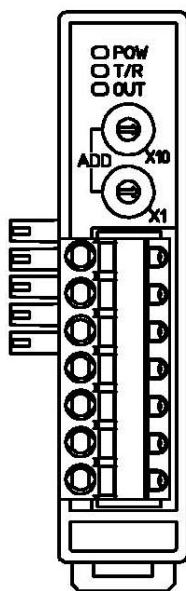


MULTI-DROP COMMUNICATION TYPE

TEMPERATURE CONTROL UNIT

# NCL-13A

INSTRUCTION MANUAL



***Shinko***

# Preface


Thank you for the purchase of Multi-drop Communication type Temperature Control Unit NCL-13A. This manual contains instructions for the mounting, functions, operations and notes when operating the NCL-13A. To prevent accidents arising from the misuse of this control unit, please ensure the operator receives this manual.

## Notes

- This instrument should be used in accordance with the specifications described in the manual. If it is not used according to the specifications, it may malfunction or cause fire.
- Be sure to follow the warnings, cautions and notices. If they are not observed, serious injury or malfunction may occur.
- Specifications, external appearance of the NCL-13A and the contents of this instruction manual are subject to change without notice.
- Care has been taken to assure that the contents of this instruction manual are correct, but if there are any doubts, mistakes or questions, please inform our sales department.
- This instrument is designed to be installed on a DIN rail. If it is not, measures must be taken to ensure that the operator does not touch power terminals or other high voltage sections.
- Any unauthorized transfer or copying of this document, in part or in whole, is prohibited.
- Shinko Technos CO., LTD. is not liable for any damages or secondary damages incurred as a result of using this product, including any indirect damages.

## SAFETY PRECAUTIONS (Be sure to read these precautions before using our products.)

The safety precautions are classified into categories: "Warning" and "Caution".

Depending on circumstances, procedures indicated by  Caution may be linked to serious results, so be sure to follow the directions for usage.



### Warning

Procedures which may lead to dangerous conditions and cause death or serious injury, if not carried out properly.



### Caution

Procedures which may lead to dangerous conditions and cause superficial to medium injury or physical damage or may degrade or damage the product, if not carried out properly.



### Warning

- To prevent an electric shock or fire, only Shinko or qualified service personnel may handle the inner assembly.
- To prevent an electric shock, fire or damage to instrument, parts replacement may only be undertaken by Shinko or qualified service personnel.



## SAFETY PRECAUTIONS

- To ensure safe and correct use, thoroughly read and understand this manual before using this instrument.
- This instrument is intended to be used for industrial machinery, machine tools and measuring equipment. Verify correct usage after consulting purpose of use with our agency or main office (Never use this instrument for medical purposes with which human lives are involved.)
- External protection devices such as protection equipment against excessive temperature rise, etc. must be installed, as malfunction of this product could result in serious damage to the system or injury to personnel. Also proper periodic maintenance is required.
- This instrument must be used under the conditions and environment described in this manual

Shinko Technos Co., Ltd. does not accept liability for any injury, loss of life or damage occurring due to the instrument being used under conditions not otherwise stated in this manual.

### Caution with respect to Export Trade Control Ordinance

To avoid this instrument from being used as a component in, or as being utilized in the manufacture of weapons of mass destruction (i.e. military applications, military equipment, etc.), please investigate the end users and the final use of this instrument. In the case of resale, ensure that this instrument is not illegally exported.

# 1. Installation precautions



## Caution

This unit is intended to be used under the following environmental conditions (IEC61010-1): Overvoltage category II, Pollution degree 2

Ensure the mounting location corresponds to the following conditions:

- A minimum of dust, and an absence of corrosive gases
- No flammable, explosive gases
- No mechanical vibrations or shocks
- No exposure to direct sunlight, an ambient temperature of 0 to 50°C (32 to 122°F) that does not change rapidly
- An ambient non-condensing humidity of 35 to 85%RH
- No large capacity electromagnetic switches or cables through which large current flows
- No water, oil or chemicals or where the vapors of these substances can come into direct contact with the unit

**Note:** Do not install this unit near flammable material even though the case of this unit is made of flame resistant resin.

Avoid setting this unit directly on flammable material.

