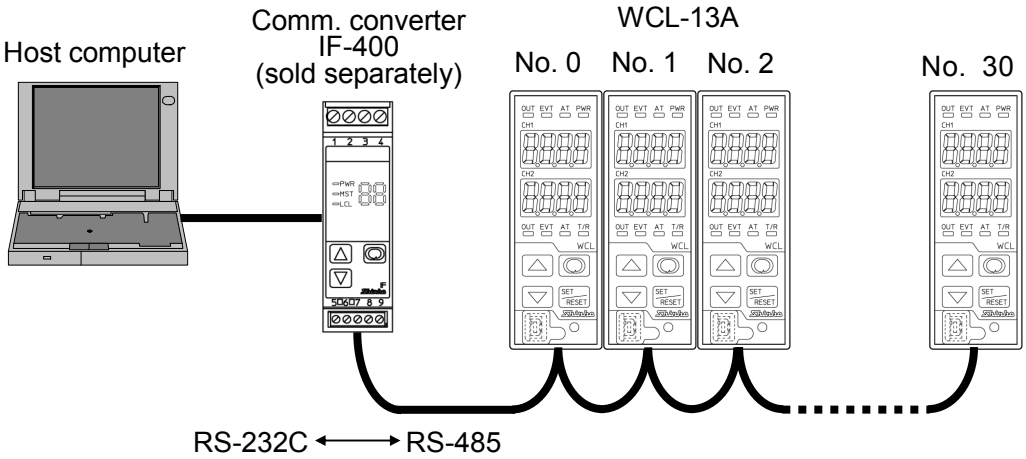
No. WCL1CE3 2011.11

This manual contains instructions for communication functions of the WCL-13A.
To prevent accidents arising from the misuse of this controller, please ensure the operator receives this manual.

Serial communication and Console communication cannot be used together.
When performing Serial communication, remove the USB communication cable (CMB-001) from the USB port of the PC and Console connector of the WCL-13A.
When performing Console communication, it is not required to remove the Serial communication cables. However, do not send a command from the master side.

1. System Configuration

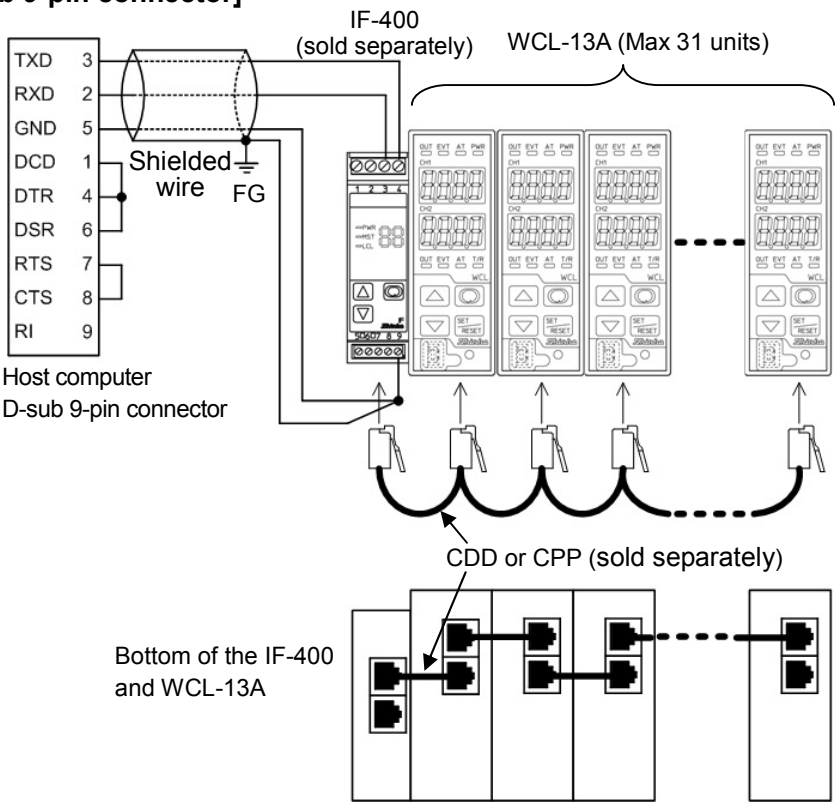


(Fig. 1-1)

2. Wiring

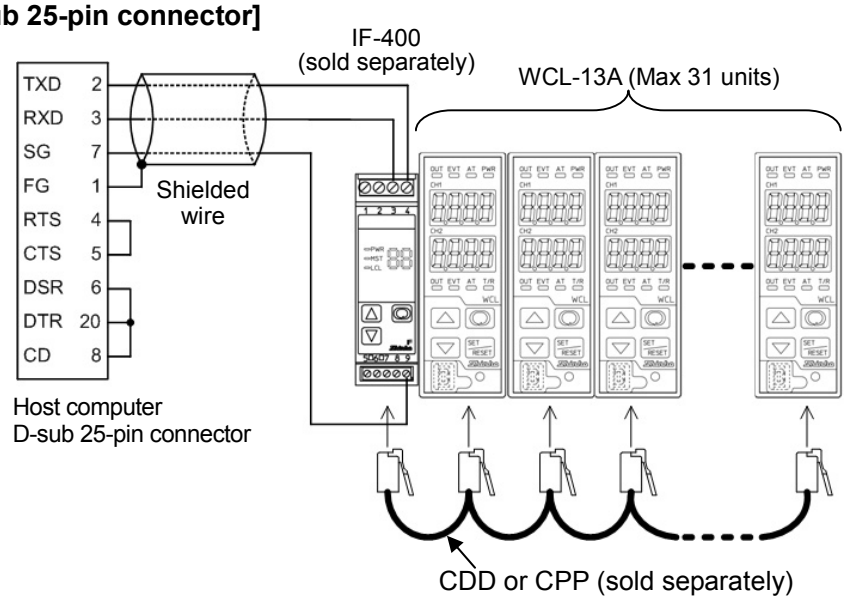
When using communication converter IF-400

