March 7, 2014
Reference No. TS-TRX5-002
ver.1.0

Ultrasonic Flow Meter for Air TRX/TRZ

MODBUS RTU Communication Specifications

Aichi tokei denki co., ltd.

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1 Overview

This communication specifications apply to the ultrasonic flow meter for air TRX(R)-□/5P, TRZ(R)-C/5P.

This document explains only the communication procedures. For other operations, see the operation manual supplied with the ultrasonic flow meter for air (hereinafter referred to as the flow meter).

The flow meter adopts the start-stop synchronous serial bus interface which complies with EIA-485. This interface enables to connect up to 31 flow meters[*1] to establish a system.
As a communication protocol, Modbus RTU Protocol is adopted, enabling reference to measurement data and internal information using commands to each flow meter.

*1 The number of connectable units varies according to the communication parameters. Please see “3 Communication Specifications.”

2 Before Using Product

2.1 Connection

As referring to the operation manual of the ultrasonic flow meter for air, connect the flow meter to your communication device.

2.2 Setting of items related to communication (flow meter)

For the setting methods of 2.2.1 to 2.2.4, see “2-2 Procedures to change settings” and “2-3 Details of setting items” of the Operation Manual.

2.2.1 Setting of RTU address of flow meter

Set the RTU address in the item No. F19 using the setting button of the flow meter main unit.
If you connect multiple flow meters, do no use the same number.

Available numbers: 001 to 247

*000 cannot be used.

2.2.2 Setting of baud rate of flow meter

Select the baud rate in the item No. F20 using the setting button of the flow meter main unit.

*If 115200 bps is selected, the maximum number of the connectable units is 8.

2.2.3 Setting of communication protocol of flow meter

Select the stop bit length in the item No. F21 and the parity in the item No. F22 using the setting button of the flow meter main unit.

2.2.4 Setting of terminator resistor

Select whether or not to use a terminator resistor in the item No. F23 using the setting button of the flow meter main unit.
Select OFF under the normal conditions.
If multiple flow meters are connected, set ON to the flow meter which is the physically farthest from the communication device.

2.3 Setting of items related to communication (communication device)

Match the communication speed, stop bit length, and parity with the settings of the flow meter.
*Set 8 bits to the data length.

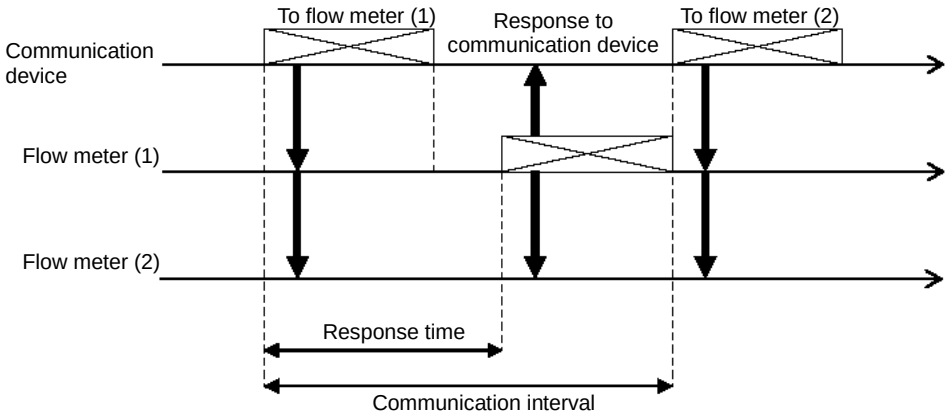
3 Communication specifications

Interface	Compliance with EIA-485
Communication method	Half-duplex communication
Synchronous system	Start-stop synchronous communication method
Max. number of connectable units	115200 bps Max. 8 units 9600 to 57600 bps Max. 31 units
Transmission mode	Modbus RTU
Baud rate [bps]	Can be selected by parameter setting. 9600, 19200, 38400, 57600, **115200**
Bit length [bit]	8
Stop bit [bit]	Can be selected by parameter setting. **1**, 2
Parity	Can be selected by parameter setting. No parity, odd parity, **even parity**
Sending and receiving buffer size [byte]	100
Response time*	9600 bps: 100 to 130 ms 19200 bps: 70 to 100 ms 38400 bps: 50 to 80 ms 57600 bps: 40 to 70 ms 115200 bps: 40 to 70 ms
Communication intervals*	Response time + longest time of a response message

The **items in bold letters** in the table are selected in the initial settings.

*About response time and communication intervals
Since the response time and communication interval change according to the length of a message from the communication device and the length of a response message from the flow meter to the communication device, their values vary according to the baud rate. See the figure below.

<Figure of communication timing>



4 Message frame configuration

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

*Non-communication time of 3.5 letters or more

<RTU address>
The number specified to the flow meter (1 to 247 (01H to F7H)).
01H is set in the initial setting.
Only the flow meter which matches the RTU address processes a message from the communication device and returns a response message.

*A broadcast function is not supported.

<Function code>
A code to specify the function you want the flow meter to execute.
The available function codes are shown below.

Code (hex)	Function
03	Read the parameters and information of the flow meter.
05	Clear the accumulated flow volumes. (Clear the forward flow, reverse flow, and trip flow at a time.) Clear parameters. (Reset the parameter values.)
06	Write a single parameter.
10	Write multiple parameters.

<Data>
Data to execute a function code. The configuration of the data section varies according to the function code. Please see 7 Data Specifications for details.

