# Rail-type Multifunction Electrical Instrument with External Split Core Current Transformer

Use and Installation Manual    V1.4

Acrel Co., Ltd.

# 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.
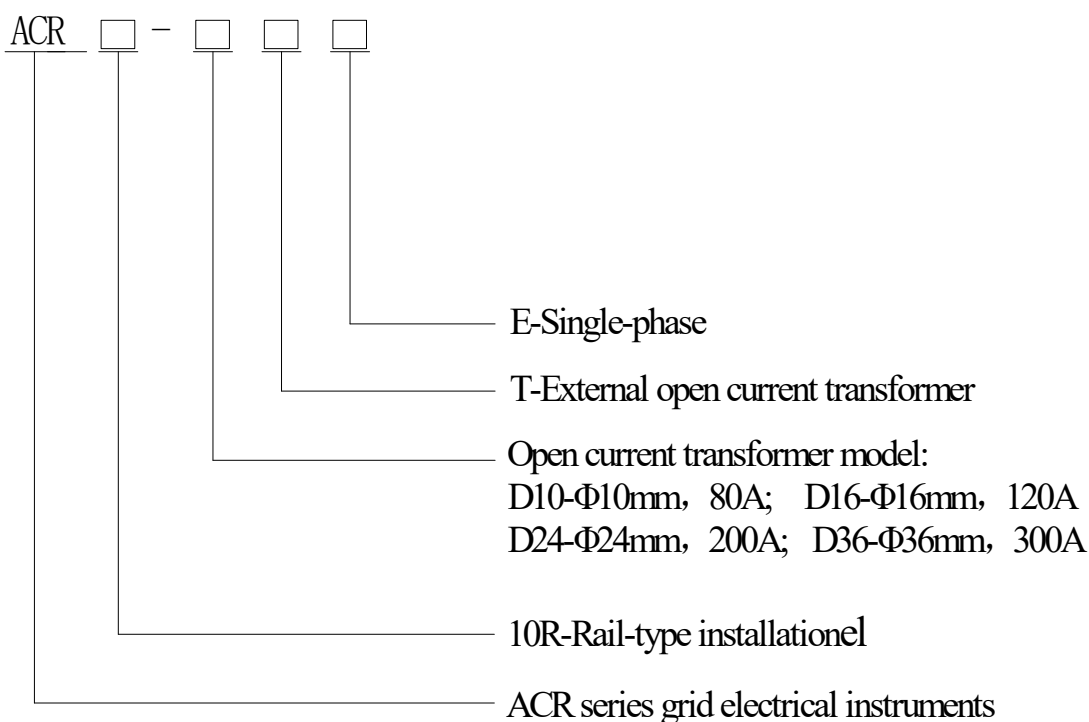
# Content

**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

ACR □ － □ □ □

E-Single-phase

T-External open current transformer

Open current transformer model:
D10-Φ10mm，80A；　D16-Φ16mm，120A
D24-Φ24mm，200A；　D36-Φ36mm，300A

10R-Rail-type installationel

ACR series grid electrical instruments

3．Product Function

| Model / Function | | ACR10R-DxxTE |
|---|---|---|
| Measurement Parameters | Single-phase current | ■ |

