COMMUNICATION INSTRUCTION MANUAL

PCD-33A (C5, SVTC)

No.PCD3CE3 2017.10

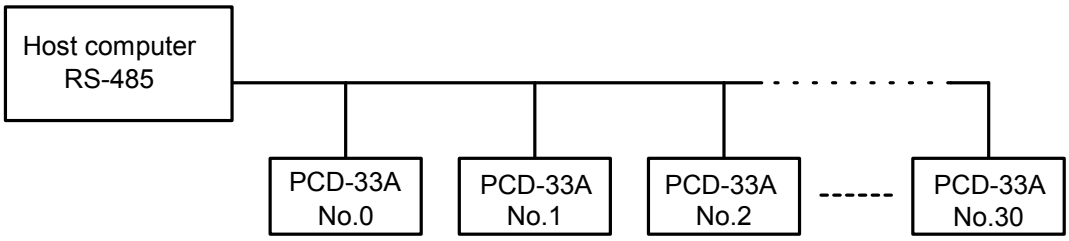
This manual contains instructions for the communication functions, operations and notes when operating the PCD-33A.
To prevent accidents arising from the misuse of this controller, please ensure the operator receives this manual.

⚠ Warning

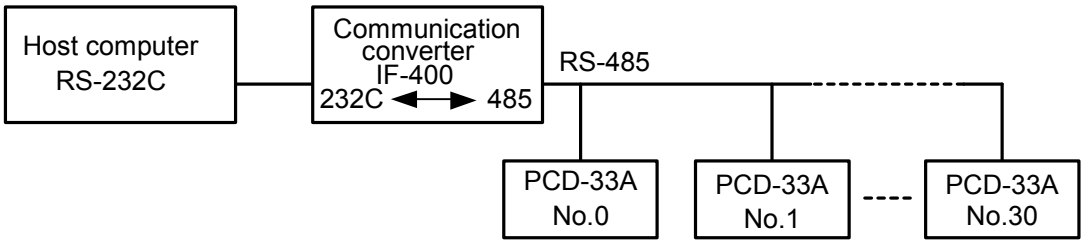
Turn the power supply to the instrument off before wiring or checking.
Working on or touching the terminal with the power switched on may result in severe injury or death due to electrical shock.

1. System configuration

RS-485 multi-drop connection communication (C5 option)

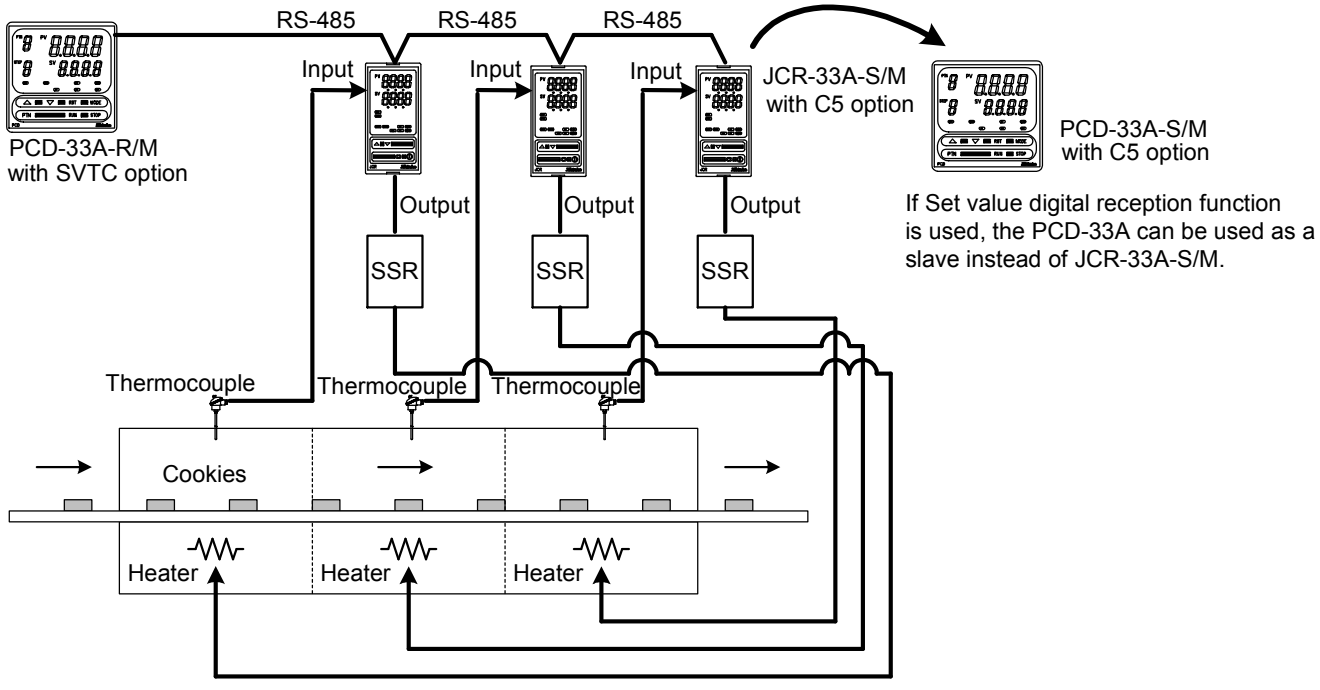


(Fig. 1-1)



(Fig. 1-2)

Set value digital transmission (SVTC option) applications example



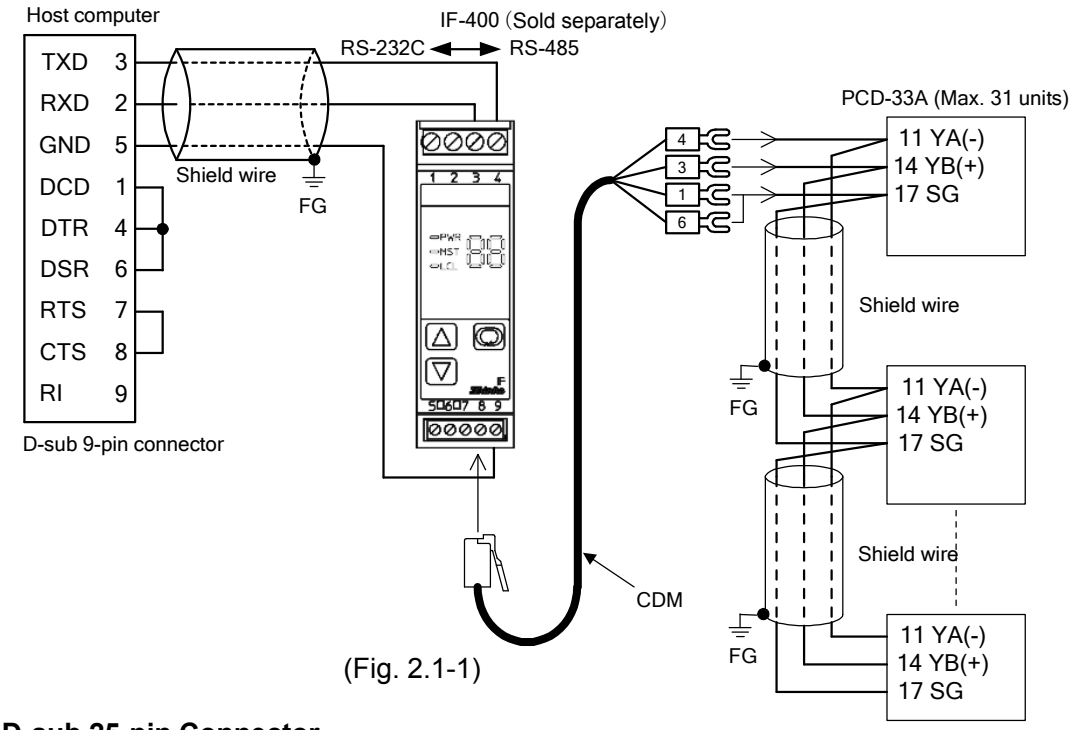
(Fig. 1-3)