<Error check code>
A code to detect an error (change of bit) in a message during signal transmission. The check method is based on the CRC method. See “9 Calculation of Error Check Code (CRC-16)” for details.
When the flow meter receives a message, it calculates the CRC value based on the received message and compares it with the received CRC value. If these 2 values do not match, it results in an error.
When the flow meter sends a message, it calculates the CRC value based on the message and attaches the CRC value at the end of the message to be sent.

5 Function code

5.1 [Function code 03] Read the parameters and information of the flow meter.

Function code 03H is a function code to read the parameters and information of the flow meter. The function code and data sections in “4 Message Frame Configuration” are shown below.

<Query configuration>

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

Function code : 03H
Start address : Resistor address (0100H to 0117H)
Number of resistors : Number of read data (0001H to 0018H)

<Response configuration>

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

Function code : 03H
Number of data bytes : Number of bytes of response data
Data : Read data

Example) When reading [Address 010AH] Unit pulse output unit (0001H: 100L/P) and [Address 010BH] Output pulse width (0000H: 50ms).

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			03
Data	Start address	(Upper)	01
		(Lower)	0A
	Number of resistors	(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 010A)	(Upper)	00
		(Lower)	01
	Data 2 (Data of address 010B)	(Upper)	00
		(Lower)	00
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

5.2 [Function code 05] Clear the accumulated flow volume and parameters.

Function code 05H is a function code to clear all the accumulated flow volume (forward flow, reverse flow, and trip flow) calculated by the flow meter and reset the parameters to the standard factory delivery settings.

When the parameters are reset, the flow meter operates using the parameters with the standard initial settings after communication starts.
The items related to communication ([Address 0114 to 0117] RTU address, bit rate, stop bit length, parity bit) are out of the scope of clearing the parameters. For details, see [Address 0301H] Parameter reset on page 25.

The function code and data sections in “4 Message Frame Configuration” are shown below.

<Query configuration>

Function code		05H
Data	Start address	(Upper)
		(Lower)
	Data to be changed	00H
		00H

Function code : 05H
Start address : Resistor address (0300H to 0301H)
Data to be changed : 0000H (fixed)

<Response configuration>

Function code		05H
Data	Start address	(Upper)
		(Lower)
	Data to be changed	00H
		00H

Function code : 05H
Start address : Same as the start address in query.
Data to be changed : 0000H (fixed)

Example) When the accumulated flow volumes are cleared.

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			05
Data	Start address	(Upper)	03
		(Lower)	00
	Data to be changed	(Upper)	00
		(Lower)	00
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

<Response> (hex value)

Start			Silent interval
RTU address			01
Function code			05
Data	Start address	(Upper)	03
		(Lower)	00
	Data to be changed	(Upper)	00
		(Lower)	00
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

5.3 [Function code 06] Write a single parameter.

Function code 06H is a function code to change (write) a single parameter.
The function code and data sections in “4 Message Frame Configuration” are shown below.

<Query configuration>

Function code		06H
Data	Start address	(Upper)
		(Lower)
	Data to be changed	(Upper)
		(Lower)

Function code : 06H
Start address : Resistor address (0100H to 0117H)
Data to be changed : Optional (For the settable range of data to be changed, see “7.2.1 Parameters.”)

<Response configuration>

Function code		06H
Data	Start address	(Upper)
		(Lower)
	Data to be changed	(Upper)
		(Lower)

Function code : 06H
Start address : Same as the start address in query.
Data to be changed : Same as the data to be changed in query.

Example) When display/output selection in [Address 0100H] is changed to forward/reverse (0001H).

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			06
Data	Start address	(Upper)	01
		(Lower)	00
	Data to be changed	(Upper)	00
		(Lower)	01
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
	Data to be changed	(Upper)	00
		(Lower)	01
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

5.4 [Function code 10] Write multiple parameters.

Function code 10H is a function code to change (write) multiple serial parameters.
The function code and data sections in “4 Message Frame Configuration” are shown below.

<Query configuration>

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

Function code : 10H
Start address : Resistor address (0100H to 0117H)
Number of resistors : Number of written data (0001H to 0018H)
Number of data bytes : Number of bytes of written data
Data to be changed : Optional (For the settable range of data to be changed, see “7.2.1 Parameters.”

<Response configuration>

Function code		06H
Data	Start address	(Upper)
		(Lower)
	Number of resistors	(Upper)
		(Lower)

Function code : 06H
Start address : Same as the start address in query.
Number of resistors : Same as the number of resistors in query.

Example) When the flow-rate moving average number of times in [Address 0109H] is changed to 32 (0005H), and the flow rate conversion selection in [Address 010AH] is changed to ON (0001H).

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			10
Data	Start address	(Upper)	01
		(Lower)	0B
	Number of resistors	(Upper)	00
		(Lower)	02
	Number of data bytes	Optional	04
	Data 1 (Flow-rate moving average number of times)	(Upper)	00
		(Lower)	05
	Data 2 (Flow-rate conversion selection)	(Upper)	00
		(Lower)	01
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)	0B
	Number of resistors	(Upper)	00
		(Lower)	02
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

5.5 About items related to communication

When one or more of the items related to communication (RTU address, communication bit rate, stop bit length, and parity bit) are written, a response is returned with the parameter(s) before the change, and the flow meter will operate with the new setting(s) from the next communication.

