FT100 Electromagnetic heat meter converter communication protocol

version number: *HMODRTUV77*
FT100 V1.2

2017.3.25

Note: The routines in the application examples of this protocol are only for reference. Some parameters in the routines do not match the definition of the MODBUS register address. Please refer to the definition of the MODBUS register address.

Ⅰ. Overview

FT100 electromagnetic heat meter has a standard MODBUS communication interface, supporting baud rates 1200, 2400, 4800, 9600, 19200. through the MODBUS communication network, the master can collect nstantaneous flow, instantaneous flow rate, cumulative flow and other parameters.

FT100 electromagnetic heat meter using serial parameters: 1 bit start, 8 bits data, 1 bit stop, no checksum.

FT100 electromagnetic heat meter MODBUS communication interface in the physical structure of the electrical isolation method, isolation voltage 1500 volts, and has ESD protection, can overcome a variety of industrial site interference, to ensure the reliable operation of the communication network.

Ⅱ. FT100 network structure and wiring

The standard MODBUS communication network of FT100 electromagnetic heat meter is a bus-type network structure, which supports 1 to 99 electromagnetic flowmeter networking. The electromagnetic flowmeter farthest in the network usually needs to be connected in parallel with a 120 ohm terminal matching resistor at both ends of the communication line. The standard The

communication connection medium is shielded twisted pair.

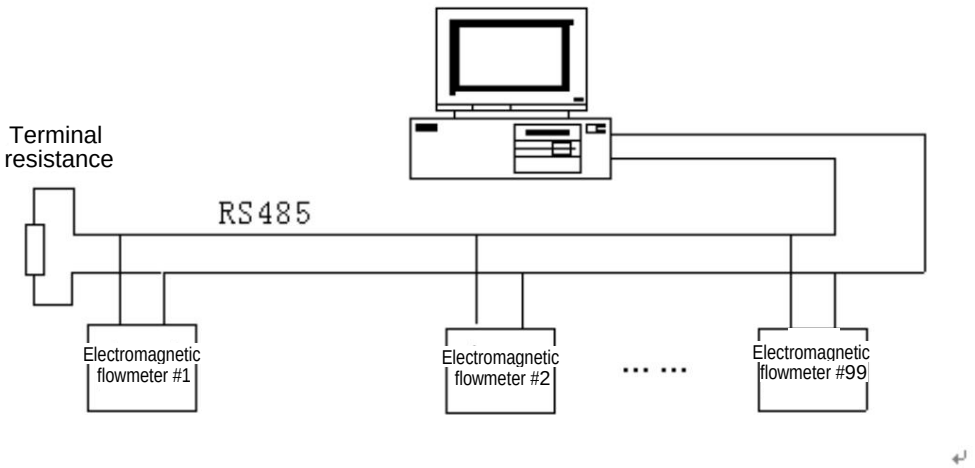


Figure-1 Electromagnetic flowmeter network structure

For the communication wiring of FT100 electromagnetic heat meter, please refer to the instruction manual of electromagnetic flowmeter.

Ⅲ. Modbus protocol RTU frame format

The MODBUS protocol is a master-slave communication method. Each communication is initiated by the master station, and the slave station responds to the master station's command to return data.

FT100 electromagnetic heat meter adopts MODBUS RTU format (hexadecimal format), and its frame structure is shown in Figure-2.

1. Master station command frame structure

Frame start	Device address	Function code	Register address	Register length	CRC check	Frame end
T1-T2-T3-T4	8Bit	8Bit	16Bit	16Bit	16Bit	T1-T2-T3-T4

Figure-2 Master station RTU message frame

2. Slave response frame structure

Frame start	Device address	Function code	Data	CRC check	Frame end
T1-T2-T3-T4	8Bit	8Bit	n 8Bit	16Bit	T1-T2-T3-T4

Figure 3 Slave station RTU message frame

Note:

(1) T1-T2-T3-T4 is frame start or frame end, MODBUS protocol stipulates frame start or frame end It is realized by delaying 3.5 char characters between frames, as shown in Figure-4.

