Smart Metering MCCB

MTM5M、MT88M、MTM5EL

Communication Protocol

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1 Modbus Communication

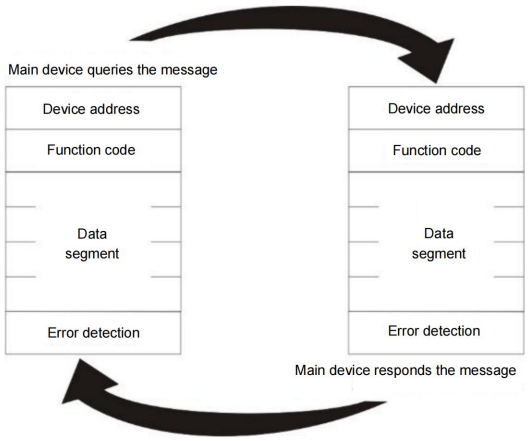
1.1 Overview

In networking communication, the wiring should be insulated from the strong electric cable or other strong electromagnetic environment. It is recommended to use a bus-type (T-type) network topology when wiring. Star or other connection methods are not recommended.

1.2 Modbus Protocol

MODBUS protocol uses a connection of master-slave response mode on a communication line. Firstly, the signal from the master is addressed to a terminal device (slave) with a unique address. Then, the response signal from the terminal device transmits to the master in the opposite direction,i.e., the signal transmits all communication data flow in two opposite directions on a single communication line (half-duplex working mode).

MODBUS protocol only allows the communication between the master (PC, PLC, etc.) and the terminal device, doesn’t allow the data exchange between independent terminal devices. In this way, each terminal device will not occupy the communication line when they are initialized, but only responses to the signals which reach it.



Master query: Query message frame including the device address code, function code, data information code, and check code. The device address code indicates the function code of the slave device which will be selected, and informs the selected slave device which function to execute, such as function code 03 or 04 requires the device to

read the register and return the content; The data segment contains the additional information of the function to be executed by the salve device. Fox example, in the read command, the additional information of the data segment contains the numbers of the registers from the one where read was started; The check code is used to verify the correctness of a frame and provide a way to verify the message content for the slave device. It adopts the calibration rule of CRC16.

Slave device response: If a normal response is generated from the slave device, there will be the address code, function code, data information code, and CRC16 check code in the response message. The data information code includes the data collected from the slave device, such as a register value or status. If an error occurs, it is agreed that the slave device never response.

1.3 Modbus_RTU Transmission Mode

The transmission mode is a series of independent data structures within a data frame and the limited rules used to transmit data. The transmission mode compatible with the MODBUS protocol - RTU mode is defined below. Each byte consists of 1 start bit, 8 data bits, (parity bit), 1 stop bit (when there is parity bit) or 2 stop bits (when there is no parity bit).

Structure of data frames: the message format.

Slave address	Function code	Command	CRC check
8-Bits	8-Bits	N×8-Bits	16-Bits Checking

Address code: At the beginning of the frame, it consists of a byte (8-bit binary code), in decimal is 0 ~ 255. Only 1 ~ 247 is used in our system, the other addresses are reserved. These bits indicate the address of the terminal device specified by the user, the device will receive master data that is connected to it. The address of each terminal device must be unique. The terminal being addressed will respond to a query that contains this address, and when the terminal sends back a response, the address data in the response from the slave device will inform the master that the terminal is communicating with it.

Function code: It informs what function the addressed terminal performs. The

following table lists the function codes supported by multi-functional electric devices, as well as their meanings and functions.

Data code: It contains the data necessary for a terminal to execute a particular function, or the data collected by a terminal response query. The contents of these data may be numeric values, reference addresses, or set values. For example, the function domain code informs the terminal to read from a register, the data domain needs to reflect the reading started from which register and how many data were read, and the slave device data code returns the contents including the data length and corresponding data.

Check code: the error check (CRC) domain occupies two bytes and contains a binary value of 16 bits. The CRC value is calculated by the transmission device and then attached to the data frame. The receiving device recalculates the CRC value when receiving the data, and compares it with the values received in the CRC domain. If these two values are not equal, an error occurs.

1.4 CRC Check Code Generation Process

The process to generate a CRC:

1) Preset a 16-bit register as FFFFH (hexadecimal, all 1), called CRC register.

2) The 8-bit of the first byte in the data frame and the low byte in the CRC register is calculated by XOR, and the result is saved back to the CRC register.

