MR13 Series
Digital Controller

COMMUNICATION INTERFACE
(RS-232C/RS-485)

INSTRUCTION MANUAL

Thank you for purchasing the Shimaden MR13 series 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.

CE

This instruction manual describes the communication interface which is an optional function of the MR13 digital controller. For details of MR13's performance and parameters, please refer to the separate instruction manual.

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SHIMADEN CO., LTD.

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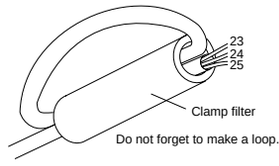
1. Outline

There are two types of communication systems, RS-232C and RS-485 employable as the MR13 series communication interface. Each of them is capable of setting various data for the MR13 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 MR13 controllers 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

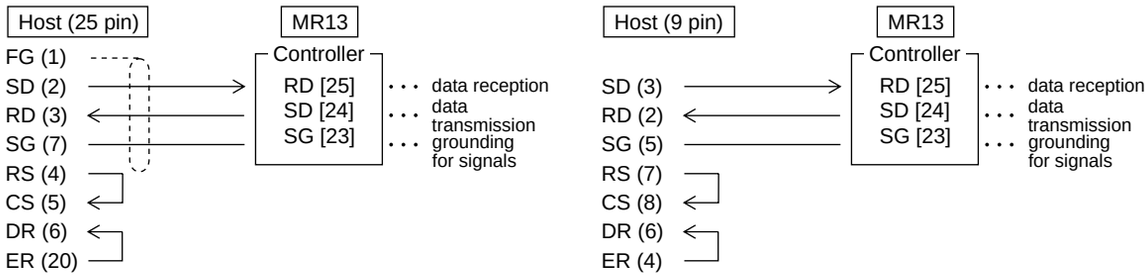
Signal level	:	Following EIA'S RS-232C and RS-485
Communication system	:	RS-232C 3-line half duplex system RS-485 2-line half duplex multidrop (bus) system
Synchronization system	:	Half duplex start-stop synchronization system
Communication distance	:	RS-232C 15 m maximum RS-485 maximum total of 500 m (differs depending on conditions.)
Communication speed	:	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
Other matters	:	MR13 communication systems meet EMC standards on condition that clamp filters E04SR301334, SEIWA Information Systems products, are used appropriately.



3. Connecting controller with host computer

The MR13 series 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 (shaded portions). 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

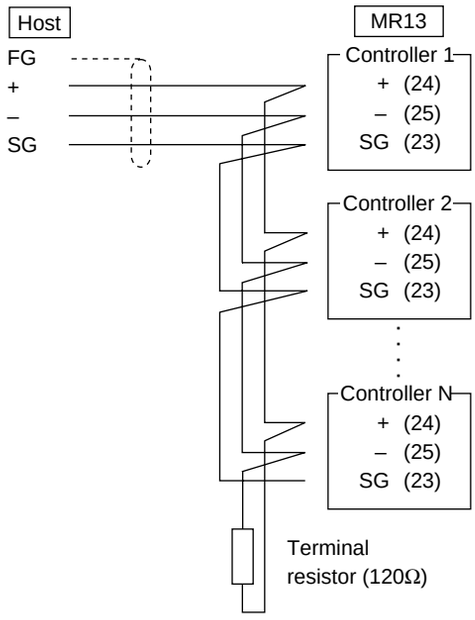


Note 1: Figures in ( ) represent pin numbers of connector.
Note 2: Figures in [ ] represent terminal numbers of MR13.

3-2 RS-485

The input/output logical level of the MR13 controller is basically as follows:
In the mark state - terminal < + terminal
In the space state - terminal > + terminal

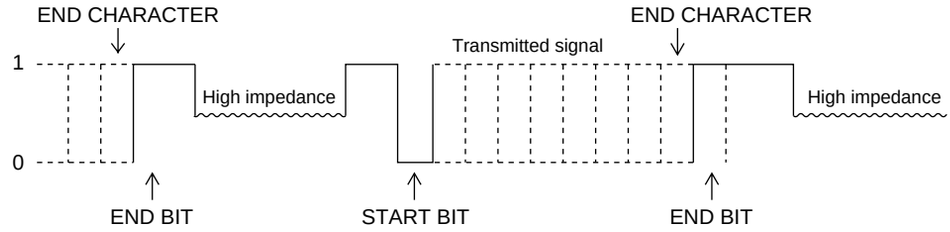
Until immediately before transmission, however, plus terminals and minus terminals of the controller have high impedance and outputs at the above levels are produced immediately before starting transmission. (See 3-3 3-state output control.)



