TOHO ELECTRONICS INC.

Operation Manual, Communications

Model: TTM-509
Designation: Digital Controller

Thank you very much for purchasing a TTM-509 (with communications). Please read this operation manual carefully and use this product correctly.

Contents

1. Before using the product

1.1. On this operation manual

This is an operation manual regarding communications with a TTM-509 (hereinafter referred to as "this product").

1.2. Conditions for communications

The communications function of this product is optionally specified. For that reason, you should specify a communications option (RS-485/RS-232C or infrared communications) in purchasing this product.

The RS-485 and RS-232C are internally connected. They therefore cannot be used simultaneously.

Conditions for availability

	RS-485/RS-232C	Infrared communications
TOHO communications	Available	Available
MODBUS communications	Available	Available

* A combination of RS-232C and infrared communications is on a one-to-one basis.

1.3. What can be done with communications

With this product, users can write and read items specified in "10. Table of identifiers (codes)," such as "reconfiguring, starting, or stopping items that are operable with the front keys" and "reading information displayable on the display."

However, reading and writing with ordinary commands are performed with regarding to the RAM in this product. Written data can be turned back into the values before the writing (the values stored on the EEPROM) by turning power off and on again. To store the written data on the EEPROM of this product, execute a store request message. (See "3.7. Communications precautions.")

Settings regarding options not added and other unnecessary settings cannot be read or written.

1.4. Positioning communications (priority ranking)

Data and parameters in this product can be changed with keys while in operation in the communications mode.

While this product is in operation in the RO (read-only) mode, no data or parameter setting can be changed by communications. (Provided that communications modes can be changed.)

1.5. Setting before communications

Before performing communications, this product must be set.

This product is compatible with the TOHO communications protocol and the MODBUS communications (RTU, ASCII).

Select a protocol with the protocol setting (Prt) on communications 1/2 setting (SET E/F). For the TOHO communications protocol, see "2. Settings regarding TOHO communications." For the MODBUS communications protocol, see "5. Settings regarding MODBUS communications."

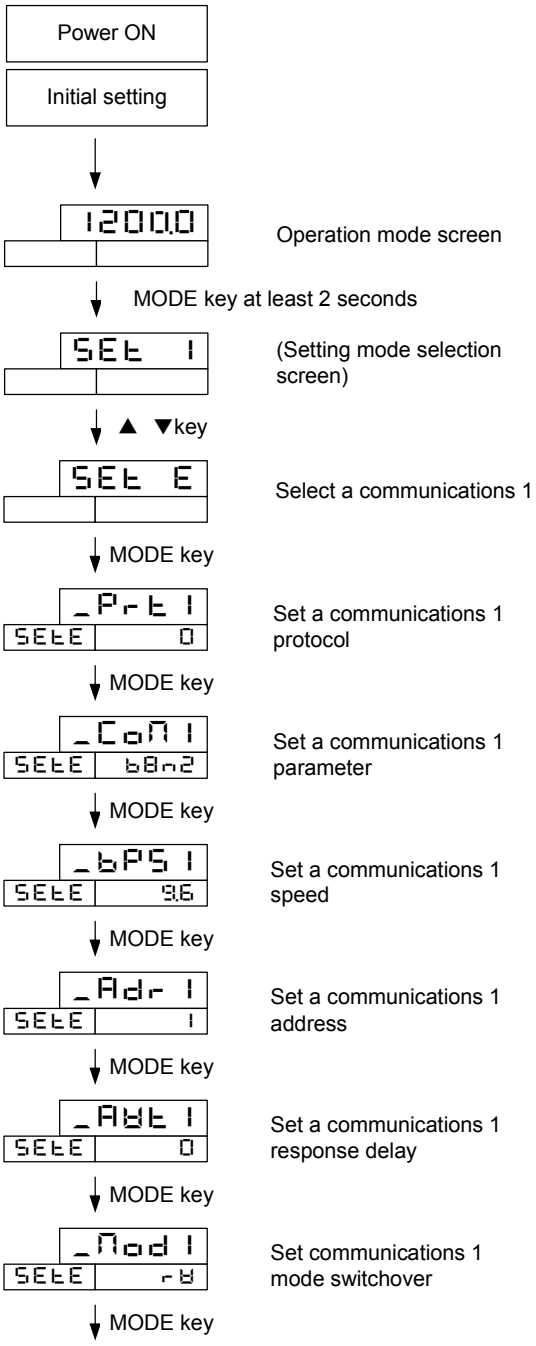
2. Settings regarding TOHO communications

2.1 Overview

Before communications is performed, initial settings must be made on this product. Enter such settings with the keys on the front panel.

To switch to a series of setting screens, take the steps described below.

For details, see the operation manual furnished with this product.



When the settings are over, press the MODE key at least 2 seconds to go back to the operation mode. The parameters indicated above are initial values.

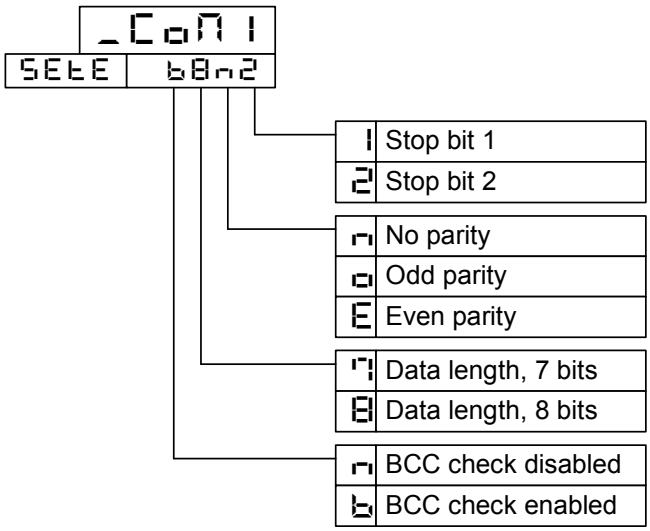
2.2 Setting a data length

2.3 Setting a stop bit length

2.4 Setting a parity

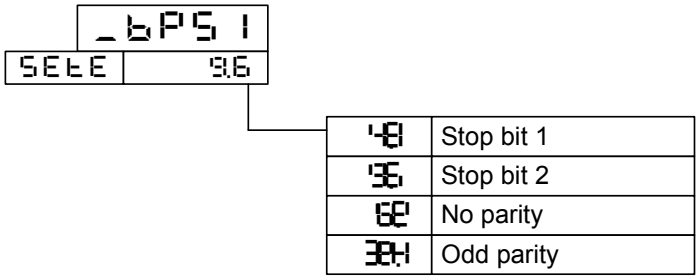
2.5 Setting whether to conduct a BCC check

While in the "Set a communications parameter" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 8n2.



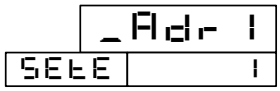
2.6 Setting a communications speed

While in the "Set a communications speed" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 9.6.



2.7 Setting an address

While in the "Set a communications address" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 1.

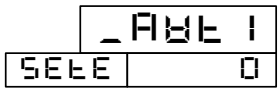


Setting range: 1 to 99 stations (It cannot be set to a 0.)

2.8 Setting a response delay

Set a time from the time when the high-level computer finished sending a "request message" until the time when it delivers the line and enters an input state.

While in the "Set a response delay" on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 0.

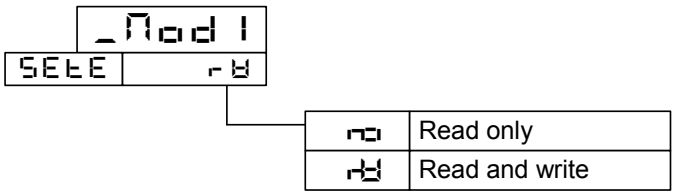


Setting range: 0 to 250ms

* If the response delay is set to a short setting, the communications may not be conducted normally.
* In a real operation, the processing time for this product will be added, in addition to the response delay.

2.9 Switching communications mode

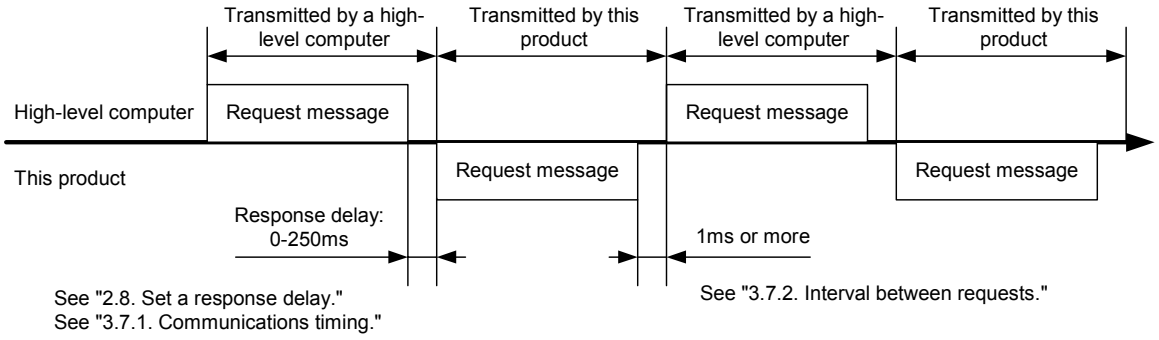
While in the "Set communications mode switchover" screen on the preceding page, operate the ▲ and ▼ keys to make the settings.



3. TOHO communications control

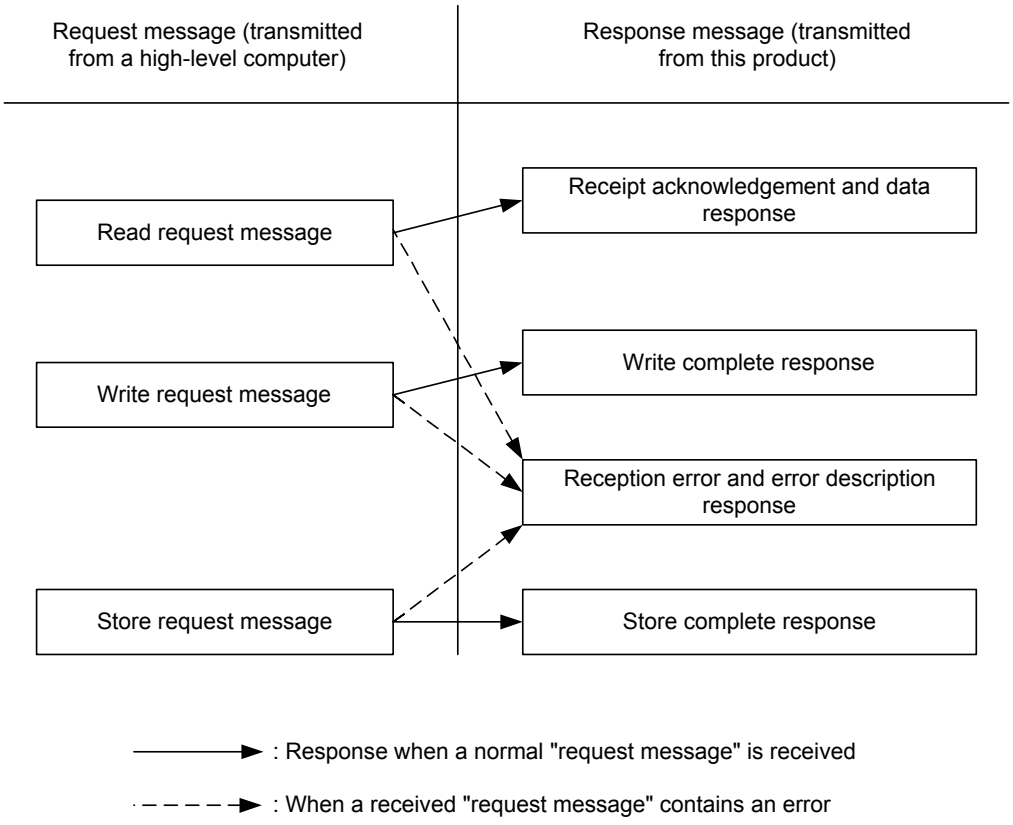
3.1 Communications procedure

This product returns a "response message" in response to a "request message" from a high-level computer. It therefore does not initiate a transmission.



