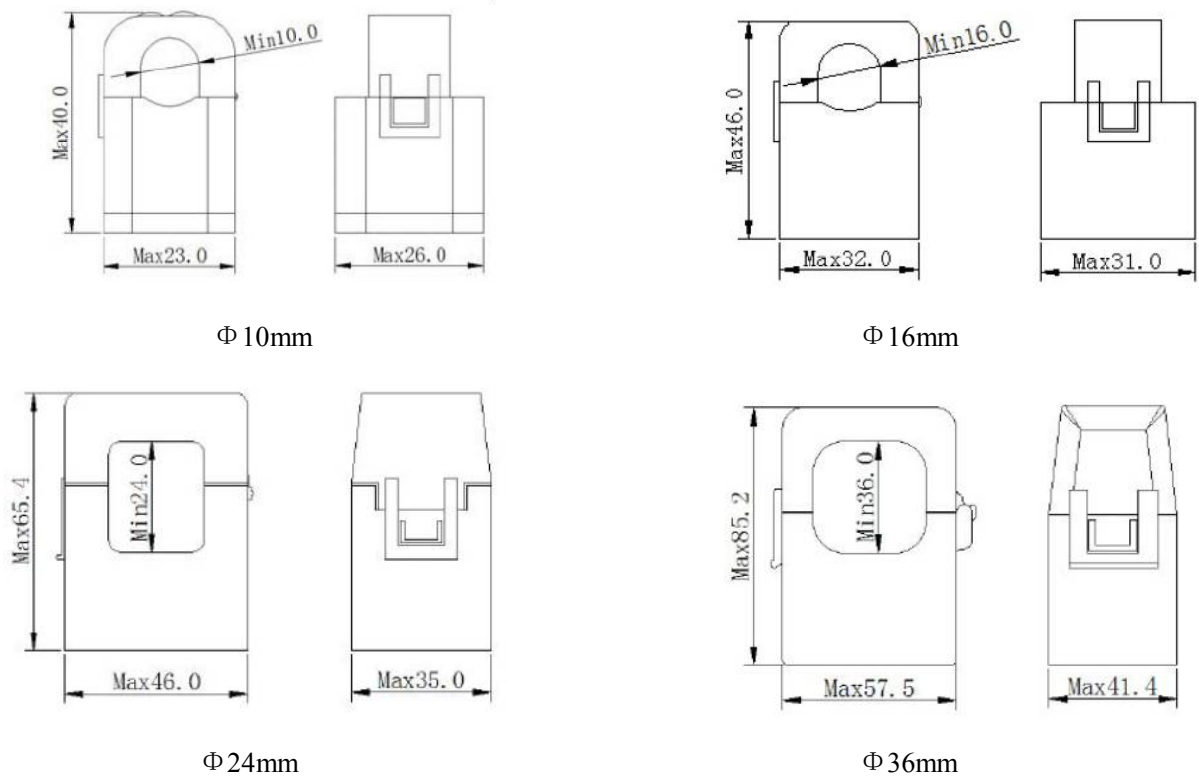
	Insulating resistor	Input,output terminal to housing >100M $\Omega$
Environment	Working temperature: -10℃~+55℃;storage temperature: -20℃~+70℃ Relative humidity:5%~95%, non-condensing; altitude:≤2500m	

5. Installation

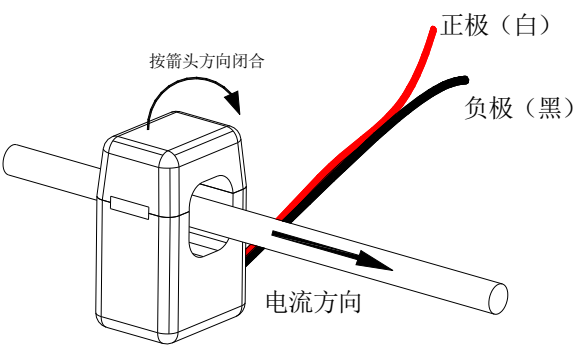
5.1 Overall and Installation Dimensions (Unit: mm)