Note 1: In the case of RS-485, provide it with a terminal resistor of about 1/2W, 120Ω across terminals 24 and 25 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: Figures in [ ] represent terminal numbers of MR13.

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.

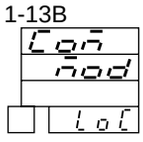


4. Setting of parameters related to communication

There are the following 8 communication-related parameters for the MR13 series controller. These parameters are unable to be set or changed by communication; use front key for setting and changing. When parameters are set, see 4-2. "key sequence" of the separate instruction manual for the controller and follow the described steps.

4-1 Communication mode selecting screen

1-13B



Initial value: LOC
Selectable range: COM→LOC

Select communication mode. Front key operation allows only change from COM to LOC, though.
LOC mode: Only read commands are valid in communication.
COM mode: Read and write commands are valid in communication.

4-2 Communication address setting screen

1-14B

Initial value: 1
Setting range: 1～99

While one MR13 controller is connected to one host computer in the case of 232C, RS-485 employs the multidrop system allowing it to be connected to a maximum of 32. Actually, however, communication has to be carried out bilaterally. Therefore, each instrument is assigned an address (machine No.) so that only the instrument with the designated address can answer.
Note 1: Addresses are from 01 to 99, which can be assigned to 32 instruments maximum.

4-3 Communication speed selecting screen

1-15B

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

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

4-4 Communication data format selecting screen

1-16B

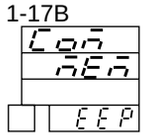
Initial value: 7E1
Selectable range: 8 types listed in the following table

Select a data format from the following 8 types.

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

4-5 Communication memory mode selecting screen

1-17B



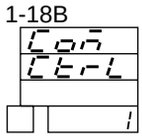
Initial value: EEP
Selectable range: EEP, RAM

Since the number of writing cycles of volatile memory EEPROM 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.

4-6 Communication control code selecting screen

1-18B

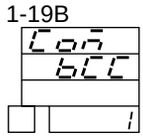


Initial value: 1
Selectable range: 1～3

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

4-7 Communication check sum selecting screen

1-19B



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

4-8 Communication delay time setting screen

1-20B

Initial value: 40
Setting range: 0～125

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 speed 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 MR13 series 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 a 1 second minimum as the time-out duration.

