

TOHO ELECTRONICS INC.

**Operation Manual, Communications
(TOHO protocol and MODBUS)**

Model: TTM-200 Series
Designation: Digital Controller

Thank you very much for purchasing a TTM-200 Series (with communications). Please read this operation manual carefully and use this product correctly.

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1. Before using the product

1.1 On this operation manual

This is an operation manual regarding communications with a TTM-200 Series (hereinafter referred to as "this product").

1.2 Conditions for communications

The communications function of this product incorporates loader communications as standard equipment. RS-485 communications, however, is optional.

If you need RS-485 communications, therefore, you should specify a communication option (RS-485).

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 "Communications precautions." in chapter 3.6, 6.6 and 6.11.)

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 **0** (write disabled) 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. See "2. Settings regarding TOHO communications" and "5. Settings regarding MODBUS communications."

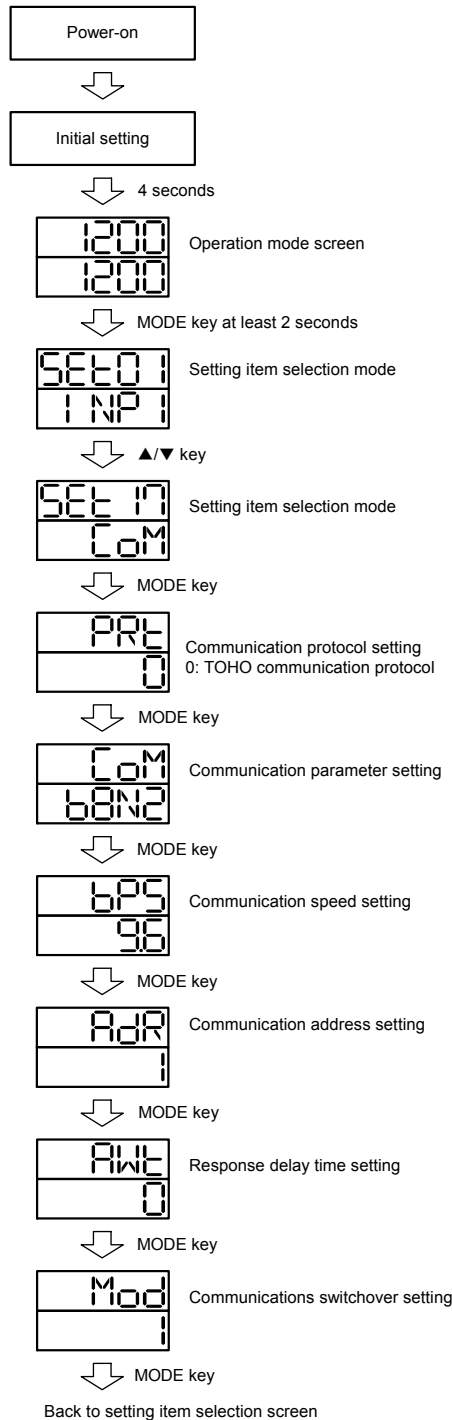
2. Settings regarding TOHO communications

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.

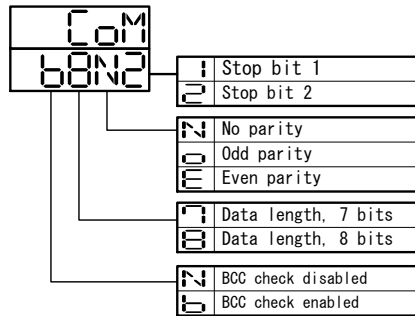
2.2 Setting a data length

2.3 Setting a stop bit length

2.4 Setting a parity

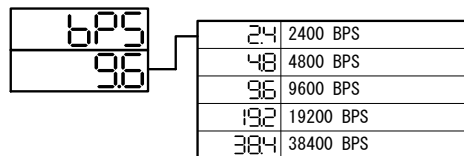
2.5 Setting whether to conduct a BCC check

While in the "Set a communications parameter" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is **b8N2**.



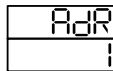
2.6 Setting a communications speed

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**.

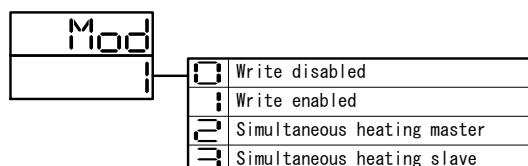


Setting range: 0 to 250msec

- * 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

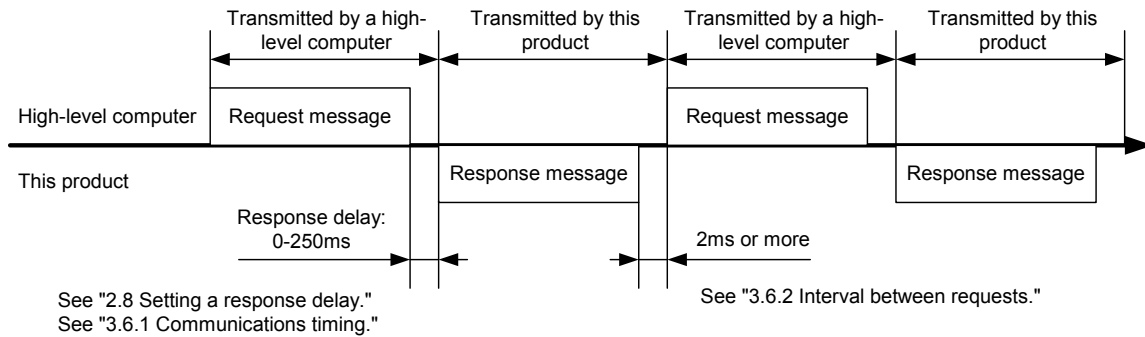
While in the "Set communications mode switchover" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is **1**.



3. TOHO communications control

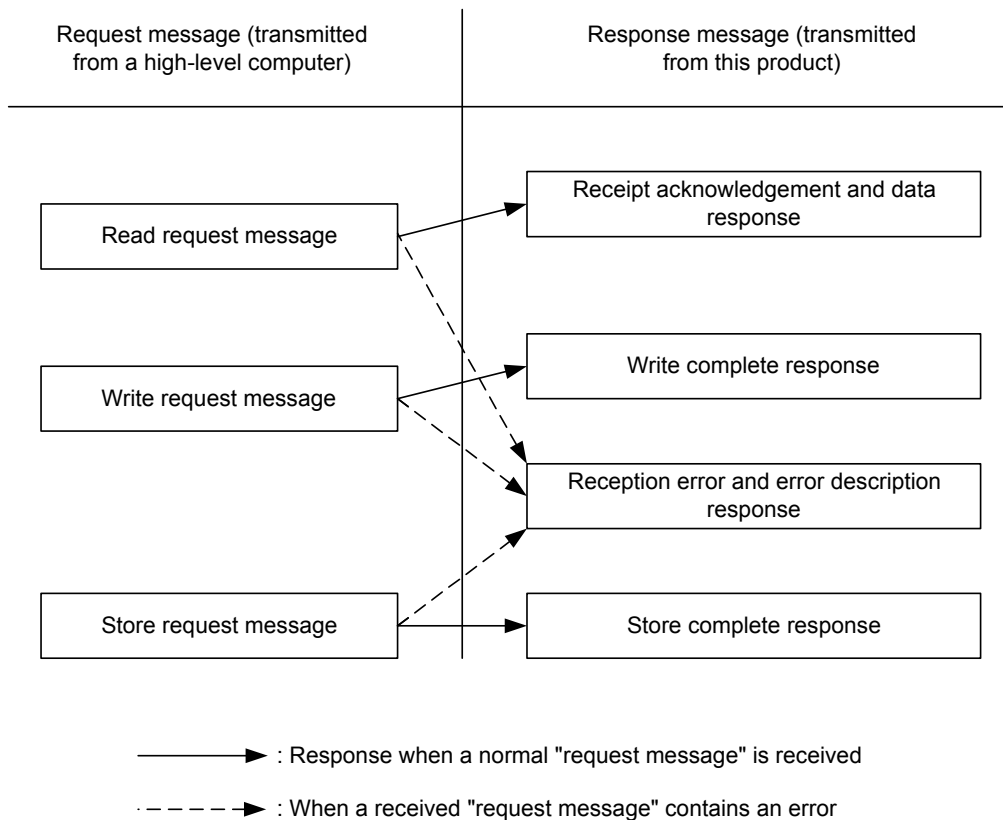
3.1 Communications procedure

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:

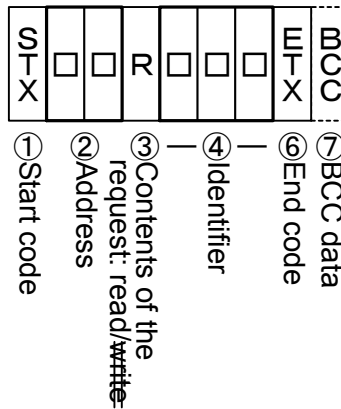


- All codes (except for BCC) from STX and data to ETX are expressed in ASCII codes.
- In assembling a program for a high-level computer, see "10. Table of identifiers (codes)" and "11. Table of ASCII codes" at the end of the book.

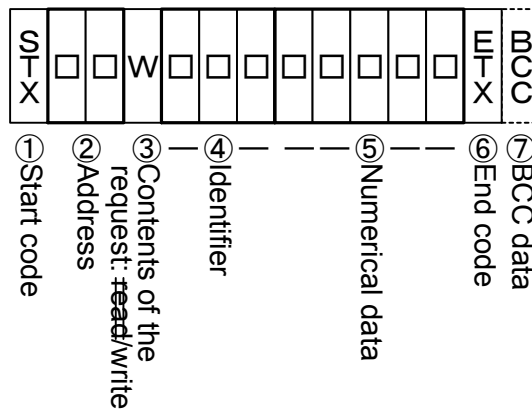
3.3 Composition of a request message (transmitted from a high-level computer to this product)

- For codes ① to ⑩, see "3.5 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."