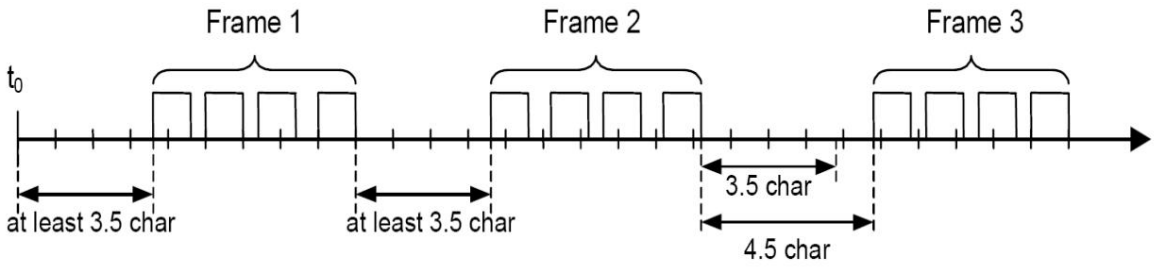


Figure-4 MODBUS frame interval

(2) Device address: The communication address of the electromagnetic flowmeter, there cannot be two identical addresses in a network.

(3) Function code: The function code stipulated in the MODBUS protocol. L-MAG-H electromagnetic heat meter uses function code 4 to read the input register to realize data collection.

(4) Register address and register number

The parameter in the command of the master is the register starting from the address of the register, and the N registers of the length of the read register memory.

(5) Response data from the slave station

The slave station response data is: byte number and N number of byte data.

See MODBUS protocol for details.

Ⅳ. Modbus protocol command code definition

The definition of MODBUS function codes is shown in Table-1, and the FT100-electromagnetic flowmeter only uses the 04 function code.

Table 1

Function code	Name	Effect
01	Read coil status	reserve
02	Read input status	reserve
03	Read holding register	reserve
04	Read input register	Read the real-time information of the electromagnetic heat meter
05	Forced single coil	reserve
06	Preset single register	reserve
07	Read abnormal status	reserve
08	Return diagnostic check	reserve
09	Programming (for 484 only)	reserve
10	control query (only for 484)	reserve
11	Read event count	reserve
12	Read communication event records	reserve
13	Programming (184/384 484 584)	reserve
14	Inquiry (184/384 484 584)	reserve
15	Forced multi-coil	reserve

Ⅴ. FT100 electromagnetic heat meter MODBUS register definition

1. FT100 electromagnetic heat meter **MODBUS** register address definition table-2

Protocol Addresses (Decimal)	Protocol Addresses (HEX)	Data Format	register definition
4112	0x1010	Float Inverse	Instantaneous flow floating point representation (M3/h)
4114	0x1012	Float Inverse	Floating point representation of instantaneous flow rate
4116	0x1014	Float Inverse	reserve
4118	0x1016	Float Inverse	Fluid conductance ratio floating point representation
4120	0x1018	Long Inverse	Flow accumulation value integer part
4122	0x101A	Unsigned short	Decimal part of flow accumulation value
4124	0x101C	Unsigned short	cooling unit 0: indicates MJ/h; 1: indicates GJ/h 2: indicates KWh/h; 3 indicates MWh/h total
4125	0x101D	Unsigned short	cooling capacity unit 0: indicates MJ; 1: indicates GJ 2: indicates KWh; 3 indicates MWh
4128	0x1020	Unsigned short	instantaneous heat unit 0: indicates MJ/h; 1: indicates GJ/h 2: indicates KWh/h; 3 indicates MWh/h
4129	0x1021	Unsigned short	flow cumulative total unit (m3)
4130	0x1022	Unsigned short	Pressure range 0：Indicates 0.6MPa 1：Indicates 1.6MPa
4131	0x1023	Unsigned short	Total unit of heat 0: denotes MJ; 1: denotes GJ 2: denotes KWh; 3 denotes MWh
4132	0x1024	Unsigned short	Empty pipe alarm 0: normal; 1: alarm
4133	0x1025	Unsigned short	system alarm 0: normal; 1: alarm
4134	0x1026	Float Inverse	instantaneous heat flow
4136	0x1028	Long Inverse	total cumulative value
4138	0x102A	Float Inverse	heat total cumulative decimal value
4140	0x102C	Unsigned short	Inlet temperature (°C)
4141	0x102D	Unsigned short	Outlet temperature (°C)
4142	0x102E	Long Inverse	Total cumulative cooling capacity
4144	0x1030	Float Inverse	Cooling Capacity Total Cumulative Decimal Value Instantaneous
4146	0x1032	Float Inverse	Cooling Capacity