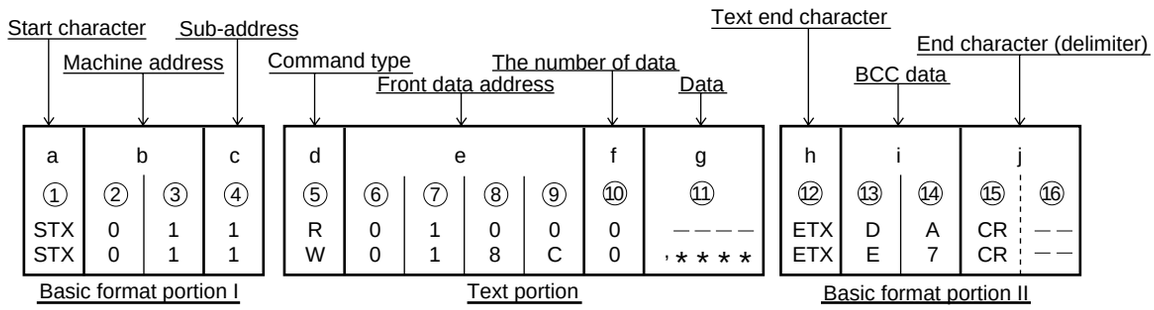
5-2 Communication format

The MR13 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

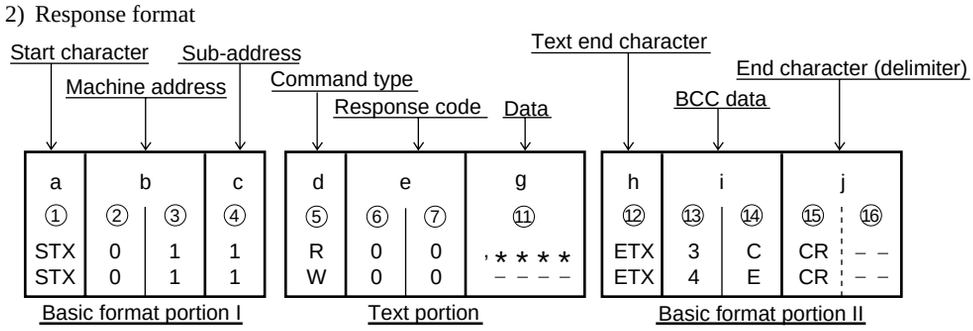
For setting a communication format and a communication data format, see "4. Setting of parameters related to communication."

(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 4-6 Communication control code selecting 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 MR13 series controller does not support broadcast instruction, address=0 has no response.

c : Sub-address [④ : 1 digit / any one of 1(31H), 2(32H) and 3(33H)]
- Designates a channel in which communication is carried out.
  1 (31H) ····· channel 1
  2 (32H) ····· channel 2
  3 (33H) ····· channel 3
  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 result of one 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	0	0	0	ETX	D	A	CR	
02H	+30H	+31H	+31H	+52H	+30H	+31H	+30H	+30H	+30H	+03H	= 1DAH			

Low position 1 byte of result of addition (1DAH)=DAH
⑬: "D"=44H, ⑭: "A" = 41H

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	0	0	0	ETX	2	6	CR	
02H	+30H	+31H	+31H	+52H	+30H	+31H	+30H	+30H	+30H	+03H	= 1DAH			

Low position 1 byte of result of addition (1DAH)=DAH
Two's complement of low position 1 byte (DAH)=26H
⑬ : "2"=32H, ⑭: "6"=36H

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	0	0	0	ETX	5	0	CR	
02H	30H	⊕31H	⊕31H	⊕52H	⊕30H	⊕31H	⊕30H	⊕30H	⊕30H	⊕03H	= 50H			

- ⊕ = XOR (exclusive OR), though.

Low position 1 byte of result of operation (50H)=50H
⑬ : "5"=35H, ⑭: "0"=30H

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 (0AII)

(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 MR13 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 MR13 from personal computer, PLC, etc.
- "B" (42H/capital letter): Indicates that it is broadcast instruction. Since MR13 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)
- 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)

"," 2CH	First data				Second data					nth data			
	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 (f: ⑩) determines the number of data 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 MR13.

(1) Read Command (R) format

- The format of the text portion of a read command 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	4	0	0	4
52H	30H	33H	30H	30H	34H

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	=	0400H	(hexadecimal)
	=	0000 0100 0000 0000	(binary)
The number of data to be read	=	4H	(hexadecimal)
	=	0100	(binary)
	=	4	(decimal)
(The actual number of data)	=	Five (4 + 1)	

Thus, the command designates reading of five data from the data address 0400H.

(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					⑪ second data							5th data				
R	0	0	,	0	0	1	E	0	0	7	8				0	0	0	3	
52H	30H	30H	2CH	30H	30H	31H	45H	30H	30H	37H	38H				30H	30H	30H	33H	

- 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:

		Data address 16 bits (1 word)	Data 16 bits (1 word)	
		Hexadecimal	Hexadecimal	decimal
Data address (0400H)	0	0400	001E	30
	1	0401	0078	120
The number of data to be read (4H: five)	2	0402	001E	30
	3	0403	0000	0
	4	0404	0003	3
		0405	0000	0
		0406	03E8	1000
		0407	0028	40

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 indicates 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 MR13.

