EM70

Servo Controller

COMMUNICATION INTERFACE

(RS-232C/RS-485)

INSTRUCTION MANUAL

Thank you for purchasing the Shimaden EM70 Servo Controller.
Please check that the delivered product is the correct item you ordered.
Please do not begin operating this product until you have read this instruction manual thoroughly and you understand its contents.

Request

The instruction manual should be kept in a handy place where the end user can refer to it when necessary.

Preface

This instruction manual describes the basic functions and usage method of the communications interface (RS-232C/RS-485) for the EM70 Series.
For product overview and details on product functions, or information on wiring, installation, operation or routine maintenance, see the “EM70 Series Servo Controller Instruction Manual” (hereinafter referred to as “the instruction manual”).

SHIMADEN CO., LTD.

EM70C-1CE
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Contents

Request 1

Preface 1

1. Safety rules 3

2. Overview 4

2-1. Communication interface 4

2-2. Communications protocol and specifications ... 4

3. Controller and host computer connection 6

3-1. When using RS-232C Interface 6

3-2. When using RS-485 Interface 6

3-3. 3-State output control 6

4. Settings related to communication 7

4-1. Communication Protocol settings 7

4-2. Communication mode settings 7

4-3. Communication address settings 7

4-4. Communication speed setting 7

4-5. Communication data format settings 7

4-6. State character setting 8

4-7. BCC operation/protocol type setting 8

4-8. Communication memory mode settings 8

4-9. Delay time setting 8

4-10. Communication mode type setting 9

5. Overview of shimaden communication protocol 10

5-1. Communication procedure 10

(1) Master-slave relationship 10
(2) Communication procedure 10
(3) Time out 10

5-2. Communication format 10

(1) Communication format overview 10
(2) Details of basic format portion I 11
(3) Details of basic format portion II 11
(4) Overview of text portion 12

5-3. Read command (R) details 14

(1) Read command format 14
(2) Normal response format for read command 14
(3) Abnormal response format for read command 15

5-4. Write command (W) details 15

(1) Write command format 16
(2) Normal response format for write command 16
(3) Abnormal response format for write command 17

5-5. Broadcast command (B) details 17

(1) Broadcast command format 17

5-6. Response code details 18

(1) Response code types 18
(2) Response code priority ranking 18

6. MODBUS protocol overview 19

6-1. Transmission mode overview 19

(1) ASCII mode 19
(2) RTU mode 19

6-2. Message configuration 19

(1) ASCII mode 19
(2) RTU mode 19

6-3. Slave address 19

6-4. Function code 19

6-5. Data 20

6-6. Error check 20

(1) ASCII mode 20
(2) RTU mode 20

6-7. Sample messages 20

(1) ASCII mode 20
(2) RTU mode 21

7. Communication data address 22

7-1. Communication data address details 22

(1) Data address and read/write 22
(2) Data address and No. of data items 22
(3) Data 22
(4) “Spare” of parameter portion 22
(5) Parameters concerning optional items 22
(6) Parameters not displayed on the front panel display due to action or setting specifications 22

7-2. Communication data addresses 23

8. Supplementary explanation 25

8-1. Types of event 25

8-2. ASCII codes table 25

1. Safety rules

Safety rules, precautions concerning equipment damage, additional instructions and notes are written based on the following headings.

WARNING ⚠: Matters that could result in injury or death if instructions are not followed.
CAUTION ⚠: Matters that could result in equipment damage if instructions are not followed.

⚠ WARNING

The EM70 Series Servo controllers are control instruments designed for industrial use to operate control motors and other physical amounts for industrial equipment. You should therefore avoid using the devices for control that could have a serious effect on human life. It is the customer's responsibility to take measures to ensure safety. Shimaden shall not be liable for accidents resulting from failure to take proper safety measures.

- If the controller is mounted inside a control box, etc., be sure to take measures so the terminal element is not touched by any part of the human body.
- Do not open the case, touch the pc board, or stick your hands or any electrical conductor inside the case. Do dot attempt to repair or modify the equipment yourself. Doing so could result in electric shock accident involving death or serious injury.

⚠ CAUTION

If there is danger of damage to any peripheral device or equipment due to failure of the controller, you should take appropriate safety measures such as mounting a fuse or overheating prevention device. Shimaden shall not be liable for accidents resulting from failure to take proper safety measures.

Be sure to read the safety precautions in the instruction manual thoroughly and get a good understanding of the contents before attempting to use the equipment.

2. Overview

2-1. Communication interface

With the EM70 Series, RS-232C/RS-485 communications is optionally available. With this option, you can set and read various types of data using the RS-485 interface.
RS-232C/RS-485 is the data communications standard established by the Electronic Industries Association of the U.S. (EIA). This standards stipulate the hardware. The data transmission procedure software is however not defined, so communication cannot be carried out unconditionally with another device equipped with the same interface. The customer must therefore get a good understanding of data transmission specifications and procedures prior to using the equipment.

Using the RS-485 interface enables you to connect multiple EM70 Series controllers in parallel. Few PC models currently support the RS-485 interface, but if you equip your machine with a commercially available “RS-485 converter”, you can use the RS-485 interface.

2-2. Communications protocol and specifications

The EM70 Series supports Shimaden protocol and MODBUS (RTU/ASCII) communication protocol.

■ Shared by each protocol

Signal level	EIA RS-232C, RS-485-compliant
Communication system	RS-232C: 3-line half duplex system RS-485: 2-line half duplex multidrop (bus) system
Synchronization system	Half duplex start-stop synchronization system
Communication distance	RS-232C: maximum 15 m RS-485: total maximum 500 m (differs according to connection condition)
Communication speed	1200/2400/4800/9600/19200/38400 bps
Transmission procedure	No procedure
Communication delay time	1 – 100 (x 0.25 msec)
No. of communication units	RS-232S 1 units RS-485 Up to 31 units (differs according to connection conditions)
Communication address	1 – 255
Communication memory mode	EEP/RAM

■ Shimaden protocol

Shimaden's own original communication protocol. A list of specifications is provided below.

Data format Data length Parity Stop bits	Data length: 7 bits, parity: even, stop bits: 1 Data length: 7 bits, parity: even, stop bits: 2 Data length: 7 bits, parity: none, stop bits: 1 Data length: 7 bits, parity: none, stop bits: 2 Data length: 8 bits, parity: even, stop bits: 1 Data length: 8 bits, parity: even, stop bits: 2 Data length: 8 bits, parity: none, stop bits: 1 Data length: 8 bits, parity: none, stop bits: 2
Communication code	ASCII code
Control code	STX_ETX_CR, @_:_CR
BCC check	ADD/ADD_two’s cmp/XOR/NONE

■ MODBUS (RTU/ASCⅡ) communication protocol

MODBUS (RTU/ASCII) communication protocol is communication protocol developed for PLC by Modicon Inc. The specifications have been discloded to the public, but only communication protocol is defined by MODBUS (RTU/ASCII) communication protocol, and physical layers such as communication media is not prescribed.
A list of specifications is provided below.