5.2 Open Current Transformer’s Dimension (Unit: mm)



5.3 Installation Method

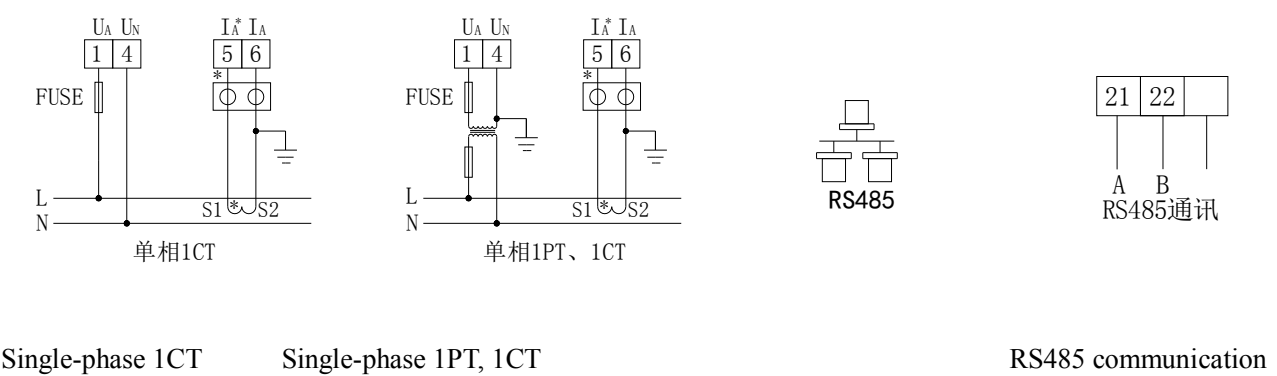


Installation Method of the Open Current Transformer Close

按箭头方向闭合	Close according to the arrow direction
正极 (白)	Positive (White)
负极 (黑)	Negative (Black)
电流方向	Current direction

5.4 Connection Mode

(Note: The connection diagram on the instrument housing shall prevail in case of any discrepancies with it)

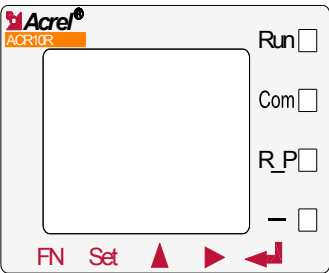


注：接线图中保险丝推荐使用 0.5A 或者 3A；  
It is recommended to use 0.5A or 3A for the fuse in the connection diagram;  
RS485 communication terminal connection can use either RJ45 female or normal connector.



6. Programming and Use


6.1 Panel Description



	熄灭	常亮	闪烁
Run （绿色）	仪表未运行	/	仪表正常运行
Com （红色）	仪表未通讯	/	处于通讯状态
R-P （红色）	功率为正	功率为负	/
— （红色）	/	负值指示灯	/

	Off	On	Flashing
Run （Green）	The instrument is not running	/	The instrument is running normally
Com （Red）	The instrument is not communicating	/	The instrument is in communication status.
R-P （Red）	Positive power	Negative power	/
— （Red）	/	Negative value indicator lamp	/