2. Wiring

2.1 Serial communication (C5 option)

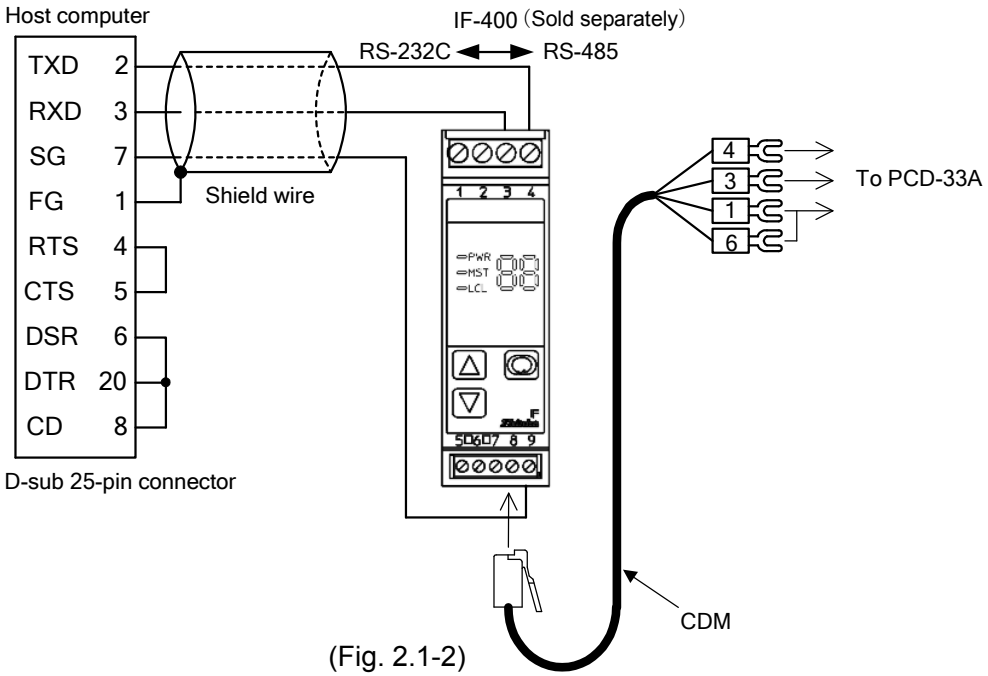
When using communication converter IF-400

• **D-sub 9-pin connector**



(Fig. 2.1-1)

• **D-sub 25-pin Connector**



(Fig. 2.1-2)

Shield Wire

Connect only one end of the shield to avoid a ground loop. If both ends of the shield wire are connected, the circuit will be closed, resulting in a ground loop. This may cause noise.

Recommended cable: OTSC-VB 2PX0.5SQ (made by Onamba Co., Ltd.) or equivalent (Use a twisted pair cable.)

Terminator (Terminal resistor)

The terminator is mounted at the end of the wire when connecting multiple peripheral devices to a personal computer. The terminator prevents signal reflection and disturbance.

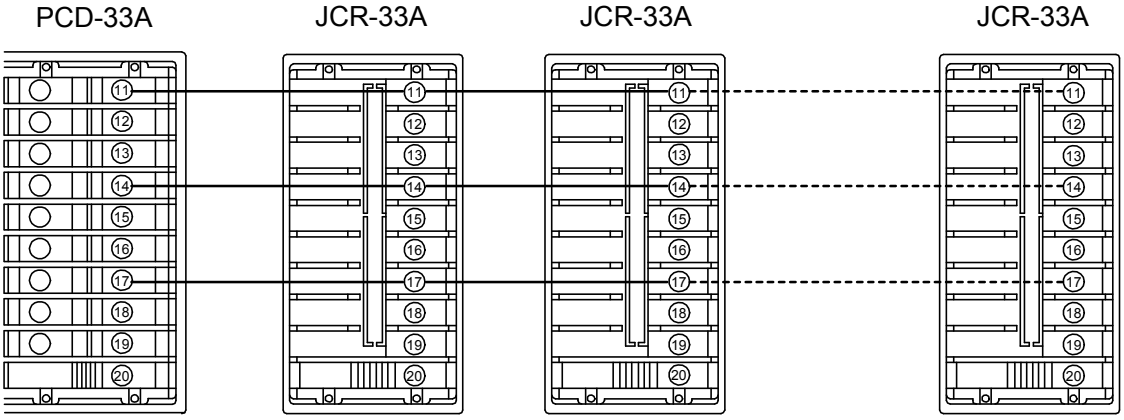
Do not connect the terminator to the communication line because each PCD-33A has built-in pull-up and pull-down resistors instead of a terminator.

2.2 Set value digital transmission (SVTC option)

For the wiring of the Set value digital transmission, connect YA (-) to YA (-), YB (+) to YB (+) and SG to SG respectively.

A maximum of 31 units of controller can be connected.

The following shows a connection example for Set value digital transmission between the PCD-33A and JCR-33A



(Fig. 2.2-1)

3. Setup of the PCD-33A

Set communication parameters using front keypad. (Refer to the Instruction manual for the PCD-33A.)

3.1 Serial communication (C5 option)

(1) Communication protocol
Select a communication protocol (Shinko protocol, Modbus ASCII, Modbus RTU). (Default: Shinko protocol)

(2) Instrument number
Set an instrument number (0 to 95) to each controller individually when communicating by connecting plural units. (Default: 0)

(3) Communication speed
Select a communication speed (2400 bps, 4800 bps, 9600 bps, 19200 bps) equal to that of the host computer. (Default: 9600 bps)

(4) Parity (*)
Select the parity (Odd, Even, No parity) equal to that of the host computer. (Default: Even parity)

(5) Stop bit (*)
Select the stop bit (1 or 2) equal to that of the host computer. (Default: Stop bit 1)

(*) This item is available only when Modbus ASCII mode or Modbus RTU mode is selected.