# 2. Wiring precautions



## Caution

- Do not leave wire chips in the unit, because they could cause fire, malfunction or trouble.
- When wiring terminals of the NCL-13A, use ferrules with an insulation sleeve applicable to the connecting plugs.
- A screw type plug for lines (sold separately) is required for wiring of power and communication lines. Use the ferrules with an insulation sleeve in which an M2 screw fits.
- Tighten the terminal screw within the specified torque. If excessive force is applied to the screw when tightening, the screw or case may be damaged.
- Do not apply a commercial power source to the sensor connected to the NCL-13A nor allow the power source to come into contact with the sensor, as the input circuit may be burnt out.
- Use a thermocouple, compensating lead wire and RTD (3-wire) according to the input of this unit.
- With the relay contact output type, externally use a relay according to the capacity of the load to protect the built-in relay contact.
- Keep the input wire (TC, compensating lead wire, etc.), power line and load wire away from one another.
- To prevent the unit from harmful effects of unexpected level noise, it is recommended that a surge absorber be installed between the electromagnetic switch coils.
- Externally install a protecting circuit in case there is unexpected trouble due to the environment, aging, etc.
- This unit has neither a built-in power switch nor a fuse. Therefore, it is necessary to install them in the circuit near the unit externally.
- The supply voltage of this unit is 24V DC. Do not confuse the polarity.

### 3. Running and maintenance precautions



#### **Warning**

- It is recommended that the PID auto-tuning be performed on the trial run.
- Do not touch live terminals. This may cause electric shock or problems in operation.
- Turn the power supply to the instrument OFF before retightening the terminal and cleaning.

Working or touching the terminal with the power switched ON may result in severe injury or death due to Electric Shock.

- Use a soft, dry cloth when cleaning the unit.  
(Alcohol based substances may cause tarnishing or defacement of the unit)
- As the display section is vulnerable, do not strike or scratch it with a hard object.

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## 2. Model name

### 2.1 Model name

|                       |      |  |
|-----------------------|------|--|
| NCL-13A-□/□ □ □ □ □   |      | Series name: NCL-13A (W17.5 x H75 x D85mm)                                       |
| Alarm                 | A    | Alarm 1 output, Alarm 2, Alarm 3, Alarm 4 (*1)                                   |
| Control output (OUT1) | R    | Relay contact: 1a  |
|                       | S    | Non-contact voltage (for SSR drive): 12 <sup>+2</sup> <sub>0</sub> V DC          |
|                       | A    | DC current: 4 to 20mA DC   |
|                       | C    | Open collector: 0.1A 24V DC (maximum)  |
| Input                 | M    | Multi-range (*2)   |
| Option                | DC   | Heating/Cooling control output   Open collector output (OUT2)                    |
|                       | W/W3 | Heater burnout alarm/Actuator short circuit alarm (W: Single phase, W3: 3-phase) |

\*1: An alarm action (9 types and No alarm action) and Alarm 1 output Energized/Deenergized can be selected from the host computer through communication function.

For Alarm 2, Alarm 3 and Alarm 4, the output and Energized/Deenergized selection are not available. By reading status flags in serial communication, their alarm status can be assessed.

\*2: Thermocouple, RTD, DC current or DC voltage can be selected from the host computer through communication function.

For DC current input, 50Ω shunt resistor (RES-S03-050, sold separately) must be installed between input terminals.

### 2.2 How to read the model name label

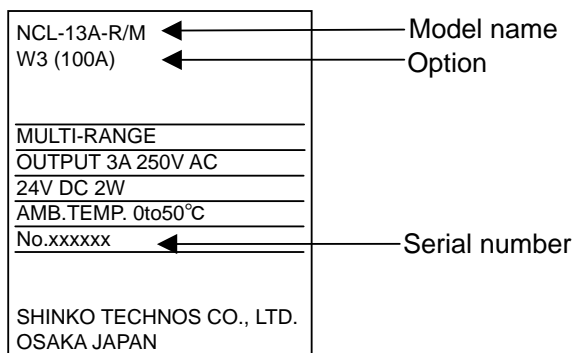
**Warning**

Turn the power supply to the instrument off before confirming the model name labels.