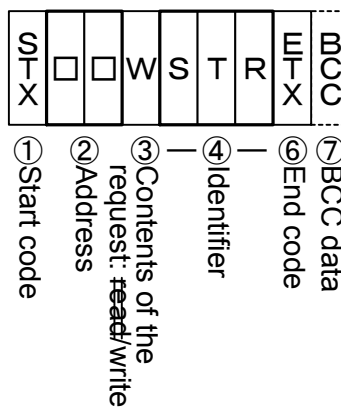
3.3.1 Composition of a read request message



3.3.2 Composition of a write request message



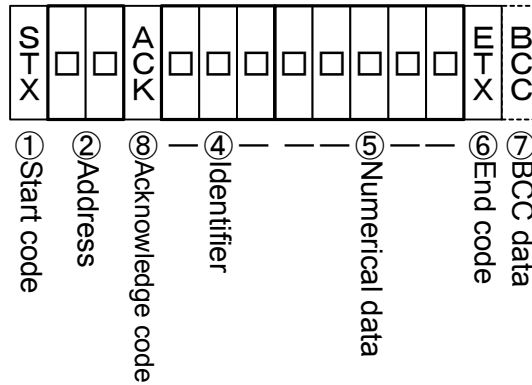
3.3.3 Composition of a store request message



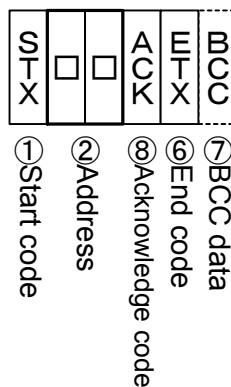
3.4 Composition of a response message (transmitted from this product to a high-level computer)

- For codes ① to ⑩, see "3.5 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."

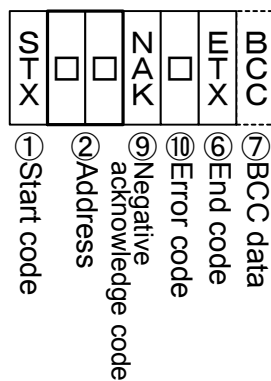
3.4.1 Response message in response to a read request message



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 Description of codes

- The codes from ① STX, ② address to ⑩ ERR type 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.

③ Contents requested

Enter a code R / W. / L / B

R: to read data from this product

W: to write or store data in this product

L: to read blind setting from this product

B: to write or store blind setting in this product

④ Identifier

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

⑤ Numerical data

In writing mode, you can write 5 or 6 digits of numerical data. In reading, you can set this product to 5 or 6 digits of numerical data. Following are the conditions for switchover between 5 and 6 digits.

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

Position of the decimal point: 5-digit data does not include a decimal point.

Example: The table below indicates the significances of 5-digit numerical data -9999

	Example	Significance of the value
Data (PV), etc, whose decimal point can be shifted	decimal point setting (DP) is 0	-9999
	decimal point setting (DP) is 0.0	-999.9
	decimal point setting (DP) is 0.00	-99.99
	decimal point setting (DP) is 0.000	-9.999
	Decimal point setting (DP) is 0.0000	-0.9999

When the character data is " INP".

Example: The table below indicates the significances of 6-digit numerical data -10000

	設定	数値の意味
Data (PV), etc, whose decimal point can be shifted	decimal point setting (DP) is 0	-10000
	decimal point setting (DP) is 0.0	-1000.0
	decimal point setting (DP) is 0.00	-100.00
	decimal point setting (DP) is 0.000	-10.000
	Decimal point setting (DP) is 0.0000	-1.0000

- 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."
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 "0" 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.

3.6 Communications precautions

3.6.1 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 communications.

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

3.6.2 Interval between requests

In transmitting a series of "request messages" from a high-level computer, allow for an interval of 2msec or more from the reception of a "response message" from this product to a next transmission.

3.6.3 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, the high-level computer transmits the necessary "request message" again if a "request message" is sent to this product 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.

3.6.4 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, the high-level computer transmits the necessary "request message" again if a "request message" is sent to this product 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.

3.6.5 Number of digits in data and the decimal position

See "3.5 Description of codes, ⑤ Numerical data."

3.6.6 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.

3.6.7 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.

3.6.8 Storing data other than a store request message

In the two cases described below, the unit stores the parameter to EEPROM even if no store request message is received.

- 1) If a parameter is changed by key operation, writing will be done only for the changed parameter and the related parameter.
- 2) If auto-tuning is started and ends normally, writing will be done only for the PID constant.

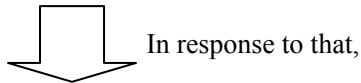
3.6.9 Changing the setting (SV) by communications during auto-tuning

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

4. Examples of TOHO communications

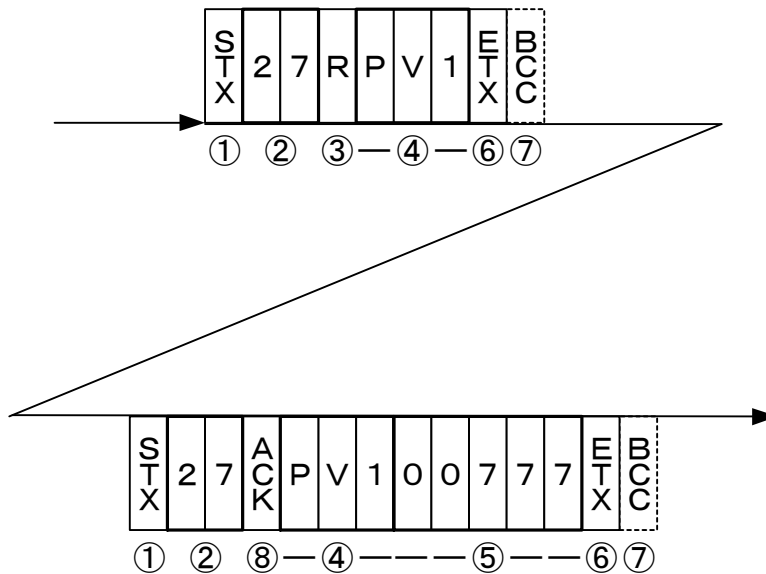
4.1 Examples of communications to be read

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



Response message: This returns PV data (00777).
(This product)

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

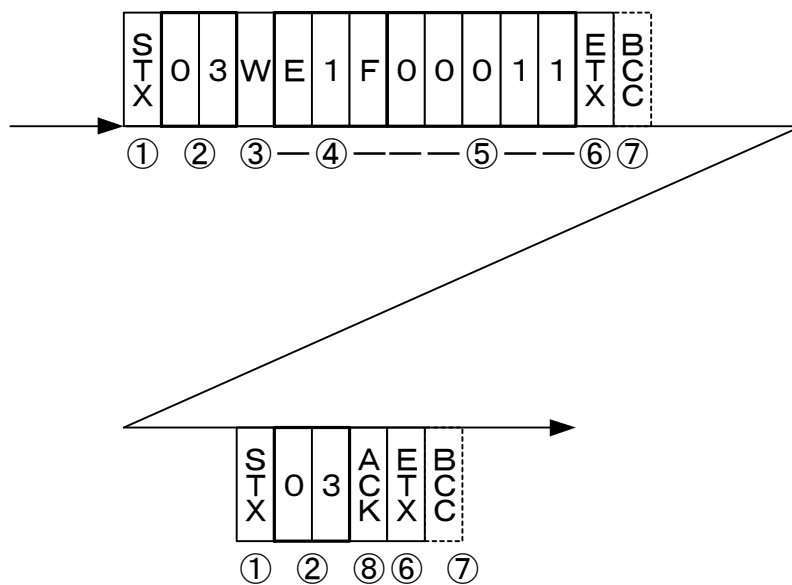
(This sets the function in event 1 to the deviation upper and lower limits + hold.)

In response to that,

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

*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)	E11	41H 31H 31H
⑤ Numerical data	00011	30H 30H 30H 31H 31H
⑥ End code	ETX	03H
⑦ BCC data request		53H
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."

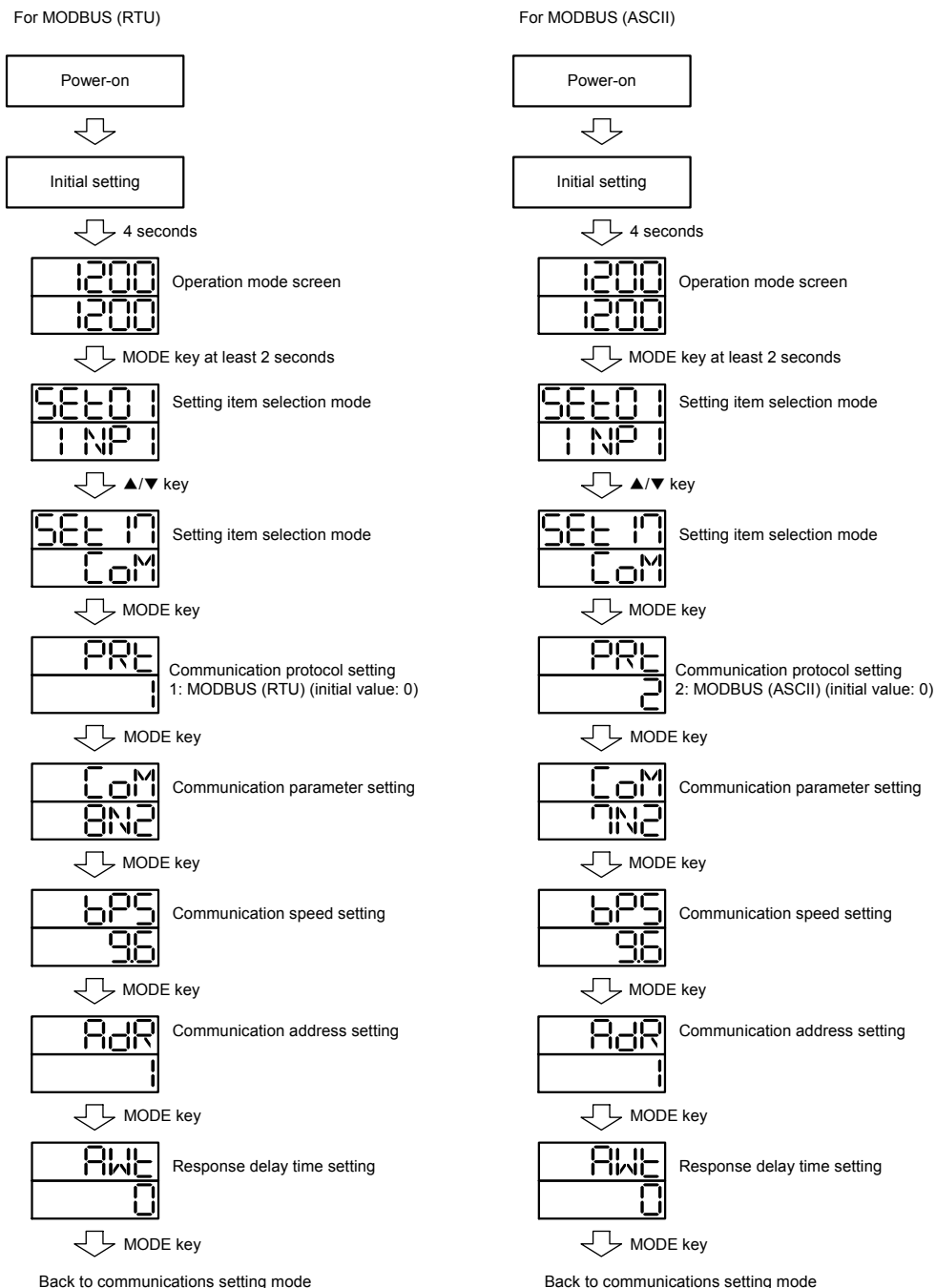
5. Settings regarding MODBUS communications

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.