[D-sub 9-pin connector]



(Fig. 2-1)

[D-sub 25-pin connector]



(Fig. 2-2)

Shielded Wire

Connect only one side of the shielded wire to the FG terminal so that current cannot flow to the shielded wire. If both sides of the shielded wire are connected to the FG terminal, the circuit will be closed between the shielded wire and the ground. As a result, current will run through the shielded wire and this may cause noise.

Be sure to ground the FG terminal.

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 a personal computer with multiple peripheral devices. The terminator prevents signal reflection and disturbance.

Do not connect a terminator to the communication line because each WCL-13A has built-in pull-up and pull-down resistors instead of a terminator.

Communication converter IF-400 (sold separately) has a built-in terminator.

3. Communication Parameter Setting

Communication parameters can be set in the Special function group.

To enter the Special function group, follow the procedures below.

(1) aT.Er Press the ◎ key in the PV/SV display mode until the left characters appear.

(2) cnnL Press the SET/RESET key twice. Communication protocol will be indicated.

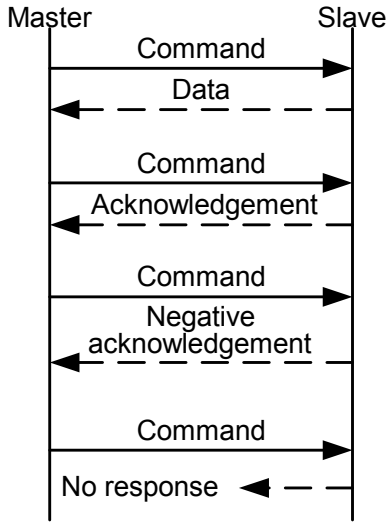
(3) Make a selection using the △ or ▽ key, and register the value by pressing the SET/RESET key.

Character	Name, Function, Setting range	Default Value
cnnL nonL	**Communication Protocol** • Selects communication protocol. • nonL: Shinko protocol nodA: Modbus ASCII mode nodr: Modbus RTU mode	Shinko protocol
cnno □□0	**Instrument Number** • Sets the instrument number individually to each instrument when communicating by connecting plural instruments. • Setting range: 0 to 95	0
cnnP □□96	**Communication Speed** • Selects a communication speed equal to that of the host computer. • □□96: 9600bps □ 192: 19200bps □384: 38400bps	9600bps
cnFT 7Evn	**Data Bit/Parity** • Selects data bit and parity. • 8non: 8 bits/No parity 7non: 7 bits/No parity 8Evn: 8 bits/Even 7Evn: 7 bits/Even 8odd: 8 bits/Odd 7odd: 7 bits/Odd	7 bits/Even
cnST □□□1	**Stop Bit** • Selects the stop bit. • □□□1: Stop bit 1 □□□2: Stop bit 2	Stop bit 1

(4) Press the SET/RESET key several times. The unit reverts to the PV/SV display mode.

4. Communication Procedure

Communication starts with command transmission from the host computer (hereafter Master) and ends with the response of the WCL-13A (hereafter Slave).



(Fig.4-1)

- **Response with data**
  When the master sends the reading command, the slave responds with the corresponding set value or current status.
- **Acknowledgement**
  When the master sends the setting command, the slave responds by sending the acknowledgement after the processing is terminated.
- **Negative acknowledgement**
  When the master sends a non-existent command or 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 mode), CRC-16 discrepancy (Modbus RTU mode)

Communication Timing of the RS-485

Master Side (Take note while programming)

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 the collision of transmissions between the master and the slave, send the next command after carefully checking that the master 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. (Retry twice or more is recommended.)

Slave Side

When the slave starts transmission through a 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 with hexadecimal number.
Negative numbers are represented with 2's complement.
Numerals written below the command represent 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

(Fig. 5.2-1)

(2) Reading Command

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

(Fig. 5.2-2)

(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

(Fig. 5.2-3)

(4) Acknowledgement

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

(Fig. 5.2-4)

(5) Negative Acknowledgement

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

(Fig. 5.2-5)

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

Instrument number (Address): Numbers by which the master discerns each slave.
Instrument numbers 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 hexadecimal 4 digits, using ASCII codes.
(Refer to “7. Communication command table”.)

Data : The contents of data (set value) differs depending on the setting command.
Composed of hexadecimal 4 digits, using ASCII codes.
(Refer to “7. Communication command table”.)

Checksum : 2-character data to detect communication errors. (Refer to “5.3 Checksum calculation”.)