Example 1) When the RTU address of the flow meter is changed 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)	14	14
	Data to be changed	(Upper)	00	00
		(Lower)	02	02
Error check code		(Lower)	(CRC)	(CRC)
		(Upper)	(CRC)	(CRC)
End			Silent interval	Silent interval

A response is returned with 01H.

After that, the flow meter operates with the RTU address of 02.

Example 2) When the baud rate bit rate is changed from 9600 bps to 115200 bps, and the stop bit length is changed from 1 bit to 2 bits (hex value)

			Query	Response
Start			Silent interval	Silent interval
RTU address			01	01
Function code			10	10
Data	Start address	(Upper)	01	01
		(Lower)	15	15
	Number of resistors	(Upper)	00	00
		(Lower)	02	02
	Number of data bytes		04	
	Data 1 (Communication bit rate)	(Upper)	00	
		(Lower)	04	
	Data 2 (Stop bit length)	(Upper)	00	
		(Lower)	01	
Error check code		(Lower)	(CRC)	(CRC)
		(Upper)	(CRC)	(CRC)
End			Silent interval	Silent interval

A response is returned at 9600 bps with 1 stop bit.

After that, the flow meter operates at 115200 bps with 2 stop bits.

6 About communication errors

6.1 List of communication errors

Communication errors are defined as shown in the table below.

Error code	Error item	Description
01H	Illegal function	The function code is not 03H, 05H, 06H, and 10H.
02H	Illegal data address	The address does not exist. An internal address exceeding the buffer size is specified.
03H	Illegal data	The data value is out of the scope.
No (no response)	Other communication errors	Framing error, overrun error, parity error, CRC check error

6.2 Error response

The function code and data sections in “4 Message Frame Configuration” are shown below.
In the case of an error response, the function code becomes an error function code in which 1 is set in the highest bit.

Error function code

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

<Response configuration>

Error function code		See the above table.
Data	Error code	Any of 01H, 02H, or 03H

Example) When 0002H is set to fluid selection.
Since the setting data 0002H is out of the scope, the error code 03H for illegal code is returned.

<Query> (hex value)

Start			Silent interval
RTU address			01
Function code			06
Data	Start address	(Upper)	01
		(Lower)	0F
	Data to be changed	(Upper)	**00**
		(Lower)	**02**
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 bit of 06H.
Data	Error code		**03**
Error check code		(Lower)	(CRC)
		(Upper)	(CRC)
End			Silent interval

6.3 About processing of illegal data

Upon writing of a single item, if illegal data is detected, writing is canceled.

When you write multiple items, if illegal data is detected in any of the items, the values before the illegal data are set, but those after the illegal data are not set.

For instance, if you write [Addresses 010EH to 0110H],

Example 1)

Test mode time : 0001H (Normal data)
Fluid selection : 0011H (**Illegal data**)
Current output item selection: 0000H (Normal data)

As shown above, if the second item among the three setting items has illegal data, the test mode time in the first item is set, but the fluid selection and current output item selection are not set.
As a response, the error code 03H for illegal data is returned.

Example 2)

Test mode time : 0003H (**Illegal data**)
Fluid selection : 0001H (Normal data)
Current output item selection: 0000H (Normal data)

As shown above, if the first item among the three setting items has illegal data, all three items are not set.
As a response, the error code 03H for illegal data is returned.

7 Data specifications

7.1 Address and data

Data are arranged as shown below.

Address	
0000H to 00FFH	For system use
0100H to 0117H	Parameters of flow meter
0118H to 01FFH	For system use
0200H to 0212H	Information of flow meter
0213H to 02FFH	For system use
0300H to 0301H	Clear command
0302H to FFFFH	For system use

*The areas for system use cannot be used.

7.2 List of data

7.2.1 Parameters

The setting and internal information of each parameter can be referenced. For that purpose, the following function codes can be used.

Code (hex)	Function
03	Read the parameter.
06	Write a single parameter.
10	Write multiple parameters.

Function code (hex)	Address (hex)	Area name	Parameter	Setting value (Range in hex)	Details Page
03 or 06 or 10	0100	Parameters of flow meter	Display/output selection	0000: Forward flow 0001: Forward/reverse flow	17
	0101		Analog output full scale flow-rate: Upper 2 bytes	0000 to 0001	17
	0102		Analog output full scale flow-rate: Lower 2 bytes	0000 to FFFF	
	0103		State of contact point selection	0000: Normal open 0001: Normal close	17
	0104		Lower limit alarm flow-rate: Upper 2 bytes	0000 to FFFF	17
	0105		Lower limit alarm flow-rate: Lower 2 bytes	0000 to FFFF	
	0106		Upper limit alarm flow-rate: Upper 2 bytes	0000 to FFFF	17
	0107		Upper limit alarm flow-rate: Lower 2 bytes	0000 to FFFF	
	0108		Alarm judgment value hysteresis width	0000 to 270F	18
	0109		Flow-rate moving average number of times	0000: 1 time 0001: 2 times 0002: 4 times 0003: 8 times 0004: 16 times 0005: 32 times 0006: 64 times	18
	010A		Output pulse unit	0000: 10L/P 0001: 100L/P 0002: 1000L/P 0003: 10000L/P	18
	010B		Pulse output method	0000: 50 ms one-shot 0001: 100 ms one-shot 0002: 125 ms one-shot 0003: 250 ms one-shot 0004: 500 ms one-shot 0005: Duty	19
	010C		Flow-rate conversion selection	0000: No conversion (actual flow-rates) 0001: Normal conversion 0002: Standard conversion	19