3.2 Set value digital transmission (SVTC option)

When this function is used, the received SV will not be memorized as it is not written in the non-volatile memory of the connected controllers.

To use the Set value digital transmission and Set value digital reception function, select a communication protocol as follows.

Setting procedure for Set value digital transmission between PCD-33A and JCR-33A

(1) Setting the PCD-33A
If the SVTC option is added, it is not necessary to set any item.
Check if Set value digital transmission [SVT□] has been selected in [Communication protocol, COML] in Auxiliary function setting mode 1.

(2) Setting the JCR-33A
Check if the communication speed in Auxiliary function setting mode 1 is identical to that of PCD-33A.

(3) Starting Set value digital transmission
Enter the program set value on PCD-33A.
If the program is initiated by pressing the RUN key, the set values of the PCD-33A are sent to the JCR-33A.
During program standby mode, 0 (zero) is sent to the JCR-33A.

Setting procedure for Set value digital transmission between PCD-33A units

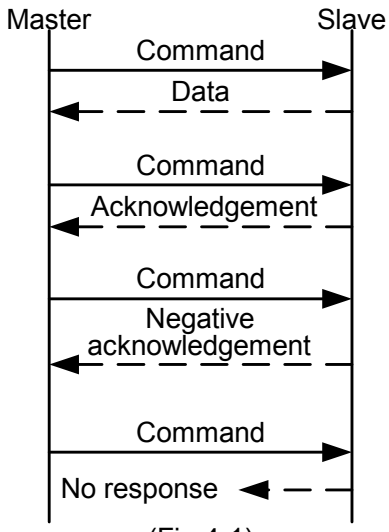
(1) Setting the PCD-33A with Set value digital transmission
If the SVTC option is added, it is not necessary to set any item.
Check if Set value digital transmission [SVT□] has been selected in [Communication protocol, COM] in Auxiliary function setting mode 1.

(2) Setting the PCD-33A with Set value digital reception
Check if Set value digital reception [SVTr] has been selected in [Communication protocol, COM] in Auxiliary function setting mode 1.
Check if the communication speed is identical to that of the PCD-33A with Set value digital transmission.

(3) Starting Set value digital transmission
Enter the program set values on PCD-33A with Set value digital transmission.
If the program is initiated by pressing the RUN key, the set values of the PCD-33A with Set value Digital transmission will be sent to the PCD-33A with Set value digital reception.
During program control standby, 0 (zero) is sent to the PCD-33A with Set value digital reception.

4. Communication procedure

Communication starts with command transmission from the host computer (hereafter Master) and ends with the response of the PCD-33A (hereafter Slave).



(Fig.4-1)

- **Response with data**
  When the master sends the Read command, the slave responds with the corresponding set value or current status.
- **Acknowledgement**
  When the master sends the Set command, the slave responds by sending the acknowledgement after the processing is terminated.
- **Negative acknowledgement**
  When the master sends a non-existent command or a value out of the setting range, the slave returns a negative acknowledgement.
- **No response**
  The slave will not respond to the master in the following cases:
- Global address (Shinko protocol) is set.
- Broadcast address (Modbus protocol) is set.
- Communication error (framing error, parity error)
- Checksum error (Shinko protocol), LRC discrepancy (Modbus ASCII), CRC-16 discrepancy (Modbus RTU)

Communication timing of the RS-485 (C5 option)

Master side (Take note while programming)

When the master starts transmission through the RS-485 communication line, the master is arranged so as to provide an idle status (mark status) transmission period of 1 or more characters before sending the command to ensure synchronization on the receiving side.
Set the program so that the master can disconnect the transmitter from the communication line within a 1 character transmission period after sending the command in preparation for reception of the response from the slave.
To avoid collision of transmissions between the master and the slave, send the next command after carefully checking that the master has received the response.
If a response to the command is not returned due to communication errors, set the Retry Processing to send the command again. (It is recommended to execute Retry twice or more.)

Slave side

When the slave starts transmission through the RS-485 communication line, the slave is arranged so as to provide an idle status (mark status) transmission period of 1 or more characters before sending the response to ensure synchronization on the receiving side.
The slave is arranged so as to disconnect the transmitter from the communication line within a 1 character transmission period after sending the response.

5. Shinko protocol

5.1 Transmission mode

Shinko protocol is composed of ASCII codes.
Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.

Data format Start bit: 1 bit
Data bit: 7 bits
Parity: Even
Stop bit: 1 bit
Error detection: Checksum

5.2 Command configuration

All commands are composed of ASCII. The data (set value, decimal number) is represented by a hexadecimal number. The negative numbers are represented in 2's complement. Numerals written below the command represent the number of characters.

(1) Setting command

Header (02H)	Address	Sub address (20H)	Command type (50H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(2) Reading command

Header (02H)	Address	Sub address (20H)	Command type (20H)	Data item	Checksum	Delimiter (03H)
1	1	1	1	4	2	1

(3) Response with data

Header (06H)	Address	Sub address (20H)	Command type (20H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(4) Acknowledgement

Header (06H)	Address	Checksum	Delimiter (03H)
1	1	2	1

(5) Negative acknowledgement

Header (15H)	Address	Error code	Checksum	Delimiter (03H)
1	1	1	2	1

Header: Control code to represent the beginning of the command or the response.
ASCII codes are used.
Setting command, Reading command : STX(02H) fixed
Response with data, Acknowledgement : ACK(06H) fixed
Negative acknowledgement : NAK(15H) fixed

Address (Instrument number): Numbers by which the master discerns each slave.
Instrument number 0 to 94 and Global address 95.
ASCII codes (20H to 7FH) are used by adding 20H to instrument numbers 0 to 95 (00H to 5FH).
95 (7FH) is called the Global address, which is used when the same command is sent to all the slaves connected. However, a response is not returned.

Sub address: (20H) fixed

Command type: Code to discern Setting command (50H) and Reading command (20H).

Data item: Data classification of the command object.
Composed of 4-digit hexadecimal numbers, using ASCII.
(Refer to the Communication command table.)

Data: The contents of data (set value) differs depending on the setting command.
Composed of 4-digit hexadecimal numbers, using ASCII.
(Refer to the Communication command table.)

Checksum: 2-character data to detect communication errors.

