English
Rev.1.0

MODBUS Communication Protocol

for FaraMag FM750 electromagnetic flow meters

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NOTE: Some parameters in this manual are different from the address definition in the MODBUS menu. Please refer to the address definition in the MODBUS menu.

1. introduction

FaraMag FM750 electromagnetic flow meter has the standard MODBUS communication interface supporting baud rate 1200, 2400, 4800, 9600, 19200. Through MODBUS communication network, user can receive instantaneous flow, instantaneous velocity and accumulative flow readouts.

FaraMag FM750 electromagnetic flow meter uses serial port parameters: 1 start bit, 8 data bits, 1 stop bit, none parity bit.

FaraMag FM750 electromagnetic flow meter MODBUS communication port uses electric isolation mode in its physical structure. The isolation voltage is 1500V and it possesses ESD protection. Thus it can overcome various interferences from the environment to ensure the reliability service of the communication network.

2. FM750 network structure and wiring

FM750 electromagnetic flow meter's standard MODBUS communication network is bus network. It can support 1-99 electromagnetic flow meters on the same network. 120 Ω is needed to connect the two ports of the communication wire in parallel.

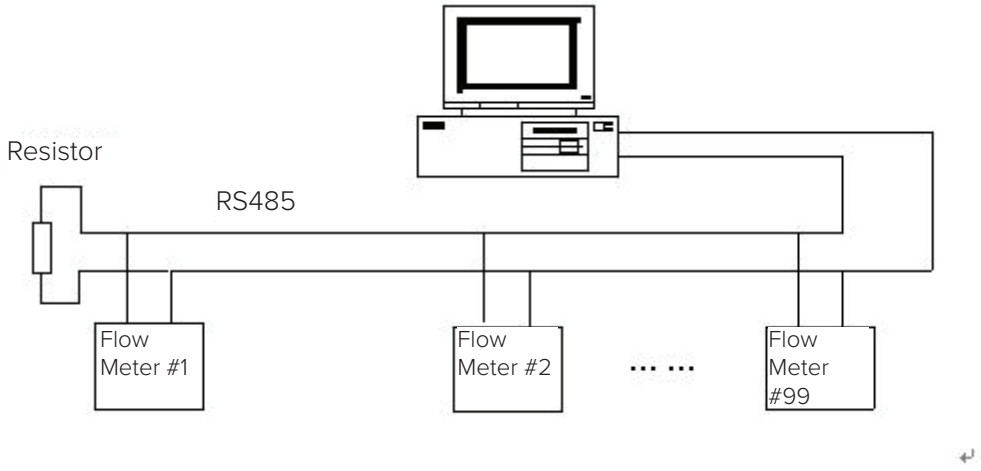

Fig.1 Electromagnetic flow meter network structure

3. RTU frame format of MODBUS protocol

MODBUS protocol is a kind of master-slave communication. Every communication is started from master, and slave responds to master's order by passing back data.

FaraMag FM750 uses the MODBUS RTU frame format (hexadecimal format). Its frame format is shown in fig. 2 below.

3.1 Master order frame structure

Start	Device Address	Function Code	Register Address	Register Length	CRC	Stop
T1-T2-T3-T4	8Bits	8Bits	16Bits	16Bits	16Bits	T1-T2-T3-T4

Fig.2 Master RTU message frame

3.2 Slave response frame structure

Start	Device Address	Function Code	Data	CRC	Stop
T1-T2-T3-T4	8Bits	8Bits	8Bits	16Bits	T1-T2-T3-T4

Fig.3 Slave RTU message frame

NOTE: T1-T2-T3-T4 is a start or stop frame. MODBUS protocol is set for every two frames to have at least a 3.5 char delay. This is shown in Fig.4.

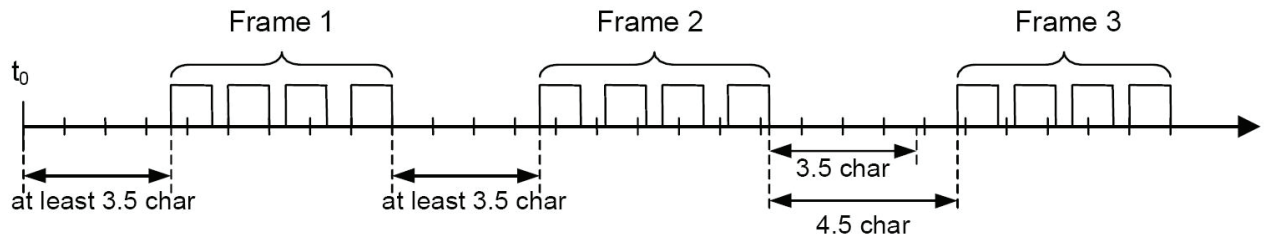

Fig.4 MODBUS frame interval

- **Device Address:** This is the communication address for FaraMag FM750. No two addresses can be the same, within the same network.
- **Function Code:** This is set by the MODBUS protocol. FM750 uses the function code 4, which recognizes the collection function through reading the input register.
- **Register Address and Register Number:** The start address of the register, which restores data. The register number is the number that is used to store the data.
- **Slave Response Data:** Byte number and N bytes data.