Function code (hex)	Address (hex)	Area name	Parameter	Setting value (Range in hex)	Details Page
	010D		Standard conversion temperature	FFF6 to 003C	19
	010E		Test mode time selection	0000: 3 min. 0001: 60 min. 0002: Unlimited	20
	010F		Fluid selection	0000: Air 0001: Nitrogen	20
	0110		Current output correlation value	0000: Flow rate 0001: Pressure 0002: Temperature	20
	0111		Low flow cutoff flow rate	0000 to 0190	20
	0112		Atmospheric pressure of the working environment	0000 to 270F	21
	0113		With or without pressure value averaging	0000: OFF 0001: ON (10 times)	21
	0114		RTU address	0001 to 00F7	21
	0115		Communication bit rate	0000: 9600 bps 0001: 19200 bps 0002: 38400 bps 0003: 57600 bps 0004: 115200 bps	21
	0116		Stop bit length	0000: 1 bit 0001: 2 bits	21
	0117		Parity bit	0000: None 0001: Odd number 0002: Even number	21

7.2.2 Details of parameters

[Address 0100H] Display/output selection

Select “Forward flow (0000H)” measurement or “Forward/reverse flow (0001H)” measurement.

- Forward flow
  The “forward accumulated flow volume” or “trip accumulated flow volume” is indicated on the main display.
- Forward/reverse flow
  The “forward accumulated flow volume” or “reverse accumulated flow volume” is indicated on the main display.

The current output value varies according to the selection. For details, see [Address 0110H] Current output correlation value on page 20.

[Address 0101H, 0102H] Analog output full scale flow-rate

Select the analog output full scale flow-rate.
This setting takes effect when [Address 0110H] Analog output correlation value is set to "Instantaneous flow-rate."
The FS flow-rate corresponds to the setting of [Address 010HC] Flow-rate conversion selection.

The full scale flow-rate value is 4-byte data and any value in the range of 0 to 99999 (00000000H to 0001869FH) [m^3/h] can be set.
The addresses are assigned to the upper 2 bytes and lower 2 bytes separately.
[Address 0101H] Analog output full scale flow-rate (upper bytes)
[Address 0102H] Analog output full scale flow-rate (lower bytes)

You can set the upper bytes only or lower bytes only. Note that, however, 4-byte data is used to judge if the value is within the settable range or not.
Example) Upper bytes: 0000H, Lower bytes: 9876H -> Analogy output full scale flow-rate = 00009876H -> 39030 [m^3/h]
If you attempt to change the upper bytes only to 0001H,
Analog output full scale flow-rate = 00019876H -> 104566 [m^3/h] > 99999 [m^3/h]
Since the value is out of the setting range, it cannot be set.

[Address 0103H] State of contact point selection

Select “Normal open (0000H)” or “Normal close (0001H)”.
Set this parameter to "Normal open" in case of using a battery-powered pulse signal receiving device.

Addresses 0104H to 0108H are judgment values for "Error information and Flow-rate upper/lower limit aberrations Y/N" of flow meter information.

[Addresses 0104H and 0105H] Lower limit alarm flow-rate

Set the lower limit alarm flow-rate of the upper/lower limit flow-rate alarms.

* This value is 4-byte data as with the analog output full scale flow-rate. You can set upper 2 bytes and lower 2 bytes. Note that the settable range is -59999 to 59999 (FFFF15A1H to 0000EA5FH) [m^3/h] in 4 bytes.

[Addresses 0106H and 0107H] Upper limit alarm flow-rate

Set the upper limit alarm flow-rate of the upper/lower limit flow-rate alarms.

* This value is 4-byte data as with the analog output full scale flow-rate. You can set upper 2 bytes and lower 2 bytes. Note that the settable range is -59999 to 59999 (FFFF15A1H to 0000EA5FH) [m^3/h] in 4 bytes.

[Address 0108H] Alarm judgment value hysteresis width

With regard to the flow-rate value defined for the upper/lower limits of the upper/lower limit flow-rate alarms, a hysteresis width range is defined for the alarm judgment value as the range of flow-rates for terminating the alarm.
The settable range is 0 to 9999 (0000H to 270FH) [m^3/h].

[Address 0109H] Flow-rate moving average number of times

This denotes the moving average number of times for the instantaneous flow-rate measurement results.
“No moving average (0000H)”, “2 times (0001H)”, “4 times (0002H)”, “8 times (0003H)”, “16 times (0004H)”, “32 times (0005H)”, and “64 times (0006H)” are selectable.
The most recently measured instantaneous flow-rate is displayed/output as the average value of the selected moving average number of times.
”4 times” is set in the standard factory delivery settings, and there is no need to change this setting.

[Address 010AH] Output pulse unit

Select the weight of the output pulse from “10L/P (0000H)”, “100L/P (0001H)”, “1000L/P (0002H)”, and “10000L/P (0003H)”.

This setting may not be available depending on the nominal diameter and combination of the pulse output method in [Address 0101BH] and flow-rate conversion selection in [Address 010CH].
Please see the table below for details.

