Truflo® — MF-1000

In-Line Magnetic Flow Meter

ICON™ PROCESS CONTROLS Corrosion-Free Instrumentation Equipment™

MODBUS PROTOCOL

Read the user's manual carefully before starting to use the unit.
Producer reserves the right to implement changes without prior notice.

MODBUS Protocol

The MF1000 Magnetic Flow Meter can support the Modus-RTU protocol, and users can customize it according to their needs. When selecting bus control, please select the required protocol in the communication settings. The term "slave" in this document refers to the Magnetic flow meter.

Types and Formats of Communication Data

Information is transmitted asynchronously and in bytes. The communication information transmitted between the master station and the slave station is a 10-bit word format:

Word Format (Serial Data)	10 bit binary
Start bit	1
Data bit	8
Parity bit	None
Stop bit	1

Communication Data (Information Frame) Format				
Data Format	Address Code	Function Code	Data Area	CRC Check
Data Length	1bit	1bit	N bit	16-bit CRC code (redundant cyclic code)

Communication Information Transmission Process

When the communication command is sent from the sending device (master) to the flow meter, the flow meter that matches the corresponding address code receives the communication command, and reads the information according to the function code and related requirements. If the CRC check is correct, execute the corresponding command. task, and then return the execution result (data) to the host. The returned information includes address code, function code, executed data and CRC check code. If the CRC check error does not return any information.

1.1 Address Code

The address code is the first byte (8 bits) of each communication information frame, from 0 to 255. This byte indicates that the slave whose address is set by the user will receive the information sent by the master. Each slave must have a unique address code, and only the slave that matches the address code can respond to the echo message. When the slave sends back information, the returned data starts with its own address code. The address code sent by the master indicates the slave address to send to, and the address code returned by the slave indicates the slave address to send back. The corresponding address code indicates where the information comes from.

1.2 Function Code

It is the second byte transmitted by each communication information frame. The function codes that can be defined in the ModBus communication protocol are 1 to 127, and the smart electromagnetic flowmeter only uses a part of the function codes. Send as a host request, and tell the slave what action to perform through the function code. As a response from the slave, the function code returned by the slave is the same as the function code sent from the master, and indicates that the slave has responded to the master and has performed related operations. At the same time, the device customizes individual commands for special control of the device.

MODBUS Part Function Codes		
Function Code	Definition	Operation (binary)
03	Read Register Data	Read data from one or more registers
10	Write multiple register	Write multiple sets of binary data to multiple registers

1.3 Data Area

The data area includes what information needs to be returned or what action needs to be performed by the slave. These information can be data (such as: instantaneous flow, flow rate, cumulative flow, etc.), reference address, etc. For example, the host tells the slave to return the value of the register (including the start address of the register to be read and the length of the read register) through the function code 03, and the returned data includes the data length and data content of the register. For different slaves, the address and data information are different (communication information table should be given).

The intelligent electromagnetic flowmeter adopts the Modbus communication protocol, and the host (PLC, RTU, PC, DCS, etc.) can read its data registers arbitrarily by using communication commands (see the appendix for the data information table). The variables stored in the data registers of the intelligent electromagnetic flowmeter (such as: instantaneous flow, cumulative flow, etc.) are all 16-bit (2 bytes) binary data, and the high bit is in front; the maximum number of registers (that is, various variables) can be read at one time. The number) is 50; a single variable may be 4 bytes of data, such as positive cumulative flow, you can read the high 2 bytes and low 2 bytes twice.

The command format of the slave machine response is the slave machine address, function code, data area and CRC code. The data in the data area is two bytes, and the high bit comes first.

1.4 Standstill Time Requirements

Before sending data, the data bus static time is required, that is, no data sending time is greater than (50ms when the baud rate is 9600).

1.5 Timeout Requirements

After the host sends the command, set the timeout time should be greater than (200ms when the baud rate is 9600).

2. Introuction to MODBUS Function Codes

2.1 Function Code

“03”: read multiple register input

For example: the master wants to read the data of 3 slave registers whose slave address is 01 and whose variable start address is 000E.