Working or touching the terminal with the power switched on may result in severe injury or death due to Electric Shock.

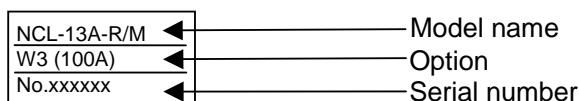
Model name labels are attached to the case and the inner assembly.

(e.g.) Case



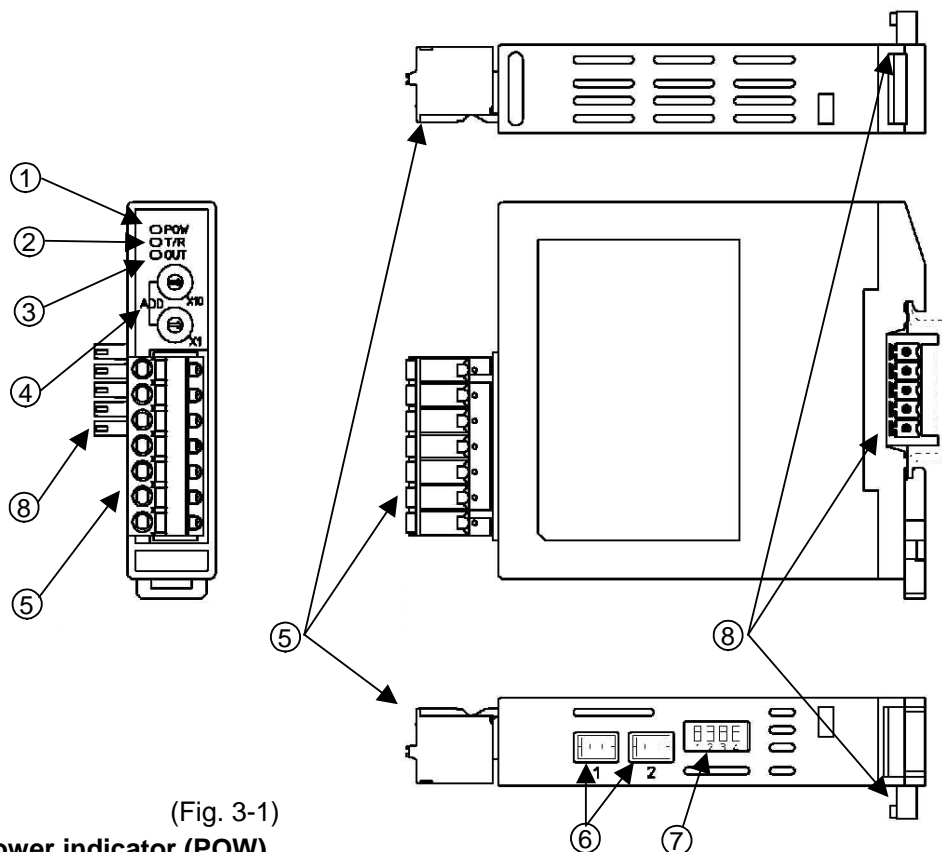
(Fig. 2.2-1)

(e.g.) Internal assembly



(Fig. 2.2-2)

### 3. Name and functions of the sections



(Fig. 3-1)

- ① **Power indicator (POW)**  
A green LED lights up when the power to the unit is turned on.  
A green LED flashes if any alarm (temperature alarm, Heater burnout/Actuator short circuit alarm or Loop break alarm) occurs.
- ② **Communication indicator (T/R)**  
A yellow LED lights up during serial communication TX.
- ③ **Control output indicator (OUT)**  
A green LED lights up when control output (OUT1) is on.  
For DC current output, a green LED flashes corresponding to the MV (manipulated variable).
- ④ **Rotary switch for instrument number setting**  
Sets the instrument number of the NCL-13A.
- ⑤ **Spring type plug:** Plug for input, control output (OUT1) and event output.
- ⑥ **CT1, CT2 input connector:** Connector for CT input of Heater burnout/Actuator short circuit alarm (W, W3 option).
- ⑦ **DIP switch for selecting communication speed and communication protocol**  
Selects communication speed and communication protocol of the NCL-13A.
- ⑧ **Bus plug:**  
Plug for lines (power bus, communication bus).  
When connecting multiple units, the bus plug can connect to another bus plug.