Nominal diameter	Pulse constant	Duty output			One-shot pulse output														
					Pulse ON width [ms]														
					During actual flow rate					Standard conversion					Normal conversion				
		Actual flow rate	Standard	Normal	50	100	125	250	500	50	100	125	250	500	50	100	125	250	500
25A	10		✕	✕					✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100			○										✕					✕
	1000																		
	10000	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
32A	10		✕	✕				✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100			○									✕	✕				✕	✕
	1000																		
	10000	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
40A	10		✕	✕				✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100			○									✕	✕				✕	✕
	1000																		
	10000	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
50A	10		✕	✕		✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100			○							✕	✕	✕	✕		✕	✕	✕	✕
	1000																		
	10000	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
65A	10		✕	✕		✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100			○						✕	✕	✕	✕	✕		✕	✕	✕	✕
	1000													✕					
	10000	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
80A	10		✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100		✕	○					✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	1000													✕					✕
	10000	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
100A	10	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100		✕	✕					✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	1000			○									✕	✕					✕
	10000																		
150A	10	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100		✕	✕			✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	1000			○							✕	✕	✕	✕			✕	✕	✕
	10000																		
200A	10	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	100		✕	✕		✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕	✕
	1000			○							✕	✕	✕	✕		✕	✕	✕	✕
	10000																		

○ Standard factory delivery setting
Setting available
✕ Setting not available

[Address 010BH] Pulse output method

Select the pulse output method from the five one-shot modes (ON times: "50 ms (0000H)", "100 ms (0001H)", "125 ms (0002H)", "250 ms (0003H)", or "500 ms (0004H)") or Duty (0005H) mode.
Selecting one of the one-shot modes is recommended in case the signal receiving instrument you are using is battery-powered.
Make sure to check the specifications of the signal receiving instrument and set the appropriate ON time.

*The pulse ON width of a one-shot pulse has maximum +5 ms margin from the setting value.

Setting value	Scope of setting
50 ms	50 to 55 ms
100 ms	100 to 105 ms
125 ms	125 to 130 ms
250 ms	250 to 255 ms
500 ms	500 to 505 ms

[Address 010H] Flow-rate conversion selection

Select "N (OFF) (0000H)", "Y (Normal) (0001H)", or "Y (Standard) (0002H)" for flow rate conversion.
If you select "Yes" for conversion, the "Normal" or "Standard" lamp above the partition line will be turned on, and the accumulated flow volume display, instantaneous flow-rate display, and output signal will all correspond to the converted flow-rate.
If you select "No" for conversion, the "Normal" or "Standard" lamp above the partition line will be turned off, and the accumulated flow volume display, instantaneous flow-rate display, and output signal will all correspond to the actual flow-rate.

Note that **if you set flow-rate conversion**, the following settings are automatically set.

Pulse constant : 1000L/P
Pulse output width : 50 ms (When the pulse output method is one-shot pulse)

Example 1) When you change the setting from No conversion to Standard conversion
Nominal diameter 25A, pulse constant **10L/P**, pulse ON width **100 ms**, actual flow rate
↓ Standard flow-rate is set.
Nominal diameter 25A, pulse constant **1000L/P**, pulse ON width 5**0 ms**, standard flow rate

Example 2) When you change the setting from No conversion to No conversion
Nominal diameter 25A, pulse constant **10L/P**, pulse ON width **100 ms**, actual flow rate
↓ Actual flow-rate is set.
Nominal diameter 25A, pulse constant **1000L/P**, pulse ON width **50 ms**, actual flow rate

[Address 010DH] Standard conversion temperature

This parameter is used to set the temperature [ºC] to use as the basis for standard conversion.
The temperature can be set within a range between -10°C and +60°C (FFF6H to 003CH) in 1°C increments. When you set this parameter, treat it as data with sign.

Standard conversion temperature is enabled only when “Standard conversion flow-rate” is selected in Flow-rate conversion selection.
When “Actual flow rate” and “Normal flow-rate conversion” are selected in Flow-rate conversion selection, the conversion temperature can be changed, but it is not reflected to flow-rate conversion.

[Address 010EH] Test mode time selection

Select the test mode time from “3 min (0000H)”, “60 min (0001H)”, and “Unlimited (0002H)”.
The test mode is a mode to clear the low flow cutoff temporarily and perform a simple detection of leakage from pipes. For details, see “3) Test mode of 7. Operation Modes” in Operation Manual.

[Address 010FH] Fluid selection

Select “Air (0000H)” or “Nitrogen (0001H)”.
Even if you specified a flow meter for air in your initial order, you can use it for nitrogen by changing this setting. However, nitrogen cannot be selected when the nominal diameter is 100 to 200A.

[Address 0110H] Current output correlation value

Select any of "Instantaneous flow-rate (0000H)", "Pressure (0001H)", or "Temperature (0002H)" for the functional assignment of the current output.
When instantaneous flow-rate is selected, the instantaneous flow-rate correlation value that you have selected in [Address 010CH] Flow-rate conversion selection will be used.
The current output value varies according to [Address 0100H] Display/output selection.
Please see the table below.