6.2 Button Function Description

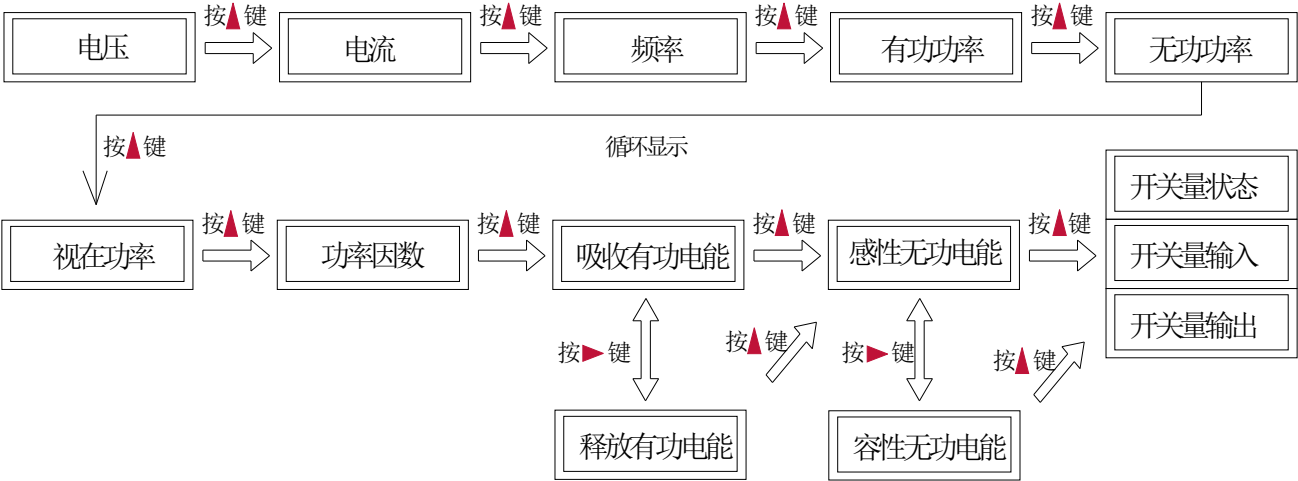
仪表五个按键从左到右依次为 FN 键、SET 键、 键、回车键。

The five buttons of the instrument are FN button, SET button,,Enter button from left to right.



FN button	The button function is not yet available.
SET button	In the measurement mode, press this button to enter the programming mode. The instrument will indicate entering password. When the correct password is entered, you can set the programming for the instrument; in the programming mode, use it to return to the previous menu

▲ 键	<p>In the measurement mode, it is used to switch display items;</p> <p>In the programming mode, it is used to switch menus of the same level or reduce the units.</p>
► 键	<p>In the measurement mode, it can be used to see relevant parameters. For details, see the display menu;</p> <p>In the programming mode, it is used to switch menus of the same level or increase the units.</p>
Enter button	In the programming mode, it is used to confirm the items selected form the menu and the modification of parameters.
▲ button+Enter button	In the programming mode, the combination is used to reduce hundreds
► button+Enter button	In the programming mode, the combination is used to increase hundreds

### 6.3 Operation Instructions



电压	Voltage
电流	Current
频率	Frequency
有功功率	Active power
无功功率	Reactive power

视在功率	Apparent power
功率因素	Power factor
吸收有功电能	Absorb active energy
感性无功电能	Inductive reactive energy
开关量状态	Switch status
开关量输入	Switch input
开关量输出	Switch output
释放有功电能	Release active energy
容性无功电能	Capacitive reactive energy
按  键	Press  button

## 6.4 Programming Menu

### 6.4.1 General Programming Menu

1 <sup>st</sup> level menu	2 <sup>nd</sup> level menu	3 <sup>rd</sup> level menu	Description
555	dISP		Selection for start-up picture without auto page turning
	Code	0-9999	Password setting (initial password 0001)
	Clr.E		OK is displayed when energy cleared off
	Err		Abnormal data statistics
In	Line	1P2L, 3P3L、3P4L	Connection mode (single-phase, three-phase three-wire, three-phase four-wire)
	InU	100、400	Input voltage range
	InI	10, 20, 40, 80, 120, 200, 300 等 (详细见产品规格) 10, 20, 40, 80, 120, 200, 300etc. (For details, please see product	Input current scope (not for user operation)

		specifications)	
	InPt	0-9999	Voltage multiplier
	InLt	0-9999	Current multiplier
bus	Addr	1-247	Communication address
	bAUD	4800、9600、19200、38400	Communication baul rate
	mode	None/2bit/odd/even	Communication mode (no parity, 2 stop bit, odd parity, even parity)
IO	do	do1	Switch output setting (see 6.4.2)
		do2	
	di	di1	Switch input setting
		di2	

#### 6.4.2 Additional Menu with Switch Output

The switch output of the instrument adopts relay output with two control mode: 1. alarm mode( “SEL” is not zero);2. bus control mode ( “SEL” is selected as “0. do” and level output for zero “dLy” . When “dLy” is not zero, it is automatically cut off after do action in the set delay time. )

Set Do output type in the “SEL” . “0. do” usually refers to communication control (if “dLy” is set to 0, the output is level or pulse. If dly is set to 2, the circuit will be off after closing for two seconds) Others are alarm control (see list below).