▪ ASCⅡ mode

Data format Data length Parity Stop bits	Data length: 7 bits, parity: even, stop bits: 1 Data length: 7 bits, parity: even, stop bits: 2 Data length: 7 bits, parity: none, stop bits: 1 Data length: 7 bits, parity: none, stop bits: 2
Communication code	ASCII code
Control code	:_CRLF
Error check	LRC

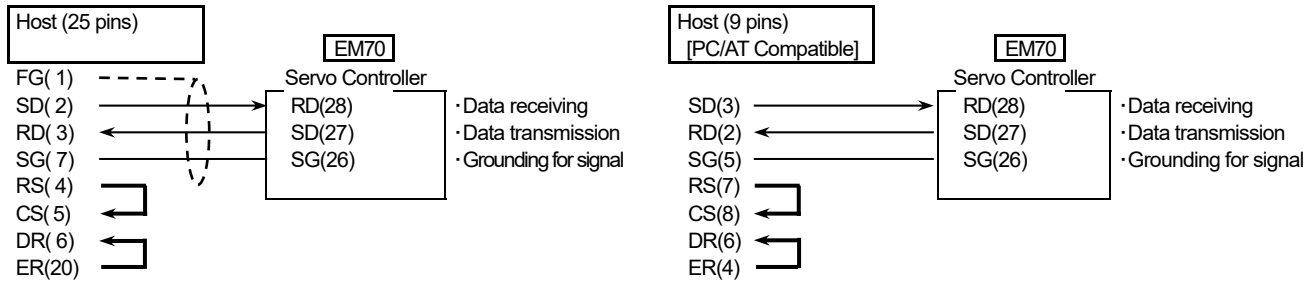
▪ RTU mode

Data format Data length Parity Stop bits	Data length: 8 bits, parity: even, stop bits: 1 Data length: 8 bits, parity: even, stop bits: 2 Data length: 8 bits, parity: none, stop bits: 1 Data length: 8 bits, parity: none, stop bits: 2
Communication code	Binary data
Control code	None
Error check	CRC

3. Controller and host computer connection

A transmission data line and a reception data line are connected between the EM70 Series controller and host computer. A connection example is provided below. For details see the host computer manual.

3-1. When using RS-232C Interface



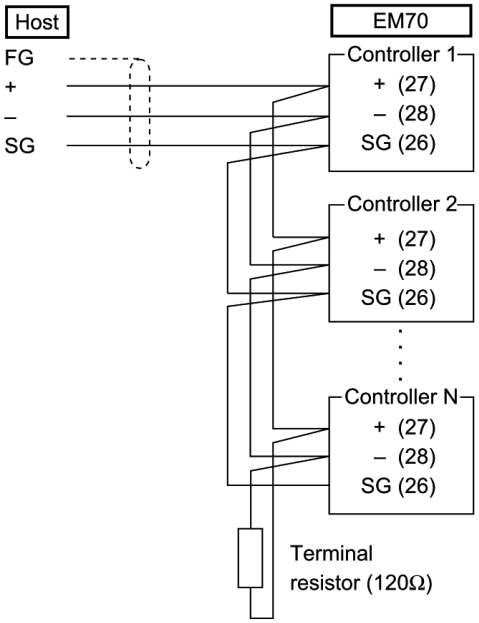
Note 1: Figures in ( ) represent pin numbers of connector.

3-2. When using RS-485 Interface

The input/output logic level of the EM70 Series is basically as follows.

Mark - terminal < + terminal
Space - terminal > + terminal

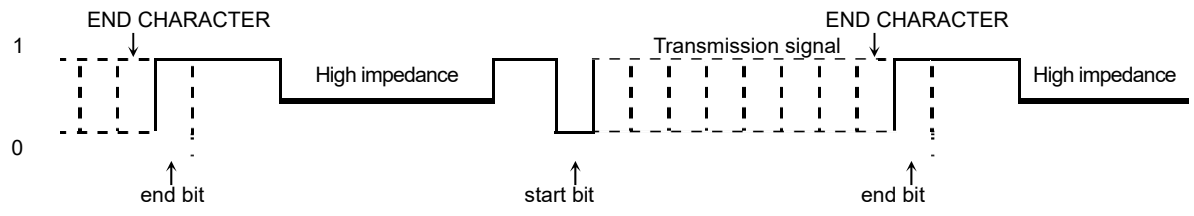
The + and - terminals of the controller are however high impedance up until immediately before transmission begins and the level described above is output immediately before transmission starts. (See 3-3. 3-State output control.)



Note 1: With RS-485 specifications, you should mount the 1/2W 120Ω terminating resistor that comes with the terminal element (between + and -) if necessary.
The terminating resistor should however be ultimately mounted on a single controller only.
Operation cannot be guaranteed if a terminating resistor is mounted on more than one controller.

3-3. 3-State output control

Because RS-485 is a multidrop system, in order to avoid collision of transmitted signals, transmission is always high impedance if communication is not conducted or during reception. Status changes from high impedance to communication output immediately prior to transmission, and is once again controlled to high impedance as soon as transmission is complete.
However, because 3-state control is delayed approximately 1 msec after end bit transmission of end character is finished, you should provide several msec of delay time when starting transmission immediately after the host receives the transmission.

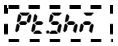


4. Settings related to communication

There are 10 types of parameters related to communication for the EM70 Series as follows. The parameters cannot be set or modified by communication; use the keys on the front panel to set or modify the parameters.
When setting the parameters, you should follow the procedure as described in " 7. Screen description and settings" in the instruction manual.

4-1. Communication Protocol settings

1-17



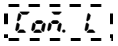
Initial value: Shm
Setting range: Shm, ASc, rtu

Communication protocol can be selected and set from the options below.

Selection	Communication Protocol
Shm	Shimaden Standard Protocol
ASc	MODBUS ASCII MODE
rtu	MODBUS RTU MODE

4-2. Communication mode settings

1-18



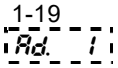
Initial value: L
Setting range: L, C

Communication can be selected and set from the options below. Can be changed only from Com to Loc with the front panel keys.

	Valid command		
	Mode1	Mode2	COM lamp
Loc	Read, write	Read	Off
Com	Read, write	Read, write	On

4-3. Communication address settings

1-19



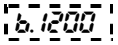
Initial value: 1
Setting range: 1 to 255

While one EM70 controller is to be connected to a host computer in the case of RS-232C, the RS485's multidrop system allows 31 controllers (maximum) to be connected to a host computer.
Therefore, an address (machine No.) is assigned to each controller for identification so that only the one with a designated number can respond.

Note 1: Address can be set to 1 to 255. Up to 31 machines can be connected.

4-4. Communication speed setting

1-20

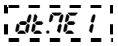


Initial value: 1200 (bps)
Setting range: 1200, 2400, 4800, 9600, 19200, 38400 (bps)

Selects/sets communication speed to transmit data to the host.

4-5. Communication data format settings

1-21



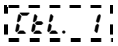
Initial value: 7E1
Setting range: 8 types in the following table

You can select format of communication data from among the following 8 selections.

Selection	Data length	Parity	Stop bits	Shimaden standard	MODBUS/ASCII mode	MODBUS/RTU mode
7E1	7 bits	EVEN	1bit	○	○	-
7E2	7 bits	EVEN	2bit	○	○	-
7N1	7 bits	None	1bit	○	○	-
7N2	7 bits	None	2bit	○	○	-
8E1	8 bits	EVEN	1bit	○	-	○
8E2	8 bits	EVEN	2bit	○	-	○
8N1	8 bits	None	1bit	○	-	○
8N2	8 bits	None	2bit	○	-	○

4-6. State character setting

1-22



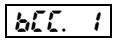
Initial value: 1
Setting range: 1 to 3

Selects the control code to be used. This parameter is valid only when Shimaden standard protocol is used.