		[Address 0100H] Display/output selection	
		Forward flow	Forward/reverse flow
[Address 0110H] Current output correlation value	Instantaneous flow-rate	Flow-rate 0 to + FS* Current 4 to 20 [mA] (Flow rate 0 → Current 4 [mA])	Flow-rate -FS to +FS* Current 4 to 20 [mA] (Flow rate 0 → Current 12 [mA])
	Pressure	Current value according to pressure [mA]	
	Temperature	Current value according to temperature [mA]	

*FS: Setting value of [Address 0101H, 0102H] Analog output full scale flow-rate

[Address 0111H] Low flow cutoff flow rate

This parameter is used to set the low flow cutoff (Q_{cut}) where the instantaneous flow-rate is 0 m^3/h.
When you set this parameter, set a 10-fold value. For instance, when you set 1.0 [m^3/h], set 1.0 × 10 = 10 (dec) → 000A (hex), and -1.0 to +1.0 [m^3/h] becomes 0 [m^3/h].
The settable range is defined as $0 \leq Q_{cut} <$ Qmin. Qmin varies according to the nominal diameter. See the table below for details.

Nominal diameter	Qmin [m^3/h]	Maximum setting value (hex)
25A	0.7	0007
32A	1.3	000D
40A	1.6	0010
50A	3	001E
65A	4.8	0030
80A	6	003C
100A	10	0064
150A	24	00F0
200A	40	0190

The set flow-rate will be the flow-rate you selected in [Address 010CH] Flow-rate conversion selection.

[Address 0112H] Atmospheric pressure of the working environment

Set the atmospheric pressure value [kPa] of the working environment in absolute pressure. When you set this parameter, set a 10-fold value. For instance, when you set 101.3 [kPa], set 101.3 × 10 = 1013 (dec) → 03F5 (hex).

The standard factory setting has been set to 101.3 [kPa]. Leave this setting unchanged unless you are operating the meter at higher elevations, etc.

[Address 0113H] With or without pressure value averaging

Set with or without pressure value averaging to either "With averaging (0001H)" or "No averaging (0000H)." If "With averaging" is selected, the moving average value of the 10 most recently measured pressures is used for display and output.

[Address 0114H] thru [Address 0117H] are settings relating to communication. When you change this setting, be sure to change the settings of the communication device as well.

[Address 0114H] RTU address

Set the RTU address of the flow meter.
The settable range is 001 to 247 (0001H to 00F7H).

[Address 0115H] Communication bit rate

Set the communication bit rate from “9600 bps (0000H)”, “19200 bps (0001H)”, “38400 bps (0002H)”, “57600 bps (0003H)”, or “115200 bps (0004H)”.

[Address 0116H] Stop bit length

Select the stop bit length from “1 bit (0000H)” or “2 bits (0001H)”.

[Address 0117H] Parity bit

Select the parity bit from “None (0000H)”, “Odd number (0001H)”, or “Even number (0002H)”.

7.2.3 Clearing information of flow meter

The internal information of the flow meter can be referenced. For that purpose, the following function codes can be used.

Code (hex)	Function
03	Read the parameter.

The following function code can be used to clear the information.

Code (hex)	Function
05	Clear the accumulated flow volume, clear the parameters.

Function code (hex)	Address (hex)	Area name	Function	Page
03	0200	Information of flow meter	Instantaneous flow-rate (upper 2 bytes)	23
	0201		Instantaneous flow-rate (lower 2 bytes)	
	0202		Pressure (2 bytes)	23
	0203		Temperature (2 bytes)	23
	0204		Accumulated forward flow volume (upper 2 bytes)	23 to 24
	0205		Accumulated forward flow volume (middle 2 bytes)	
	0206		Accumulated forward flow volume (lower 2 bytes)	
	0207		Accumulated reverse flow volume (upper 2 bytes)	23 to 24
	0208		Accumulated reverse flow volume (middle 2 bytes)	
	0209		Accumulated reverse flow volume (lower 2 bytes)	
	020A		Accumulated trip flow volume (upper 2 bytes)	23 to 24
	020B		Accumulated trip flow volume (middle 2 bytes)	
	020C		Accumulated trip flow volume (lower 2 bytes)	
	020D		Error information/ultrasonic measurement aberration (2 bytes)	24
	020E		Error information/temperature measurement aberration (2 bytes)	24
	020F		Error information/pressure measurement aberration (2 bytes)	24
	0210		Error information/power voltage drop (2 bytes)	24
	0211		Error information/flow-rate upper/lower limit aberration (2 bytes)	24
	0212		Nominal diameter information	24
05	0300	Clear	Clear accumulated flow volume.	25
	0301		Clear parameters (initial settings)	25

[Addresses 0200H and 0201H] Instantaneous flow-rate

These parameters indicate the instantaneous flow-rate based on the flow-rate conversion selection in [Address 010CH]. A 100-fold value of the actual value is returned in 4-byte data with code.

The upper 2 bytes and lower 2 bytes in the 4-byte data can be read separately.

(Example) When instantaneous flow-rate is 123.45 [m^3/h] (123.45 × 100 = 12345 (dec) -> 00003039 (hex))

- Read data of upper 2 bytes: 0000H
- Read data of lower 2 bytes: 3039H
- Read data of 4 bytes: 00003039H

[Address 0202] Pressure [kPa]

A 10-fold value of the actual value is returned in 2-byte data without code.

(Example) When the pressure is 123.4 [kPa] (123.4 × 10 = 1234 (dec) -> 04D2 (hex))

- Read data: 04D2H

[Address 0203] Temperature [°C]

A 10-fold value of the actual value is returned in 2-byte data with code.