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

Error code : Represents an error type with ASCII codes.
1 (31H)-----Non-existent command
2 (32H)-----Not used
3 (33H)-----Setting 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

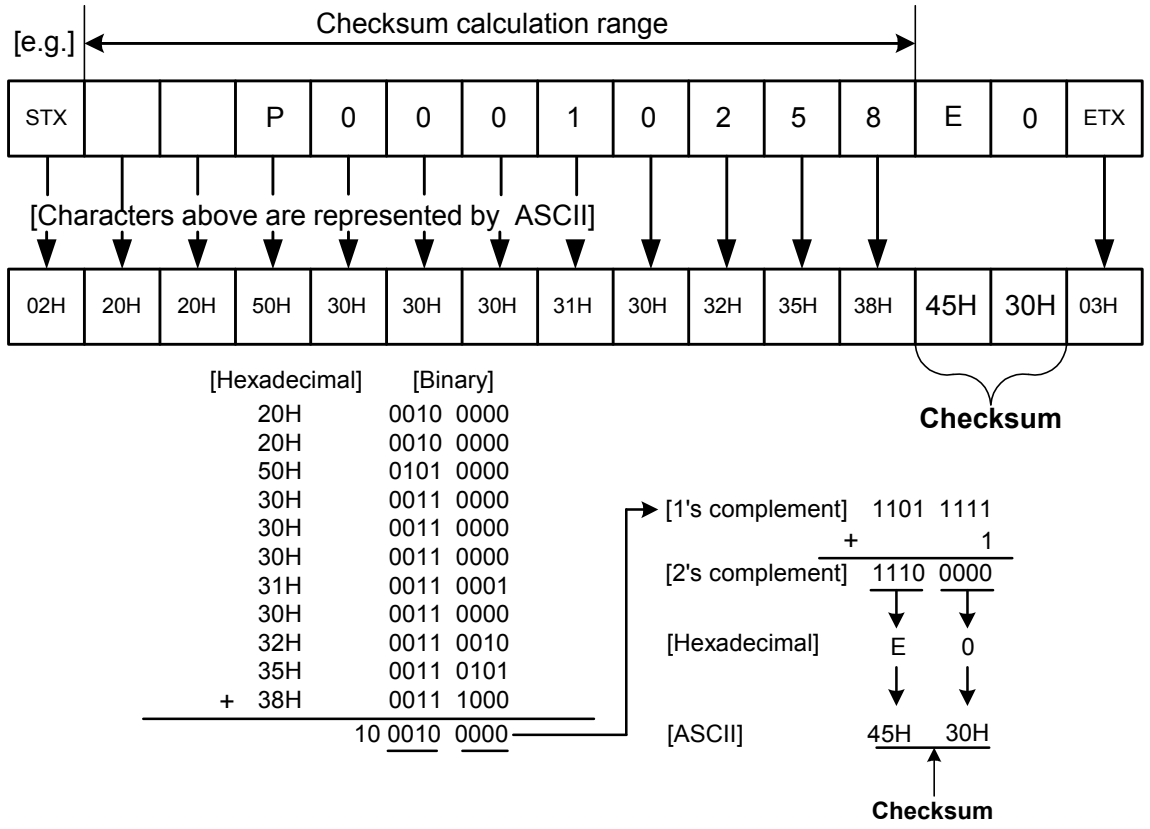
Checksum is used to detect receiving errors in the command or data.
Set the program for the master side as well to calculate the checksum of the response data from the slaves so that communication errors can be checked.

The ASCII code (hexadecimal) corresponding to the characters which range from the address (instrument number) to that before the checksum is converted to binary notation, and the total value is calculated.
The lower 2-digits of the total value are converted to 2's complement, and then to hexadecimal figures, that is, ASCII code for the checksum.

Checksum Calculation Example

CH1 SV1: 600℃ (0258H)
Address (instrument number): 0 (20H)

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



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 command is transmitted as ASCII characters.

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

(1) Message Configuration

ASCII mode message is configured to start by Header [: (colon)(3AH)] and end by Delimiter [CR (carriage return) (0DH) + LF (Line feed)(0AH)]. (Fig. 6.2-1)

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

(Fig. 6.2-1)

(2) 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 connected. However slaves do not respond.

(3) Function Code

The function code is the command code for the slave to undertake the following action types. (Table 6.2-1)

(Table 6.2-1)

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

The 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 to 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 below are set to the data of the response message、and returned to the master in order to inform it of what kind of error has occurred. (Table 6.2-2)

(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 protocol error code 4 (Status unable to be set)
18 (12H)	Shinko protocol error code 5 (During setting mode by keypad operation)

(4) Data

Data differs depending on the function code.

A request message from the master is composed of a data item, number of data and setting data.

A response message from the slave is composed of a number of bytes, data and exception codes in negative acknowledgements.

The effective range of data is -32768 to 32767 (8000H to 7FFFH).

(5) 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 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.

(6) Message Example of ASCII Mode

Numerals written below the command represent the number of characters.

① **Reading (Slave address 1, CH1 SV)**

• A request message from the master

The number of data means how many data items are to be read, and it is fixed as (30H 30H 30H 31H).

Header	Slave address	Function code	Data item [0001H]	Number of data [0001H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 33H)	(30H 30H 30H 31H)	(30H 30H 30H 31H)	(46H 41H)	(0DH 0AH)
1	2	2	4	4	2	2

(Fig. 6.2-2)

• Response message from the slave in normal status [When CH1 SV=600℃ (0258H)]

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

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

(Fig. 6.2-3)

• 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 [02H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(38H 33H)	(30H 32H)	(37H 41H)	(0DH 0AH)
1	2	2	2	2	2

(Fig. 6.2-4)

② **Setting (Slave address 1, CH1 SV)** [When setting CH1 SV to 600℃ (0258H)]

• A request message from the master

Header	Slave address	Function code	Data item [0001H]	Data [0258H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 31H)	(30H 32H 35H 38H)	(39H 45H)	(0DH 0AH)
1	2	2	4	4	2	2

(Fig. 6.2-5)

• Response message from the slave in normal status

Header	Slave address	Function code	Data item [0001H]	Data [0258H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 31H)	(30H 32H 35H 38H)	(39H 45H)	(0DH 0AH)
1	2	2	4	4	2	2

(Fig. 6.2-6)

• 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 [03H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(38H 36H)	(30H 33H)	(37H 36H)	(0DH 0AH)
1	2	2	2	2	2

(Fig. 6.2-7)

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/Odd/No parity Selectable
Stop bit: 1 bit/2 bits Selectable
Error detection: CRC-16 (Cyclic Redundancy Check)
Data interval: 3.5 character transmission times or less

(1) Message Configuration

RTU mode is configured to start after idle time is processed for more than 3.5 character transmissions, and end after idle time is processed for more than 3.5 character transmissions.