Delimiter: Control code to represent the end of command.
ASCII code ETX (03H) fixed

Error code: Represents an error type using ASCII.
1 (31H)-----Non-existent command
2 (32H)-----Not used
3 (33H)-----Set value outside the setting range
4 (34H)-----Status unable to be set (e.g. AT is performing)
5 (35H)-----During setting mode by keypad operation

5.3 Checksum calculation

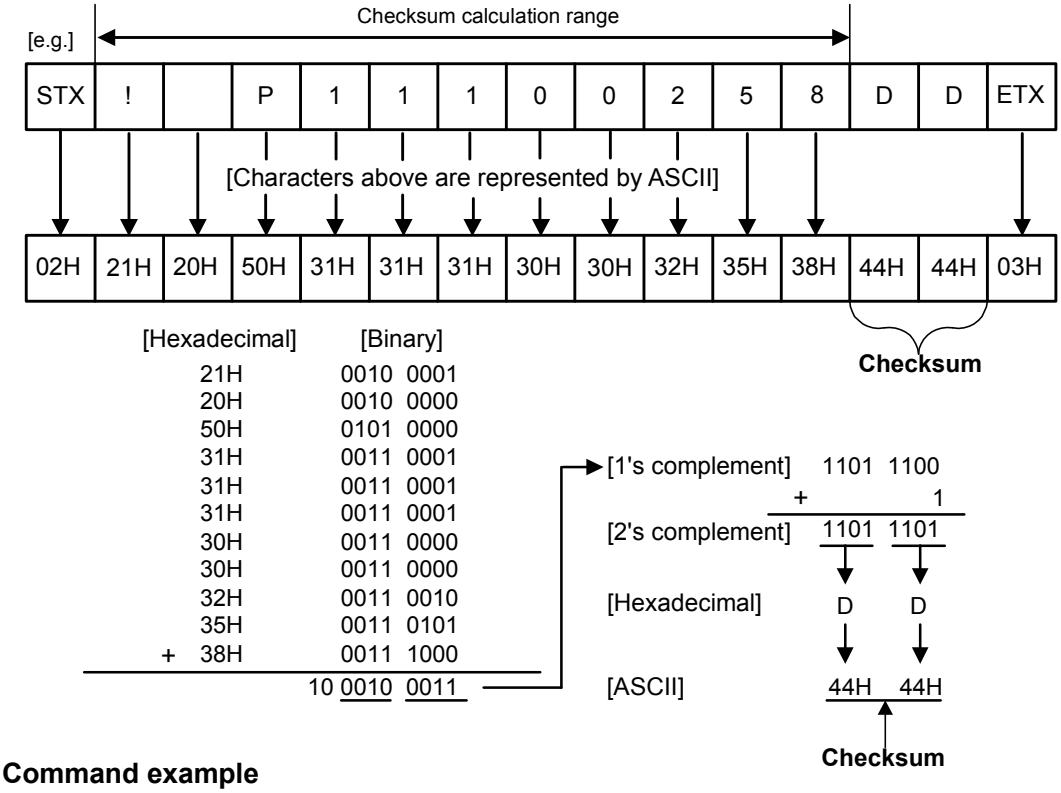
Checksum is used to detect receiving errors in the command or data.
Set the program for the master side as well to calculate the checksum of the response data from the slaves so that the communication errors can be checked.

The ASCII code (hexadecimal) corresponding to the characters which range from the address to that before the checksum is converted to binary notation, and the total value is calculated.
The lower one byte of the total value is converted to 2's complement and then to hexadecimal numbers, that is, ASCII code for the checksum.

Checksum calculation example

Pattern 1, Step 1 SV: 600℃ (0258H)
Address (instrument number): 1 (21H)

- 1's complement: Reverse each binary bit. 0 will become 1 and vice versa.
- 2's complement: Add 1 to 1's complement.



5.4 Command example

(1) Reading (Address 1, PV)

Numerals written below the command represent the number of characters.

- Reading command from the master

Header	Address	Sub address	Command type	Data item [0080H]	Checksum	Delimiter
(02H)	(21H)	(20H)	(20H)	(30H 30H 38H 30H)	(44H 37H)	(03H)
1	1	1	1	4	2	1

- Response from the slave in normal status [When PV=25℃ (0019H)]

Header	Address	Sub address	Command type	Data item [0080H]	Data [0019H]	Checksum	Delimiter
(06H)	(21H)	(20H)	(20H)	(30H 30H 38H 30H)	(30H 30H 31H 39H)	(30H 44H)	(03H)
1	1	1	1	4	4	2	1

(2) Reading (Address 1, Pattern 1, Step 1 SV)

- Reading command from the master

Header	Address	Sub address	Command type	Data item [1110H]	Checksum	Delimiter
(02H)	(21H)	(20H)	(20H)	(31H 31H 31H 30H)	(44H 43H	(03H)
1	1	1	1	4	2	1

- Response from the slave in normal status [When Step SV=600℃ (0258H)]

Header	Address	Sub address	Command type	Data item [1110H]	Data [0258H]	Checksum	Delimiter
(06H)	(21H)	(20H)	(20H)	(31H 31H 31H 30H)	(30H 32H 35H 38H)	(30H 44H)	(03H)
1	1	1	1	4	4	2	1

(3) Setting (Address 1, Pattern 1, Step 1 SV) [when setting Step 1 SV to 600℃ (0258H)]

- Setting command from the master

Header	Address	Sub address	Command type	Data item [1110H]	Data [0258H]	Checksum	Delimiter
(02H)	(21H)	(20H)	(50H)	(31H 31H 31H 30H)	(30H 32H 35H 38H)	(44H 44H)	(03H)
1	1	1	1	4	4	2	1

- Response from the slave in normal status

Header	Address	Checksum	Delimiter
(06H)	(21H)	(44H 46H)	(03H)
1	1	2	1

6. Modbus protocol

6.1 Transmission mode

There are 2 transmission modes (ASCII and RTU) in Modbus protocol.

6.2 ASCII mode

Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in the command is transmitted as ASCII characters.

Data format Start bit: 1 bit
Data bit: 7 bits
Parity: Even/No parity/Odd (Selectable)
Stop bit: 1 bit/2 bits (Selectable)
Error detection: LRC (Longitudinal Redundancy Check)
Data interval: 1 second or less (Max.1 sec of interval between characters)

(1) Message configuration

ASCII mode message is configured to start by [: (colon)(3AH)] and end by [CR (carriage return) (0DH) + LF (Line feed)(0AH)].

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

Slave address

Slave address is an individual instrument number on the slave side, and is set within the range 0 to 95 (00H to 5FH).
The master identifies slaves by the slave address of the requested message.
The slave informs the master which slave is responding to the master by placing its own address in the response message.
[Slave address 0 (00H, broadcast address) can identify all the slaves. However slaves do not respond.]

Function code

The function code is the command code for the slave to undertake the following action types.

(Table 6.2-1)

Function code	Contents
03 (03H)	Reading the set value and information from slaves
06 (06H)	Setting to slaves

Function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master.
When acknowledgement is returned, the slave simply returns the original function code.
When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.
(For example, when the master sends a request message setting 10H for the function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.)
For negative acknowledgement, the exception codes (Table 6.2-2) below are set to the data of response message, and returned to the master in order to inform it of what kind of error has occurred.

(Table 6.2-2)

Exception code	Contents
1 (01H)	Illegal function (Non-existent function)
2 (02H)	Illegal data address (Non-existent data address)
3 (03H)	Illegal data value (Value out of the setting range)
17 (11H)	Shinko error code 4 (Status unable to be set)
18 (12H)	Shinko error code 5 (During setting mode by keypad operation)

Data

Data differs depending on the function code.
A request message from the master is composed of data item, amount of data and setting data.
A response message from the slave is composed of number of bytes, data and exception code in negative acknowledgement. Effective range of data is –32768 to 32767 (8000H to 7FFFH).