3) Shift the CRC register to the right one bit, the highest bit is 0, and the minimum is shifted out and detected.

4) The one removed in the previous step is 0, the third step is repeated (next shift): 1; the CRC register will do XOR operation with a preset fixed value (0A001H).

5) Repeat step 3 and step 4 up to 8 shifts to finish a complete 8 bits.

6) Repeat step 2 to step 5 to process the next 8 bits until all of the byte processing ends.

7) The final value of the CRC register is the value of CRC.

```
unsigned int CRC16(unsigned char *crc,unsigned char n,unsigned char after){
```

```
 unsigned char crc_lo=0xff,crc_hi=0xff,savelo,savehi;
unsigned char crc_reg,crc_reg1;
 unsigned int nCRC;
       for(crc_reg=0;crc_reg<n;crc_reg++)
{
crc_lo^=*crc++;
for(crc_reg1=0;crc_reg1<8;crc_reg1++)
      {
       savehi=crc_hi;
       savelo=crc_lo;
       crc_hi>>=1;
       crc_lo>>=1;
       if((savehi&0x01)==0x01)
            crc_lo|=0x80;
       if((savelo&0x01)==0x01)
           {
            crc_hi^=0xa0;
            crc_lo^=0x01;
           }
      }
}
if(after)
{
 *crc++=crc_lo;//low byte first
 *crc=crc_hi;    //high byte last
}
nCRC=crc_hi;
nCRC<<=8;
nCRC|=crc_lo;
```

```
return nCRC;
}
```

1.5 Examples of Communication Messages

(0x03)

Request Frame			Response Frame		
Frame Format	Value/ Range	Bytes	Frame Format	Value/ Range	Bytes
Address Code	0～247	1	Address Code	0～247	1
Function Code	0x03	1	Function Code	0x03	1
Register Start Address	0～0xFFFF	2	Return Data Length	2*N	1
Number of Consecutive Registers N	1～125	2	Return Data	2～250	2*N
CRC Check		2	CRC Check		2

For frame data (except CRC) with 2 bytes, the high byte is first and low byte is last.

Write a single holding register, which is mainly used to configure parameters, occupying 8 bytes in total, and the return frame is consistent with the request frame. The register value is the write value.

Request Frame			Response Frame		
Frame Format	Value/ Range	Bytes	Frame Format	Value/ Range	Bytes
Address Code	0～247	1	Address Code	0～247	1
Function Code	0x06	1	Function Code	0x06	1
Register Address	0～0xFFFF	2	Register Address	0～0xFFFF	1
Register Value	0～0xFFFF	2	Register Value	0～0xFFFF	2
CRC Check		2	CRC Check		2

Write multiple consecutive register block data(0x10). A write cannot exceed 120

registers, that is, less than 240 bytes. The returned frame data field is the starting address and number of the registers being written.

Request Frame			Response Frame		
Frame Format	Value/ Range	Bytes	Frame Format	Value/ Range	Bytes
Address Code	0～247	1	Address Code	0～247	1
Function Code	0x10	1	Function Code	0x10	1
Register Start Address	0～0xFFFF	2	Register Start Address	0～0xFFFF	1
Register Number N	1～120	2	Register Number N	1～120	2
Data Length	2*N	1	CRC Check		2
Register Value	0～0xFFFF	2*N			
CRC Check		2			

2 Register List: Basic Electrical Parameters

MODBUS address information table (in decimal).

Note: All marked types are 16-bit integers, registers are holding registers, support 03, 06, 10 commands for operation, R stands for read, W stands for write, Dword type data are all high byte first, low byte last.

2.1 Basic Electrical Parameter Query

Basic Electrical Parameter Query (03 Function Code Reading)				Base Address(1000)		
Offset Address	**Data Item**	**R/W**	**Range**	**Data Types**	**Byte Length**	**Unit/ Description**
0	Phase A voltage	R	0~65535	word	2	0.1V
1	Phase B voltage	R	0~65535	word	2	0.1V
2	Phase C voltage	R	0~65535	word	2	0.1V
3	Residual current	R	0~65535	word	2	mA
4	Phase A current	R	0-999999999	Dword	4	0.1A
6	Phase B current	R	0-999999999	Dword	4	0.1A
8	Phase C current	R	0-999999999	Dword	4	0.1A
10	Phase A current direction	R	0:Grid flows to the user side 1: User side flows to the grid	word	2	
11	Phase B current direction	R	0:Grid flows to the user side 1: User side flows to the grid	word	2	
12	Phase C current direction	R	0:Grid flows to the user side 1: User side flows to the grid	word	2	
13	Switch Status	R	0: Opening 1：Close	word	2	-
14	Total active power Psum	R	-2,147,483,648~2,147,483,648	Long	4	0.01kW