“dLy” refers to alarm delay (which is not recommended to set as 0 to prevent disturbance or mistake. Pulse or level output control for Do output type)

“bAnd”

“bAnd” refers to setting of the non-action band

“AL.Hi” refers to the setting of high alarm number (no need to set the max. 9999)

“AL.Lo” refers to the setting of low alarm number (no need to set the min. -9999)

(The above three settings correspond to the energy display which contains decimal point. Eg. input 220V 100A/5A, three-phase four-wire, the calculation of 100% P total is  $220 \times 100 \times 3 = 66\text{kW}$ . If high alarm for 100% power, return for 90% power, the “AL.Hi” can be set to 66.00, the “bAnd” to 6.00. If high alarm for 100% voltage, return for 95% voltage, the “AL.Hi” can be set to 220.0, the “bAnd” to 11.0. If high alarm for 100% current, return for 95% current, the “AL.Hi” can be set to 100.0, the “bAnd” to 5.0)

“In.=0” refers to whether low alarm is allowed if the signal is 0. Lo. on enable it and Lo.of disable it.

01	02	03	04	05	06	07	08
UA	UB	UC	三相相电压最值 Max/min value of three-phase phase voltage	UAB	UBC	UCA	三相线电压最值 Max/min value of three-phase linevoltage
09	10	11	12	13	14	15	16
IA	IB	IC	三相电流最值 Max/min value of three-phase current	PA	PB	PC	P 总 P total
17	18	19	20	21	22	23	24
QA	QB	QC	Q 总 Q total	SA	SB	SC	S 总 S total
25	26	27	28	29	30	31	31
PFA	PFB	PFC	PF	F	电压不平衡 Unbalanced voltage	电流不平衡 Unbalanced current	

三相 Three-phase

01	02	03	04	05	06	07
U	I	P	Q	S	PF	F

单相 Single-phase

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Note: 1. Max/min value of three-phase ....refers to:maximum value for three-phase high alarm, minimum value for three-phase low alarm.

The second channel DO can set a “32.FL” combined alarm function. After setting, the 2<sup>nd</sup> level menu will become “SEL” (Function Selection), “dLy” (Delay), “H-U” (Overvoltage), “L-U” (Undervoltage), “H-F” (Overfrequency), “L-F” (Underfrequency), “H-P” (Overpower), “L-P” (Underpower), “H-I” (Overcurrent), “L-PF” (Underpower Factor), “H-b.U” (Unbalanced Overvoltage. Missing phase for -1 setting. The judgement conditions are at least one phase $>0.2I_e$ , one phase $<0.01I_e$ )

### 3. Unbalance calculation

(Difference between the max.mean deviation and the mean value)/mean value\*100%. If the mean value in the denomintor is less than the rated value, the denomintor will be the rated value.

Rated voltage value  $U_e$ : three-phase four-wire  $U_e$  is phase voltage. The 400V instrument set in the menu is  $220V*PT$ , and 100V instrument is  $57V*PT$ .

Rated current value  $I_e$ :  $5A*CT$  for 5A instrument,  $1A*CT$  for 1A instrument.