2. PLC address setting instructions

If there is no function code setting item in PLC setting, 3 should be added in front of the register address when using function 04. In addition, the base address of the PLC register address starts from 1, so the PLC should add 1 to the original address when setting the register address.

Example: The FT100 electromagnetic heat meter MODBUS register address is 4112 (0x1010), and the PLC register address is 34113 when the MODBUS function code is 4.

See the application examples section for detailed settings 2.

3. Description of data meaning

(1) Floating point format:

FT100 electromagnetic heat meter **MODBUS** adopts IEEE754 32-bit floating-point number format, and its structure is as follows Below: (taking instantaneous flow as an example)

0X1010 (34113)		0x1011 (34114)	
BYTE1	**BYTE2**	**BYTE3**	**BYTE4**
S EEEEEEE	**E MMMMMMM**	**MMMMMMMM**	**MMMMMMMM**

S—sign of the mantissa; 1=negative number, 0=positive number;

E—exponent; expressed as the difference with the decimal number 127.

M - mantissa; lower 23 bits, fractional part.

When E is not all "0", and not all "1" when the floating point number and decimal number conversion formula.

$$V = (-1)^S 2^{(E-127)}(1+M)$$

(2) Cumulative total units:

table 3

code	0	1	2	3
accumulation unit	reserved	M3	reserved	reserved

(3) Alarm

Empty traffic control alarm, system alarm means:

0----no alarm; 1----alarm

VI. Communication data analysis

Instantaneous flow, instantaneous flow velocity, flow percentage, fluid conductance ratio, positive and negative cumulative fractional parts Format transfer of floating point numbers. The integer part of the forward and reverse cumulants is transmitted as a long integer.

1 read instantaneous flow

Command sent by the master station (hexadecimal)

01	04	10	10	00	02	74	CE
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives the data:

01	04	04	C4	1C	60	00	2F	72
equipment address	Function code	data length	**4** byte float (instantaneous flow)				**CRC** high position	**CRC** low

Float C4 1C 60 00

1100 0100 0001 1100 0110 0000 0000 0000

Float byte 1 Float byte 2 Float byte 3 Float byte 4

S=1: The mantissa symbol is 1, which means it is a negative number.

E = 10001000: exponent is 136

M= 001 1100 0110 0000 0000 0000, the mantissa is

$$V = (-1)^1 2^{(136-127)} (1 + \frac{1}{8} + \frac{1}{16} + \frac{1}{32} + \frac{1}{512} + \frac{1}{1024})$$

$$= -625.5$$

2. Read the instantaneous flow rate:

The master station sends commands:

01	04	10	12	00	02	D5	0E
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives data :

01	04	04	C1	B0	80	00	A6	5F
equipment address	Function code	data	**4** byte float (instantaneous velocity)				**CRC** high position	**CRC** low

The float is: C1 B0 80 00

1100 0001 1011 0000 1111 1000 0000 0000

S = 1

E = 10000011

M = 011 0000 1111 1000 0000 0000

$$V = (-1)^1 2^{(1 \quad 31 \quad 13} (1 + \frac{1}{4} + \frac{1}{8} + \frac{1}{2^{7}})$$

$$= \quad -22.0625$$

3 read cumulative flow

In order to fully express the 9-bit cumulative value of the electromagnetic flowmeter, the integer and decimal of the cumulative flow expressed separately. The integer part uses a long integer variable, and the decimal part uses a floating point number.