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	4	0	0	0	,	0	0	2	8
57H	30H	34H	30H	30H	30H	2CH	30H	30H	32H	38H

- 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	= 0400H	(hexadecimal)
	= 0000 0100 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	= 0028H	(hexadecimal)
	= 0000 0000 0010 1000	(binary)
	= 40	(decimal)

Thus, writing (changing) of data address 0400H and one piece of data (40: decimal) is designated.

	Data address 16 bits (1 word)		Data 16 bits (1 word)	
	Hexadecimal	Decimal	Hexadecimal	Decimal
Address (400H) ⟶ 0	0400	1024	0028	**40**
The number of data to be written one (0H)	0401	1025	0078	120
	0402	1026	001E	30

(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. (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 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.

Note 1: If an abnormal response code is returned to a write command (writing of two or more data), writing of all data becomes invalid.

(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" is returned.

(2) Data address and the number of data
- If a data address which is not included in the data addresses for MR13 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" 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 a data address error, 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

* 1 Read / Write possible only for CH1 data.

* 2 Read / Write possible for each channel data except read-only / write-only addresses.

Data address (hex)	Parameter	Details of parameter	R/W
0100	PV value	Within measuring range	R
0101	Execution SV value	Within setting limiter	R
0102	OUT	Control output value 0.0～100.0%	R
0103	Reserved		
0104	EXE_FLG	Action flag (See detailed explanation below.)	R
0105	EV_FLG	Event output flag (See detailed explanation below.) *2	R
0106	Reserved		
0107	Reserved		
0108	REM value		R
0109	Reserved		
010A	Reserved		
010B	DI_FLG	DI input state flag (See detailed explanation below.) *2	R

0111	RANGE	Refer to the measuring range code list.	R
0112	Reserved		
0113	DP	Position of decimal point (0:Without decimal point, 1:With decimal point)	R
0114	PV SC_L	For Linear input: -1999～9999 Unit; For thermocouple and and R.T.D. input: Measuring range to be displayed.	R
0115	PV SC_H		

0120	E_PRG	Program action flag *1	R
0121	Reserved		
0122	Reserved		
0123	E_PRT	The number of execution patterns (When program is reset, value=7FFEH) *1	R
0124	E_STP	Execution step No. (When program is reset, value=7FFEH) *1	R
0125	E_TIM	Remaining time of execution step (When program is reset, value=7FFEH) *1	R
0126	E_PID	Execution PID No. (When program is reset, value=7FFEH) *1	R

• Subaddress : 1=CH1, 2=CH2, 3=CH3

• HHHH CJHH b--- rEHH =7FFFH

• LLLL CJLL rELL C--- =8000H

• The details of EXE_FLG, EV_FLG, DI_FLG and E_PRG are as follows.
(While in no action → bit = 0, while in action → bit=1)

	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	REM	0	0	0	0	AT
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	0	0	D1
E_PRG:	PRG/FIX	0	0	0	0	0	0	0	0	0	0	0	0	0	HLD	RUN/RST

When D15=1, PRG; when D15=0, FIX.
When D1=1, HLD; when D1=0, noHLD.
When D0=1, RUN; when D0=0, RST.

Note 1: No write command can be used unless the communication mode is in the COM mode.
For details, refer to 5-4 Details of write commands (W).

0184	Auto Tuning	0 : No execution, 1 : Execution	W

018C	Operation	0 : LOCAL, 1 : COMM *2	W

Data address (hex)	Parameter	Details of parameter	R/W
0190	PROG RUN/RST	0 : PROG RST, 1 : PROG RUN (Writing is possible only in CH1.)	W
0191	PROG HLD	0 : Release of HLD, 1 : HLD (Writing is possible only in CH1.)	W
0192	PROG ADV	0 : No execution, 1 : ADV (Invalid when HLD. Writing is possible only in CH1.)	W
0280	PV(CH1)	Reading possible in every channel	R
0281	PV(CH2)	Same as above	R
0282	PV(CH3)	Same as above	R
0300	SV	Local SV value, within set value limiter	R/W
030A	SV Limt_L	Within measuring range, on condition that SV Limt_L < SV Limt_H.	R/W
030B	SV Limt_H		
0314	REM SC_L	Within measuring range, on condition that REM SC_L ≠ REM SC_H.	R/W
0315	REM SC_H		
0316	REM Bias	-1999～5000 Unit	R/W
0317	REM Filt	0～100 sec.	R/W
031A	REM_CH	Remote channel assignment 0 : OFF, 1 : CH1, 2 : CH2, 3 : CH3 *2	R/W
0320	SFLW	CH2 and CH3 SV follow setting flag, 1 : Follow, 0 : No	R/W
0321	S_FL	Follow type deviation SV set value 1999～5000 Unit	R/W