# 4. Communication parameter setting

This chapter describes how to set or select the instrument number, communication speed and communication protocol.



## Warning

Set communication parameters after turning the power to the unit OFF. Setting communication parameters with the power switched on may result in severe injury or death due to Electric Shock.

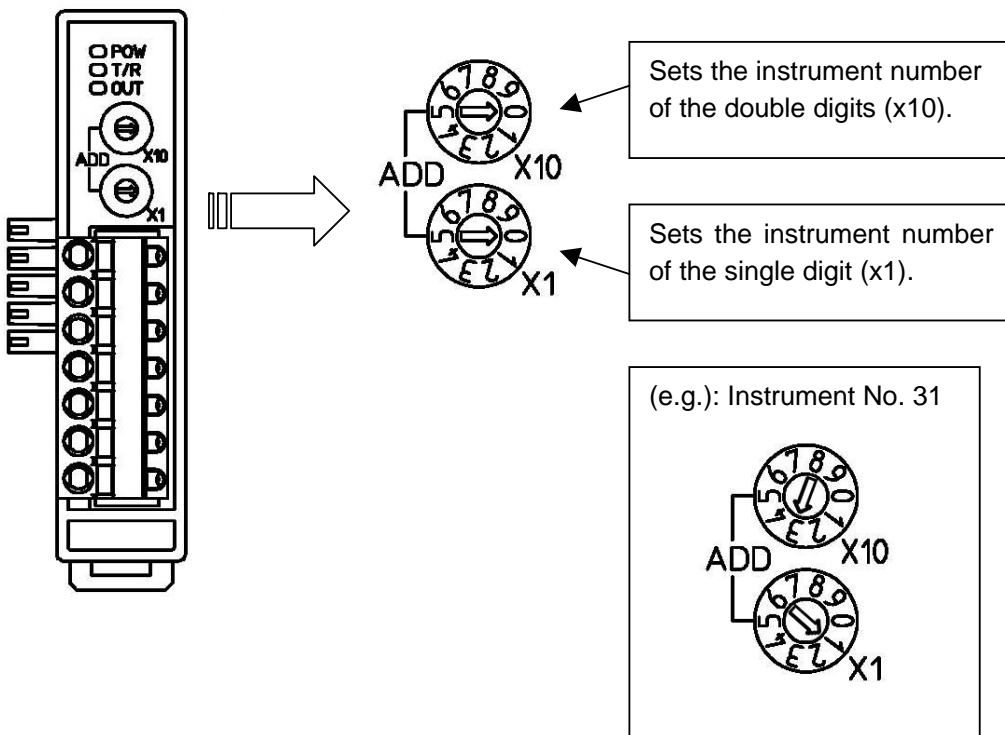


## Caution

When the power to the unit is turned on, this unit reads the contents set by the rotary switch and DIP switch. If any setting is changed after the power-on, turn the power off and on again.

### 4.1 Instrument number setting

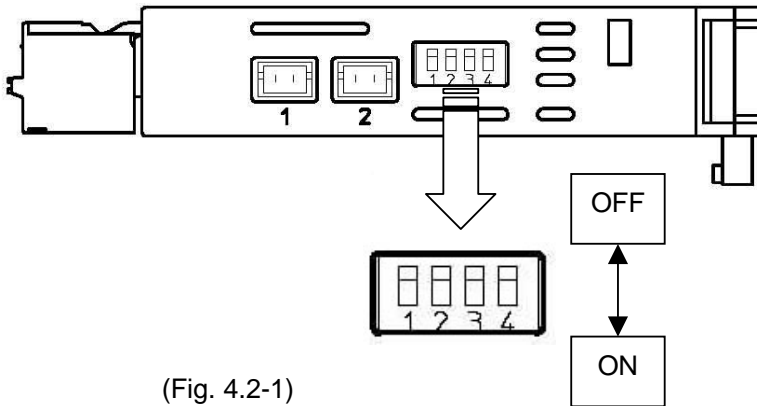
When communicating by connecting multiple NCL-13A units, set the instrument number of each unit by means of the rotary switch. (Default value: 0 x10, 0 x 1)



(Fig. 4.1-1)

## 4.2 Communication speed and protocol selection

Select the communication speed and protocol with the DIP switch.