Cumulative flow is 1587m3

The master station sends the command to collect the integer value of the accumulated flow:

01	04	10	18	00	02	F5	0C
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives the data:

01	04	04	00	00	70	71	1E	60
equipment address	Function code	data length	**4** byte long integer (integer part of cumulant)				**CRC** high position	**CRC** low

The integer part of the cumulative flow is = 28785

The master station sends a command to collect cumulative flow fractional values

01	04	10	1A	00	02	54	CC
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives the data:

01	04	04	3F	00	00	00	3B	90
equipment address	Function code	data length	**4** byte float (Cumulative decimal part)				**CRC** high position	**CRC** low

Floats are: 3F 00 00 00

0011 1111 0000 0000 0000 0000 0000 0000

S = 0

E = 0111111 126

M = 000 0000 0000 0000 0000 0000

$$V = (-1)^1 2^{(126-127)}$$

$$= 0.5$$

4. Read the total flow unit

The master station sends the 8-byte command to read the instantaneous flow unit:

01	04	10	twenty one	00	01	65	00
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives 7 bytes of data sent back from the slave station:

01	04	02	00	01	78	F0
equipment address	Function code	data length	**2** byte integer (cumulative unit)		**CRC** high position	**CRC** low

According to Table 3, it is found that the flow unit is M3

5. Read alarm status

The master station sends the command to read alarm 8 bytes:

01	04	10	twenty four	00	01	75	01
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives 7 bytes of data sent back from the slave station:

01	04	02	00	01	78	F0
equipment address	Function code	data length	**2** byte integer (Call the police)		**CRC** high position	**CRC** low

A state of 1 means that the empty pipe is in an alarm state.

Other alarms can be deduced by analogy.

6. Read the instantaneous heat unit

The master station sends the command to read alarm 8 bytes:

01	04	10	20	00	01	75	01
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives 7 bytes of data sent back from the slave station:

01	04	02	00	01	78	F0
equipment address	Function code	data length	**2** byte integer (instantaneous heat unit)		**CRC** high position	**CRC** low

1 means GJ/h. 0 means MJ/h

7. Read cumulative heat units

The master station sends the command to read alarm 8 bytes:

01	04	10	twenty three	00	01	75	01
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives 7 bytes of data sent back from the slave station:

01	04	02	00	01	78	F0
equipment address	Function code	data length	**2** byte integer (cumulative heat unit)		**CRC** high position	**CRC** low

1 means GJ. 0 means MJ.

7. Read pressure range

The master station sends the command to read alarm 8 bytes:

01	04	10	22	00	01	75	01
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives 7 bytes of data sent back from the slave station:

01	04	02	00	01	78	F0
equipment address	Function code	data length	**2** byte integer (pressure range)		**CRC** high position	**CRC** low

1 means 1.6MPa. 0 means 0.6MPa.

8. Read heat flow (same as reading instantaneous flow)

9. Reading heat accumulation (same as reading cumulative flow)

10. Read inlet temperature

The master station sends the command to read alarm 8 bytes:

01	04	10	23	00	01	75	01
equipment address	Function code	register address high	register address high	register length high	register low length	**CRC** high position	**CRC** low

The master station receives 7 bytes of data sent back from the slave station:

01	04	02	03	20	78	F0
equipment address	Function code	data length	**2** byte integer (inlet temperature)		**CRC** high position	**CRC** low

Temperature with 1 decimal

place. Inlet temperature = 80.0°C

10. Read outlet temperature (same as read inlet temperature)

VII.Application example

1. C language **MODBUS** sample program

(1).CRC16 algorithm:

```
INT16U CRC16(INT8U *puchMsg, INT16U usDataLen)
{
    INT8U uchCRCHi = 0xFF;                          /* High CRC byte initialization */ /
    INT8U uchCRCLo = 0xFF;                          * Low CRC byte initialization */
    INT8U uIndex;                                   /* index in CRC loop */ /* transmit
    while (usDataLen--) {                           message buffer */

        uIndex = uchCRCHi ^ *puchMsg++; /* calculate CRC */
        uchCRCHi = uchCRCLo ^ auchCRCHi[uIndex];
        uchCRCLo = auchCRCLo[uIndex];

    } return (uchCRCHi << 8 | uchCRCLo);
}
```