(Example) When the temperature is -9.4 [°C] (-9.4 × 10 = -94 (dec) -> FFA2 (hex))

- Read data: FFA2H

[Address 0204H, 0205H, 0206H] Accumulated forward flow volume
[Address 0207H, 0208H, 0209H] Accumulated reverse flow volume
[Address 020AH, 020BH, 020CH] Accumulated trip flow volume

These parameters indicate the instantaneous flow-rate based on the flow-rate conversion selection in [Address 010CH]. A 1- to 100-fold value of the actual value is returned in 6-byte data without code.

The upper 2 bytes, middle 2 bytes, and lower 2 bytes in the 6-byte data can be read separately.

The multiple number varies according to the nominal diameter and the flow-rate conversion selection in [Address 010CH]. See the table below.

	Nominal diameter	
	25 to 80A	100 to 200A
Normal conversion, standard conversion	10-fold value	1-fold value
No conversion	100-fold value	1-fold value

Each accumulated flow volume can be read regardless of the setting of [Address 0100H] Display/Output. For instance, the accumulated trip flow volume can be read even if forward/reverse flow display is selected.

(Example) When the read value is 0000075BCD15H

	Accumulated forward flow volume, Accumulated trip flow volume	Accumulated reverse flow volume
[1-fold value]	123456789	-123456789
[10-fold value]	12345678.9	-12345678.9
[100-fold value]	1234567.89	-1234567.89

Even if the accumulated flow volumes are overflowed in display, the correct accumulated flow volumes are read as read values.
(Example) When the read value is 00086B76CF28H

	Accumulated forward flow volume	Trip accumulated flow volume	Accumulated reverse flow volume
[1-fold value]	3***6162686760***	36***162686760***	-36***162686760***
[10-fold value]	3***616268676.0***	36***16268676.0***	-36***16268676.0***
[100-fold value]	3***61626867.60***	36***1626867.60***	-36***1626867.60***

*The underlined italic section is the displayed value.

[Address 020DH] Error information/ultrasonic measurement aberration
This is used to read the state of the ultrasonic measurement (measurement of the flow rate).
Error: FFFFH or No error: 0000H is returned.

[Address 020EH] Error information/temperature aberration
This is used to read the state of the temperature value.
Error: FFFFH or No error: 0000H is returned.

[Address 020FH] Error information/pressure measurement aberration
This is used to read the state of the pressure measurement.
Error: FFFFH or No error: 0000H is returned.

[Address 0210H] Error information/power voltage drop
This is used to read the state of the power voltage.
The flow meter stops the communication operation when the power voltage is dropped and the power supply is cut off. For this reason, no power voltage drop: 0000H only can be returned.

[Address 0211H] Error information/flow-rate upper/lower limit aberration
This is used to read the state of the instantaneous flow-rate value.
This is alarm judgment using the lower limit alarm output flow rate in [Address 0104H, 0105H], upper limit alarm output flow rate in [Addresses 0106H and 0107H], and alarm judgment value hysteresis width in [Address 0108H]. Error: FFFFH or No error: 0000H is returned.

[Address 0212H] Nominal diameter information
This is used to read the nominal diameter of the flow meter.

The relationship between the nominal diameter and read data is shown in the table below.

Read data (hex)	Nominal diameter
0000	25A
0001	32A
0002	40A
0003	50A
0004	65A
0005	80A
0006	100A
0007	150A
0008	200A

[Address 0300H] Clear accumulated flow volume

Clear all the accumulated flow volumes including the accumulated forward flow volume, accumulated reverse flow volume, and accumulated trip flow volume to zero.
Only the clear command using 0000H is accepted as the setting.

Note that you cannot clear the accumulated forward flow volume or accumulated reverse flow volume or accumulated trip flow volume individually.
Meanwhile, the accumulated trip flow volume can be cleared individually using the setting button on the flow meter main unit. For details, see “7. Operation Modes, 1) Measurement mode, A) Switchover of the main display” in Operation Manual.

[Address 0301H] Parameter reset

Set the items from [Address 0100H] to [Address 0113H] to the standard factory delivery settings. Only the clear command using 0000H is accepted as the setting.

For the standard factory delivery setting of each item, see “8 Standard Factory Delivery Settings List.”
However, note that the pulse output unit is 1000L/P.

8 Standard Factory Delivery Settings List

Function code (hex)	Address (hex)	Area name	Function	Data	(hex)
03 or 06 or 10	0100	Parameter	Display/output selection	Forward flow	0000
	0101		Analog output full scale flow-rate: Upper 2 bytes	25A: 300 [m^3/h] 32A: 600 40A: 700 50A: 1200	0000012C 00000258 000002BC 000004B0
	0102		Analog output full scale flow-rate: Lower 2 bytes	65A: 2000 80A: 2500 100A: 5000 150A: 10000 200A: 20000	000007D0 000009C4 00001388 00002710 00004E20
	0103		State of contact point selection	Normal open	0000
	0104		Lower limit alarm flow-rate: Upper 2 bytes	0 [m^3/h]	00000000
	0105		Lower limit alarm flow-rate: Lower 2 bytes		
	0106		Upper limit alarm flow-rate: Upper 2 bytes	59999 [m^3/h]	0000EA5F
	0107		Upper limit alarm flow-rate: Lower 2 bytes		
	0108		Alarm judgment value hysteresis width	0 [m^3/h]	0000
	0109		Flow-rate moving average number of times	4 times	0002
	010A		Output pulse unit	25 to 80A: 100L/P 100 to 200A: 1000L/P Parameter reset: 1000L/P	0001 0002 0002
	010B		Pulse output method	duty	0005
	010C		Flow-rate conversion selection	ON (Normal conversion)	0001
	010D		Standard conversion temperature	20°C	0014
	010E		Test mode time selection	3 min	0000
	010F		Fluid selection	Air	0000
	0110		Current output correlation value	Flow-rate	0000
	0111		Low flow cutoff flow rate	25A: 0.1 [m^3/h] 32A: 0.2 40A: 0.2 50A: 0.4 65A: 0.6 80A: 0.8 100A: 2.6 150A: 5.0 200A: 9.0	0001 0002 0002 0004 0006 0008 001A 0032 005A
	0112		Atmospheric pressure of the working environment	101.3kPa (10 folds)	03F5
	0113		With or without pressure value averaging	ON	0001
	0114		RTU address	01	0001
	0115		Bit rate	115200 bps	0004
	0116		Stop bit length selection	1 bit	0000
	0117		Parity bit selection	Even number	0002

