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Ultrasonic Flow meter for Fuel Gas Management UX/UZ(Bore 25s and 32,40,50)

Modbus RTU Communication Specifications

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1 Overview

This communication specifications applies to "External power supply type (24VDC)" and "External power supply type (100VAC)" of the Ultrasonic Flow Meter UX/UZ for fuel gas management.

Since this document only describes the communication procedures, refer to the operation manual of the ultrasonic flow meter for fuel gas management (hereinafter referred to as "the flow meter") for instructions of operations, etc., other than communication,

The flow meter has the communication interface which equips the asynchronous serial bus interface conforming to EIA-485. This interface enables to connect up to 31 flow meters to build a networked system.

Modbus RTU Protocol is used as the communication protocol, so that measurement data and internal information of each flow meter can be acquired by sending commands to each flow meter.

2 Prior to Use

2.1 Connection

With reference to the operation manual of the flow meter, connect it to the upper-level communication device.

2.2 Setting of Items Related to Communications (Flow Meter)

For the setting procedures of 2.2.1 through 2.2.4, refer to “Operation manual 8-1. Details of setting items”.

2.2.1 Setting of the Flow Meter's RTU Address

Set the RTU address with Item No. F14, using the setting buttons on the display portion of the flow meter. When connecting multiple flowmeters, be sure to use a unique RTU address for each of them.

Available addresses: 001 to 247

* "000" cannot be used.

2.2.2 Setting a Communication Bit Rate of the Flow Meter

Select a communication bit rate with Item No. F13, using the setting buttons on the display portion of the flow meter.

2.3 Setting Items Related to Communications (Higher-level Communication Device)

Match its communication bit rate with the setting of the flow meter.

* Set the data length to “8 bits", stop bit to “1 bit", and parity to “None.”

3 Communication Specifications and Communication Timing

3.1 Communication Specifications

Interface	Conforming to EIA-485
Communication method	Half-duplex system
Synchronization method	Asynchronous
Maximum number of connectable flow meters	Up to 30 flow meters
Protocol	Modbus RTU
Communication speed [bps]	Selectable according to parameter setting※ 4800, 9600
Data length [bit]	8
Stop bit length[bit]	1
Parity bit	None
Sending/Reception Buffer size [byte]	100

*The factory defaults are 9600bps.

Refer to the next section for the communication timing.

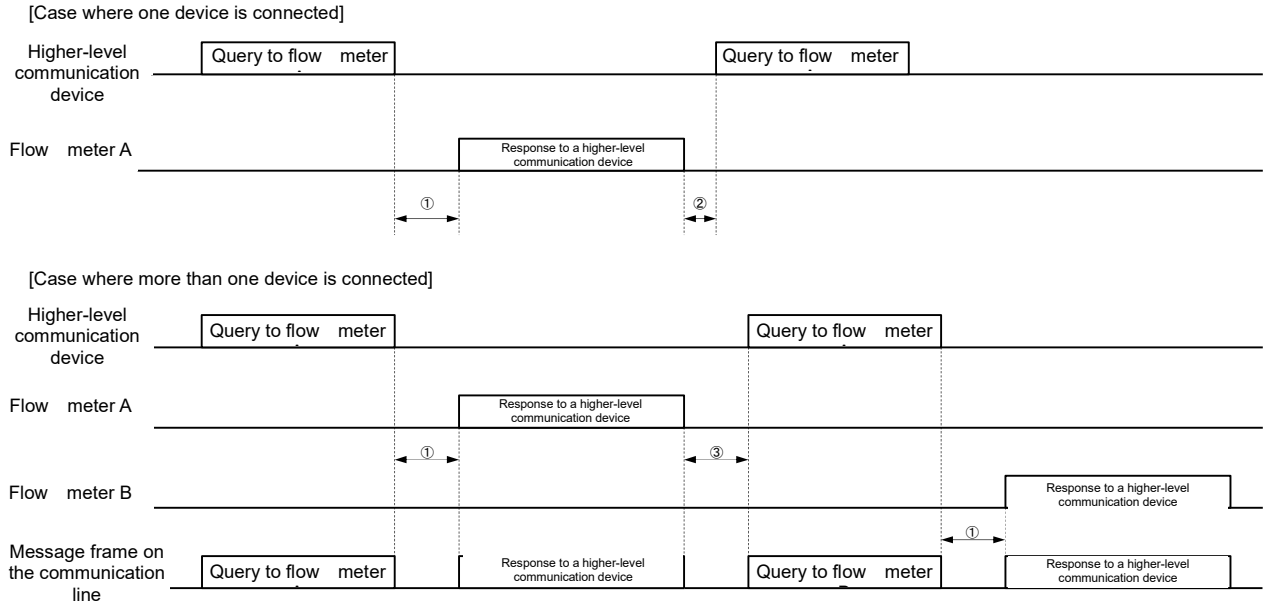
3.2 Communication Timing

The response time, standby time, and communication interval vary depending on the baud rate and contents of a query from the higher-level communication device. Thus, refer to the table below <Response Time and Standby Time> and the figure below <Communication Timing Diagram>.

<Response Time and Standby Time>

<table>
<tr><td>Maximum response time① [ms]</td><td>- Writing various types of parameters
<table>
<tr><th>min</th><th>max</th><th>Remarks</th></tr>
<tr><td>100</td><td>400</td><td>If you set an item</td></tr>
<tr><td>300</td><td>800</td><td>If you set all items</td></tr>
</table>
- Reading out various types of parameters, reading out flow meter information, and clearing an integration value upper limit alarm
<table>
<tr><th>min</th><th>max</th></tr>
<tr><td>40</td><td>200</td></tr>
</table></td></tr>
<tr><td>Maximum standby time after response from the own machine ② [ms]</td><td>100</td></tr>
<tr><td>Maximum standby time after response from other machine ③ [ms]</td><td>100</td></tr>
<tr><td>Minimum communication interval</td><td>Query maximum time + Response time ① (Maximum value) + Maximum response time+ Maximum standby time (② or ③)</td></tr>
</table>

<Communication Timing Diagram>



(1): Prepare to receive a response within the above-described time (the minimum value of ①) after sending a query to the flow meter.