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

(Fig. 6.3-1)

(2) 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 connected. However slaves do not respond.

(3) 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 to 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 below are set to the data of the response messages, and returned to the master in order to inform it of what kind of error has occurred. (Table 6.3-2)

(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 protocol error code 4 (Status unable to be set)
18 (12H)	Shinko protocol error code 5 (During setting mode by keypad operation)

(4) Data

Data differs depending on the function code.

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

A response message from the slave side is composed of a number of bytes, data and exception codes in negative acknowledgements.

Effective range of data is –32768 to 32767 (8000H to 7FFFH).

(5) Error Check of RTU Mode

After calculating CRC-16 (Cyclic Redundancy Check) from the slave address to the end of the data, the calculated 16-bit data is appended to the end of 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 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 final data.
⑨ Set X as CRC-16 to the end of message in sequence from low order to high order.

(6) Message Example of RTU Mode

Numerals written below the command represent number of characters.

① **Reading (Slave address 1, CH1 SV)**

• A request message from the master
The number of data means how many data items are to be read, and it is fixed as 1 (0001H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (0001H)	Number of data (0001H)	Error check CRC-16 (D5CAH)	3.5 idle characters
	1	1	2	2	2	

(Fig. 6.3-2)

• Response message from the slave in normal status [When CH1 SV=600℃ (0258H)]
The number of response bytes means the number of bytes of 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	

(Fig. 6.3-3)

• Response message from the slave in exception (error) status (When a 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	

(Fig. 6.3-4)

② **Setting (Slave address 1, CH1 SV)** [When setting CH1 SV to 600℃ (0258H)]

• A request message from the master

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0001H)	Data (0258H)	Error check CRC-16 (D890H)	3.5 idle characters
	1	1	2	2	2	

(Fig. 6.3-5)

• Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0001H)	Data (0258H)	Error check CRC-16 (D890H)	3.5 idle characters
	1	1	2	2	2	

(Fig. 6.3-6)

• 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	

(Fig. 6.3-7)

7. Communication Command Table

● **Data**

Note on Setting, Reading Command

- The data (set value, decimal) is converted to hexadecimal figures. A negative number is represented by 2's complement.
- When connecting plural slaves, the address (instrument number) must not be duplicated.

Setting Command

- Setting range of each item is the same as that of keypad operation.
- When the data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used.
- It is possible to set values with the setting command of the communication function even when the set value is locked.
- Even if options are not added, setting items for options is possible using the setting command. However, they will not function.
- The instrument numbers and communication speed of the slave cannot be set by communication function.
- When sending a command by Global address [95 (7FH)], the same command is sent to all the slaves connected. However, the response is not returned.
- Up to 1,000,000 (one million) entries can be stored in memory.
  If the number of settings exceeds the limit, the data will not be saved. So frequent transmission via communication is not recommended.

Reading Command

- When the data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used for a response.

CH1 Communication Command

Shinko Command Type	Modbus Function Code	Data Item		Data
20H/50H	03H/06H	0001H	SV	Set value
20H/50H	03H/06H	0002H	AT/Auto-reset Perform/Cancel	0000H: AT/Auto-reset Cancel 0001H: AT/Auto-reset Perform
20H/50H	03H/06H	0003H	Proportional band	Set value
20H/50H	03H/06H	0004H	OUT2 proportional band	Set value
20H/50H	03H/06H	0005H	Integral time	Set value
20H/50H	03H/06H	0006H	Derivative time	Set value
20H/50H	03H/06H	0007H	ARW	Set value
20H/50H	03H/06H	0008H	Manual reset value	Set value
20H/50H	03H/06H	0009H	Proportional cycle	Set value
20H/50H	03H/06H	000AH	OUT2 proportional cycle	Set value
20H/50H	03H/06H	000BH	Alarm 1 value	Set value
20H/50H	03H/06H	000CH	Heater burnout alarm 1 value	Set value
20H/50H	03H/06H	000DH	Heater burnout alarm 2 value	Set value
20H/50H	03H/06H	000EH	Loop break alarm span	Set value
20H/50H	03H/06H	000FH	Loop break alarm time	Set value
20H/50H	03H/06H	0010H	Input type	**Multi-range input:** 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℃

