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(Not for use in Japan)

No. CP-SP-1458E

Digital Mass Flow Controller

Model F4Q

User's Manual for RS-485 Communication Functions

Thank you for purchasing your Azbil Corporation product.

This manual contains information for ensuring the safe and correct use of the product.

Those designing or maintaining equipment that uses this product should first read and understand this manual. This manual contains information not only for installation, but also for maintenance, troubleshooting, etc. Be sure to keep it nearby for handy reference.

Azbil Corporation

NOTICE

Please make sure that this manual is available to the user of the product.

Unauthorized duplication of this user's manual in part or in whole is forbidden. The information and specifications in this manual are subject to change without notice.

Considerable effort has been made to ensure that this manual is complete and accurate, but if you should find an omission or error, please contact us.

In no event is Azbil Corporation liable to anyone for any indirect, special, or consequential damages as a result of using this product.

Conventions Used in This Manual

■ The safety precautions explained below aim to prevent injury to you and others, and to prevent property damage.

⚠WARNING	**Warnings are indicated when mishandling this product may result in death or serious injury.**
⚠CAUTION	**Cautions are indicated when mishandling this product may result in minor injury or property damage only.**

■ In describing the product, this manual uses the icons and notations listed below.

Indicates that caution is required in handling.

The indicated action is prohibited.

Be sure to follow the indicated instructions.

Handling Precautions:

Information to be aware of when handling.

Note: Indicates information that may be useful.

☞: Indicates an item or page to which the user may refer.

(1) (2) (3): Steps in a sequence or parts of a figure, etc.

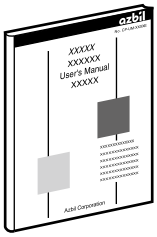
Safety Precautions

⚠CAUTION

Use this product within the operating conditions (for temperature, humidity, voltage, vibration, shock, mounting orientation, atmosphere, etc.) given in the specifications in *Digital Mass Flow Controller Model F4Q User's Manual* (CP-UM-5978JECK). Otherwise there is a danger of device failure.
Before wiring the device, turn the power off. Otherwise there is a danger of device failure.
Wire this device correctly by using the wiring method, power, and installation method specified in this user's manual. Otherwise there is a danger of device failure.
Do not allow wire clippings, metal shavings, water, etc., to enter the device. There is a danger of device failure.
If there is a risk of a power surge caused by lightning, use a surge absorber (surge protector). Otherwise there is a danger of fire or device failure.
Make sure that the wiring is correct before turning the power on. Incorrect wiring may result in damage or malfunction.
Do not disassemble this device. There is a danger of device failure.
Do not apply excessive force to cables or connectors when connector cables or the AC adapter is attached. Doing so may damage the connector or circuit board.

The Role of This Manual

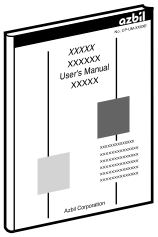
There are four different manuals related to model F4Q. Read them as necessary for your specific requirements. If you do not have a manual you require, please contact us or one of our dealers.



Digital Mass Flow Controller Model F4Q User's Manual for RS-485 Communication Functions **Document No. CP-SP-1458E**

This manual.

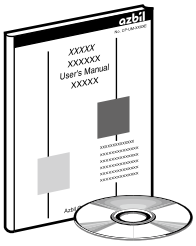
Personnel who use this device's communications functions should read this manual. The manual gives an overview of communications, describes wiring, transmission protocols, communications data, and communication troubleshooting, and gives communications specifications.



Digital Mass Flow Controller Model F4Q User's Manual **Document No. CP-SP-1461E**

Personnel who are using the F4Q for the first time or who are in charge of hardware design and/or maintenance of a control panel containing the F4Q should read this manual thoroughly.

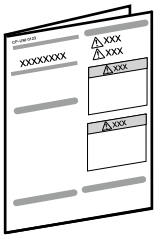
This manual gives an overview of the product, describes installation, wiring, operation, functions, maintenance, and troubleshooting, and gives hardware specifications.



User's Manual for Smart Loader Package Model MLP-F4Q for Digital Mass Flow Controller Model F4Q **Document No. CP-SP-1457E**

The user can specify and check parameters of the F4Q on a PC using the MLP-F4Q loader. Personnel who configure the F4Q or check the settings using the loader should read this manual.

This manual also describes the installation of the software on a PC and its functions and operation.



Digital Mass Flow Controller Model F4Q User's Manual **Document No. CP-UM-5978JECK**

This manual is supplied with the product.

Personnel in charge of the design or manufacture of equipment that incorporates the F4Q and personnel in charge of installation of this device should read this manual thoroughly.

The manual covers safety precautions, installation, wiring, and main specifications.

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Contents

Chapter 1. Overview

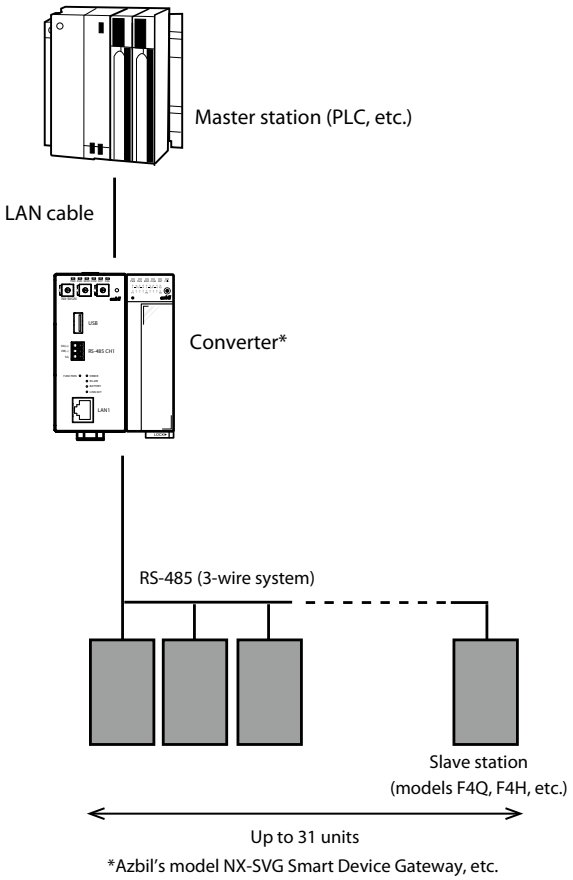
1 - 1 Overview

Model F4Q (hereafter also “this device” or “the slave station”) can exchange data with host devices (master stations) such as a PC or a PLC via RS-485 communication.

■ Features

- The master station transmits read and write commands to slave stations.
- Through the reading and writing of data, the user can control this device, collect process data, and configure device settings.
- Using RS-485 communication, up to 31 slave stations (devices like this device that are compatible with RS-485) can be connected to a master station. Station addresses are used to communicate with specific slave stations.
- The communication program is to be developed by the user.
- The data to be read/written can be freely selected by the data address.
- CPL (Azbil Corporation’s protocol) and Modbus RTU communication protocols are supported. The user can select either one of the protocols.

■ System configuration



*Azbil’s model NX-SVG Smart Device Gateway, etc.

Handling Precautions

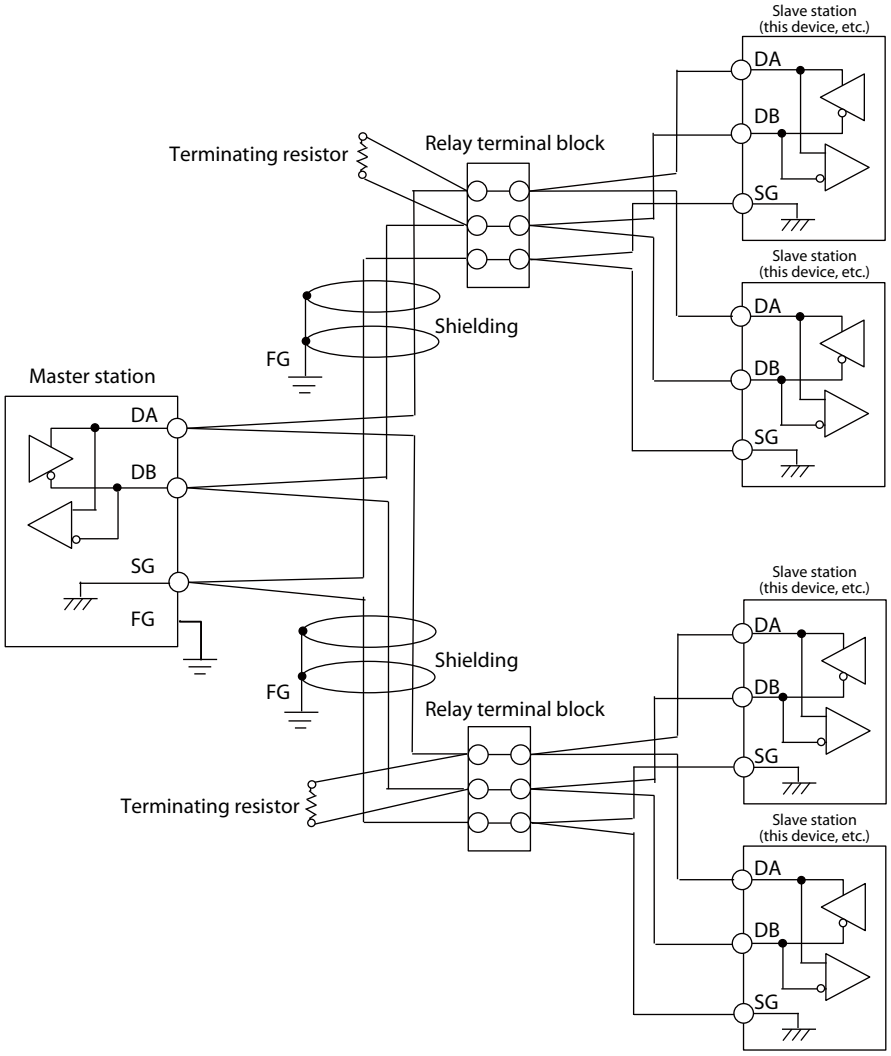
- Do not write data by RS-485 and by the loader at the same time.

-MEMO-

Chapter 2. Wiring

2 - 1 RS-485 Connection

A sample connection is shown below.



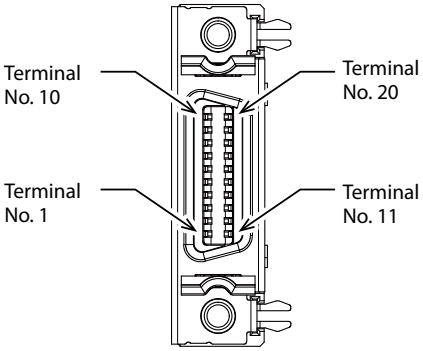
- Attach terminating resistors (150 Ω ±5 %, ½ W min.) to both ends of the transmission line.
- A relay terminal block is required because this device uses a connector.
- The cable to the relay terminal block from this device must be as short as possible.
- The frame ground must be connected to only one end of the shielded cable, not to both ends.

! Handling Precautions

- Be sure to connect the signal ground (SG) terminals to each other. Otherwise, communication may be unreliable.

2 - 2 Terminal Layout of This Device

The terminal layout of this device is shown below.