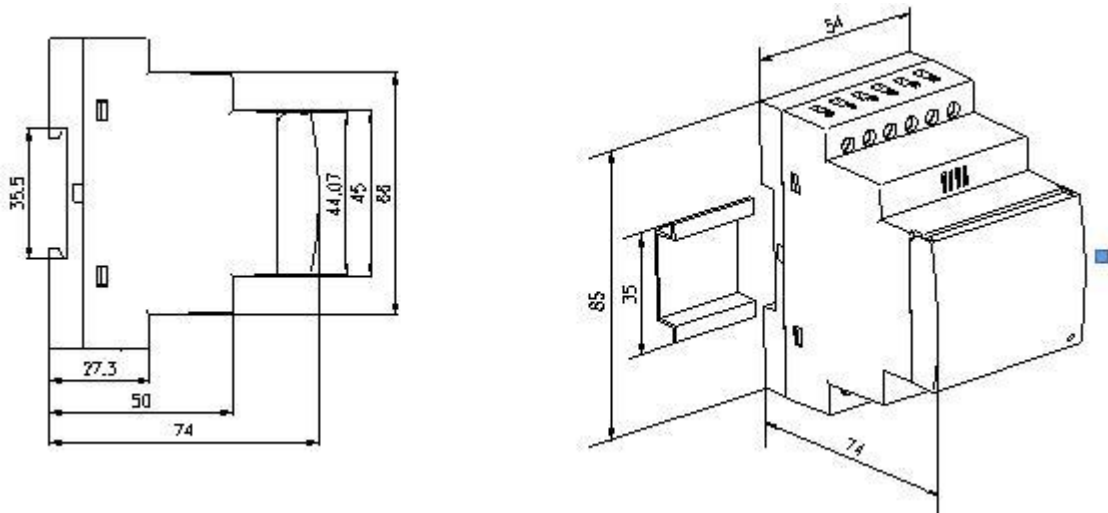| | | |
|---|---|---|
| Single-phase voltage | | ■ |
| Single-phase (active power, reactive power, power factor） | | ■ |
| Three-phase (active energy, reactive energy) | | ■ |

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 then 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 then 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, urrent input and voltage input. |
| | Insulating resistor | Input,output terminal to housing >100MΩ |
| 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)



Φ10mm



Φ16mm



Φ24mm



Φ36mm

3

## 5.3 Installation Method



Close according to the arrow direction

Positive (White)

Negative (Black)
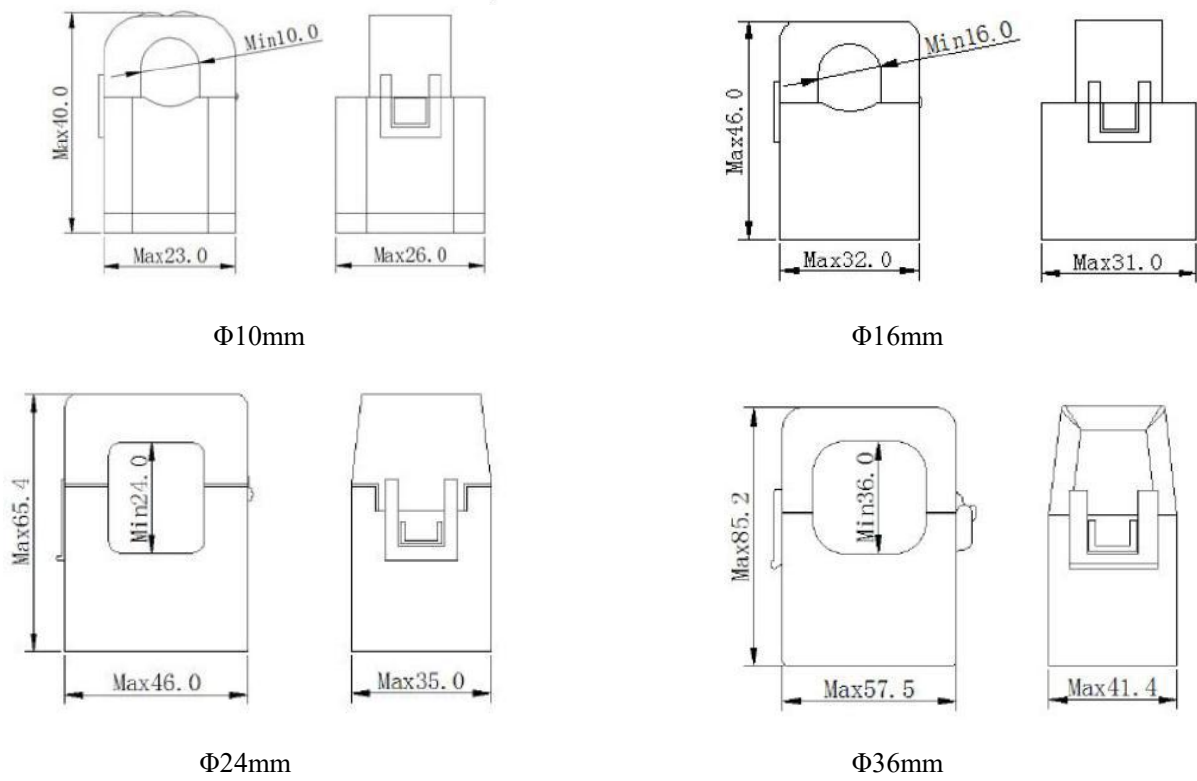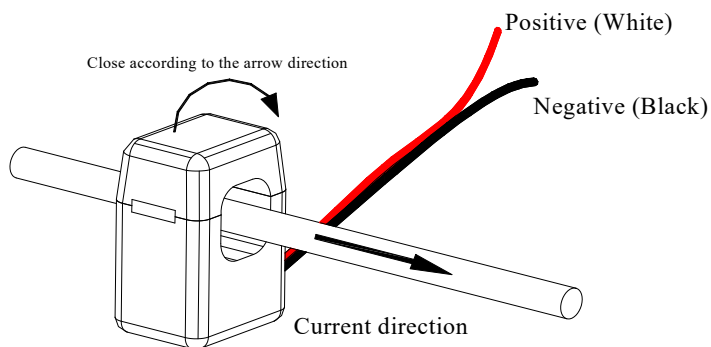
Current direction