- In case two or more data are written in response to one write command, occurrence of an error in only one of such data makes the write command invalid, and an error code is returned.
- The display of SV Follow and SV Follow SW for CH1 is ----. To a read command, value=7FFEH, to a write command, error (0BH) is returned.
- Parameters related to remote function (except REM_CH) can be read and written only when Sub-address=REM_CH.
- Writing of PROG RUN/RST, HLD and ADV gives priority to DI setting. In case DI is set, there is no writing and error (0AH) is returned.

0400	FIX P	0.0～999.9% (0.0 : OFF)	R/W
0401	FIX I	0～6000 Sec. (0 : OFF)	R/W
0402	FIX D	0～3600 Sec (0 : OFF)	R/W
0403	FIX MR	-50.0～50.0%	R/W
0404	FIX DF	1～999 Unit	R/W
0405	FIX OUT Limt_L	0.0～99.9%	R/W
0406	FIX OUT Limt_H	0.1～100.0%	R/W
0407	FIX SF	OFF, 0.01～1.00	R/W
0408	Prog P1	PROG mode PB1 0.0～999.9% (0.0 : OFF)	R/W
0409	Prog I1	PROG mode IT1 0～6000 Sec. (0 : OFF)	R/W
040A	Prog D1	PROG mode DT1 0～3600 Sec (0 : OFF)	R/W
040B	Prog MR1	PROG mode MR1 -50.0～50.0%	R/W
040C	Prog DF1	PROG mode DF1 1～999 Unit	R/W
040D	Prog O_Lmt_L1	PROG mode lower limit side output limiter 1 0.0～99.9%	R/W
040E	Prog O_Lmt_H1	PROG mode higher limit side output limiter 1 0.1～100.0%	R/W
040F	Prog SF1	PROG mode target value function 1 OFF, 0.01～1.00	R/W

Data address (hex)	Parameter	Details of parameter	R/W
0410	Prog P2	PROG mode PB2 0.0～999.9% (0.0 : OFF)	R/W
0411	Prog I2	PROG mode IT2 0～6000 Sec. (0 : OFF)	R/W
0412	Prog D2	PROG mode DT2 0～3600 Sec. (0 : OFF)	R/W
0413	Prog MR2	PROG mode MR2 -50.0～50.0%	R/W
0414	Prog DF2	PROG mode DF2 1～999 Unit	R/W
0415	Prog O_Lmt_L2	PROG mode lower limit side output limiter 2 0.0～99.9%	R/W
0416	Prog O_Lmt_H2	PROG mode higher limit side output limiter 2 0.1～100.0%	R/W
0417	Prog SF2	PROG mode target value function 2 OFF, 0.01～1.00	R/W
0418	Prog P3	PROG mode PB3 0.0～999.9% (0.0 : OFF)	R/W
0419	Prog I3	PROG mode IT3 0～6000 Sec. (0 : OFF)	R/W
041A	Prog D3	PROG mode DT3 0～3600 Sec. (0 : OFF)	R/W
041B	Prog MR3	PROG mode MR3 -50.0～50.0%	R/W
041C	Prog DF3	PROG mode DF3 1～999 Unit	R/W
041D	Prog O_Lmt_L3	PROG mode lower limit side output limiter 3 0.0～99.9%	R/W
041E	Prog O_Lmt_H3	PROG mode higher limit side output limiter 3 0.1～100.0%	R/W
041F	Prog SF3	PROG mode target value function 3 OFF, 0.01～1.00	R/W