Selection	Start character	Text end character	End character
1	STX (02H)	ETX (03H)	CR (0DH)
2	STX (02H)	ETX (03H)	CRLF (0DH 0AH)
3	" @ " (40H)	" : " (3AH)	CR (0DH)

4-7. BCC operation/protocol type setting

1-23



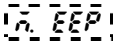
Initial value: 1
Setting range: 1 to 4

Select a BCC operation method to be used in BCC checking.

Selection	Operation method
1	Addition
2	Addition + 2's complement
3	XOR (exclusive OR)
4	None

4-8. Communication memory mode settings

1-24



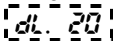
Initial value: EEP
Setting range: EEP, RAM

The non-volatile memory EEPROM used in the EM70 series has a fixed write cycle, so frequent rewriting through communication shortens the life of the EEPROM.
To prevent this, when data is frequently rewritten in communication, the RAM mode is set so that only the RAM data is rewritten without rewriting the EEPROM, thereby prolonging the life of the EEPROM.

Selection	Processing contents
EEP	Mode whereby EEPROM data is also replaced when data is changed by communications. Consequently data is preserved even if the power is turned off.
rAm	Mode whereby only RAM data is replaced instead of replacing EEPROM data if data is changed by communications. Consequently the data in the RAM is cleared when the power is turned off. When the power is turned back on, operation boots by the data stored in the EEPROM.

4-9. Delay time setting

1-25



Initial value: 20
Setting range: 1 to 100

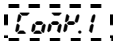
You can set delay time from when communication command is received until transmission.

Delay time (msec) = Setting value (count) x 0.25 (msec)

Note 1: In the case of RS-485, it may take a while for 3-state control by line converter and signal collision may occur in some cases. This can be avoided by increasing delay time. Caution is required particularly if communication speed is slow (1200/2400 bps, etc.).
Note 2: Actual delay time from when the communication command is received until transmission is the total of the delay time and time it takes software to process the command. Especially in the case of a write command, it may take about 400 msec to process the command.

4-10. Communication mode type setting

1-26



Initial value: 1
Setting range: 1(Mode1), 2(Mode2)

Selects type of communication mode.
Set to 1 if you want to enable key operation while writing by communication.

Communication mode types	Mode1		Mode2	
Communication mode	COM	LOC	COM	LOC
Key operation	Available	Available	Not available	Available
Communication writing	Available	Available	Available	Not available

If "communication mode type" is modified by communication command, it becomes as follows.

Communication mode	LOC	COM
Communication writing	Mode1 ⇒ Mode2 Available	Mode1 ⇒ Mode2 Available
	Mode2 ⇒ Mode1 Not Available	Mode2 ⇒ Mode1 Available

5. Overview of shimaden communication protocol

The EM70 Series uses Shimaden communication protocol.
For this reason, data acquisition can be changed by same communication format even if machine of different series using Shimaden communication protocol is connected.

5-1. Communication procedure

(1) Master-slave relationship

- PC and PLC (host) side are on the master side.
- The EM70 Series is on the slave side.
  However, EM70 Series can be operated as the master when it is set to master mode.
  In the master mode, hosts such as PC and PLC cannot be connected.
- Communication is started by communications command from the master side and ends by communication response from the slave side.
  There is however no communication response if an error such as communication format error or BCC error is recognized.
  There is also no communication response for broadcast command as well.

(2) Communication procedure

Communication procedure calls for slave side responding to master side, with mutual transmission authority.

(3) Time out

The controller times out if end character reception is not completed within 1 second after receiving the start character, and begins waiting for another command (new start character).
Therefore set at least 1 second at the time out time on the host side.

5-2. Communication format

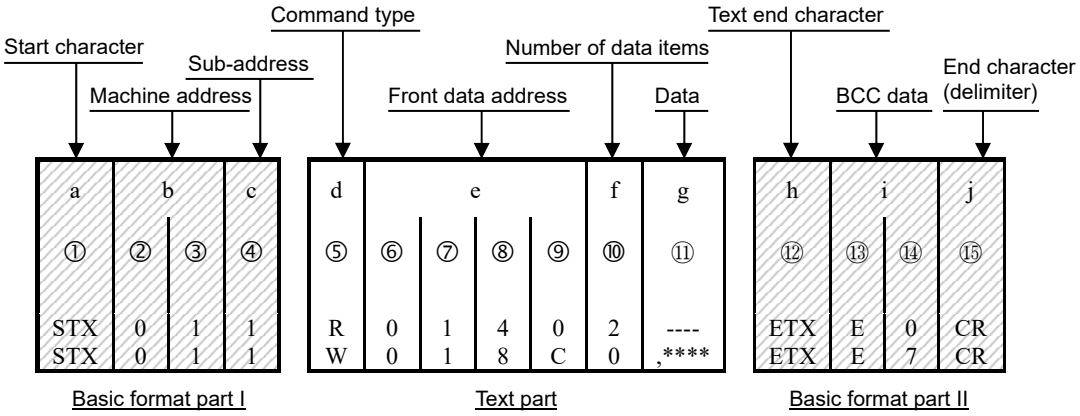
Because the EM70 Series supports various types of protocol, you can make a wide range of selections by communication format (control code and BCC operating method) and communication data format (data bit length, parity or no parity, stop bit length).
But for the sake of convenience and in order to avoid confusion when making communication settings, we recommend using the following format.

	Recommended format	
Control code	STX_FTX_CR	
BCC operating method	ADD	
Communication data format	7E1	8N1

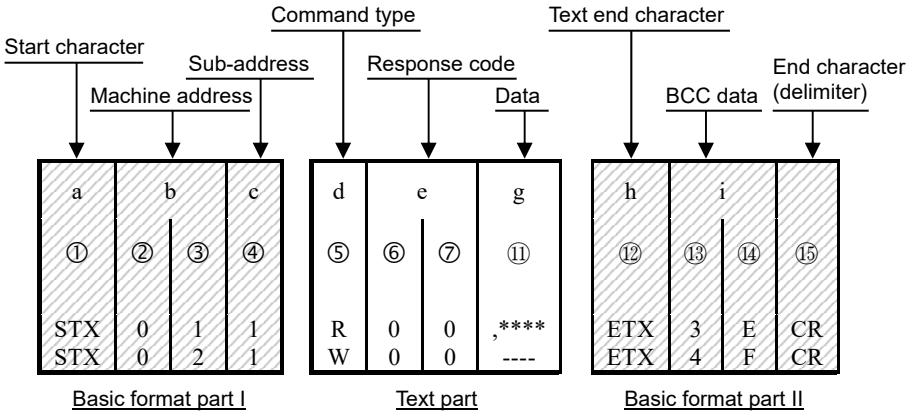
(1) Communication format overview

The communication command format sent from the master and communication response format sent from the slave consist of 3 blocks: basic format portion I, text portion, and basic format portion II.
Basic format portions I and II share read command (R) and write command (W) for communication response.
Operation results data is however inserted for BCC data of i (13 and 14) as it occurs.
Text portion differs according to command type, data address and communication response.

■ Communication command format



■ **Communication response format**



(2) Details of basic format portion I

a: Start character [①: 1 digit/STX (02H) or "@" (40H)]

- Indicates start character of communication string.
- When start character is received, it is judged to be the first character of a new communication string.
- Start character and text end character are selected as a pair.