● **Connector signal table**

Terminal No.	Signal	Description	Notes
1	DA	RS-485 comm., DA	
2	DB	RS-485 comm., DB	
3	S.GND	RS-485 comm. (–)	
4	AI	Analog input (+)	Flow rate set point (SP) input
5	AO	Analog output (+)	Controlled flow rate (PV) or flow rate set point (SP) output
6	A.GND	Analog signal (–)	Common ground for analog signals
7	P.GND	24 V DC (–) power	
8	P.GND	24 V DC (–) power	
9	POWER (24 V)	24 V DC (+) power	
10	POWER (24 V)	24 V DC (+) power	
11	DO1	Digital output 1 (+)	Open drain non-isolated output
12	DO2	Digital output 2 (+)	
13	DO3	Digital output 3 (+)	
14	D.GND	Digital signal (–)	Common ground for digital signals
15	DI1	Digital input 1 (+)	2-way (OPEN/GND) switching input
16	DI2	Digital input 2 (+)	
17	DI3	Digital input 3 (+)	
18	D.GND	Digital signal (–)	Common ground for digital signals
19	-	Not connected	
20	-	Not connected	

Note

- For wiring not related to the RS-485 communication line:
  ☞ *Digital Mass Flow Controller Model F4Q User's Manual*, CP-SP-1461E.

● Compatible connectors (all made by Japan Aviation Electronics Industry, Limited)

● Solder type

Compatible wire	Plug	Hood				Clamp plate	Appropriate outer diameter (reference)
22–30 AWG	DF02P020F22A1	Hood for EMI shielding	Lock spring	Straight long	DF02D020A11	DF02HCLP05A	φ6.5–7.0
						DF02HCLP02A	φ7.0–7.5
						DF02HCLP01A	φ7.5–8.0
						DF02HCLP10A	φ8.5–9.0
		Hood without resin coating	Lock spring	Straight long	DF02D020A22		φ11.0–12.0
			Screw lock	Straight long	DF02D020A22		

● Crimp type

Compatible wire	Plug	Hood				Clamp plate	Appropriate outer diameter (reference)
28 AWG	DF02P020G28A1	Hood for EMI shielding	Lock spring	Straight long	DF02D020A11	DF02HCLP05A	φ6.5–7.0
						DF02HCLP02A	φ7.0–7.5
						DF02HCLP01A	φ7.5–8.0
						DF02HCLP10A	φ8.5–9.0
		Hood without resin coating	Lock spring	Straight long	DF02D020A22		φ11.0–12.0
			Screw lock	Straight long	DF02D020A22		

-MEMO-

Chapter 3. Settings

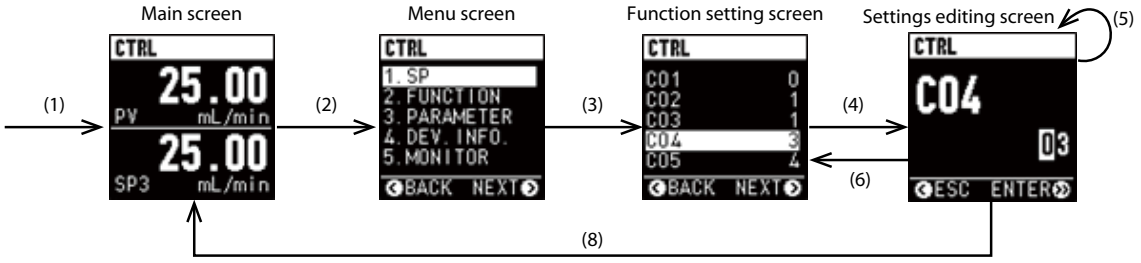
3 - 1 Communication Function Settings

Specify the following to use the communication function of this device.

Display	Parameter name	Settings and description	Initial value	Notes
C-30	Communication address setting	0: Communication function disabled 1 to 127	0	
C-31	Transfer speed selection	0: 38400 bps 1: 19200 bps 2: 9600 bps 3: 4800 bps	1	
C-32	Data format selection	0:Even parity, 1 stop bit 1: No parity, 2 stop bits	0	Data bits: 8
C-33	Communication protocol	0: Modbus-RTU 1: CPL	1	
C-47	Totalized flow rate communication data format	0: First 4 digits + last 4 digits 1: Upper 16 bits + lower 16 bits	0	Total flow–related data is read/written by combining/separating the upper and lower values.
C-48	Flow rate unit (communication)	0: mL/min 1: L/min 2: m^3/h	-	Specifies the unit and the number of decimal places of fixed-point data. The initial value differs according to the model. The unit and the number of decimal places set here do not apply to the data displayed on the panel.
C-49	Flow rate digits after the decimal point (communication)	0 to 3	-	
C-50	Totalized flow rate unit (communication)	0: mL 1: L 2: m^3	-	
C-51	Totalized flow rate digits after the decimal point (communication)	0 to 3	-	

3 - 2 Setup Method

The following is the procedure for specifying communication settings using the keys on the top panel of this device.



(1) Press the [◁] key several times to display the main screen.
(If the main screen is already displayed, skip this step.)

(2) Press the [▷] key.

≫ The menu screen is displayed.

(3) Press the [△] or [▽] key to select [2. FUNCTION], and then press the [▷] key.

≫ The function setting screen is displayed.

(4) Press the [△] or [▽] key to select the desired item and then press the [▷] key.

≫ The settings editing screen is displayed.

(5) Use the [▷] key to select the digit to edit, and press the [△] or [▽] key to select the desired value.

(6) Press and hold the [▷] key to finalize the setting.

≫ The setting is saved at this time. Afterward, the function setting screen is shown again.

(7) If there is another setting to change, return to step 4. If not, proceed to step 8.

(8) Press the [◁] key twice.

≫ The display returns to the main screen.

Handling Precautions

- If no key is pressed for 5 minutes, the display automatically returns to the main screen.
- After step 5, if the [◁] key is pressed without pressing and holding the [▷] key, the setting will not be saved and the previous setting will remain in effect.
- If the setting of C-33 (communication protocol) is changed, this device must be restarted in order to apply the new setting.

Note

- Settings can also be specified using the MLP-F4Q Smart Loader Package for the F4Q digital mass flow controller.
☞ *User's Manual for Smart Loader Package Model MLP-F4Q for Digital Mass Flow Controller Model F4Q* (CP-SP-1457E) (for details on MLP-F4Q operation)

Chapter 4. CPL Communication

4 - 1 Communication Procedure

The following is the communication procedure in its simple form:

(1) The master station sends an instruction message to slave stations specifying the station it wishes to communicate with.

(2) The slave station receives the instruction message, and performs read or write processing according to the content of the message.

(3) The slave station sends a message corresponding to the processing content as a response message.

(4) The master station receives the response message.

4 - 2 Message Structure

■ Overview of a CPL Frame

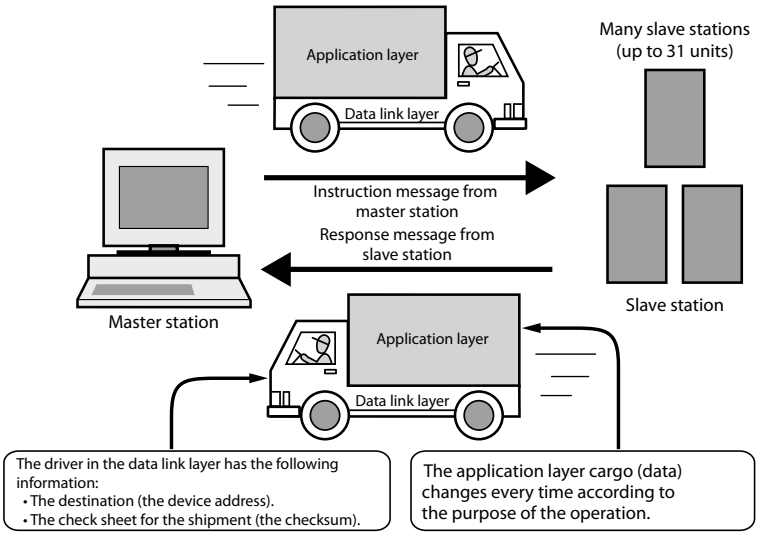
A message consists of the following two layers. Both the instruction message from the master station and the response message from the slave station take this form.

- Data link layer:

  This layer contains the basic information required for communication. For example, it tells the destination of the message and the checksum information.

- Application Layer:

  Data is read and written in this layer. The content of the layer varies according to the purpose of the message.

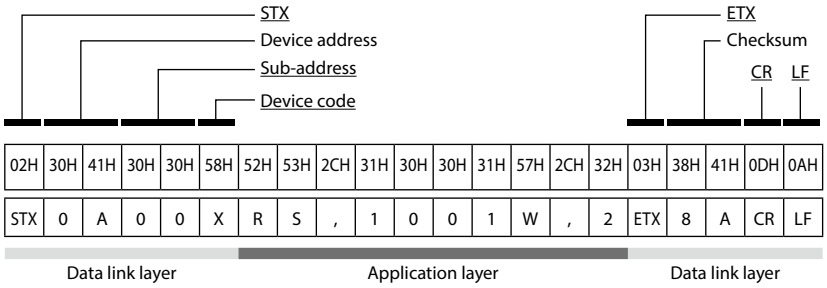


Details on each layer are given in the next section.

■ Data link layer

The data link layer contains eight items of basic information necessary for transmitting a message. The instruction message and response message have the same structure in the data link layer.

The data link layer has a fixed length. The position of each item of data and its length are prescribed. The position of data in the data link layer from ETX onwards shifts according to the number of characters in the application layer, but the number of characters does not change.



● STX (Start of Text)

◆ Role : Indicates the beginning of a message.

◇ Description: Always 02H. If this device receives "STX," it interprets STX to be the first character of a new instruction message, even if it occurs in the middle of a message.

● Device address

◆ Role : This specifies the destination station. This makes it possible to communicate with a specific device.

◇ Description: The hexadecimal codes for two characters. For details, see the example below.

☐ Example: The destination device address is "10"

(1) 10 (decimal) = 0AH (0A hexadecimal)

(2) Replacement of characters by their hexadecimal character codes

0 = 30H

A = 41H

(3) The characters "0A" (30H, 41H) obtained in step 2 are used as the device address.

Note

- It is necessary to set the device address in advance for the slave station.
☞ Chapter 3. Settings (p. 3-1) (for details on settings)

Handling Precautions

- Note that the function of the device address differs entirely from that of the data address in the application layer. Be sure to note the difference.
- Set a unique device address for each multi-dropped device.

- If "0" is set on a slave station, its RS-485 communication function will be disabled. To enable a station to communicate, be sure to set its address to "1" or above.
- Do not send a command addressed to device address "0" from the master station.

● **Subaddress**

◇ Description: Always the same for this device. Be sure to set the subaddress "00" (30H, 30H), the same format as the device address.

● **Device type code**

◇ Description: Only the hex character codes for "X" (58H) or "x" (78H) can be used on this device.

● **ETX (End of Text)**

◆ Role : This indicates the end of the application layer.

◇ Description: Always 03H.

● **Checksum**

◆ Role : The checksum is used to check whether the message changed due to some problem (e.g., electrical noise) during communication.

◇ Description: The hexadecimal codes for two characters.
· How to create a checksum

(1) Add all the values of each byte of the message from STX to ETX.

(2) Take the two's complement of the sum.

(3) Convert the result to character codes.

□ Example: The instruction message described above is used in the following example:

(1) Add all the character codes from STX to ETX.
The lowest 1 byte of the calculation result is 76H.

(2) Take the two's complement of the addition result.
The result is 8AH.

(3) Replace the characters of the result with their hexadecimal character codes. The result is used for the checksum.
"8A" becomes 38H and 41H.

Note

- ☞ Device address (p. 4-3)(for the example of conversion to character codes)

Handling Precautions

- The checksum of the instruction message cannot be omitted.

● CR and LF (Carriage Return / Line Feed)

◆ Role : These indicate the end of a message.

◇ Description : "CR" is (0DH), and "LF" is (0AH).
CR and LF must be used as a pair.

Handling Precautions

- If any of the following problems is found in the data link layer, this device will not respond.
  - · The communication settings of the stations do not match (device address, transmission speed, etc.)
  - · The device address is set to "00."
  - · STX, ETX, CR or LF are not in the right positions.
  - · The device code is not "X."
  - · The calculated checksum does not match the checksum in the message.
  - · The message contains invalid characters.
  - · The device address transmitted is different from the device address of the target device.
- In the data link layer, the same message (except for the checksum) as the instruction message from the master station is used as the response message.
- Use capital letters from "A" to "F" for the hexadecimal numbers used in the device address and checksum.
- If "1" (2 stop bits) is set for "Data format selection" of this device, messages from the host device will be accepted regardless of whether they have 1 or 2 stop bits.