Error check: 2-character data to detect communication errors. [Refer to (2) Error check of ASCII mode.]

(2) Error check of ASCII mode

After calculating LRC (Longitudinal Redundancy Check) from the slave address to the end of data, the calculated 8-bit data is converted to two ASCII characters, and are appended to the end of the message.

How to calculate LRC

① Create a message in RTU mode.
② Add all the values from the slave address to the end of data. This is assumed as X.
③ Make a complement for X (bit reverse). This is assumed as X.
④ Add a value of 1 to X. This is assumed as X.
⑤ Set X as an LRC to the end of the message.
⑥ Convert the whole message to ASCII characters.

(3) Message example of ASCII mode

Numerals written below the command represent the number of characters.

① **Reading (Slave address 1, PV)**

• A request message from the master

The amount of data means the data item to be read, and it is fixed as 1 (30H 30H 30H 31H).

Header	Slave address	Function code	Data item	Amount of data	Error check	Delimiter
(3AH)	(30H 31H)	(30H 33H)	[0080H] (30H 30H 38H 30H)	[0001H] (30H 30H 30H 31H)	LRC (37H 42H)	CR+LF (0DH 0AH)
1	2	2	4	4	2	2

• Response message from the slave in normal status [When PV=600℃ (0258H)]

The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (30H 32H).

Header	Slave address	Function code	Number of response bytes	Data	Error check	Delimiter
(3AH)	(30H 31H)	(30H 33H)	[02H] (30H 32H)	[0258H] (30H 32H 35H 38H)	LRC (41H 30H)	CR+LF (0DH 0AH)
1	2	2	2	4	2	2

② **Reading (Slave address 1, Pattern 1, Step 1 SV)**

• A request message from the master

The amount of data means the data item to be read, and it is fixed as 1 (30H 30H 30H 31H).

Header	Slave address	Function code	Data item	Amount of data	Error check	Delimiter
(3AH)	(30H 31H)	(30H 33H)	[1110H] (31H 31H 31H 30H)	[0001H] (30H 30H 30H 31H)	LRC (44H 41H)	CR+LF (0DH 0AH)
1	2	2	4	4	2	2

• Response message from the slave in normal status [When Step SV=600℃ (0258H)]

The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (30H 32H).

Header	Slave address	Function code	Number of response bytes	Data	Error check	Delimiter
(3AH)	(30H 31H)	(30H 33H)	[02H] (30H 32H)	[0258H] (30H 32H 35H 38H)	LRC (41H 30H)	CR+LF (0DH 0AH)
1	2	2	2	4	2	2

• Response message from the slave in exception (error) status (When a data item has been mistaken)

The function code MSB is set to 1 for the response message in exception (error) status [83H (38H 33H)].
The exception code 02H (30H 32H: Non-existent data address) is returned (error).

Header	Slave address	Function code	Exception code	Error check	Delimiter
(3AH)	(30H 31H)	(38H 33H)	[02H] (30H 32H)	LRC (37H 41H)	CR+LF (0DH 0AH)
1	2	2	2	2	2

③ **Setting (Slave address 1, Pattern 1, Step 1 SV)** [When setting Step 1 SV to 600℃ (0258H)]

• A request message from the master

Header	Slave address	Function code	Data item	Data	Error check	Delimiter
(3AH)	(30H 31H)	(30H 36H)	[1110H] (31H 31H 31H 30H)	[0258H] (30H 32H 35H 38H)	LRC (37H 45H)	CR+LF (0DH 0AH)
1	2	2	4	4	2	2

• Response message from the slave in normal status

Header	Slave address	Function code	Data item	Data	Error check	Delimiter
(3AH)	(30H 31H)	(30H 36H)	[1110H] (31H 31H 31H 30H)	[0258H] (30H 32H 35H 38H)	LRC (37H 45H)	CR+LF (0DH 0AH)
1	2	2	4	4	2	2

• Response message from the slave in exception (error) status (When a value out of the setting range is set)

The function code MSB is set to 1 for the response message in exception (error) status [86H (38H 36H)].
The exception code 03H (30H 33H: Value out of the setting range) is returned (error).

Header	Slave address	Function code	Exception code	Error check	Delimiter
(3AH)	(30H 31H)	(38H 36H)	[03H] (30H 33H)	LRC (37H 36H)	CR+LF (0DH 0AH)
1	2	2	2	2	2

6.3 RTU mode

8-bit binary data in command is transmitted as it is.

Data format Start bit: 1 bit
Data bit: 8 bits
Parity: Even/No parity/Odd (Selectable)
Stop bit: 1 bit/2 bits (Selectable)

Error detection : CRC-16 (Cyclic Redundancy Check)

Data interval : 3.5 characters transmission time or less
To transmit continuously, an interval between characters which consist of one message, must be within 3.5 character transmission times.

(1) Message configuration

RTU mode is configured to start after idle time is processed for more than a 3.5 characters transmission, and end after idle time is processed for more than a 3.5 characters transmission.

3.5 idle characters	Slave address	Function Code	Data	Error check CRC-16	3.5 idle characters

Slave address

Slave address is an individual instrument number on the slave side and is set within the range 0 to 95 (00H to 5FH).

The master identifies slaves by the slave address of the requested message.

The slave informs the master which slave is responding to the master by placing its own address in the response message.

[Slave address 0 (00H, broadcast address) can identify all the slaves. However slaves do not respond.]

Function code

The function code is the command code for the slave to undertake the following action types (Table 6.3-1).

(Table 6.3-1)

Function code	Contents
03 (03H)	Reading the set value and information from slaves
06 (06H)	Setting to slaves

Function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master.

When acknowledgement is returned, the slave simply returns the original function code.

When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.

(For example, when the master sends request message setting 10H for the function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.)

For negative acknowledgement, the exception codes (Table 6.3-2) below are set to the data of response message, and returned to the master in order to inform it of what kind of error has occurred.

(Table 6.3-2)

Exception code	Contents
1 (01H)	Illegal function (Non-existent function)
2 (02H)	Illegal data address (Non-existent data address)
3 (03H)	Illegal data value (Value out of the setting range)
17 (11H)	Shinko error code 4 (Status unable to be set)
18 (12H)	Shinko error code 5 (During setting mode by keypad operation)

Data

Data differs depending on the function code.

A request message from the master side is composed of data item, amount of data and setting data.

A response message from the slave side is composed of number of bytes, data and exception code in negative acknowledgement. Effective range of data is –32768 to 32767 (8000H to 7FFFH).

Error check: 16-bit data to detect communication errors. [Refer to (2) Error check of RTU mode.]

(2) Error check of RTU mode

After calculating CRC-16 (Cyclic Redundancy Check) from the slave address to the end of data, the calculated 16-bit data is appended to the end of the message in sequence from low order to high order.