  Selected by STX (02H) - - - ETX (03H)
  Selected by "@" (40H) - - - " : " (3AH)

b: Machine address [②, ③: 2 digits]

- Specifies machine to carry out communication.
- Address is specified in the range of 1 to 255 (decimal notation)
- Binary 8-bit data (1: 0000 0001 to 255: 1111 1111) is divided into top 4 bits and bottom 4 bits and converted to ASCII data.
  ②: Top 4 bits is data converted to ASCII.
  ③: Bottom 4 bits is data converted to ASCII.
- Machine address = 0 (30H, 30H) is used for broadcast command.
  The EM70 Series supports broadcast command.
  There is however no response for broadcast command, regardless of whether it is normal or not.

c: Sub-address [④: 1 digit]

- The EM70 Series is a single loop controller and is fixed to 1 (31H).
  If other sub-address is used, there is no response due to sub-address error.

(3) Details of basic format portion II

h: Text end character [⑫: 1 digit/ETX (03H)] or [":" (3AH)]

- Indicates text portion runs up to immediately preceding.

I : BCC data [⑬, ⑭: 2 digits]

- BCC (Block Check Character) data is for checking if there was an error in the communications data.
- In the case of BCC error, the result of BCC operation is no response.
- BCC operation includes the following 4 types. (BCC operation types can be set by the front screen.)
  (1) ADD
  Addition is performed by ASCII data 1 character (1 byte) unit from start character ① to text end character ⑫.
  (2) ADD_two's cmp
  Addition is performed by ASCII data 1 character (1 byte) unit from start character ① to text end character ⑫ and the 2's complement of the lower 1 byte of operation results is used.
  (3) XOR
  XOR (Exclusive OR) operation is performed by ASCII data 1 character (1 byte) unit from immediately following start character (machine address ②) to text end character ⑫.
  (4) None
  BCC operation is not performed. (⑬ and ⑭ omitted)
- Operation is performed by 1 byte (8 bits) unit regardless of data bit length (7 or 8).
- The lower 1 byte data of the results of the previously described operation are divided into top 4 bits and bottom 4 bits and converted to ASCII data.
  ⑬: Top 4 bits is data converted to ASCII.
  ⑭: Bottom 4 bits is data converted to ASCII.

Example 1: Read command (R) by BCC Add setting

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑫	⑬	⑭	⑮
STX	0	1	1	R	0	1	4	0	2	ETX	E	0	CR

02H +30H +31H +31H +52H +30H +31H +30H +30H +32H +03H = 1E0H
Result of addition (1E0H) lower 1 byte = E0H
⑬ : " E " = 45H, ⑭ : " 0 " = 30H

Example 2: Read command (R) by BCC Add_two's cmp setting

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑫	⑬	⑭	⑮
STX	0	1	1	R	0	1	4	0	2	ETX	2	0	CR

02H +30H +31H +31H +52H +30H +31H +34H +30H +32H +03H = 1E0H
Result of addition (1 E0H) lower 1 byte = E0H
Complement of 2 of lower 1 byte (E0H) = 20H
⑬ : " 2 " = 32H, ⑭ : " 0 " = 30H

Example 3: Read command (R) by BCC i XOR setting

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑫	⑬	⑭	⑮
STX	0	1	1	R	0	1	4	0	2	ETX	5	6	CR

02H 30H⊕31H⊕31H⊕52H⊕30H⊕31H⊕30H⊕30H⊕30H⊕03H = 56H
(However + = XOR (exclusive OR)
Result of operation (56H) lower 1 byte = 56H
⑬ : " 5 " = 35H, ⑭ : " 6 " = 36H

j: End character (delimiter) [⑮: 1 digit/CR]

- Indicates end of communication string.

Note

There is no response if an error such as the following is recognized in the basic format portion.

- If a hardware error occurs
- If the machine address or sub-address differs from that of the specified machine
- If character established by previously mentioned communication format is not in the established position
- If BCC operating results differ from BCC data

With data conversion, binary data is converted to ASCII data each 4 bits.
Hexidecimal A to F is converted to ASCII data using upper case letters.

(4) Overview of text portion

Text portion differs according to command type, data address and communication response. For details of the text portion, see "5-3. Read command (R) details," "5-4. Write command (W) details."

d: Command type [⑤: 1 digit]

- "R" (52H/upper case letter)
  Indicates read command or read command response.
  Used to read various types of data of the EM70 Series from master PC or PLC.

- "W" (57H/upper case letter)
  Indicates write command or write command response.
  Used to write various types of data from master PC or PLC to the EM70 Series.

- "B" (42H/upper case letter)
  Indicates broadcast command.

- There is no response if any character other than "R", "W" or "B" is recognized.

e: Front data address [⑥, ⑦, ⑧, ⑨: 4 digits] (Communication command format)

▪ Specifies the read front data address of the read command (R) or the write front data address of the write command (W).
  ▪ The front data address is specified by binary 16-bit data (1 word/0 to 65535).
  ▪ 16-bit data is divided into 4-bit segments and converted to ASCII data.

Binary (16 bits)	D15, D14, D13, D12 0 0 0 0	D11, D10, D9, D8 0 0 0 1	D7, D6, D5, D4 1 0 0 0	D3, D2, D1, D0 1 1 0 0
Hexadecimal (Hex)	0H	1H	8H	CH
	“0”	“1”	“8”	“C”
ASCII data	30H	31H	38H	43H
	⑥	⑦	⑧	⑨

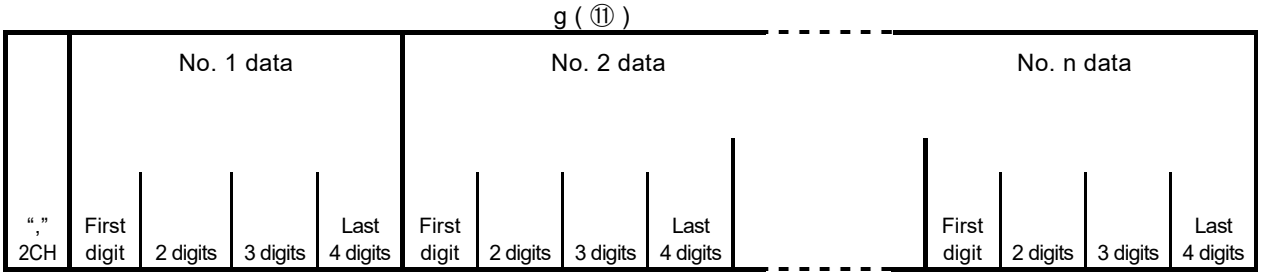
  ▪ For more information on data address, see “7-2. Communication Data Addresses.”

f: No. of data items [⑩: 1 digit]

▪ Specify the number of read data for read command (R) or write data for write command (W).
▪ The number of data is specified by converting binary 4-bit data to ASCII data.
▪ In the read command (R), the number of data can be specified in the range of 1 item: "0" (30H) to 10 items: "9" (39H).
▪ The number of data for write command (W) is fixed at 1 item: "0" (30H).
▪ The actual number of data is "number of data = specified data value + 1".

g: Data [⑪: No. of digits is decided by the No. of data items]

▪ Specifies write data for write command (W)/broadcast command (B) or read data for read command (R) response.
▪ The data format is as follows.