■ Application layer

The application layer contains instruction codes, start data address, data, number of data records, and information on the success of the instruction message (termination code). In the application layer, the structure of the instruction message is different from that of the response message.

There are two types of instruction message: read and write. The response message corresponds to one of these types of instruction message. The termination code indicates how the instruction message was processed.

The application layer of the instruction message is composed of the following 4 items:

Item	Description
(1) Command	"RS" (consecutive address data read command in decimal format)
	"WS" (consecutive address data write command in decimal format)
	"RD" (fixed length consecutive address data read command in hexadecimal format)
	"WD" (fixed length consecutive address data write command in hexadecimal format)
(2) Data delimiter	RS/WS: "," (comma) RD/WD: None
(3) Data address	RS/WS: "W" is added to a decimal number, as in "1001W." RD/WD: A four-digit hexadecimal number such as "03E9"
(4)-1 Read count	RS: A decimal number such as "1" RD: A four-digit hexadecimal number such as "0001"
(4)-2 Value to write	WS: Value of character expression such as "123" WD: A four-digit hexadecimal number such as "007B"

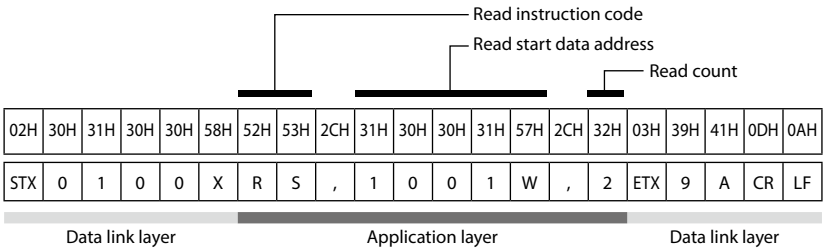
4 - 3 Description of Commands

■ RS command (decimal format consecutive data read)

● RS command instruction message

This is a command—in one message—to read the contents of consecutive data addresses from the specified read start data address.

The application layer consists of the following three types of data.



- Data is delimited by commas (“,” = hex character code 2CH).
- The above figure shows how a single message instructs the reading of two pieces of data (starting from address "1001").

1. Read instruction code (RS)

◆ Role : This is the command for reading data in decimal format.

◇ Description : Two characters, "RS" (52H, 53H).

2. Read start data address

◆ Role : This specifies by a decimal number the first data address to read.

◇ Description : ☞ 6 - 2 Communication Data Table (p. 6-3) (for the relationship between data addresses and read data)
Be sure to add “W” (57H) to the end of the data address.

3. Number of read data records

◆ Role : This specifies by a decimal number how many consecutive data records to read, starting from the specified data address.

◇ Description : Up to 10 data records can be read in one message.

● Response message to the RS command

If the message in the data link layer is correct, a response message appropriate for the contents of the instruction message is returned.

All data in the application layer is expressed in decimal character.

(However, in the case of an error response, read data is not included.)

● Termination code

◆ Role : This tells how the instruction message was processed by the device. Different codes are used according to the result of processing. A response message always includes a termination code.
☞ 4 - 4 Termination Code (p. 4-16) (for termination code types)

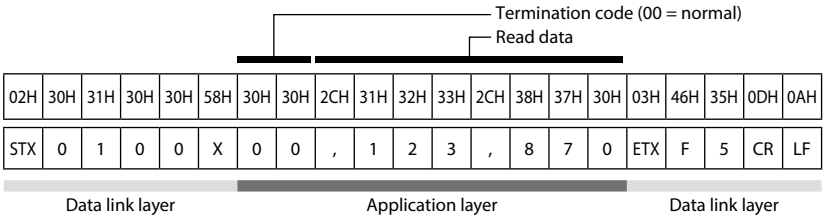
1. Normal response

It contains the termination code and the specified number of data records delimited by commas.

- Data is delimited by commas (“,” = 2CH).
- The range and number of digits of each piece of data depends on the data read.
- Data is expressed without a decimal point.

  ☐ Ex.: "20.0" is converted to "200."

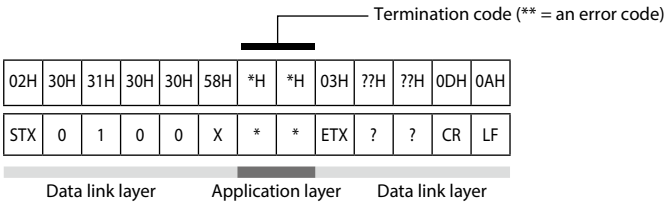
The figure below shows an example of a normal response. (two pieces of data are read normally).



2. Error response

If there is an error in the instruction message so that data cannot be read out normally, an error response is returned.

The figure below shows an example of an error response. ("**" stands for the error code.)



! Handling Precautions

- The data address, read count, value to write, and data to read must conform to the following rules.
  - Use capital letters in character codes for all numbers and characters.
  - All numbers are in base 10.
  - Unnecessary leading zeros and spaces are not allowed.

☐ Ex.: "0123" (30H, 31H, 32H, 33H) is not allowed.
☐ Ex.: " 123" (20H, 31H, 32H, 33H) is not allowed.

・If the number is 0, one "0" is used.
☐Ex.: "0" (30H).
☐ Ex.: "00" (30H, 30H) is not allowed.

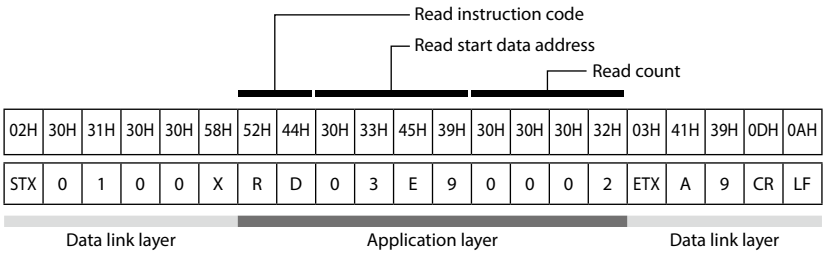
・Negative numbers are preceded by a minus sign (2DH).
☐ Ex.: "−123" (2DH, 31H, 32H, 33H)

・Positive numbers are not preceded by a plus sign.
☐ Ex.: "+123" (2BH, 31H, 32H, 33H) is not allowed.

■ RD command (hexadecimal format consecutive data read)

● RD command instruction message

This is a command—in one message—to read fixed-length data from consecutive data addresses starting from the specified address in hexadecimal format.
This command is suitable for handling data in ladder programs sent by PLC communications as the data is of a fixed length.



- Use capital letters in character codes for all numbers and characters in the application layer.
- Each value is expressed as a four-digit hexadecimal number.
- Since the data length is fixed, commas are not used to delimit the data.
- The above figure shows how a single message instructs the reading of two pieces of data (starting from address "03E9").

1. Read instruction code (RD)

◆ Role : This is the command for reading fixed-length data in hexadecimal format.

◇ Description : Two characters, "RD" (52H, 44H).

2. Read start data address

◆ Role : This specifies by a four-digit hexadecimal number the first data address to be read.

◇ Description : ☞ 6 - 2 Communication Data Table (p. 6-3) (for the relationship between data addresses and read data)
Do not add "W" (57H) to the end of the data address.

3. Number of read data records

◆ Role : This specifies how many consecutive pieces of data to read, starting from the data address specified with four hexadecimal digits.

◇ Description : Up to 10 data records can be read in one message.

● Response message to the RD command

If the message in the data link layer is correct, a response message appropriate for the contents of the instruction message is returned.

The data in the application layer is the termination code (two decimal digits) and the number of pieces of data to read (four hexadecimal digits × number of items), which is specified by the instruction message. (However, in the case of an error response, read data is not included.)

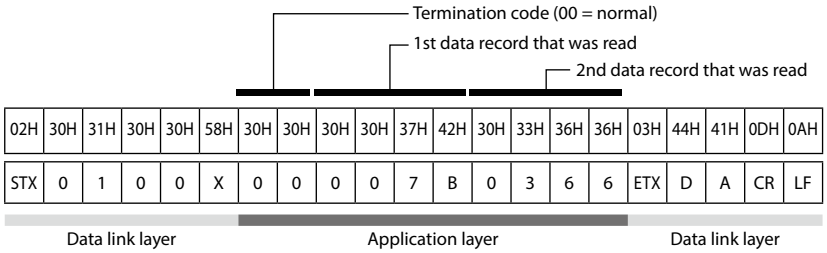
As in the case of RS commands, a response message always includes a termination code.

1. Normal response

Returns the specified number of data records as a four-digit hexadecimal number.

- The range of the data records depends on the individual data read.
- Data is expressed without a decimal point.

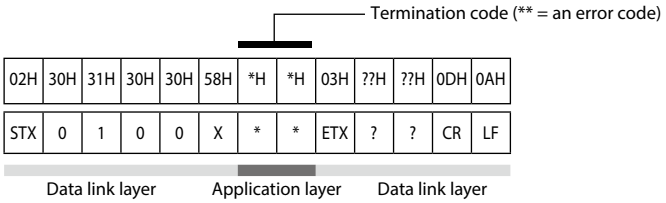
  ☐ Ex.: The decimal number "20.0" is expressed as "00C8."
- Since the data length is fixed, commas (2CH) are not added to delimit data.
- The figure below shows an example of a normal response. (two pieces of data are read normally).



2. Error response

If there is an error in the instruction message so that data cannot be read out normally, an error response is returned.

The figure below shows an example of an error response. ("**" stands for the error code.)



Handling Precautions

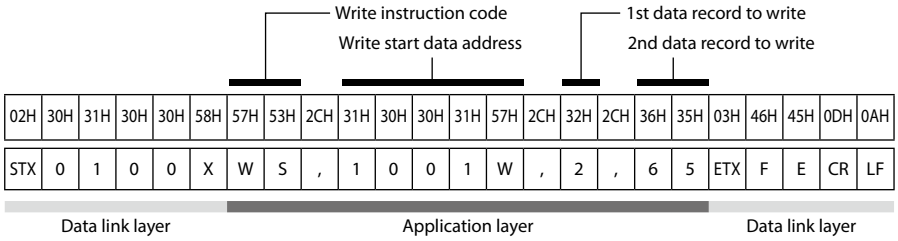
- The data address, read count, value to write, and data to read must conform to the following rules.
  - A decimal value with four or fewer digits must be converted to a four-digit hexadecimal value.
    - ☐ Ex.: Decimal value "0" is converted to "0000" (30H, 30H, 30H, 30H).
    - ☐ Ex.: Decimal value "123" is converted to "007B" (30H, 30H, 37H, 42H).
  - A negative value is converted to the 2's complement of a four-digit hexadecimal value.
    - ☐ Ex.: Decimal value "–123" is converted to "FF85" (46H, 46H, 38H, 35H). (The value is not preceded by a minus sign).

■ WS command (decimal format consecutive data write)

● WS command instruction message

This is a command—in one message—to consecutively write the contents of multiple consecutive data addresses starting at the specified start data address.

The application layer of the write instruction consists of the following three types of data.



- Data is delimited by commas (“,” = hex character code 2CH).
- It is not necessary to specify the number of data records to write.
- All numbers are in base 10.
- The figure above shows an example of an instruction message used to write “2” and “65” to addresses “1001” and “1002” respectively.

1. Write instruction code (WS)

◆ Role : This is a command for writing data in decimal format.

◇ Description : Two characters, "WS" (57H, 53H).