(2): Prepare time-out time to be longer than the above-described time (the maximum value of ①) after sending a query to the flow meter.

(3): In case the flow meter is only the one connected to the master communication device, after receiving a response from the flow meter, send the next query to the same flow meter after the above-described time (②) passes.

(4): In case multiple meters are connected to the master communication device, after receiving a response from any of them, send the next query after the above-described time (③) passes.

<Notes on programming>

(1): Provide some margins for the times mentioned above for safety when programing the master communication device.

(2): If a response from the flow meter cannot be received correctly after the master communication device has sent a query, it is recommended to resend the query.

4 Message Frame Configuration

Start	RTU address	Function code	Data	Error check code	End
Silent interval※	1 byte	1 byte	n bytes	2 bytes	Silent interval*

* Silent communication time for 3.5 characters or more

<RTU address>

“1” - “247” (01H - F7H) can be set for the flow meter.

The default is "1” (01H).

When a message from the master communication device is received, only the flow meter with the matching RTU address returns a response.

* Broadcast communication is not supported.

<Function code>

Each code specifies a function that the flow meter is commanded to perform.

The following function codes are available.

Code (hex)	Function
03	Read out a parameter or flow meter information.
05	Clear the integration value upper limit alarm.
06	Writing of a single parameter
10	Writing of multiple parameters

<Data>

Data used to perform a function code. Configuration of this data section varies depending on the function code. Refer to “7. Data Specifications” for details.

<Error check code>

This code is intended to detect an error (bit change) in a message in the signal transmission process. The checking method is based on the CRC method.

For details, refer to "9 Calculation of Error Check Code(CRC-16)”.

When the flow meter receives a message, it calculates a CRC value based on the received message, and compares it with the sent CRC value.

If the two values do not match, the flowmeter determines that an error has occurred.

In the case of a message to be transmitted by the flowmeter, the flowmeter calculates a CRC value based on the message to be transmitted, and transmits the message with the CRC value added to the end of the message.

5 Function Code

5.1 [Function code 03] Reading of parameters and flow meter information

The function code 03H reads parameters, and flow meter information.

The function code and data portions, which are described in "4 Message Frame Configuration," are shown below.

<Query configuration>

Function code		03H
Data	Start address	(Upper)
		(Lower)
	Number of registers	(Upper)
		(Lower)

Function code: 03H

Start address: Register address (0100H to 0119H) and (0200H to 020EH)

Number of registers: Number of data to be read out (0001H to 001AH)

Note that the maximum number of reading data depends on register addresses.

<Response configuration>

Function code		03H
Data	Number of data bytes	Arbitrary
	Data 1	(Upper)
		(Lower)
	Data 2	(Upper)
		(Lower)
	:	
	Data N	(Upper)
		(Lower)

Function code: 03H

Number of data bytes: Number of bytes in response data

Data: Read out data

Example) A case where [Address 0101H] Output pulse constant (0001H：10L/P,) and [Address 0102H] Alarm output contact state (0000H：normal open) are read out.

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			03
Data	Start address	(Upper)	01
		(Lower)	01
	Number of registers	(Upper)	00
		(Lower)	02
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

<Response> (hex value)

Start			Silent interval
RTU address			01
Function Code			03
Data	Number of data bytes		04
	Data 1 (Data of address 010)	(Upper)	00
		(Lower)	01
	Data 2 (Data of address 0102)	(Upper)	00
		(Lower)	00
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

5.2 [Function code 05] Integration value upper limit alarm clear

Function code 05H is intended for a command to clear an integration value upper limit alarm of the flow meter.
An alarm state occurs when an integration value per hour exceeds a set upper limit.

The function code and data portions, which are described in "4 Message Frame Configuration," are shown below.

<Query configuration>

Function code		05H
Data	Start address	03H
		00H
	Changed data	00H
		00H

Function code: 05H
Start address: 0300H (Fixed)
Changed data: 0000H (Fixed)

<Response configuration>

Function code		05H
Data	Start address	03H
		00H
	Changed data	00H
		00H

Function code: 05H
Start address: 0300H (Fixed)
Changed data: 000H (Fixed)

5.3 [Function code 06] Single parameter write

Function code：06H is intended to make a change (perform a write) to contents of a parameter. Shown below are parts of the function code and the data in “4 Message Frame Configuration”.

<Query configuration>

Function code		06H
Data	Start address	(Upper)
		(Lower)
	Changed data	(Upper)
		(Lower)

Function code: 06H
Start address: Register address（0100H to 0119H）
Changed data: Arbitrary (For the range of changed data that may be set, refer to “7.2.1 Various Types of Parameters).

<Response configuration>

Function code		06H
Data	Start address	(Upper)
		(Lower)
	Changed data	(Upper)
		(Lower)

Function code: 06H
Start address: Same as the start address in a query
Changed data: Same as the changed data in a query

Example) A case where [Address 0100H] Conversion reference temperature is changed to 35℃ (0x0023).

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			06
Data	Start address	(Upper)	01
		(Lower)	00
	Changed data	(Upper)	00
		(Lower)	23
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

<Response> (hex value)

Start			Silent interval
RTU Address			01
Function code			06
Data	Start address	(Upper)	01
		(Lower)	00
	Changed data	(Upper)	00
		(Lower)	23
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

5.4 [Function code 10] Multiple parameter writes

Function code: 10H is an intended to change (write) contents of a plurality of consecutive parameters.

Shown below are parts of the function code and data in “4 Message Frame Configuration”.

<Query configuration>

Function code		10H
Data	Start address	(Upper)
		(Lower)
	Number of registers	(Upper)
		(Lower)
	Number of data bytes	Arbitrary
	Data 1	(Upper)
		(Lower)
	Data 2	(Upper)
		(Lower)
	:	
	Data N	(Upper)
		(Lower)

Function code: 10H
Start address: Register address (0100H to 0119H)
Number of registers: Number of data to be written (0001H to 001AH)
Number of data bytes: Number of bytes of data to be written
Changed data: Arbitrary (For the range of changed data that may be set, refer to “7.2.1 Various Types of Parameters).