3.2 Message types

- Messages are roughly divided into the following types:

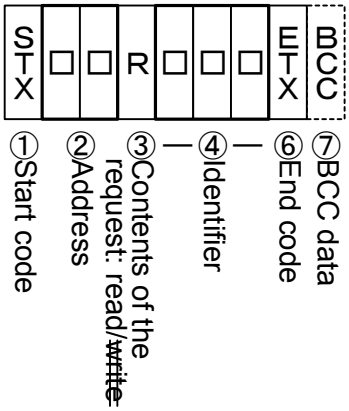


- All codes (except for BCC) from STX data to ETX are expressed in ASCII codes.
- In assembling a program for a high-level computer, see "10. Table of identifiers (codes)" and "11. Table of ASCII codes" at the end of the book.

3.3 Composition of a request message (transmitted from a high-level computer to this product)

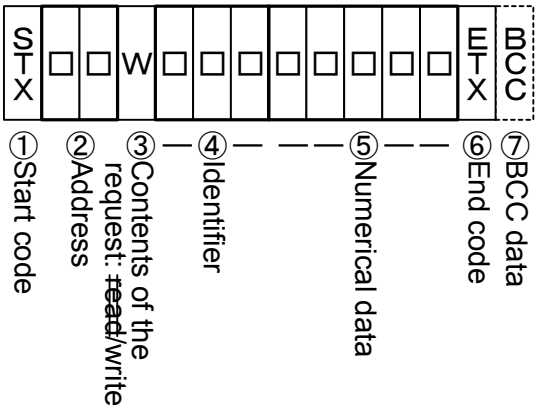
- For codes ① to ⑩, see "3.6. Description of codes."
- For specific examples of request messages, see "4.1. Examples of communications to be read" and "4.2. Examples of communications to be written."

3.3.1 Composition of a read request message

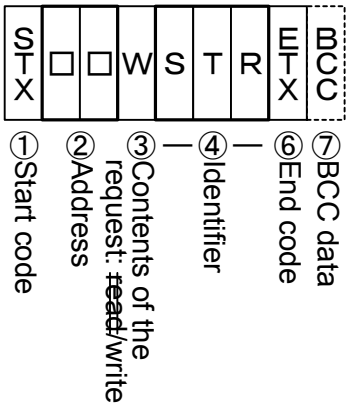


3.3.2 Composition of a write request message

Numerical data may come in 5 or 6 digits. For details, see "3.6. Description of codes."



3.3.3 Composition of a store request message

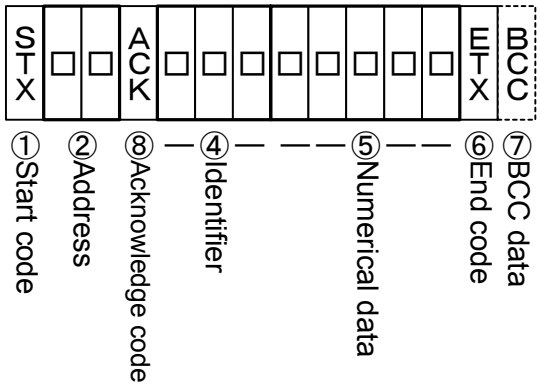


3.4 Composition of a response message (transmitted from this product to a high-level computer)

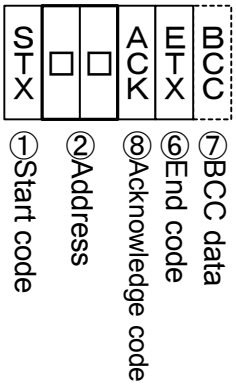
- For codes ① to ⑩, see "3.6. Description of codes."
- For specific examples of request messages, see "4.1. Examples of communications to be read" and "4.2. Examples of communications to be written."

3.4.1 Response message in response to a read request message

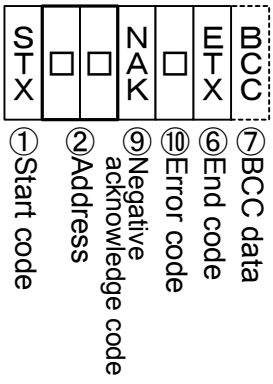
Numerical data may come in 5 or 6 digits. For details, see "3.6. Description of codes."



3.4.2 Response message in response to a write/store request message



3.4.3 Response message in the case of an error

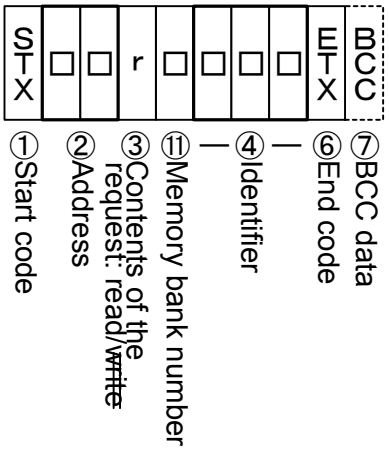


3.5. Composition of a memory bank function message

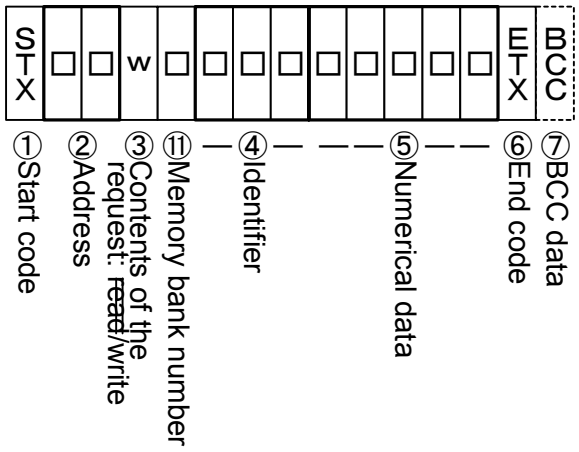
- For codes ① to ⑩, see "3.6. Description of codes."
- For specific examples of request messages, see "4.1. Examples of communications to be read" and "4.2. Examples of communications to be written."

3.5.1. Composition of a read request message

Numerical data may come in 5 or 6 digits. For details, see "3.6. Description of codes."



3.5.2. Composition of a write request message



* It is a w (in lower case).

3.6 Description of codes

- The codes from ① STX, ② address to ⑪ Bank number as indicated below are expressed in ASCII codes.
- For the ASCII codes, see "11. Table of ASCII codes."
- For conversion to ASCII codes, see "4. Examples of TOHO communications."

① STX

This code is needed for the receiver to detect the top of the message. It is affixed to the top of a character string to be sent.

② Address

This is the address of the party (this product) with whom a high-level computer communicates. The address in the response message from this product indicates the sender of the response message. Note that, when CH2 is used, two addresses are occupied. (Setting ADR to 1 causes this product to occupy addresses 1 and 2.)

③ Contents requested

Enter a code R or W.

R: to read data from this product

W: to write or store data in this product

r□: To read bank area data from this product (□ represents a bank number)

w□: To write bank area data in this product (□ represents a bank number)

④ Identifier

An identifier is a classification code (identifier) for data to be read or written and expressed in a three-digit alphanumerical ASCII code. See "10. Table of identifiers (codes)."

⑤ Numerical data

In writing, numerical data can be written in 5 or 6 digits. In reading, numerical data can be switched to 5- or 6-digit by setting this product accordingly. Following are conditions for switchover between 5- and 6-digit.

1) If the range of SLL and SLH goes out of the range -1999 to 9999 in analog input
   Example: SLL=-3000, SLH=1000
2) If the decimal point is set to 0.01 in temperature input
   Example: When a resistance bulb is used and DP is set to 0.01

If the system changes to 6-digit, all identifiers change to 6-digit.

Negative data: The "-" (minus) sign is in a single digit at the largest digit.

Position of the decimal point: Numerical data does not include a decimal point.

Example: The table below indicates the significances of 5-digit numerical data 00010.

Example	Significance of the value
Proportional band (P)	→1.0%
Data (PV), etc, whose decimal point can be shifted	
When the decimal point setting (DP) is 0	10
When the decimal point setting (DP) is 0.1	1.0

If DP = 0.1, the numerical data "12000" means 1200.0. In the case of text data, it is "□□INP." (The □ is a space.)

Example: The table below indicates the significances of 6-digit numerical data 00010.

Example	Significance of the value
Proportional band (P)	→1.0%
Data (PV), etc, whose decimal point can be shifted	
When the decimal point setting (DP) is 0.01	0.1

If DP = 0.01, the numerical data "-19999" means -199.99. In the case of text data, it is "□□□INP." (The □ is a space.)

⑥ ETX

This code is needed for the receiver to detect the end of a message. It is affixed to the end of a character string to be sent (except for BCC).

⑦ BCC

This is a check code for error detection and is the exclusive OR (EX-OR) of all characters from STX to ETX.

If the BCC check is set to "Disabled" in the communications settings in this product, this code (BCC) will not be incorporated in the response message. See "2. Settings regarding TOHO communications."

⑧ ACK

It is an acknowledge code. If a message received by this product is error-free, this code will be incorporated in the "response message" from this product and returned.

⑨ NAK

It is a negative acknowledge code. If a "request message" received by this product is error-ridden, this code will be incorporated in the "response message" from this product and returned.

If the "request message" received is error-ridden, the error contents (⑩ ERR type) will be incorporated in the "response message" from this product, following NAK.

⑩ ERR type

If a "request message" received from this product is error-ridden, the error contents (either of the numbers in the table below) will be incorporated in the "response message" from this product, following "⑨ NAK."

The error number 0 is an instrument error (memory error or A/D conversion error). It will be incorporated in the "response message" regardless of whether there is an error in the "request message."

The error number 9 is an AT error. It will therefore be incorporated in the "response message" regardless of whether there is an error in the "request message." Remove the cause of the error immediately and start the AT again.

If there are two or more errors occurring at the same time, the largest error number will be incorporated.

The table below indicates the error contents and classifications.

Error No.	Error contents in the "request message" received by this product
0	Instrument error (memory error or A/D conversion error)
1	The numerical data deviated from the "range of settings designated specifically with setting items."
2	The change of requested items is disabled or there are no items to be read.
3	An ASCII code other than the numerical data was specified in the field of numerical data. An ASCII code other than numbers and "-" was specified in the field of codes.
4	Format error
5	BCC error
6	Overrun error
7	Framing error
8	Parity error
9	A PV error occurred during AT. Or AT will not end 3 hours later.

⑪ Bank number

The memory bank can store up to 8 sets of parameters that can be written in it. This item specifies which memory bank (between 0 and 7) to be read from or written in. The setting range is between 0 and 7.

3.7 Communications precautions

3.7.1 Communications timing

Set a sufficient response delay to make sure that this product is switched over from transmission to reception with regard to a high-level computer in using an RS-485.

See the figure in "3.1. Communications procedure" and "2.8. Setting a response delay."

3.7.2 Interval between requests

In transmitting a series of "request messages" from a high-level computer, allow for an interval of 1msec or more from the reception of a "response message" from this product to a next transmission.

3.7.3 Response conditions

This product will not return a "response message" unless it receives a "request message" containing an STX and ETX (BCC).