▪ A comma (“,” 2CH) is always added to the beginning to indicate the following is data.
  Punctuation marks cannot be used to separate data items.
▪ The number of data follows the number of data (f: ⑩) in the communication command format.
▪ One item of data is expressed in binary 16-bit units (1 word), excluding decimal point. The position of the decimal point is determined by each item of data.
▪ 16-bit data is divided into 4-bit segments and converted to ASCII data respectively.
▪ For details on data, see “5-3. Read command (R) details” and “5-4. write command (W) details.”

e: Response code [⑥,⑦: 2 digits] (Communication response format)

▪ Specifies response code for read command (R) and write command (W).
  Binary 8-bit data (0 to 255) is divided into top 4 bits and bottom 4 bits, and each 4 bits is converted to ASCII data respectively.
    ⑥: Top 4 bits of data converted to ASCII
    ⑦: Bottom 4 bits of data converted to ASCII

▪ “0” (30H), “0” (30H) is specified when response is normal.
  When response is abnormal, it is specified by converting the error code No. to ASCII data.
  For details on response code, see “5-5. Response code details.”

5-3. Read command (R) details

Used to read various types of data of the EM70 Series from master PC or PLC.

(1) Read command format

▪ The text portion format of the read command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e				f
⑤	⑥	⑦	⑧	⑨	⑩
R	0	1	4	0	2
52H	30H	31H	34H	30H	32H

▪ d (⑤): Indicates read command.
"R" (52H) fixed.
▪ e (⑥ – ⑨): Specifies front data address of read data.
▪ f (⑩): Specifies number of read data items (words).

▪ The command is as follows:

Front data address for reading = 0140H (hexadecimal)
= 0000 0001 0100 0000 (binary)
Number of read data items = 2H (hexadecimal)
= 0010 (binary)
= 2 (decimal)
(Actual No. of data items) = 3 (2 + 1)

In other words, it specifies reading of 3 consecutive items of data beginning from 0140H.

(2) Normal response format for read command

▪ The normal response format (text portion) for the read command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e		g															
⑤	⑥	⑦	⑪															
				No. 1 data				No. 2 data					No. 5 data					
R	0	0	,	0	1	F	4	0	0	3	2		0	0	1	E		
52H	30H	30H	2CH	30H	31H	46H	34H	30H	30H	33H	32H		30H	30H	31H	45H		

▪ d (⑤) : <R (52H)> that indicates it is response to read command is inserted.
▪ e (⑥ and ⑦): Response code <00 (30H and 30H)> that indicates it is a normal response to the read command is inserted.
▪ g: (⑪) : Response data to read command is inserted.
1. <"," (2CH)> that indicates beginning of data is inserted.
2. Next, the amount of data corresponding to <No. of read data items> is inserted in sequence from <data of front data address for reading>.
3. Nothing is inserted between items of data.
4. One item of data consists of binary 16-bit data (1 word) excluding the decimal point. Each 4 bits is converted into ASCII data and inserted.
5. The position of the decimal point is determined by each item of data.
6. The number of characters of response data is "No. of characters = 1 + 4 x No. of read data items."

▪ In specific terms, the following data is returned as response data in sequence.

Front data address for reading (0140H) → 0
1
Number of read data items (2H: 3) 2

Data address 16 bits (1 word)	Data 16 bits (1 word)	
Hexadecimal	Hexadecimal	Decimal
0140	01F4	500
0141	0032	50
0142	001E	30

(3) Abnormal response format for read command

▪ The abnormal response format (text portion) for the read command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e	
⑤	⑥	⑦
R 52H	0 30H	7 37H

▪ d (⑤): <R (52H)> that indicates it is response to read command is inserted.
▪ e (⑥ and ⑦): Response code that indicates it is an abnormal response to the read command is inserted.
▪ Response data is not inserted for abnormal response.
▪ For details of error code, see "5-5. Response code details."

5-4. Write command (W) details

The write command (W) is used to write (modify) various types of data from master PC or PLC to the EM70 Series.

CAUTION

If the communication mode type is 2, it is necessary to change the communication mode from LOC to COM when using the write command.

The communication mode cannot be changed by the front panel keys.

Change by transmitting the following command from the master side.

Not required if communication mode type is 1

■ Command format

For ADDR=1, CTRL=STX_ETX_CR, BCC=ADD:

STX	0	1	1	W	0	1	8	C	0	,	0	0	0	1	ETX	E	7	CR
02H	30H	31H	31H	57H	30H	31H	38H	43H	30H	2CH	30H	30H	30H	31H	03H	45H	37H	0DH

When a normal response is returned for the command given above, the COM LED on the front panel lights and communication mode changes to COM.

(1) Write command format

The text portion format of the write command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text part

d	e				f	g				
⑤	⑥	⑦	⑧	⑨	⑩	⑪ write data				
W 57 H	0 30H	5 35H	0 30H	0 30H	0 30H	, 2CH	0 30H	0 30H	0 30H	2 32H

- d (⑤) : Indicates write command.
  "W" (57H) fixed.
- e (⑥ to ⑨): Specifies front data address of write data (change).
- f (⑩) : Specifies number of write data items (change).
  The number of write data items is fixed at 1: "0" (30H).
- g (⑪) : Specifies write data (change).
  1. <"," (2CH)> that indicates beginning of data is inserted.
  2. Next, the write data is inserted.
  3. One item of data consists of binary 16-bit data (1 word) excluding the decimal point. Each 4 bits is converted into ASCII data and inserted.
  4. The position of the decimal point is determined by each item of data.

The command is as follows:

Write front data address = 0500H (hexadecimal)
= 0000 0101 0000 0000 (binary)
No. of write data items = 0H (hexadecimal)
= 0000 (binary)
= 0 (decimal)
(Actual No. of data items) = 1 (0 + 1)

Write data items = 0002H (hexadecimal)
= 0000 0000 0000 0010 (binary)
= 2 (decimal)

In other words, write (change) of 1 data item (2: decimal) is specified for data address 0500H.

Front data address for reading (500H) → 0
Number of write data items 1 (01)

Data address 16 bits (1 word)		Data 16 bits (1 word)	
Hexadecimal	Decimal	Hexadecimal	Decimal
0500	1280	0002	2
0501	1281	0032	50
0502	1282	0003	3

(2) Normal response format for write command

- The normal response format (text portion) for the write command is as follows.
  Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e	
⑤	⑥	⑦
W 57H	0 30H	0 30H

- d (⑤) : <W (57H)> that indicates it is response to write command is inserted.
- e (⑥ and ⑦): Response code <00 (30H and 30H)> that indicates it is a normal response to the write command is inserted.

(3) Abnormal response format for write command

▪ The abnormal response format (text portion) for the write command is as follows.
Basic format portion I and basic format portion II are common for all commands and command responses.

Text portion

d	e	
⑤	⑥	⑦
W 57H	0 30H	9 39H

▪ d (⑤) : <W (57H) > that indicates it is response to write command is inserted.
▪ e (⑥ and ⑦): Response code that indicates it is an abnormal response to the write command is inserted.
▪ For details of error code, see "5-6. Response code details."

5-5. Broadcast command (B) details

The broadcast command (B) is used to write (change) all data for all machines that support the broadcast command from the master PC or PLC at once.
Broadcast command does not respond to communication.
Broadcast command corresponds with Shimaden protocol; Not with MODBUS protocol.
Broadcast command corresponds with write (W) data address.

(1) Broadcast command format

The text portion format for the broadcast command is as follows.
The machine address of the basic format portion I is fixed to "00" .