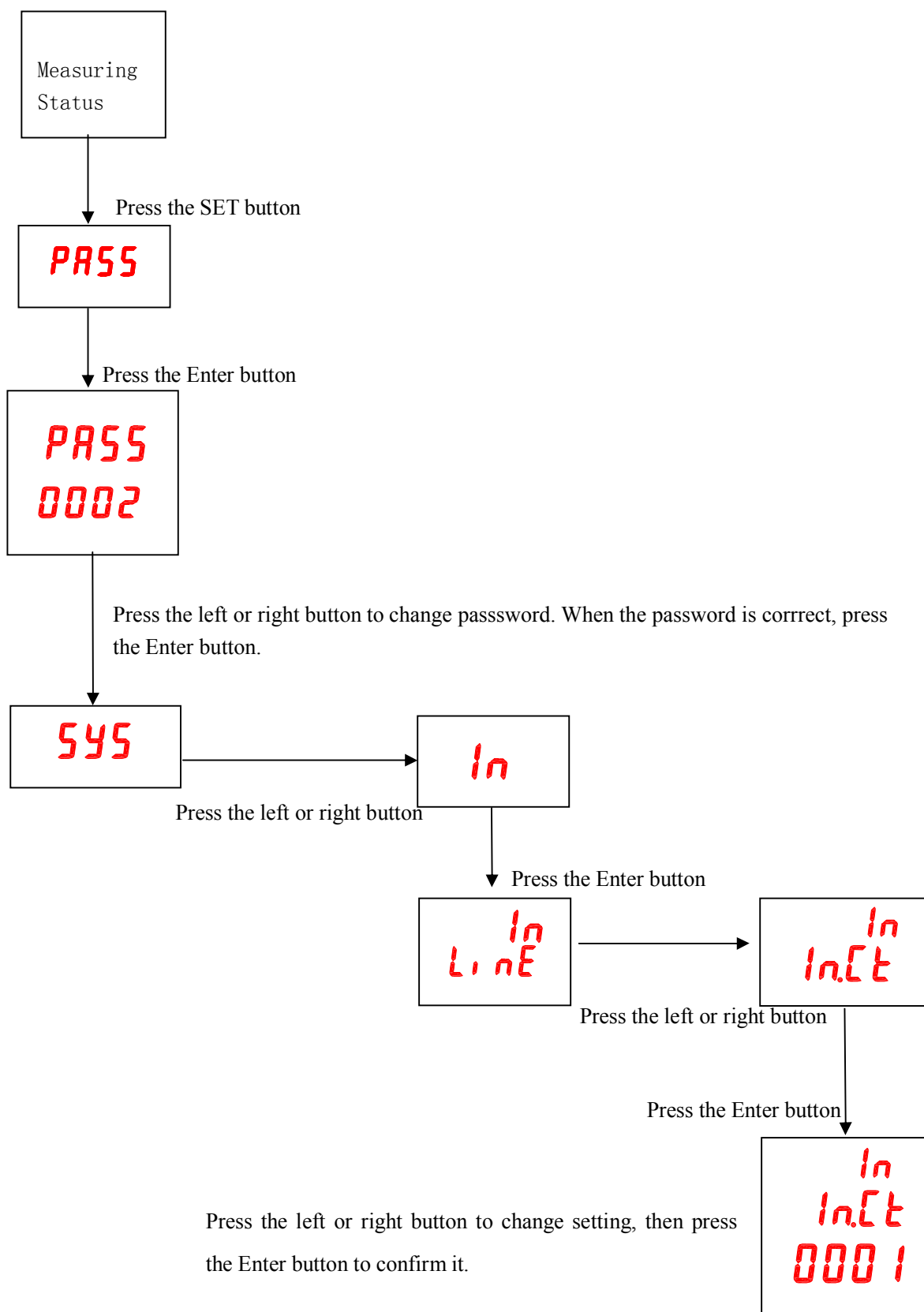
The parameter setting for the unblance is in the percentage form, such as 20 refers to 20%.

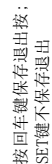
## 6.5 Programming Examples

This section introduces some option change in the programming menu in the form of work flow chart, such as the current multiplier, transformer setting.

Note: When the setting or selection is done, the Enter button must be pressed to confirm it. After the confirmation is complete, continuously press the SET button until the SAVE/YES page appears. At this time, the Enter button must be pressed at this time or the setting will not be valid.

### 6.5.1 How to Change Current Multiplier (CT Transformation Ratio)







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## 7. Communication Connection

The instrument provides asynchronous half-duplex RS485 communication interface which adopts MODBUS-RTU protocol so all kinds of data can be transmitted on the communication line. Theoretically, one communication line can be connected with up to 128 instruments, each of which can set a communication address (Addr) and communication rate (baud) via setting.

