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.

This instruction manual describes the communication interface which is an optional function of the EM70 Servo Controller. For details of EM70 performance and parameters, please refer to the separate instruction manual.

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SHIMADEN CO.,LTD.

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1. Outline

There are two types of communication systems, RS-232C and RS-485 employable as the EM70 communication interface. Each of them is capable of setting various data for the EM70 and reading through a personal computer or the like, using signals which comply with EIA standards. RS-232C and RS-485 are data communication standards established by the Electronic Industries Association of the U.S. (EIA). The standards cover electrical and mechanical aspects, that is, matters related to applicable hardware but not the data transmission procedure of software. Therefore, it is not possible to communicate unconditionally with an apparatus which has the same interface. Hence, users need to have sufficient knowledge of specifications and transmission procedure.

When RS-485 is used, two or more of EM70 Servo Controller can be connected to one another. There seems to be a limited number of personal computers, etc., which support this interface, but the use of a line converter for RS-232C <---> RS-485 creates stability.

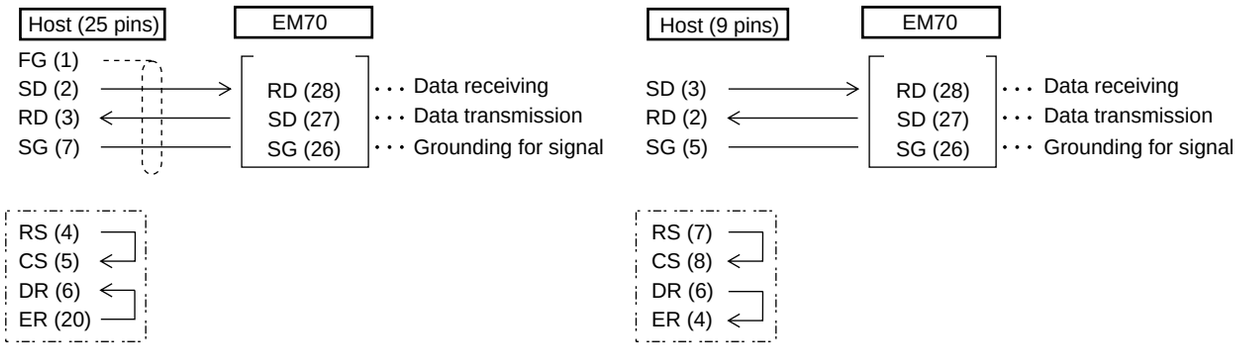
2. Specifications

Signal level:	Following EIA RS-232C and RS-485
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 15m maximum
	RS-485 maximum total of 500m (differs depending on conditions.)
Communication rate:	1200, 2400, 4800, 9600 and 19200bps
Transmission procedure:	No procedure
Data format:	Data 7 bits, even parity stop 1 bit
	Data 7 bits, even parity stop 2 bits
	Data 7 bits, no parity, stop 1 bit
	Data 7 bits, no parity, stop 2 bits
	Data 8 bits, even parity, stop 1 bit
	Data 8 bits, even parity, stop 2 bits
	Data 8 bits, no parity, stop 1 bit
	Data 8 bits, no parity, stop 2 bits
Communication code:	ASCII codes
Isolation:	Insulated between communication signals and various inputs, system and various outputs

3. Connecting controller with host computer

The EM70 Servo Controller is provided with only 3 lines for input and output, i.e., for data transmission, data reception and grounding for signals, not with any other signal lines. Since the controller has no control line, control signals should be taken care of on the host side.
In this instruction, an example of control signal processing methods is shown in drawings (portions surrounded by dotted lines). As the method depends on the system, however, you are advised to refer to the specifications of the host computer for details.

3-1 RS-232C

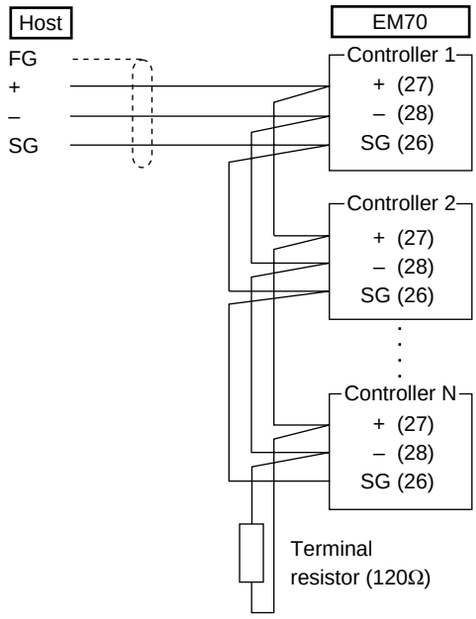


Note 1: Figures in ( ) represent pin numbers of connector.

3-2 RS-485

The input/output logical level of the EM70 Servo Controller is basically as follows:
In the mark state - terminal < + terminal
In the space state - terminal > + terminal

Until immediately before transmission, however, plus terminals and minus terminals of the controller have high impedance and outputs at the above levels are produced immediately before starting transmission. (See 3-3 3-state output control.)