<Response configuration>

Function code		10H
Data	Start address	(Upper)
		(Lower)
	Number of registers	(Upper)
		(Lower)

Function code: 10H
Start address: Same as the start address in the query
Number of registers: Same as the number of registers in the query

Example) A case of changing [Address 010FH] Actual flow conversion select to Yes (0x0001) and changing [Address 0110H] Used gas pressure set value to 50kPa (1388H)/

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			10
Data	Start address	(Upper)	01
		(Lower)	0F
	Number of registers	(Upper)	00
		(Lower)	02
	Number of data bytes	Arbitrary	04
	Data 1 (Actual flow conversion select)	(Upper)	00
		(Lower)	01
	Data 2 (Used gas pressure set value)	(Upper)	13
		(Lower)	88
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

<Response> (hex value)

Start			Silent interval
RTU address			01
Function code			10
Data	Start address	(Upper)	01
		(Lower)	0F
	Number of registers	(Upper)	00
		(Lower)	02
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

5.5 Communication-related Item

When a single write or a multiple write to a item / items related to the communications (RTU address, communication bit rate) is performed,the flow meter responds thereto with parameters before the change has been made. For subsequent communications, the flowmeter operates with the changed set value.

Example 1）A case of changing the RTU address of the flow meter from 01 to 02 (hex value)

			Query	Response
Start			Silent interval	Silent interval
RTU address			01	01
Function code			06	06
Data	Start address	(Upper)	01	01
		(Lower)	0E	0E
	Changed data	(Upper)	00	00
		(Lower)	02	02
Error check code		(Lower)	(CRC)	(CRC)
		(Upper)	(CRC)	(CRC)
End			Silent interval	Silent interval

Returning a response with 01H

Subsequently, the flow meter operates with the RTU address = 02

Example 2）A Case of changing the communication bit rate from 9600bps to 4800bps (hex value)

			Query	Response
Start			Silent interval	Silent interval
RTU address			01	01
Function code			10	10
Data	Start address	(Upper)	01	01
		(Lower)	0D	0D
	Number of registers	(Upper)	00	00
		(Lower)	01	01
	Number of data bytes		02	
	Data 1 (Communication bit rate)	(Upper)	00	
		(Lower)	01	
Error check code		(Lower)	(CRC)	(CRC)
		(Upper)	(CRC)	(CRC)
End			Silent interval	Silent interval

Returning a response at 9600bps

Subsequently, the flow meter operates at 4800bps

6 Communication Error

6.1 List of Communication Errors

Communication errors are defined as listed in the table below.

Error code	Error item	Error description
01H	Illegal function	A function code other than 03H, 05H, 06H, and 10H.
02H	Invalid data address	No existing address A specified internal address exceeding buffer size
03H	Invalid data	A data value being out of range
None (No response)	Any communication error other than those listed above	Framing error, overrun error, parity error, CRC check error

6.2 Error Response

Listed below are parts of the function code and data in “4 Message Frame Configuration”.
In the case of an error response, the function code is an error function code. The error function code is a code to the highest-order bit of which 1 is set.

Error Function code

Function code (hex)	Error function code (hex)
03	83
05	85
06	86
10	90

<Response configuration>

Error function code		Refer to the above table.
Data	Error code	Any of 01H, 02H, and 03H

Example) If you set 0006H for the gas species select:
You receive a response with the error code 03H for the invalid data, because the set data 0006H is a value out of the range.

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			06
Data	Start address	(Upper)	01
		(Lower)	16
	Changed data	(Upper)	**00**
		(Lower)	**06**
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

<Response> (hex value)

Start			Silent interval
RTU address			01
Error function code			**86** ← Set 1 to the highest-order bit of 06H
Data	Error Code		**03**
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

6.3 Processing of Invalid Data

If invalid data is detected in a single write, no write is performed.

If invalid data is detected in certain data in a multiple write, no values after the invalid data is detected are set. However, values before the invalid data is detected are set.

For example, if you write [Addresses 0100H to 0102H] multiple times:

Example 1）
Conversion reference temperature: 0014H (20°C Normal data)
Output pulse constant: 0005H (Invalid data)
Alarm output contact state: 0000H (Normal open Normal data)

As shown above, when the second data of the three pieces of set data is the invalid data, the first conversion reference temperature is set. However, because the second output pulse constant is the invalid data, the output pulse constant and the alarm output contact state are not set.
A response with the error code 03H for invalid data is returned.

Example 2）
Conversion reference temperature: 003FH (63°C Invalid data)
Output pulse constant: 0001H (10L/P Normal data)
Alarm output contact state: 0000H (Normal open Normal data)

As shown above, when the first data of the three setting data is the invalid data, neither of the three data is set.

The response returned is the error code 03H for invalid data.

7 Data Specifications

7.1 Address and Data

Data is arranged as shown below:

Address	
0000H to 00FFH	For system
0100H to 011AH	Various types of parameters for the flow meter
011BH to 01FFH	For system
0200H to 020EH	Flow meter information
020FH to 02FFH	For system
0300H	Clear command
0301H to FFFFH	For system

*Use of the area for system is not allowed.

7.2 List of Data

7.2.1 Various Types of Parameters

You can set various types of parameters and acquire internal information. Therefore, you can use the following function codes.

Code(hex)	Function
03	Read out a parameter.
06	Single write of a parameter
10	A multiple write of a parameter

*1Model: Only the type wiht pressure sensor can be accepted.

*2Model: Only the type wihtout pressure sensor can be accepted.