If, therefore, the "request message" is error-ridden, this product will not return a "response message" (error reply) containing a NAK and ERR unless the conditions mentioned above are met.

Therefore transmit the necessary "request message" again if a "request message" is sent to the high-level computer but the latter does not return a "response message" at the end of an appropriate period.

The moment this product receives an STX, it clears all codes received before that.

3.7.4 Errors in address specification

This product will not respond to any "request message" that specifies an address other than that specified for itself. If, therefore, the address portion of a "request message" is error-ridden, none of the mobile units will return a "response message."

Therefore transmit the necessary "request message" again if a "request message" is sent to the high-level computer but the latter does not return a "response message" at the end of an appropriate period.

The moment this product receives an STX, it clears all codes received before that.

3.7.5 Number of digits in data and the decimal position

See "3.6. Description of codes, ⑤ Numerical data."

3.7.6 Operation after receiving a store request message

This product starts to store data after correctly receiving a store request message from a high-level computer.

This product only stores data different from the contents of the EEPROM (data that is changed). The time (TW) required for storing data is within 6 seconds.

This product transmits a storage-complete reply (ACK) when the data is stored.

This product will not guarantee that the data is stored if this product is turned off during a storage operation. Do not turn off this product for 6 seconds after transmitting a store request message.

3.7.7 Operation after turning on the power

This product will not perform communications (no response) for about 4 seconds after it is turned on. Allow for a delay until communications is started after this product is turned on.

3.7.8 Storing data other than a store request message

Store all parameters in the EEPROM in either of the two cases described below, even if no store request message is received.

1) If a parameter is changed by key operation
2) If auto-tuning is started and ends normally.

3.7.9 Changing the settings (SV or SV2) by communications during auto-tuning

Even if the settings (SV or SV2) used in control for auto-tuning are changed by communications, the settings (SV or SV2) will not be changed until the auto-tuning ends.

4. Examples of TOHO communications

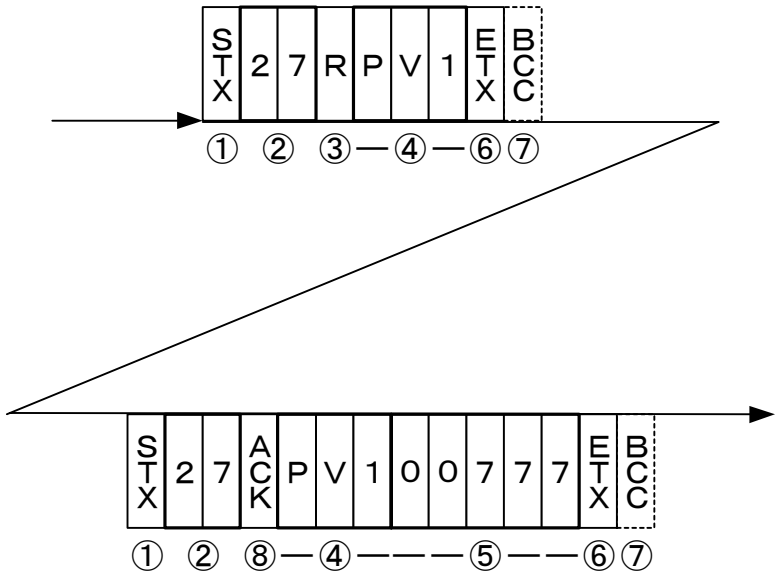
4.1 Examples of communications to be read

Example: Request message: This requests this product set at address 27 to read the PV. (High-level computer)

In response to that,

Response message: This returns PV data (00777).

Read request message (transmitted from the high-level computer)



Code	Code, data	ASCII code, note 2)
① Start code	STX	02H
② Address	27	32H 37H
③ Request contents	R (Read)	52H
④ Identifier, note 1)	PV1	50H 56H 31H
⑤ Numerical data	00777	30H 30H 37H 37H 37H
⑥ End code	ETX	03H
⑦ BCC data request		61H
response		02H
⑧ Acknowledge code	ACK	06H

Note 1): See "10. Table of identifiers (codes)."
Note 2): For the ASCII codes, see "11. Table of ASCII codes."

4.2 Examples of communications to be written

Example: Request message: (High-level computer) This requests this product set at address 03 to set "the E1F setting to 011" (write 011).

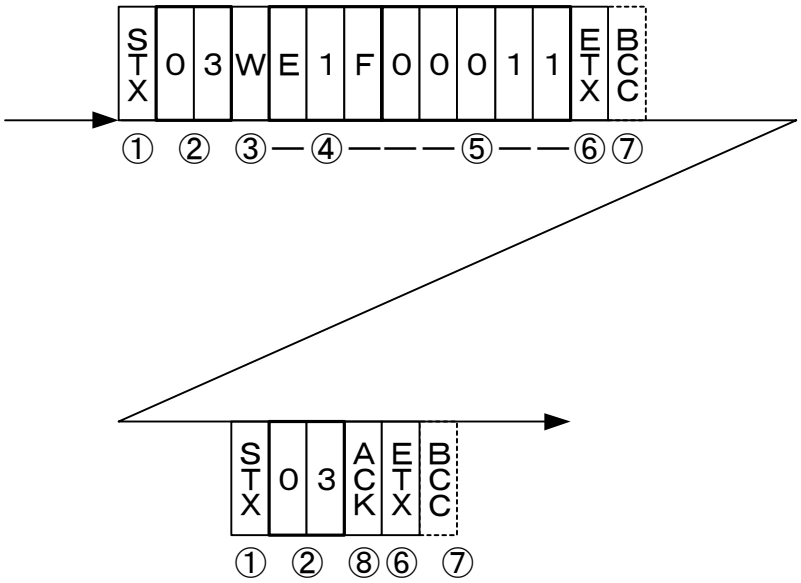
(This sets the function in event 1 to the deviation upper and lower limits + hold.)

In response to that,

Response message: (This product) This returns a notice that the request message has been received.

*Check that it has been written by reading the data separately.

Write request message (transmitted from a high-level computer)



Code	Code, data	ASCII code, note 2)
① Start code	STX	02H
② Address	03	30H 33H
③ Request contents	W (Write)	57H
④ Identifier, note 1)	E1F	41H 34H 46H
⑤ Numerical data	00011	30H 30H 30H 31H 31H
⑥ End code	ETX	03H
⑦ BCC data request		57H
response		04H
⑧ Acknowledge code	ACK	06H

Note 1): See "10. Table of identifiers (codes)."
Note 2): For the ASCII codes, see "11. Table of ASCII codes."

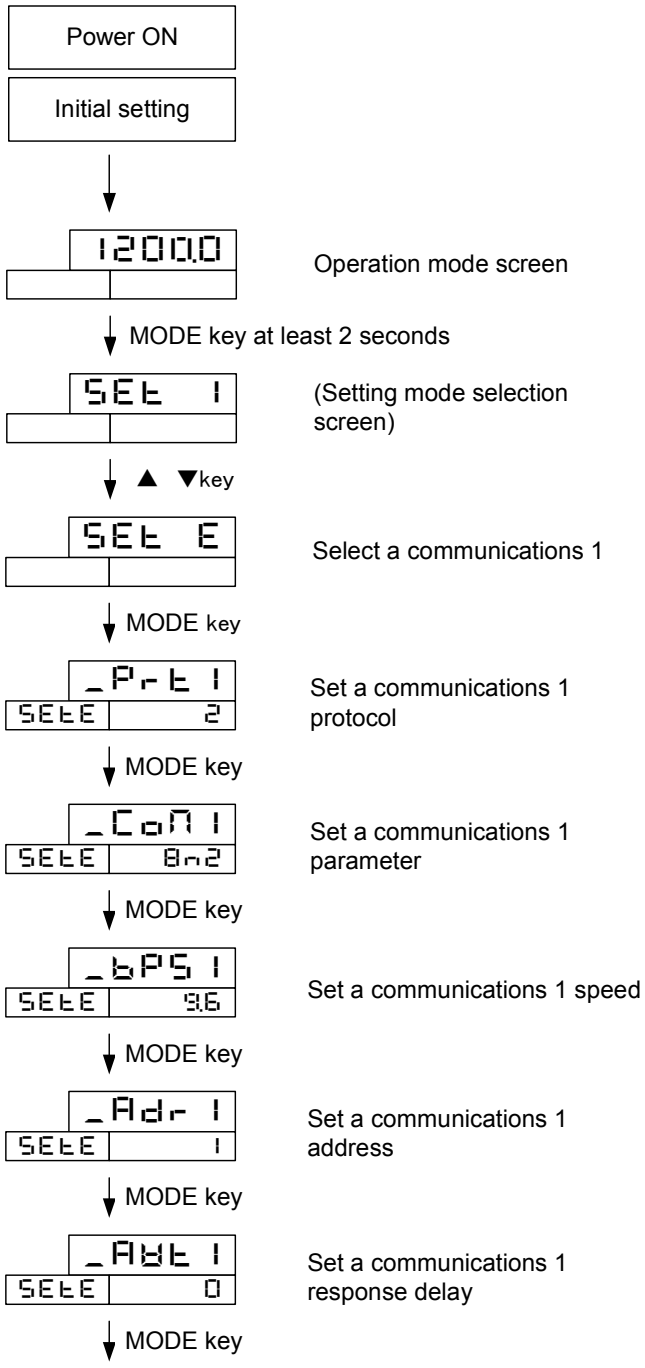
5. Settings regarding MODBUS communications

5.1 Overview

Before communications is performed, initial settings must be made on this product. Enter such settings with the keys on the front panel.

To switch to a series of setting screens, take the steps described below.

For details, see the operation manual furnished with this product.



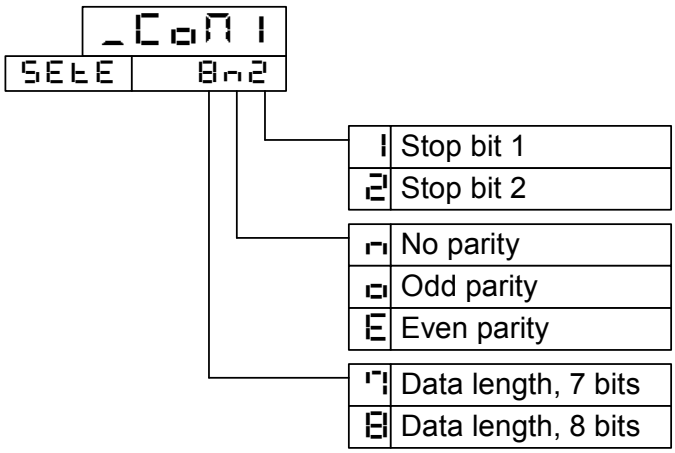
When the settings are over, press the MODE key at least 2 seconds to go back to the operation mode. The parameters indicated above are initial values.

5.2 Setting a data length

5.3 Setting a stop bit length

5.4 Setting a parity

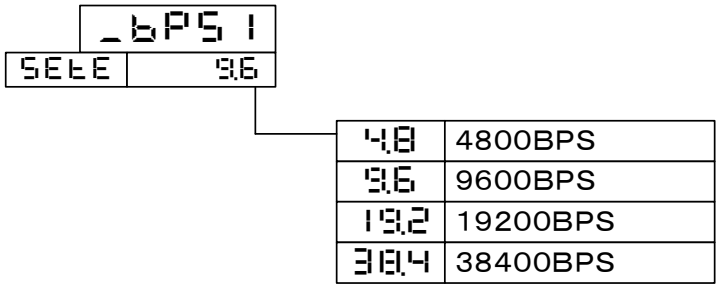
While in the "Set a communications parameter" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 8n2.