16	Phase A active power P1	R	-2,147,483,648~2,147,483,648	Long	4	0.01kW
18	Phase B active power P2	R	-2,147,483,648~2,147,483,648	Long	4	0.01kW
20	Phase C active power P3	R	-2,147,483,648~2,147,483,648	long	4	0.01kW
22	Total reactive power Qsum	R	-2,147,483,648~2,147,483,648	long	4	0.01KVar
24	Phase A reactive power Q1	R	-2,147,483,648~2,147,483,648	long	4	0.01KVar
26	Phase B reactive power Q2	R	-2,147,483,648~2,147,483,648	long	4	0.01KVar
28	Phase C reactive power Q3	R	-2,147,483,648~2,147,483,648	long	4	0.01KVar
30	Total apparent power Ssum	R	0~4,294,967,296	word	4	0.01KVA
32	Phase A apparent power S1	R	0~4,294,967,296	word	4	0.01KVA
34	Phase B apparent power S2	R	0~4,294,967,296	word	4	0.01KVA
36	Phase C apparent power S3	R	0~4,294,967,296	word	4	0.01KVA
38	Total power factor PF	R	-1000~1000	interger	2	0.01
39	Phase A power factor PF1	R	-1000~1000	interger	2	0.01
40	Phase B power factor PF2	R	-1000~1000	interger	2	0.01
41	Phase C power factor PF3	R	-1000~1000	interger	2	0.01
42	Phase A grid frequency	R	4500~6500	word	2	0.01Hz
43	Phase B grid frequency	R	4500~6500	word	2	0.01Hz
44	Phase C grid frequency	R	4500~6500	word	2	0.01Hz

45	Voltage asymmetry	R	2-100	word	2	0.01%
46	Current asymmetry	R	2-100	word	2	0.01%
47	Running status (reserved)	R	/	interger	2	
48	Front-end phase A temperature	R	0-150	word	2	0.01℃
49	Front-end phase B temperature	R	0-150	word	2	0.01℃
50	Front-end phase C temperature	R	0-150	word	2	0.01℃
51	Front-end phase N temperature	R	0-150	word	2	0.01℃
52	Switch Status	R	0-1	word	2	1: ON 0: OFF
53	Running status word	R			4	
55	Rear end phase A voltage	R	0~65535	word	2	0.01V
56	Rear end phase B voltage	R	0~65535	word	2	0.01V
57	Rear end phase C voltage	R	0~65535	word	2	0.01V
58	Rear end voltage frequency	R	4500~6500	word	2	0.01Hz
59	Total forward active energy	R	0~4,294,967,296	Dword	4	0.01Kw/h
61	Phase A forward active energy	R	0-999999999	Dword	4	0.01Kw/h
63	Phase B forward active energy	R	0-999999999	Dword	4	0.01Kw/h
65	Phase C forward active energy	R	0-999999999	Dword	4	0.01Kw/h
67	Total reverse active energy	R	0-999999999	Dword	4	0.01Kw/h
69	Phase A reverse active energy	R	0-999999999	Dword	4	0.01Kw/h
71	Phase B reverse active energy	R	0-999999999	Dword	4	0.01Kw/h
73	Phase C reverse active energy	R	0-999999999	Dword	4	0.01Kw/h
75	Rear end phase A temperature	R	0-150	word	2	0.01℃

76	Rear end phase B temperature	R	0-150	word	2	0.01℃
77	Rear end phase C temperature	R	0-150	word	2	0.01℃
78	Rear end phase N temperature	R	0-150	word	2	0.01℃
100	Modbus protocol version	R	0-9999	word	2	
101	Frame current	R	125/250/400/630/800/0000	Word	2	