0500	EV1_MODE	0: Not assigned 1: Higher limit deviation value alarm 2: Lower limit deviation value 3: Out of range between higher and lower limits 4: Within range between higher and lower limits 5: Higher limit absolute value 6: Lower limit absolute value 7: Scaleover 8: Program RUN 9: Program END 10: Program STEP Only when Subaddress=EV1_CH.	R/W
0501	EV1 Set Point	1. Higher limit deviation value alarm: 0～1999 Unit 2. Lower limit deviation value alarm: 0～-1999 Unit 3. Out of range between higher and lower limits value alarm: 0～1999 Unit 4. Within range between higher and lower limits value alarm: 0～1999 Unit 5. Higher limit absolute value alarm: Within measuring range 6. Lower limit absolute value alarm: Within measuring range Only when Subaddress=EV1_CH.	R/W
0502	EV1 Diffrnt	Alarm hysteresis 1～999 Unit Only when Subaddress=EV1_CH.	R/W
0503	EV1 Inhibit	Alarm standby 1～4 Only when Subaddress=EV1_CH.	R/W
0504	EV1 Delay	Alarm delay time 0～9999 Sec. Only when Subaddress=EV1_CH.	R/W

0506	EV1_CH	Channel No. setting 1 : CH1, 2 : CH2, 3 : CH3 *2	R/W

Data address (hex)	Parameter	Details of parameter	R/W
0510	EV2_MODE	0: Not assigned 1: Higher limit deviation value alarm 2: Lower limit deviation value 3: Out of range between higher and lower limits 4: Within range between higher and lower limits 5: Higher limit absolute value 6: Lower limit absolute value 7: Scaleover 8: Program RUN 9: Program END 10: Program STEP Only when Subaddress=EV2_CH.	R/W
0511	EV2 Set Point	1. Higher limit deviation value alarm: 0～1999 Unit 2. Lower limit deviation value alarm: 0～-1999 Unit 3. Out of range between higher and lower limits value alarm: 0～1999 Unit 4. Within range between higher and lower limits value alarm:0～1999 Unit 5. Higher limit absolute value alarm: Within measuring range 6. Lower limit absolute value alarm: Within measuring range Only when Subaddress=EV2_CH.	R/W
0512	EV2 Diffrnt	Alarm hysteresis 1～999 Unit Only when Subaddress=EV2_CH.	R/W
0513	EV2 Inhibit	Alarm standby 1～4 Only when Subaddress=EV2_CH.	R/W
0514	EV2 Delay	Alarm delay time 0～9999 Sec. Only when Subaddress=EV2_CH.	R/W

0516	EV2_CH	Channel No. setting 1 : CH1, 2 : CH2, 3 : CH3 *2	R/W

0520	EV3_MODE	0: Not assigned 1: Higher limit deviation value alarm 2: Lower limit deviation value 3: Out of range between higher and lower limits 4: Within range between higher and lower limits 5: Higher limit absolute value 6: Lower limit absolute value 7: Scaleover 8: Program RUN 9: Program END 10: Program STEP Only when Subaddress=EV3_CH.	R/W
0521	EV3 Set Point	1. Higher limit deviation value alarm: 0～1999 Unit 2. Lower limit deviation value alarm: 0～-1999 Unit 3. Out of range between higher and lower limits value alarm: 0～1999 Unit 4. Within range between higher and lower limits value alarm: 0～1999 Unit 5. Higher limit absolute value alarm: Within measuring range 6. Lower limit absolute value alarm: Within measuring range Only when Subaddress=EV3_CH.	R/W
0522	EV3 Diffrnt	Alarm hysteresis 1～999 Unit Only when Subaddress=EV3_CH.	R/W
0523	EV3 Inhibit	Alarm standby 1～4 Only when Subaddress=EV3_CH.	R/W
0524	EV3 Delay	Alarm delay time 0～9999 Sec. Only when Subaddress=EV3_CH.	R/W