* The ASCII mode settings come only in three types: 7n2 · 7o 1 · 7E 1.
The RTU mode settings come only in three types: 8n2 · 8o 1 · 8E 1.

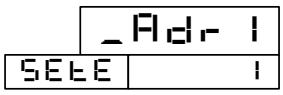
5.5 Setting a communications speed

While in the "Set a communications speed" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 9.6.



5.6 Setting an address

While in the "Set a communications address" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 1.

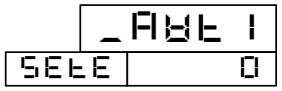


Setting range: 1 to 247 stations (It cannot be set to a 0.)

5.7 Setting a response delay

Set a time from the time when the high-level computer finished sending a "request message" until the time when it delivers the line and enters an input state.

While in the "Set a response delay" on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is 0.



Setting range: 0 to 250ms

* If the response delay is set to a short setting, the communications may not be conducted normally.
* In a real operation, the processing time for this product will be added, in addition to the response delay.

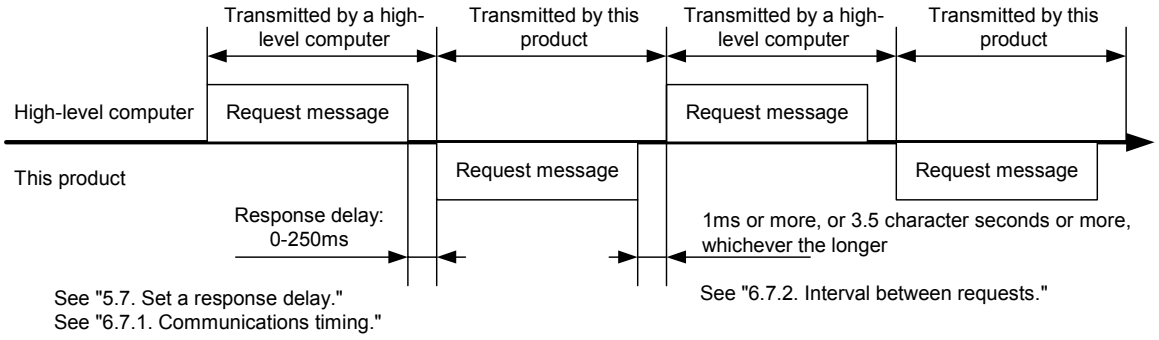
5.8 Switching communications mode

MODBUS does not accommodate _Mod switchover.

6. MODBUS communications control

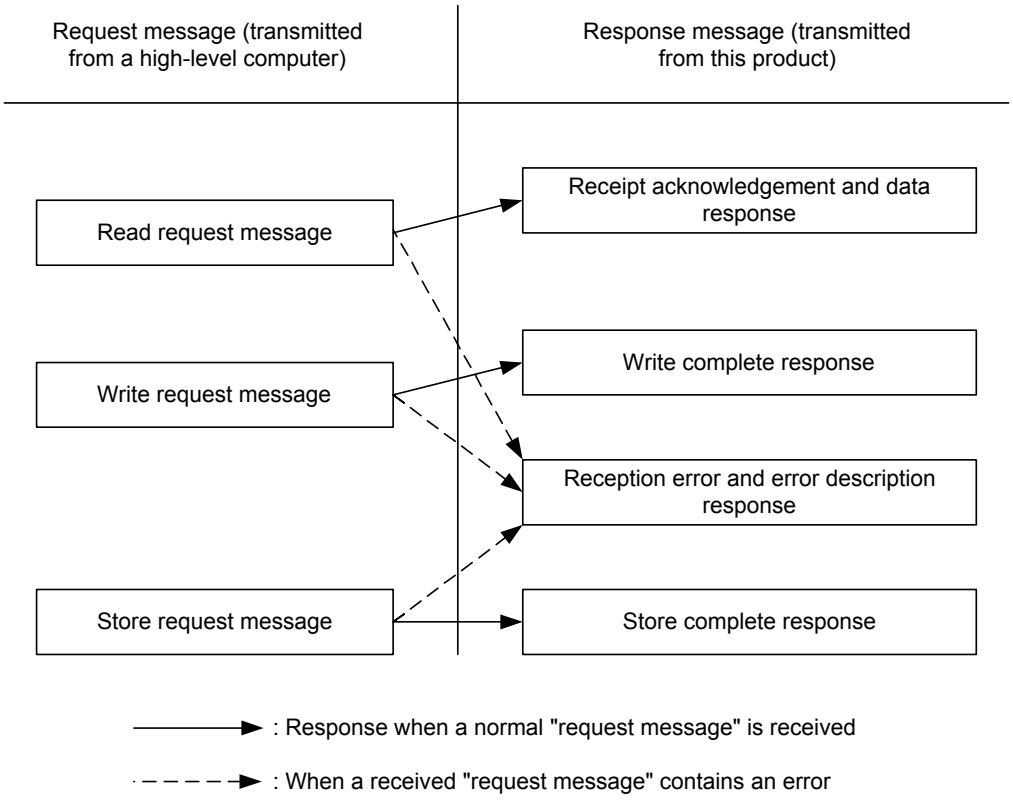
6.1 Communications procedure

This product returns a "response message" in response to a "request message" from a high-level computer. It therefore does not initiate a transmission.



6.2 Message types

- Messages are roughly divided into the following types:



- In RTU codes, the data is binary.
- In ASCII codes, all codes are expressed in ASCII codes.
- In assembling a program for a high-level computer, see "10. Table of identifiers (codes)" and "11. Table of ASCII codes" at the end of the book.

6.3 Composition of an RTU request message (transmitted from a high-level computer to this product)

■ For codes a) through i), see "6.6. Description of RTU codes."

6.3.1 Composition of a read request message

a)	Slave address		1BH	
b)	Function code		03H	
c)	Register address	High level	00H	First register address
		Low level	00H	
d)	Number of registers	High level	00H	Fixed at 2
		Low level	02H	
e)	CRC-16	High level	C6H	
		Low level	31H	

6.3.2 Composition of a write request message

a)	Slave address		03H	
b)	Function code		10H	
c)	Register address	High level	00H	First register address
		Low level	C0H	
d)	Number of registers	High level	00H	Fixed at 2
		Low level	02H	
f)	Number of data items		04H	Number of registers × 2
g)	Data for the first register (a low-level word)	High level	00H	③ When writing ①, ②, ③, and ④ H in the data, write them in the order described on the left-hand side. (① represents 1 byte.)
		Low level	6FH	④
	Data for the first register + 1 (a high-level word)	High level	00H	①
		Low level	00H	②
e)	CRC-16	High level	C4H	
		Low level	5AH	

6.3.3 Composition of a store request message

a)	Slave address		03H	
b)	Function code		10H	
c)	Register address	High level	02H	First register address
		Low level	0EH	
d)	Number of registers	High level	00H	Fixed at 2
		Low level	02H	
f)	Number of data items		04H	Number of registers × 2
g)	Data for the first register (a low-level word)	High level	00H	The data about the storage of settings is arbitrary.
		Low level	00H	
	Data for the first register + 1 (a high-level word)	High level	00H	
		Low level	00H	
e)	CRC-16	High level	60H	
		Low level	FBH	

6.4 Composition of an RTU response message (transmitted from this product to a high-level computer)

■ For codes a) through h), see "6.6. Description of RTU codes."

6.4.1 Response message for a read request message

a)	Slave address		1BH	
b)	Function code		03H	
d)	Number of data items		04H	Number of registers × 2
g)	Data for the first register (a low-level word)	High level	03H	③ When writing ①, ②, ③, and ④ H in the data, write them in the order described on the left-hand side. (① represents 1 byte.)
		Low level	09H	④
	Data for the first register + 1 (a high-level word)	High level	00H	①
		Low level	00H	②
e)	CRC-16	High level	91H	
		Low level	B4H	

6.4.2 Response message for a write/store request message

a)	Slave address		03H	
b)	Function code		10H	
c)	Register address	High level	00H	First register address
		Low level	00H	
d)	Number of registers	High level	00H	Fixed at 2
		Low level	02H	
e)	CRC-16	High level	40H	
		Low level	2AH	

6.4.3 Response message in the case of an error

a)	Slave address		1BH	
b)	Function code		83H	← In the case of an error, the function code for the request message + 80H is entered.
h)	Error code		02H	
e)	CRC-16	High level	E1H	
		Low level	36H	

6.5. Composition of a memory bank function message

■ For codes a) to h), see "6.6. Description of RTU codes."

To write in memory bank 0, add 1000H to the address.

Every time the bank number increases by 1, add 1000H.

The parameter applicable to the bank is SET2 and comes between addresses 110 and 189.

Others are the same as in the usual message composition.

6.6 Description of RTU codes

■ The codes from a) slave address to b) function code to h) error code shown below are expressed in 8-bit binary numbers.

a) Slave address

This is the address of the party (this product) with which the high-level computer communicates. The address in the response message from this product represents the source of the response message. Note that, when CH2 is used, 2 addresses are occupied. (When the ADR is set to 1, addresses 1 and 2 are occupied.)

b) Function code

Enter a code 03H or 10H.

03H: To read data from this product

10H: To write or store data in this product

* Differently from the TOHO communications protocol, writing in the bank is specified by register address.

c) Register address

The locations of the data to be read or that to be written are specified in 2 bytes.

For the addresses of the commands, see "10. Table of identifiers (codes)."

The data is written in the holding register.

The memory bank can store up to 8 sets of parameters that can be written in it.

The setting range is between 0 and 7. To specify memory bank 0, add 1000H to the usual address.

d) Number of registers

This specifies the number of registers to be written in. Since this product has a fixed number of registers (which is 2), specify 0002H.

e) CRC-16

This error check code is for detecting message errors. This transmits a CRC-16 (tour redundancy code).

The multinomial for generating a CRC-16 used in this product is $X^{16}+X^{15}+X^{2}+1$.

To learn how to calculate the CRC-16, see "6.8. Example of CRC-16 calculations."

To affix an error code at the end of the message, affix the low-level byte first, then the high-level byte of the CRC.

f) Number of data

This specifies the number of registers to be read and written x 2. Since the number of registers in this product is fixed at 2, specify 04H here.

g) Data portion

This specifies data to be written in the register. The data is fixed at 4 bytes. This product will write data without the decimal point.

Example: In the case of numerical data

Example	Significance of the value
Proportional band (P) = 1.0 %	0000000AH
PV = 1200.0°C	00002EE0H
SV = -10.00°C	FFFFFC18H

In the case of text data, write the ASCII code "□INP" (□ is a space): 20494E50H.

h) Error code

If a message from a high-level computer is error-ridden, it will be incorporated in the "response message" from this product and returned.

The error number "04" is an instrument error (memory error or A/D conversion error, AT error). It will be incorporated in the "response message" regardless of whether there is an error in the "request message."

If there are two or more errors occurring at the same time, the largest error number will be incorporated.

The table below indicates the error contents and classifications.

Error No.	Error contents in the "request message" received by this product
01	Received an unsupported function code.
02	Received an address other than the specified one.
03	The numerical data deviated from the "range of settings designated specifically with setting items."
04	Instrument error (memory error or A/D conversion error, AT error)

6.7 Precautions on RTU communications

6.7.1 Communications timing

Set a sufficient response delay to make sure that this product is switched over from transmission to reception with regard to a high-level computer in using an RS-485.

See the figure in "5.1. Overview" and "5.7. Setting a response delay."

6.7.2 Interval between requests

In transmitting a series of "request messages" from a high-level computer, allow for an interval of 1msec or more or 3.5 character minutes, whichever the longer, from the reception of a "response message" from this product to a next transmission.

