Ultrasonic water meter Modbus communication protocol

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1. Overview of the Modbus communication protocol

Our products use the Modbus-RTU communication protocol. The Modbus protocol is fully defined in the Modbus application protocol specification, please refer to the Modbus official website (https://modbus.org/specs.php)。This document mainly describes the communication protocol for the ultrasonic water meter.

1.1Modbus-RTU

Modbus-RTU communication protocol is a common communication protocol, using the master-slave response connection (half-duplex). Modbus Protocol is a master / slave architecture protocol. One device on the bus is a host (such as PC, etc.), other devices are slave (up to 247 units supported), and each slave has a unique address. Each communication is initiated by the host, and the addressed slave frame on the bus receives the request frame and sends the response frame to the host.

1.2Modbus transfer format

1.2.1-byte format

The byte format includes start bits, data bits, parity bits, and stop bits. Host and slave on the same bus must use the same byte format to ensure normal communication. By default, each byte contains 1 start bit, 8 data bit, 1 parity bit and 1 stop bit. The low level is before, and the port rate is 2400bps by default.

1.2.2, the data frame format

Data frame format of the Modbus-RTU:

address code	FC	data field	verification
1 Bytes	1 Bytes	N byte	2 Bytes

address code:

The address code is the first byte of each communication information frame, occupying one byte, with the range of 0~247 (the address 0 is the broadcast address).

Each slave must have a unique address code, and only those that meet the address code can respond and return the information. When the information is returned, the data starts with the respective address code. The sent address code indicates the slave address to be sent to, and the returned slave address code indicates the returned slave address. The corresponding address code can indicate which slave the information comes from.

Communication can be divided into unicast mode and broadcast mode.

In unicast mode, the host addresses a single slave, receives and processes the request, and returns a reply to the host. Each slave must have a unique address to distinguish from other stations and be addressed independently.

Broadcast mode is that the host can send requests to all servers, 00H is the broadcast address, and all substations respond to the broadcast command. FC:

The function code tells the addressed slave device what action to do, occupying a byte.

The function code used for ultrasonic water meter is shown in the following table (H represents 16 decimal system):

Functional code value	use	explain
03H	Read register data	The function code can read the device measurement data and other information, and can read a single or more registers at a time

10H	Write multiple registers	The function code is used to write multiple registers, and a single or multiple registers can be modified at one time

data field:

The data domain is the data exchange between the host machine and the slave in the way of read and write register, and the data length is variable. Low tail is used every 2 bytes and high tail is used inside 2 bytes. For example, if the integer data of a register is 0x1234, send 0x12 first and then send 0x34 first. A hexadecimal number 0xaabbccdd in sending order 0xcc 0xdd 0xaa 0xbb.

verification:

Data may be disturbed or attacked during the transmission process. Through verification, it can detect whether the data changes during the transmission process, ensuring that the host or slave is not affected by the wrong data. Modbus Use CRC 16 verification mode, and use small end byte order transmission, that is, low byte first transmission high byte after transmission.

All communications shown below are not specified according to the Modbus-RTU protocol.

1.2.3 Function code 03H frame format

If read register data is required, a 03H function code is required. The request frame format is as follows:

address code	FC	data field		verification
1~247	0x03	Register address	Number of read data	CRC16
1 Bytes	1 Bytes	2 Bytes	2 Bytes	2 Bytes

The response frame format is as follows:

address code	FC	data field		verification
1~247	0x03	Number of data bytes	Register data	CRC16
1 Bytes	1 Bytes	1 Bytes	The Number of data bytes byte	2 Bytes

1.2.4 Function code 10H frame format

If you need to write the data to a register, a 10H function code is required. The request frame format is as follows:

address code	FC	data field				verification
1~247	0x10	Register address	Number of registers	Number of register data	Register data	CRC16
1 Bytes	1 Bytes	2 Bytes	2 Bytes	1 Bytes	n byte	2 Bytes