These values are all shown in the MODBUS protocol in detail.

4. code definition of MODBUS protocol order

Function Code	Name	Function
01	Read coil status	Reservation
02	Read input status	Reservation
03	Read holding registers	Reservation
04	Read input register	Read electromagnetic flow meter real-time information
05	Strong set single coil	Reservation
06	Preset single register	Reservation
07	Read abnormal status	Reservation
08	Loopback diagnostic check	Reservation
09	Program (only used for 484)	Reservation
10	Control exercise (only used for 484)	Reservation
11	Read events count	Reservation
12	Read communication events record	Reservation
13	Program (184/384 484 584)	Reservation
14	Inquire (184/384 484 584)	Reservation
15	Strong multi-coil set	Reservation

Table 1

5. MODBUS register definition of electromagnetic flow meter

5.1 MODBUS register definition of electromagnetic flow meter

Protocol Addresses (decimal)	Protocol Addresses (HEX)	Data Format	Register Definition
4112	0x100	Float Inverse	Instantaneous flow float representation
4114	0x1012	Float Inverse	Instantaneous velocity float representation
4116	0x1014	Float Inverse	Float representation of the flow percentage (reservation for battery-powered)
4118	0x1016	Float Inverse	Floating representation of fluid conductivity ratio
4120	0x1018	Long Inverse	Integer part of the cumulative positive value
4122	0x101A	Float Inverse	Decimal part of the cumulative positive value
4124	0x101C	Long Inverse	Integer part of the cumulative negative value
4126	0x101E	Float Inverse	Decimal part of the cumulative negative value
4128	0x1020	Unsigned Short	Instantaneous flow unit (table 3)
4129	0x1021	Unsigned Short	Cumulative total units (table 4 of table 5)
4130	0x1022	Unsigned Short	Upper limit alarm
4131	0x1023	Unsigned Short	Lower limit alarm
4132	0x1024	Unsigned Short	Empty pipe alarm
4133	0x1025	Unsigned Short	System alarm

Table 2

5.2 PLC address set illustration

If there aren't any function code setting options when configuring the PLC, add the number '3' in front of the register address when using function code 04.

If the PLC register addresses basic address is from 1, add '1' to the original address when configuring the register address.

Example: The FaraMag FM750's MODBUS register address is 4112(0x1010) and MODBUS function code is 4. So, the PLC register address is 34113.

5.3 Address configuration illustration of KingView software

There is no option to configure function code. Different drivers have different configuration methods.

Take PLC-Modicon-MODBUS (RTU) for example: Add the number '8' in front of the register address when using function code 04. KingView's register addresses basic address is 1. Add the number '1' when configuring a KingView register address.

The MODBUS register address for FM750 mag meters is 4112(0x1010) and MODBUS function code is 4. So PLC register address is 84113.

5.4 Illustration of data's meaning

- **Float Format:** The MODBUS for FM750 mag meters uses IEEE754 which is a 32 bit float format. Its structure is shown as follows (take instantaneous flow as an example):

0x1010 (34113		0x1011 (34114	
BYTE1	BYTE2	BYTE3	BYTE4
S EEEEEEE	E MMMMMMM	MMMMMMMM	MMMMMMMM

S - Mantissa symbol; 1 = negative, 0 = positive

E - Exponent; expressed by the difference with decimal number 127

M - Mantissa; low 23 bits and the decimal part

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

$$V = (-1)^5 \, 2^{(E-127)} \, (1 + M)$$

Instantaneous flow unit

Code	Unit	Code	Unit	Code	Unit	Code	Unit
1	L/S	3	M3/S	6	T/S	9	GPS
2	L/M	4	M3/M	7	T/M	10	GPM
3	L/H	5	M3/H	8	T/H	11	GPH

Table 3

Cumulative flow unit

Code	0	1	2	3
Cumulative Unit	L	M3	T	USG

Table 4 (suitable for type B and type 511 electromagnetic converters

Code	0	1	2	3	4	5
Cumulative Unit	L	L	L	M3	M3	M3
Code	6	7	8	9	10	11
Cumulative Unit	T	T	T	USG	USG	USG

Table 5 (suitable for type C electromagnetic converters

Upper limit alarm, lower limit alarm, empty pipe alarm, system alarm:

0 ------- No alarm; 1 ------- Alarm

6. communication data analysis

Instantaneous flow, instantaneous velocity, flow percentage, fluid conductivity ratio, decimal part of the cumulative positive and negative value, format conversion of float, integer part of the cumulative positive and negative value, transmission of long.