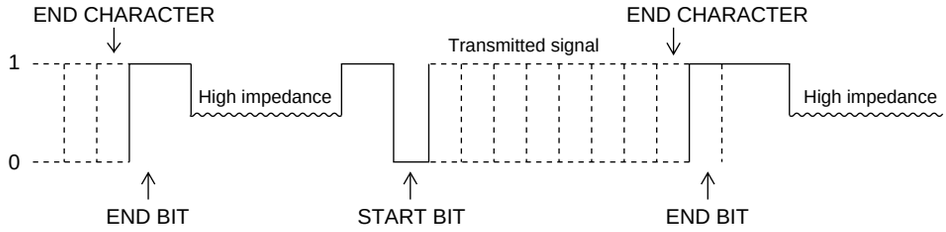


Note 1: In the case of RS-485, provide it with the attached terminal resistor of 1/2W, 120Ω across terminals + and – before use, if necessary. Nevertheless, it should be provided to only the last controller.
If two or more controllers are provided with terminal resistors, correct operation cannot be guaranteed.

Note 2: The figures in parentheses represent the connector pin numbers.

3-3 3-state output control

Since RS-485 is of the multidrop system, transmission output has high impedance always while communication is not carried out or signals are being received in order to avoid collision between transmission signals. It changes from high impedance to the normal output condition immediately before transmission and returns to high impedance control simultaneously when transmission terminates. As the 3-state control is delayed by about 1 msec (maximum) from the completion of transmission of an end character end bit, however, a few microseconds' delay should be provided if the host side starts transmission immediately upon reception.

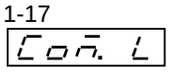


4. Setting of parameters related to communication

There are the following 8 communication-related parameters for the EM70 Servo Controller. These parameters are unable to be set or changed by communication; use front key for setting and changing. To set parameters, see the separate instruction manual for the controller and follow the described steps.

4-1 Communication Mode Selection Screen

1-17



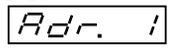
Initial value: L
Selectable range: C, L

A communication mode is selected. However, front key operation can change only from COM to LOC.
L mode: Only read commands through communication are valid.
C mode: Both read and write commands through communication are valid.

Note: When a communication mode is selected, all the setting screens except the communication mode setting screen are locked.

4-2 Communication address setting screen

1-18



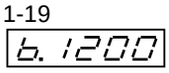
Initial value: 1
Selectable range: 1 ~ 99

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: Addresses 1 to 99 can be set but the number of connectable apparatuses is limited to 31.

4-3 Communication rate setting screen

1-19

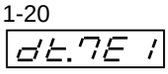


Initial value: 1200
Setting range: 1200, 2400, 4800, 9600, 19200bps

Select a rate at which data are transmitted to host computer.

4-4 Communication data format setting screen

1-20



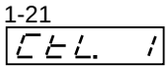
Initial value: 7E1
Selectable range: 8 types listed in the following table

Select a communication data format from the following 8 types.

	Length of data	Parity	Stop bit		Length of data	Parity	Stop bit
7E1	7 bit	EVEN	1 bit	8E1	8 bit	EVEN	1 bit
7E2	7 bit	EVEN	2 bit	8E2	8 bit	EVEN	2 bit
7N1	7 bit	None	1 bit	8N1	8 bit	None	1 bit
7N2	7 bit	None	2 bit	8N2	8 bit	None	2 bit

4-5 Communication control code setting screen

1-21

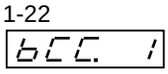


Initial value: 1
Selectable range: 1 ~ 3

Set a control code to be used.
1. STX_ETX_CR 2. STX_ETX_CRLF 3. @_:_CR

4-6 Communication BCC check setting screen

1-22

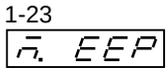


Initial value: 1
Selectable range: 1 ~ 4

Select a BCC operation method to be used in BCC checking.
1. ADD 2. ADD_two's cmp 3. XOR 4. None

4-7 Communication memory mode selecting screen

1-23

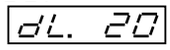


Initial value: EEP
Selectable range: EEP, Ram
Since the number of writing cycles of volatile memory EEPROM useded in the EM70 is fixed, the life of EEPROM is shortened if SV data or the like are rewritten frequently by communication. To prevent this, in case data are to be rewritten frequently by communication, set the RAM mode in which only RAM data are rewritten without rewriting EEPROM, thereby maintaining the life of EEPROM as long as possible.

- EEP mode: In this mode EEPROM data are also rewritten every time data are changed by communication. Accordingly, data are maintained when power is turned off.
- RAM mode: In this mode only RAM data are rewritten but EEPROM data are not when data are changed by communication. Therefore, RAM data are deleted when power is turned off. Upon applying power again, operation starts with data stored in EEPROM.