How to calculate CRC-16

In the CRC-16 system, the information is divided by the polynomial series. The remainder is added to the end of the information and transmitted. The generation of a polynomial series is as follows.

(Generation of a polynomial series: $X^{16} + X^{15} + X^{2} + 1$)

① Initialize the CRC-16 data (assumed as X) (FFFFH).
② Calculate exclusive OR (XOR) with the 1st data and X. This is assumed as X.
③ Shift X one bit to the right. This is assumed as X.
④ When a carry is generated as a result of the shift, XOR is calculated by X of ③ and the fixed value (A001H). This is assumed as X. If a carry is not generated, go to step ⑤.
⑤ Repeat steps ③ and ④ until shifting 8 times.
⑥ XOR is calculated with the next data and X. This is assumed as X.
⑦ Repeat steps ③ to ⑤.
⑧ Repeat steps ③ to ⑤ up to the last data.
⑨ Set X as CRC-16 to the end of message in sequence from low order to high order.

(3) Message example of RTU mode

Numerals written below the command represent the number of characters.

① **Reading (Slave address 1, PV)**

• Request message from the master

The amount of data means the data item to be read, and it is fixed as 1 (0001H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (0080H)	Amount of data (0001H)	Error check CRC-16 (85E2H)	3.5 idle characters
	1	1	2	2	2	

• Response message from the slave in normal status [When PV=600℃ (0258H)]

The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (02H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Number of response bytes (02H)	Data (0258H)	Error check CRC-16 (B8DEH)	3.5 idle characters
	1	1	1	2	2	

② **Reading (Slave address 1, Pattern 1, Step 1 SV)**

• A request message from the master

The amount of data means the data item to be read, and it is fixed as 1 (0001H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (1110H)	Amount of data (0001H)	Error check CRC-16 (80F3H)	3.5 idle characters
	1	1	2	2	2	

• Response message from the slave in normal status [When Step SV=600℃ (0258H)]

The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (02H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Number of response bytes (02H)	Data (0258H)	Error check CRC-16 (B8DEH)	3.5 idle characters
	1	1	1	2	2	

• Response message from the slave in exception (error) status (When data item is mistaken)

The function code MSB is set to 1 for the response message in exception (error) status (83H).
The exception code (02H: Non-existent data address) is returned (error).

3.5 idle characters	Slave address (01H)	Function code (83H)	Exception code (02H)	Error check CRC-16 (C0F1H)	3.5 idle characters
	1	1	1	2	

③ **Setting (Slave address 1, Pattern 1, Step 1 SV)** [When setting Step 1 SV to 600℃ (0258H)]

• A request message from the master

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (1110H)	Data (0258H)	Error check CRC-16 (8DA9H)	3.5 idle characters
	1	1	2	2	2	

• Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (1110H)	Data (0258H)	Error check CRC-16 (8DA9H)	3.5 idle characters
	1	1	2	2	2	

• Response message from the slave in exception (error) status (When a value out of the setting range is set)

The function code MSB is set to 1 for the response message in exception (error) status (86H).
The exception code (03H: Value out of the setting range) is returned (error).

3.5 idle characters	Slave address (01H)	Function code (86H)	Exception code (03H)	Error check CRC-16 (0261H)	3.5 idle characters
	1	1	1	2	

7. Communication command table

Shinko command type	Modbus function code	Data item	Data
20H/50H	03H/06H	1xx0H: Step SV (*1)	Set value
20H/50H	03H/06H	1xx1H: Step time (*1)	Set value (Minute or Second) (*3)
20H/50H	03H/06H	1xx2H: Wait Used/Not used (*1)	0000H: Not used 0001H: Used
20H/50H	03H/06H	1x13H: Wait value (*2)	Set value
20H/50H	03H/06H	1x14H: Alarm 1 (A1) value (*2)	Set value
20H/50H	03H/06H	1x15H: Alarm 2 (A2) value (*2)	Set value
20H/50H	03H/06H	1x16H: Time signal OFF time (*2)	Set value (Minute or Second) (*3)
20H/50H	03H/06H	1x17H: Time signal ON time (*2)	Set value (Minute or Second) (*3)
20H/50H	03H/06H	0002H: Proportional band	Set value
20H/50H	03H/06H	0003H: Integral time	Set value
20H/50H	03H/06H	0004H: Derivative time	Set value
20H/50H	03H/06H	0005H: ARW (Anti-reset windup)	Set value
20H/50H	03H/06H	000EH: AT(auto-tuning) Perform/Cancel	0000H: Cancel 0001H: Perform
20H/50H	03H/06H	000FH: Alarm 1 (A1) type 0010H: Alarm 2 (A2) type	0000H: No alarm action 0001H: High limit alarm 0002H: Low limit alarm 0003H: High/Low limits alarm 0004H: High/Low limit range alarm 0005H: Process high alarm 0006H: Process low alarm 0007H: High limit alarm with standby 0008H: Low limit alarm with standby 0009H: High/Low limits alarm with standby
20H/50H	03H/06H	0011H: Alarm 1 (A1) hysteresis	Set value
20H/50H	03H/06H	0012H: Alarm 2 (A2) hysteresis	Set value
20H/50H	03H/06H	0015H: Alarm 1 (A1) action delay time	Set value
20H/50H	03H/06H	0016H: Alarm 2 (A2) action delay time	Set value
20H/50H	03H/06H	001BH: Proportional cycle	Set value
20H/50H	03H/06H	001CH: Control output(OUT) high limit	Set value
20H/50H	03H/06H	001DH: Control output(OUT) low limit	Set value
20H/50H	03H/06H	001EH: Control output(OUT) ON/OFF hysteresis	Set value
20H/50H	03H/06H	0027H: SV high limit	Set value
20H/50H	03H/06H	0028H: SV low limit	Set value
20H/50H	03H/06H	002CH: Scaling high limit	Set value
20H/50H	03H/06H	002DH: Scaling low limit	Set value
20H/50H	03H/06H	002EH: Decimal point place	0000H: XXXX (No decimal point) 0001H: XXX.X (1 digit after decimal point) 0002H: XX.XX (2 digits after decimal point) 0003H: X.XXX (3 digits after decimal point)
20H/50H	03H/06H	002FH: Sensor correction	Set value
20H/50H	03H/06H	0030H: PV filter time constant	Set value
20H/50H	03H/06H	0031H: Set value lock	0000H: Unlock 0001H: Lock
20H/50H	03H/06H	0032H: Step SV when control starts	Set value
20H/50H	03H/06H	0033H: Program control start type	0000H: PV start 0001H: SV start
20H/50H	03H/06H	0035H: Step time unit	0000H: Hours:Minutes 0001H: Minutes:Seconds
20H/50H	03H/06H	0038H: Pattern end output time	Set value
20H/50H	03H/06H	003BH: Event output function	0000H: Time signal output 0001H: Pattern end output 0002H: RUN output
20H/50H	03H/06H	003FH: Running pattern number	1 to 9