Shinko Command Type	Modbus Function Code	Data Item		Data
20H/50H	03H/06H	0010H	Input type	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] **Infrared thermocouple input:** 0000H: -18 to 25℃ [-50 to 500℃] 0001H: 5 to 45℃ [-50 to 500℃] 0002H: 25 to 80℃ [-50 to 500℃] 0003H: 70 to 105℃ [-50 to 500℃] 0004H: 90 to 120℃ [-50 to 500℃] 0005H: 115 to 155℃ [-50 to 500℃] 0006H: 145 to 190℃ [-50 to 500℃] 0007H: 180 to 250℃ [-50 to 500℃] 0008H: -18 to 25℃ [-58 to 932℉] 0009H: 5 to 45℃ [-58 to 932℉] 000AH: 25 to 80℃ [-58 to 932℉] 000BH: 70 to 105℃ [-58 to 932℉] 000CH: 90 to 120℃ [-58 to 932℉] 000DH: 115 to 155℃ [-58 to 932℉] 000EH: 145 to 190℃ [-58 to 932℉] 000FH: 180 to 250℃ [-58 to 932℉]
20H/50H	03H/06H	0011H	Scaling high limit	Set value
20H/50H	03H/06H	0012H	Scaling low limit	Set value
20H/50H	03H/06H	0013H	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	0014H	PV filter time constant	Set value
20H/50H	03H/06H	0015H	Sensor correction	Set value
20H/50H	03H/06H	0016H	Emissivity	Set value
20H/50H	03H/06H	0017H	Output high limit	Set value
20H/50H	03H/06H	0018H	Output low limit	Set value
20H/50H	03H/06H	0019H	Output ON/OFF hysteresis	Set value
20H/50H	03H/06H	001AH	OUT2 action mode	0000H: Air cooling (Linear characteristics) 0001H: Oil cooling (1.5th power of the linear characteristics 0002H: Water cooling (2nd power of the linear characteristics)

Shinko Command Type	Modbus Function Code	Data Item		Data
20H/50H	03H/06H	001BH	OUT2 high limit	Set value
20H/50H	03H/06H	001CH	OUT2 low limit	Set value
20H/50H	03H/06H	001DH	OUT2 ON/OFF hysteresis	Set value
20H/50H	03H/06H	001EH	Overlap/Dead band	Set value
20H/50H	03H/06H	001FH	Output rate-of-change	Set value
20H/50H	03H/06H	0020H	Output when input abnormal	Set value
20H/50H	03H/06H	0021H	Alarm 1 type (*1)	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 with standby
20H/50H	03H/06H	0022H	Alarm 1 hysteresis	Set value
20H/50H	03H/06H	0023H	Alarm 1 action delay timer	Set value
20H/50H	03H/06H	0024H	SV rise rate	Set value
20H/50H	03H/06H	0025H	SV fall rate	Set value
20H/50H	03H/06H	0026H	Direct/Reverse action	0000H: Reverse (Heating) action 0001H: Direct (Cooling) action
20H/50H	03H/06H	0027H	AT bias	Set value
20H/50H	03H/06H	0028H	Control Allowed/Prohibited	0000H: Control Allowed 0001H: Control Prohibited
20H/50H	03H/06H	0029H	Auto/Manual control	0000H: Automatic control 0001H: Manual control
20H/50H	03H/06H	002AH	Manual MV	Set value
20H/50H	03H/06H	002BH	SV (for temporary storage) (*2)	Set value
20H/50H	03H/06H	002CH	Difference (Addition) indication high limit	Set value
20H/50H	03H/06H	002DH	Difference (Addition) indication low limit	Set value
20H/50H	03H/06H	00D0H	Alarm 2 value	Set value
20H/50H	03H/06H	00D1H	Alarm 3 value	
20H/50H	03H/06H	00D2H	Alarm 4 value	
20H/50H	03H/06H	00D3H	Alarm 2 type (*1)	Refer to 0021H (Alarm 1 type).
20H/50H	03H/06H	00D4H	Alarm 3 type (*1)	
20H/50H	03H/06H	00D5H	Alarm 4 type (*1)	
20H/50H	03H/06H	00D6H	Alarm 2 hysteresis	Set value
20H/50H	03H/06H	00D7H	Alarm 3 hysteresis	
20H/50H	03H/06H	00D8H	Alarm 4 hysteresis	
20H/50H	03H/06H	00D9H	Alarm 2 action delay timer	Set value
20H/50H	03H/06H	00DAH	Alarm 3 action delay timer	
20H/50H	03H/06H	00DBH	Alarm 4 action delay timer	
20H/50H	03H/06H	00DCH	Event 1 output	0000H: Alarm (temperature) 0001H: Loop break alarm 0002H: Alarm+ Loop break alarm

(*1) If the alarm type is changed at 0021H (Alarm 1 type), Alarm 1 value defaults to “0”.
And the alarm output status will be initialized. This will be the same with Alarm 2, Alarm 3 and Alarm 4.
(*2) Reverts to the previous value after the power is turned OFF.

Shinko Command Type	Modbus Function Code	Data Item		Data
20H/50H	03H/06H	00DDH	Event 2 output	0000H: Alarm (temperature) 0001H: Loop break alarm 0002H: Alarm+ Loop break alarm 0003H: Heater burnout alarm 0004H: Alarm+ Heater burnout alarm 0005H: Loop break alarm+ Heater burnout alarm 0006H: Alarm+ Loop break alarm+ Heater burnout alarm