Text portion

d	e				f	g				
⑤	⑥	⑦	⑧	⑨	⑩	⑪ write data				
B 42 H	0 30H	5 35H	0 30H	0 30H	0 30H	, 2CH	0 30H	0 30H	0 30H	2 32H

▪ d (⑤) : Indicates broadcast command.
"B" (42H) fixed.
▪ e (⑥ to ⑨): Specifies front data address of write data (change).
▪ f (⑩) : Specifies number of write data items (change).
The number of write data items is fixed at 1: "0" (30H).
▪ g (⑪) : Specifies write data (change).
1. <"," (2CH)> that indicates beginning of data is inserted.
2. Next, the write data is inserted.
3. One item of data consists of binary 16-bit data (1 word) excluding the decimal point. Each 4 bits is converted into ASCII data and inserted.
4. The position of the decimal point is determined by each item of data.

The command given above is as follows for all machines that support the broadcast command.

Write front data address = 0500H (hexadecimal)
= 0000 0101 0000 0000 (binary)
No. of write data items = 0H (hexadecimal)
= 0000 (binary)
= 0 (decimal)
(Actual No. of data items) = 1 (0 + 1)

Write data items = 0002H (hexadecimal)
= 0000 0000 0000 0010 (binary)
= 2 (decimal)

5-6. Response code details

(1) Response code types

The response code is always included in the communication response to the read command (R) and write command (W).
The response code includes normal response code and abnormal response code.
Response code is binary 8-bit data (0 to 255). The details are given in the following table.

Response code list

Response code		Code type	Code contents
Binary	ASCII		
0000 0000	“0”, “0”: 30H, 30H	Normal response	Normal response code for read command (R) and write command (W)
0000 0001	“0”, “1”: 30H, 31H	Hardware error of text part	If a hardware error such as framing overrun or parity is detected in the data of the text part
0000 0111	“0”, “7”: 30H, 37H	Format error of text part	If the format of the text part differs from the established format
0000 1000	“0”, “8”: 30H, 38H	Text part data format,data address, number of data items error	If data format of the text part differs from the established format or data address or number of data items not specified
0000 1001	“0”, “9”: 30H, 39H	Data error	If write data exceeds the data setting range
0000 1010	“0”, “A”: 30H, 41H	Execution command error	When an execution command (such as the MAN command) is received when it cannot be accepted.
0000 1011	“0”, “B”: 30H, 42H	Write mode error	When receiving a write command containing data that should not be overwritten due to the type of data.
0000 1100	“0”, “C”: 30H, 43H	Specifications, optional item error	When receiving a write command that contains specifications or optional data that has not been appended.

(2) Response code priority ranking

With the response code, the lower the number the higher the priority ranking is.
If more than one response codes is generated, the one with the highest priority ranking is returned.

6. MODBUS protocol overview

MODBUS protocol includes ASCII and RTU transmission modes.

6-1. Transmission mode overview

(1) ASCII mode

Eight-bit binary data in the command is divided into top and bottom 4 bits and is transmitted as ASCII characters in hexadecimal notation.

■ Data configuration
Data format: Selection of 7E1, 7E2, 7N1 or 7N2
Error check: LRC (horizontal redundancy test)
Data communication standard: Max. 1 sec.

(2) RTU mode

Eight-bit binary data in the command is transmitted as is.

■ Data configuration
Data format: Selection of 8E1, 8E2, 8N1 or 8N2
Error check: CRC-16 (cycle redundancy test)
Data transmission interval: 3.5 character transmission time or less

6-2. Message configuration

(1) ASCII mode

Configured to begin with start character [: (colon) (3AH)] and end with end character [CR (carriage return) (0DH)] +[LF (line feed) (0AH)].

Header (:)	Slave address	Function code	Data	Error check LRC	Delimiter (CR)	Delimiter (LF)

(2) RTU mode

Configures to begin after idling over the 3.5 character transmission time and ending when idling over the 3.5 character transmission time elapses.

Idle 3.5 character	Slave address	Function code	Data	Error check CRC	Idle 3.5 character

6-3. Slave address

Slave addresses are slave machine numbers 1 to 255 Individual slaves are distinguished by specifying slave address by request message. The master is informed which slave is responding by setting slave address and returning it for the response message on the slave side.

6-4. Function code

The function code specifies the type of action to the slave.

Function code	Details
03 (03H)	Slave setting value and information read
06 (06H)	Slave write

The function code is also used to show if the response is normal (affirmative response) or what sort of error (negative response) is occurring when the slave returns a response message to the master.

With affirmative response, the original code is set and returned.

With a negative response, the highest bit of the original function code is set to “1” and returned.
If for instance the function code is mistakenly set to 10H and a request message is sent to the slave, because it is a nonexistent function code, the highest bit is set to “1” and returned as 90H.
Also for a negative response, in order to inform the master what sort of error has occurred, an abnormal code is set in the data of the response message and sent.

Abnormal code	Details
1 (01H)	Illegal function (nonexistent function)
2 (02H)	Illegal data address (nonexistent data address)
3 (03H)	Illegal data value (value outside setting range)

6-5. Data

Configuration of data differs according to the function code.
With request messages from master machines, it consists of data items, number of data items and set data.
With response messages from slave machines, it consists of number of bytes relative to the request, or abnormal code, etc., for negative response.
The valid range of data is -32768 to 32767.

6-6. Error check

The error check method differs according to transmission mode.

(1) ASCII mode

Error check in the ASCII mode calculates LRC from slave address to final data item; the 8-bit calculated data is converted to ASCII character 2 character and set following the data.

■ LRC calculation method

1. Prepare a message in RTU mode.
2. Add from slave address to final data item and substitute for X.
3. Take the complement of X (bit inverse) and substitute for X.
4. Add 1 to X and substitute for X.
5. Set X as LRC following data.
6. Convert message to ASCII characters.

(2) RTU mode

Error check in the RTU mode calculates CRC-16 from slave address to final data item; the 16-bit calculated data is set in bottom/top order following the data.

■ CRC-16 calculation method

CRC formula divides data to be sent by generating polynomial and the remainder is added to the end of the data and sent.

Generating polynomial: $X^{16}+ X^{15}+X^{2}+1$

1. Initialize CRC data (X) (FFFFH)
2. Take the first data item and exclusive OR (XOR) and substitute for X.
3. Shift X 1 bit to the right and substitute for X.
4. If carry is enabled by shifting, take XOR by results X of (3) and fixed value (A001H) and substitute for X.
   If carry is enabled, proceed to 5.
5. Repeat steps 3 and 4 until shifted 8 times.
6. Take the next data item and XOR of X and substitute for X.
7. Repeat steps 3 to 5.
8. Repeat steps 3 to 5 up to the final data item.

X is set as CRC-16 in message following the data in bottom/top order.

6-7. Sample messages

(1) ASCII mode

■ **Machine No. 1, EV1_M read**

▪ Request message from master machine

Header (:)	Slave address (01H)	Function code (03H)	Data address (0500H)	No. of data items (0001H)	Error check LRC (F6H)	Delimiter (CR・LF)
1	2	2	4	4	2	2 ← No. of characters (17)

▪ Response message from slave when normal (**EV1_M=0**).

Header (:)	Slave address (01H)	Function code (03H)	No. of response bytes (02H)	Data 0000H)	Error check LRC (FAH)	Delimiter (CR・LF)
1	2	2	2	4	2	2 ← No. of characters (15)

▪ Response message from slave when abnormal (data item mistaken)

Header (:)	Slave address (01H)	Function code (83H)	Abnormal code (02H)	Error check LRC (7AH)	Delimiter (CR・LF)
1	2	2	2	2	2 ← No. of characters (11)

With response messages when an error occurs, “1” is set (83H) as the highest bit of the function code. Abnormal code 02H is returned (nonexistent data address) as response message of error contents.