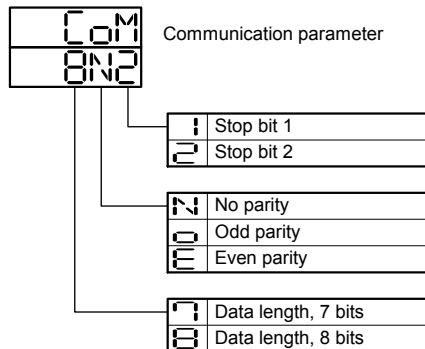
5.2 Setting a data length

5.3 Setting a stop bit length

5.4 Setting a parity

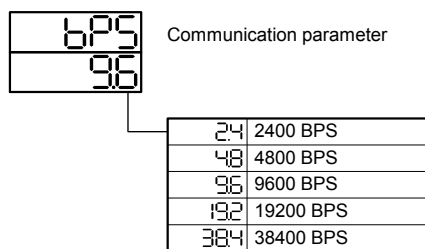
5.5 Setting a BCC check

The BCC check is disabled.



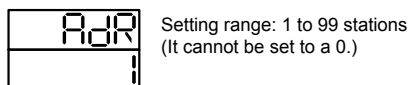
5.6 Setting a communications speed

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**.



5.7 Setting an address

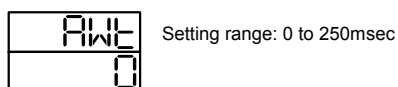
While in the "Set a communications address" screen on the preceding page, operate the ▲ and ▼ keys to make the settings. The initial value is **1**.



5.8 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**.



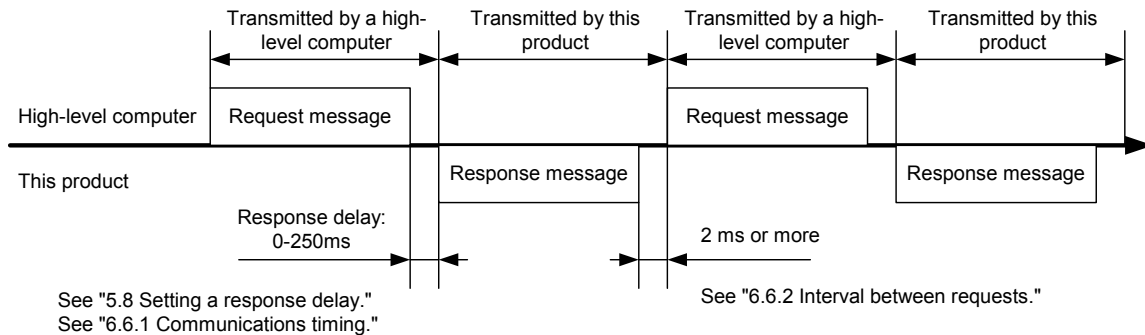
* If the response delay is set to a short setting, the communications may not be conducted normally.

* In a real operation, the processing time for this product will be added, in addition to the response delay.

6. MODBUS communications control

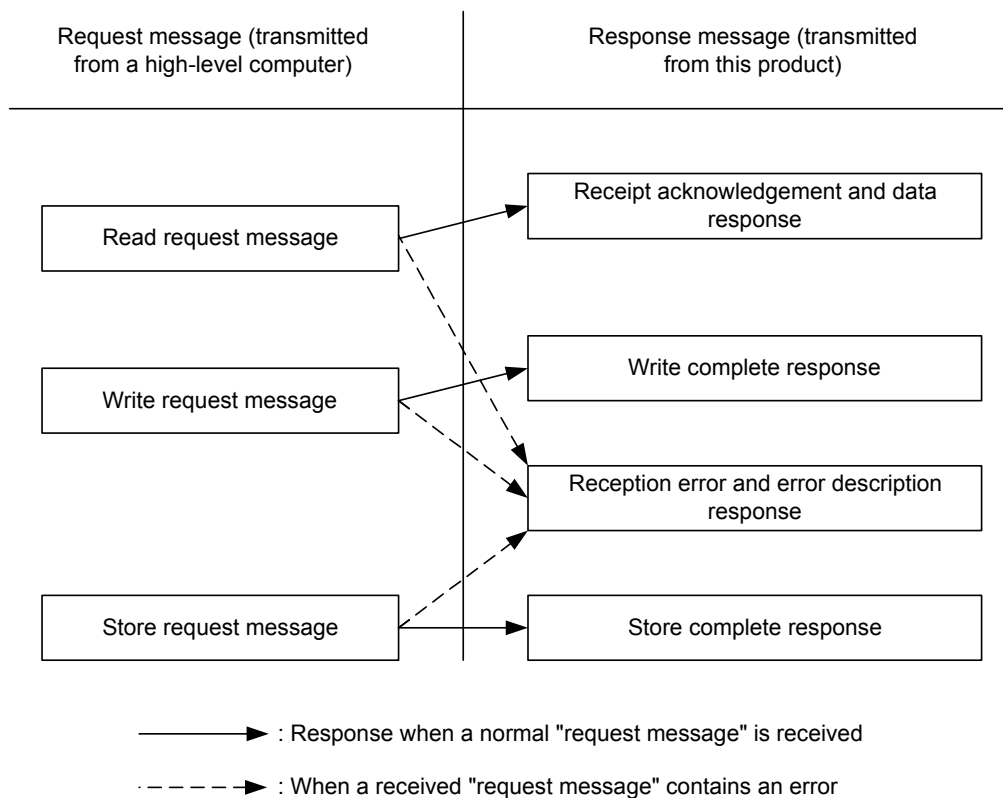
6.1 Communications procedure

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 "6.5 Description of RTU codes."

6.3.1 Composition of a read request message

a)	Slave address		01H	
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	Low level	0BH	
		High level	C4H	

6.3.2 Composition of a write request message

a)	Slave address		01H	
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	
f)	Number of byte items		04H	Number of registers × 2
g)	Data for the first register (a low-level word)	High level	00H	③
		Low level	00H	④
g)	Data for the first register (a high-level word)	High level	00H	①
		Low level	00H	②
e)	CRC-16	Low level	3FH	
		High level	FEH	

④ Data composition is ①, ②, ③, and ④H. (① represents 1 byte.)

6.3.3 Composition of a store request message

a)	Slave address		01H	
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 byte 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	
g)	Data for the first register (a high-level word)	High level	00H	
		Low level	00H	
e)	CRC-16	Low level	E2H	
		High level	EBH	

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

■ For codes a) through h), see "6.5 Description of RTU codes."

6.4.1 Response message for a read request message

a)	Slave address		01H	
b)	Function code		03H	
d)	Number of byte items		04H	Number of registers × 2
g)	Data for the first register (a low-level word)	High level	0AH	③
		Low level	A1H	④
g)	Data for the first register (a high-level word)	High level	00H	①
		Low level	00H	②
e)	CRC-16	Low level	09H	
		High level	A8H	

④ Data composition is ①, ②, ③, and ④H. (① represents 1 byte.)

6.4.2 Response message for a write/store request message

a)	Slave address		01H	
b)	Function code		10H	
c)	Register address	High level	01H	First register address
		Low level	00H	
d)	Number of registers	High level	00H	Fixed at 2
		Low level	02H	
e)	CRC-16	Low level	34H	
		High level	40H	

6.4.3 Response message in the case of an error

a)	Slave address		01H	
b)	Function code		83H	← In the case of an error, the function for the request message + 80H is entered.
h)	Error code		03H	
e)	CRC-16	Low level	31H	
		High level	01H	

6.5 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.
- 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
- 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.
- 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 (four 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 "6.7 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 byte
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 %	0000000 AH
PV = 1200.0°C	00002EE0H
SV = -10.00°C	FFFFFFC18H

Example: In the case of text data

Example	Significance of the value
Priority screen01=" INP"	20494E50h
Priority screen02=" MV1"	204D5631h
Priority screen02=" P1"	20205031h

In the case of text data, write the ASCII code " INP" (is a space): 20494E50

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.

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)

6.6 Precautions on RTU communications

6.6.1 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 "6.1 Communications procedure" and "5.8 Setting a response delay."

6.6.2 Interval between requests

In transmitting a series of "request messages" from a high-level computer, allow for an interval of 2msec or more from the reception of a "response message" from this product to a next transmission.

6.6.3 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, the high-level computer transmits the necessary "request message" again if a "request message" is sent to this product 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.

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

6.6.5 Number of digits in data and the decimal position

See "6.5 Description of RTU codes, g) Data portion."

6.6.6 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.

6.6.7 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.

6.6.8 Storing data other than a store request message

In the two cases described below, the unit stores the parameter to EEP-ROM even if no store request message is received.

- 1) If a parameter is changed by key operation, writing will be done only for the changed parameter and the related parameter.
- 2) If auto-tuning is started and ends normally, writing will be done only for the PID constant.