For the communication connection, we recommend to use the three-core shielding wire. The core wires are connected to A,B,COM2 respectively and the shielding layer is connected to the ground. COM2 is forbidden to have ground connection. When laying the wires, the communication line shall be kept away from the strong current cable or other strong electric field.

It is recommended to add a matching resistor between A and B of the end instruments. The resistance range is  $120\Omega \sim 10k\Omega$ .

See 7.6 for specific connection case.

### 7.1 Transmitting Method

The information transmission is asynchronous and in bytes. The communication message transmitted from the master to the slave is in 10-bit format including 1 start bit, 8 data bit (LSB first delivered), no parity bit, one stop bit. If parity bit or 2 stop bit is set, the format is 11-bit.

### 7.2 Information Frame Format

地址码 Address code	功能码 Function code	数据区 Data zone	CRC 校验码 CRC check code
1 字节 1 byte	1 字节 1 byte	n 字节 n byte(s)	2 字节 2 bytes

Address code: the address code is in the beginning of the frame, which is composed of a byte (8 bit binary code) representing  $0 \sim 255$  in decimal system. The PZ instrument only uses 1~247 and keeps other addresses. The bits indicate the address of the terminal device designated by the user. The device

will receive the data from the linked master. The address of every terminal device must be unique. Only the end addressed will correspond to the query containing its address. When the terminal sends back a response, the responding slave address will tell the master which terminal is communicating with it.

Function code: the function code tells the addressed terminal to carry out which functions. The table below lists up the function codes used by this instrument as well as their meanings and functions.

Function	Definition	Operation
03H/04H	Data reading register	Obtaining the current binary value of one or more registers.
10H	Preset multi-register	Set the binary value into a series of multi-register

Data zone: the data zone contains the data needed for carrying out certain functions or collected when the terminal responds to the query. The content of the data may be number, reference address or set value. For example: if the function code tells the terminal to read a register, the data zone needs to specify which register to start with and how much data to be read. The embedded address and data will vary with types and different content of the slaves.

CRC check code: CRC field occupies two bytes including one 16-bit binary value. The CRC value is calculated by the transmitting device then added to the data frame. The receiving device will recalculate the CRC value upon receiving the data then compare it with the received value in the CRC field. If the two values are not identical, there is an error.

#### **The procedure to generate a CRC**

Preset a 16-bit register as 0FFFFH (full 1), which is called CRC register.

b、

Make XOR calculation with 8 bit of the first byte in the data frame and the lower byte in the CRC register and store the result into the CRC register.

c、

Shift the CRC register right a bit and fill the MSB with 0 and take out the LSB for checking.

d

---

If the LSB is 0, repeat step 3 (one more shift); if the LSB is 1, make XOR calculation with CRC register and preset fixed value (0A001H).

e、

Repeat step three and step four until the 8<sup>th</sup> shift. The entire 8 bit processing is complete in this way.

f、

Repeat step two to five to process the next 8 bits until all bytes are processed. g、

Finally, the CRC register value becomes the CRC value.

Besides, there is also a way to calculate CRC using the preset table. It is characterized by rapid calculation speed. However, the table needs relatively large storage room. We will not introduce it here, please refer to relevant materials.

## 7.3 Function Code Introduction

### 7.3.1 Function Code 03H or 04H: Reading Register

The function allows the user to obtain the data collected and recorded by the device and system parameters. The data number requested by the master computer for one time has no limitation but cannot exceed the defined address range.

The following examples are 3 basic data read from 01 slave computer (every address in the data frame takes up 2 bytes):UAB, UBC, UCA. Among them, UAB' s address is 0028H, UBC' s address is 0029H and UCA' s address is 002AH.

Sent by master		Sent message
Address code		01H
Function code		03H
Start address	UB	00H
	LB	28H
Number of registers	UB	00H
	LB	03H
CRC	LB	85H

Feedback by slave		Feedback message
Address code		01H
Function code		03H
Bytes		06H
Register data	UB	Undefined
	LB	Undefined
Register data	UB	Undefined
	LB	

CRC check code					Undefined
	UB	C3H	Register data	UB	Undefined
				LB	Undefined
			Register data	LB	Undefined
				UB	Undefined

### 7.3.2 Function Code 10H: Writing Register

The function code 10H allows the user to change the contents of multiple registers. The function code can be used to write the system parameters and switch output status. The master computer can write a maximum of 16 pieces of data (32 bytes) at once.