3 Register List: Basic Parameter

3.1 Basic Parameter Settings/Query

Basic Parameter Settings/Query (03,06,10 Function Code)					**Base Address(2000)**		
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Default Value**	**Byte Length**	**Unit/ Description**
0	Power outage/ voltage loss value	R/W	20.0-100.0	word	30	2	0.1V
1	Power outage/ voltage loss delay	R/W	0-9999	word	0	2	S
2	Overvoltage value	R/W	231.0-330.0	word	265	2	0.1V
3	Overvoltage delay	R/W	1-9999	word	3	2	S
4	Undervoltage value	R/W	88.0-209.0	word	165	2	0.1V
5	Undervoltage delay	R/W	1-9999	word	3	2	S
6	Phase loss voltage	R/W	10-100.0	word	30	2	0.1V

7	Phase loss delay	R/W	1-9999	word	1	2	S
8	Recovery closing delay	R/W	0-200	word	5	2	S
12	Overload Ir1 current level	R/W	Ir1 current setting gear	word	0 gear	2	0.1A
13	Overload Ir1 delay	R/W	3-18	word	6	2	S
14	Short circuit Ir2 multiple gear	R/W	2-10	word	6	2	Times
15	Short circuit Ir2 delay gear	R/W	1-10	word	4	2	ms
16	Instantaneous Ir3 multiple gear	R/W	2-12	word	10	2	Times
17	Device time-year	R/W	19-99	word	Real time value	2	
18	Device time-month	R/W	1-12	word	Real time value	2	
19	Device time-day	R/W	1-31	word	Real time value	2	
20	Device time-hour	R/W	0-23	word	Real time value	2	
21	Device time-minute	R/W	0-59	word	Real time value	2	

22	Device time-second	R/W	0-59	word	Real time value	2	
23	Time control 1 hour-minute	R/W	High Byte:00~23	word	Real time value	2	Valid in time control mode
24	Time control 2 hour-minute	R/W	Low Byte:00~59	word	Real time value	2	Valid in time control mode
25	Fee control effective time	R/W	0-50-0	word	5	2	Second (valid for pulse control signal)
26	Voltage imbalance delay	R/W	2-100	word	5	2	Second
27	Current imbalance delay	R/W	2-100	word	5	2	Second
28	Voltage imbalance	R/W	20-100	word	30	2	%
29	Current imbalance	R/W	20-100	word	30	2	%
30	Active reporting time	R/W	10-1000	word	300	2	S
31	Overfrequency threshold	R/W	1-50	word	20	2	0.1Hz
32	Overfrequency delay	R/W	0-9	word	5	2	S
33	Underfrequency threshold	R/W	1-50	word	20	2	0.1Hz
34	Underfrequency delay	R/W	0-9	word	5	2	S

35	Temperature action value	R/W	50-120	word	80	2	℃
36	Temperature delay	R/W	1-9999	word	5	2	s
37	The maximum voltage allowed for closing the rear end	R/W	0-6000	word	3000	2	0.01V
199	Overload alarm reset	R	0-1	word	0	2	Reset the overload alarm after writing 1

4 Register List: Control

4.1 Command Software Control

Software Remote Control (05 Function Code Reading)					**Base Address (0000)**	
Offset Address	**Data Item**		**Range**	**Data Type**	**Byte Length**	**Unit/ Description**
1	Software closing	W	0~0XFFFF	WORD	1	Write 0xFF00
2	Software opening	W	0~0XFFFF	WORD	1	Write 0xFF00

4.2 Remote Control/Query

Remote Control/Query (03, 06, 10 Function Code)						**Base Address(4500)**	
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Default Value**	**Byte Length**	**Unit/ Description**
0	Scheduled opening time unit	R/W	2: minute 3: hour	word	0	2	Write operations trigger re-timing

1	Scheduled opening time	R/W	0-99	word	0	2	Write operations trigger re-timing
2	Scheduled opening timing	R	-1~2147483648	Long	-1	4	S (The countdown reaches 0 to perform the operation, and it changes to -1 after the operation is completed)
4	Scheduled closing time unit	R/W	2: minute 3: hour	word	0	2	Write operations trigger re-timing
5	Scheduled closing time	R/W	0-99	word	0	2	Write operations trigger re-timing
6	Scheduled closing timing	R	-1~2147483648	Long	-1	4	S (The countdown reaches 0 to perform the operation, and it changes to -1 after the operation is completed)
8	Scheduled mode unit	R/W	2: minute 3: hour	word	0	2	Write operations trigger re-timing