6.6.9 Changing the setting (SV) by communications during auto-tuning

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

6.7 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 Long
Dim crc_array(64) As Integer
```

Then enter calculable data into the `crc_array()`, 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_array(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.

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

- For the codes a) through g), see "6.10 Description of ASCII codes."

6.8.1 Composition of a read request message

a)	Start code		"."	
b)	Slave address		"0", "1"	
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		"F", "A"	
g)	End code		CR, LF	

6.8.2 Composition of a write request message

a)	Start code		"."	
b)	Slave address		"0", "1"	
c)	Function code		"1", "0"	
d)	Register address	High level	"0", "1"	First register address
		Low level	"0", "0"	
e)	Number of registers	High level	"0", "0"	Fixed at 2
		Low level	"0", "2"	
h)	Number of byte items		"0", "4"	Register × 2
i)	First register data (a low-level word)	High level	"0", "0"	③
		Low level	"0", "0"	④
i)	First register data (a high-level word)	High level	"0", "0"	①
		Low level	"0", "0"	②
f)	LRC		"E", "8"	
g)	End code		CR, LF	

① Data composition is ①, ②, ③, and ④H. (① represents 1 byte.)

6.8.3 Composition of a store request message

a)	Start code		"."	
b)	Slave address		"0", "1"	
c)	Function code		"1", "0"	
d)	Register address	High level	"2", "0"	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 byte items		"0", "4"	Register × 2
i)	First register data (a low-level word)	High level	"0", "0"	The data about the storage of settings is arbitrary.
		Low level	"0", "0"	
i)	First register data (a high-level word)	High level	"0", "0"	
		Low level	"0", "0"	
f)	LRC		"B", "B"	
g)	End code		CR, LF	

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

- For the codes a) through g), see "6.10 Description of ASCII codes."

6.9.1 Response message for a read request message

a)	Start code		"."	
b)	Slave address		"1", "1"	
c)	Function code		"0", "3"	
h)	Number of byte items		"0", "4"	Register × 2
i)	First register data (a low-level word)	High level	"0", "0"	③
		Low level	"0", "0"	④
i)	First register data (a high-level word)	High level	"0", "0"	①
		Low level	"0", "0"	②
f)	LRC		"5", "3"	
g)	End code		CR, LF	

Data composition is ①, ②, ③, and ④H. (① represents 1 byte.)

6.9.2 Response message for a write/store request message

a)	Start code		"."	
b)	Slave address		"0", "1"	
c)	Function code		"1", "0"	
d)	Register address	High level	"0", "1"	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", "C"	
g)	End code		CR, LF	

6.9.3 Response message in the case of an error

a)	Start code		"."	
b)	Slave address		"0", "1"	
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", "3"	
f)	LRC		"7", "9"	
g)	End code		CR, LF	

6.10 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 6.8 and 6.9 "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

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)."

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 "1" and "B" are considered as "1BH."

To learn how to calculate the LRC, see "6.12 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 byte

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	FFFFFFC18H

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.

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	An unsupported function code was received.
02	An unspecified address was received.
03	The numerical data was out of a "specific setting range specified with a setting item."
04	Instrument failure (memory error, A/D conversion error or AT error)

6.11 Precautions on ASCII communications

6.11.1 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 "6.1 Communications procedure" and "5.8 Setting a response delay."

6.11.2 Interval between requests

In transmitting a series of "request messages" from a high-level computer, allow for an interval of 2msec or more from the reception of a "response message" from this product to a next transmission.

6.11.3 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, high-level computer transmits the necessary "request message" again if a "request message" is sent to this product 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.

6.11.4 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, the high-level computer transmits the necessary "request message" again if a "request message" is sent to this product 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.

6.11.5 Number of digits in data and the decimal position

See "6.10 Description of ASCII codes, i) Data portion."

6.11.6 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.

6.11.7 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.

6.11.8 Storing data other than a store request message

In the two cases described below, the unit stores the parameter to EEP-ROM even if no store request message is received.

- 1) If a parameter is changed by key operation, writing will be done only for the changed parameter and the related parameter.
- 2) If auto-tuning is started and ends normally, writing will be done only for the PID constant.

6.11.9 Changing the setting (SV) by communications during auto-tuning

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

6.12 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_array(128) As Integer
```

Then enter calculable data into the `lrc_array()`, 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_array(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. Loader communications

7.1 Communication procedure

This product receives “request messages” from a high-level computer and returns “response messages.” This product therefore does not start to transmit a message.

The timing for communications and similar matters are the same as those of TOHO and MODBUS communications. Those depend on the way this product is set.

7.2 Message types

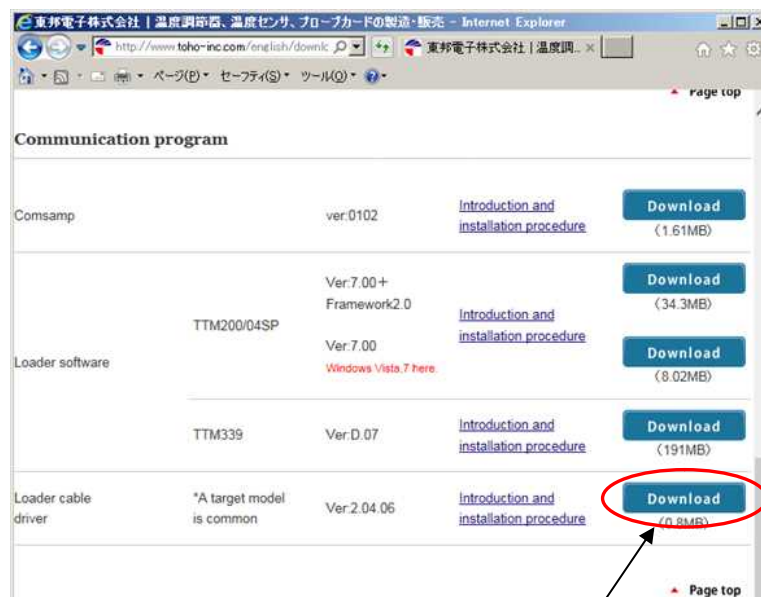
The configuration of messages and similar aspects are the same as in TOHO and MODBUS communications. That depends on the way this system is set.

7.3 Cautions on loader communications

Insert the stereo jack of the loader cable all the way home (until it clicks). When using a loader cable, either use the driver software furnished with this product or download driver software from the website of TOHO and install it into your PC. For details, see 7.4. You should exercise caution when making the connections for RS-485 communications and those for loader communications simultaneously. You cannot conduct loader communications while data is communicated through the communication line. Be sure to stop the RS-485 communications before conducting any communication you wish to make.

7.4 How to install the loader cable driver

To download driver software from the website of TOHO, download a zip file from the following URL: <http://www.toho-inc.com/english/download/index.html> Click "Download" of the Loader cable driver.



http://r7.s901v.smilestart.ne.jp/toho/english/CDM2.04.06WHQL_Certified.zip

Following is how to install the software on Microsoft Windows XP. If you are using any other OS, consult us.

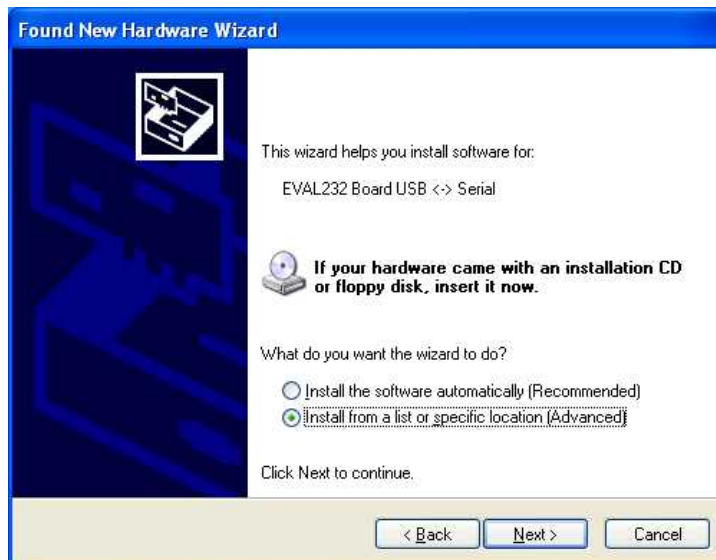
- 1) Uncompress the zip file on the hard disk.
The following description assumes that you have your file uncompressed on the desktop.
- 2) Insert the loader cable into a USB port of the PC. When the PC recognizes the loader cable, the following screen will pop up.



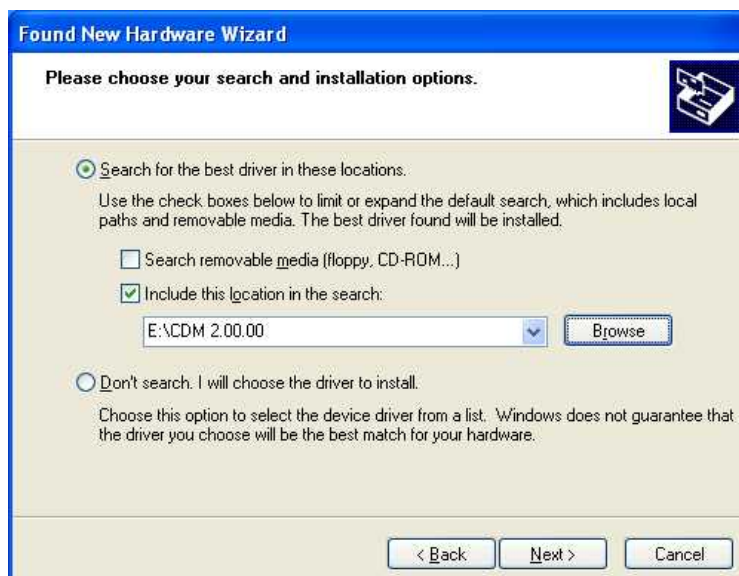
- 3) A screen as follows will then pop up. Select “No, not this time.” and click “Next >.”



- 4) Next, a screen as follows will pop up. Select “Install from a list or specific location (Advanced)” and click “Next >.”



- 5) Next, a screen as follows will pop up. Select “Include this location in the search”. Click “Next >.”



- 6) When a screen as follows pops up, click “Finish”



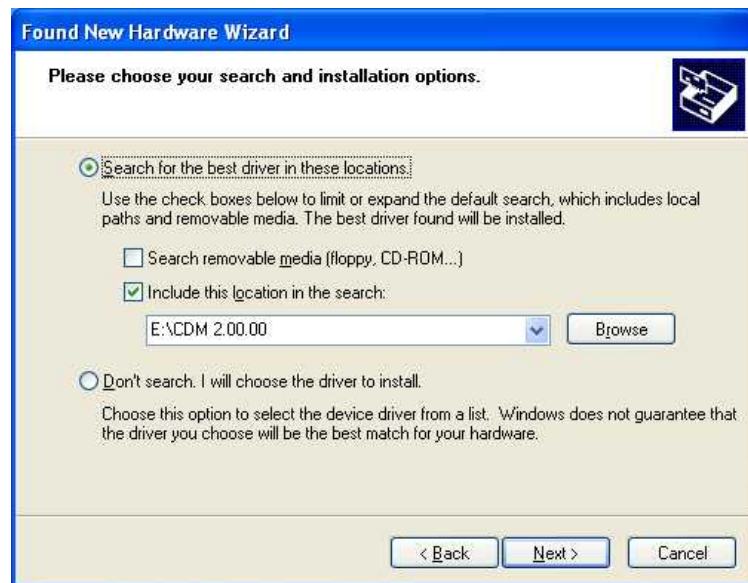
- 7) Next, a screen as follows will pop up. Select “No, not this time” and click “Next >.”