■ **Machine No. 1, EV1_M = 1 write**

▪ Request message from master machine

Header	Slave address	Function code	Data address	Data	Error check LRC	Delimiter
(:)	(01H)	(06H)	(0500H)	(0001H)	(F3H)	(CR・LF)
1	2	2	4	4	2	2

← No. of characters (17)

▪ Response message from slave when normal.

Header	Slave address	Function code	Data address	Data	Error check LRC	Delimiter
(:)	(01H)	(06H)	(0500H)	(0001H)	(F3H)	(CR・LF)
1	2	2	4	4	2	2

← No. of characters (17)

▪ Slave side response message when abnormal (value set outside range)

Header	Slave address	Function code	Abnormal code	Error check LRC	Delimiter
(:)	(01H)	(86H)	(03H)	(76H)	(CR・LF)
1	2	2	2	2	2

← No. of characters (11)

With response messages when an error occurs, “1” is set (86H) as the highest bit of the function code. Abnormal code 03H is returned (value set outside range) as response message of error contents.

(2) RTU mode

■ **Machine No. 1, EV1_M read**

▪ Request message from master machine

Idle	Slave address	Function code	Data address	No. of data items	Error check CRC	Idle
3.5 character	(01H)	(03H)	(0500H)	(0001H)	(84C6H)	3.5 character
	1	1	2	2	2	

← No. of characters (8)

▪ Response message from slave when normal (EV1_M=0).

Idle	Slave address	Function code	No. of response bytes	Data	Error check CRC	Idle
3.5 character	(01H)	(03H)	(02H)	(0000H)	(B844H)	3.5 character
	1	1	1	2	2	

← No. of characters (7)

▪ Response message from slave when abnormal (data item mistaken)

Idle	Slave address	Function code	Abnormal code	Error check LRC	Idle
3.5 character	(01H)	(83H)	(02H)	(C0F1H)	3.5 character
	1	1	1	2	

← No. of characters (5)

With response messages when an error occurs, “1” is set (83H) as the highest bit of the function code. Abnormal code 02H is returned (nonexistent data address) as response message of error contents.

■ **Machine No. 1, EV1_M= 1 setting**

▪ Request message from master machine

Idle	Slave address	Function code	Data address	Data	Error check CRC	Idle
3.5 character	(01H)	(06H)	(0500H)	(0001H)	(48C6H)	3.5 character
	1	1	2	2	2	

← No. of characters (8)

▪ Response message from slave when normal

Idle	Slave address	Function code	Data address	Data	Error check CRC	Idle
3.5 character	(01H)	(06H)	(0500H)	(0001H)	(48C6H)	3.5 character
	1	1	2	2	2	

← No. of characters (8)

▪ Slave response message when abnormal (value set outside range)

Idle	Slave address	Function code	Abnormal code	Error check CRC	Idle
3.5 character	(01H)	(86H)	(03H)	(0261H)	3.5 character
	1	1	1	2	

← No. of characters (5)

With response messages when an error occurs, “1” is set (86H) as the highest bit of the function code. Abnormal code 03H is returned (value set outside range) as response message of error contents.

7. Communication data address

7-1. Communication data address details

Note: The error response code is explained using the code when using Shimaden protocol.

(1) Data address and read/write

- Data address is expressed by expressing binary (16-bit) data in hexadecimal notation, 4 bits at a time.
- R/W is data that can be read and written.
- R is read only data.
- W is write only data.
- If a write-only data address is specified by read command (R), or if a read-only data address is specified by write command (W) or broadcast command (B), a data address error results and error response code “0” or “8” (30H, 38H) (text portion format, data address, No. of data items error) is returned.

(2) Data address and No. of data items

- If a data address not given in the data addresses for EM70 is specified as the initial data address, a data address error results and error response code “0” or “8” (30H, 38H) (text portion format, data address, No. of data items error) is returned.
- For read command, if the front data address is among the given data addresses and the data address to which the number of data items is added makes it outside the given data addresses, read data is “0.”

(3) Data

- Because the various data items is binary (16-bit) data without decimal points, the data format, existence of decimal points, etc., must be checked. (Refer to the EM70 Series Instruction Manual.)

Example: Expression of data with decimal point

				Hexadecimal data
20.0 %	→	200	→	00C8
100.00°C	→	10000	→	2710
-40.00°C	→	-4000	→	F060

- The decimal point position is decided by measuring range for data for which the unit is DIGIT.
- Data is handled as coded binary (16-bit data: -32768 to 32767).

Example: Expression of 16-bit data

Coded data	
Decimal	Hexadecimal
0	0000
1	0001
≈	≈
32767	7FFF
-32768	8000
-32767	8001
≈	≈
-2	FFFE
-1	FFFF

(4) “Spare” of parameter portion

If the “Spare” portion is read by read command (R) or written by write command (W), normal response code “0”, “0” (30H, 30H) is returned.

(5) Parameters concerning optional items

If the data address of a parameter not added as an optional item is specified, abnormal response code “0”, “C” (30H, 43H) (Specification/optional item error) is returned for both the read command (R) and write command (W).

(6) Parameters not displayed on the front panel display due to action or setting specifications

Parameters not displayed (not used) on the front panel display depending on action or setting specifications can be read and written by communication.

7-2. Communication data addresses

Data Addr. (Hex)	Parameter	Setting range	R/W/B
0040		Series code 1	R
0041		Series code 2	R
0042		Series code 3	R
0043		Series code 4	R

▪ The address area given above is the product ID data, and is 8-bit unit ASCII data.
Two data items are therefore expressed as 1 address.

▪ The series code is expressed as a maximum of 8 data items. 00H data is inserted in surplus area.

Example: EM70 address

	H	L	H	L
0040	"E",	"M"	45H,	4DH
0041	"7",	"0"	37H,	30H
0042			00H,	00H
0043			00H,	00H

0100	Reserved		R
0101	Reserved		R
0102	Reserved		R
0103	Reserved		R
0104	EXE_FLG	Action flag (no action bit = 0) (*See bit information)	R
0105	EV_FLG	Event output flag (no optional items = 0000H) (*See bit information)	R

010B	DI_FLG	External input (DI) status flag	R

▪ Bit information details are as follows:

	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
EXE_FLG :	0	0	0	0	0	0	0	COM	0	0	0	0	0	STBY	MAN	0
EV_FLG :	0	0	0	0	0	0	0	0	0	0	0	0	0	EV3	EV2	EV1
DI_FLG :	0	0	0	0	0	0	0	0	0	0	0	0	0	DI3	DI2	DI1

0111	INP_RANGE	Input range Current : 0: 4 to 20mA, 1: 0 to 20mA Voltage : 0: 0 to 10V, 1: 0 to 5V, 2: 1 to 5V	R

0118	INP_MOD	Type of input 0: Current, 1: Voltage	R

0140	INP	Input value	R
0141	DES	Target value of degree of opening	R
0142	POSI	Value of degree of opening	R
0143	Reserved		R
0144	LOOP_ERR	Control loop error 0: Normal, 1: Control loop error	R

• Higher limit side scale-over : POSI_SO, INP_SO = 7FFFH
• Lower limit side scale-over : POSI_SO, INP_SO = 8000H

0186	STBY	1: Stand-by, 0: Run	W/B

018C	COM	0: Loc, 1: Com	W/B

0500	EV1_M	Type of event 1 Refer to 8-1. Types of event	R/W/B
0501	EV1_SP	Set value of event 1 Refer to 8-1. Types of event	R/W/B
0502	EV1_DF	Event 1 hysteresis 1 to 50	R/W/B
0503	EV1_STB	Event 1 stand-by action 0: Without, 1: With	R/W/B