9	Scheduled mode time	R/W	0-99	word	0	2	Write operations trigger re-timing
10	Scheduled mode timing	R/W	-1~2147483648	word	-1	4	S (The countdown reaches 0 to perform the operation, and it changes to -1 after the operation is completed)
12	Scheduled self-test unit	R/W	2: minute 3: hour	word	0	2	Write operations trigger re-timing
13	Scheduled self-test time	R/W	0-99	word	0	2	Write operations trigger re-timing
14	Scheduled self-test timing	R/W	-1~2147483648	word	-1	4	S (The countdown reaches 0 to perform the operation, and it changes to -1 after the operation is completed)

5 Register List: Energy

5.1 Energy Query

Energy Query (03 Function Code Reading)				Base Address(6000)		
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Byte Length**	**Unit/ Description**
0	Combined total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
2	Tariff 1-Combined total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
4	Tariff 2-Combined total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
6	Tariff 3-Combined total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
8	Tariff 4-Combined total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
10	Total forward active energy Ep-net	R	0-999999999	Dword	4	0.01kWh
12	Tariff 1-Total forward active energy Ep-net	R	0-999999999	Dword	4	0.01kWh
14	Tariff 2-Total forward active energy Ep-net	R	0-999999999	Dword	4	0.01kWh
16	Tariff 3-Total forward active energy Ep-net	R	0-999999999	Dword	4	0.01kWh
18	Tariff 4-Total forward active energy Ep-net	R	0-999999999	Dword	4	0.01kWh
20	Total reverse active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
22	Tariff 1-Total reverse active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
24	Tariff 2-Total reverse active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
26	Tariff 3-Total reverse active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
28	Tariff 4-Total reverse active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
30	Total forward reactive	R	0-999999999	Dword	4	0.01KVarh

	energy (combined 1) Eq-total					
32	Tariff 1-Total forward reactive energy (combined 1) Eq-total	R	0-999999999	Dword	4	0.01KVarh
34	Tariff 2-Total forward reactive energy (combined 1) Eq-total	R	0-999999999	Dword	4	0.01KVarh
36	Tariff 3-Total forward reactive energy (combined 1) Eq-total	R	0-999999999	Dword	4	0.01KVarh
38	Tariff 4-Total forward reactive energy (combined 1) Eq-total	R	0-999999999	Dword	4	0.01KVarh
40	Total reverse reactive energy (combined 1) Eq-total	R	0-999999999	Dword	4	0.01KVarh
42	Tariff 1-Total reverse reactive energy (combined 1) Eq-total	R	0-999999999	Dword	4	0.01KVarh
44	Tariff 2-Total reverse reactive energy (combined 1) Eq-total	R	0-999999999	Dword	4	0.01KVarh
46	Tariff 3-Total reverse reactive energy (combined 1) Eq-total	R	0-99999999	Dword	4	0.01KVarh
48	Tariff 4-Total reverse reactive energy (combined 1) Eq-total	R	0-99999999	Dword	4	0.01KVarh
50	Capacitive release reactive energy Eq-exp	R	0-99999999	Dword	4	0.01KVarh
52	Tariff 1-Capacitive release reactive energy Eq-exp	R	0-99999999	Dword	4	0.01KVarh
54	Tariff 2-Capacitive release reactive energy Eq-exp	R	0-99999999	Dword	4	0.01KVarh
56	Tariff 3-Capacitive release reactive energy Eq-exp	R	0-99999999	Dword	4	0.01KVarh
58	Tariff 4-Capacitive	R	0-999999999	Dword	4	0.01KVarh

	release reactive energy Eq-exp					
92	Phase A total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
94	Tariff 1-Phase A total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
96	Tariff 2-Phase A total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
98	Tariff 3-Phase A total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
100	Tariff 4-Phase A total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
102	Phase A forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
104	Tariff 1-Phase A forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
106	Tariff 2-Phase A forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
108	Tariff 3-Phase A forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
110	Tariff 4-Phase A forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
112	Phase A reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
114	Tariff 1-Phase A reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
116	Tariff 2-Phase A reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
118	Tariff 3-Phase A reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
120	Tariff 4-Phase A reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
122	Phase A combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
124	Tariff 1-Phase A	R	0-999999999	Dword	4	0.01KVarh

	combination 1 reactive energy					
126	Tariff 2-Phase A combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
128	Tariff 3-Phase A combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
130	Tariff 4-Phase A combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
132	Phase A combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
134	Tariff 1-Phase A combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
136	Tariff 2-Phase A combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
138	Tariff 3-Phase A combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
140	Tariff 4-Phase A combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
142	Phase A inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
144	Tariff 1-Phase A inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
146	Tariff 2-Phase A inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
148	Tariff 3-Phase A inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
150	Tariff 4-Phase A inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
152	Phase A capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh

154	Tariff 1-Phase A capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
156	Tariff 2-Phase A capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
158	Tariff 3-Phase A capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
160	Tariff 4-Phase A capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
192	Phase B total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
194	Tariff 1-Phase B total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
196	Tariff 2-Phase B total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
198	Tariff 3-Phase B total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
200	Tariff 4-Phase B total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
202	Phase B forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
204	Tariff 1-Phase B forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
206	Tariff 2-Phase B forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
208	Tariff 3-Phase B forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
210	Tariff 4-Phase B forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
212	Phase B reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
214	Tariff 1-Phase B	R	0-999999999	Dword	4	0.01kWh

	reverse active energy Ep-exp					
216	Tariff 2-Phase B reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
218	Tariff 3-Phase B reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
220	Tariff 4-Phase B reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
222	Phase B combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
224	Tariff 1-Phase B combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
226	Tariff 2-Phase B combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
228	Tariff 3-Phase B combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
230	Tariff 4-Phase B combination 1 reactive energy	R	0-999999999	Dword	4	0.01KVarh
232	Phase B combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
234	Tariff 1-Phase B combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
236	Tariff 2-Phase B combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
238	Tariff 3-Phase B combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
240	Tariff 4-Phase B combination 2 reactive energy	R	0-999999999	Dword	4	0.01KVarh
242	Phase B inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
244	Tariff 1-Phase B	R	0-999999999	Dword	4	0.01KVarh

	inductive reactive energy Eq-imp					
246	Tariff 2-Phase B inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
248	Tariff 3-Phase B inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
250	Tariff 4-Phase B inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01KVarh
252	Phase B capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
254	Tariff 1-Phase B capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
256	Tariff 2-Phase B capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
258	Tariff 3-Phase B capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
260	Tariff 4-Phase B capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01KVarh
292	Phase B total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
294	Tariff 1-Phase C total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
296	Tariff 2-Phase C total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
298	Tariff 3-Phase C total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
300	Tariff 4-Phase C total active energy Ep-total	R	0-999999999	Dword	4	0.01kWh
302	Phase C forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh

304	Tariff 1-Phase C forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
306	Tariff 2-Phase C forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
308	Tariff 3-Phase C forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
310	Tariff 4-Phase C forward active energy Ep-imp	R	0-999999999	Dword	4	0.01kWh
312	Phase C reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
314	Tariff 1-Phase C reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
316	Tariff 2-Phase C reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
318	Tariff 3-Phase C reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
320	Tariff 4-Phase C reverse active energy Ep-exp	R	0-999999999	Dword	4	0.01kWh
322	Phase C combination 1 reactive energy Ep-total	R	0-999999999	Dword	4	0.01kWh
324	Tariff 1-Phase C combination 1 reactive energy Ep-total	R	0-999999999	Dword	4	0.01kWh
326	Tariff 2-Phase C combination 1 reactive energy Ep-total	R	0-999999999	Dword	4	0.01kWh
328	Tariff 3-Phase C combination 1 reactive energy Ep-total	R	0-999999999	Dword	4	0.01kWh
330	Tariff 4-Phase C combination 1 reactive energy Ep-total	R	0-999999999	Dword	4	0.01kWh
332	Phase C combination 2 reactive energy	R	0-999999999	Dword	4	0.01kWh

	Eq-net					
334	Tariff 1-Phase C combination 2 reactive energy Eq-net	R	0-999999999	Dword	4	0.01kWh
336	Tariff 2-Phase C combination 2 reactive energy Eq-net	R	0-999999999	Dword	4	0.01kWh
338	Tariff 3-Phase C combination 2 reactive energy Eq-net	R	0-999999999	Dword	4	0.01kWh
340	Tariff 4-Phase C combination 2 reactive energy Eq-net	R	0-999999999	Dword	4	0.01kWh
342	Phase C inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01kWh
344	Tariff 1-Phase C inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01kWh
346	Tariff 2-Phase C inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01kWh
348	Tariff 3-Phase C inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01kWh
350	Tariff 4-Phase C inductive reactive energy Eq-imp	R	0-999999999	Dword	4	0.01kWh
352	Phase C capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01kWh
354	Tariff 1-Phase C capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01kWh
356	Tariff 2-Phase C capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01kWh
358	Tariff 3-Phase C capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01kWh