The address and data of the slave data register are:		
Register Address	**Register Data (Hexadecimal)**	**Corresponding Variable**
000E	0180	Variable 1
000F	0180	Variable 2
0010	0180	Variable 3

The message format sent by the host:			
Sent by the host	**Number of bytes**	**Information Sent**	**Remarks**
Slave Address	1	01	Send to slave with address 01
Function Code	1	03	Read register
Start Address	2	000E	The start address is 0x000E
Data Length	2	0003	Read 3 registers (6 bytes in total)
CRC Code	2	6408	The CRC code is calculated by the host

The message format returned by the slave response:			
Slave Response	**Bit**	**Message**	**Remarks**
	No.	Return	
Slave Address	1	01	From slave 01
Function Code	1	03	Read register
Returns the number of bytes	2	06	3 registers total 6 bytes
Register Data 1	2	0180	Contents of memory at address 0x000E
Register Data 2	2	0180	Contents of memory at address 0x000F
Register Data 3	2	0180	Contents of memory at address 0x0010
CRC Code	2	215E	The CRC code is calculated by the meter

2.2 Function Code

"10": write multiple registers

The master uses this function code to save multiple data to the data memory of the slave meter. The register in the Modbus communication protocol refers to 16 bits (that is, 2 bytes), and the high bit comes first. In this way, the memory of the slave machine is two bytes. Since the Modbus communication protocol allows up to 60 registers to be saved each time, the slave also allows up to 60 data registers to be saved at one time.

For example: the host wants to save 0003, 00FF to the slave registers whose addresses are 003A and 003B (the slave address code is 01):

The message format sent by the host:			
Sent by the host	**Number of bytes**	**Sending Information**	**Example**
Slave Address	1	01	Send to slave 01
Function Code	1	10	Write multiple registers
Start Address	2	003A	The start address of the register to be written
Number of Storage Registers	2	0002	Number of storage registers (2 in total)
Save data byte length	1	04	Save data byte length (total 4 bytes)
Save data 1	2	0003	Data address 003A
Save data 2	2	00FF	Data address 003B
CRC Code	2	C084	CRC code calculated by the host

The message format returned by the slave response:			
Slave Response	**Number of bytes**	**Message Return**	**Example**
Slave Address	1	01	From slave 01
Function Code	1	10	Write multiple registers
Start Address	2	003A	The start address is 003A
Save the Number of Registers	2	0002	Save the data of 2 registers
CRC Code	2	61C5	CRC code calculated by the slave

2.3 Error Check Code (CRC Check)

The host or slave can use the check code to judge whether the received information is correct. Due to electronic noise or some other interference, information sometimes has errors during transmission. The error check code (CRC) can check whether the information of the master or slave is wrong during the communication data transmission process, and the wrong data can be discarded (regardless Whether to send or receive), which increases the security and efficiency of the system.

The CRC (Redundant Cyclic Code) of the MODBUS communication protocol contains 2 bytes, that is, 16-bit binary numbers. The CRC code is calculated by the sending device (host) and placed at the end of the sending information frame.

The device (slave) that receives the information recalculates the CRC of the received information, and compares whether the calculated CRC is consistent with the received one. If the two do not match, it indicates an error.

Only 8 data bits are used in the CRC calculation, and the start bit, stop bit and parity bit are not involved in the CRC calculation.

3. Communication Error Information and Data Processing

When the flowmeter detects an error other than the CRC code error, it must send information back to the master, and the highest position of the function code is 1, that is, the function code returned from the slave to the master is the function code sent by the master plus 128 . The following codes indicate that an unexpected error has occurred.

If there is a CRC error in the information received by the slave from the master, it will be ignored by the slave.

The format of the error code returned by the slave is as follows (except for the CRC code):

Address Code	1 byte
Function Code	1 byte (the highest bit is 1)
Error Code	1 byte
CRC Code	2 bytes

The slave responds with the following error code:

81	Illegal function code. The received function code is not supported by the slave table.
82	Read illegal data address. The specified data location is outside the readable address range of the slave table.
83	Illegal data value. The received data value sent by the master exceeds the data range of the corresponding address of the slave.