6.7.3 Response conditions

If there is a time interval of 3.5 characters or more between data items constituting a "request message," this product cannot recognize it as a "request message." It will therefore not return a "response message." If, therefore, the "request message" contains an error, this product will not return a "response message" (error reply) containing an ERR unless the above conditions are met.

Therefore transmit the necessary "request message" again if a "request message" is sent to the high-level computer but the latter does not return a "response message" at the end of an appropriate period.

The moment a period of 3.5 characters or more has elapsed, it clears all codes received before that.

6.7.4 Errors in address specification

This product will not respond to any "request message" that specifies an address other than that specified for itself. If, therefore, the address portion of a "request message" is error-ridden, none of the mobile units will return a "response message."

Therefore transmit the necessary "request message" again if a "request message" is sent to the high-level computer but the latter does not return a "response message" at the end of an appropriate period.

6.7.5 Number of digits in data and the decimal position

See "6.6. Description of RTU codes, g) Data portion."

6.7.6 Operation after receiving a store request message

This product starts to store data after correctly receiving a store request message from a high-level computer.

This product only stores data different from the contents of the EEPROM (data that is changed). The time (TW) required for storing data is within 6 seconds.

This product transmits a storage-complete reply after the data is stored.

This product will not guarantee that the data is stored if this product is turned off during a storage operation. Do not turn off this product for 6 seconds after transmitting a store request message.

6.7.7 Operation after turning on the power

This product will not perform communications (no response) for about 4 seconds after it is turned on. Allow for a delay until communications is started after this product is turned on.

6.7.8 Storing data other than a store request message

This product will store all parameters in the EEPROM in either of the two cases described below, even if no store request message is received.

1) If a parameter is changed by key operation
2) If auto-tuning is started and ends normally.

6.7.9 Changing the settings (SV or SV2) by communications during auto-tuning

Even if the settings (SV or SV2) used in control for auto-tuning are changed by communications, the changes (SV or SV2) will not be changed until the auto-tuning ends.

6.8 Example of CRC-16 calculations

Following is an example of calculating CRC-16 with VisualBasic6.0.

Variables are declared as shown below.

VisualBasic6.0 cannot use code-free variables. It therefore uses code-equipped 16-bit integer variables as data. Similarly, the CRC calculation results are entered into code-equipped 32-bit integer variables.

```
Dim CRC As Long
Dim i, j, arry_count As Integer

Dim c_next, c_carry As LongDim crc_arry(64) As Integer
```

Then enter calculable data into the crc_arry(), and enter the number of data items into the arry_count. After that, run the following program to cause the calculation results to enter the CRC.

```
i = 0
CRC = 65535
For i = 0 To arry_count
    c_next = crc_arry(i)
    CRC = (CRC Xor c_next) And 65535
    For j = 0 To 7
        c_carry = CRC And 1
        CRC = CRC ¥ 2
        If c_carry Then
            CRC = (CRC Xor &HA001) And 65535
        End If
    Next
Next
```

To affix an error code to the end of the message, affix first the low-level byte and then the high-level byte of the CRC.

6.9 Composition of an ASCII request message (transmitted from a high-level computer to this product)

■ For the codes a) through g), see "6.12. Description of ASCII codes."

6.9.1 Composition of a read request message

a)	Start code		":"	
b)	Slave address		"1" , "B"	
c)	Function code		"0" , "3"	
d)	Register address	High level	"0" , "0"	First register address
		Low level	"0" , "0"	
e)	Number of registers	High level	"0" , "0"	Fixed at 2
		Low level	"0" , "2"	
f)	LRC		"E" , "0"	
g)	End code		CR, LF	

6.9.2 Composition of a write request message

a)	Start code		":"	
b)	Slave address		"0" , "3"	
c)	Function code		"1" , "0"	
d)	Register address	High level	"0" , "0"	First register address
		Low level	"C" , "0"	
e)	Number of registers	High level	"0" , "0"	Fixed at 2
		Low level	"0" , "2"	
h)	Number of data items		"0" , "4"	Number of registers × 2
i)	Data for the first register (a low-level word)	High level	"0" , "0"	③ When writing ①, ②, ③, and ④ H in the data, write them in the order described on the left-hand side. (① represents 1 byte.)
		Low level	"6" , "F"	④
	Data for the first register + 1 (a high-level word)	High level	"0" , "0"	①
		Low level	"0" , "0"	②
f)	LRC		"E" , "0"	
g)	End code		CR, LF	

6.9.3 Composition of a store request message

a)	Start code		":"	
b)	Slave address		"0" , "3"	
c)	Function code		"1" , "0"	
d)	Register address	High level	"0" , "2"	First register address
		Low level	"0" , "E"	
e)	Number of registers	High level	"0" , "0"	Fixed at 2
		Low level	"0" , "2"	
h)	Number of data items		"0" , "4"	Number of registers × 2
i)	Data for the first register (a low-level word)	High level	"0" , "0"	The data about the storage of settings is arbitrary.
		Low level	"0" , "0"	
	Data for the first register + 1 (a high-level word)	High level	"0" , "0"	
		Low level	"0" , "0"	
f)	LRC		"D" , "7"	
g)	End code		CR, LF	

6.10 Composition of ASCII response messages (transmitted from this product to a high-level computer)

■ For the codes a) through g), see "6.12. Description of ASCII codes."

6.10.1 Response message for a read request message

a)	Start code		":"	
b)	Slave address		"1" , "B"	
c)	Function code		"0" , "3"	
h)	Number of data items		"0" , "4"	Number of registers × 2
i)	Data for the first register (a low-level word)	High level	"0" , "3"	③ When writing ①, ②, ③, and ④ H in the data, write them in the order described on the left-hand side. (① represents 1 byte.)
		Low level	"0" , "9"	④
	Data for the first register + 1 (a high-level word)	High level	"0" , "0"	①
		Low level	"0" , "0"	②
f)	LRC		"D" , "2"	
g)	End code		CR, LF	

6.10.2 Response message for a write/store request message

a)	Start code		":"	
b)	Slave address		"0" , "3"	
c)	Function code		"1" , "0"	
d)	Register address	High level	"0" , "0"	First register address
		Low level	"0" , "0"	
e)	Number of registers	High level	"0" , "0"	Fixed at 2
		Low level	"0" , "2"	
f)	LRC		"E" , "B"	
g)	End code		CR, LF	

6.10.3 Response message in the case of an error

a)	Start code	":"	
b)	Slave address	"1" , "B"	
h)	Function code	"8" , "3"	← In the case of an error, the function code for the request message + 80H is entered.
j)	Error code	"0" , "2"	
f)	LRC	"6" , "0"	
g)	End code	CR, LF	

6.11. Composition of a memory bank function message

- For codes a) to j), see "6.12. Description of ASCII codes."
  To write in memory bank 0, add 1000H to the address.
  Every time the bank number increases by 1, add 1000H.
  The parameter applicable to the bank is SET2 and comes between addresses 110 and 189.
  Others are the same as in the usual message composition.

6.12 Description of ASCII codes

- The codes from a) start code to b) slave address to j) error type described below are expressed in ASCII codes.
- For ASCII codes, see "11. Table of ASCII codes."
- For converting to ASCII codes, see 6.9 and 6.10 "Message composition."

a) Start code
The receiver side is the code required for detecting the top of the message. It is affixed to the top of a character string to be transmitted.

b) Slave address
This is the address of the party (this product) with which the high-level computer communicates. The address in the response message from this product represents the source of the response message. Note that, when CH2 is used, 2 addresses are occupied.

(When the ADR is set to 1, addresses 1 and 2 are occupied.)

c) Function code

Enter a code 03H or 10H.

03H: To read data from this product

10H: To write or store data in this product

* Differently from the TOHO communications protocol, writing in the bank is specified by register address.

d) Number of registers

This specifies the number of registers to be written in. Since this product has a fixed number of registers (which is 2), specify 0002H.

e) Register address

The locations of the data to be read or that to be written are specified in 2 bytes.

For the addresses of the commands, see "10. Table of identifiers (codes)."

The memory bank can store up to 8 sets of parameters that can be written in it.

The setting range is between 0 and 7. To specify memory bank 0, add 1000H to the usual address.

f) LRC

LRC is an error check code for detecting message errors. An LRC is transmitted. The LRC used in this product is the 2-complement of the sum of the data portions without a carry, except for the start code and end code of the message.

The parts of the data portions expressed as a "1" and "B" are considered as "1BH."

To learn how to calculate the LRC, see "6.14. Example of LRC calculations."

If 12H is calculated as an error code, affix a "1" or "2" at the end of the message.

g) End code

This code is required for the receiver to detect the end of a message. Affix CR (0DH) and LF (0AH) at the end of a character string to be transmitted.

h) Number of data

This specifies the number of registers to be read and written x 2. Since the number of registers in this product is fixed at 2, specify 04H here.

i) Data portion

This specifies data to be written in the register. The data is fixed at 4 bytes. This product will write data without the decimal point.

Example: In the case of numerical data

Example	Significance of the value
Proportional band (P) = 1.0 %	0000000AH
PV = 1200.0°C	00002EE0H
SV = -10.00°C	FFFFFC18H

In the case of text data, write the ASCII code "□INP" (□ is a space): 20494E50H.

j) Error code

If a message from a high-level computer is error-ridden, it will be incorporated in the "response message" from this product and returned.

The error number "0" is an instrument error (memory error or A/D conversion error). It will be incorporated in the "response message" regardless of whether there is an error in the "request message."

Error number "9" is an AT error. It is therefore incorporated into the "response message" regardless of whether the "request message" is error-ridden. Remove the cause of the error immediately and start the AT again.

If there are two or more errors occurring at the same time, the largest error number will be incorporated.

The table below indicates the error contents and classifications.

Error No.	Error contents in the "request message" received by this product
0	Instrument failure (memory error or A/D conversion error)
1	The numerical data was out of a "specific setting range specified with a setting item."
2	The required modification in an item is prohibited, or such an item to be read does not exist.
3	Reservation number
4	Format error
5	LRC error
6	Overrun error
7	Framing error
8	Parity error
9	A PV error occurred during AT. Or AT does not end 3 hours later.

6.13 Precautions on ASCII communications

6.13.1 Communications timing

Set a sufficient response delay to make sure that this product is switched over from transmission to reception with regard to a high-level computer in using an RS-485.

See the figure in "5.1. Overview" and "5.7. Setting a response delay."

6.13.2 Interval between requests

In transmitting a series of "request messages" from a high-level computer, allow for an interval of 1msec or more or 3.5 character minutes, whichever the longer, from the reception of a "response message" from this product to a next transmission.

6.13.3 Response conditions

This product will not return a "response message" unless the "request message" contains a start code and end code.

If, therefore, the "request message" contains an error, this product will not return a "response message" (error reply) containing an error code unless the above conditions are met.

Therefore transmit the necessary "request message" again if a "request message" is sent to the high-level computer but the latter does not return a "response message" at the end of an appropriate period.

The moment a start code is received, this product clears all codes received before that.

6.13.4 Errors in address specification

This product will not respond to any "request message" that specifies an address other than that specified for itself. If, therefore, the address portion of a "request message" is error-ridden, none of the mobile units will return a "response message."

Therefore transmit the necessary "request message" again if a "request message" is sent to the high-level computer but the latter does not return a "response message" at the end of an appropriate period.

The moment a start is received, this product clears all codes received before that.

6.13.5 Number of digits in data and the decimal position

See "6.12. Description of ASCII codes, i) Data portion."

6.13.6 Operation after receiving a store request message

This product starts to store data after correctly receiving a store request message from a high-level computer.

This product only stores data different from the contents of the EEPROM (data that is changed). The time (TW) required for storing data is within 6 seconds.