6.1 Read instantaneous flow

Master sends command (hexadecimal number)

01	04	10	10	00	02	74	CE
Device Address	Function Code	Register High Address	Register High Address	Register High Length	Register Low Length	CRC High	CRC Low

Data that master receives

01	04	04	C4	1C	60	00	2F	72
Device Address	Function Code	Data Length	4 bytes float (instantaneous flow)				CRC High	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; if mantissa symbol is 1, it is a negative.

E = 10001000: Exponent is 136

M = 001 1100 0110 0000 0000 0000, The mantissa is:

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

6.2 Read instantaneous velocity

Master sends command (hexadecimal number)

01	04	10	12	00	02	D5	0E
Device Address	Function Code	Register High Address	Register High Address	Register High Length	Register Low Length	CRC High	CRC Low

Data that master receives

01	04	04	C1	B0	80	00	A6	5F
Device Address	Function Code	Data Length	4 bytes float (instantaneous velocity)				CRC High	CRC Low

Float	C1	B0	80	00
	1100 0100	0011 0000	1111 1000	0000 0000

S = 1

E = 10000011

M = 011 0000 1111 1000 0000 0000

$$V = (-1)^1 2^{(131-127)} (1 + 1/4 + 1/8 + 1/256)$$

$$= -22.0625$$

6.3 Read cumulative flow

To completely express the 9 bits cumulative value of electromagnetic flow meter, integer and decimal parts of cumulative flow are expressed respectively. The integer part uses long variable and the decimal uses float variable.

Cumulative flow is 1578m^3

Master sends command to collect the integer value of cumulative flow

01	04	10	18	00	02	F5	0C
Device Address	Function Code	Register High Address	Register High Address	Register High Length	Register Low Length	CRC High	CRC Low

Data that master receives

01	04	04	00	00	70	71	1E	60
Device Address	Function Code	Data Length	4 bytes float (integer value of cumulative flow)				CRC High	CRC Low

Integer value of cumulative flow is 28785

Master sends command to collect the decimal value of cumulative flow

01	04	10	1A	00	02	54	CC
Device Address	Function Code	Register High Address	Register High Address	Register High Length	Register Low Length	CRC High	CRC Low

Data that master receives

01	04	04	3F	00	00	00	3B	90
Device Address	Function Code	Data Length	4 bytes float (decimal value of cumulative flow)				CRC High	CRC Low

Float	3F	00	00	00
	0011 1111	0000 0000	0000 0000	0000 0000

S = 0

E = 0111111 126

M = 000 0000 0000 0000 0000 0000

$$V = (-1)^1 2^{(126-127)} = 0.5$$

6.4 Read instantaneous flow unit

Master sends 8 bytes command to read instantaneous flow unit

01	04	10	20	00	01	34	C0
Device Address	Function Code	Register High Address	Register High Address	Register High Length	Register Low Length	CRC High	CRC Low

7 bytes data that master receives from slave

01	04	02	00	05	79	33
Device Address	Function Code	Data Length	2 bytes integer (instantaneous flow unit)		CRC High	CRC Low

NOTE: Flow unit is m^3/h from table 3

6.5 Read the unit of the total amount of flow

Master sends 8 bytes command to read instantaneous flow unit

01	04	10	21	00	01	65	00
Device Address	Function Code	Register High Address	Register High Address	Register High Length	Register Low Length	CRC High	CRC Low

7 bytes data that master receives from slave

01	04	02	00	01	78	F0
Device Address	Function Code	Data Length	2 bytes integer (cumulative flow unit)		CRC High	CRC Low

NOTE: Flow unit of type B and type 511 is m^3 from table 4
Flow unit of type C is L from table 5

6.6 Read alarm status

Master sends 8 bytes command to read instantaneous flow unit

01	04	10	24	00	01	75	01
Device Address	Function Code	Register High Address	Register High Address	Register High Length	Register Low Length	CRC High	CRC Low

7 bytes data that master receives from slave

01	04	02	00	01	78	F0
Device Address	Function Code	Data Length	2 bytes integer (alarm)		CRC High	CRC Low

NOTE: Empty pipe is in alarm status if status is 1
Other alarm status is the same, and so on

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