360	Tariff 4-Phase C capacitive release reactive energy Eq-exp	R	0-999999999	Dword	4	0.01kWh

5.2 Hourly Frozen Energy Query

Hourly Frozen Energy Query (03 Function Code Reading)				**Base Address(7000)**		
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Byte Length**	**Unit/ Description**
0	Hourly frozene time (year, month) (last time)	R		Word	2	
1	Hourly frozen time (day, hour) (last time)	R		Word	2	
2	Hourly frozen time (minutes, seconds) (last)	R		Word	2	
3	Hourly frozen total forward active energy	R	0~4294967295	Dword	4	0.01KVW/h
5	Hourly frozen total reverse active energy	R	0~4294967295	Dword	4	0.01KVW/h

6 Register List: Protection

6.1 Function Selection Settings/Query

Function Selection Settings/Query (03,06,10 Function code)					Base Address(3000)		
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Default Value**	**Byte Length**	**Unit/ Description**
0	Overvoltage protection	R/W	0~2	word	0	2	0: OFF 1: Alarm 2: Trip
1	Undervoltage protection	R/W	0~2	word	0	2	0: OFF 1: Alarm 2: Trip
2	Phase loss protection	R/W	0~2	word	0	2	0: OFF 1: Alarm 2: Trip
3	Power failure protection	R/W	0~1	word	0	2	0: OFF 1: Trip
4	Neutral loss protection	R/W	0~3	word	0	2	0: OFF 1: Alarm 2: Trip
7	Overload protection	R/W	0~3	word	2	2	0: OFF 1: Alarm 2: Trip

8	Short circuit protection	R/W	0~3	word	2	2	0: OFF 1: Alarm 2: Trip
9	Instantaneous protection	R/W	0~3	word	2	2	0: OFF 1: Alarm 2: Trip
10	Voltage imbalance protection	R/W	0~3	word	0	2	0: OFF 1: Alarm 2: Trip
11	Current imbalance protection	R/W	0~3	word	0	2	0: OFF 1: Alarm 2: Trip
12	Remote control allowed	R/W	0-1	word	1	2	0: Prohibited 1: Allowed
13	Working mode	R/W	0-2	word	0	2	0: Normal mode 1: Time control mode 2: Fee control mode
14	Gear return	R/W	0-1	word	1	2	0: Prohibited 1: Allowed

15	Alarm allowed	R/W	0-1	word	1	2	0: Prohibited 1: Allowed
16	Automatic reclosing allowed	R/W	0-1	word	1	2	0: Prohibited 1: Allowed
17	Timed trial trip	R/W	0-1	word	1	2	0: Prohibited 1: Allowed
18							Null
19	Overfrequency function	R/W	0~3	word	0	0	0: OFF 1: Alarm 2: Trip
20	Underfrequency function	R/W	0~3	word	0	0	0: OFF 1: Alarm 2: Trip
21	Island function	R/W	0~3	word	0	0	0: OFF 1: Alarm 2: Trip
22	Current harmonic protection	R/W	0~3	word	0	0	0: OFF 1: Alarm 2: Trip

23	Temperature protection	R/W	0~3	word	0	0	0: OFF 1: Alarm 2: Trip
500-519	Device serial number	R/W		word			

7 Register List: Record Query

7.1 Cumulative Record Query

Cumulative Record Query (03 Function Code Reading)					**Base Address(5000)**	
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Byte Length**	**Unit/ Description**
0	Total data clearing times	R	0~4294967295	Dword	4	Times
2	Total trip times	R	0~65535	word	2	Times
3	Residual current locking trip	R	0~65535	word	2	Times
4						
5	Overload protection trip times	R	0~65535	word	2	Times
6	Overvoltage protection trip times	R	0~65535	word	2	Times
7	Manual trip times	R	0~65535	word	2	Times
8	Neutral loss protection trip times	R	0~65535	word	2	Times
9	Trial trip times (remote, button)	R	0~65535	word	2	Times
10	Short circuit short delay trip	R	0~65535	word	2	Times
11	Short circuit instantaneous trip times	R	0~65535	word	2	Times
12	Undervoltage protection trip times	R	0~65535	word	2	Times
13	Phase loss protection trip times	R	0~65535	word	2	Times