4. Data Format Description

RO read-only parameter;

RW readable and writable parameters;

DW 4-byte data, which needs to be divided into high 2 bytes and low 2 bytes for communication respectively, and the shaping data format;

W 2 bytes of data;

B Single-byte data, in modbus, this type of parameter is zero-filled, that is, the supplement is 2 bytes, and the high byte is 0;

SF 4-byte data, which needs to be divided into high 2 bytes and low 2 bytes for communication, floating point data format;

In this protocol, data is divided into three formats: unsigned integer data, signed integer data and floating point format.

Unsigned integer data: most of the data in the instrument are unsigned integer data.

DW*1000 means that the data is expressed by 1000 times magnification, for example: the original data of 0.001 is in the format of 1000 times magnification in modbus,

That is, "0.001*1000" -> "1" to represent, and so on for other data formats;

Signed integer data: zero point correction data is a positive or negative number, and its sign data is represented by the highest bit, the highest bit is 0, then the remaining 15 bits represent a positive number, and the highest bit is 1, then the remaining 15 digits represent a negative number;

Floating point format:

This protocol adopts IEEE754 32-bit floating-point number format, with a total of 4 bytes and two registers. Its structure is as follows:

Register 1		Register 2	
BYTE1	BYTE2	BYTE3	BYTE4
S EEEEEEE	E MMMMMMM	MMMMMMMM	MMMMMMMM

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

E - exponent; expressed as the difference from the decimal number 127.

M - mantissa; lower 23 bits, fractional part.

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

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

4.1 Special Function Description

This protocol provides the function of clearing the cumulative amount, which is used in batch control and other control occasions. Accumulator clearing corresponds to registers 96 and 97. When clearing, write the accumulated amount clearing password to registers 96 and 97. Please consult the manufacturer for the reset password of the cumulative amount.

Description of individual communication parameters:

Alarm_Bits:

bit 1: upper limit alarm, bit 2: lower limit alarm, bit 3: empty pipe alarm, bit 4: excitation alarm

Flow_Unit	
0	L/H
1	L/M
2	L/S
3	M3/H
4	M3/M
5	M3/S
6	KG/H
7	KG/M
8	KG/S
9	T/H
10	T/M
11	T/S

Throughput_Unit	
0	0.001L
1	0.01L
2	0.1L
3	1L
4	0.001M3
5	0.01M3
6	0.1M3
7	1M3
8	1KG
9	1T

Excitation_Freq	
0	1/32 Power Frequency
1	1/16 Power Frequency
2	1/8 Power Frequency
3	1/4 Power Frequency
4	1/2 Power Frequency

Excitation_Current	
0	100%
1	90%
2	80%
3	70%
4	55%
5	40%
6	20%
7	0%

Measure_Direction	
0	Reverse
1	Forward

Output_Pulse	
0	Frequency Output
1	Pulse Output

Pulse_Unit	
0	0.001L
1	0.01L
2	0.1L
3	1L
4	0.001M3
5	0.01M3
6	0.1M3
7	1M3

5. Flow Meter Register Address Definition

5.1 Definition of Common Register Address of Flow Meter

(SF is single precision floating point format, DW is long integer format, W is integer format)

register	PLC Memory Address	Unit	Number of Bytes	Attribute	Format	Register Definition
90	40091		4	RO	SF	Forward Cumulative Flow - Float Format
92	40093		4	RO	SF	Reverse Cumulative Flow - Float Format
94	40095		4	RO	SF	Total Cumulative Flow - Float Format
96	40097		4	RW	DW	Cumulative flow reset
98	40099	refer to Register 105	4	RO	SF	flow - float format
100	40101	m/s	4	RO	SF	Velocity - float format
102	40103	%	4	RO	SF	Flow Percent - Float Format
104	40105	%	2	RO	W	Empty Tube Percentage
105	40106		2	RO	W	flow unit
106	40107		2	RO	W	Empty pipe alarm
107	40108		2	RO	W	Excitation alarm