Installation Method of the Open Current Transformer Close

## 5.4 Connection Mode

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

According to different design requirements ,it is recommended to add fuses at power supply and voltage input terminals to meet the safety requirements of relevant electrical specifications



Single-phase 1CT

Single-phase 1PT, 1CT
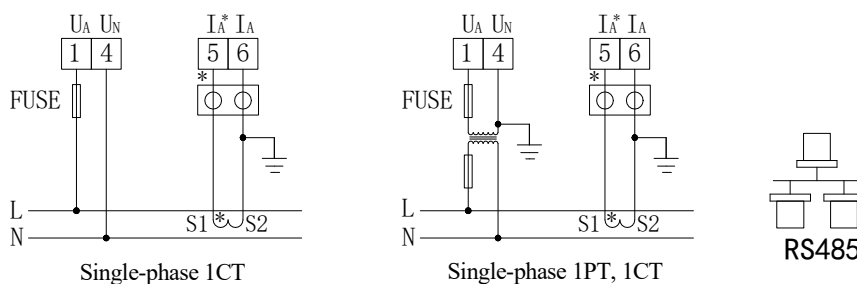
RS485

NOTE：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
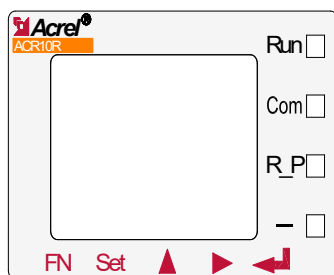


|  | Off | On | Flashing |
|---|---|---|---|
| Run (Green) | The instrument is not running | / | The instrument is running normally |
| Com (Red) | The instrument is not communicating | / | The instrument is in communication status. |
| R-P (Red) | Positive power | Negative power | / |
| — (Red) | /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

## 6.2 Button Function Description

The five buttons of the instrument are FN button, SET button,▲button,▶ 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 |
| ▲button | In the measurement mode, it is used to switch display items; In the programming mode, it is used to switch menus of the same level or reduce the units. |
| ▶ button | In the measurement mode, it can be used to see relevant parameters. For details, see the display menu; In the programming mode, it is used to switch menus of the same level or increase the units. |
| 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