Class UX[Bore]-[Pressure][Power Supply]-[Flow Direction]-[Gas Type]
UZ[Bore]-[Pressure][Power Supply]-[Flow Direction]-[Gas Type]
[Pressure]=0 : Type wihtout pressure sensor
[Pressure]=100 or 500 : Type wiht pressure sensor

Function code (hex)	Address (hex)	Area Name	Parameter	Set Value (Range hex)	Details page
03 06 10	0100	Various types of parameters of flow meters	Conversion reference temperature	0xFFF6 to 0x003C (Set a complement.) (-10 to +60°C, set a 1x value.)	18
	0101		Output pulse constant	0x0001 : 10L/P 0x0002 : 100L/P 0x0003 : 1000L/P 0x0004 : 10000L/P	18
	0102		Alarm output contact state	0x0000 : Normal open 0x0001 : Normal close	18
	0103		Alarm output upper limit (Upper 2 bytes)	0x00000000 to 0x0001869F (0.0 to +9999.9 m3/h, set a 10x value.)	19
	0104		Alarm output upper limit (Lower 2 bytes)		
	0105		Alarm output lower limit (Upper 2 bytes)	0x00000000 to 0x0001869F (0.0 to +9999.9 m3/, set a 10x value.)	19
	0106		Alarm output lower limit (Lower 2 bytes)		
	0107		Alarm output hysteresis width (Upper 2 bytes)	0x00000000 to 0x0001869F (0.0 to +9999.9 m3/h, set a 10x value.)	19
	0108		Alarm output hysteresis width (Lower 2 bytes)		
	0109		Instantaneous flow moving average times	0x0001 to 0x0010 (1 to 16[times])	19
	010A		Analog output full-scale flow rate (Upper 2 bytes)	0x00000000 to 0x0001869F (0.0 to +9999.9 m^3/h, set a 10x value.)	19
	010B		Analog output full-scale flow rate (Lower 2 bytes)		
	010C		Analog output switching	0x0000 : Instantaneous flow rate 0x0001 : Temperature 0x0002 : Pressure*1	19
	010D		Communication bit rate	0x0000 : 4800bps 0x0001 : 9600bps	20
	010E		RTU Address	0x0001 to 0x00F7 (1 to 247)	20
	010F		Flow rate conversion select*1	0x0000 : Not select (Actual flow rate)	20

Function code (hex)	Address (hex)	Area Name	Parameter	Set Value (Range hex)	Details page
03 06 10		Various types of parameters of flow meters		0x0001 : Select (Normal or standard flow rate)	
	0110		Used gas pressure set value （gage）*2	UX :0x0000 to 0x2710 (0.00 to 100.00kPa, set a 100x value.) UZ : 0x0000 to 0xC350 (0.00 to 500.00kPa, set a 100x value.)	21
	0111		Test mode time select	0000 : 3 minutes 0001 : 60 minutes 0002 : No limit	21
	0112		Conversion reference pressure (gage)	0x0000 to 0x03E8 (0.00 to 10.00kPa, set a 100x value.)	21
	0113		Integration value upper limit alarm threshold (Upper 2 bytes)	0x00000000 to 0x000F423F (0000.00 to 9999.99 m^3, set a 100x value.)	22
	0114		Integration value upper limit alarm threshold (Lower 2 bytes)		
	0115		Alarm output select	0x0000 : Flow rate upper and lower limit alarm 0x0001 : Integration value upper limit alarm	22
	0116		Gas species select	0x0000 : 13A 0x0001 : Propane 0x0002 : Butane 0x0003 : Nitrogen 0x0004 : Air 0x0005 : Argon	22
	0117		Low flow cut-off value	0x0000 to (*Refer to the detailed page.) (Maximum value for each of 0.00 to bore, set a 100x value.)	22
	0118		Atmospheric pressure in usage environment	0x0000 to 0x07D0 (000.0 to 200.0kPa, set a 10x value.)	23
	0119		Pressure moving average select*1	0x0000 : Not select 0x0001 : Select (Moving average of 10 times)	23
	0011A		With or without pressure zero-cut*1	With zero-cut (ON) Without zero-cut(OFF)	23

7.2.2 Details of Various Types of Parameters

1. [Address 0100H] Conversion reference temperature

This item is to set a designated temperature [°C] that is used as a reference at the time of conversion.

Setting is possible in the increment of 1°C, in the range of -10 to +60°C (FFF6H to 003CH). To set the parameter, treat it as date with sign (+/-).

The conversion temperature is valid only when selecting “Yes (Normal or standard flow rate)” for [Address 010FH] Actual flow conversion selection.
When “No (Actual flow rate)” is selected for Actual flow rate conversion selection, a conversion reference temperature can be changed, but the change is not reflected in the flow rate conversion.

This is only valid in the Type wiht pressure sensor. The setting and read-out cannot be performed with the Type wihtout pressure sensor.

2. [Address 0101H] Output Pulse Constant

The parameter is to select weight “10L/P(0001H)”, ”100L/P(0002H)”, ”1000L/P(0003H)”, or “10000L/P(0004H)”.
You cannot set the parameter depending on a combination of a class, and [Address 010FH] Actual flow conversion select.
For details, refer to the table below.

	Bore	Pressure sensor	Conversion	Pulse constant				
				1	10	100	1000	10000
UX	25s 32	0	No conversion					
			Conversion					
		100	No conversion					
			Conversion					
	40	0						
		100	No conversion					
			Conversion					
	50	0						
		100	No conversion					
			Conversion					
UZ	40	0						
		500	No conversion					
			Conversion					
	50	0						
		500	No conversion					
			Conversion					

Cannot select

3. [Address 0102H] Alarm output contact state

The parameter is to select “Normal open (0000H)” or”Normal close (0001H)”.
If you use a battery-driven pulse receiver, use Normal open.

4. [Address 0103H, 0104H] Alarm output upper limit

The parameter is to set an alarm output upper limit of the flow rate upper/lower limit alarm.
When you set this parameter, set a 10x value.
With 4byte data, setting is possible in the range of 10x values 00000000H to 0001869FH of 0 to 9999.9[m^3/h].

An address is assigned to each of upper 2 bytes and lower 2 bytes.
[Address 0103H]: Alarm output upper limit (Upper)
[Address 0104H]: Alarm output upper limit (Lower)

You can set upper level only or lower level only. Note, however, that a settable range is determined as the 4byte data.
Example) Upper 0000H, Lower 9876H→Alarm output upper limit=00009876H→3903.0[m^3/h]
If you try to change only the upper bytes to 0001H, setting is not allowed due to out of setting range.
Alarm output upper limit=00019876H→10456.6[m^3/h]>9999.9[m^3/h]

5. [Address 0105H, 0106H] Alarm output lower limit

The parameter is to set an alarm output lower limit of the flow rate upper/lower limit alarm.
Details are similar to [Address 0103H, 0104H] Alarm output upper limit.

6. [Address 0107H, 0108H] Alarm output hysteresis width

For a flow rate value set in the alarm output upper limit and lower limit, set an alarm output hysteresis width as a flow rate width for stopping the alarm.
Details are similar to [Address 0103H, 0104H] Alarm output upper limit.