This product transmits a storage-complete reply after the data is stored.

This product will not guarantee that the data is stored if this product is turned off during a storage operation. Do not turn off this product for 6 seconds after transmitting a store request message.

6.13.7 Operation after turning on the power

This product will not perform communications (no response) for about 4 seconds after it is turned on. Allow for a delay until communications is started after this product is turned on.

6.13.8 Storing data other than a store request message

This product will store all parameters in the EEPROM in either of the two cases described below, even if no store request message is received.

1) If a parameter is changed by key operation
2) If auto-tuning is started and ends normally.

6.13.9 Changing the settings (SV or SV2) by communications during auto-tuning

Even if the settings (SV or SV2) used in control for auto-tuning are changed by communications, the changes (SV or SV2) will not be changed until the auto-tuning ends.

6.14 Example of LRC calculations

Following is an example of calculating LRC with VisualBasic6.0.

Variables are declared as shown below.

VisualBasic6.0 cannot use code-free variables. It therefore uses code-equipped 16-bit integer variables as data. Similarly, the LRC calculation results are entered into code-equipped 16-bit integer variables.

```
Dim LRC As Integer
Dim i, arry_count As Integer
```

```
Dim lrc_arry(128) As Integer
```

Then enter calculable data into the 1rc_arry(), and enter the number of data items into the arry_count. After that, run the following program to cause the calculation results to enter the LRC.

```
For i = 0 To arry_count
    LRC = (LRC + lrc_arry(i)) And &HFF
Next

LRC = ((Not LRC) + 1) And &HFF
```

If the error code is calculated as 12H as an example, affix a "1" or "2" at the end of the message.

7. Specifications

7.1. Communications standard category

Compliant with EIA standard RS-485 and
Compliant with EIA standard RS-232C

7.2. Communications specifications

7.2.1. Communications system

Network: ..... For RS-485, multi-drop system (up to 1 pair, 31 stations)
For RS-232C, Point-to-point system (up to 1 pair, 1 station)
Direction of information: ..... Half duplex
Synchronization system: ..... Asynchronous
Transmission code: ..... ASCII, 7/8 bit code, except for BBC data
(highest-level bit = 0 in 8-bit code)

7.2.2. Interface system

Signal line: ..... For RS-485, 2 lines for transmission and reception
For RS-232C, 2 lines for transmission and reception, 1 for SG
Communications speed: ..... One speed is selected from 4,800, 9,600, 19,200 and 38,400 bps and this product is set to it.
Communications distance: ..... For RS-485, 500m maximum
For RS-232C, 15m maximum
Provided that it varies somewhat depending on the cable and other ambient conditions.

7.2.3 TOHO communications characters

Start bit length: ..... Fixed at 1 bit
Stop bit length: ..... Either 1 or 2 bit is selected and this product is set to it.
Data length: ..... Either 7 or 8 bit is selected and this product is set to it.
Parity: ..... No. Either odd or even is selected and this product is set to it.
BCC check: ..... Yes or no is selected and this product is set to it.
Communications address: 1-99

7.2.4 MODBUS communications (RTU) characters

Start bit length: ..... Fixed at 1 bit
Stop bit length: ..... Either 1 or 2 bit is selected and this product is set to it. (If parity-equipped, fixed at 1 bit.)
Data length: ..... Fixed at 8 bit.
Parity: ..... No. Either odd or even is selected and this product is set to it.
CRC-16 check: ..... Fixed at yes.
Communications address: 1-247

7.2.5 MODBUS communications (ASCII) characters

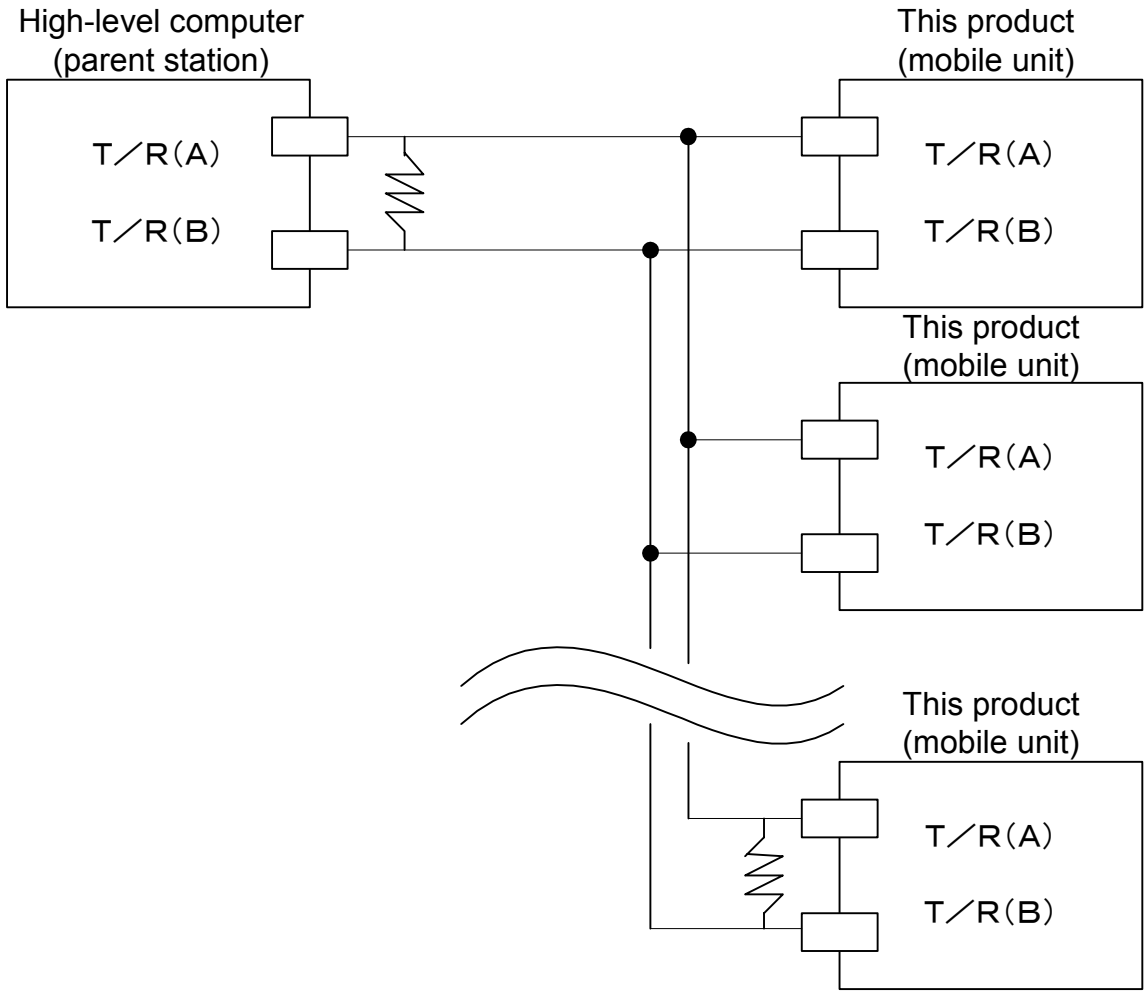
Start bit length:.....Fixed at 1 bit
Stop bit length:.....Either 1 or 2 bit is selected and this product is set to it. (If parity-equipped, fixed at 1 bit.)
Data length:.....Fixed at 7 bit.
Parity:.....No. Either odd or even is selected and this product is set to it.
LRC check: .....Fixed at yes.
Communications address: 1-247

7.2.6 MODBUS communications (ASCII/RTU) function codes

03H (reading the contents of the holding register)
10H (writing the contents of two or more holding registers)

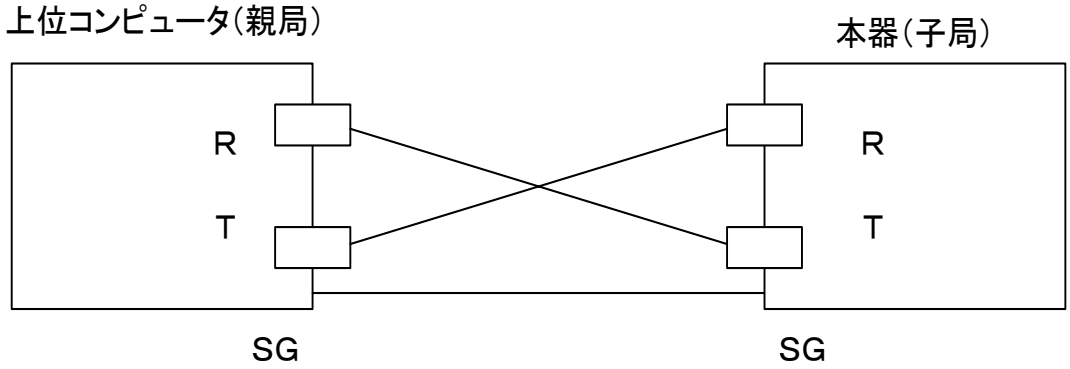
8. Connections

8.1 Connections for the RS-485



Install an end of line resistor at both of the farthest devices in the parent station and the mobile unit. For a resistance value, use one that matches the characteristic impedance of the cable. Provided that the synthesis is set to at least 75Ω.

8.2. Connections for the RS-232C



In actual practice, it is necessary to connect the CS (enable communications) in the connector to the ER (data terminal ready), and the RS (request communications) to the DR (data set ready) to the CD (detect the reception carrier).

10. Table of identifiers (codes)

MODBUS ADR Operation mode

Low-level W	High-level W	Identifier	Character	Name	R/W	Description
0	1	PV1		Measurement	R	Use it as a monitor for measurements (PV). When overscale: HHHHH (HHHHHH) When underscale: LLLLL (LLLLLL)
2	3	SV1		Control setting	R/W	R/W of the setting (SV)
4	5	PR1	Pr 01	Priority screen setting 1	R/W	R/W the priority screen function setting Example: □□INP (identifier) For MODBUS A character string enters in the lower level, then in the higher level. Example: □INP (identifier)
6	7	PR2	Pr 02	Priority screen setting 2	R/W	〃
8	9	PR3	Pr 03	Priority screen setting 3	R/W	〃
10	11	PR4	Pr 04	Priority screen setting 4	R/W	〃
12	13	PR5	Pr 05	Priority screen setting 5	R/W	〃
14	15	PR6	Pr 06	Priority screen setting 6	R/W	〃
16	17	PR7	Pr 07	Priority screen setting 7	R/W	〃
18	19	PR8	Pr 08	Priority screen setting 8	R/W	〃
20	21	PR9	Pr 09	Priority screen setting 9	R/W	〃
22	23	P11	Pr 11	Priority screen setting 11	R/W	〃
24	25	P12	Pr 12	Priority screen setting 12	R/W	〃
26	27	P13	Pr 13	Priority screen setting 13	R/W	〃
28	29	P14	Pr 14	Priority screen setting 14	R/W	〃
30	31	P15	Pr 15	Priority screen setting 15	R/W	〃
32	33	P16	Pr 16	Priority screen setting 16	R/W	〃
34	35	P17	Pr 17	Priority screen setting 17	R/W	〃
36	37	P18	Pr 18	Priority screen setting 18	R/W	〃
38	39	P19	Pr 19	Priority screen setting 19	R/W	〃
40	41	P21	Pr 21	Priority screen setting 21	R/W	〃
42	43	P22	Pr 22	Priority screen setting 22	R/W	〃
44	45	P23	Pr 23	Priority screen setting 23	R/W	〃
46	47	P24	Pr 24	Priority screen setting 24	R/W	〃
48	49	P25	Pr 25	Priority screen setting 25	R/W	〃
50	51	P26	Pr 26	Priority screen setting 26	R/W	〃
52	53	P27	Pr 27	Priority screen setting 27	R/W	〃
54	55	P28	Pr 28	Priority screen setting 28	R/W	〃
56	57	P29	Pr 29	Priority screen setting 29	R/W	〃
58	59	P31	Pr 31	Priority screen setting 31	R/W	〃
60	61	P32	Pr 32	Priority screen setting 32	R/W	〃
62	63	P33	Pr 33	Priority screen setting 33	R/W	〃
64	65	P34	Pr 34	Priority screen setting 34	R/W	〃
66	67	P35	Pr 35	Priority screen setting 35	R/W	〃
68	69	P36	Pr 36	Priority screen setting 36	R/W	〃
70	71	P37	Pr 37	Priority screen setting 37	R/W	〃
72	73	P38	Pr 38	Priority screen setting 38	R/W	〃
74	75	P39	Pr 39	Priority screen setting 39	R/W	〃