0526	EV3_CH	Channel No. setting 1 : CH1, 2 : CH2, 3 : CH3 *2	R/W

Data address (hex)	Parameter	Details of parameter	R/W
0580	DI	DI setting flag 0 : NON, 1 : FLW, 2 : RUN, 3 : HLD, 4 : ADV *2	R/W
05B0	MEM	0 : EEP 1 : RAM *2	R/W
0600	Out Actn	Output characteristic setting flag 0 : Rev Act, 1 : Dir Act	R/W
0601	Out_Cyc	Control output cycle (Unit: 0.5 sec.) 0.5～120.0 sec.	R/W
0602	Reserved		
0603	SOFTSW	Soft start setting flag 0 : OFF, 1 : ON	R/W
0610	At Point	AT pointer 0～5000 Unit	R/W
0611	Key Lock	0 : OFF, 1 : LOCK1, 2 : LOCK2, 3 : LOCK3 *2	R/W

- When Out_Cyc is written, writing data is adjusted to 0.5 sec. as a unit.
  Example: When writing data=0008H, Out_Cyc=0.5 sec.
- The write command lock by keylock is the same as the screen lock. (Refer to the instruction manual of the instrument.)
- If there is a change in EV1_CH, EV2_CH and EV3_CH, related parameters are initialized.

0701	PV Bias	PV bias -1999～1999 Unit	R/W
0702	PV Filt	PV filter 0～100 Sec.	R/W
0710	PFLW	Setting of CH2, CH3 PV input follow 0 : OFF, 1 : ON	R/W
0711	CH_P	Selection of CH2, CH3 PV display or not 0 : without, 1 : with	R/W
0800	FP_MOD	Selection between FIX and PROG (Writing possible only in CH1) *1 0 : FIX, 1 : PROG	R/W
0801	PV_ST	Setting of PV start 0 : OFF, 1 : ON (Writing possible only in CH1) *1	R/W
0882	STP	The number of steps 1～9 (Writing possible only in CH1)*1	R/W
0883	RPT	The number of execution repetitions 1～9999 (Writing possible only in CH1)*1	R/W
0884	ST_SV	Start SV (Writing possible only in CH1)*1	R/W

- CH1's PFLW, CH_P display ----, Read value=7FFEH.
  To a write command, error (0BH) is returned.

Data address (hex)	Parameter	Details of parameter	R/W
08A0	Step1 SV	Step 1 SV (Writing possible only in CH1) *1	R/W
08A1	Step1 Time	Step 1 time (Writing possible only in CH1) *1	R/W
08A2	Step1 PID No	Step 1 PID No.	R/W
08A3	Reserved		
08A4	Step2 SV	Step 2 SV (Writing possible only in CH1) *1	R/W
08A5	Step2 Time	Step 2 time (Writing possible only in CH1) *1	R/W
08A6	Step2 PID No	Step 2 PID No.	R/W
08A7	Reserved		
08A8	Step3 SV	Step 3 SV (Writing possible only in CH1) *1	R/W
08A9	Step3 Time	Step 3 time (Writing possible only in CH1) *1	R/W
08AA	Step3 PID No	Step 3 PID No.	R/W
08AB	Reserved		
08AC	Step4 SV	Step 4 SV (Writing possible only in CH1) *1	R/W
08AD	Step4 Time	Step 4 time (Writing possible only in CH1) *1	R/W
08AE	Step4 PID No	Step 4 PID No.	R/W
08AF	Reserved		
08B0	Step5 SV	Step 5 SV (Writing possible only in CH1) *1	R/W
08B1	Step5 Time	Step 5 time (Writing possible only in CH1) *1	R/W
08B2	Step5 PID No	Step 5 PID No.	R/W
08B3	Reserved		
08B4	Step6 SV	Step 6 SV (Writing possible only in CH1) *1	R/W
08B5	Step6 Time	Step 6 time (Writing possible only in CH1) *1	R/W
08B6	Step6 PID No	Step 6 PID No.	R/W
08B7	Reserved		
08B8	Step7 SV	Step 7 SV (Writing possible only in CH1) *1	R/W
08B9	Step7 Time	Step 7 time (Writing possible only in CH1) *1	R/W
08BA	Step7 PID No	Step 7 PID No.	R/W
08BB	Reserved		
08BC	Step8 SV	Step 8 SV (Writing possible only in CH1) *1	R/W
08BD	Step8 Time	Step 8 time (Writing possible only in CH1) *1	R/W
08BE	Step8 PID No	Step 8 PID No.	R/W
08BF	Reserved		
08C0	Step9 SV	Step 9 SV (Writing possible only in CH1) *1	R/W
08C1	Step9 Time	Step 9 time (Writing possible only in CH1) *1	R/W
08C2	Step9 PID No	Step 9 PID No.	R/W
08C3	Reserved		