7. [Address 0109H] Instantaneous flow moving average times

The parameter is to refer to a moving average times of instantaneous flow measurement results.
You can select once (No average)(0x0001) to 16 times (0x0010).
The instantaneous flow rate measured most recently is displayed/outputted as an average value of the selected moving average times.

8. [Address 010AH, 010BH] Analog output full-scale flow rate

The parameter is to set a full-scale flow rate value of analog output.
Setting is enabled when you select “Instantaneous flow rate”for [Address 010CH] Analog output switching.
It is FS flow rate corresponding to setting of [Address 010FH] Actual flow conversion select.

When you set this parameter, set a 10x value.
Details are similar to [Address 0103H, 0104H] Alarm output upper limit.

9. [Address 010CH] Analog output switching

The item is to select the function assignment of analog output from “Flow rate (0000H)”,

"Temperature (0001H)", or "Pressure (0002H)".

When you select the instantaneous flow, set a relative value of the instantaneous flow rate selected for [Address 010FH] Actual flow conversion select.

[Address 010CH] Analog output switching	Instantaneous flow rate	Flow rate 0: Currents 4 [mA] Flow rate FS*: Currents 20 [mA]
	Temperature	Current value corresponding to temperature [mA]
	Pressure	Current value corresponding to pressure [mA]

*FS: Set value of [Address 010AH, 010BH] Analog output full-scale flow rate

The option "Pressure" is only valid for the type wiht pressure sensor. You cannot set the parameter in the Type wihtout pressure sensor.

10. [Address 010DH] Communication bit rate

The parameter is to set the communication bit rate "4800bps (0000H)""9600bps(0001H)".

11. [Address 010EH] RTU Address

The parameter is to set an RTU address of the flow meter.
A range of setting of an RTU address is from 001 to 247（0001H to 00F7H）.

12. [Address 010FH] Flow rate conversion select

The parameter is to set a Actual flow rate, normal conversion flow rate, and standard conversion flow rate for the flow rate conversion.
With settings of the flow rate conversion select and the conversion reference temperature, you can select a Actual flow rate, normal conversion flow rate, and standard conversion flow rate.

Actual flow conversion select	Conversion Reference Temperature	Conversion reference pressure	Flow rate
0x0000 (Not select)	-	-	Actual flow rate
0x0001 (Select)	0x0000 (0.0°C)	0x0000 (0.00kPa)	Normal conversion flow rate
	Other than 0x0000 (0.0°C)	-	Standard conversion flow rate

When you select "with" conversion, "Normal" or "Standard" display above the partition line turns on. The integrated flow rate/instantaneous flow rate display/output signal correspond to the conversion flow rate together.
When you select "without" conversion, "Normal" or "Standard" display above the partition line turns off. The integrated flow rate/instantaneous flow rate display/output signal correspond to the Actual flow rate together.

Be careful because if you set the flow rate conversion select (in a case where you access the internal address 010FH of the flow rate conversion by means of the function code 06 or 10 even if you do not change the setting),a pulse constant automatically switches to the setting of 1000[L/P].

Example: A case where you switch to Conversion from No conversion
Pulse constant 10L/P, No conversion
↓ Select Conversion.
Pulse constant 1000L/P, normal flow rate or standard flow rate

13. [Address 0110H] Used gas pressure set value（gage）

When you set this parameter, set a 100x value.
With 2byte data, setting is possible in the following ranges:

UX: 100x value within 0 to 100.00[kPa] 0000H to 2710H
UZ: 100x value within 0 to 500.00[kPa] 0000H to C350H

This is only valid in the type wiht pressure sensor. You cannot perform setting or read-out in the type wiht pressure sensor.

14. [Address 0111H] Test mode time select

The parameter is to select a valid period of the test mode, “3 minutes (0000H)”, “60 minutes (0001H”, or “Unlimited (0002H)”.
The test mode is designed to simply perform sensing of any piping leak by temporarily cancelling the low flow cut-off. For details, refer to “4 - 2. Measuring Microflow Rate (Test Mode)” in the instruction manual.

15. [Address 0112H] Conversion reference pressure（gage）

The item is to set a specified pressure that serves as a reference at the time of conversion.
When you set this parameter, set a 100x value.
Setting is possible in in the range of 0.01 kPa, in the range of 100x values 0x0000 to 0x03E8 of 0.00 to 10.00kPa.
The conversion reference pressure is valid only when you select “Yes (Normal or standard flow rate)” for [Address 010FH] Actual flow conversion select.
When you select “No (Actual flow rate）” for Actual flow conversion select, you may change a conversion reference pressure, but the change is not reflected in the flow rate conversion.

16. [Address 0113H, 0114H] Integration value upper limit alarm threshold

The parameter is to set an integration value upper limit alarm threshold.
When you set this parameter, set a 100x value.
With 4byte data, setting is possible in the range of 100x values 00000000H to 000F423FH of 0 to 9999.99[m3/h].

An address is assigned to each of upper 2 bytes and lower 2 bytes.
[Address 0113H]: Integration value upper limit alarm threshold (Upper)
[Address 0114H]: Integration value upper limit alarm threshold (Lower)

You can set upper level only or lower level only. Note, however, that a settable range is determined as the 4byte data.
Example) Upper 0005H, Lower 9876H→Integration value upper limit alarm threshold=00059876H→3667.10[m3/h]
If you try to change only the upper bytes to 000FH, setting is not allowed due to out of setting range.
Alarm output upper limit=000F9876H→10220.70[m3/h]>9999.99[m3/h]

17. [Address 0115H] Alarm output select

The item is to set function assignment of contact output to “Flow rate upper and lower limit alarm（0000H）”or “Integration value upper limit alarm (0001H)”.

18. [Address 0116H] Gas species select

The parameter is to set “13A (0000H)”, “Propane (0001H)”, “Butane (0002H)”, “Nitrogen (0003H)”, “Air (0004H)”, or “Argon (0005H)”.

Since the specified gas species is set at the time of factory shipment, you do not have to change it.
In addition, “Air”in the choices is intended for maintenance, no use with “Air” is allowed.