5.2 Definition of All Register Address of the Flow Meter

(SF is single precision floating point format DW is long integer format W is integer format)

Variable address	PLC Memory Address	Unit	Number of Bytes	Attribute	Format	Register Definition
0	40001	m/s	2	R0	DW*1000	Flow Rate - High Byte
1	40002	m/s	2	R0	DW*1000	Flow Rate - Low Byte
2	40003		2	R0	DW*100	Instantaneous traffic - high byte
3	40004		2	R0	DW*100	Instantaneous Traffic - Low Byte
4	40005	%	2	R0	B*100	Flow percentage
5	40006	%	2	R0	B*100	Empty Tube Percentage
6	40007		2	R0	DW*1	Forward Cumulative Flow—High Byte
7	40008		2	RO	DW*1	Forward Cumulative Flow—Low Byte
8	40009		2	RO	DW*1	Reverse Cumulative Flow—High Byte
9	40010		2	RO	DW*1	Reverse Cumulative Flow—Low Byte
10	40011		2	RO	DW*1	reserved address
11	40012		2	RO	DW*1	reserved address
12	40013		2	RO	B*1	Alarm information
13	40014		2	RO	B*1	fluid flow
14	40015		2	RO	DW	System Time - Year - High Byte
15	40016		2	RO	DW	System Time - Year - Low Byte
16	40017		2	RO	B	System Time—Month

17	40018		2	RO	B	System Time—Day
18	40019		2	RO	B	System time—hour
19	40020		2	RO	B	System time—minute
20	40021		2	RO	B	System time—seconds
21	40022	mm	2	RW	W	pipe diameter
22	40023		2	RW	DW	Instantaneous flow range - high byte
23	40024		2	RW	DW	Instantaneous flow range - low byte
24	40025		2	RW	B	Instantaneous flow unit
25	40026		2	RW	B	cumulative flow unit
26	40027	S	2	RW	W*1	Response time
27	40028		2	RW	W*10000	Sensor parameters
28	40029	HZ	2	RW	B	Excitation frequency
29	40030	%	2	RW	B	Excitation current
30	40031		2	RW	B	Measuring direction setting
31	40032	mm/s	2	RW	W	Zero Point Correction
32	40033	%	2	RW	W*100	small signal point cut-off
33	40034		2	RW	B	Allows for small signal cut-off
34	40035		2	RW	B	Reverse output allows
35	40036		2	RW	B	Empty Pipe Alarm Allowed
36	40037	%	2	RW	B	Empty Pipe Alarm Threshold
37	40038		2	RW	B	Upper limit alarm allowed
38	40039	%	2	RW	W*100	Upper limit alarm threshold
39	40040		2	RW	B*1	Lower limit alarm allowed
40	40041	%	2	RW	W*100	Lower limit alarm threshold
41	40042		2	RW	B	High temperature alarm allows
42	40043	C	2	RW	W*100	High temperature alarm threshold

43	40044		2	RW	B	Excitation alarm allows
44	40045		2	RW	B	Pulse frequency output
45	40046		2	RW	B	Pulse equivalent
46	40047	HZ	2	RW	W	Frequency output range
47	40048		2	RW	W	reserved address
48	40049		2	RW	B	reserved address
49	40050		2	RW	B	reserved address
50	40051		2	RW	W	reserved address
51	40052		2	RW	B	reserved address
52	40053		2	RW	B	reserved address
53	40054		2	RW	W	reserved address
54	40055		2	RW	B	reserved address
55	40056		2	RW	B	reserved address
56	40057		2	RW	W	reserved address
57	40058		2	RW	B	reserved address
58	40059		2	RW	B	reserved address
59	40060		2	RW	DW*10000	Meter Coefficient - High Byte
60	40061		2	RW	DW*10000	Meter Coefficient - Low Byte
61	40062		2	RW	W	Empty Pipe Coefficient A
62	40063		2	RW	W	Empty Pipe Coefficient B
63	40064		2	RW	W	Empty Pipe Coefficient C
64	40065		2	RW	W	Empty Pipe Coefficient D
65	40066		2	RW	W*10000	Converter Normalization Factor
66	40067		2	RW	B	First state filtering allows
67	40068		2	RW	W*10000	First state filter factor
68	40069	Min	2	RO	DW*60	Cumulative Working Hours - High Byte
69	40070	Min	2	RO	DW*60	Cumulative Operating Hours - Low Byte