(2) Send command program

This routine uses Mag64

as the core CPU void Read_InPut(INT8U Addr,INT16U Start,INT16U Len)

```
{
    INT16UCRC;
    SendBuffer_485[0]=Addr;                         //device address//
    SendBuffer_485[1]=0x04;                         modbus function code
    SendBuffer_485[2]=Start/256;                    //Start is the register address
    SendBuffer_485[3]=Start%256;
    SendBuffer_485[4]=Len/256;                      //Len is the length of the read register
    SendBuffer_485[5]=Len%256;
    CRC=CRC16(SendBuffer_485,6);
    SendBuffer_485[6]=CRC/256;                      //CRC check high bit
    SendBuffer_485[7]=CRC%256;                      //CRC check low bit//
    R485_OUT;                                       Enable RS485 transmission
    SendLen_485=8;
    SendNum_485=0;
    CloseINT0();                                    //Close the serial port receiving interrupt//Open
    UCSR0B |= BIT(UDRIE0);                          the serial port sending interrupt
}
```

(3) Analysis of returned data (take instantaneous traffic as an example only)

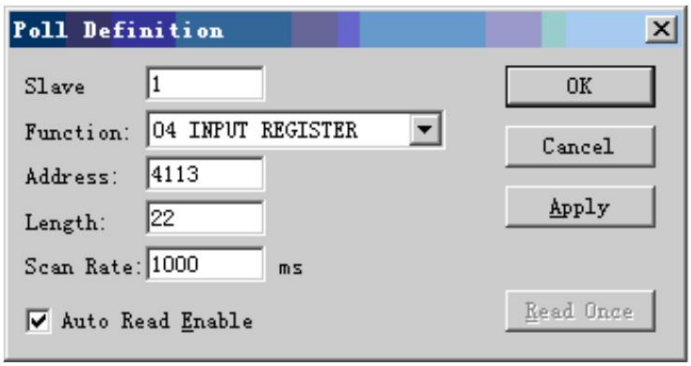
Serial port interrupt is used for data reception, ReceivedBuffer_485 is the received data group, ReceivedNum_485 is the length of received data, and ReceivedFlag_485 is the received data flag. The function float Datasum(INT8U BYTE1, INT8U BYTE2, INT8U BYTE3, INT8U BYTE4) converts 4 bytes of floating-point number into 1 floating-point number. float Datasum(INT8U FloatByte1, INT8U FloatByte2, INT8U FloatByte3, INT8U FloatByte4)

```
{
 float aa;
 union IntTOFP
     {
         FP32          F32;
         INT8U         T8[4];
     };
     union IntTOFP aa;
   aa.T8[0] = FloatByte1;
   aa.T8[1] = FloatByte2;
   aa.T8[2] = FloatByte3;
   aa.T8[3] = FloatByte4;
 return aa;
}
void Read_Lmag(INT8U Ad)
{
     INT8U i,j;
     INT8U Num1[10],BIT;
     INT16UCRC1,CRC2;
     FP32 Flow;                                          //aaa is the instantaneous flow value
     ReceivedFlag_485=1;
     Open_Time1_Ms5(20);
     Read_InPut(Ad,0x1010,2);                            //Send device address, register address, register length
     while(ReceivedFlag_485);                            //wait  for the end of receiving
     if((ReceivedNum_485==9)&&(ReceivedBuffer_485[0]==Ad)) {          //judging whether the data is correct

         CRC1=CRC16(ReceivedBuffer_485,7);
         CRC2=ReceivedBuffer_485[7]*256+ReceivedBuffer_485[8];
         if(CRC1==CRC2)
         {// convert data to floating point
           Flow = Datasum(ReceivedBuffer_485[6], ReceivedBuffer_485[5],
                          ReceivedBuffer_485[4], ReceivedBuffer_485[3]);

         }}
}
```