14	Total running time	R	0~4294967295	Dword	4	Minutes

7.2 Event Record Query

Event Record Query (03,06 Function Code Coordination Query)				**Base Address(4000)**		
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Byte Length**	**Unit/ Description**
0	Total number of events	R	0~100	word	2	Times/Including closing, opening, abnormal and other events
1	Query index	R/W	1~100	word	2	Times/Query a record write register. New records are automatically updated.
2	Event type	R	0~65535	word	2	Please refer to the event type analysis table
3	Event-year	R	0~65535	word	2	Times
4	Event-month	R	0~65535	word	2	Times
5	Event-day	R	0~65535	word	2	Times
6	Event-hour	R	0~65535	word	2	Times
7	Event-minute	R	0~65535	word	2	Times
8	Event-seconds	R	0~65535	word	2	Times
9	Event phase information	R	0~65535	word	2	Bit0: Phase A
						Bit1: Phase B
						Bit2: Phase C
						Bit3: Phase N
						Bit4: Voltage
						Bit5: Current
						Bit6: Leakage
						Bit7: Temperature

10	Event voltage A	R	0~65535	word	2	0.1V
11	Event voltage B	R	0~65535	word	2	0.1V
12	Event voltage C	R	0~65535	word	2	0.1V
13	Event current A	R	0~4294967295	Dword	4	0.1A
15	Event current B	R	0~4294967295	Dword	4	0.1A
17	Event current C	R	0~4294967295	Dword	4	0.1A
19	Event leakage	R	0-65535	Word	2	mA

7.3 Event Type Analysis

Event Type Analysis Table		
Event Value	**Event Name**	**Description**
0	"Closing standby"	
1	"Overvoltage trip"	
2	"Undervoltage trip"	
3	"Phase loss trip"	
4	"Power off and trip"	
5		
6		
7		
8	"Neutral loss trip"	
9	"Communication lock"	
10	"Communication closing"	
11	"Remote lock"	
12	"Remote closing"	
13	"Automatic closing"	
14	"Manual closing"	
15	"Button closing"	
16	"Button lock"	

17	"Mechanical lock"	
18	"Timed trial trip"	
19	"Overload lock"	
20	"Short circuit lock"	
21	"Instantaneous lock"	
22	"Failed to close"	
23	"Failed to open"	
24	"Communication trial trip"	
25	"System power off"	
26	"System power on"	
27	"Time-controlled closing"	
28	"Time-controlled opening"	
29	"Voltage imbalance"	
30	"Current imbalance"	
31	"Arrears lock"	
32	"High temperature lock"	
33		
34	"Phase sequence error"	
35	"Underfrequency protection"	
36	"Over frequency protection"	

8 Register List: Harmonics

8.1 Harmonic Content Data

Harmonic Content Data (03 Function Code Reading)					**Base Address(10000)**	
Offset Address	**Data Item**	**R/W**	**Range**	**Data Type**	**Byte Length**	**Unit/ Description**
0	Total harmonic content of phase A voltage	R	0~9999	word	2	0.01%

1~21	The 1st to 21st harmonic content of phase A voltage	R	0~9999	word	2	0.01%
100	Total harmonic content of phase B voltage	R	0~9999	word	2	0.01%
101~121	The 1st to 21st harmonic content of phase B voltage	R	0~9999	word	2	0.01%
200	Total harmonic content of phase C voltage	R	0~9999	word	2	0.01%
201~221	The 1st to 21st harmonic content of phase C voltage	R	0~9999	word	2	0.01%
300	Total harmonic content of phase A current	R	0~9999	word	2	0.01%
301~321	The 1st to 21st harmonic content of phase A current	R	0~9999	word	2	0.01%
400	Total harmonic content of phase B current	R	0~9999	word	2	0.01%
401~421	The 1st to 21st harmonic content of phase B current	R	0~9999	word	2	0.01%
500	Total harmonic content of phase C current	R	0~9999	word	2	0.01%
501~521	The 1st to 21st harmonic content of phase C current	R	0~9999	word	2	0.01%

9 Revision History

Version	Description	Date	Revised by
v1.003	Firs edition	2024/11/13	