CH2 Communication Command

Shinko Command Type	Modbus Function Code	Data Item		Data
20H/50H	03H/06H	0051H	SV	Set value
20H/50H	03H/06H	0052H	AT/Auto-reset Perform/Cancel	0000H: AT/Auto-reset Cancel 0001H: AT/Auto-reset Perform
20H/50H	03H/06H	0053H	Proportional band	Set value
20H/50H	03H/06H	0055H	Integral time	Set value
20H/50H	03H/06H	0056H	Derivative time	Set value
20H/50H	03H/06H	0057H	ARW	Set value
20H/50H	03H/06H	0058H	Manual reset value	Set value
20H/50H	03H/06H	0059H	Proportional cycle	Set value
20H/50H	03H/06H	005BH	Alarm 1 value	Set value
20H/50H	03H/06H	005CH	Heater burnout alarm 1 value	Set value
20H/50H	03H/06H	005DH	Heater burnout alarm 2 value	Set value
20H/50H	03H/06H	005EH	Loop break alarm span	Set value
20H/50H	03H/06H	005FH	Loop break alarm time	Set value
20H/50H	03H/06H	0060H	Input type	Refer to 0010H (Input type).
20H/50H	03H/06H	0061H	Scaling high limit	Set value
20H/50H	03H/06H	0062H	Scaling low limit	Set value
20H/50H	03H/06H	0063H	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	0064H	PV filter time constant	Set value
20H/50H	03H/06H	0065H	Sensor correction	Set value
20H/50H	03H/06H	0066H	Emissivity	Set value
20H/50H	03H/06H	0067H	Output high limit	Set value
20H/50H	03H/06H	0068H	Output low limit	Set value
20H/50H	03H/06H	0069H	Output ON/OFF hysteresis	Set value
20H/50H	03H/06H	006FH	Output rate-of-change	Set value
20H/50H	03H/06H	0070H	Output when input abnormal	Set value
20H/50H	03H/06H	0071H	Alarm 1 type (*1)	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 with standby

(*1) If the alarm type is changed at 0071H (Alarm 1 type), Alarm 1 value defaults to “0”.
And the alarm output status will be initialized. This will be the same with Alarm 2, Alarm 3 and Alarm 4.

Shinko Command type	Modbus Function Code	Data Item		Data
20H/50H	03H/06H	0072H	Alarm 1 hysteresis	Set value
20H/50H	03H/06H	0073H	Alarm 1 action delay timer	Set value
20H/50H	03H/06H	0074H	SV rise rate	Set value
20H/50H	03H/06H	0075H	SV fall rate	Set value
20H/50H	03H/06H	0076H	Direct/Reverse action	0000H: Reverse (Heating) action 0001H: Direct (Cooling) action
20H/50H	03H/06H	0077H	AT bias	Set value
20H/50H	03H/06H	0078H	Control Allowed/Prohibited	0000H: Control Allowed 0001H: Control Prohibited
20H/50H	03H/06H	0079H	Auto/Manual control	0000H: Automatic control 0001H: Manual control
20H/50H	03H/06H	007AH	Manual MV	Set value
20H/50H	03H/06H	007BH	SV (for temporary storage) (*2)	Set value
20H/50H	03H/06H	007CH	Difference (Addition) indication high limit	Set value
20H/50H	03H/06H	007DH	Difference (Addition) indication low limit	Set value
20H/50H	03H/06H	00E0H	Alarm 2 value	Set value
20H/50H	03H/06H	00E1H	Alarm 3 value	
20H/50H	03H/06H	00E2H	Alarm 4 value	
20H/50H	03H/06H	00E3H	Alarm 2 type (*1)	Refer to 0071H (Alarm 1 type).
20H/50H	03H/06H	00E4H	Alarm 3 type (*1)	
20H/50H	03H/06H	00E5H	Alarm 4 type (*1)	
20H/50H	03H/06H	00E6H	Alarm 2 hysteresis	Set value
20H/50H	03H/06H	00E7H	Alarm 3 hysteresis	
20H/50H	03H/06H	00E8H	Alarm 4 hysteresis	
20H/50H	03H/06H	00E9H	Alarm 2 action delay timer	Set value
20H/50H	03H/06H	00EAH	Alarm 3 action delay timer	
20H/50H	03H/06H	00EBH	Alarm 4 action delay timer	
20H/50H	03H/06H	00ECH	Event 1 output	0000H: Alarm (temperature) 0001H: Loop break alarm 0002H: Alarm+ Loop break alarm
20H/50H	03H/06H	00EDH	Event 2 output	0000H: Alarm (temperature) 0001H: Loop break alarm 0002H: Alarm+ Loop break alarm 0003H: Heater burnout alarm 0004H: Alarm+ Heater burnout alarm 0005H: Loop break alarm+ Heater burnout alarm 0006H: Alarm+ Loop break alarm+ Heater burnout alarm

(*1) If the alarm type is changed at 0071H (Alarm 1 type), Alarm 1 value defaults to “0”.
And the alarm output status will be initialized. This will be the same with Alarm 2, Alarm 3 and Alarm 4.
(*2) Reverts to the previous value after the power is turned OFF.

Communication Command Common to CH1 and CH2

Shinko Command Type	Modbus Function Code	Data Item		Data
20H/50H	03H/06H	0030H	Set value lock	0000H: Unlock 0001H: Lock 1 0002H: Lock 2 0003H: Lock 3
20H/50H	03H/06H	0031H	Remote/Local	0000H: Local 0001H: Remote
20H/50H	03H/06H	0032H	External setting scaling high limit	Set value
20H/50H	03H/06H	0033H	External setting scaling low limit	Set value
20H/50H	03H/06H	0034H	Remote bias	Set value
20H/50H	03H/06H	0035H	Transmission output	0000H: PV transmission 0001H: SV transmission 0002H: MV transmission
20H/50H	03H/06H	0036H	Transmission output high limit	Set value
20H/50H	03H/06H	0037H	Transmission output low limit	Set value
20H/50H	03H/06H	0038H	Timer action	0000H: Control timer 0001H: Delay timer 1 0002H: Delay timer 2
20H/50H	03H/06H	0039H	Timer action time unit	0000H: Minute 0001H: Second
20H/50H	03H/06H	003AH	ON delay timer	Set value
20H/50H	03H/06H	003BH	OFF delay timer	Set value
20H/50H	03H/06H	003CH	Control timer start temperature	Set value
20H/50H	03H/06H	003DH	Control timer time	Set value
20H/50H	03H/06H	003EH	Auto-light function	0000H: Ineffective 0001H: Effective
20H/50H	03H/06H	003FH	Display selection	0000H: CH1 PV(*)/CH2 PV(*) 0001H: CH1 SV/CH2 SV 0002H: CH1 PV(*)/CH1 SV 0003H: CH2 PV(*)/CH2 SV 0004H: CH1 Difference(Addition)/CH1PV 0005H: CH1 Difference(Addition)/CH2 PV 0006H: CH1 PV/CH1 Difference(Addition) 0007H: CH2 PV/CH1 Difference(Addition) 0008H: CH2 Difference(Addition)/CH1 PV 0009H: CH2 Difference(Addition)/CH2 PV 000AH: CH1 PV/CH2 Difference(Addition) 000BH: CH2 PV/CH2 Difference(Addition) 000CH: No indication
20H/50H	03H/06H	0040H	Indication time	Set value
20H/50H	03H/06H	0041H	Input sampling period	0000H: 25ms 0001H: 125ms 0002H: 250ms
50H	06H	007FH	Key operation change flag clearing	0001H: Clear change flag