4-8 Communication delay time setting screen

1-24



Initial value: 20
Setting range: 0 ~ 100

Set the length of delay time from receipt of a communication command to transmission.
Delay time=0.25 × set value [msec]

Note 1: When RS-485 is used, some converters take longer time for 3-state control than others and it may lead to signal collision. This can be avoided by increasing delay time. Care should be taken particularly when the communication rate is slow (1200bps or 2400bps).
Note 2: In case set value=0, internal operation is carried out with set value=1.
Note 3: Actual delay time from receipt of a communication command to transmission is a total of the above-mentioned delay time and command processing time by software. Particularly for writing commands, about 400 msec may be taken for processing.

5. Outline of standard serial communication protocols

5-1 Communication procedure

(1) Master/slave relation
- The master side means personal computer or PLC (host).
- The slave side means the EM70 Servo Controller.
- A communication command from the master side starts communication and a response from the slave side terminates it. If abnormality such as a communication format error or a BCC error occurs, there will be no response. No response is sent, either, to broadcast instruction.

(2) Communication procedure
Communication goes on by transferring the transmission right to each other in the pattern that the slave side responds to the master side.

(3) Time-out
In case receipt of the end character does not complete within one second after receiving the start character, it is time-out and the controller is automatically put in the state of waiting for another command (a new start character). Accordingly, the host side should set one second or more as the time-out duration.

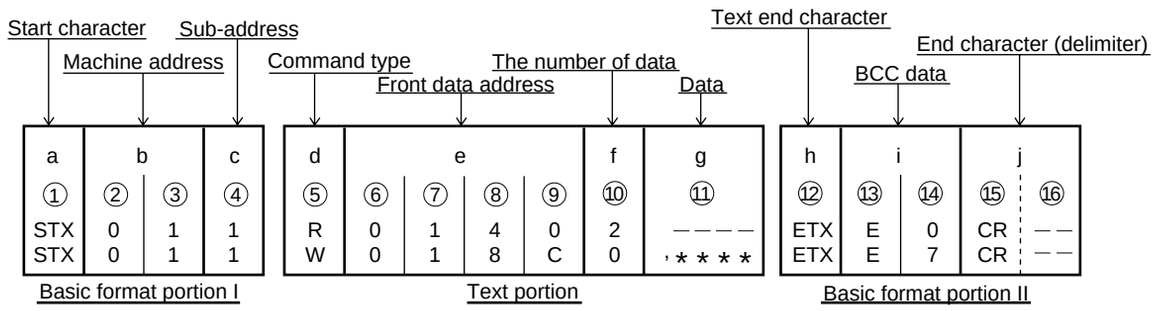
5-2 Communication format

The EM70 allows for a variety of communication formats (start character, text end character, end character and BCC operating method) and communication data formats (data bit length, whether or not of parity, and stop bit length) for easy compliance with other protocols.
Nonetheless, the following serves as their basic format and you are encouraged to use them uniformly:
- Communication format
  Control code (start character, text end character, end charactor)→STX_ETX_CR
  Check sum (BCC operating method)→Add
- Communication data format (data bit length, whether or not of parity, stop bit length)→7E1 or 8N1

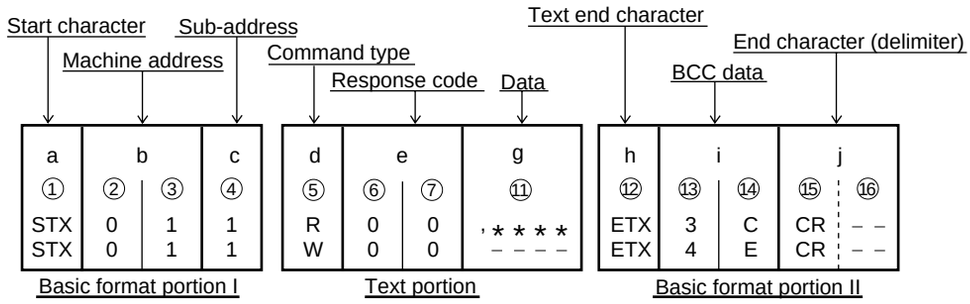
For setting a communication format and a communication data format, see "4. Setting of parameters related to communication."

(1) Outline of communication format
The communication format comprises the basic format portion I, the text portion and the basic format portion II.

1) Communication command format



2) Response format



- The basic format portions I and II are common to read commands (R), write commands (W) and responses. Nonetheless, in BCC data of i (⑬, ⑭) operation result data is inserted each time.
- The text portion differs depending on the types of commands, data addresses, responses, etc.