70	40071		2	RW	DW	Flow Correction Point 1—High Byte
71	40072		2	RW	DW	Flow Correction Point 1—Low Byte
72	40073		2	RW	DW	Flow Correction Point 2—High Byte
73	40074		2	RW	DW	Flow Correction Point 2—Low Byte
74	40075		2	RW	DW	Flow Correction Point 3—High Byte
75	40076		2	RW	DW	Flow Correction Point 3—Low Byte
76	40077		2	RW	DW	Flow Correction Point 4—High Byte
77	40078		2	RW	DW	Flow Correction Point 4—Low Byte
78	40079		2	RW	DW	Flow Correction Point 5—High Byte
79	40080		2	RW	DW	Flow Correction Point 5—Low Byte
80	40081		2	RW	DW	Flow Correction Factor 1—High Byte
81	40082		2	RW	DW	Flow correction factor 1—low byte
82	40083		2	RW	DW	Flow Correction Factor 2—High Byte
83	40084		2	RW	DW	Flow correction factor 2—low byte
84	40085		2	RW	DW	Flow Correction Factor 3—High Byte
85	40086		2	RW	DW	Flow correction factor3—low byte
86	40087		2	RW	DW	Flow Correction Factor 4—High Byte
87	40088		2	RW	DW	Flow correction factor 4—low byte
88	40089		2	RW	DW	Flow Correction Factor 5—High Byte
89	40090		2	RW	DW	Flow correction factor 5—low byte

90	40091		2	RO	SF	Forward cumulative flow floating point format—high byte
91	40092		2	RO	SF	Forward cumulative flow floating point format—low byte
92	40093		2	RO	SF	Reverse Cumulative Flow Float Format—High Byte
93	40094		2	RO	SF	Reverse Cumulative Flow Float Format—Low Byte
94	40095		2	RO	SF	Total cumulative flow floating point format—high byte
95	40096		2	RO	SF	Total cumulative flow floating point format—low byte
96	40097		2	RW	DW	Cumulative flow reset - high byte
97	40098		2	RW	DW	Cumulated flow reset—low byte
98	40099	refer to Register 105	2	RO	SF	Flow - high byte
99	40100		2	RO	SF	Flow - low byte
100	40101	m/s	2	RO	SF	Flow Rate - High Byte
101	40102	m/s	2	RO	SF	Flow Rate - Low Byte
102	40103	%	2	RO	SF	Flow Percentage—High Bytes
103	40104	%	2	RO	SF	Flow Percentage—Low Bytes
104	40105	%	2	RO	W	Empty Tube Percentage
105	40106		2	RO	W	flow unit
106	40107		2	RO	W	Empty pipe alarm
107	40108		2	RO	W	Excitation alarm
108	40109		2	RO	W	reserved address
109	40110		2	RO	W	reserved address
110	40111		2	RO	W	reserved address

111	40112		2	RO	W	reserved address
112	40113		2	RO	W	reserved address
113	40114		2	RO	W	protocol version
114	40115		2	RO	W	Unit of flow range
115	40116		2	RO	W	Reverse measurement allowed

6. RS485 Flow Reset

Normal Type:

01 10 00 60 00 02 04 00 00 38 50 E6 7B

01	Table Address
10	Function Code
00 60	Register Address
00 02	Data Length
04	Digit
00 00 38 50	Password
E6 7B CRC	Test

Special Type:

01 10 00 60 00 02 04 00 01 86 9F 86 4F

01	Table Address
10	Function Code
00 60	Register Address
00 02	Data Length
04	Digit
00 01 86 9F	Password
86 4F CRC	Test

Warranty, Returns and Limitations

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