19. [Address 0117H] Low flow cut-off flow rate

The parameter is to set a low flow cut-off value (Q_{cut}) with the instantaneous flow rate being 0m^3/h.
When you set this parameter, set a 100x value. For example, when you set 1.0[m^3/h], set 1.0×100=100(dec)→0064(hex). Then, -0.9 to +0.9[m^3/h] will be 0[m^3/h].
Setting is possible in the range of $0 \leq Q_{cut} \leq Qmin$. Qmin varies depending on a model. Refer to the table below.

Model	Qmin[m^3/h]	Set value upper limit (hex)
UX25s	3.00	012C
UX32	3.00	012C
UX40	6.00	0258
UX50	20.00	07D0
UZ40	20.00	07D0
UZ50	30.00	0BB8

The set flow rate will be the flow rate selected for [Address 010FH] Actual flow conversion select.

20. [Address 0118H] Atmospheric pressure in usage environment

The item is set an absolute pressure for the atmospheric pressure in usage environment. Use the set value when calculating the conversion flow rate.
When you set this parameter, set a 10x value. For example, if you set 101.3 [kPa], set 101.3×10=1013(dec)→03F5(hex).

The parameter is set to 101.3[kPa] at the time of factory shipment. If you use the factory default at a location with a high altitude, an error occurs during calculation of the conversion flow rate. Thus, set an appropriate atmospheric value.
The table below shows a relation of the altitude, atmospheric pressure, and an extreme error.
(Not that the following table is for reference and the values vary depending on the environmental conditions.)

Altitude（m）	Atmospheric pressure (Absolute pressure) （kPa）	Extreme error (%) (Set value of the atmospheric pressure in usage environment: 101.3kPa Measured pressure value: 0kPa (gauge pressure))
0	101.3	±0.0
200	98.95	+2.4
400	96.61	+4.9
1000	89.87	+12.7

21. [Address 0119H] Pressure moving average select

The parameter is to select “Yes (0001H)” or “No (0000H)” for averaging of pressure values. When “Yes” is selected, a moving average of the most recently measured pressure values for 10 times is taken, and displayed/outputted.

This is only valid in the type wiht pressure sensor. You cannot perform setting or read-out in the Type wihtout pressure sensor.

22. [Address 011AH] With or without pressure zero-cut

Select ”With zero-cut(on)”“or”Without zero-cut(OFF)”for zero-cut of pressure value.If ’With zero-cut(on)”is selected,in selected,in the case that the measured pressure value is 5[kPa]or less,the pressure value is indicated and outputted as 0[kPa].In the case the setting of “pressure value averaging” is “With averaging”,zero-cut judgment is to be done based on the pressure value of moving aveage after such averaging.

7.2.3 Flow meter information, Clearing

For the flow meter information, internal information can be acquired. Therefore, the following function code can be used.

Code(hex)	Function
03	Read out a parameter

In addition, for clearing, the following function can be used.

Code(hex)	Function
05	Cancel the integration value upper limit alarm

Function code (hex)	Address (hex)	Area Name	Function	Description	Details page
03	0200	Flow meter information	Instantaneous flow rate (Upper 2 bytes)	Signed 4-byte data (long type) 100x value	25
	0201		Instantaneous flow rate (Lower 2 bytes)		
	0202		- Type wihtout pressure sensor Used gas pressure set value (2 bytes)	Unsigned 2-byte data (unsigned int type) 100 x value	25
			- Type wiht pressure sensor Measured pressure (2 bytes)	Unsigned 2-byte data (unsigned int type) 10x value	
	0203		Temperature (2 bytes)	Signed 2-byte data (int type) 10x value	25
	0204		Positive integration value ① (Upper 2 bytes of 6-byte data)	Unsigned 6-byte data	25
	0205		Positive integration value ① (Middle 2 bytes of 6-byte data)		
	0206		Positive integration value ① (Lower 2 bytes of 6-byte data)		
	0207		Trip integration value ① (Upper 2 bytes of 6-byte data)	Unsigned 6-byte data	25
	0208		Trip integration value ① (Middle 2 bytes of 6-byte data)		
	0209		Trip integration value ① (Lower 2 bytes of 6-byte data)		
	020A		Error information (2 bytes)	Unsigned 2-byte data (unsigned int type)	26
	020B		Positive integration value ② (Upper 2 bytes of 4-byte data)	Unsigned 4-byte data	26
	020C		Positive integration value ② (Lower 2 bytes of 4-byte data)		
	020D		Trip integration value ② (Upper 2 bytes of 4-byte data)	Unsigned 4-byte data	26
	020E		Trip integration value ② （Lower 2 bytes of 4-byte data）		
05	0300	Integration value upper limit alarm cancel	Cancel the integration value upper limit alarm.	0000 ：Cancel the integration value upper limit alarm	27

1. [Address 0200H, 0201H] Instantaneous flow rate

The item is the instantaneous flow rate corresponding to [Address 010FH] Actual flow conversion select. For signed 4-byte data, the flow meter responds with a 100x value of an actual value.

Each of the upper 2 bytes and lower 2 bytes of the 4-byte data can be read out separately.

(Example) Case of the instantaneous flow rate 123.45[m^3/h]

(123.45×100=12345(dec)→00003039(hex))

- Read-out data for the upper2 bytes: 0000H
- Read-out data for the lower 2 bytes: 3039H
- Read-out data for the 4 bytes: 00003039H

2. [Address 0202H] Pressure [kPa]

- Type wihtout pressure sensor: This is [Address 0110H] Used gas pressure set value (gage).
  For unsigned 2-byte data, the flow meter responds with a 100x value.
  (Example) Case of pressure 3.00[kPa]
  (3.00×100=300(dec)→012C(hex))
  - Read-out data: 012CH

- Type wiht pressure sensor: This is a measured pressure value.
  For unsigned 2-byte data, the flow meter responds with a 10x value of the actual value.
  (Example) Case of pressure 123.4[kPa]
  (123.4×10=1234(dec)→04D2(hex))
  - Read-out data: 04D2H

3. [Address 0203H] Temperature [°C]

For signed 2-byte data, the flow meter responds with a 10x value of the actual value.