(2) Details of basic format portion I

a: Start character [①: 1 digit / STX(02H) or "@"(40H)]
- Indicates the start of communication bloc.
- Upon receipt of start character, it is judged as the first character of a new communication bloc.
- A start character and a text end character are selected in a pair.
  (See 4-5 Communication control code setting screen.)
  Select STX (02H) ---- ETX (03H), or select "@"(40H) ---- " : "(3AH).

b: Machine address [②, ③: 2 digits]
- Designates the instrument to communicate with.
- Address can be designated in a range from 1 to 99 (decimal numerals).
- Binary 8 bit data (1 : 0000 0001 ~ 99 : 0110 0011) are split into high position 4 bits and low position 4 bits and converted to ASCII data.
  ②: ASCII data converted from the high position 4 bits.
  ③: ASCII data converted from the low position 4 bits.
- Since the machine address=0 (30H, 30H) is used for broadcast instruction, it cannot be used as a machine address. As the EM70 controller does not support broadcast instruction, address=0 has no response.

c: Sub-address [④: 1 digit]
- As the EM70 is a single loop controller, their sub-address is fixed to ④ = 1 (31H).
  Designation of any other address is taken as a sub-address error and there will be no response.

(3) Details of basic format portion II

h: Text end character [⑫: 1 digit / ETX(03H) or ":" (3AH)]
- Indicates that the text portion terminates right before this character.

i: BCC data [⑬, ⑭: 2 digits]
- BCC (Block Check Character) checks if there is any error in communication.
- There will be no response if BCC operation results in a BCC error.
- There are the following 4 types of BCC operation: (Type of BCC operation can be set on the front screen.)
  (1) Add
  Add operation is performed on every 1 character of ASCII data (1 byte) from the start character ① through the text end character ⑫.
  (2) Add_two's cmp
  Add operation is performed on every 1 character of ASCII data (1 byte) from the start character ① through the text end character ⑫, and two's complement of the low position 1 byte of the operation result is taken.
  (3) XOR
  XOR (exclusive OR) operation is performed on every 1 character of ASCII data (1 byte) from the machine address ② right after the start character through the text end character ⑫.
  (4) None
  BCC operation is not performed. (⑬, ⑭ are omitted.)
- Regardless of the length of data bits (7 or 8), operation is carried out with 1 byte (8 bits) as a unit.
- The low position 1 byte data obtained as a result of the operations mentioned above is split into high position 4 bits and low position 4 bits and converted to ASCII codes.
  ⑬: ASCII date converted from high position 4 bits.
  ⑭: ASCII date converted from low position 4 bits.

Example 1: In the case of a read command (R) with "Add" set:

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑫	⑬	⑭	⑮	⑯
STX	0	1	1	R	0	1	4	0	2	ETX	E	0	CR	LF
02H	+30H	+31H	+31H	+52H	+30H	+31H	+34H	+30H	+32H	+03H	= 1E0H			

Low position 1 byte of result of addition (1E0H)=E0H
⑬: "E"=45H, ⑭: "0"=30H

Example 2: In the case of a read command (R) with "Add_two's cmp" set:

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑫	⑬	⑭	⑮	⑯
STX	0	1	1	R	0	1	4	0	2	ETX	2	0	CR	LF
02H	+30H	+31H	+31H	+52H	+30H	+31H	+34H	+30H	+32H	+03H	= 1E0H			

Low position 1 byte of result of addition (1E0H)=E0H
Two's complement of low position 1 byte (E0H)=20H
⑬: "2"=32H, ⑭: "0"=30H

Example 3: In the case of a read command (R) with "XOR" set:

①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑫	⑬	⑭	⑮	⑯
STX	0	1	1	R	0	1	4	0	2	ETX	5	6	CR	LF
02H	30H	⊕31H	⊕31H	⊕52H	⊕30H	⊕31H	⊕34H	⊕30H	⊕32H	⊕03H	= 56H			

・⊕ = XOR (exclusive OR), though.

Low position 1 byte of result of operation (56H)=56H
⑬: "5"=35H, ⑭: "6"=36H

j: End character (delimiter) [⑮, ⑯: 1 digit or 2 digits/CR or CR LF]
- Indicates that it is the end of communication message.
- End character can be selected from the following:
  ⑮, ⑯: CR (0DH)(CR only, LF is not added.)
  ⑮, ⑯: CR (0DH), LF (0AH)

(4) Basic format portions I and II common condition
1. If abnormalities as listed below are found in the basic format portions, there will be no response:
   - There is a hardware error.
   - Machine address or sub-address is different from that of the designated instrument.
   - Any of the characters specified in the above communication format is not in its specified position.
   - The result of BCC operation differs from BCC data.
2. Conversion of data: Every 4 bits of binary data are converted to ASCII data.
3. <A> through <F> in hexadecimal numbers are converted to ASCII data by using capital letters.