(*) This will be Difference or Addition value when Difference or Addition input is selected from the Block function (Console software).

CH1 Read Only Command

Shinko Command Type	Modbus Function Code	Data Item		Data
20H	03H	0080H	PV reading	Current PV (*1)
20H	03H	0081H	Output MV reading	Output MV
20H	03H	0082H	SV reading	Current SV
20H	03H	0083H	Status flag reading 0000 0000 0000 0000 2^{15} to 2^{0} 2^{0}: Output 0: OFF 1: ON (Current output: Not fixed) 2^{1}: Not used (Always 0) 2^{2}: Alarm 1 output 0: OFF 1: ON (*2) 2^{3}: Not used (Always 0) 2^{4}: Not used (Always 0) 2^{5}: CT1 (HB) 0: OFF 1: ON 2^{6}: CT2 (HB) 0: OFF 1: ON 2^{7}: Heater burnout alarm 0: OFF 1: ON 2^{8}: Loop break alarm 0: OFF 1: ON 2^{9}: Overscale 0: OFF 1: ON 2^{10}: Underscale 0: OFF 1: ON 2^{11}: PV/SV display mode/Standby mode 0: PV/SV display 1: Standby 2^{12}: PV/SV display mode/Setting mode 0: PV/SV display 1: Setting 2^{13}: AT/Auto-reset 0: OFF 1: During AT/Auto-reset 2^{14}: Auto/Manual control 0: Auto 1: Manual 2^{15}: Change in key operation 0: No 1: Yes	
20H	03H	0084H	CT1 current value reading	Current (ampere) value
20H	03H	0085H	CT2 current value reading	Current (ampere) value
20H	03H	0086H	Current PV reading	Current PV
20H	03H	0087H	Status flag 2 reading 0000 0000 0000 0000 2^{15} to 2^{0} 2^{0}: Alarm 1 output 0: OFF 1: ON (*2) 2^{1}: Alarm 2 output 0: OFF 1: ON (*2) 2^{2}: Alarm 3 output 0: OFF 1: ON (*2) 2^{3}: Alarm 4 output 0: OFF 1: ON (*2) 2^{4}: Difference(Addition) Overscale 0: OFF 1: ON (*3) 2^{5}: Difference(Addition) Underscale 0: OFF 1: ON (*3) 2^{6} to 2^{15}: Not used (Always 0)	

(*1) This will be the Difference (or Addition) value when Difference (or Addition) input is selected from the Block function (Console software).

(*2) If any alarm except Alarm (temperature) is selected during Event 1 output (CH1: 00DCH, CH2: 00ECH) or Event 2 output (CH1: 00DDH, CH2: 00EDH), the flag will be turned OFF or ON depending on Alarm 1, Alarm 2, Alarm 3 and Alarm 4 outputs.

(*3) Even if each channel is not in Overscale or Underscale, if the unit results in Overscale or Underscale from Difference (or Addition) computation, it will turn ON.

CH2 Read Only Command

Shinko Command Type	Modbus Function Code	Data Item		Data
20H	03H	0090H	PV reading	Current PV (*1)
20H	03H	0091H	Output MV reading	Output MV
20H	03H	0092H	SV reading	Current SV
20H	03H	0093H	Status flag reading 0000 0000 0000 0000 2^{15} to 2^{0} 2^{0}: Output 0: OFF 1: ON (Current output: Not fixed) 2^{1}: Not used (Always 0) 2^{2}: Alarm 1 output 0: OFF 1: ON (*2) 2^{3}: Not used (Always 0) 2^{4}: Not used (Always 0) 2^{5}: CT3 (HB) 0: OFF 1: ON 2^{6}: CT4 (HB) 0: OFF 1: ON 2^{7}: Heater burnout alarm 0: OFF 1: ON 2^{8}: Loop break alarm 0: OFF 1: ON 2^{9}: Overscale 0: OFF 1: ON 2^{10}: Underscale 0: OFF 1: ON 2^{11}: PV/SV display mode/Standby mode 0: PV/SV display 1: Standby 2^{12}: PV/SV display mode/Setting mode 0: PV/SV display 1: Setting 2^{13}: AT/Auto-reset 0: OFF 1: During AT/Auto-reset 2^{14}: Auto/Manual control 0: Auto 1: Manual 2^{15}: Change in key operation 0: No 1: Yes	
20H	03H	0094H	CT3 current value reading	Current (ampere) value
20H	03H	0095H	CT4 current value reading	Current (ampere) value
20H	03H	0096H	Current PV reading	Current PV
20H	03H	0097H	Status flag 2 reading 0000 0000 0000 0000 2^{15} to 2^{0} 2^{0}: Alarm 1 output 0: OFF 1: ON (*2) 2^{1}: Alarm 2 output 0: OFF 1: ON (*2) 2^{2}: Alarm 3 output 0: OFF 1: ON (*2) 2^{3}: Alarm 4 output 0: OFF 1: ON (*2) 2^{4}: Difference (Addition) Overscale 0: OFF 1: ON (*3) 2^{5}: Difference (Addition) Underscale 0: OFF 1: ON (*3) 2^{6} to 2^{15}: (Always 0)	