(Example) Case of temperature-9.4[°C] (-9.4×10=-94(dec)→ FFA2 (hex))

- Rad-out data: FFA2H

4. [Addresses 0204H, 0205H, 0206H] Positive integration value ① 6-byte data
   [Addresses 0207H, 0208H, 0209H] Trip integration value ① 6-byte data

These are the integration flow rates corresponding to [Address 010FH] Actual flow conversion select. For unsigned 6-byte data, the flow meter responds with a 1 to 100x value of the actual value.

Each of the upper 2 bytes, middle 2 bytes, and lower 2 bytes of the 6-byte data can be read out separately.

Since a multiple varies depending on [Address 010FH] Actual flow conversion select, refer to the table below.

Actual flow conversion select	
Conversion	10x value hex: 003B 9AC9 FFFFH dec: 255,999,999,999
No conversion	100x value hex: 0254 0BE3 FFFFH dec: 2,559,999,999,999

In addition, even if respective integration value displays overflow, true integration values are read out as the read-out values.

Example) Read-out value: Case of 00086B76CF28H

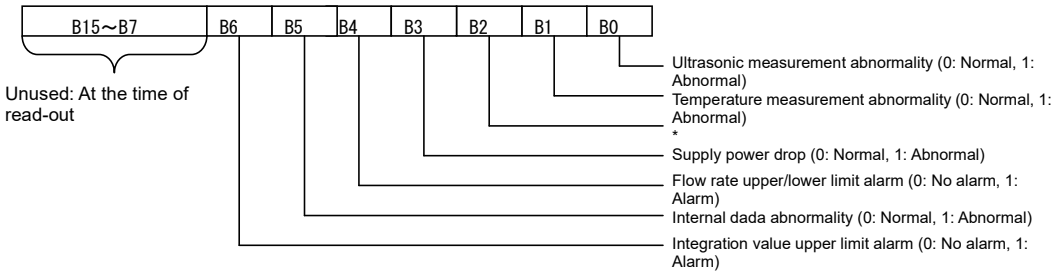
	Positive integration value	Trip integration value
[1x value]	3***6162686760***	36***162686760***
[10x value]	3***616268676.0***	36***16268676.0***
[100x value]	3***61626867.60***	36***1626867.60***

*The underlined italic parts are displayed values.

5. [Address 020AH] Error information

The item is to read out a state of the flow meter.

For 2-byte data, each bit represents the following error information. In the case of abnormality, the bit is 1, and in the case of no abnormality or in the case of no use, the bit is 0.



*Type wihtout pressure sensor: Correction abnormality (0: Normal, 1: Abnormal)

Type wiht pressure sensor: Pressure measurement abnormality (0: Normal, 1: Abnormal)

6. [Address 020BH, 020CH] Positive integration value ② 4-byte data

[Address 020DH, 020EH] Trip integration value ② 4-byte data

- Type wihtout pressure sensor: This is the integration flow rate value of the Actual flow rate.
- Type wiht pressure sensor: This is the integration flow rate corresponding to [Address 010FH] Actual flow conversion select.

In the case of unsigned 4-byte data, the flow meter responds with a ┆┈┈┆ to 100x value, for the part enclosed by the dot-line in the table below.

1) Type wihtout pressure sensor, Type wiht pressure sensor: “No flow rate conversion” is selected

	Display example	Read-out value
Positive integration value		100x value of a 9-digit display value 2FC84173H (100x value of 8016531.07) Read-out value (Max.) hex: 3B9AC9FFH dec: 999,999,999
Trip integration value		100x value of a 9-digit display value 2FC84173H (100x value of 8016531.07) Read-out value (Max.) hex: 3B9AC9FFH dec: 999,999,999

2) Type wiht pressure sensor: “Flow rate conversion” is selected.

	Display example	Read-out value
Positive integration value		100x value of a 9-digit display value 3A6C22C5H (10x value of 98016531.7) Read-out value (Max) hex: 3B9AC9FFH dec : 999,999,999
Trip integration value		100x value of a 8-digit display value 04C739C5H (10x value of 8016531.7) Read-out value (Max) hex: 05F5E0FFH dec: 99,999,999

Each of the upper 2 bytes and lower 2 bytes of the 4-byte data can be read out separately. Since the multiple varies depending on [Address 010FH] Flow rate conversion select, refer to the above example.

7. [Address 0300H] Integration value upper limit alarm clear

The item is to clear the integration value upper limit alarm.
For set data, only a clear command by 0000H is accepted.

8 Factory Default Settings List of Set Values

Address (hex)	Parameter	Setting Value					
		Contents			hex		
0100	Conversion Reference Temperature	0°C			0000H		
0101	Output Pulse Constant	1000L/P			0003H		
0102	Alarm output contact state	N.O			0000H		
0103	Alarm output upper limit	9999.9 m^3/h			0001H		
0104	Alarm output upper limit				869FH		
0105	Alarm output lower limit	0 m^3/h			0000H		
0106	Alarm output lower limit				0000H		
0107	Alarm output hysteresis width	0 m^3/h			0000H		
0108	Alarm output hysteresis width				0000H		
0109	Instantaneous flow moving average times	4 times			0004H		
010A	Analog output full-scale flow rate	*1					
010B	Analog output full-scale flow rate						
010C	Analog output switching	Instantaneous flow rate			0000H		
010D	Communication bit rate	9600bps			0001H		
010E	RTU address	001			0001H		
010F	Actual flow rate conversion select	Type wihtout pressure sensor: No conversion	Type wiht pressure sensor: Conversion		0000H	0001H	
0110	Used gas pressure set value (gage)	10kPa			03E8H		
0111	Test mode time select	3 minutes			0000H		
0112	Conversion reference pressure (gage)	0kPa			0000H		
0113	Integration value upper limit alarm threshold (Upper 2 bytes)	9999.99			000FH		
0114	Integration value upper limit alarm threshold (Lower 2 bytes)				423FH		
0115	Alarm output select	Flow rate upper/lower limit alarm			0000H		
0116	Gas species select	*The gas species that you specified at the time or ordering is set.					
0117	Low flow cut-off value	25s/32A: 0.14m3/h	40A: 0.3m^3/h	50A: 0.6m^3/h	0000EH	001EH	003CH
0118	Atmospheric pressure in usage environment	101.3			03F5H		
0119	Pressure moving average select	Yes			0001H		