## 6.4 Programming Menu

## 6.4.1 General Programming Menu

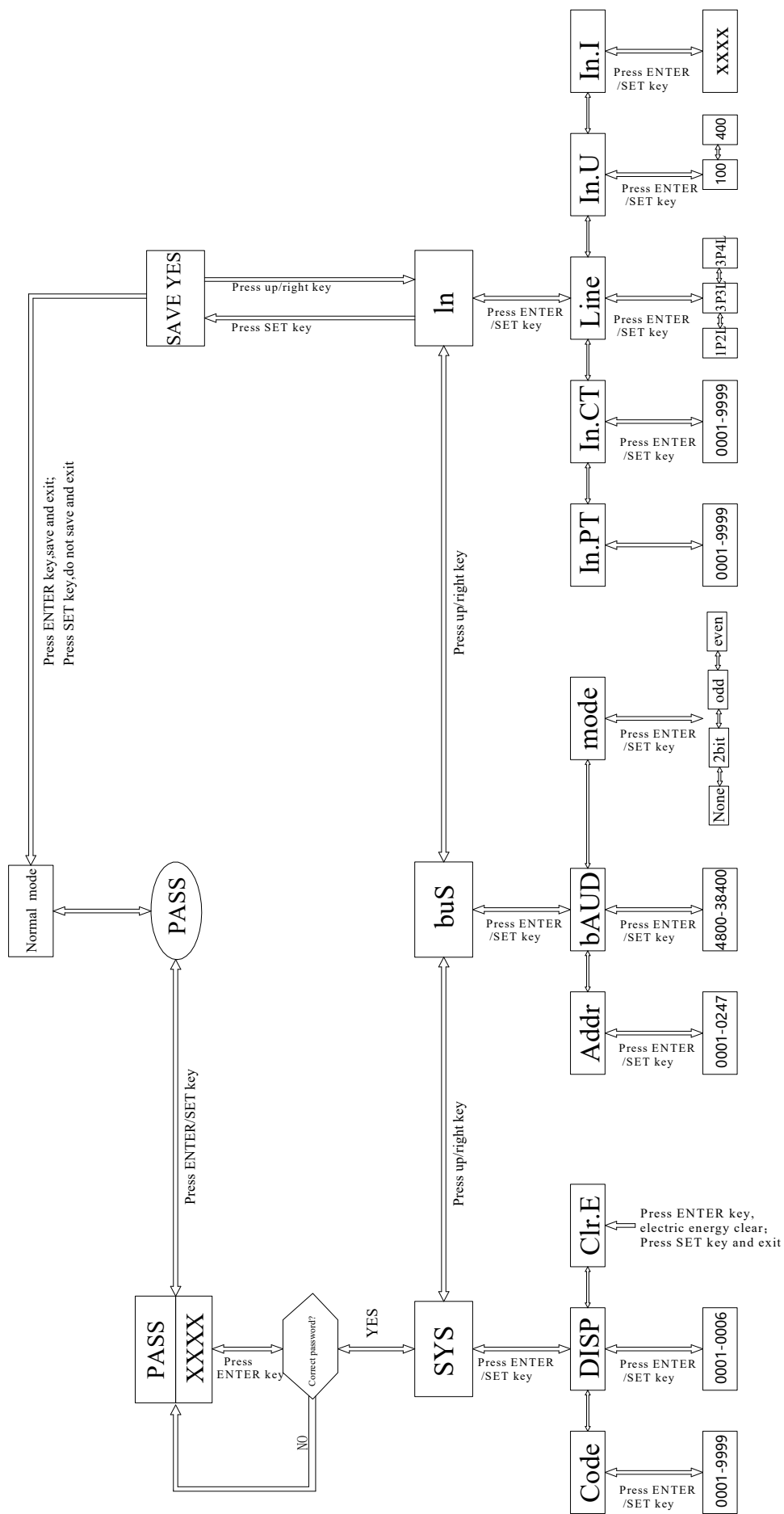| 1st level menu | 2nd level menu | 3rd level menu | Description |
|---|---|---|---|
| **5YS** | **d 15P** | | Selection for start-up picture without auto page turning |
| | **CodE** | 0-9999 | Password setting (initial password 0001) |
| | **C Ir.E** | | OK is displayed when energy cleared off |
| | **Err** | | Abnormal data statistics |
| **In** | **Li nE** | 1P2L,3P3L、3P4L | Connection mode(single-phase, three-phase three-wire, three-phase four-wire) |
| | **In.U** | 100、400 | Input voltage range |
| | **In.I** | 10,20,40,80,120,200,300etc.(For details, please see product specifications) | Input current scope (not for user operation) |
| | **InPt** | 0-9999 | Voltage multiplier |
| | **InCt** | 0-9999 | Current multiplier |
| **buS** | **Addr** | 1-247 | Communication address |
| | **bAUd** | 4800、9600、19200、38400 | Communication baul rate |
| | **ōodE** | None/2bit/odd/even | Communication mode (no parity, 2 stop bit, odd parity, even parity) |