2. Write start data address

◆ Role : This specifies by a decimal number the data address at which to begin writing.
☞ 6 - 2 Communication Data Table (p. 6-3) (for the relationship between data addresses and write data)
Be sure to add “W” (57H) to the end of the data address.

3. Write data

◆ Role : This is the data used to be written to consecutive data addresses starting from the specified data address.

◇ Description : The range of values that can be written varies depending on the data address.

- Data is delimited by commas (2CH).
- The address to which to write data is sequentially incremented by 1 following the starting data address.
- Up to 10 data records can be written in one message.

● Response message to the WS command

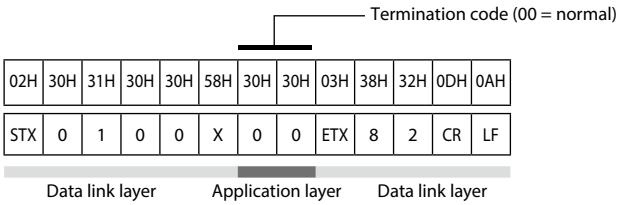
If the data in the data link layer is correct, only a termination code is returned.

☞ 4-4 Termination Code (p. 4-16) (for termination code types)

1. Normal response

If data is written correctly, a normal response is returned.

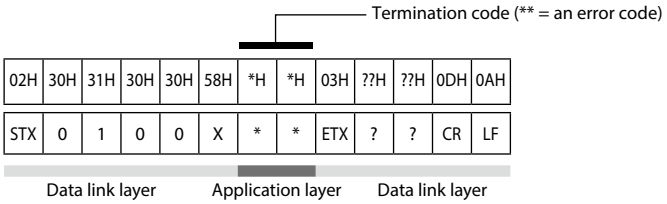
☐ Ex.: A normal response like the one below is returned when all the data is correctly written.



2. Error response

If data was not written properly due to an error in the instruction message, an error response is returned.

☐ Ex.: Error response ("**" stands for the error termination code.)



! Handling Precautions

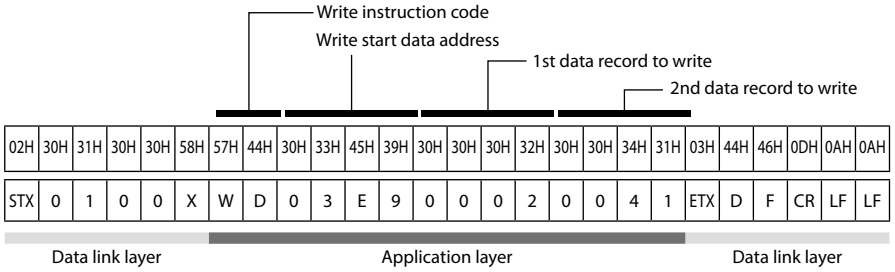
- The data address, read count, value to write, and data to read must conform to the following rules.
  - Use capital letters in character codes for all numbers and characters in the application layer.
  - Unnecessary zeros or spaces are not allowed.
    The underlined portion of "WS,0̲1001W,1" is not allowed.
    The underlined portions of "WS,_1001W,0̲1" are not allowed.

■ WD command (hexadecimal format consecutive data write)

● WD command instruction message

This is a command—in one message—to consecutively write fixed-length data in hexadecimal format to multiple consecutive data addresses starting from the specified start data address. This command is suitable for handling data in ladder programs sent by PLC communications as the data is of a fixed length.

The application layer of the write instruction consists of the following three types of data.



- It is not necessary to specify the number of data records to write.
- Use capital letters in character codes for all numbers and characters in the application layer.
- Each value is expressed as a four-digit hexadecimal number.
- Since the data length is fixed, commas are not used to delimit the data.
- The figure above shows an example of an instruction message used to write "0002" and "0041" (2 and 65 in decimal format) to addresses "03E9" and "03EA" respectively.

1. Write instruction code (WD)

◆ Role : This is a command for writing fixed-length data in hexadecimal format.

◇ Description : Two characters, "WD" (57H, 44H).

2. Write start data address

◆ Role : This specifies by a four-digit hexadecimal number the data address at which to begin writing.
☞ 6 - 2 Communication Data Table (p. 6-3) (for the relationship between data addresses and write data)
Do not add "W" (57H) to the end of the data address.

3. Write data

◆ Role : This is the data, expressed in four-digit hexadecimal numbers, that is written to consecutive data addresses starting from the specified data address.

◇ Description: The range of values that can be written varies depending on the data address.
The address to which to write data is sequentially incremented by 1 following the starting data address.
Up to 10 data records can be written in one message.

● Response message to the WD command

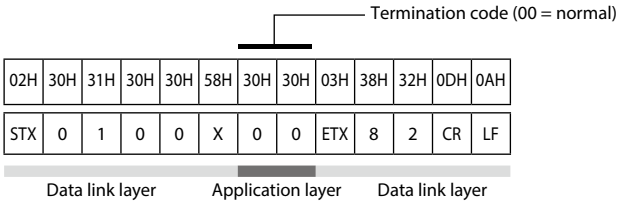
If the data in the data link layer is correct, only a termination code is returned.

☞ 4 - 4 Termination Code (p. 4-16) (for termination code types)

1. Normal response

If data is written correctly, a normal response is returned.

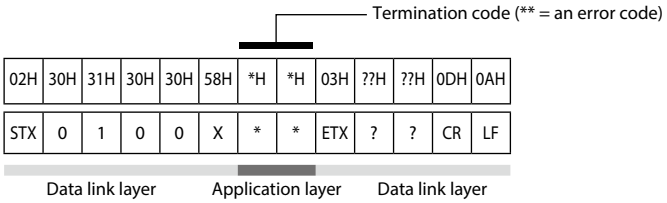
☐ Ex.: A normal response like the one below is returned when all the data is correctly written.



2. Error response

If data was not written properly due to an error in the instruction message, an error response is returned.

☐ Ex.: Error response ("**" stands for the error code.)



4 - 4 Termination Code

The following table shows termination codes.

Termination code	Type	Description	Note
00H	Normal	Normal termination	-
10H	Error	There was an error in the data address or the number of data records.	The data cannot be converted to a number, "W" is not set, the position of the comma is incorrect, etc.
13H	Error	Error in execution	An error occurred during writing or reading.
40H	Error	There was an error in the number of data records to access.	The number of data records to be read or written is not from 1 to 10.
43H	Error	Write error	Unsupported write data address, out-of-range data, writing under read-only conditions, etc.
98H	Error	System error	Memory access failure, etc.
99H	Error	Undefined command	Or other message error

Handling Precautions

- The success of writing when an error response is returned cannot be guaranteed. If an error occurs during consecutive data writing, the data may have been updated halfway. Be sure to write the data again with a correct message.

4 - 5 Timing Specifications

■ Timing for response messages

The response time of this device, from the time when the master station finishes sending the instruction message until the time when it begins to receive the response message from the slave station, is shown below.

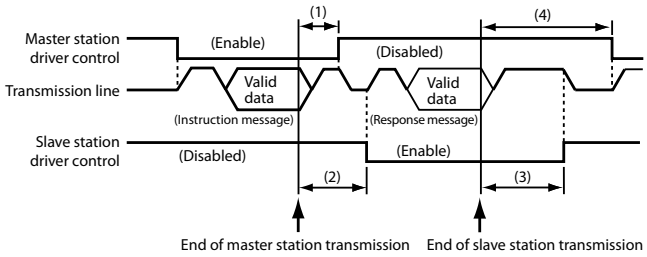
Minimum: 20 ms, maximum: 2000 ms

Therefore, monitoring of the response message should begin within 20 ms after an instruction message is sent, and the response should be monitored for 2000 ms or longer.

Generally, when a response time-out occurs, the instruction message is resent.

■ RS-485 driver control timing

When the transmission/reception on the RS-485 3-wire system is directly controlled by the master station, pay attention to the following timing:



(1) Time from completion of master station transmission to TX disabling by master station driver: Time (2) max.

(2) Time from completion of slave station reception to TX enabling by slave station driver: 20 ms min.

(3) Time from completion of slave station transmission to TX disabling by slave station driver: 1 ms max.

(4) Time from completion of master station reception to TX enabling by master station driver: Time (3) min.

! Handling Precautions

- The time from when the master station finishes sending the instruction message to when the slave station starts transmitting the response message will vary according to the amount of data to be read or written. If a faster response from the slave station is required, reduce the amount of data to be read or written by one message.
- When multiple messages are sent consecutively, a new message should be sent only after the response for the previous message from this product is received.

4-6 Character Code Table

The CPL protocol of this product supports characters in the ASCII character code table.

Upper / Lower	0	1	2	3	4	5	6	7
0			Space	0	@	P	,	p
1			!	1	A	Q	a	q
2	STX		"	2	B	R	b	r
3	ETX		#	3	C	S	c	s
4			$	4	D	T	d	t
5			%	5	E	U	e	u
6			&	6	F	V	f	v
7			'	7	G	W	g	w
8			(	8	H	X	h	x
9			)	9	I	Y	i	y
A	LF		*	:	J	Z	j	z
B			+	;	K	[	k	{
C			,	<	L	¥	l	¦
D	CR		–	=	M	]	m	}
E			.	>	N	^	n	˜
F			/	?	O	_	o	^

The shaded parts of the table above ( ) are not used in this communication system.

(The codes used differ depending on the device.)

Chapter 5. Modbus Communication (RTU Mode)

5 - 1 Communication Procedure

The following is the RS-485 communication procedure in its simple form:

(1) The master station sends an instruction message to slave stations specifying the station it wishes to communicate with.

(2) The slave station receives the instruction message, and performs read or write processing according to the content of the message.

(3) Also, the slave station sends a message corresponding to the processing content as a response message.

(4) The master station receives the response message.

5 - 2 Message Structure

■ Overview of Modbus-RTU Frame

All messages use binary data.

- Modbus-RTU communication frame

Frame structure	Number of bytes	Description
(Start)	0	Silent interval
Address	1	Device address
Function	1	For details, see on the particular function code
Data	n*	For details, see on the particular function code
CRC check	2	Check code
(End)	0	Silent interval

* From 1 to 252

Handling Precautions

- If the device address is set to 0, broadcast communication will be performed. The address is not used for normal communication.

■ Silent interval

In the Modbus-RTU protocol, the period equivalent to a minimum of 3.5 characters (depending on the transmission speed) without communication is prescribed to mark the start and end of command and response messages.

For this device, the length of the silent interval is defined as follows.

Transmission speed	Period equivalent to 3.5 characters	Silent interval for this device
38400 bps	1.003 ms	2 ms or more
19200 bps	2.005 ms	3 ms or more
9600 bps	4.010 ms	5 ms or more
4800 bps	8.021 ms	9 ms or more

One character is 11 bits (start bit + data bit + parity bit + stop bit)

If the silent interval is shorter than the above, the end of a frame may not be recognized. When sending multiple messages, allow a enough interval between frames.

■ Function code

Of the Modbus protocol public function codes, the following are supported.

Code	(Hex)	Description
03	0x03	Read Holding Registers (read multiple data records)
06	0x06	Write Single Register (write one data record)
16	0x10	Write Multiple Registers (write multiple data records)

■ Check code

In RTU mode, CRC check codes are included in both command and response messages.

● Calculation of CRC check code

The part of the message from the device address to immediately before the check code is used for the calculation. (The object of calculation is the 8-bit data for each character. It does not include the start bit, stop bit, or parity bit.)

The binary data in the message is used as is in the calculation.

The 16-bit CRC check code can be calculated with the following C language function get_crc16().