2.Modbus debugging software modbus poll communication example

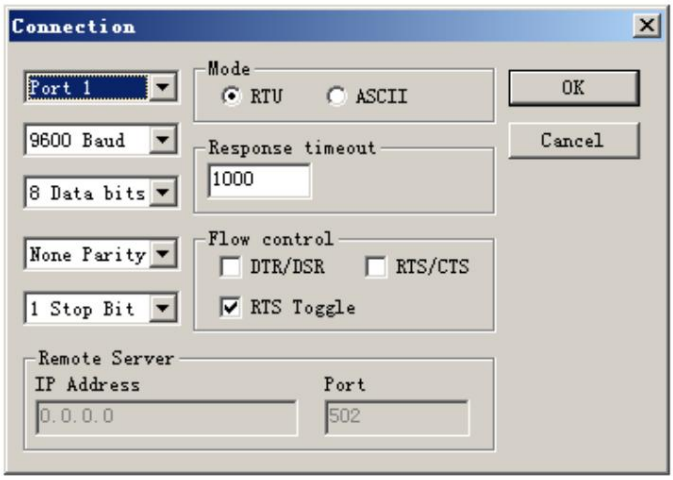
Take the slave station address as 1, baud rate as 9600, and read all real-time data as an example. The setting method is as follows: As shown in Table 2: the starting register address is 4113 and the number of registers is 22.

1. Set the acquisition command to include the device address (1) , MODBUS function code (04), register address (4113), register length (22), collection interval (1000).