(5) Outline of text portion
The text portion changes according to the types of commands and responses. For details of the text portion, see 5-3 Details of read commands (R) and 5-4 Details of write commands (W).

d: Type of commands [⑤: 1 digit]
- "R" (52H/capital letter): Indicates that it is a read command or a response to read command. Used to read (take) various data of EM70 from personal computer, PLC, etc.
- "W" (57H/capital letter): Indicates that it is a write command or a response to write command. Used to write (change) various data in EM70 from personal computer, PLC, etc.
- "B" (42H/capital letter): Indicates that it is broadcast instruction. Since EM70 does not support broadcast instruction, this is unable to be used.
- There is no response when any other abnormal character besides "R" and "W" is recognized.

e: Front data address [⑥, ⑦, ⑧, ⑨: 4 digits]
- For a read command (R) or a write command (W), designates a front data address of where to read from or write in.
- A front data address is designated by binary number 16 bit (1 word/0 ~ 65535) data.
- 16 bit data are split into 4 bit groups and converted to ASCII data.

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

- For data addresses, refer to 5-6 Details of communication data addresses.

f: The number of data [⑩: 1 digit]
- For a read command (R) or a write command (W), designates the number of data to be read or written.
- The number of data is designated in the following range by converting binary number 4 bit data to ASCII data:
  "0" (30H) (one) ~ "9" (39H) (ten)
- For write commands, the number is fixed to "0" (30H) (one).
- The actual number of data is <the number of data = designated numerical value of data + 1>.

g: Data [⑪: The number of digits depends on the number of data.]
- Designates data to be written (data to be changed) for write command (W) or data to be read for response to a read command (R).

• The data format is as follows:

g (⑪)

	First data				Second data					nth data			
"," 2CH	High position 1st digit	2nd digit	3rd digit	Low position 4th digit	High position 1st digit	2nd digit	3rd digit	Low position 4th digit		High position 1st digit	2nd digit	3rd digit	Low position 4th digit

• Data is always preceded by comma ("," 2CH) to show the subsequent portion is data.
• No punctuation code is used between data and data.
• The number of data is determined by the number of data (f: ⑩) of the communication command format.
• Each data is expressed by binary 16 bits (1 word), excluding a decimal point, as a unit. The position of decimal point is fixed in each data.
• 16 bit data are split into 4 bit groups and respectively converted to ASCII data.
• For details of data, refer to 5-3 Details of read commands (R) and 5-4 Details of write command (W).

e: Response code [⑥, ⑦: 2 digits]
• Designates a response code to a read command (R) or a write command (W).
• Binary 8 bit data (0 ~ 255) are split to high position 4 bits and low position 4 bits and respectively converted to ASCII data.
⑥: ASCII data converted from high position 4 bits.
⑦: ASCII data converted from low position 4 bits.
• In the case of normal response, "0" (30H), "0" (30H) is designated.
• In the case of abnormal response, abnormal code No. is converted to ASCII data and designated.
• For details of response codes, refer to 5-5 Details of Response codes.

5-3 Details of read commands (R)

Read commands (R) are used by a personal computer, PLC or the like to read (take) various data in EM70.

(1) Read Command (R) format
• The format of the text portion of a read command (R) is shown below:
(The basic format portions I and II are common to all commands and 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: Indicates that it is a read command.
e: Designates the front data address of data to be read.
f: Designates how many data (words) are to be read from the front data address.

• The above command means the following:
Front data address of data to be read = 0140H (hexadecimal)
= 0000 0001 0100 0000 (binary)
The number of data to be read = 2H (hexadecimal)
= 0010 (binary)
= 2 (decimal)
(The actual number of data) = 3 (2 + 1)
Thus, the command designates reading of 3 data from the data address 0140H.

(2) Normal response format to read command (R)
• The following is the normal response format (text portion) to read commands (R):
(The basic format portions I and II are common to all commands and responses.)

Text portion

d	e		g												
⑤	⑥	⑦	⑪ first data				second data				3rd 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)> indicating that it is a response to a read command (R) is inserted.
• e(⑥, ⑦): The response code <0 0 (30H, 30H)> indicating that it is a normal response to the read command (R) is inserted.
• g(⑪): Response data to the read command is inserted.
The data format is as follows:
1. To begin with, <, (2CH)> indicating the head of data is inserted.
2. Then, data in the number according to <the number of data to be read> are inserted one by one, starting from the <data of the front data address for reading>.

3. Nothing is inserted between the respective data.
4. The respective data comprise binary 16 bits (1 word) data, excluding a decimal point, and are converted, 4 bits as a unit, to ASCII data and inserted.
5. The position of decimal point is fixed in the respective data.
6. The number of characters of response data is as follows:
   Number of characters=1 + 4 × number of data to be read

- To the above read command (R), the following data are returned one by one as response data:

(Example)

		Data address 16 bits (1 word)	Data 16 bits (1 word)	
		Hexadecimal	Hexadecimal	decimal
Data address (0140H)	0	0140	01F4	500
	1	0141	0032	50
The number of data to be read (2H: 3)	2	0142	001E	30

Thus, the above data can be read.

(3) Abnormal response format to read command (R)

- The following is the abnormal response format (text portion) to read commands (R):
  (The basic format portions I and II are common to all commands and responses.)