Bank setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
76	77	0SV	bAnP0	Bank 0 SV setting screen	R/W	
78	79	1SV	bAnP1	Bank 1 SV setting screen	R/W	
80	81	2SV	bAnP2	Bank 2 SV setting screen	R/W	
82	83	3SV	bAnP3	Bank 3 SV setting screen	R/W	
84	85	4SV	bAnP4	Bank 4 SV setting screen	R/W	
86	87	5SV	bAnP5	Bank 5 SV setting screen	R/W	
88	89	6SV	bAnP6	Bank 6 SV setting screen	R/W	
90	91	7SV	bAnP7	Bank 7 SV setting screen	R/W	

* To write a setting in the bank? SV setting screen on the CH2 side, set the communications address to the CH2 side.
Example: 02R0SV000000

Initial setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
92	93	INP	_InP ch	Set a input type	R/W	Model with multiple inputs 000?? Cascade input (CH2 only) 001?? Remote input (CH2 only) 002??
94	95	□DP	_dP□ch	Set a decimal position	R/W	No decimal point : 00000 1 decimal place : 00001 2 decimal place : 00002 3 decimal place : 00003 4 decimal place : 00004 5 decimal place : 00005
96	97	PVG	_PuG ch	Set a PV corrected gain	R/W	
98	99	PVS	_PuS ch	Set a PV corrected zero point	R/W	
100	101	PDF	_PdF ch	Set a PV filter	R/W	
102	103	SQR	_SQr ch	Set whether to perform square-root operations	R/W	Disable operations: 00000 Enable operations : 00001
104	105	PA□	_PA□ch	Set whether to perform polygonal line approximation	R/W	Disable approximation: 00000 Enable approximation: 00001
106	107	DEV	_dEu ch	Set a display range of deviation	R/W	
108	109	□BU	_□bU□	Set the buzzer	R/W	

Control setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
110	111	SLH	_SLH ch	Set an SV limiter upper limit	R/W	
112	113	SLL	_SLL ch	Set an SV limiter lower limit	R/W	
114	115	CSH	_CASH	Set an upper limit for cascade scaling	R/W	CH2 only
116	117	CSL	_CASL	Set a lower limit for cascade scaling	R/W	CH2 only
118	119	CAT	_CAAt	Set the SV for cascade AT	R/W	CH2 only
120	121	REH	_rEH□	Set an upper limit for remote scaling	R/W	CH2 only
122	123	REL	_rEL□	Set a lower limit for remote scaling	R/W	CH2 only
124	125	CLS	CLoSE	Adjust feedback resistance when fully closed	R/W	CH2 only Adjust: 00001
126	127	OPN	oPEn□	Adjust feedback resistance when fully open	R/W	CH2 only Adjust: 00001
128	129	□MD	_Md□ch	Set control mode	R/W	Control execution : 00000 Manual control : 00001 Control stop : 00002 Auto-tuning in progress : 00003

Control setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
130	131	CNT	_CntE ch	Set a control type	R/W	
132	133	DIR	_dir r ch	Set positive/reverse operation switchover	R/W	
134	135	MV1	_Mv 1 ch	Main output operation amount	R/W	W possible during manual control
136	137	TUN	_tUn ch	Set a tuning type	R/W	
138	139	ATG	_AtG ch	Set an AT factor	R/W	
140	141	ATC	_AtC ch	Set an AT sensitivity	R/W	
142	143	□P1	_P 1□ch	Set a main output proportional band	R/W	
144	145	□I1	_I □□ch	Set a main output integral time	R/W	
146	147	□D1	_d□□ch	Set a main output derivative time	R/W	
148	149	□T1	_t 1□ch	Set a main output proportional frequency	R/W	
150	151	ARW	_Arw ch	Anti-reset windup	R/W	
152	153	MH1	_MH 1 ch	Set a main output amount-of-operation limiter upper limit	R/W	
154	155	ML1	_ML 1 ch	Set a main output amount-of-operation limiter lower limit	R/W	
156	157	PBB	_Pbb ch	Manual reset	R/W	
158	159	OU1	_oU 1 ch	Set a main output operation amount change limiter to rise	R/W	
160	161	OD1	_od 1 ch	Set a main output operation amount change limiter to fall	R/W	
162	163	FA1	FAL 1 ch	Set for a main output abnormality	R/W	
164	165	MV2	_Mv2 ch	Auxiliary output operation amount	R/W	W possible during manual control
166	167	□P2	_P2□ch	Set an auxiliary output proportional band	R/W	
168	169	□T2	_t2□ch	Set an auxiliary output proportional frequency	R/W	
170	171	MH2	_MH2 ch	Set an auxiliary output amount-of-operation limiter upper limit	R/W	
172	173	ML2	_ML2 ch	Set an auxiliary output amount-of-operation limiter lower limit	R/W	
174	175	OU2	_oU2 ch	Set an auxiliary output operation amount change limiter to rise	R/W	
176	177	OD2	_od2 ch	Set an auxiliary output operation amount change limiter to fall	R/W	
178	179	FA2	FAL2 ch	Set for an auxiliary output abnormality	R/W	
180	181	□C1	_C 1□ch	Set a main output control sensitivity	R/W	
182	183	□C2	_C2□ch	Set an auxiliary output control sensitivity	R/W	
184	185	CP1	_CP 1 ch	Set a main output off-point position	R/W	
186	187	CP2	_CP2 ch	Set an auxiliary output off-point position	R/W	
188	189	□DB	_db□ch	Set a dead band	R/W	

OUT 1 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
190	191	O1F	_o1F□	Set an OUT 1 function	R/W	
192	193	E1F	_E1F□	Set an event output 1 function	R/W	
194	195	E1H	_E1H□	Set an event output 1 upper limit	R/W	
196	197	E1L	_E1L□	Set an event output 1 lower limit	R/W	
198	199	E1C	_E1C□	Set an event output 1 sensitivity	R/W	
200	201	E1T	_E1t□	Set an event output 1 delay timer	R/W	
202	203	E1B	_E1b□	Set an event output 1 special function	R/W	
204	205	E1P	_E1P□	Set an event output 1 polarity	R/W	
206	207	CM1	_CM1□	CT monitor 1	R	
208	209	CS1	_CS1□	Set an abnormality-identifying CT	R/W	
210	211	CT1	_Ct1□	Set a CT1 abnormal current	R/W	
212	213	TR1	_trn1	Set the OUT 1 transmission output function	R/W	
214	215	T1H	_trH1	Set an upper limit for OUT 1 transmission scaling	R/W	
216	217	T1L	_trL1	Set a lower limit for OUT 1 transmission scaling	R/W	

OUT 2 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
218	219	O2F	_o2F□	Set an OUT 2 function	R/W	
220	221	E2F	_E2F□	Set an event output 2 function	R/W	
222	223	E2H	_E2H□	Set an event output 2 upper limit	R/W	
224	225	E2L	_E2L□	Set an event output 2 lower limit	R/W	
226	227	E2C	_E2C□	Set an event output 2 sensitivity	R/W	
228	229	E2T	_E2t□	Set an event output 2 delay timer	R/W	
230	231	E2B	_E2b□	Set an event output 2 special function	R/W	
232	233	E2P	_E2P□	Set an event output 2 polarity	R/W	
234	235	CM2	_CM2□	CT monitor 2	R	
236	237	CS2	_CS2□	Set an abnormality-identifying CT	R/W	
238	239	CT2	_Ct2□	Set a CT2 abnormal current	R/W	
240	241	TR2	_trn2	Set the OUT 2 transmission output function	R/W	
242	243	T2H	_trH2	Set an upper limit for OUT 2 transmission scaling	R/W	
244	245	T2L	_trL2	Set a lower limit for OUT 2 transmission scaling	R/W	

OUT 3 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
246	247	O3F	_o3F□	Set an OUT 3 function	R/W	
248	249	E3F	_E3F□	Set an event output 3 function	R/W	
250	251	E3H	_E3H□	Set an event output 3 upper limit	R/W	
252	253	E3L	_E3L□	Set an event output 3 lower limit	R/W	
254	255	E3C	_E3C□	Set an event output 3 sensitivity	R/W	
256	257	E3T	_E3t□	Set an event output 3 delay timer	R/W	
258	259	E3B	_E3b□	Set an event output 3 special function	R/W	
260	261	E3P	_E3P□	Set an event output 3 polarity	R/W	
262	263	CM3	_CM3□	CT monitor 3	R	
264	265	CS3	_CS3□	Set an abnormality-identifying CT	R/W	
266	267	CT3	_Ct3□	Set a CT3 abnormal current	R/W	

OUT 4 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
268	269	O4F	_o4F□	Set an OUT 4 function	R/W	
270	271	E4F	_E4F□	Set an event output 4 function	R/W	
272	273	E4H	_E4H□	Set an event output 4 upper limit	R/W	
274	275	E4L	_E4L□	Set an event output 4 lower limit	R/W	
276	277	E4C	_E4C□	Set an event output 4 sensitivity	R/W	
278	279	E4T	_E4t□	Set an event output 4 delay timer	R/W	
280	281	E4B	_E4b□	Set an event output 4 special function	R/W	
282	283	E4P	_E4P□	Set an event output 4 polarity	R/W	
284	285	CM4	_CM4□	CT monitor 4	R	
286	287	CS4	_CS4□	Set an abnormality-identifying CT	R/W	
288	289	CT4	_Ct4□	Set a CT4 abnormal current	R/W	

OUT 5 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
290	291	O5F	_o5F□	Set an OUT 5 function	R/W	
292	293	E5F	_E5F□	Set an event output 5 function	R/W	
294	295	E5H	_E5H□	Set an event output 5 upper limit	R/W	
296	297	E5L	_E5L□	Set an event output 5 lower limit	R/W	
298	299	E5C	_E5C□	Set an event output 5 sensitivity	R/W	
300	301	E5T	_E5t□	Set an event output 5 delay timer	R/W	
302	303	E5B	_E5b□	Set an event output 5 special function	R/W	
304	305	E5P	_E5P□	Set an event output 5 polarity	R/W	
306	307	CM5	_CM5□	CT monitor 5	R	
308	309	CS5	_CS5□	Set an abnormality-identifying CT	R/W	
310	311	CT5	_Ct5□	Set a CT5 abnormal current	R/W	

OUT 6 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
312	313	O6F	_o6F□	Set an OUT 6 function	R/W	
314	315	E6F	_E6F□	Set an event output 6 function	R/W	
316	317	E6H	_E6H□	Set an event output 6 upper limit	R/W	
318	319	E6L	_E6L□	Set an event output 6 lower limit	R/W	
320	321	E6C	_E6C□	Set an event output 6 sensitivity	R/W	
322	323	E6T	_E6t□	Set an event output 6 delay timer	R/W	
324	325	E6B	_E6b□	Set an event output 6 special function	R/W	
326	327	E6P	_E6P□	Set an event output 6 polarity	R/W	
328	329	CM6	_CM6□	CT monitor 6	R	
330	331	CS6	_CS6□	Set an abnormality-identifying CT	R/W	
332	333	CT6	_Ct6□	Set a CT6 abnormal current	R/W	