0508	EV2_M	Type of event 2 Refer to 8-1. Types of event	R/W/B
0509	EV2_SP	Set value of event 2 Refer to 8-1. Types of event	R/W/B
050A	EV2_DF	Event 2 hysteresis 1 to 50	R/W/B
050B	EV2_STB	Event 2 stand-by action 0: Without, 1: With	R/W/B

0510	EV3_M	Type of event 3 Refer to 8-1. Types of event	R/W/B
0511	EV3_SP	Set value of event 3 Refer to 8-1. Types of event	R/W/B
0512	EV3_DF	Event 3 hysteresis 1 to 50	R/W/B
0513	EV3_STB	Event 3 stand-by action 0: Without, 1: With	R/W/B

05A0	AO1_MD	Analog output mode 0: POSI, 1: INP	R/W/B
05A1	AO1_L	Analog output scale on lower limit side 0 to 100	R/W/B
05A2	AO1_H	Analog output scale on higher limit side 0 to 100	R/W/B

Data Addr. (Hex)	Parameter	Setting range	R/W/B
05B0	COM_MEM	Communication memory mode 0: EEP, 1: RAM	R/W/B
05B1	COM_KIND	Communication type, 0: Mode1, 1: Mode2	R/W/B

0611	KLOCK	Key lock, 0 = OFF 1 = 1=Excluding STBY, EV set value, DI setting and MAN 2 = Excluding MAN 3 = All	R/W/B

0642	INP_FILT	Input filter 0 to 99	R/W/B
0643	SQUARE	Square root extraction operation 0: Without, 1: With	R/W/B

0647	SCL_MOD	Scaling mode 0: Input, 1: Opening	R/W/B
0648	SCL_L	Scaling on lower limit side (Lower limit side < Higher limit side) -10 to 109	R/W/B
0649	SCL_H	Scaling on higher limit side (Lower limit side < Higher limit side) -9 to 110	R/W/B

064C	POSI_L	Degree of opening limiter on lower limit side (Lower limit side < Higher limit side) 0 to 99	R/W/B
064D	POSI_H	Degree of opening limiter on higher limit side (Lower limit side < Higher limit side) 1 to 100	R/W/B

0650	ACT_MOD	Control characteristics 0: DA, 1: RA	R/W/B
0651	Reserved		R/W/B
0652	DB	Dead band 2 to 100	R/W/B
0653	DF	Hysteresis 0: PrP, 1 to 50	R/W/B
0654	Reserved		R/W/B
0655	ZS_MOD	0: AUT, 1: MAN	R/W/B
0656	SPEED1	Motor speed adjustment 1 10 to 100	R/W/B
0657	IN_ERR_MOD	Processing mode when input scale-over occurs 0: NON, 1: STOP, 2: PRE	R/W/B
0658	IN_ERR_PRE	Value of opening when input scale-over occurs (preset) 0 to 100	R/W/B
0659	P_ERR_MOD	Processing mode when potentiometer scale-over occurs 0: STOP, 1: CLOSE, 2: OPEN	R/W/B
065A	OPN_CLS_TM	Time of opening or closing when potentiometer scale-over occurs 1 to 300	R/W/B
065B	Reserved		R/W/B
065C	Reserved		R/W/B
065D	SPEED2	Motor speed adjustment 2 9:OFF, 10 to 100	R/W/B

0660	DI_MOD	External input (DI) mode 0:SEP, 1:Pr1, 2:Pr2	R/W/B
0661	Reserved		R/W/B
0662	DI1_SINGL	External input (DI) 1 individual setting 0:no, 1:rA, 2:St, 3:Pr	R/W/B
0663	DI2_SINGL	External input (DI) 2 individual setting 0:no, 1:rA, 2:St, 3:Pr	R/W/B
0664	DI3_SINGL	External input (DI) 3 individual setting 0:no, 1:rA, 2:St, 3:Pr	R/W/B
0665	Reserved		R/W/B
0666	DI1_S_PRE	External input (DI) 1 individual setting of degree of opening (preset) 0 to 100	R/W/B
0667	DI2_S_PRE	External input (DI) 2 individual setting of degree of opening (preset) 0 to 100	R/W/B
0668	DI3_S_PRE	External input (DI) 3 individual setting of degree of opening (preset) 0 to 100	R/W/B
0669	Reserved		R/W/B
066A	DI_PRE1	External input (DI) value of degree of opening (preset) 1 0 to 100	R/W/B
066B	DI_PRE2	External input (DI) value of degree of opening (preset) 2 0 to 100	R/W/B
066C	DI_PRE3	External input (DI) value of degree of opening (preset) 3 0 to 100	R/W/B
066D	DI_PRE4	External input (DI) value of degree of opening (preset) 4 0 to 100	R/W/B
066E	DI_PRE5	External input (DI) value of degree of opening (preset) 5 0 to 100	R/W/B
066F	DI_PRE6	External input (DI) value of degree of opening (preset) 6 0 to 100	R/W/B
0670	DI_PRE7	External input (DI) value of degree of opening (preset) 7 0 to 100	R/W/B

8. Supplementary explanation

8-1. Types of event

Alarm code	Types of event	Value	Initial value	Setting range
no	Without	0	- - - - - - - - - - - -	- - - - - - - - - - - -
LP	Lower limit absolute value of degree of opening	1	0%	0 to 100%
HP	Higher limit absolute value of degree of opening	2	100%	0 to 100%
LC	Input lower limit absolute value	3	0%	0 to 100%
HC	Input higher limit absolute value	4	100%	0 to 100%
Aw	Run	5	EV output continues during Run mode	
AA	Manual	6	EV output continues during Manual mode	
PE	Degree of opening error	7	EV output continues despite error in the degree of opening	
CE	Input error	8	EV output continues despite input error	
LE	Control loop out of order	9	EV output continues, for example, when motor is out of operation for a long time.	

8-2. ASCII codes table

	b7b6b5	000	001	010	011	100	101	110	111
b4~b1		0	1	2	3	4	5	6	7
0000	0	NUL	TC7(DLE)	SP	0	@	P	`	p
0001	1	TC1(SOH)	DC1	!	1	A	Q	a	q
0010	2	TC2(STX)	DC2	”	2	B	R	b	r
0011	3	TC3(ETX)	DC3	#	3	C	S	c	s
0100	4	TC4(EOT)	DC4	$	4	D	T	d	t
0101	5	TC5(ENQ)	TC8(NAK)	%	5	E	U	e	u
0110	6	C6(ACK)	TC9(SYN)	&	6	F	V	f	V
0111	7	BEL	TC10(ETB)	’	7	G	W	g	w
1000	8	FE0(BS)	CAN	(	8	H	X	h	x
1001	9	FE1(HT)	EM	)	9	I	Y	i	y
1010	A	FE2(LF)	SUB	*	:	J	Z	j	z
1011	B	FE3(VT)	ESC	+	;	K	[	k	{
1100	C	FE4(FF)	IS4(FS)	,	<	L	＼	l	|
1101	D	FE5(CR)	IS3(GS)	-	=	M	]	m	}
1110	E	SO	IS2(RS)	.	>	N	^	n	~
1111	F	SI	IS1(US)	/	?	O	_	o	DEL

The contents of this manual are subject to change without notice.

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