7. Supplementary Description

7-1 Measuring range list

Input type		Code	Measure range		Code	Measure range	
Thermocouple	*1 B	01	0 ～ 1800 °C		15	0 ～ 3300 °F	
	R	02	0 ～ 1700 °C		16	0 ～ 3100 °F	
	S	03	0 ～ 1700 °C		17	0 ～ 3100 °F	
	K	04	-100.0 ～ 400.0 °C		18	-150 ～ 750 °F	
		05	0.0 ～ 800.0 °C		19	0 ～ 1500 °F	
		06	0 ～ 1200 °C		20	0 ～ 2200 °F	
	E	07	0 ～ 700 °C		21	0 ～ 1300 °F	
	J	08	0 ～ 600 °C		22	0 ～ 1100 °F	
	*2 T	09	-199.9 ～ 200.0 °C		23	-300 ～ 400 °F	
	N	10	0 ～ 1300 °C		24	0 ～ 2300 °F	
	PLII	11	0 ～ 1300 °C		25	0 ～ 2300 °F	
	WRe5-26	12	0 ～ 2300 °C		26	0 ～ 4000 °F	
	*2 U	13	-199.9 ～ 200.0 °C		27	-300 ～ 400 °F	
	L	14	0 ～ 600 °C		28	0 ～ 1100 °F	
R.T.D.	Pt100 (New) JIS/IEC	31	-200 ～ 600 °C		47	-300 ～ 1100 °F	
		32	-100.0 ～ 100.0 °C		48	-150.0 ～ 200.0 °F	
		33	-100.0 ～ 300.0 °C		49	-150 ～ 600 °F	
		34	-50.0 ～ 50.0 °C		50	-50.0 ～ 120.0 °F	
		35	*3 0.0 ～ 50.0 °C		51	0.0 ～ 120.0 °F	
		36	0.0 ～ 100.0 °C		52	0.0 ～ 200.0 °F	
		37	0.0 ～ 200.0 °C		53	0.0 ～ 400.0 °F	
		38	0.0 ～ 500.0 °C		54	0 ～ 1000 °F	
	JPt100 (Old) JIS	39	-200 ～ 500 °C		55	-300 ～ 900 °F	
		40	-100.0 ～ 100.0 °C		56	-150.0 ～ 200.0 °F	
		41	-100.0 ～ 300.0 °C		57	-150 ～ 600 °F	
		42	-50.0 ～ 50.0 °C		58	-50.0 ～ 120.0 °F	
		43	*3 0.0 ～ 50.0 °C		59	0.0 ～ 120.0 °F	
		44	0.0 ～ 100.0 °C		60	0.0 ～ 200.0 °F	
		45	0.0 ～ 200.0 °C		61	0.0 ～ 400.0 °F	
		46	0.0 ～ 500.0 °C		62	0 ～ 900 °F	
mV	-10 ～ 10	71					
	0 ～ 10	72					
	0 ～ 20	73					
	0 ～ 50	74					
	10 ～ 50	75					
	0 ～ 100	76					
V	-1 ～ 1	81					
	0 ～ 1	82					
	0 ～ 2	83					
	0 ～ 5	84					
	1 ～ 5	85					
	0 ～ 10	86					
mA	0 ～ 20	94					
	4 ～ 20	95					

The scaling function allows any measuring range to be set within the following limits:

Scaling range: -1999～9999 counts
Span : 10～5000 counts on condition that Lower limit side < Higher limit side.

*1 Thermocouple B: Accuracy cannot be guaranteed below 400 °C or 750 °F.
*2 Thermocouple T, U: ±0.5%FS between -199.9 and 100.0 °C
*3 R.T.D.: Accuracy ±0.3 °C (±0.8 °F)

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	0	NUL	TC7 (DLE)	S P	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	TC6 (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

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