Shinko command type	Modbus function code	Data item	Data
50H	06H	0042H: Program control Run/Stop	0000H: Stop 0001H: Run
50H	06H	0043H: Advance function Perform	0001H: Perform
20H/50H	03H/06H	0044H: Input type	0000H: K [–200 to 1370℃] 0001H: K [–199.9 to 400.0℃] 0002H: J [–200 to 1000℃] 0003H: R [0 to 1760℃] 0004H: S [0 to 1760℃] 0005H: B [0 to 1820℃] 0006H: E [–200 to 800℃] 0007H: T [–199.9 to 400.0℃] 0008H: N [–200 to 1300℃] 0009H: PL-Ⅱ [0 to 1390℃] 000AH: C (W/Re5-26) [0 to 2315℃] 000BH: Pt100 [–199.9 to 850.0℃] 000CH: JPt100 [–199.9 to 500.0℃] 000DH: Pt100 [–200 to 850℃] 000EH: JPt100 [–200 to 500℃] 000FH: K [–320 to 2500℉] 0010H: K [–199.9 to 750.0℉] 0011H: J [–320 to 1800℉] 0012H: R [0 to 3200℉] 0013H: S [0 to 3200℉] 0014H: B [0 to 3300℉] 0015H: E [–320 to 1500℉] 0016H: T [–199.9 to 750.0℉] 0017H: N [–320 to 2300℉] 0018H: PL-Ⅱ [0 to 2500℉] 0019H: C (W/Re5-26) [0 to 4200℉] 001AH: Pt100 [–199.9 to 999.9℉] 001BH: JPt100 [–199.9 to 900.0℉] 001CH: Pt100 [–300 to 1500℉] 001DH: JPt100 [–300 to 900℉] 001EH: 4 to 20mA DC [–1999 to 9999] 001FH: 0 to 20mA DC [–1999 to 9999] 0020H: 0 to 1V DC [–1999 to 9999] 0021H: 0 to 5V DC [–1999 to 9999] 0022H: 1 to 5V DC [–1999 to 9999] 0023H: 0 to 10V DC [–1999 to 9999]
20H/50H	03H/06H	0045H: Direct/Reverse control action	0000H: Heating (Reverse action) 0001H: Cooling (Direct action)
20H/50H	03H/06H	0048H: Alarm 1 (A1) action Energized/De-energized	0000H: Energized 0001H: De-energized
20H/50H	03H/06H	0049H: Alarm 2 (A2) action Energized/De-energized	0000H: Energized 0001H: De-energized
50H	06H	0070H: Key operation change flag clearing	0000H: No action 0001H: Clear all
20H	03H	0080H: PV (process variable) reading	PV
20H	03H	0081H: Control output (OUT) MV reading	Control output (OUT) MV
20H	03H	0083H: Current SV reading	Current SV
20H	03H	0084H: Remaining step time (currently running) reading	Remaining time (Minute or Second) (*3)
20H	03H	0085H: Running pattern, step number reading	16^0: Pattern number 16^1: Step number 16^2: Not used (Always 0) 16^3: Not used (Always 0)

Shinko command type	Modbus function code	Data item	Data
20H	03H	0086H: Status flag	2^{15} to 2^0 0000 0000 0000 0000 2^0 digit: Control output (OUT) 0: OFF 1: ON (For current output, Not fixed) 2^1 digit: Not used (Always 0) 2^2 digit: Alarm 1 (A1) output 0: OFF 1: ON 2^3 digit: Alarm 2 (A2) output 0: OFF 1: ON 2^4 digit: Event output 0: OFF 1: ON 2^5 digit: Not used (Always 0) 2^6 digit: Not used (Always 0) 2^7 digit: Overscale 0: OFF 1: ON 2^8 digit: Underscale 0: OFF 1: ON 2^9 digit: RUN 0: OFF 1: During RUN 2^{10} digit: WAIT 0: OFF 1: During WAIT 2^{11} digit: AT 0: OFF 1: During AT 2^{12} digit: HOLD 0: OFF 1: During HOLD 2^{13} digit: Not used (Always 0) 2^{14} digit: Not used (Always 0) 2^{15} digit: Change in key operation 0: No 1: Yes

Data item:

(*1) 16^1: Steps 1 to 9, 16^2: Patterns 1 to 9

(*2) 16^2: Patterns 1 to 9

(*3) **If 'Hours:Minutes' is selected in [0035H: Step time unit], the time unit will be Minute.**
If 'Minutes:Seconds' is selected, the time unit will be Second.

(e.g.) **If 'Hours:Minutes' is selected:**

- 1 hour 30 minutes: Equals 90 minutes. 005AH (if 90 is converted to hexadecimal figures)
- 99 hours 59 minutes: Equals 5999 minutes. 176FH (if 5999 is converted to hexadecimal figures)

If 'Minutes:Seconds' is selected:

- 15 minutes 30 seconds: Equals 930 seconds.
  03A2H (if 930 is converted to hexadecimal figures)
- 50 minutes 40 seconds: Equals 3040 seconds.
  0BE0H (if 3040 is converted to hexadecimal figures)

Note

The setting changes by the front key operation and by the communication function differ as follows.

- When data is changed by front keypad operation, the data that is related to the changed item is also changed automatically as shown in Example 1 below.
- When the data is changed by communication function, the related data does not change as shown in Example 2 below. (Only the changed data is altered.)

(Example 1) SV high limit: 1370℃, Step SV: 1000℃
When SV high limit is changed to 800℃ by the front keypad operation, both SV high limit and Step SV are changed to 800℃.

(Example 2) SV high limit: 1370℃, Step SV: 1000℃
When SV high limit is changed to 800℃ by communication function, SV high limit is changed to 800℃, however, Step SV is maintained at the same temperature 1000℃.

● Data

Notes about setting, reading command

- When connecting multiple slaves, the address (instrument number) must not be duplicated.
- Do not use undefined Data items. If they are used, negative acknowledgement will be returned or a random value will be written or read, resulting in malfunction.
- Modbus protocol uses Holding Register addresses. The Holding Register addresses are created as follows. A Shinko command data item is converted to decimal number, and the offset of 40001 is added. The result is the Holding Register address.

  Using Data item 1110H (Step SV) as an example:

  Data item in the sending message is 1110H, however, Modbus protocol Holding Register address is 41111 (1110 + 40001).

Setting command

- Setting range of each item is the same as that of keypad operation. For the communication command, refer to the "Communication command table" in this manual.
- The data (set value, decimal) is converted to hexadecimal figures. A negative number is represented in 2's complement.

  When data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used.
- If the alarm type is changed, the alarm value will revert to the factory default value. Also alarm output status will be initialized.
- Settings via software communication are possible while in Set value lock status.
- Even if options are not ordered, settings via software communication will be possible. However, their command contents will not function.
- The communication protocol, instrument number, communication speed, parity and stop bit of the slave cannot be set by software communication. They can only be set via the keypad.
- When sending a command by Global address [95 (7FH), Shinko protocol] or Broadcast address (00H, Modbus protocol), the same command is sent to all the slaves connected. However, the response is not returned.