The response frame format is as follows:

address code	FC	data field		verification
1~247	0x10	Register	Number of	CRC16

		address	registers	
1 Bytes	1 Bytes	2 Bytes	2 Bytes	2 Bytes

2. Register list

address	Number of registers	definition	operate	form	remarks
0000H	1	MODBUS address	R/W	HEX	Use low bytes High byte is not used
0001H-0003H	3	obligate	R/W	BCD	
0004H	1	Communication parameters	R/W	HEX	High byte for the check bit, low Bytes are for the port rate.see details See Register Definition

0005H	1	Valve function shielding	R/W	Low-byte valid BIT	See Register Definition
0006H	1	Regular on and off valve cycle	R/W	Low-byte valid BCD	Range (from 7 to 90 days)
0007H	1	obligate	R/W	HEX	
0008H	1	balance date	R/W	Low-byte valid BCD	Range (1~31)
0009H	1	Table Type (High Bytes)	R	HEX	See Register Definition
		Traffic unit (low bytes)	R	HEX	
000AH-000DH	4	Real-time time	R/W	ss--	BCD form
				hhmm	
				MMDD	
				YYYY	
000EH-000FH	2	integrated flux	R/W	HEX	flux unit
0010H-0011H	2	Cumulative flow on the settlement day	R	HEX	flux unit
0012H-0013H	2	Usage last month	R	HEX	flux unit
0014H-0015H	2	instantaneous delivery	R	HEX	flux unit
0016H	1	cell voltage	R	BCD	Unit of 0.01V
0017H	1	state ST	R	BIT	See Register Definition
0018H	1	Pipeline temperature	R	HEX	Unit of 0.01℃
0019H	1	obligate	R	obligate	
…					
002FH	1	obligate	R	HEX	
0030H	2	Water meter version number	R	HEX	See version number definition
DC					
0060H	1	DC	R/W	BIT	See Register Definition
00D0H	1	Valve timeout time	R/W	HEX	3-255 (sec)
History (read up to 12 months at a time)					
0100H-0101H	2	Accumulated flow in the first 1 month	R	HEX (flow unit)	
0102H-0103H	2	Accumulated flow in the first 2 months	R	HEX (flow unit)	
…					
012EH-012FH	2	Cumulative flow in the first 24 months	R	HEX (flow unit)	

3. Example communication

3.1 Read address (broadcast command is prohibited on bus)

Request frame:

device address	0x00
FC	0x03
Register address high byte	0x00
Register address low byte	0x00
Register number of high bytes	0x00
Register number low bytes	0x01

CRC 16 Low bytes	0x85
CRC 16 high bytes	0xDB

Reply frame:

device address	0x24
FC	0x03
The number of bytes	0x02
Register data	0x0024
CRC 16 Low bytes	0XF5
CRC 16 high bytes	0x98

The device address read in the table is 0x0024

3.2 Write address

Request frame:

device address	0x18
FC	0x10
Register address high byte	0x00
Register address low byte	0x00
Register number of high bytes	0x00
Register number is low in bytes	0x01
Number of data	0x02
Register data	0x0024
CRC 16 Low bytes	0x01
CRC 16 high bytes	0xDB

Reply frame:

device address	0x24
FC	0x10
Register address high byte	0x00
Register address low byte	0x00
Register number of high bytes	0x00
Register number is low in bytes	0x01
CRC 16 Low bytes	0x06
CRC 16 high bytes	0xFC

3.3 Read all of the data

Request frame:

device address	0x24
FC	0x03
Register address high	0x00

byte	
Register address low byte	0x01
Register number of high bytes	0x00
Register number low bytes	0x31
CRC 16 Low bytes	0xD2

CRC 16 high bytes	0xEB

Reply frame:

device address	0x24	
FC	0x03	
The number of bytes	0x62	
Register data	0x00 0000000000	obligate
	0x0002	Communication parameters: 2400E
	0x0083	Valve function shielding: see the register definition
	0x0030	Regular switching valve cycle: 30 days
	0x0400	obligate
	0x0031	Settlement date: 31
	0x0331	Table type and flow unit: see the register definition
	0x4100121805292023	Real-time time: 2023 / 05 / 2912:18:41
	0x02 4E0000	Cumulative flow rate: 590 * units
	0x02 4C0000	Settlement day cumulative flow: 588 * units
	0x00000000	Usage of last month: 0 * unit
	0x01790000	Instantaneous flow rate: 337 * units
	0x0364	Battery voltage: 3.64v
	0x0189	Status: See the Status Definition
	0x07 D0	Pipe temperature: 20.00℃
	0x0000・・・	Register 0x0019-0x002F is reserved
	0x020A11 CF	Version number: 11CF020A
CRC 16 Low bytes	0xAC	
CRC 16 high bytes	0xCC	