Text Portion

d	e	
⑤	⑥	⑦
R	0	7
52H	30H	37H

- d(⑤): <R (52H)> indicating that it is a response to a read command (R) is inserted.
- e(⑥, ⑦): A response code indicating that it is an abnormal response to the read command (R) is inserted.
- For details of abnormal response code, refer to 5-5 Details of response codes.
- No response data are inserted in an abnormal response.

5-4 Details of write commands (W)

A write command is used by a personal computer, PLC, etc. to write (change) various data in EM70.

To use a write command, the COMM mode has to be selected on the 4-1 Communication mode selecting screen. As this parameter is unable to be changed from LOC to COM by front key operation, however, the change should be made by the following command transmission: (in the case of Address=01, Sub-address=1, Control code=STX_ETX_CR, and Check sum=Add.)

Command format

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

Once the above command is transmitted and a normal response is returned, the COM LED lamp on the front panel lights and mode is changed to communication.

(1) Write command (W) format

- The following is the text format of a write command.
  (The basic format portions I and II are common to all commands and responses.)

Text Portion

d	e				f	g				
⑤	⑥	⑦	⑧	⑨	⑩	⑪				
						Data to be written				
W	0	5	0	0	0	,	0	0	0	2
57H	30H	35H	30H	30H	30H	2CH	30H	30H	30H	32H

- d: Indicates that it is a write command. It is fixed to "W" (57H).
- e: Designates the front data address of data to be written (changed).
- f: Designates the number of data to be written (changed).
- g: Designates data to be written (changed).
  1. To begin with, <, (2CH)> indicating the head of data is inserted.
  2. Then, data to be written (changed) are inserted.
  3. The respective data comprise binary 16 bits (1 word) data, excluding a decimal point, and are converted, 4 bits as a unit, to ASCII data and inserted.
  4. The position of decimal point is fixed in the respective data.
- The above command means the following:

Front data address of data to be written = 0500H (hexadecimal)
= 0000 0101 0000 0000 (binary)
The number of data to be written = 0H (hexadecimal)
= 0000 (binary)
= 0 (decimal)
(The actual number of data) = one (0+1)
Data to be written = 0002H (hexadecimal)
= 0000 0000 0000 0010 (binary)
= 2 (decimal)

Thus, writing (changing) of data address 0500H and one piece of data (2: decimal) is designated.

(Example)

Address (500H) ⟶ 0
The number of data to be written: one (0H)

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 to write command (W)
- The following is the normal response format (text portion) to a write command (W).
  (The basic format portions I and II are common to all commands and responses.)

text portion

d	e	
⑤	⑥	⑦
W	0	0
57H	30H	30H

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

(3) Abnormal response format to write command (W)
- The following is the abnormal response format (text portion) to a write command (W).
  (The basic format portions I and II are common to all commands and responses.)

text portion

d	e	
⑤	⑥	⑦
W	0	9
57H	30H	39H

- d(⑤): <W (57H)> indicating that it is a response to a write command (W) is inserted.
- e(⑥, ⑦): A response code indicating that it is an abnormal response to the write command (W) is inserted.
- For details of abnormal codes, refer to 5-5 Details of response codes.

5-5 Details of response codes

(1) Types of response codes
- Communication responses to read commands (R) and write commands (W) always contains response codes.
- Response codes are divided broadly into two types:

Response codes { Normal response codes / Abnormal response codes

- A response code comprises 8 bits data of binary numbers (0 ~ 255).
- The types of response codes are listed below:

A List of Response Codes

Response code		Type of code	Description
Binary numbers	ASCII		
0000 0000	"0", "0" : 30H, 30H	Normal response	Normal response to read command (R) or write command (W)
0000 0001	"0", "1" : 30H, 31H	Hardware error in text portion	When a hardware error such as framing overrun or parity error has been detected in data in the text portion.
0000 0111	"0", "7" : 30H, 37H	Format error of text portion	Format of text portion is different from what was fixed.
0000 1000	"0", "8" : 30H, 38H	Error in data of text portion, data address or the number of data	Data of text portion is not in fixed format, or data address or the number of data is different from designated one.
0000 1001	"0", "9" : 30H, 39H	Data error	Data to be written get beyond range in which setting is possible.
0000 1010	"0", "A" : 30H, 41H	Execution command error	Execution command (such as AT command) was received in conditions where that execution command is not acceptable.
0000 1011	"0", "B" : 30H, 42H	Write mode error	Some types of data are unable to be changed at certain points in time. Write command containing such data was received at such a time.
0000 1100	"0", "C" : 30H, 43H	Specification or option error	Write command containing data of specification or option which was not added was received.

(2) Priority order of response codes
The smaller the value of response code, the higher the priority of the response code; When two or more response codes are generated, a response code of higher priority order is returned.