- 8) Next, a screen as follows will pop up. Select “Install from a list or specific location (Advanced)” and click “Next >.”



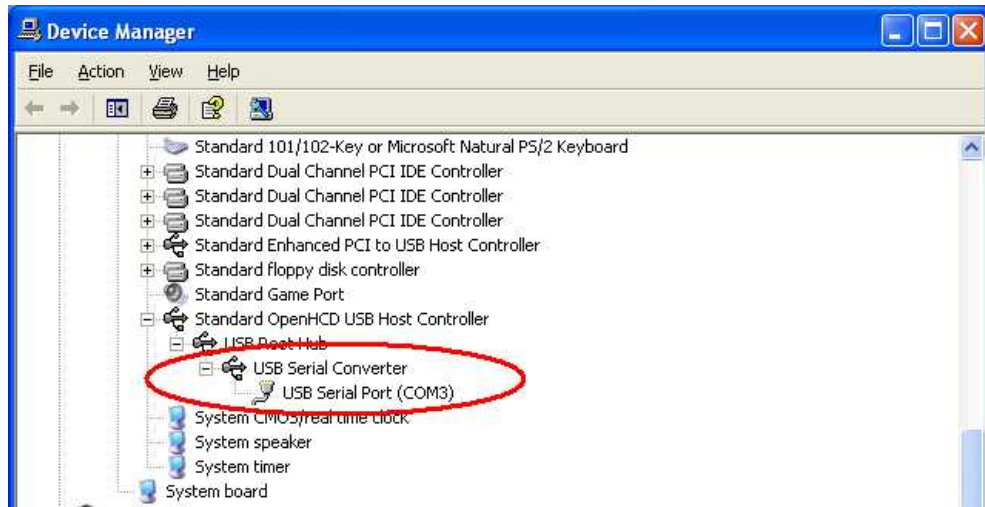
9) Next, a screen as follows will pop up. Select “Include this location in the search”. Click “Next >”



10) When a screen as follows pops up, click “Finish”. The installation is now complete.



- 11) To know to which number communication port the loader cable has been allocated, refer to the port on the device manager.



8. Specifications

8.1 Communications standard category

Compliant with EIA standard RS-485

8.2 Communications specifications

8.2.1 Communications system

Network: Multi-drop system (up to 1 pair, 31 stations)
Direction of information: Half duplex
Synchronization system: Asynchronous
Transmission code: ASCII, 7 bit code, except for BBC data
(highest-level bit = 0 in 8-bit code)

8.2.2 Interface system

Signal line: 2 lines for transmission and reception
Communications speed: 2,400, 4,800, 9,600, 19,200 and 38,400 bps and this product is set to it.
Communications distance: 500m maximum
Provided that it varies somewhat depending on the cable and other ambient conditions.

8.2.3 Character

- 1) TOHO communications protocols
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
- 2) MODBUS communications (RTU) protocols
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: 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
- 3) MODBUS communications (ASCII) protocols
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: 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
- 4) MODBUS communications (RTU/ASCII) function codes
03H (reading the contents of the holding register)
10H (writing the contents of two or more holding registers)

8.3 Types of loader communication standards: TTL

8.4 Loader communications specifications

8.4.1 Communication system

- Network: Point-to-point system (1 to 1 station)
- Direction of information: Half duplex
- Synchronization system: Asynchronous
- Transmission code: ASCII, 7 bit code, except for BBC data
(highest-level bit = 0 in 8-bit code)

8.4.2 Interface system

- Signal line: 2 transmission/reception lines, 1 ground line
- Communications speed: 2,400, 4,800, 9,600, 19,200 and 38,400 bps and this product is set to it.
- Communications distance: Use a special-purpose loader cable.

8.4.3 Character

- 1) TOHO communications protocols
 - 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

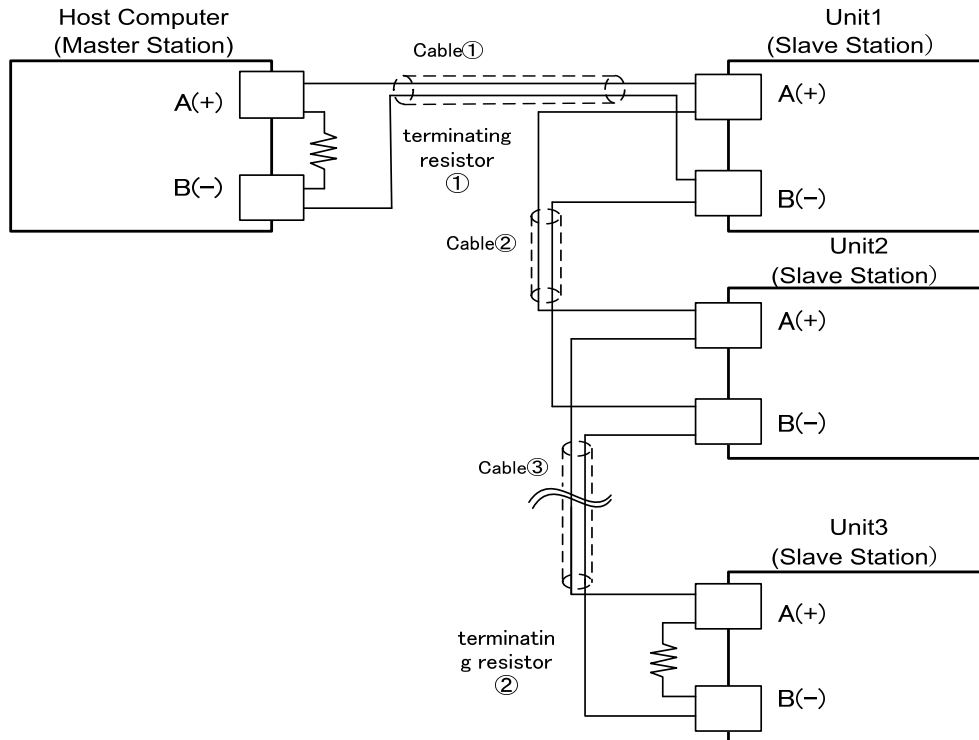
- 2) MODBUS communications (RTU) protocols
 - Start bit length: Fixed at 1 bit
 - Stop bit length: Either 1 or 2 bit is selected and this product is set to it.
 - Data length: Either 7 or 8 bit is selected and this product is set to it.
 - Parity: No. Either odd or even is selected and this product is set to it.
 - CRC-16 check: Fixed at yes.
 - Communications address: 1-247

- 3) MODBUS communications (ASCII) protocols
 - 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.
 - LRC check: Fixed at yes.
 - Communications address: 1-247

- 4) MODBUS communications (RTU/ASCII) function codes
 - 03H (reading the contents of the holding register)
 - 10H (writing the contents of two or more holding registers)

9. Connections

9.1 RS-485 communications



○ Above drawing shows example of connecting 1 to 3 slave stations to a master station.

◇ Use cables with the same characteristic impedance for cables ① to ③.

- For slave station nos. 1 to 3, connect them dependently as shown in the drawing.

The same characteristic impedance cables are used for the connections between the slave stations.

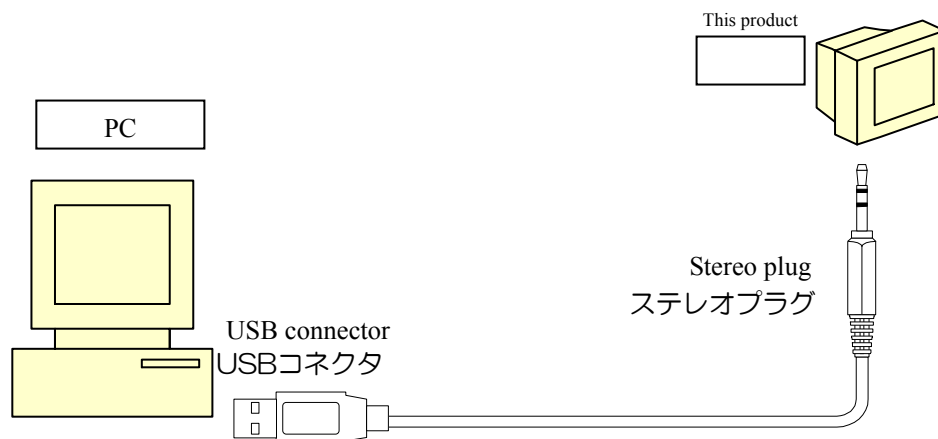
◇ Attach terminating resistor to both the master station side ① and the farthest ② ones among the slave stations (no. 3).

◇ Make sure to select terminating resistor in order that the [Characteristic Impedance from cables ① to ③] = [Resistance Value of ①] = [Resistance Value of ②]

- Furthermore, use characteristic impedance cable whose [Resistance Value of ①] // [Resistance Value of ②] (parallel combination resistance value) becomes above 75-ohms.

◇ Use a shielded twisted pair cable.

9.2 Loader communications



10. Table of identifiers (codes)

- For the setting range, options, initial values, and similar parameters, see the operation manual for this system.

Note: 1. The R/W to characters that do not meet the display conditions responds with "NAK2."

2. □ in the identifier table indicates a space (ASCII code:20H).

3. L/B is not applicable during MODBUS communications. (L/B is usable only with TOHO communications.)

Run mode

Identifier	modbus		Screen character	Name	Command	Remark	
	Absolute (DEC)	Relative (hex)					
PV1	40001	0000		Measuring temperature	RLB	HHHHH: Overscale LLLLL: Underscale At L/B 00000: Displays PV alone 00001: Displays SV alone 00002: Displays PV/SV	
STS	40003	0002		Step SV screen	RWLB		
STM	40005	0004		Step time monitor	RWLB		
PRM	40007	0006		Operating screen	Run operation	W	00000: Run stop 00001: Run start 00002: Run pause 00003: Run restart 00004: Step feed 00000: Before a run 00001: In WAIT (in ramp) 00002: In a run 00003: Pause 00004: Run end
					Run status monitor	R	

* Regarding the operating screen (PRM): Meanings of the same numerical data is different for between reading and writing.