Transmission setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
334	335	TRN	_trn□	Set the OUT 1 transmission output function	R/W	
336	337	TRH	_trH□	Set an upper limit for OUT 1 transmission scaling	R/W	
338	339	TRL	_trL□	Set a lower limit for OUT 1 transmission scaling	R/W	

DI1 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
340	341	D1F	_d 1F□	Set a DI1 function	R/W	
342	343	D1P	_d 1P□	Set a DI1 polarity	R/W	
344	345	SV2	_Su2□	Set a DI1 SV2	R/W	

DI2 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
346	347	D2F	_d2F□	Set a DI2 function	R/W	
348	349	D2P	_d2P□	Set a DI2 polarity	R/W	
350	351	SV3	_Su3□	Set a DI2 SV3	R/W	

DI3 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
352	353	D3F	_d3F□	Set a DI3 function	R/W	
354	355	D3P	_d3P□	Set a DI3 polarity	R/W	
356	357	SV4	_Su4□	Set a DI3 SV4	R/W	

DI4 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
358	359	D4F	_d4F□	Set a DI4 function	R/W	
360	361	D4P	_d4P□	Set a DI4 polarity	R/W	
362	363	SV5	_Su5□	Set a DI4 SV5	R/W	

Communications 1 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
364	365	PRT	_Prt 1	Set a communications 1 protocol	R/W	
366	367	COM	_Com 1	Set a communications 1 parameter	R/W	Example: □B8N2
368	369	BPS	_bPS 1	Set a communications 1 speed	R/W	Example: 00096 (if 9600 bps)
370	371	ADR	_Adr 1	Set a communications 1 address	R/W	
372	373	AWT	_AWt 1	Set a communications 1 response delay	R/W	
374	375	MOD	_Mod 1	Set communications 1 mode switchover	R/W	RO: 00000 RW: 00001

Communications 2 setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
376	377	P2T	_Prt2	Set a communications 2 protocol	R/W	
378	379	C2M	_Com2	Set a communications 2 parameter	R/W	Example: □B8N2
380	381	B2S	_bPS2	Set a communications 2 speed	R/W	Example: 00096 (if 9600 bps)
382	383	A2R	_Adr2	Set a communications 2 address	R/W	
384	385	A2T	_AWt2	Set a communications 2 response delay	R/W	
386	387	M2D	_Mod2	Set communications 2 mode switchover	R/W	RO: 00000 RW: 00001

Timer setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
388	389	TMF	_tMF□	Set a timer function	R/W	
390	391	H/M	_HrM□	Set a timer unit	R/W	
392	393	TSV	_tSu□	Set a timer SV start tolerance	R/W	
394	395	ONT	ondtM	Set the ON delay timer	R/W	
396	397	OFT	oFdtM	Set the OFF delay timer	R/W	
398	399	□TC	_tCnt	Set a repetition frequency	R/W	
400	401	TIA	_ti A□	Set a timer remaining time	R	

Logging setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
402	403	INT	_I nt□	Set a logging interval	R/W	
404	405	LOG	_LoG□	Set logging start/stop	R/W	R/W logging start/stop Start: 00001 Stop: 00000 If it is read during logging, the system will return a 00001.
406	407	YER	_YEAr	Set a calendar	R/W	Data format: 000YY (the last 2 digits of the calendar year) Example: the year 2004 = 00004 R causes the current calendar year to be returned. During setting by key operation, the system will return a 08888. If the time is unset, the system will return a 09999.
408	409	DAY	_ dAY	Set a time	R/W	Data format: 0MMDD Example: October 25 = 01025 R causes the current time to be returned. During setting by key operation, the system will return a 08888. If the time is unset, the system will return a 09999.
410	411	TME	_ti nE	Set a time	R/W	Data format: 0HHMM (24-hour system) Example: 1:23 p.m. = 01323 R causes the current time to be returned. During setting by key operation, the system will return a 08888. If the time is unset, the system will return a 09999.

CT setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
412	413	CI1	_CI 1□	Set a CT1 detection destination	R/W	
414	415	CI2	_CI 2□	Set a CT2 detection destination	R/W	

CH1 polygonal line approximation setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
416	417	AA0	_PAA0	Set a polygonal line approximation 0 input	R/W	
418	419	AA1	_PAA1	Set a polygonal line approximation 1 input	R/W	
420	421	AA2	_PAA2	Set a polygonal line approximation 2 input	R/W	
422	423	AA3	_PAA3	Set a polygonal line approximation 3 input	R/W	
424	425	AA4	_PAA4	Set a polygonal line approximation 4 input	R/W	
426	427	AA5	_PAA5	Set a polygonal line approximation 5 input	R/W	
428	429	AA6	_PAA6	Set a polygonal line approximation 6 input	R/W	
430	431	AA7	_PAA7	Set a polygonal line approximation 7 input	R/W	
432	433	AA8	_PAA8	Set a polygonal line approximation 8 input	R/W	
434	435	AA9	_PAA9	Set a polygonal line approximation 9 input	R/W	
436	437	AAA	_PAAA	Set a polygonal line approximation A input	R/W	
438	439	AAB	_PAAb	Set a polygonal line approximation B input	R/W	
440	441	AAC	_PAAC	Set a polygonal line approximation C input	R/W	
442	443	AAD	_PAAd	Set a polygonal line approximation D input	R/W	
444	445	AAE	_PAAE	Set a polygonal line approximation E input	R/W	
446	447	AAF	_PAAF	Set a polygonal line approximation F input	R/W	
448	449	AB0	_PAb0	Set a polygonal line approximation 0 output	R/W	
450	451	AB1	_PAb1	Set a polygonal line approximation 1 output	R/W	
452	453	AB2	_PAb2	Set a polygonal line approximation 2 output	R/W	
454	455	AB3	_PAb3	Set a polygonal line approximation 3 output	R/W	
456	457	AB4	_PAb4	Set a polygonal line approximation 4 output	R/W	
458	459	AB5	_PAb5	Set a polygonal line approximation 5 output	R/W	
460	461	AB6	_PAb6	Set a polygonal line approximation 6 output	R/W	
462	463	AB7	_PAb7	Set a polygonal line approximation 7 output	R/W	
464	465	AB8	_PAb8	Set a polygonal line approximation 8 output	R/W	
466	467	AB9	_PAb9	Set a polygonal line approximation 9 output	R/W	
468	469	ABA	_PAbA	Set a polygonal line approximation A output	R/W	
470	471	ABB	_PAbb	Set a polygonal line approximation B output	R/W	
472	473	ABC	_PAbC	Set a polygonal line approximation C output	R/W	
474	475	ABD	_PAbd	Set a polygonal line approximation D output	R/W	
476	477	ABE	_PAbE	Set a polygonal line approximation E output	R/W	
478	479	ABF	_PAbF	Set a polygonal line approximation F output	R/W	

* To write a setting in "Set a polygonal line approximation" on the CH2 side, set the communications address to the CH2 side.
  Example: 02WPAA000000

Logging contents setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
480	481	LO1	_LoG1	First logging setting	R/W	R/W logging contents setting Example: ☐☐INP (identifier)
482	483	LO2	_LoG2	Second logging setting	R/W	〃
484	485	LO3	_LoG3	Third logging setting	R/W	〃
486	487	LO4	_LoG4	Fourth logging setting	R/W	〃
488	489	LO5	_LoG5	Fifth logging setting	R/W	〃
490	491	LO6	_LoG6	Sixth logging setting	R/W	〃
492	493	LO7	_LoG7	Seventh logging setting	R/W	〃
494	495	LO8	_LoG8	Eighth logging setting	R/W	〃
496	497	LO9	_LoG9	Ninth logging setting	R/W	〃

Key setting mode

MODBUS ADR		Identifier	Character	Name	R/W	Description
498	499	FU1	_FU1☐	Set the FUNC 1 key	R/W	
500	501	FU2	_FU2☐	Set the FUNC 2 key	R/W	
502	503	FU3	_FU3☐	Set the FUNC 3 key	R/W	
504	505	A/M	_AnM☐	A/M key setting	R/W	
506	507	ENT	_EnE☐	ENT key setting	R/W	
508	509	SUB	_SUbd	Set an auxiliary screen display	R/W	
510	511	INI	_Ini☐	Initial setting	R/W	R/W initialization start Initialization: 00001 If the data is read during initialization, the system will return a 00001.
512	513	LOC	_LoC☐	Set key lock	R/W	

Screen-less commands

MODBUS ADR		Identifier	Character	Name	R/W	Description
514	515	TST		Timer start stop	R/W	
516	517	OM1		Output monitor 1	R	R of the output monitor 1 ①②③④⑤ ⑤: OUT1 (1: ON 0: OFF) ④: OUT2 (1: ON 0: OFF) ③: EV1 (1: ON 0: OFF) ②: EV2 (1: ON 0: OFF)
518	519	OM2		Output monitor 2	R	R of the output monitor 2 ①②③④⑤ ⑤: OUT3 (1: ON 0: OFF) ④: OUT4 (1: ON 0: OFF) ③: EV3 (1: ON 0: OFF) ②: EV4 (1: ON 0: OFF)
520	521	OM3		Output monitor 3	R	R of the output monitor 3 ①②③④⑤ ⑤: OUT5 (1: ON 0: OFF) ④: OUT6 (1: ON 0: OFF) ③: EV5 (1: ON 0: OFF) ②: EV6 (1: ON 0: OFF)
522	523	EM1		Event input monitor	R	R of the event input monitor ①②③④⑤ ⑤: Event 1 (1: ON 0: OFF) ④: Event 2 (1: ON 0: OFF) ③: Event 3 (1: ON 0: OFF) ②: Event 4 (1: ON 0: OFF)
524	525	DM1		Deviation monitor	R	R of the deviation monitor ①②③④⑤ ⑤: If over the deviation display tolerance: 1 ④: If within the deviation display tolerance ③: If under the deviation display tolerance If the deviation monitor is unset, all will be set to 0.
526	527	□AT		Start/release AT	R/W	Read/write AT start/release Start : 00001 Release : 00000 Reading during startup causes this product to replay with 00001.
528	529	STR		Store data	W	Store data
530	531	□BK		Set bank switchover	R/W	Bank switchover

MODBUS ADR		Identifiers used only in blind setting				
532	533	000		SET0	B/L	Blinding enabled: 00000 Blinding disabled: 00001
534	535	001		SET1	B/L	
536	537	002		SET2	B/L	
538	539	003		SET3	B/L	
540	541	004		SET4	B/L	
542	543	005		SET5	B/L	
544	545	006		SET6	B/L	
546	547	007		SET7	B/L	
548	549	008		SET8	B/L	
550	551	009		SET9	B/L	
552	553	00A		SETA	B/L	
554	555	00B		SETB	B/L	
556	557	00C		SETC	B/L	
558	559	00D		SETD	B/L	
560	561	00E		SETE	B/L	
562	563	00F		SETF	B/L	
564	565	00G		SETG	B/L	
566	567	00H		SETH	B/L	
568	569	00I		SETI	B/L	
570	571	00J		SETJ	B/L	
572	573	00K		SETK	B/L	
574	575	00L		SETL	B/L	
576	577	00M		SETM	B/L	
578	579	00N		SETN	B/L	
580	581	00O		SETO	B/L	
582	583	00P		SETP	B/L	