3.4 Write time

Request frame:

device address	0x24	

FC	0x10	
Register address high byte	0x00	
Register address low byte	0x0A	
Register number of high bytes	0x00	
Register number is low bytes	0x04	
Number of data	0x08	
Register data	0x48001324	13:24:48 sec
	0x02142023	On February 14,2023
CRC 16 Low bytes	0x25	
CRC 16 high bytes	0xEE	

Reply frame:

device address	0x24

FC	0x10
Register address high byte	0x00
Register address low byte	0x0A
Register number of high bytes	0x00
Register number is low bytes	0x04
CRC 16 Low bytes	0xE6
CRC 16 high bytes	0xFD

4. Register definition

4.1 state ST

The state ST has two bytes, defined as follows:

State ST first-byte definition table

	D0	D1	D2	D3	D4	D5	D6	D7
definition	Valve status		cell voltage	make known	booster	blank pipe	Temperature error	Valve control function
explain	00: Valve open 01: Valve closed 10: Ratio open valve 11: Abnormal		0: Normal 1: Underpressure	0: Normal 1: leakage	0: Normal 1: Tube burst	0: There is water 1: Air traffic control	0: Normal 1: Error	0: No valve control 1: Valve control

Status ST second-byte definition table

	D0	D1	D2	D3	D4	D5	D6	D7
definition	The tube section is not calibrated	water direction	Valve mode		Fees		obligate	Sensor anomaly
explain	0: Calibrated 1: Not calibrated	0: Positive 1: Reverse	00: Free control 01: Prepaid control 10: Reserved 11: Compulsory control		00: Normal 01: Insufficient balance 10: Overdue 11: Overdraw up		-	0: Normal 1: Abnormal

Note: When the protocol is sent, the second byte of status ST is earlier and the first byte is later.

4.2 Communication parameters

high byte		lower byte	
check bit	code name	Baud rate	code name
even parity check	00H	1200	01H

No check	01H	2400	02H
		4800	03H
		9600	04H

4.3, Table type

High bytes are measured (read-only):

0: switching quantity mechanical type (dry reed clarinet, Hall, magnetic resistance) 1: no magnetic mechanical type

2: ergen
mechanical type
3: ultrasonic
meter
Low bytes are units of measurement:

Flow rate and instantaneous flow rate unit definition

	D7~D4	D3~D0
definition	0~6	0~6
description	Instantaneous flow rate decimal number (m3/h)	Flow rate of decimal places (m3)
	Default value: 3 (0.001 m3/h)	Default value: 3(0.001m3)

4.4 Valve function shielding

Valve function shielding

BIT	D7	D6	D5	D4	D3	D2	D1	D0
definition	obligate	obligate	obligate	obligate	obligate	Periodic switch valve	obligate	
explain	1	-	-	-	-	0: Have 1: No	-	

4.5 Definition of equipment control

Definition of device control

	D15~D8	D7	D6~D5	D4~D3	D2	D1	D0
definition	valve opening	obligate	W: obligate	W: obligate	Valve status		
explain	Values are 1-99 in units% Write valid only if D1: D0 is 1:1	obligate	Write: reserved	Write: reserved	0: Free control	01: Open the valve 10: Turn off the valve 11: Valve opening control	
			Read: [Limit Switch Status]	Read: [Valve status]	1: Mandatory control		

Free control, allows the system to control the valve, forced control only allows the regular opening and closing valve, the system can not perform other operations on the valve.[Valve status] 00: Undefined; 01: valve open; 10: valve close; 11: abnormal.
[Limit switch status] D5:1 means that the open valve limit switch is closed; D6:1 means that the closed valve limit switch is closed.