Reading command

- The data (set value, decimal) is converted to hexadecimal figures. A negative number is represented in 2's complement. When the data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used for a response.

● Negative acknowledgement

The slave will return Error code 1 (31H) (Shinko protocol) or Exception code 1 (01H) (Modbus protocol) in the following case.

- When AT Perform/Cancel (000EH) is executed during PI action or ON/OFF action.

The slave will return Error code 4 (34H) (Shinko protocol) or Exception code 17 (11H) (Modbus protocol) in the following cases.

- If "Cancel (0000H)" is selected in [AT Perform/Cancel (000EH)] while AT (auto-tuning) is being cancelled.
- When "Perform (0001H)" is selected in [AT Perform/Cancel (000EH) while AT (auto-tuning) is performing.

● Notes about programming monitoring software

How to speed up the scan time

When monitoring plural units of PCD-33A, set the program so that requisite minimum pieces of data such as PV (0080H), Control output (OUT) MV (0081H), Status flag (0086H), etc. can be read. For other data, set the program so that they can be read only when their set value has changed. This will speed up the scan time.

How to read the set value change made by front keypad operation

If any set value is changed by the keypad operation, the PCD-33A sets the [Status flag (0086H) 2^{15}: Change in key operation] to [Yes (1)].

There are 2 methods of reading the set value change by the front keypad as follows.

Reading method 1

(1) On the software side, check that [Status flag (0086H) 2^{15}: Change in key operation] has been set to [Yes (1)], then read all set values.

(2) Clear the [Status flag (0086H) 2^{15}: Change in key operation], by setting the [Key operation change flag clearing (0070H)] to [Clear all (0001H)].

If [Key operation change flag clearing (0070H)] is set to [Clear all (0001H)] during the setting mode of the PCD-33A, Error code 5 (35H, Shinko protocol) or Exception Code 18 (12H, Modbus protocol) will be returned as a negative acknowledgement. And [Status flag (0086H) 2^{15}: Change in key operation] cannot be cleared.

Set a program so that all set values can be read when a negative acknowledgement is returned.

(3) Read all set values again after acknowledgement is returned.

Reading method 2

(1) On the software side, check that [Status flag (0086H) 2^{15}: Change in key operation] has been set to [Yes (1)], then set the [Key operation change flag clearing (0070H)] to [Clear all (0001H)].

(2) Set the program depending on the acknowledgement or negative acknowledgement as follows.

When acknowledgement is returned;

Consider it as settings completed, and read all set values.

When Error code 5 (35H, Shinko protocol) or Exception code 18 (12H, Modbus protocol) is returned as a negative acknowledgement;

Consider it as still in setting mode, and read the requisite minimum pieces of data such as PV (0080H), Control output (OUT) MV (0081H), Status flag (0086H), etc. then return to step (1).

Thus, programs which do not affect the scan time can be created using the methods described above, even if set values on the monitoring software will not be updated until settings are complete.

How to read PID parameters after AT (auto-tuning) finishes

The PCD-33A sets [Status flag (0086H) 2^{11}: AT] to [During AT (1)] while AT is performing.

After AT is finished, PID parameters are updated.

On the software side, read the parameters such as P, I, D, ARW after checking that [Status flag (0086H) 2^{11}: AT] has been set to [OFF (0)].

Note when sending all set values simultaneously

- When changing alarm types in [Alarm 1 type (000FH)] or [Alarm 2 type (0010H)], the alarm value will revert to 0 (zero). First, send the selected alarm type, then send the alarm value.
- When changing input types in [Input type (0044H)], set values such as Step SV, Proportional band, Alarm 1 value, etc. will be initialized.
  First, send the selected input type, then send other set values.

● **When communicating with a PLC**

To communicate with a PLC, use a Shinko PLC interface unit SIF-600. No programming is needed for connection.

PLCs Corresponding to SIF-600, its manufacturer and host link units:

PLC Manufacturer	PLC Model	Host Link Unit
Mitsubishi Electric Corp.	MELSEC Q series, QnA series (*)	AJ71UC24, A1SJ71UC24-R2/R4/PRF A1SJ71C24-R2/R4/PRF, QJ71C24
	MELSEC FX series (*)	————
Omron Corp.	SYSMAC CJ series	CS1W-SCU21-V1 CJ1W-SCU21, CJ1W-SCU41
Keyence Corp.	KV	KV-L20V
Yokogawa Electric Corp.	FA-M3	F3LC11-2N, F3LC11-1F, F3LC12-1F
Fuji Electric Co., Ltd.	MICREX-SX series	NP1L-RS1, NP1L-RS2, NP1L-RS3, NP1L-RS4

(*) Models with compatible QR/QW communication commands (MC protocol 1C format 4).

8. Specifications

Cable length: Maximum communication distance 1.2km
Cable resistance: Within 50 Ω (Terminators are not necessary, but if used, use 120 Ω or more on one side.)
Communication line: EIA RS-485
Communication method: Half-duplex communication
Communication speed : 9600bps (2400, 4800, 9600, 19200bps) (Selectable by keypad)
Synchronization method: Start-stop synchronization
Code form: ASCII, binary
Communication protocol: Shinko protocol, Modbus ASCII, Modbus RTU (Selectable by keypad)
(Default: Shinko protocol)

Data format: Data bit is automatically selected upon selecting the communication protocol.
( ): Basic set value (Parity and Stop bit of Modbus ASCII and RTU)

Communication protocol	Shinko protocol	Modbus ASCII	Modbus RTU
Start bit	1	1	1
Data bit	7	7	8
Parity	Even	No parity, Even, Odd Selectable (Even)	No parity, Even, Odd Selectable (No parity)
Stop bit	1	1, 2 Selectable (1)	1, 2 Selectable (1)

Error correction: Command request repeat system
Error detection: Parity check, Checksum (Shinko protocol), LRC (Modbus ASCII), CRC-16 (Modbus RTU)

9. Troubleshooting

Check that power is being supplied to the master and slave that customers use. If communication failure still occurs, check the following.

• Problem: Communication failure

Check the following
Connection or wiring of communication is not secure.
Burnout or imperfect contact between the communication cable and the connector.
Communication speed of the slave does not match that of the master.
The data bit, parity and stop bit of the master do not correspond to those of the slave.
The instrument number (address) of the slave does not correspond to that of the command.
The instrument numbers (addresses) are duplicated in multiple slaves.
Make sure that the program is appropriate for the transmission timing.

• Problem: Though communication is occurring, the response is 'Negative acknowledgement'.

Check the following
Check whether a non-existent command code has not been sent.
The setting command data goes outside the setting range of the slave.
The controller cannot be set when functions such as AT are performing.
The PCD-33A is in front keypad operation setting mode.

For all other malfunctions, please contact our main office or dealers.

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