## 6.5Programming 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)

```
          ┌─────────────────┐
          │ Measuring status │
          └─────────────────┘
                   │ Press the SET button
          ┌─────────────────┐
          │      PASS        │
          └─────────────────┘
                   │ Press the Enter button
          ┌─────────────────┐
          │      PASS        │
          │      0001        │
          └─────────────────┘
                   │ Press the left or right button to change passsword. When
                   │ the password is corrrect, press the Enter button
   ┌────────┐    ┌────────┐    ┌──────────┐
   │  SYS   │────│   In   │────│   In     │
   └────────┘    └────────┘    │   LinE   │
  Press the left  Press the    └──────────┘
  or right button  Enter button      │ Press the left or right button
                              ┌──────────┐
                              │   In     │
                              │   Ln.Ct  │
                              └──────────┘
                                   │ Press the Enter button
                              ┌──────────┐
                              │   In     │
                              │   Ln.Ct  │
                              │   0001   │
                              └──────────┘
```

Press the left or right button to change setting, then press the Enter button to confirm it.

## 6.5.2 Programming Cases

## 7．Communication Connection

The instrument provides asynchronous half-duplex RS485 communication interface wich 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.

## 7.1Transmitting Method

The information transmission is asynchronous and in bytes. The communication message tranmitted 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 et, the format is 11-bit.

## 7.2Information Frame Format

| Address code | Function code | Data zone | CRC check code |
|---|---|---|---|
| 1 byte | 1 byte | n byte(s) | 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 0~255 in decimal system. The PZ instrument only uses $1 \sim 247$ 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 termnial to carry out which functions. The table below lists up the function codes used by this instrument as well as their meanings and funcitons.

| 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 specifiy 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 devicie 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"**

A.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, m,ake XOR calculation with CRC register and preset fixed value (0A001H).

E.Repeat step three and step four until the 8$^{th}$ 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 wayt 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 check code | LB | 85H |
| | UB | C3H |

| Feedback by slave | | Feedback message |
| --- | --- | --- |
| Address code | | 01H |
| Function code | | 03H |
| Bytes | | 06H |
| Register data | UB | Undefined |
| | LB | Undefined |
| Register data | UB | Undefined |
| | LB | Undefined |
| 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 than 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 check code | LB | A1H |
| 0022H data to be written | UB | 10H | | 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.

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

(1Float=2Word，1Word=8Byte)

| Address | Parameters | 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 | |
| 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 | 0-99999999999 | Float | Primary energy |
| 0049H～004AH | Releasing active energy | R | 0-99999999999 | Float | Primary energy |
| 004BH～004CH | Reactive energy | R | 0-99999999999 | Float | Primary energy |
| 004DH～004EH | Capacitive reactive energy | R | 0-99999999999 | Float | Primary energy |