In the CRC in the message, the lower byte precedes the upper byte. This order is the opposite of that in other 16-bit data.

```
/ ************************************************
Argument 1: Length of character string (number of bytes)
Argument 2: Pointer to beginning of character string
Function value: Calculation result
************************************************ /
unsigned short get_crc16(signed int len, unsigned char *p)
{
   unsigned short crc16;
   unsigned short next;
   unsigned short carry;
   signed int i;

   crc16 = 0xffff;
   while (len > 0) {
      next = (unsigned short)*p;
      crc16 ^= next;
      for (i = 0; i < 8; i++) {
         carry = (unsigned short) (crc16 & 0x0001);
         crc16 >>= 1;
         if (carry != 0) {
            crc16 ^= 0xA001;
         }
      }
      p++;
      len--;
   }
   return crc16;
}
```

● Example of CRC calculation

Device address is 1, function code is 03, start data address is 2001 (0x07D1), and the number of data records to read is 1.

Address	01
Function	03
Data address (upper byte)	07
Data address (lower byte)	D1
Number of data records to read (upper byte)	00
Number of data records to read (lower byte)	01
CRC: 1st byte	D5
CRC: 2nd byte	47

The part of the message from the device address to immediately before the check code (01 03 07 D1 00 01) is used for the calculation. In this case, the result of calculation is 47D5.

For the calculation, see the CRC check code calculation method described above.

When the calculation result "47D5" is entered into the message, the order is changed so that the lower byte precedes the upper byte: D547.

■ Error termination code

If an error occurs, an error response according to the Modbus protocol is returned.

The error response is the same for all function codes.

Error response format

Frame structure	Number of bytes	Description
Start	0	Silent interval
Address	1	Device address
Function	1	Function code + 0x80
Exception code	1	Error termination code
CRC check	2	Check code (lower byte → upper byte)
End	0	Silent interval

Of the Modbus protocol exception codes, the following are supported.

Exception code (error termination code)

Error code	Description	Notes
01	ILLEGAL FUNCTION	• Unsupported function code No processing was performed.
03	ILLEGAL DATA VALUE	• Start data address error (inaccessible area) • Error in the number of data records (illegal address included in the specified data) • In a consecutive data access, an undefined data address followed or was included. • The number of data records to access was outside the range. • Incorrect data size • The data to be written was outside the specifiable range. • A write command was received during zero point adjustment.

Handling Precautions

- The success of writing when an error response is returned cannot be guaranteed. If an error occurs during consecutive data writing, the data may have been updated halfway. Be sure to write the data again with a correct message.

■ Conditions under which no response message is returned (no-response conditions)

No response message is returned under the following conditions:

- The message was received during the device initialization period after power-on. (Initialization takes about 10 seconds after power-on.)
- Mismatch of communication settings
- A CRC error occurred.
- Overflow of the received message (length over 256 bytes)
- Incorrect time interval between frames

5 - 3 Description of Commands

■ Function 03 (multiple data read command)

Function 03 is the command for reading multiple data records.

The command and normal response formats are shown in the table.

Note

- ☞ ■ Error termination code (p. 5-4) (for details of error response)

● Send command format

Frame structure		Number of bytes	Description
Address		1	Device address
Function		1	03 (0x03)
Data	Data address	2	Data address (upper byte → lower byte)
	Number of data records	2	Number of data records (upper byte → lower byte)
CRC check		2	Check code (lower byte → upper byte)

● Normal response format

Frame structure		Number of bytes	Description
Address		1	Device address
Function		1	03 (0x03)
Data	Data size	1	Number of data bytes that were read (= 2 × number of data records)
	1st data record	2	Read data (upper byte → lower byte)
	to		(more read data)
	nth data record	2	Read data (upper byte → lower byte)
CRC check		2	Check code (lower byte → upper byte)

Examples:

Sent message: Read 2 data records from data address 2001 (0x07D1)

Device address	Function code	Data address		Number of data records		CRC	
01H	03H	07H	D1H	00H	02H	95H	46H

Normal response: When the data that was read is 0 (0x0000) and 1 (0x0001)

Device address	Function code	Data size	Data 1		Data 2		CRC	
01H	03H	04H	00H	00H	00H	01H	3BH	F3H

Error response:

Device address	Function code	Error termination code	CRC	
01H	83H	02H	51H	32H

The function code when an error occurs (here, 83H) is obtained by flipping the most significant bit of the function code (0x03) to 1.

■ Function 06 (one data write command)

Function 06 is the command for writing one data record.

The command and the normal response have the same format.

Note

- ☞ ■ Error termination code (p. 5-4) (for details of error response)

● Send command format

Frame structure		Number of bytes	Description
Address		1	Device address
Function		1	6 (0x06)
Data	Data address	2	Data address (upper byte → lower byte)
	Data	2	Data to write (upper byte → lower byte)
CRC check		2	Check code (lower byte → upper byte)

● Normal response format

The format is the same as the send command.

Examples:

Sent message: Write "1" (0x0001) to data address 2001 (0x07D1)

Device address	Function code	Data address		Data		CRC	
01H	06H	07H	D1H	00H	01H	D5H	47H

Normal response:

Device address	Function code	Data size		Data		CRC	
01H	06H	07H	D1H	00H	01H	D5H	47H

Error response:

Device address	Function code	Error termination code	CRC	
01H	86H	02H	51H	32H

The function code when an error occurs (here, 86H) is obtained by flipping the most significant bit of the function code (0x06) to 1.

■ Function 16 (multiple data write command)

Function 16 is the command for writing multiple data records.

The command and normal response formats are shown in the table.

Note

- ☞ ■ Error termination code (p. 5-4) (for details of error response)

● Send command format

Frame structure		Number of bytes	Description
Address		1	Device address
Function		1	16 (0x10)
Data	Data address	2	Data address (upper byte → lower byte)
	Number of data records	2	Number of data records to write (upper byte → lower byte)
	Data size	1	Number of data bytes to write (= 2 × number of data records)
	1st data record	2	Data to write (upper byte → lower byte)
	to		(more write data)
	nth data record	2	Data to write (upper byte → lower byte)
CRC check		2	Check code (lower byte → upper byte)

● Normal response format

Frame structure		Number of bytes	Description
Address		1	Device address
Function		1	16 (0x10)
Data	Data address	2	Data address (upper byte → lower byte)
	Number of data records	2	Number of data records to write (upper byte → lower byte)
CRC check		2	Check code (lower byte → upper byte)

Examples:

Sent message: Write 2 data records (1 and 2) in order, starting at data address 2001 (0x07D1)

Device address	Function code	Data address		Number of data records		Data size	Data 1		Data 2		CRC	
01H	10H	07H	D1H	00H	02H	04H	00H	01H	00H	02H	D5H	47H

Normal response:

Device address	Function code	Data address		Number of data records		CRC	
01H	10H	07H	D1H	00H	02H	10H	85H

Error response:

Device address	Function code	Error termination code	CRC	
01H	90H	02H	51H	32H

The function code when an error occurs (here, 90H) is obtained by flipping the most significant bit of the function code (0x10) to 1.

5 - 4 Timing Specifications

Timing specifications are the same as those of CPL communications. ☞ 5 - 4 Timing Specifications (p. 5-11) (for details)

For Modbus communication, pay attention to the interval between frames (silent interval).

-MEMO-

Chapter 6. Communication Data

6 - 1 Basic Information for Handling Communication Data

■ Communication data types and formats

● Types of communication data

Communication data can be categorized as follows:

- Data related to the device
- Data related to operating status
- Data related to the instantaneous flow rate setpoint
- Data related to total flow volume
- Data related to function settings
- Data related to parameter settings

● Format of communication data

Communication data has one of the following formats:

- Numeric data: Data that represents a number.
  Read/write data does not have a decimal point. Data must be combined or separated when it is sent or received.
  The unit and the number of decimal places is determined for each type of data. ☞ 6 - 2 Communication Data Table (p. 6-3)
- Bit data: Data whose meaning is contained in a single bit Data must be combined or separated when it is sent or received.

! Handling Precautions

- Numerical data and fixed-point data are 16 bits long at a maximum. If the data specified by the user-defined unit and number of decimal places settings is outside the 16-bit range (−32238 to +32237 or 0 to 65535), the maximum or minimum value in the 16-bit range is read.

■ Communication data storage memory

● Memory type

Communication data is stored in the memory of the device. This device has two types of memory.

· RAM : Data is erased when the power is turned off.

· NVRAM : Data is not erased if the power is turned off. (Write/read capacity: 10^{12}/bytes)

● **Data address and storage memory according to data types**

Communication data	Data address Decimal (hexadecimal)	Storage memory
Data related to the device	1001 to 1199 (03E9 to 04AF)	RAM
Data related to operating status	1201 to 1399 (04B1 to 0577)	RAM
Data related to the instantaneous flow rate setpoint	1401 to 1599 (0579 to 063F)	RAM + NVRAM
Data related to total flow volume	1601 to 1699 (0579 to 063F)	
Data related to function settings	2001 to 2199 (07D1 to 0897)	
Data related to parameter settings	2201 to 2399 (0899 to 095F)	

Note

- For compatibility with the older MQV models, the data addresses they use, 4001–4199, 4201–4399, 4401–4599, 4601–4799, 5001–5199, and 5201–5399 (data addresses in the table plus 3000), can be used to write/read data. However, the memory to access for communication is defined in the table above. For the MQV, the memory to access is determined by the address of each piece of data, but for the F4Q, it is defined by the type of data.

Handling Precautions

- Be sure to do an operation check when replacing a model MQV with the F4Q. ☞ *Digital Mass Flow Controller Model F4Q User's Manual*, CP-SP-1461E (for details)

6 - 2 Communication Data Table

The following table shows the predefined address for each type of data and whether or not reading or writing is allowed.

■ Meaning of the symbols in columns R and W

✓: Allowed

× : Not allowed

△: Allowed under some conditions

■ Data related to the device

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
Gas type	0:Gas type set by the user 1: Air/nitrogen 2: Oxygen 3: Argon 4: Carbon dioxide (CO_2) 6: 100 % propane 7: 100 % methane 8: 100 % butane 11: Fuel gas 13A	1001 (03E9)	✓	×	Gas type can be specified by C-18, Gas type selection 1.
Full scale flow rate	–	1002 (03EA)	✓	×	The flow rate that can be measured and controlled depends on the model and the gas type selected. The value is without a decimal point. For the number of decimal places and the unit, see "Flow rate digits after the decimal point" (address 1003) and "Flow rate unit" (address 1005).
Flow rate digits after the decimal point (communication)	0 to 3	1003 (03EB)	✓	×	The number of decimal places used by the parameter that reads or writes the instantaneous flow rate can be read out. The setting can be changed by C-49, Flow rate digits after the decimal point (communication).
Totalized flow rate digits after the decimal point (communication)	0 to 3	1004 (03EC)	✓	×	The number of decimal places used by the parameter that reads or writes the total flow volume can be read out. The setting can be changed by C-51, Totalized flow rate digits after the decimal point (communication).

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
Flow rate unit (communication)	0: mL/min 1: L/min 2: m^3/h	1005 (03ED)	✓	×	The unit used by the parameter that reads or writes the instantaneous flow rate can be read out. The setting can be changed by C-48, Flow rate unit (communication).
Totalized flow rate unit (communication)	0: mL 1: L 2: m^3	1006 (03EE)	✓	×	The unit used by the parameter that reads or writes the total flow volume can be read out. The setting can be changed by C-50, Totalized flow rate unit (communication).

● Example of combining decimal point position and unit:

When the values read for the full scale flow rate, the flow rate digits after the decimal point (communication), and the flow rate unit (communication) are 5000, 2, and 1 (L/min) respectively, the actual full scale flow rate is as follows.

- Add a decimal point according to the flow rate digits after the decimal point (communication) setting: 5000 → 50.00
- Add the unit: 50.00 → 50.00 L/min

When writing fixed-point data, use the reverse procedure and write the separated values.