*1 Refer to the following:

Class UX[Bore]-[Pressure][Power Supply]-[Flow direction]-[Gas species]

UZ[Bore]-[Pressure][Power Supply]-[Flow direction]-[Gas species]

	[Bore]	[Pressure]	Full-scale [m^3/h]	Upper 2 bytes	Lower 2 bytes
UX	25s	0	35	0000H	015EH
	32	100	100	0000H	03E8H
	40A	0	80	0000H	0320H
		100	300	0000H	0BB8H
	50A	0	150	0000H	05DCH
		100	600	0000H	1770H
UZ	40A	0	80	0000H	0320H
		500	700	0000H	1B58H
	50A	0	150	0000H	05DCH
		500	1300	0000H	32C8H

9 Calculation of Error Check Code (CRC-16)

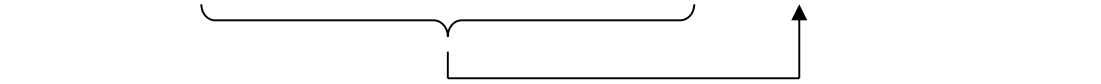
9.1 Overview

The Modbus RTU protocol includes an error check code based on the CRC method in each message. The error check code consists of 16 bits, is calculated by the transmitting side, and is added to the message. The
receiving side recalculates a CRC based on the received message and compares the result of the calculation with the actually received error check code. If the two values do not match, it is determined that an error has occurred.

CRC calculation is performed, starting with the RTU address at the head of the message to the tail end of the data. For the calculation, only 8 bits of each characters are used, and start and stop, and parity bit are not applied to the CRC.

When the error check code is added to the message, the lower byte of the calculation result is added first, followed by the upper byte.

Start	RTU address	Function code	Data	Error check code	End
Silent interval	1 byte	1 byte	n bytes	2 bytes	Silent Interval



9.2 Calculation Procedure

① Initializes the CRC code to “FFFFH.”

② Calculates an exclusive OR (XOR) with the lower 1 byte of the CRC code and the first character of the message, and store it in the CRC code.

③ Proceeds to ④ if the least significant bit of the CRC code is “1.”
Proceeds to ⑤ if the least significant bit of the CRC code is “0.”

④ Shift the CRC code to the right by 1 bit. Then, calculates exclusive OR with the generating polynomial A001H and store it in the CRC code.→Proceed to ⑥.

⑤ Shift the CRC code to the right by 1 bit.→Proceed to ⑥.

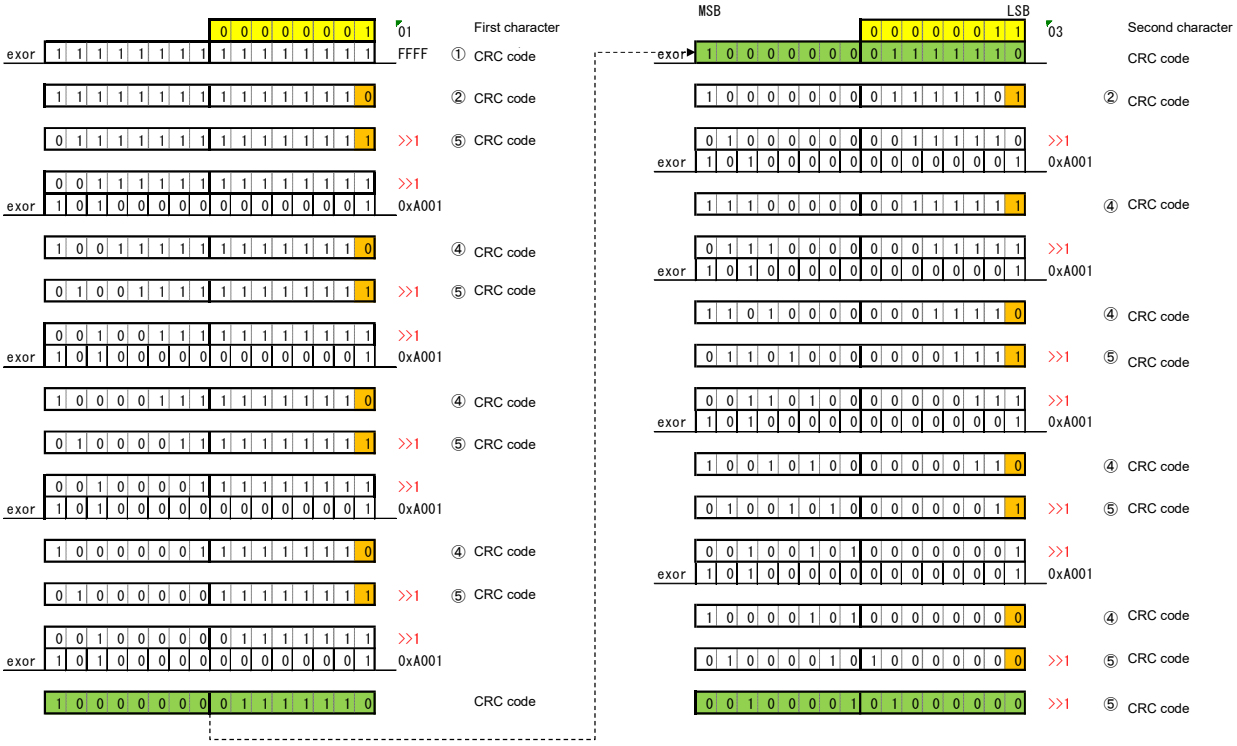
⑥ Repeat steps ③→④ or ⑤ until the CRC code is shifted by 8 bits.

⑦ Repeat steps ② to ⑥ similarly for the second and subsequent characters, and apply to all characters in the calculation range.

⑧ A value that finally remains in the CRC code is the error check code.

<Calculation Example>
When a message is 01 03 02 01 09 (hex), the CRC code is to be D279H.
Since the lower bytes of the calculation result is first added, the transmission data is to be 01 03 02 01 09 79 D2.

[Details]
The following figure illustrates contents of the calculation of the first and second characters (01 and 03):



When the third to fifth characters are calculated in a similar manner, the CRC code will be D279H.