Input 1 setting mode (set1)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
INP	40257	0100	INP1	Set an input 1 input type	RWLB	
FSH	40259	0102	FSH1	Set an input 1 scaling upper limit	RWLB	
FSL	40261	0104	FSL1	Set an input 1 scaling lower limit	RWLB	
PVF	40273	0110	PVF1	PV compensation function setting	RWLB	Pay attention to MODBUS address.
PVG	40263	0106	PVG1	Set an input 1 PV correction gain	RWLB	
PVS	40265	0108	PVS1	Set an input 1 PV correction zero	RWLB	
PX1	40275	0112	PX1	Lower limit setting before PV compensation	RWLB	Pay attention to MODBUS address.
PX2	40277	0114	PX2	Upper limit setting before PV compensation	RWLB	Pay attention to MODBUS address.
PY1	40279	0116	PY1	Lower limit setting after PV compensation	RWLB	Pay attention to MODBUS address.
PY2	40281	0118	PY2	Upper limit setting after PV compensation	RWLB	Pay attention to MODBUS address.
PDF	40267	010A	PdF1	Set an input 1 PV filter	RWLB	
<input type="checkbox"/> DP	40269	010C	dP1	Set an input 1 decimal point	RWLB	00000 : 0 00001 : 0.0 00002 : 0.00 00003 : 0.000 00004 : 0.0000

Input 2 setting mode (set2)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
IN2	40513	0200	INP2	Set an input 2 input type	RWLB	
FH2	40515	0202	FSH2	Set an input 2 scaling upper limit	RWLB	
FL2	40517	0204	FSL2	Set an input 2 scaling lower limit	RWLB	
PG2	40519	0206	PVG2	Set an input 2 PV correction gain	RWLB	
PS2	40521	0208	PVS2	Set an input 2 PV correction zero	RWLB	
PF2	40523	020A	PdF2	Set an input 2 PV filter	RWLB	
<input type="checkbox"/> LR	40525	020C	LR	Set a Local/Remote change	RWLB	00000: Local 00001: Remote 1 00002: Remote 2

Key function setting mode (set3)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
<input type="checkbox"/> FU	40769	0300	FU1	Set a function key 1 key function	RWLB	Ex) (Pressingtime)(Function) 00000: (No)(No)
FU2	40771	0302	FU2	Set a function key 2 key function	RWLB	
FU3	40773	0304	FU3	Set a function key 3 key function	RWLB	
FU4	40775	0306	FU4	Set a function key 4 key function	RWLB	
FU5	40777	0308	FU5	Set a function key5 key function	RWLB	
LOC	40779	030A	LoC	Set a key lock	RWLB	00001 (No)(Digit shift) 00026 (2sec)(ENT) 0004A (4sec)(Constant/program) 0005d (5sec)(SET 22 shortcut)

Control setting mode (set4)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
BNK	41025	0400	bANK	Switch to another bank	RWLB	
BKH	41139	0472	bANKH	Bank upper limit setting	RWLB	Pay attention to MODBUS address.
SV1	41027	0402	SV	Control set	RWLB	
SLH	41029	0404	SLH	SV limiter upper limit	RWLB	
SLL	41031	0406	SLL	SV limiter lower limit	RWLB	
<input type="checkbox"/> MD	41033	0408	Md	Control mode	RWLB	00000:RUN 00001:MAN 00002:RdY 00003:TIME1 00004:TIME2 00005:TIME3
CNT	41035	040A	CNT	Set a control type	RWLB	
TYP	41037	040C	tYP	Set a PID control type	RWLB	
BMD	41039	040E	bMd	Set type B mode	RWLB	
DIR	41041	0410	dIR	Set a forward/backward action	RWLB	
MV1	41043	0412	MV1	Main control operation amount	RWLB	
M1G	41045	0414	MV1G	Set an output gain	RWLB	
TUN	41047	0416	tUN	Set a tuning type	RWLB	
ATG	41049	0418	AtG	Set an AT factor	RWLB	
ATC	41051	041A	AtC	Set an AT sensitivity	RWLB	
<input type="checkbox"/> AT	41053	041C	At	Start/stop tuning	RWLB	00000: Stop 00001: Start
<input type="checkbox"/> P1	41055	041E	P1	Set a main control proportional band	RWLB	
<input type="checkbox"/> I1	41057	0420	I	Set an integration time	RWLB	
<input type="checkbox"/> D1	41059	0422	d	Set a derivative time	RWLB	
<input type="checkbox"/> T1	41061	0424	t1	Set a main control proportional period	RWLB	
ARW	41063	0426	ARW	Anti-reset windup	RWLB	
MH1	41065	0428	MLH1	Main control operation amount limiter, upper limit	RWLB	
ML1	41067	042A	MLL1	Main control operation amount limiter, lower limit	RWLB	
OU1	41069	042C	oU1	Set a main control change limiter rise	RWLB	
OD1	41071	042E	od1	Set a main control change limiter decline	RWLB	
SFM	41119	045E	SFM	Set a main control soft-start output	RWLB	Pay attention to MODBUS address.
SFT	41121	0460	SFt	Set a main control soft-start time	RWLB	Pay attention to MODBUS address.
FA1	41073	0430	FAL1	Set a main control anomaly	RWLB	
1TS	41127	0466	tS1	Set a main control loop anomaly PV threshold	RWLB	Pay attention to MODBUS address.
1MS	41129	0468	MS1	Set a main control loop anomaly MV threshold	RWLB	Pay attention to MODBUS address.
1PS	41131	046A	PS1	Set a main control loop anomaly PV change threshold	RWLB	Pay attention to MODBUS address.
LP1	41075	0432	LoP1	Set a main control loop anomaly time	RWLB	
CMD	41077	0434	CMod	Set an OFF point position selection	RWLB	
<input type="checkbox"/> C1	41079	0436	C1	Set a main control sensitivity	RWLB	
CP1	41081	0438	CP1	Set an OFF point position	RWLB	
FD1	41123	0462	Fdt1	Main control protection off timer	RWLB	Pay attention to MODBUS address.
ND1	41141	0474	Ndt1	Main control protection on timer	RWLB	Pay attention to MODBUS address.
MV2	41083	043A	MV2	Auxiliary control operation amount	RWLB	
M2G	41085	043C	MV2G	Set an auxiliary control output gain	RWLB	
<input type="checkbox"/> P2	41087	043E	P2	Set an auxiliary control proportional band	RWLB	
<input type="checkbox"/> T2	41089	0440	t2	Set an auxiliary control proportional period	RWLB	
MH2	41091	0442	MLH2	Auxiliary control operation amount limiter, upper limit	RWLB	
ML2	41093	0444	MLL2	Auxiliary control operation amount limiter, lower limit	RWLB	
OU2	41095	0446	oU2	Set an auxiliary control change limiter rise	RWLB	
OD2	41097	0448	od2	Set an auxiliary control change limiter decline	RWLB	

Control setting mode (set4)

toho Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
FA2	41099	044A	FAL2	Set an auxiliary control anomaly	RWLB	
2TS	41133	046C	tS2	Set an auxiliary control loop anomaly PV threshold	RWLB	Pay attention to MODBUS address.
2MS	41135	046E	MS2	Set an auxiliary control loop anomaly MV threshold	RWLB	Pay attention to MODBUS address.
2PS	41137	0470	PS2	Set an auxiliary control loop anomaly PV change threshold	RWLB	Pay attention to MODBUS address.
LP2	41101	044C	LoP2	Set an auxiliary control loop anomaly time	RWLB	
<input type="checkbox"/> C2	41103	044E	C2	Set an auxiliary control sensitivity	RWLB	
CP2	41105	0450	CP2	Set an auxiliary control OFF point	RWLB	
FD2	41125	0464	Fdt2	Auxiliary control protection off timer	RWLB	Pay attention to MODBUS address.
ND2	41143	0476	Ndt2	Auxiliary control protection on timer	RWLB	Pay attention to MODBUS address.
PBB	41107	0452	Pbb	Manual reset	RWLB	
<input type="checkbox"/> DB	41109	0454	db	Set a dead band	RWLB	
RMP	41111	0456	RMP	Set a lamp time	RWLB	
VLT	41113	0458	Vlt	Set a valve motor stroke time	RWLB	
VDB	41115	045A	Vdb	Set a valve motor drive dead band	RWLB	
ASP	41117	045C	ASP	Post-AT initial aperture	RWLB	

Out1 setting mode (set5)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
O1F	41281	0500	o1F	Set an out1 destination	RWLB	
E11	41283	0502	E1F1	Set an out1 event function 1	RWLB	
E1H	41285	0504	E1H	Set an out1 event upper limit	RWLB	
E1L	41287	0506	E1L	Set an out1 event upper limit	RWLB	
E1C	41289	0508	E1C	Set an out1 event sensitivity	RWLB	
E1T	41291	050A	E1t	Set an out1 event delay timer	RWLB	
E12	41293	050C	E1F2	Set an out1 event function 2	RWLB	
E13	41295	050E	E1F3	Set an out1 event function 3	RWLB	
E14	41297	0510	E1F4	Set an out1 event function 4	RWLB	
E1P	41299	0512	E1P	Set an out1 event polarity	RWLB	
TR1	41301	0514	tRN1	Set an out1 transmission output function	RWLB	
TH1	41303	0516	tRH1	Set an out1 transmission scaling upper limit	RWLB	
TL1	41305	0518	tRL1	Set an out1 transmission scaling lower limit	RWLB	

Out2 setting mode (set6)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
O2F	41537	0600	o2F	Set an out2 destination	RWLB	
E21	41539	0602	E2F1	Set an out2 event function 1	RWLB	
E2H	41541	0604	E2H	Set an out2 event upper limit	RWLB	
E2L	41543	0606	E2L	Set an out2 event upper limit	RWLB	
E2C	41545	0608	E2C	Set an out2 event sensitivity	RWLB	
E2T	41547	060A	E2t	Set an out2 event delay timer	RWLB	
E22	41549	060C	E2F2	Set an out2 event function 2	RWLB	
E23	41551	060E	E2F3	Set an out2 event function 3	RWLB	
E24	41553	0610	E2F4	Set an out2 event function 4	RWLB	
E2P	41555	0612	E2P	Set an out2 event polarity	RWLB	
TR2	41557	0614	tRN2	Set an out2 transmission output function	RWLB	
TH2	41559	0616	tRH2	Set an out2 transmission scaling upper limit	RWLB	
TL2	41561	0618	tRL2	Set an out2 transmission scaling lower limit	RWLB	