■ Data related to operating status

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
Alarm status bit for compatibility with the MQV	*1	1201 (04B1)	✓	×	A code indicating the device status is given for reference. Use only when replacing an older model MQV is replaced with the F4Q.
Digital I/O status bit	*2	1202 (04B2)	✓	×	For an RS command, statuses are expressed as decimal numbers.
Control condition bit	*3	1203 (04B3)	✓	×	
Operation mode	0: Valve fully closed 1: Valve control 2: Valve fully open 3. Fixed valve MV	1204 (04B4)	✓	△	If the operation mode is defined by C-16 (Operational mode at error occurrence) or by C-10, C-11, or C-12 (Digital input 1–3 function assignment), the setting cannot be changed by communication. If writing is attempted, a normal response will be returned. The operation mode will be "3" (fixed valve MV) only if "4" (Fixed valve MV) is set for C-16 (Operational mode at error occurrence) and an error occurs. The setting cannot be changed by communication.

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
Number of the SP currently in use	0–7	1205 (04B5)	✓	△	If "3" (SP No. switching) is set for C-10, C-11, or C-12 (Digital input 1–3 function assignment), the setting cannot be changed by communication. If writing is attempted, an error response will be returned.
Value of the SP currently in use	(0–100 % FS)	1206 (04B6)	✓	×	The value is without a decimal point. For the number of decimal places and the unit of data, see "Flow rate digits after the decimal point" (address 1003) and "Flow rate unit" (address 1005).
PV	(0–100 % FS)	1207 (04B7)	✓	×	
Valve manipulated variable (MV)	0–1000 [× 0.1 %]	1208 (04B8)	✓	×	The value is without a decimal point.
Online SP		1209 (04B9)	✓	✓	This SP is used if "2" (online SP) is set for C-03, Flow rate setup method (SP setup method selection).
Error	*4	1210 (04BA)	✓	×	A code indicating the device status is given for reference. For an RS command, statuses are expressed as decimal numbers.
Alarm	*4	1211 (04BB)	✓	×	
Warning	*4	1212 (04BC)	✓	×	
Information	*4	1213 (04BD)	✓	×	

*1. Alarm status bits for compatibility with the MQV (address 1201)

Bit No.	Item	Description
0	Flow rate deviation lower limit event (AL01)	0: OFF. 1: ON
1	Flow rate deviation upper limit event (AL02)	0: OFF. 1: ON
2	Undefined (normally 0)	–
3	Undefined (normally 0)	–
4	Sensor error (common to AL81–AL83)	0: OFF. 1: ON
5	Error in the settings set when product was shipped (AL91, AL92)	0: OFF. 1: ON
6	Undefined (normally 0)	0: OFF. 1: ON
7	User setting error (AL93)	0: OFF. 1: ON
8	Valve overheating prevention limit (AL71)	0: OFF. 1: ON
9 to 15	Undefined (normally 0)	–

*2. Digital I/O status bits (address 1202)

Bit No.	Item	Description
0	Digital output 1 status	0: OFF. 1: ON
1	Digital output 2 status	0: OFF. 1: ON
2	Digital output 3 status	0: OFF. 1: ON
3	Digital input 1 status	0: OFF. 1: ON
4	Digital input 2 status	0: OFF. 1: ON
5	Digital input 3 status	0: OFF. 1: ON
6 to 15	Undefined (normally 0)	–

*3. Control status bits (address 1203)

Bit No.	Item	Description
0	Flow rate (PV control) evaluation	0: Not OK. 1: OK
1	Undefined (normally 0)	–
2	SP analog setting	0: Disabled. 1: Enabled
3	Total flow event	0: OFF. 1: ON
4	SP ramp control	0: Normal operation 1: SP ramp control
5	Undefined (normally 0)	–
6	External 24 V supply	0: None (fallback operation by USB in progress) 1: In use
7 to 15	Undefined (normally 0)	–

*4. Device status bits (addresses 1209 to 1212)
These bits are used for errors, alarms, warnings, and information.

Bit No.	Item	Description
0	Zero point adjustment diagnosis	0: OFF. 1: ON
1	SP is being limited	0: OFF. 1: ON
2	Valve overheat prevention limit	0: OFF. 1: ON
3	Flow rate warning	0: OFF. 1: ON
4	Undefined (normally 0)	–
5	User-defined settings error	0: OFF. 1: ON
6	Communication protocol error	0: OFF. 1: ON
7	Flow rate control error	0: OFF. 1: ON
8	Watchdog time-out	0: OFF. 1: ON
9	Valve error	0: OFF. 1: ON
10	Sensor module error	0: OFF. 1: ON
11	Parameter mismatch	0: OFF. 1: ON
12	Parameter error	0: OFF. 1: ON
13	Hardware error	0: OFF. 1: ON
14	Programmable ROM error	0: OFF. 1: ON
15	Run-time error	0: OFF. 1: ON

Handling Precautions

- ☞ *Digital Mass Flow Controller Model F4Q User's Manual*, CP-SP-1461E (for details of each status)

■ Data related to the instantaneous flow rate setpoint

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
Flow rate setpoint (SP-0)	(0 to 100 % FS)*2	1401 (0579)	✓	✓	The value is without a decimal point.*1
Flow rate setpoint (SP-1)	Same as above	1402 (057A)	✓	✓	
Flow rate setpoint (SP-2)	Same as above	1403 (057B)	✓	✓	
Flow rate setpoint (SP-3)	Same as above	1404 (057C)	✓	✓	
Flow rate setpoint (SP-4)	Same as above	1405 (057D)	✓	✓	
Flow rate setpoint (SP-5)	Same as above	1406 (057E)	✓	✓	
Flow rate setpoint (SP-6)	Same as above	1407 (057F)	✓	✓	
Flow rate setpoint (SP-7)	Same as above	1408 (0580)	✓	✓	

*1. For the number of decimal places and the unit of data, see "Flow rate digits after the decimal point" (address 1003) and "Flow rate unit" (address 1005).
Ex.: If the flow rate digits after the decimal point is set to "1" and the flow rate unit is set to "0" (mL/min), the value "1234" means 123.4 mL/min.

*2. The setting range is the full scale flow rate (address 1002) multiplied by the percentage in parentheses. (The setting range varies depending on model and gas type.)

■ Data related to total flow volume

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
Cumulative flow event setting (last digits)	0 to 9999 or 0 to 0xFFFF (see the notes on the right)	1601 (0641) Note: Address 2218 is also used.	✓	✓	The method for combining upper and lower digits/bits and the data range depend on the setting of C-47, Totalized flow rate communication data format.*1 The value is without a decimal point.*2
Cumulative flow event setting (first digits)	Same as above	1602 (0642) Note: Address 2219 is also used.	✓	✓	
Total flow volume (lower)	Same as above	1603 (0643)	✓	✓	
Total flow volume (upper)	Same as above	1604 (0644)	✓	✓	

*1. If the data exceeds the range, the maximum value of the range is read.

*2. For the number of decimal places and the unit of data, see "Totalized flow rate digits after the decimal point" (address 1004) and "Totalized flow rate unit" (address 1006).

Note: If the upper and lower digits/bits are divided into two frames during writing, the total flow volume may be updated between the frames, so an unintended value may be written, depending on the timing. Write data consecutively to keep them in one frame whenever possible.

● Example of total flow volume-related data combination:

When the values read for the total flow volume are 1234 (upper bits) and 5678 (lower bits), and if the totalized flow rate digits after the decimal point (communication) is set to "2" and the totalized flow rate unit (communication) is set to "1" (L/min), the actual total flow volume is as follows.

- If C-47, Totalized flow rate communication data format, is set to "0" (first 4 digits + last 4 digits)

  (1) Combine the upper and lower digits: 1234, 5678 → 12345678

  (2) Add a decimal point according to the totalized flow rate digits after the decimal point (communication) setting: 12345678 → 123456.78

  (3) Add the unit: 123456.78 → 123456.78 L

- If C-47, Totalized flow rate communication data format, is set to "1" (upper 16 bits + lower 16 bits)

  (1) Convert the upper and lower bits to hexadecimal numbers: 1234, 5678 → 0x04D2, 0x162E
  (For CPL communication RD commands and Modbus communication, data is originally hexadecimal.)

  (2) Combine the upper and lower bits: 0x04D2, 0x162E → 0x04D2162E

  (3) Convert to a decimal number: 0x04D2162E → 80877102

(4) Add a decimal point according to the totalized flow rate digits after the decimal point (communication) setting: 80877102 → 808771.02

(5) Add the unit: 808771.02 → 808771.02 L

When writing total flow volume–related data, use the reverse procedure and write the separate values.

■ Data related to function settings

Note

- ☞ *Digital Mass Flow Controller Model F4Q User's Manual*, CP-SP-1461E (for details of the functions)

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(C-01) Key lock	0: Key lock disabled 1: Settings other than flow rate (SP) and RUN are key-locked 2: All settings are key-locked	2001 (07D1)	✓	✓	
(C-02) Operational mode selection when power turned ON	0: Control mode 1: Mode before power shutdown 2: Fully closed mode	2002 (07D2)	✓	✓	
(C-03) Flow rate setup method (SP setup method selection)	0: Select from SP-0 to SP-7 1: Analog setup 2: Online SP	2003 (07D3)	✓	✓	
(C-04) Undefined	Always 0	2004 (07D4)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-05) Undefined	Always 0	2005 (07D5)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-06) ★ Analog input and output type and range selection	0: 0 to 5 V (PV output) 1: 1 to 5 V (PV output) 3: 4 to 20 mA (PV output) 4: 0 to 5 V (SP output) 5: 1 to 5 V (SP output) 7: 4 to 20 mA (SP output)	2006 (07D6)	✓	✓	

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(C-07) ★ Digital output 1 type assignment	0: Not used (OFF at all times) 1: ON when total flow event occurs 2: Totalizer pulse output 3: ON when flow rate is OK 4: ON when operating mode = control 5: ON when operating mode = fully open 6: ON when operating mode = control or fully open 7: ON when operating mode = fully closed 8: ON when error occurs 9: ON when error or alarm occur 10: ON when flow rate deviation event occurs –1 to –10: Inverted output of 1 to 10 above	2007 (07D7)	✓	✓	
(C-08) ★ Digital output 2 type assignment		2008 (07D8)	✓	✓	
(C-09) Undefined	Always 0	2009 (07D9)	–	–	Returns "0" when the setting is read and returns a normal response when written.

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(C-10) Digital input 1 function assignment	0: Not used 1: Totalized flow reset 2: Totalized flow count pause 3: SP No. switching 4: Flow rate analog setup 5: Operation mode forced fully closed by contact ON 6: Operation mode forced fully open by contact ON 7: SP ramp control ON/OFF switching 8: Operation mode switching (control by contact ON, forced fully closed by contact OFF) 9: Flow rate zero adjustment 10: Gas type setting switching 11: Analog scaling switching 12: SP ramp control ramp slope switching 13: Device status deletion	2010 (07DA)	✓	✓	1: While the input is ON, the total value remains 0 and does not increase. 4: The analog setting is valid when the input is ON, and the C-03 setting is valid when the input is OFF. 5,6,8: If there is a conflict of forced full-close and forced full-open at two contact inputs, both inputs will be invalid. 10: After the input is switched, the change takes about 1 second to be applied to the operation. Do not execute other operations meanwhile. 12: Used to switch the ramp slope if C-27, SP ramp control function, is set to "2" (Ramp control 2 enabled). 13: When the input is turned ON, the device status (alarm, warning, information) is deleted. Errors are not deleted.
(C-11) Digital input 2 function assignment		2011 (07DB)	✓	✓	
(C-12) Digital input 3 function assignment		2012 (07DC)	✓	✓	
(C-13) Automatic valve shut-off when the totalized flow event occurs	0: Disabled 1: Enabled	2013 (07DD)	✓	✓	
(C-14) On/off of totalized flow reset function at start of control	0: Disabled 1: Enabled	2014 (07DE)	✓	✓	

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(C-15) Flow rate deviation event setup	0: Disabled 1: Enabled only for upper limit event 2: Enabled only for lower limit event 3: Enabled for upper/ lower limit event	2015 (07DF)	✓	✓	
(C-16) ★ Operational mode at error occurrence	1: No change 2: Forced fully closed 3: Forced fully open 4. Fixed valve MV	2016 (07E0)	✓	✓	1: If 0 is written, "1" (no change) will apply. If the data is read at this time, "1" will be read. 3: The MV remains at the value specified by P-27, Valve manipulated variable when error occurs.
(C-17) Undefined	Always 0	2017 (07E1)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-18) Gas type selection 1	0:Gas type set by the user 1: Air/nitrogen 2: Oxygen 3: Argon 4: Carbon dioxide (CO_2) 6: 100 % propane 7: 100 % methane 8: 100 % butane 11: Fuel gas 13A	2018 (07E2)	✓	✓	If you set this parameter to "0", also specify P-10, User-set gas conversion factor (C.F.) If a setting that is not listed here is set, this device will not operate properly. Change to the correct setting. After the setting is written, it takes about 2 seconds to be applied to the operation. Do not execute other operations meanwhile.
(C-19) Temperature at reference conditions	0: 20 °C 1: 0 °C 2: 25 °C 3: 35 °C	2019 (07E3)	✓	✓	The flow rate is converted to the volumetric flow rate at the temperature (at 1 atm) set here.
(C-20) Undefined	Always 0	2020 (07E4)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-21) Direct setup function	0: Disabled 1: Enabled	2021 (07E5)	✓	✓	
(C-22) Undefined	Always 0	2022 (07E6)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-23) ★ PV filter constant	0 to 9999 [ms]	2023 (07E7)	✓	✓	
(C-24) Undefined	Always 0	2024 (07E8)	–	–	Returns "0" when the setting is read and returns a normal response when written.