The following example shows that when the preset address is 01, the switch output is Do1. The switch input/output status indication register's address is 0022H. The 9–12 bit corresponds to DI1–DI4, the 13–14 bit corresponds to D01–D02 respectively.

Sent by master			Sent message		Feedback by slave			Feedback message		
Address code			01H		Address code			01H		
Function code			10H		Function code			10H		
Start address	UB		00H		Start address	UB		00H		
	LB		22H			LB		22H		
Register number	UB		00H		Register number	UB		00H		
	LB		01H			LB		01H		
Byte number			02H		CRC 校验码	LB		A1H		
0022H data to be written	UB		10H			CRC check code	UB		C3H	
	LB		00H							
CRC check code	LB		ADH							
	UB		12H							

## 7.4 Communication Application Details

The instrument design has a uniform planning for the communication address list. The user can easily realize the functions of remote measurement, remote signalling and remote control according to the following introduction.

### 7.4.1 Switch Input and Output

The switch input of the instrument adopts dry contact switch signal input method. The instrument is equipped with +5V operating power inside so it does not need external power supply. When the external contact is close or open, the instrument will show the switch status locally. At the same time, the communication port of the instrument can realize the long distance transmission function, i.e., the “remote signalling” function.

When the switch output is the relay output, the instrument can not only be remotely controlled by the upper computer(two ways of remote control:1.level triggering 2. Pulse triggering) to realize “remote control” function but also realize corresponding alarm function upon customer’ s request (such as overcurrent, undervoltage).

The communication address related to the switch input/output is 0022H with relations to the switch I/O as below:

0022H	16	15	14	13	12	11	10	9	8~1
			D02	D01	DI4	DI3	DI2	DI1	Reserved

## 7.5 Communication Address List (MODBUS-RTU Protocol)

(1Float=2Word, 1Word=8Byte)