Out3 setting mode (set7)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
O3F	41793	0700	o3F	Set an out3 destination	RWLB	
E31	41795	0702	E3F1	Set an out3 event function 1	RWLB	
E3H	41797	0704	E3H	Set an out3 event upper limit	RWLB	
E3L	41799	0706	E3L	Set an out3 event upper limit	RWLB	
E3C	41801	0708	E3C	Set an out3 event sensitivity	RWLB	
E3T	41803	070A	E3t	Set an out3 event delay timer	RWLB	
E32	41805	070C	E3F2	Set an out3 event function 2	RWLB	
E33	41807	070E	E3F3	Set an out3 event function 3	RWLB	
E34	41809	0710	E3F4	Set an out3 event function 4	RWLB	
E3P	41811	0712	E3P	Set an out3 event polarity	RWLB	

Out4 setting mode (set8)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
O4F	42049	0800	o4F	Set an out4 destination	RWLB	
E4I	42051	0802	E4F1	Set an out4 event function 1	RWLB	
E4H	42053	0804	E4H	Set an out4 event upper limit	RWLB	
E4L	42055	0806	E4L	Set an out4 event upper limit	RWLB	
E4C	42057	0808	E4C	Set an out4 event sensitivity	RWLB	
E4T	42059	080A	E4t	Set an out4 event delay timer	RWLB	
E42	42061	080C	E4F2	Set an out4 event function 2	RWLB	
E43	42063	080E	E4F3	Set an out4 event function 3	RWLB	
E44	42065	0810	E4F4	Set an out4 event function 4	RWLB	
E4P	42067	0812	E4P	Set an out4 event polarity	RWLB	

Out5 setting mode (set9)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
O5F	42305	0900	o5F	Set an out5 destination	RWLB	
E5I	42307	0902	E5F1	Set an out5 event function 1	RWLB	
E5H	42309	0904	E5H	Set an out5 event upper limit	RWLB	
E5L	42311	0906	E5L	Set an out5 event upper limit	RWLB	
E5C	42313	0908	E5C	Set an out5 event sensitivity	RWLB	
E5T	42315	090A	E5t	Set an out5 event delay timer	RWLB	
E52	42317	090C	E5F2	Set an out5 event function 2	RWLB	
E53	42319	090E	E5F3	Set an out5 event function 3	RWLB	
E54	42321	0910	E5F4	Set an out5 event function 4	RWLB	
E5P	42323	0912	E5P	Set an out5 event polarity	RWLB	

Out6 setting mode (set10)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
O6F	42561	0A00	o6F	Set an out6 destination	RWLB	
E6I	42563	0A02	E6F1	Set an out6 event function 1	RWLB	
E6H	42565	0A04	E6H	Set an out6 event upper limit	RWLB	
E6L	42567	0A06	E6L	Set an out6 event upper limit	RWLB	
E6C	42569	0A08	E6C	Set an out6 event sensitivity	RWLB	
E6T	42571	0A0A	E6t	Set an out6 event delay timer	RWLB	
E62	42573	0A0C	E6F2	Set an out6 event function 2	RWLB	
E63	42575	0A0E	E6F3	Set an out6 event function 3	RWLB	
E64	42577	0A10	E6F4	Set an out6 event function 4	RWLB	
E6P	42579	0A12	E6P	Set an out6 event polarity	RWLB	

Out7 setting mode (set11)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
O7F	42817	0B00	o7F	Set an out7 destination	RWLB	
E7I	42819	0B02	E7F1	Set an out7 event function 1	RWLB	
E7H	42821	0B04	E7H	Set an out7 event upper limit	RWLB	
E7L	42823	0B06	E7L	Set an out7 event upper limit	RWLB	
E7C	42825	0B08	E7C	Set an out7 event sensitivity	RWLB	
E7T	42827	0B0A	E7t	Set an out7 event delay timer	RWLB	
E72	42829	0B0C	E7F2	Set an out7 event function 2	RWLB	
E73	42831	0B0E	E7F3	Set an out7 event function 3	RWLB	
E74	42833	0B10	E7F4	Set an out7 event function 4	RWLB	
E7P	42835	0B12	E7P	Set an out7 event polarity	RWLB	

CT setting mode (set12)

toho		modbus		Screen character	Name	Command	Remark
Identifier	Absolute (DEC)	Relative (hex)					
CI1	43073	0C00	C11	Set a CT1 detection destination	RWLB		
CM1	43075	0C02	CM1	Monitor the CT1 current	RLB	HHHHH: Overscale	
CT1	43077	0C04	Ct1	Set a CT1 abnormal current	RWLB		
CI2	43079	0C06	CI2	Set a CT2 detection destination	RWLB		
CM2	43081	0C08	CM2	Monitor the CT2 current	RLB	HHHHH: Overscale	
CT2	43083	0C0A	Ct2	Set a CT2 abnormal current	RWLB		

DI setting mode (set13)

toho		modbus		Screen character	Name	Command	Remark
Identifier	Absolute (DEC)	Relative (hex)					
DIF	43329	0D00	dIF	Set a di function	RWLB	Ex.) DI (4,3,2,1) 00000 (None, None, None, None) 00026 (None, None, RDY, Timer) 05008 (AT, None, None, Step)	
DIP	43331	0D02	dIP	Set a di polarity	RWLB		

* DI function setting (DIF): For MODBUS, letter characters (ASCII code) are handled as data.

Timer 1 setting mode (set14)

toho		modbus		Screen character	Name	Command	Remark
Identifier	Absolute (DEC)	Relative (hex)					
TMF	43585	0E00	tMF1	Set a timer 1 function	RWLB		
<input type="checkbox"/> HM	43587	0E02	H/M1	Set a timer 1 unit	RWLB		
TSV	43589	0E04	tSV1	Set a timer 1 SV allowable range	RWLB		
ONT	43591	0E06	oNt1	Timer 1 ON delay timer	RWLB		
OFT	43593	0E08	oFt1	Timer 1 OFF delay timer	RWLB		
<input type="checkbox"/> TC	43595	0E0A	RUN1	Set a timer 1 repetition count	RWLB		
TIA	43597	0E0C	tIA1	Monitor the timer 1 residual time	RWLB		

Timer 2 setting mode (set15)

toho		modbus		Screen character	Name	Command	Remark
Identifier	Absolute (DEC)	Relative (hex)					
TM2	43841	0F00	tMF2	Set a timer 2 function	RWLB		
HM2	43843	0F02	H/M2	Set a timer 2 unit	RWLB		
TS2	43845	0F04	tSV2	Set a timer 2 SV allowable range	RWLB		
ON2	43847	0F06	oNt2	Timer 2 ON delay timer	RWLB		
OF2	43849	0F08	oFt2	Timer 2 OFF delay timer	RWLB		
TC2	43851	0F0A	RUN2	Set a timer 2 repetition count	RWLB		
TA2	43853	0F0C	tIA2	Monitor the timer 2 residual time	RWLB		

Timer 3 setting mode (set16)

toho		modbus		Screen character	Name	Command	Remark
Identifier	Absolute (DEC)	Relative (hex)					
TM3	44097	1000	tMF3	Set a timer 3 function	RWLB		
HM3	44099	1002	H/M3	Set a timer 3 unit	RWLB		
TS3	44101	1004	tSV3	Set a timer 3 SV allowable range	RWLB		
ON3	44103	1006	oNt3	Timer 3 ON delay timer	RWLB		
OF3	44105	1008	oFt3	Timer 3 OFF delay timer	RWLB		
TC3	44107	100A	RUN3	Set a timer 3 repetition count	RWLB		
TA3	44109	100C	tIA3	Monitor the timer 3 residual time	RWLB		

Communication setting mode (set17)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
PRT	44353	1100	PRT	Set a communication protocol	RWLB	
COM	44355	1102	CoM	Set a communication parameter	RWLB	Read/write communication parameter settings Example: □B8N2
BPS	44357	1104	bPS	Set a transmission speed	RWLB	00024 : 2400bps 00048 : 4800bps 00096 : 9600bps 00192 : 19200bps 00384 : 38400bps
ADR	44359	1106	AdR	Set a communication address	RWLB	
AWT	44361	1108	AWt	Set a response delay time	RWLB	
MOD	44363	110A	Mod	Set communication switchover	RWLB	

Initial setting mode (set18)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
NDS	44609	1200	NdSP	PV normal display color	RWLB	For R or W, transmit signals for the password cancel command. Example: Host TTM-200 (01WPAS00000) → ← (01ack) (01WNDS00000) → ← (01ack)
ADL	44627	1212	AdSL	PV color auto-display low	RWLB	
ADM	44629	1214	AdSM	PV color auto-display middle	RWLB	
ADH	44631	1216	AdSH	PV color auto-display high	RWLB	
PVC	44633	1218	PVC	Switchover range for PV display color	RWLB	
E1D	44611	1202	E1dSP	PV event output display color	RWLB	
E2D	44613	1204	E2dSP	PV anomaly display color	RWLB	
E3D	44615	1206	E3dSP	CT anomaly display color	RWLB	
E4D	44617	1208	E4dSP	Loop anomaly display color	RWLB	
BLD	44619	120A	bLd	Set a blind function	RWLB	
BKU	44621	120C	bKUP	Setting backup	LB	
RES	44623	120E	RESEt	Initialize the settings	RWLB	
PAS	44625	1210	PASS	Set a password	WLB	

Priority screen setting mode (set19)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
PR1	44865	1300	PRI01	Set a priority screen 1	RWLB	Read/write priority screen 1 settings Example: □INP1 (screen character)
PR2	44867	1302	PRI02	Set a priority screen 2	RWLB	Read/write priority screen 2 settings Example: □INP1 (screen character)
PR3	44869	1304	PRI03	Set a priority screen 3	RWLB	Read/write priority screen 3 settings Example: □INP1 (screen character)
PR4	44871	1306	PRI04	Set a priority screen 4	RWLB	Read/write priority screen 4 settings Example: □INP1 (screen character)
PR5	44873	1308	PRI05	Set a priority screen 5	RWLB	Read/write priority screen 5 settings Example: □INP1 (screen character)
PR6	44875	130A	PRI06	Set a priority screen 6	RWLB	Read/write priority screen 6 settings Example: □INP1 (screen character)
PR7	44877	130C	PRI07	Set a priority screen 7	RWLB	Read/write priority screen 7 settings Example: □INP1 (screen character)
PR8	44879	130E	PRI08	Set a priority screen 8	RWLB	Read/write priority screen 8 settings Example: □INP1 (screen character)
PR9	44881	1310	PRI09	Set a priority screen 9	RWLB	Read/write priority screen 9 settings Example: □INP1 (screen character)
PRA	44883	1312	PRI10	Set a priority screen 10	RWLB	Read/write priority screen 10 settings Example: □INP1 (screen character)
PRB	44885	1314	PRI11	Set a priority screen 11	RWLB	Read/write priority screen 11 settings Example: □INP1 (screen character)
PRC	44887	1316	PRI12	Set a priority screen 12	RWLB	Read/write priority screen 12 settings Example: □INP1 (screen character)
PRD	44889	1318	PRI13	Set a priority screen 13	RWLB	Read/write priority screen 13 settings Example: □INP1 (screen character)
PRE	44891	131A	PRI14	Set a priority screen 14	RWLB	Read/write priority screen 14 settings Example: □INP1 (screen character)
PRF	44893	131C	PRI15	Set a priority screen 15	RWLB	Read/write priority screen 15 settings Example: □INP1 (screen character)
PRG	44895	131E	PRI16	Set a priority screen 16	RWLB	Read/write priority screen 16 settings Example: □INP1 (screen character)