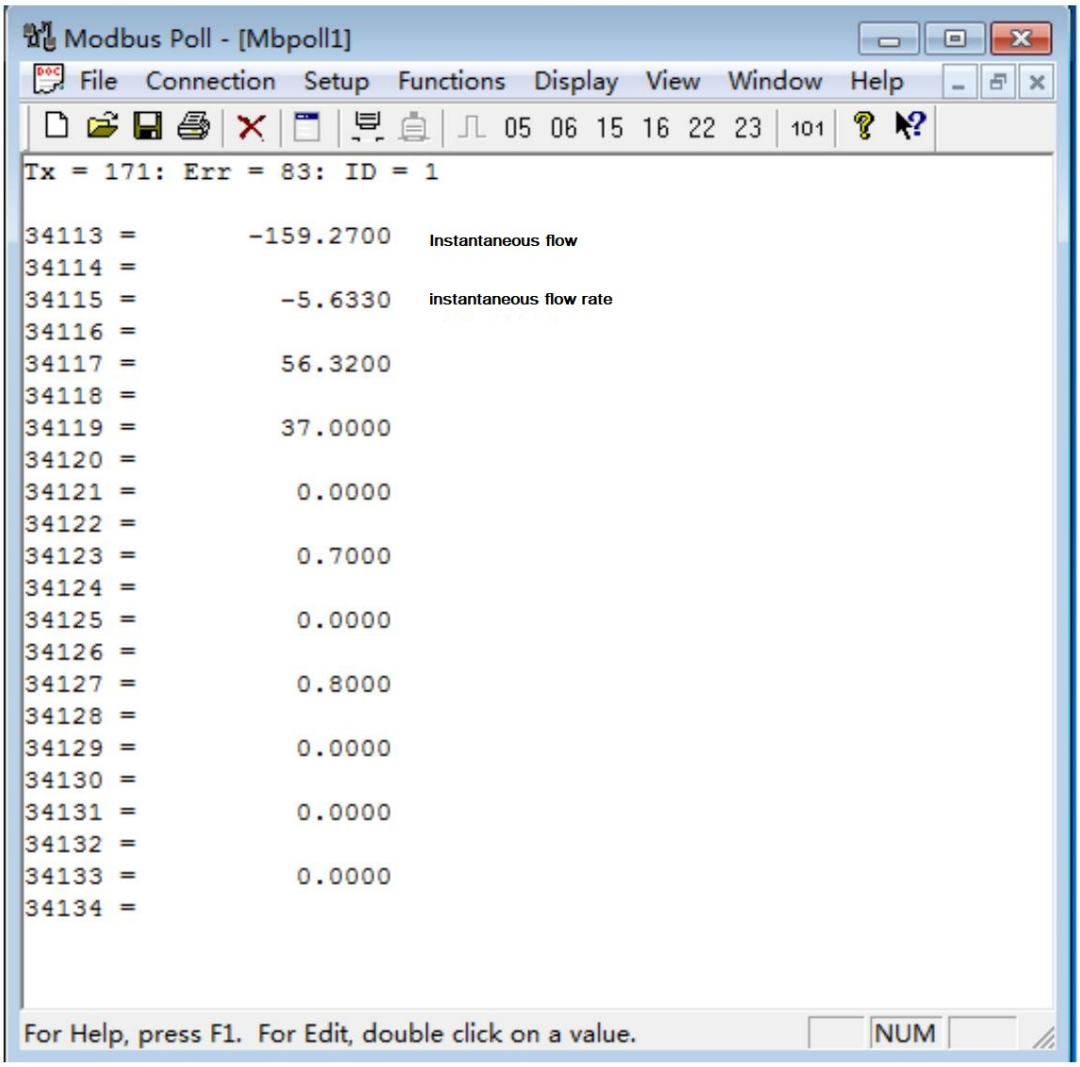
2. Set the serial port data

according to the serial port format of the FT100 electromagnetic heat meter (1 start bit, 8 data bits, 1 stop bit, no parity) and set as shown in the figure below:



3. Set the data display format

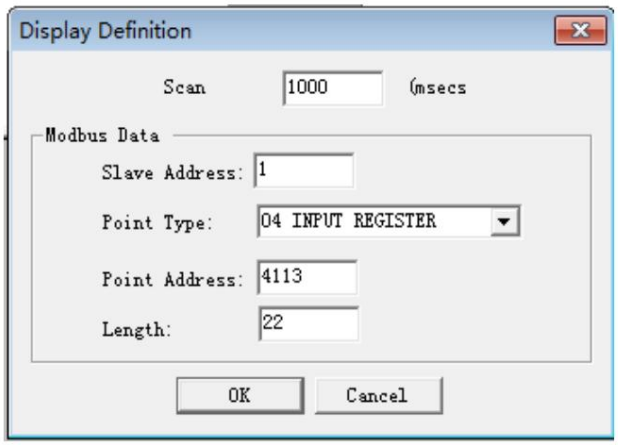
4. Communication success interface



3. Modbus debugging software modscan32 communication exampple

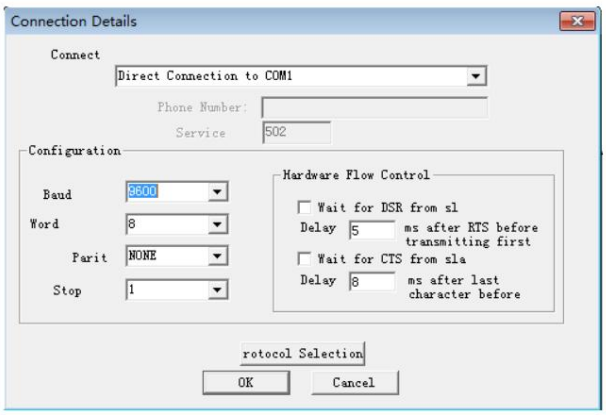
Take the slave station address as 1, baud rate as 9600, and read all real-time data as an example. The setting method is as follows: As shown in Table 2: the starting register address is 4113 and the number of registers is 22.

1. Set the acquisition command to include the device address (1) , MODBUS function code (04), register address (4113), register length (2), and collection interval (1000).

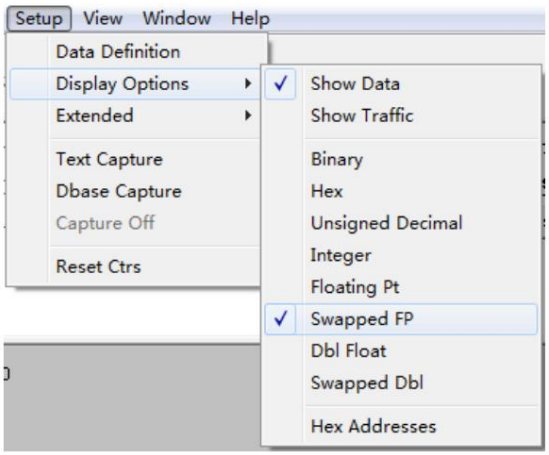


2. Set the serial port data

according to the serial port format of the FT100 electromagnetic heat meter (1 start bit, 8 data bits, 1 stop bit, no parity) and set as shown in the figure below:



3. Set the data display mode



4. Communication success interface