5-6 Details of communication data addresses

(1) Data address and read/write
- In a data address, binary numbers (16 bit data) are expressed by hexadecimal numbers, with 4 bits as a unit.
- R/W means that data are capable of being read and written.
- R means that data are only for reading.
- W means that data are only for writing.
- In case a data address only for writing is designated by a read command (R), or a data address only for reading is designated by a write command (W), it results in a data address error and the abnormal response code "0", "8" (30H, 38H) "error in data format, data address or the number of data in text portion" is returned.

(2) Data address and the number of data
- If a data address which is not included in the data addresses for EM70 is designated as the front data address, it results in a data address error, and the abnormal response code "0", "8" (30H, 38H) "error in data format, data address or the number of data in text portion" is returned.
- Even when a front data address is included in the data address list, the data address added with the number of data gets out of the data address list, it results in an error of the number of data, and abnormal response code "0", "8" (30H, 38H) " is returned.

(3) Data
- Since data comprise binary numbers (16 bit data) without a decimal point, the form of data, whether there is a decimal point or not, etc., have to be confirmed. (See the instruction manual of the instrument itself.)

  Example: How to express data with decimal point

		Hexadecimal data
20.0%	→ 200	→ 00C8

- In data of which the unit is UNIT, the position of decimal point depends on the measuring range.
- In other data than the above, binary numbers with code (16 bit data: -32768 ~ 32767) are used.

Example) How to express 16 bit data

Data with code		Data without code	
Decimal	Hexadecimal	Decimal	Hexadecimal
0	0000	0	0000
1	0001	1	0001
≀	≀	≀	≀
32767	7FFF	32767	7FFF
-32768	8000	32768	8000
-32767	8001	32769	8001
≀	≀	≀	≀
-2	FFFE	65534	FFFE
-1	FFFF	65535	FFFF

(4) <Reserved> in parameter portions
- When a <reserved> portion is read in reply to a read command, the (0000 H) data are returned.
- When a <reserved> portion is written in reply to a write command, normal response code "0", "0" (30H, 30H) is returned but no data is rewritten.

(5) Option-related parameters
- When the data address of a parameter which is not added as an option is designated, abnormal response code "0", "C" (30H, 43H) [Specification, option error] is returned to a read command (R) as well as a write command (W). If an address of data only for reading is read, however, the (0000H) data are returned.

(6) Parameters not shown in front panel displays owing to action specifications or setting specifications
- Even parameters which are not shown (used) on the front panel displays owing to action specifications or setting specifications are possible to be read and written in communication.

6. Communication data address list

Data address (hex)	Parameter	Details of parameter	R/W
0040		Series code 1	R
0041		Series code 2	R
0042		Series code 3	R
0043		Series code 4	R

- The address areas listed above become product ID data areas and data are ASCII data, 8 bits as a unit. Therefore, one address represents two data.
- A series code is expressed by 8 data maximum and a surplus area is filled with 00H data.

Series code: EM70	Address	H	L	H	L
	0040	"E"	"M"	45H	4DH
	0041	"7"	"0"	37H	30H
	0042	" "	" "	00H	00H
	0043	" "	" "	00H	00H

Data address (hex)	Parameter	Details of parameter	R/W
0104	EXE_FLG	Action flag	R
0105	EV_FLG	Event output flag	R

010B	DI_FLG	External input (DI) status flag	R

- Details of EXE_FLG, EV_FLG and DI_FLG are shown below:

	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

Data address (hex)	Parameter	Details of parameter	R/W
0111	INP_RANGE	Input range (Current: 0: 4~20mA, 1: 0~20mA Voltage: 0: 0~10V, 1: 0~5V, 2: 1~5V)	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

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

Data address (hex)	Parameter	Details of parameter	R/W
0186	STBY	1: Stand-by, 0: Run	W
018C	COM	0: LOC, 1: COM	W

Data address (hex)	Parameter	Details of parameter	R/W
0500	EV1_M	Type of event 1 Refer to supplementary explanation.	R/W
0501	EV1_SP	Set value of event 1 Refer to supplementary explanation.	R/W
0502	EV1_DF	Event 1 hysteresis	R/W
0503	EV1_STB	Event 1 stand-by action 0: Without, 1: With	R/W
0508	EV2_M	Type of event 2 Refer to supplementary explanation.	R/W
0509	EV2_SP	Set value of event 2 Refer to supplementary explanation.	R/W
050A	EV2_DF	Event 2 hysteresis	R/W
050B	EV2_STB	Event 2 stand-by action 0: Without, 1: With	R/W
0510	EV3_M	Type of event 3 Refer to supplementary explanation.	R/W
0511	EV3_SP	Set value of event 3 Refer to supplementary explanation.	R/W
0512	EV3_DF	Event 3 hysteresis	R/W
0513	EV3_STB	Event 3 stand-by action 0: Without, 1: With	R/W
05A0	A0_MOD	Analog output mode 0: POSI, 1: INP	R/W
05A1	A0_L	Analog output scale on lower limit side	R/W
05A2	A0_H	Analog output scale on higher limit side	R/W
05B0	COM_MEM	Communication memory mode 0: EEP, 1: RAM	R/W
0611	KEY_LOCK	Keylock (0=OFF, 1=Excluding STBY, EV set value, DI setting and MAN, 2=Excluding MAN, 3=All)	R/W
0642	INP_FILT	Input filter	R/W
0643	SQUARE	Square root extraction operation 0: Without, 1: With	R/W