Bank setting mode (set20)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
B01	45121	1400	bNK01	Set bank selection 1	RWLB	Read/write bank selection 1 settings Example: <input type="checkbox"/> INP1 (screen character)
B02	45123	1402	bNK02	Set bank selection 2	RWLB	Read/write bank selection 1 settings Example: <input type="checkbox"/> INP1 (screen character)
B03	45125	1404	bNK03	Set bank selection 3	RWLB	Read/write bank selection 2 settings Example: <input type="checkbox"/> INP1 (screen character)
B04	45127	1406	bNK04	Set bank selection 4	RWLB	Read/write bank selection 4 settings Example: <input type="checkbox"/> INP1 (screen character)
B05	45129	1408	bNK05	Set bank selection 5	RWLB	Read/write bank selection 5 settings Example: <input type="checkbox"/> INP1 (screen character)
B06	45131	140A	bNK06	Set bank selection 6	RWLB	Read/write bank selection 6 settings Example: <input type="checkbox"/> INP1 (screen character)
B07	45133	140C	bNK07	Set bank selection 7	RWLB	Read/write bank selection 7 settings Example: <input type="checkbox"/> INP1 (screen character)
B08	45135	140E	bNK08	Set bank selection 8	RWLB	Read/write bank selection 8 settings Example: <input type="checkbox"/> INP1 (screen character)
B09	45137	1410	bNK09	Set bank selection 9	RWLB	Read/write bank selection 9 settings Example: <input type="checkbox"/> INP1 (screen character)
B10	45139	1412	bNK10	Set bank selection 10	RWLB	Read/write bank selection 10 settings Example: <input type="checkbox"/> INP1 (screen character)
B11	45141	1414	bNK11	Set bank selection 11	RWLB	Read/write bank selection 11 settings Example: <input type="checkbox"/> INP1 (screen character)
B12	45143	1416	bNK12	Set bank selection 12	RWLB	Read/write bank selection 12 settings Example: <input type="checkbox"/> INP1 (screen character)
B13	45145	1418	bNK13	Set bank selection 13	RWLB	Read/write bank selection 13 settings Example: <input type="checkbox"/> INP1 (screen character)
B14	45147	141A	bNK14	Set bank selection 14	RWLB	Read/write bank selection 14 settings Example: <input type="checkbox"/> INP1 (screen character)
B15	45149	141C	bNK15	Set bank selection 15	RWLB	Read/write bank selection 15 settings Example: <input type="checkbox"/> INP1 (screen character)
B16	45151	141E	bNK16	Set bank selection 16	RWLB	Read/write bank selection 16 settings Example: <input type="checkbox"/> INP1 (screen character)

Program function setting mode (set21)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
C/P	45377	1500	C/P	Operating type setting	RWLB	
PMD	45379	1502	PGMd	Program mode setting	RWLB	
POC	45381	1504	PoC	Power failure compensation range setting	RWLB	
HMP	45383	1506	H/Mp	Time unit setting	RWLB	
WAI	45385	1508	WAI	WAIT range setting	RWLB	

Program setting mode (set22)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
SPN	45633	1600	StEPN	Number-of-use-step setting	RWLB	
SB1	45635	1602	St1bK	Step 1 designation bank setting	RWLB	
SS1	45637	1604	SV1	Step SV 1 setting	RWLB	
ST1	45639	1606	TIM1	Step time 1 setting	RWLB	
SB2	45641	1608	St2bK	Step 2 designation bank setting	RWLB	
SS2	45643	160A	SV2	Step SV 2 setting	RWLB	
ST2	45645	160C	TIM2	Step time 2 setting	RWLB	
SB3	45647	160E	St3bK	Step 3 designation bank setting	RWLB	
SS3	45649	1610	SV3	Step SV 3 setting	RWLB	
ST3	45651	1612	TIM3	Step time 3 setting	RWLB	
SB4	45653	1614	St4bK	Step 4 designation bank setting	RWLB	
SS4	45655	1616	SV4	Step SV 4 setting	RWLB	
ST4	45657	1618	TIM4	Step time 4 setting	RWLB	
SB5	45659	161A	St5bK	Step 5 designation bank setting	RWLB	
SS5	45661	161C	SV5	Step SV 5 setting	RWLB	
ST5	45663	161E	TIM5	Step time 5 setting	RWLB	
SB6	45665	1620	St6bK	Step 6 designation bank setting	RWLB	
SS6	45667	1622	SV6	Step SV 6 setting	RWLB	
ST6	45669	1624	TIM6	Step time 6 setting	RWLB	
SB7	45671	1626	St7bK	Step 7 designation bank setting	RWLB	
SS7	45673	1628	SV7	Step SV 7 setting	RWLB	
ST7	45675	162A	TIM7	Step time 7 setting	RWLB	
SB8	45677	162C	St8bK	Step 8 designation bank setting	RWLB	
SS8	45679	162E	SV8	Step SV 8 setting	RWLB	
ST8	45681	1630	TIM8	Step time 8 setting	RWLB	
RST	45683	1632	StRSt	Repetitive start step setting	RWLB	
EST	45685	1634	ENdSt	Repetitive end step setting	RWLB	00001 to 8: End step 1 to 8 00009: StEPN
□SC	45687	1636	RUNP	Execution count setting	RWLB	

Bank automatic switching function setting mode (set23)

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
BAF	45889	1700	bAF	Bank automatic switching function selection	RWLB	
BAS	45891	1702	bAS	Bank automatic switching source setting	RWLB	
PM1	45893	1704	PM1	Zone threshold 1 setting	RWLB	
PM2	45895	1706	PM2	Zone threshold 2 setting	RWLB	
PM3	45897	1708	PM3	Zone threshold 3 setting	RWLB	
PM4	45899	170A	PM4	Zone threshold 4 setting	RWLB	
PM5	45901	170C	PM5	Zone threshold 5 setting	RWLB	
PM6	45903	170E	PM6	Zone threshold 6 setting	RWLB	
PM7	45905	1710	PM7	Zone threshold 7 setting	RWLB	
ASC	45907	1712	ASC	Zone threshold sensitivity range setting	RWLB	

Identifier	modbus		Screen character	Name	Command	Remark
	Absolute (DEC)	Relative (hex)				
TST	48193	2000		Start/stop timer 1	RW	00000: Stop 00001: Start
TT2	48195	2002		Start/stop timer 2	RW	00000: Stop 00001: Start
TT3	48197	2004		Start/stop timer 3	RW	00000: Stop 00001: Start
OM1	48199	2006		Output monitor 1"	R	00000 ||| ||+--out1 ||+---out2 |+---out3 +----out4
OM2	48201	2008		Output monitor 2"	R	00000 ||| ||+--out5 |+---out6 +----out7
EM1	48203	200A		DI monitor	R	00000 ||| ||+--DI1 ||+---DI2 |+---DI3 +----DI4
BM1	48205	200C		Bank monitor	R	
STR	48207	200E		Store instruction	W	
001				Input 1 setting mode (for blinding only)	LB	
002				Input 2 setting mode (for blinding only)	LB	
003				Key function setting mode (for blinding only)	LB	
004				Control setting mode (for blinding only)	LB	
005				Out1 setting mode (for blinding only)	LB	
006				Out2 setting mode (for blinding only)	LB	
007				Out3 setting mode (for blinding only)	LB	
008				Out4 setting mode (for blinding only)	LB	
009				Out5 setting mode (for blinding only)	LB	
010				Out6 setting mode (for blinding only)	LB	
011				Out7 setting mode (for blinding only)	LB	
012				CT setting mode (for blinding only)	LB	
013				DI setting mode (for blinding only)	LB	
014				Timer 1 setting mode (for blinding only)	LB	
015				Timer 2 setting mode (for blinding only)	LB	
016				Timer 3 setting mode (for blinding only)	LB	
017				Communication setting mode (for blinding only)	LB	
018				Initial setting mode (for blinding only)	LB	
019				Priority screen setting mode (for blinding only)	LB	
020				Bank screen setting mode (for blinding only)	LB	
021				Program function setting mode (for blinding only)		
022				Program setting mode (for blinding only)		
023				Bank automatic switching function setting mode (for blinding only)		
TB1				Timer 1 screen	LB	
TB2				Timer 2 screen	LB	
TB3				Timer 3 screen	LB	
CSV	48449	2100		Control SV	R	
PV2	48451	2102		Input 2 read	R	
STP	48453	2104		Current step monitor	R	
RUN	48455	2106		Execution count monitor	R	

11. Table of ASCII codes

Upper Lower	00h	10h	20h	30h	40h	50h	60h	70h	
	00h	NUL	DLE	SPACE	0	@	P	`	p
	01h	SOH	DC1	!	1	A	Q	a	q
	02h	STX	DC2	"	2	B	R	b	r
	03h	ETX	DC3	#	3	C	S	c	s
	04h	EOT	DC4	\$	4	D	T	d	t
	05h	ENQ	NAK	%	5	E	U	e	u
	06h	ACK	SYN	&	6	F	V	f	v
	07h	BEL	ETB	'	7	G	W	g	w
	08h	BS	CAN	(	8	H	X	h	x
	09h	HT	EM	)	9	I	Y	i	y
	0Ah	LF	SUB	*	:	J	Z	j	z
	0Bh	VT	ESC	+	;	K	[	k	{
	0Ch	FF	FS	,	<	L	¥	l	|
	0Dh	CR	GS	-	=	M	]	m	}
	0Eh	SO	RS	.	>	N	^	n	~
	0Fh	SI	US	/	?	O	_	o	DEL

※How to look at ASCII Code table

(ASCII Code) = (Upper Level) + (Lower Level)

Ex. 1) In case of "A": (41h) = (40h) + (01h)

Ex. 2) In case of "M": (6Dh) = (60h) + (0Dh)

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