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(C-25) Undefined	Always 0	2025 (07E9)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-26) Gas type selection 2	The same as C-18, Gas type selection 1.	2026 (07EA)	✓	✓	
(C-27) SP ramp control function	0: Disabled 1: Ramp control 1 enabled 2: Ramp control 2 enabled	2027 (07EB)	✓	✓	Ramp control 1: SP ramp control slope 1 applies when SP > PV and SP ramp control slope 2 applies when SP < PV. Ramp control 2: SP ramp control slope 1 applies when the digital input is off, and SP ramp control slope 2 applies when the digital input is on. If none of C-10 to C-12 is set to "12" (SP ramp control ramp slope switching), slope 1 will apply.
(C-28) Optional analog scaling function	0: Disabled 1: Enabled	2028 (07EC)	✓	✓	Set the scale by address 2217.
(C-29) PV fluctuation control function when fully closed	0: Disabled 1: Enabled	2029 (07ED)	✓	✓	
(C-30) Communication address setting	0: Communication function disabled 1 to 127: Communications address	2030 (07EE)	✓	✓	If you wish to change the communication settings, check that RS-485 communication is not in progress. Use the keys or the loader to make changes. Otherwise, a communication error may result.
(C-31) ★ Transfer speed selection	0: 38400 bps 1: 19200 bps 2: 9600 bps 3: 4800 bps	2031 (07EF)	✓	✓	If the communication protocol setting is changed, this device must be restarted for the new setting to take effect.
(C-32) Data format selection	0: Even parity, 1 stop bit 1: No parity, 2 stop bits	2032 (07F0)	✓	✓	
(C-33) Communication protocol	0: Modbus-RTU 1: CPL	2033 (07F1)	✓	✓	
(C-34) Installation orientation setup	0: Horizontal → 1: Vertical ↑ 2: Vertical ↓	2034 (07F2)	✓	✓	

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(C-35) SP limit function	0: Disabled 1: Only upper limit enabled 2: Only lower limit enabled 3: Upper and lower limits enabled	2035 (07F3)	✓	✓	
(C-36) Control response setup	0: Response prioritized 1: Standard 2: Stability prioritized 3: PID set by user	2036 (07F4)	✓	✓	
(C-37) ★ Flow rate display unit change function	0: mL/min 1: L/min 2: m^3/h	2037 (07F5)	✓	✓	
(C-38) ★ Flow rate digits after decimal point (display)	0 to 3	2038 (07F6)	✓	✓	
(C-39) Undefined	Always 0	2039 (07F7)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-40) Undefined	Always 0	2040 (07F8)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-41) Undefined	Always 0	2041 (07F9)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-42) Reserved	–	2042 (07FA)	–	–	Returns "0" when the setting is read. Do not write any values other than 0.
(C-43) Totalized flow rate unit (display)	0: mL 1: L 2: m3	2043 (07FB)	✓	✓	
(C-44) Digital output 3 type assignment	The same as C-07, Digital output 1 type assignment	2044 (07FC)	✓	✓	
(C-45) Undefined	Always 0	2045 (07FD)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(C-46) Operation when flow rate deviation event occurs	0: No change 1. Fully closed 2: Fully open	2046 (07FE)	✓	✓	
(C-47) Totalized flow rate communication data format	0: First 4 digits + last 4 digits 1: Upper 16 bits + lower 16 bits	2047 (07FF)	✓	✓	Data related to total flow volume is divided into two pieces of data in a frame when it is sent or received. With this setting, the combination/ separation method can be specified.

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(C-48) Flow rate unit (communication)	0: mL/min 1: L/min 2: m^3/h	2048 (0800)	✓	✓	If the unit or the number of decimal places is changed, the new setting will apply to other parameters automatically. Before setting parameters, check the settings of C-48 to C-51.
(C-49) Flow rate digits after the decimal point (communication)	0 to 3	2049 (0801)	✓	✓	
(C-50) Totalized flow rate unit (communication)	0: mL 1: L 2: m^3	2050 (0802)	✓	✓	
(C-51) Totalized flow rate digits after the decimal point (communication)	0 to 3	2051 (0803)	✓	✓	
(C-52) Display orientation setup	0: LEDs left, keys right 1: LEDs below, keys above 2: LEDs above, keys below 3: LEDs right, keys left	2052 (0804)	✓	✓	
(C-53) Analog output when error occurs	0: Normal output 1: Zero output 2: Full output	2053 (0805)	✓	✓	Zero output: 0 V or 0 mA is output. Full output: approx. 6.2 V or approx. 24.8 mA is output.

★: It may be necessary to change the setting when replacing the MQV with the F4Q.

■ Data related to parameter settings

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(P-1) Flow rate OK judgment range	(0.5 to 100 % FS)*2	2201 (0899)	✓	✓	The value is without a decimal point.*1
(P-2) Flow rate OK judgment hysteresis	(0.5 to 100 % FS)*2	2202 (089A)	✓	✓	
(P-3) Flow rate deviation upper limit event	(0.5 to 100 % FS)*2	2203 (089B)	✓	✓	
(P-4) Flow rate deviation upper limit event hysteresis	(0.5 to 100 % FS)*2	2204 (089C)	✓	✓	
(P-5) Flow rate deviation lower limit event	(0.5 to 100 % FS)*2	2205 (089D)	✓	✓	
(P-6) Flow rate deviation lower limit event hysteresis	(0.5 to 100 % FS)*2	2206 (089E)	✓	✓	
(P-7) Flow rate deviation event judgment delay time	5 to 9999 [× 0.1 s]	2207 (089F)	✓	✓	
(P-8) Digital output 1 delay time	0 to 9999 [× 0.1 s]	2208 (08A0)	✓	✓	
(P-9) Digital output 2 delay time	0 to 9999 [× 0.1 s]	2209 (08A1)	✓	✓	
(P-10) User-set gas conversion factor (C.F.)	40 to 9999 [× 0.001]	2210 (08A2)	✓	✓	Before using this setting, please contact us. Some gas types may not be supported.
(P-11) Undefined	Always 0	2211 (08A3)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(P-12) Undefined	Always 0	2212 (08A4)	–	–	
(P-13) Undefined	Always 0	2213 (08A5)	–	–	
(P-14) Undefined	Always 0	2214 (08A6)	–	–	

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(P-15) SP ramp control slope 1	0 to 9999	2215 (08A7)	✓	✓	Specifies the change in flow rate per second. Note: The unit for the setting varies depending on the model. F4Q9200/9500: × 0.1 mL/min F4Q0002/0005: × 0.001 L/min F4Q0020/0050: × 0.01 L/min F4Q0200/0500: × 0.1 L/min
(P-16) SP ramp control slope 2	0 to 9999	2216 (08A8)	✓	✓	
(P-17) Analog scaling 1	(10 to 100 % FS)*2	2217 (08A9)	✓	✓	The value is without a decimal point.*1
(P-18) Cumulative flow event setting (last digits)	0 to 9999 or 0 to 0xFFFF (see the notes on the right)	2218 (08AA) Note: Address 1601 is also used.	✓	✓	The method for combining upper and lower digits/bits and the data range depend on the setting of C-47, Totalized flow rate communication data format.*3
(P-19) Cumulative flow event setting (first digits)	Same as above	2219 (08AB) Note: Address 1602 is also used.	✓	✓	The value is without a decimal point.*4
(P-20) PV fluctuation control delay time when fully closed	0 to 9999 [× 0.1 s]	2220 (08AC)	✓	✓	
(P-21) SP upper limit flow rate	(0 to 100 % FS)*2	2221 (08AD)	✓	✓	The value is without a decimal point.*1
(P-22) SP lower limit flow rate	(0 to 100 % FS)*2	2222 (08AE)	✓	✓	
(P-23) Primary pressure specification	[kPa (gauge)]	2223 (08AF)	✓	✓	
(P-24) Undefined	Always 0	2224 (08B0)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(P-25) Undefined	Always 0	2225 (08B1)	–	–	Returns "0" when the setting is read and returns a normal response when written.
(P-26) Low flow cutoff threshold	0 to 9999 [× 0.01 %]	2226 (08B2)	✓	✓	
(P-27) Valve manipulated variable when error occurs	0 to 100 [%]	2227 (08B3)	✓	✓	This MV applies when "4" (Fixed valve MV) is set for C-16, Operational mode at error occurrence.
(P-28) Digital output 3 delay time	0 to 9999 [× 0.1 s]	2228 (08B4)	✓	✓	

Item	Data range / [unit]	Data address Decimal (hexadecimal)	R	W	Notes
(P-29) Automatic display off time	0 to 9999 [s]	2229 (08B5)	✓	✓	When set to "0," the display is always lit. (display turnoff function is disabled)
(P-30) PV display filter time constant	0 to 9999 [ms]	2230 (08B6)	✓	✓	First-order lag low-pass filter for display output
(P-31) Keylock password	0 to 9999	2231 (08B7)	✓	✓	
(P-32) Analog scaling 2	(10 to 100 % FS)*2	2232 (08B8)	✓	✓	The value is without a decimal point.*1
(P-33) Totalization pulse weight	[1/pulse]	2233 (08B9)	✓	✓	The value is without a decimal point.*1
(P-34) Totalization pulse width	20 to 100 [ms]	2234 (08BA)	✓	✓	Set in multiples of 10.

*1. For the number of decimal places and the unit of data, see "Flow rate digits after the decimal point" (address 1003) and "Flow rate unit" (address 1005).
Ex.: If the flow rate digits after the decimal point is set to "1" and the flow rate unit is set to "0" (mL/min), the value "1234" means 123.4 mL/min.

*2. The setting range is the full scale flow rate (address 1002) multiplied by the percentage in parentheses. (The setting range varies depending on the model and gas type.)

*3. If the data exceeds the range, the maximum value of the range is read.

*4. For the number of decimal places and the unit of data, see "Totalized flow rate digits after the decimal point" (address 1004) and "Totalized flow rate unit" (address 1006).

Chapter 7. Device Operation by Communication Commands

By sending a write command to a specific data address, the following operations can be executed on this device.