Data address (hex)	Parameter	Details of parameter	R/W
0647	SCL_MOD	Scaling mode 0: Input, 1: Opening	R/W
0648	SCL_L	Scaling on lower limit side (Lower limit side < Higher limit side)	R/W
0649	SCL_H	Scaling on higher limit side (Lower limit side < Higher limit side)	R/W

064C	POSI_L	Degree of opening limiter on lower limit side (Lower limit side < Higher limit side)	R/W
064D	POSI_H	Degree of opening limiter on higher limit side (Lower limit side < Higher limit side)	R/W

0650	ACT_MOD	Control characteristics 0: DA, 1: RA	R/W
0651	Reserved		R/W
0652	DB	Dead band	R/W

0655	ZS_MOD	0: AUT, 1: MAN	R/W
0656	SPEED	Motor speed adjustment	R/W
0657	IN_ERR_MOD	Processing mode when input scale-over occurs 0: NON, 1: STOP, 2: PRE	R/W
0658	IN_ERR_PRE	Value of opening when input scale-over occurs (preset)	R/W
0659	P_ERR_MOD	Processing mode when potentiometer scale-over occurs 0: STOP, 1: CLOSE, 2: OPEN	R/W
065A	OPN_CLS_TM	Time of opening or closing when potentiometer scale-over occurs	R/W

0660	DI_MOD	External input (DI) mode	R/W
0661	Reserved		R/W
0662	DI1_SINGL	External input (DI) 1 individual setting	R/W
0663	DI2_SINGL	External input (DI) 2 individual setting	R/W
0664	DI3_SINGL	External input (DI) 3 individual setting	R/W
0665	Reserved		R/W
0666	DI1_S_PRE	External input (DI) 1 individual setting of degree of opening (preset)	R/W
0667	DI2_S_PRE	External input (DI) 2 individual setting of degree of opening (preset)	R/W
0668	DI3_S_PRE	External input (DI) 3 individual setting of degree of opening (preset)	R/W
0669	Reserved		R/W
066A	DI_PRE1	External input (DI) value of degree of opening (preset) 1	R/W
066B	DI_PRE2	External input (DI) value of degree of opening (preset) 2	R/W
066C	DI_PRE3	External input (DI) value of degree of opening (preset) 3	R/W
066D	DI_PRE4	External input (DI) value of degree of opening (preset) 4	R/W
066E	DI_PRE5	External input (DI) value of degree of opening (preset) 5	R/W
066F	DI_PRE6	External input (DI) value of degree of opening (preset) 6	R/W
0670	DI_PRE7	External input (DI) value of degree of opening (preset) 7	R/W

7. Supplementary Explanation

7-1. Event Type List

Event code	Event type	Value	Setting range of event SV	Event SV initial value
no	Without	0	----------	----------
LP	Lower limit absolute value of degree of opening	1	0 ~ 100%	0%
HP	Higher limit absolute value of degree of opening	2	0 ~ 100%	100%
LL	Input lower limit absolute value	3	0 ~ 100%	0%
HL	Input higher limit absolute value	4	0 ~ 100%	100%
Ru	Run	5	EV output continues during Run mode	
nA	Manual	6	EV output continues during Manual mode	
PE	Degree of opening error	7	EV output continues despite error in the degree of opening	
LE	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.	

7-2. ASCII code list

b7b6b5	000	001	010	011	100	101	110	111
b4 ~ b1	0	1	2	3	4	5	6	7
0000	NUL	TC7 (DLE)	SP	0	@	P	`	p
0001	TC1 (SOH)	DC1	!	1	A	Q	a	q
0010	TC2 (STX)	DC2	”	2	B	R	b	r
0011	TC3 (ETX)	DC3	#	3	C	S	c	s
0100	TC4 (EOT)	DC4	$	4	D	T	d	t
0101	TC5 (ENQ)	TC8 (NAK)	%	5	E	U	e	u
0110	TC6 (ACK)	TC9 (SYN)	&	6	F	V	f	v
0111	BEL	TC10 (ETB)	’	7	G	W	g	w
1000	FE0 (BS)	CAN	(	8	H	X	h	x
1001	FE1 (HT)	EM	)	9	I	Y	i	y
1010	FE2 (LF)	SUB	*	:	J	Z	j	z
1011	FE3 (VT)	ESC	+	;	K	[	k	{
1100	FE4 (FF)	IS4 (FS)	,	<	L	\	l	|
1101	FE5 (CR)	IS3 (GS)	–	=	M	]	m	}
1110	SO	IS2 (RS)	.	>	N	^	n	~
1111	SI	IS1 (US)	/	?	O	_	o	DEL

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