(*1) This will be the Difference (or Addition) value when Difference (or Addition) input is selected from the Block function (Console software).

(*2) If any alarm except Alarm (temperature) is selected during Event 1 output (CH1: 00DCH, CH2: 00ECH) or Event 2 output (CH1: 00DDH, CH2: 00EDH), the flag will be turned OFF or ON depending on Alarm 1, Alarm 2, Alarm 3 and Alarm 4 outputs.

(*3) Even if each channel is not in Overscale or Underscale, if the unit results in Overscale or Underscale from Difference (or Addition) computation, it will turn ON.

● Notes on Programming Monitoring Software

How to speed up the scan time

When monitoring plural units of WCL-13A, set the program so that the requisite minimum pieces of data such as PV (CH1: 0080H, CH2: 0090H), Output MV (CH1: 0081H, CH2: 0091H), status flag (CH1: 0083H, CH2: 0093H), 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 by the front keypad operation

If any set value is changed by keypad operation, the WCL-13A sets the [Status flag (CH1: 0083H, CH2: 0093H) 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 (CH1: 0083H, CH2: 0093H) 2^{15}: Change in key operation] has been set to [Yes (1)], then read all set values.

(2) Clear the [Status flag (CH1: 0083H, CH2: 0093H) 2^{15}: Change in key operation], by setting the [Key operation change flag clearing (007FH)] to [Clear change flag (0001H)].

If [Key operation change flag clearing (007FH)] is set to [Clear change flag (0001H)] during the setting mode of the WCL-13A, Error code 5 (35H, Shinko protocol) or Exception Code 18 (12H, Modbus protocol) will be returned as a negative acknowledgement. And [Status flag (CH1: 0083H, CH2: 0093H) 2^{15}: Change in key operation] cannot be cleared. Set a program so that all set values can be read when acknowledgement is returned.

Reading method 2

(1) On the software side, check that [Status flag (CH1: 0083H, CH2: 0093H) 2^{15}: Change in key operation] has been set to [Yes(1)], then set the [Key operation change flag clearing (007FH)] to [Clear change flag (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 (CH1: 0080H, CH2: 0090H), Output MV (CH1: 0081H, CH2: 0091H), status flag (CH1: 0083H, CH2: 0093H), 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 finishes

The WCL-13A sets [Status flag (CH1: 0083H, CH2: 0093H) 2^{13}: AT/Auto-reset] to [(1) During AT/Auto-reset] 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 (CH1: 0083H, CH2: 0093H) 2^{13}: AT/Auto-reset] has been set to [OFF (0)].

Note when sending all set values at one time

- When changing alarm type during Alarm 1 type selection (CH1: 0021H, CH2: 0071H), Alarm 1 value will revert to “0”. First, send the selected alarm type, then send the alarm value.
  This will be the same with Alarm 2, Alarm 3 and Alarm 4.
- When changing input type during Input type selection (CH1: 0010H, CH2: 0060H), set values such as SV, proportional band, Alarm value, etc. will be initialized. First, send the selected input type, then send other set values.

8. Specifications

Cable length: Max. communication distance 1.2km
Cable resistance: Within 50Ω (Terminators are not necessary, but if used, use 120Ω or more on one side.)
Communication interface: EIA RS-485
Communication method: Half-duplex communication
Synchronization method: Start-stop synchronization
Communication speed: 9600/19200/38400bps (Selectable by keypad) (Default: 9600bps)
Code form: ASCII, binary
Communication protocol: Shinko protocol/Modbus ASCII/Modbus RTU (Selectable by keypad) (Default: Shinko protocol)

Data format:

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

Data bit/Parity: 8 bits/No parity, 7 bits/No parity, 8 bits/Even, 7 bits/Even, 8 bits/Odd, 7 bits/Odd, Selectable by keypad (Default: 7 bits/ Even)
Stop bit: 1, 2 (Selectable by keypad) (Default: 1)
Error correction: Command request repeat system
Error detection: Parity, checksum (Shinko protocol), LRC (Modbus ASCII), CRC-16 (Modbus RTU)

9. Troubleshooting

If any malfunctions occur, refer to the following items after checking that power is being supplied to the master and the slave.

• Problem: Communication failure

Check the following
Make sure that communication connector is securely connected.
Check that wiring of the communication connector is correct.
Burnout or imperfect contact on the communication cable and the connector.
Communication speed of the slave does not coincide with that of the master.
The data bit, parity and stop bit of the master do not accord with those of the slave.
The instrument number (address) of the slave does not coincide with 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: Although communication is occurring, the response is 'NAK'.

Check the following
Check that a non-existent command code has not been sent.
The setting command data exceeds the setting range of the slave.
The controller cannot be set when functions such as AT are performing.
The WCL-13A is in the front keypad operation setting mode.

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

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