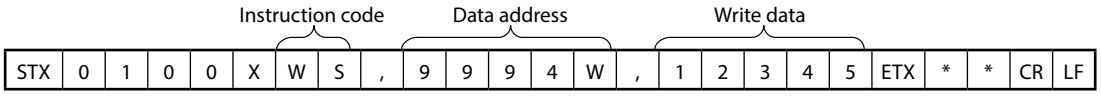
The data address and write data for each operation are as follows.

Device operation	Data address Decimal (hexadecimal)	Write data Decimal (hexadecimal)	Notes
Device status deletion	9994 (270A)	12345 (3039)*	The device status (alarm, warning, information) is deleted. Errors are not deleted.
Automatic zero point adjustment	9995 (270B)	12345 (3039)*	The current flow rate is reset to 0. Before executing this command, set to control mode and SP = 0, or to fully closed mode, and stop the flow completely.
Total flow volume reset	9996 (270C)	12345 (3039)*	The total flow volume is reset to 0.

* For Modbus communication, use Function 16 (multiple data write command) to write the data in the above table and "0" in order.

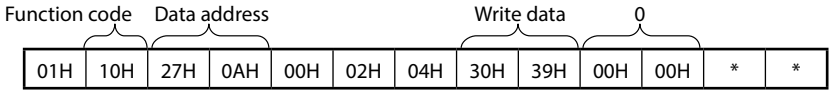
Ex.: Send message of the communication command for device status deletion (checksum and CRC omitted)

- **For CPL communications**



*Check code

- **For Modbus communications**



*Check code

Chapter 8. Troubleshooting

■ Communication failure

- Check if the device is turned on. RS-485 communication is not possible during fallback operation with USB power.
- Check the wiring.
- Check that the communication settings for this device are the same as those for the host device.
  If even one of the following settings differs, communication is not possible.
  The underlined settings can be configured directly on the F4Q.
  - Transmission speed: 38400, 19200, 9600, 4800 bps
  - Data length: 7 bits, 8 bits
  - Stop bits: 1, 2
  - Parity: No parity, even, odd
- Check the communication protocol settings.
  With this unit, the user can select either CPL communication or Modbus communication (RTU mode). CPL communication is the default protocol.
  Also, if the communication protocol setting is changed, this device needs to be restarted in order to apply the new setting.
- Check that the device address in the command frame transmitted from the host device matches the address set for the F4Q. “0” (no communication) is the the default address of the F4Q, but if the device address in the command frame is set to 00, the F4Q will not respond.
- Check that different device addresses are given to multi-dropped devices.
- Check that the communications timing conforms to 4 - 5 Timing Specifications (p. 4-17).
- Check the command frame. Use capital letters in all character codes.

-MEMO-

Chapter 9. Specifications

■ RS-485 specifications

Item	Specifications
Transmission mode	Balanced
Transmission line	3-wire system
Transmission speed (bps)	4800, 9600, 19200, 38400
Transmission distance	500 m max.
Communication system	Half duplex
Synchronization	Start-stop synchronization
Data format	8-bit data, 1 stop bit, even parity Or 8-bit data, 2 stop bits, no parity
Error detection	Parity check, check code (checksum or CRC16)
Communication protocol	Modbus (RTU mode), CPL
Device address	0 to 127 (communication function is disabled if address is set to 0)
Network type	1:N (31 units max.)

-MEMO-

Revision History (CP-SP-1458E)

Printed	Edn.	(New) Page No.	Description
June 2021	1		

-MEMO-

Terms and Conditions

We would like to express our appreciation for your purchase and use of Azbil Corporation's products.

You are required to acknowledge and agree upon the following terms and conditions for your purchase of Azbil Corporation's products (system products, field instruments, control valves, and control products), unless otherwise stated in any separate document, including, without limitation, estimation sheets, written agreements, catalogs, specifications and instruction manuals.

1. Warranty period and warranty scope

   1.1 Warranty period

   Azbil Corporation's products shall be warranted for one (1) year from the date of your purchase of the said products or the delivery of the said products to a place designated by you.

   1.2 Warranty scope

   In the event that Azbil Corporation's product has any failure attributable to azbil during the aforementioned warranty period, Azbil Corporation shall, without charge, deliver a replacement for the said product to the place where you purchased, or repair the said product and deliver it to the aforementioned place. Notwithstanding the foregoing, any failure falling under one of the following shall not be covered under this warranty:

   (1) Failure caused by your improper use of azbil product (noncompliance with conditions, environment of use, precautions, etc. set forth in catalogs, specifications, instruction manuals, etc.);
   (2) Failure caused for other reasons than Azbil Corporation's product;
   (3) Failure caused by any modification or repair made by any person other than Azbil Corporation or Azbil Corporation's subcontractors;
   (4) Failure caused by your use of Azbil Corporation's product in a manner not conforming to the intended usage of that product;
   (5) Failure that the state-of-the-art at the time of Azbil Corporation's shipment did not allow Azbil Corporation to predict; or
   (6) Failure that arose from any reason not attributable to Azbil Corporation, including, without limitation, acts of God, disasters, and actions taken by a third party.

   Please note that the term "warranty" as used herein refers to equipment-only-warranty, and Azbil Corporation shall not be liable for any damages, including direct, indirect, special, incidental or consequential damages in connection with or arising out of Azbil Corporation's products.

2. Ascertainment of suitability

   You are required to ascertain the suitability of Azbil Corporation's product in case of your use of the same with your machinery, equipment, etc. (hereinafter referred to as "Equipment") on your own responsibility, taking the following matters into consideration:

   (1) Regulations and standards or laws that your Equipment is to comply with.
   (2) Examples of application described in any documents provided by Azbil Corporation are for your reference purpose only, and you are required to check the functions and safety of your Equipment prior to your use.
   (3) Measures to be taken to secure the required level of the reliability and safety of your Equipment in your use
   Although azbil is constantly making efforts to improve the quality and reliability of Azbil Corporation's products, there exists a possibility that parts and machinery may break down. You are required to provide your Equipment with safety design such as fool-proof design,*1 and fail-safe design*2 (anti-flame propagation design, etc.), whereby preventing any occurrence of physical injuries, fires, significant damage, and so forth. Furthermore, fault avoidance,*3 fault tolerance,*4 or the like should be incorporated so that the said Equipment can satisfy the level of reliability and safety required for your use.

   *1. A design that is safe even if the user makes an error.
   *2. A design that is safe even if the device fails.
   *3. Avoidance of device failure by using highly reliable components, etc.
   *4. The use of redundancy.

3. Precautions and restrictions on application

   3.1 Restrictions on application

   Please follow the table below for use in nuclear power or radiation-related equipment.

	Nuclear power quality*5 required	Nuclear power quality*5 not required
Within a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Cannot be used (except for limit switches for nuclear power*7)
Outside a radiation controlled area*6	Cannot be used (except for limit switches for nuclear power*7)	Can be used

   *5. Nuclear power quality: compliance with JEAG 4121 required
   *6. Radiation controlled area: an area governed by the requirements of article 3 of "Rules on the Prevention of Harm from Ionizing Radiation," article 2 2 4 of "Regulations on Installation and Operation of Nuclear Reactors for Practical Power Generation," article 4 of "Determining the Quantity, etc., of Radiation-Emitting Isotopes,"etc.
   *7. Limit switch for nuclear power: a limit switch designed, manufactured and sold according to IEEE 382 and JEAG 4121.

   Any Azbil Corporation's products shall not be used for/with medical equipment.

   The products are for industrial use. Do not allow general consumers to install or use any Azbil Corporation's product. However, azbil products can be incorporated into products used by general consumers. If you intend to use a product for that purpose, please contact one of our sales representatives.

   3.2 Precautions on application

   you are required to conduct a consultation with our sales representative and understand detail specifications, cautions for operation, and so forth by reference to catalogs, specifications, instruction manual, etc. in case that you intend to use azbil product for any purposes specified in (1) through (6) below. Moreover, you are required to provide your Equipment with fool-proof design, fail-safe design, anti-flame propagation design, fault avoidance, fault tolerance, and other kinds of protection/safety circuit design on your own responsibility to ensure reliability and safety, whereby preventing problems caused by failure or nonconformity.

(1) For use under such conditions or in such environments as not stated in technical documents, including catalogs, specification, and instruction manuals
(2) For use of specific purposes, such as:
    * Nuclear energy/radiation related facilities
      [When used outside a radiation controlled area and where nuclear power quality is not required]
      [When the limit switch for nuclear power is used]
    * Machinery or equipment for space/sea bottom
    * Transportation equipment
      [Railway, aircraft, vessels, vehicle equipment, etc.]
    * Antidisaster/crime-prevention equipment
    * Burning appliances
    * Electrothermal equipment
    * Amusement facilities
    * Facilities/applications associated directly with billing
(3) Supply systems such as electricity/gas/water supply systems, large-scale communication systems, and traffic/air traffic control systems requiring high reliability
(4) Facilities that are to comply with regulations of governmental/public agencies or specific industries
(5) Machinery or equipment that may affect human lives, human bodies or properties
(6) Other machinery or equipment equivalent to those set forth in items (1) to (5) above which require high reliability and safety

4. Precautions against long-term use

   Use of Azbil Corporation's products, including switches, which contain electronic components, over a prolonged period may degrade insulation or increase contact-resistance and may result in heat generation or any other similar problem causing such product or switch to develop safety hazards such as smoking, ignition, and electrification. Although acceleration of the above situation varies depending on the conditions or environment of use of the products, you are required not to use any Azbil Corporation's products for a period exceeding ten (10) years unless otherwise stated in specifications or instruction manuals.

5. Recommendation for renewal

   Mechanical components, such as relays and switches, used for Azbil Corporation's products will reach the end of their life due to wear by repetitious open/close operations.

   In addition, electronic components such as electrolytic capacitors will reach the end of their life due to aged deterioration based on the conditions or environment in which such electronic components are used. Although acceleration of the above situation varies depending on the conditions or environment of use, the number of open/close operations of relays, etc. as prescribed in specifications or instruction manuals, or depending on the design margin of your machine or equipment, you are required to renew any Azbil Corporation's products every 5 to 10 years unless otherwise specified in specifications or instruction manuals. System products, field instruments (sensors such as pressure/flow/level sensors, regulating valves, etc.) will reach the end of their life due to aged deterioration of parts. For those parts that will reach the end of their life due to aged deterioration, recommended replacement cycles are prescribed. You are required to replace parts based on such recommended replacement cycles.

6. Other precautions

   Prior to your use of Azbil Corporation's products, you are required to understand and comply with specifications (e.g., conditions and environment of use), precautions, warnings/cautions/notices as set forth in the technical documents prepared for individual Azbil Corporation's products, such as catalogs, specifications, and instruction manuals to ensure the quality, reliability, and safety of those products.

7. Changes to specifications

   Please note that the descriptions contained in any documents provided by azbil are subject to change without notice for improvement or for any other reason. For inquires or information on specifications as you may need to check, please contact our branch offices or sales offices, or your local sales agents.

8. Discontinuance of the supply of products/parts

   Please note that the production of any Azbil Corporation's product may be discontinued without notice. After manufacturing is discontinued, we may not be able to provide replacement products even within the warranty period.

   For repairable products, we will, in principle, undertake repairs for five (5) years after the discontinuance of those products. In some cases, however, we cannot undertake such repairs for reasons, such as the absence of repair parts. For system products, field instruments, we may not be able to undertake parts replacement for similar reasons.

9. Scope of services

   Prices of Azbil Corporation's products do not include any charges for services such as engineer dispatch service. Accordingly, a separate fee will be charged in any of the following cases:

   (1) Installation, adjustment, guidance, and attendance at a test run
   (2) Maintenance, inspection, adjustment, and repair
   (3) Technical guidance and technical education
   (4) Special test or special inspection of a product under the conditions specified by you

   Please note that we cannot provide any services as set forth above in a nuclear energy controlled area (radiation controlled area) or at a place where the level of exposure to radiation is equivalent to that in a nuclear energy controlled area.

azbil

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