9 Calculation of Error Check Code (CRC-16)

9.1 Overview

In MODBUS RTU, a message contains an error check code based on the CRC method. An error check code consists of 16 bits and is calculated and attached to a message by the transmission side. The reception side recalculates CRC of a received message and compares the calculation result with an actual received error check code. If these two values do not match, it results in an error.

CRC calculation is performed from the RTU address at the top of a message to the end of the data. Only 8 bits of each character are used, and the start, stop, and parity bits are not applied to CRC. When an error check code is attached to a message, the lower bytes of the calculation result are attached first, and then the upper bytes are attached.

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

9.2 Calculation procedure

(1) Initialize the CRC code to FFFFH.

(2) Calculate the exclusive OR (XOR) of the lower 1 byte of the CRC code and the 1st character of a message and store it in the CRC code.

(3) When the lowest bit of the CRC code is 1, go to (4) →
When the lowest bit of the CRC code is 0, go to (5) →

(4) Shift the CRC code to the right by 1 bit and calculate exclusive OR with the generating polynomial A001H and store it in the CRC code. → Go to (6).

(5) Shift the CRC code to the right by 1 bit. → Go to (6).

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

(7) Repeat (2) to (6) for the second and following characters in the scope of calculation.

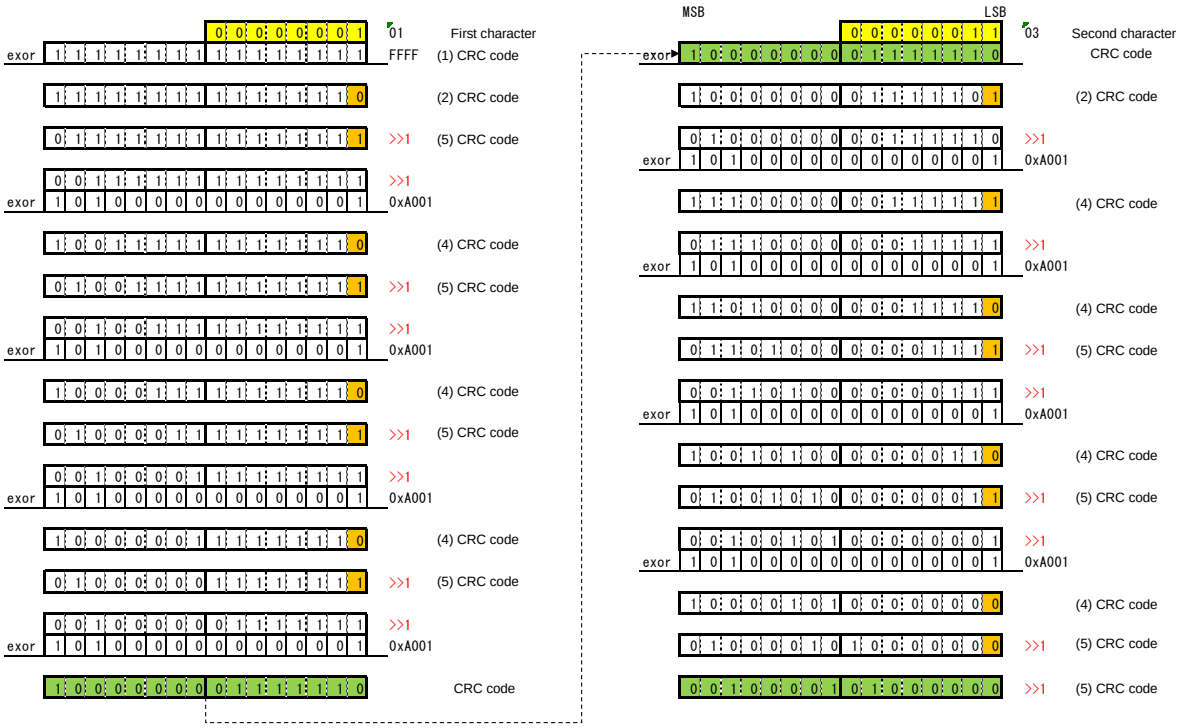
(8) The last value left in the CRC code is the error check code.

<Calculation example>

When a message is 01 03 02 01 09 (hex), the CRC code becomes D279H. Since the lower byte of the calculation result is attached first, the transmission data becomes 01 03 02 01 09 79 D2.

[Details]

The calculation of the first character and second character (01 and 03) is shown in the figure below.



Calculate the third to fifth characters in a same way, and the CRC code becomes D279H.