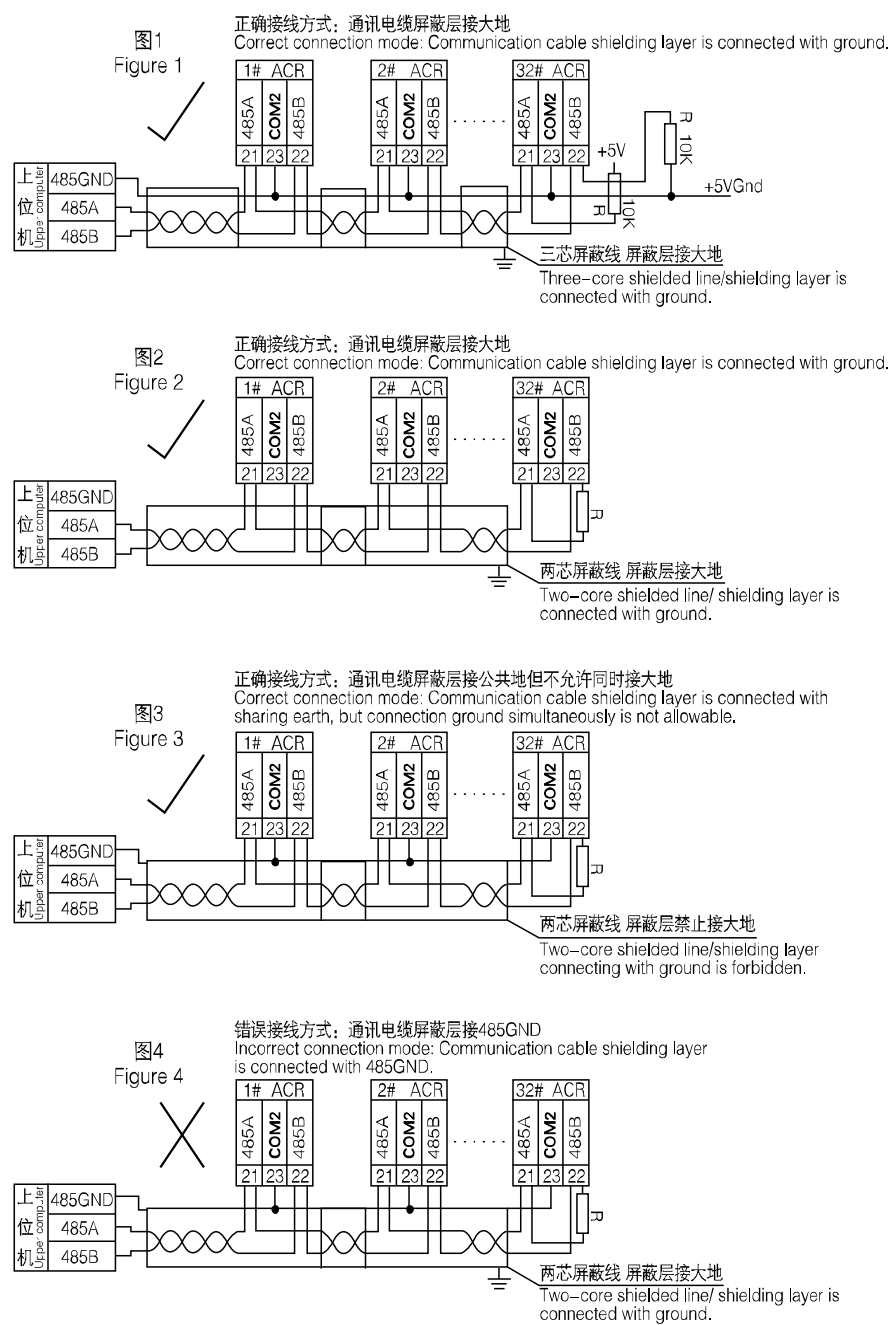
Address	Parameters	R/W attribute	Number range	Data type	Remarks
0000H	Protective password	R/W	0001-9999	word	
0001H UB	Communication address	R/W	0001-0247	word	
0001H LB	Baud rate	R/W	0-3: 38400、19200、 9600、4800bps		
0002H	Reserved	R	Factory parameters. Users are not allowed to write an order.	word	
0003H	PT transformation ratio	R/W	1-9999	word	
0004H	CT transformation ratio	R/W	1-9999	word	

0005H~0021H	Reserved	R	Factory parameters. Users are not allowed to write an order.	word	
0022H	Switch I/O status	R/W	7.3.2	word	
0061H	U	R	0-65535	word	1 bit decimal is reserved
0062H~0063H	Reserved	R		word	
0064H	I	R	0-65535	word	2 bit decimal is reserved
0065H~0066H	Reserved	R		word	
0067H	P	R	-32760~+32760	word	3 bit decimal is reserved, KW
0068H~006AH	Reserved	R		word	
006BH	Q	R	-32760~+32760	word	3 bit decimal is reserved, KVar
006CH~006EH	Reserved	R		word	
006FH	S	R	0-65535	word	3 bit decimal is reserved, KVA
0070H~0072H	Reserved	R		word	
0073H	PF	R	0-100	word	2 bit decimal is reserved
0074H~0076H	Reserved	R		word	
0077H	F	R	4500-6500		2 bit decimal is reserved
0078H~007AH	Reserved				
Energy adress list below					
0047H~0048H	Absorbing active energy	R	0-9999999999	Float	Primary energy
0049H~004AH	Releasing active	R	0-9999999999	Float	Primary

	energy				energy
004BH~004CH	Reactive energy	R	0-99999999999	Float	Primary energy
004DH~004EH	Capacitive reactive energy	R	0-99999999999	Float	Primary energy

7.6 Communication Connection Cases

The communication connection cases are shown as below:



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Postal code: 201801

Manufacture base: Jiangsu Acrel Electric Appliance Manufacturing Co.,

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Postal code: 214405

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