(Fig. 4.2-1)

### 4.2.1 Communication speed selection

Select the communication speed with DIP switch 1 and 2 to be equal to that of the host computer. (Default value: 9600bps)

(Table 4.2.1-1)

| DIP switch No. |     | Communication speed |
|----------------|-----|---------------------|
| 1              | 2   |                     |
| OFF            | OFF | 9600bps             |
| ON             | OFF | 4800bps             |
| OFF            | ON  | 19200bps            |

### 4.2.2 Communication protocol selection

Select the communication protocol with DIP switch 3 and 4.

(Default value: Shinko protocol)

(Table 4.2.2-1)

| DIP switch No. |     | Communication protocol | Start bit | Data length | Stop bit | Parity bit |
|----------------|-----|------------------------|-----------|-------------|----------|------------|
| 3              | 4   |                        |           |             |          |            |
| OFF            | OFF | Shinko protocol        | 1         | 7           | 1        | Yes (Even) |
| ON             | OFF | Modbus ASCII           | 1         | 7           | 1        | Yes (Even) |
| OFF            | ON  | Modbus RTU             | 1         | 8           | 1        | No parity  |

# 5. Mounting

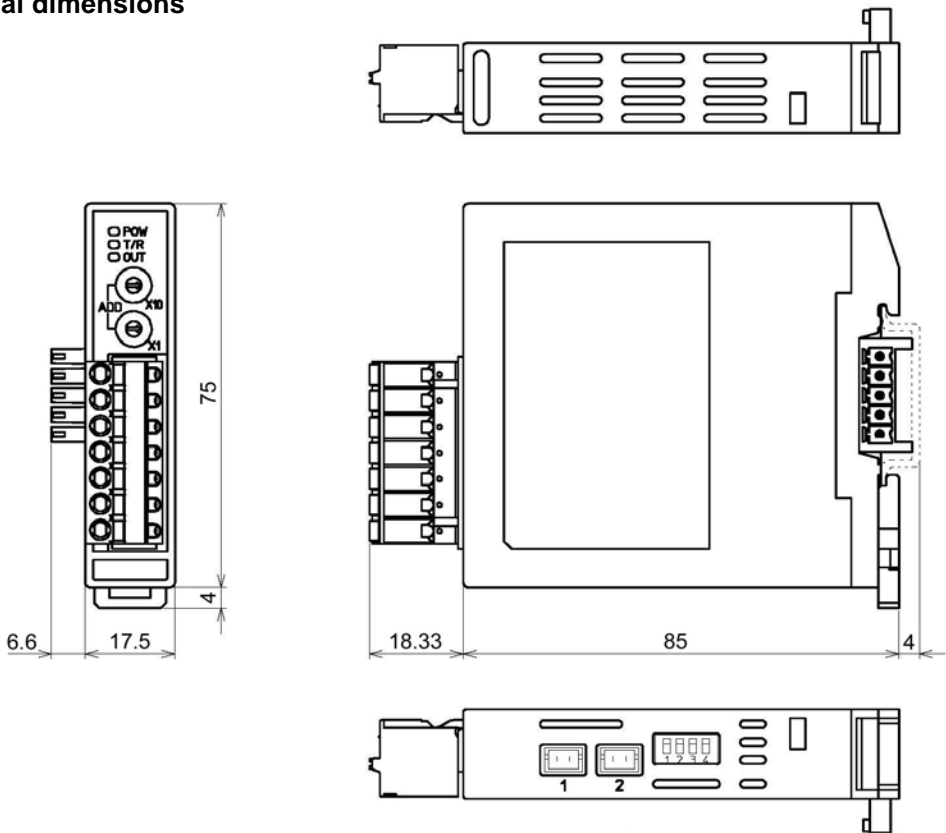
## 5.1 Site selection

This unit is intended to be used under the following environmental conditions (IEC61010-1): Overvoltage category II, Pollution degree 2

Ensure the mounting location corresponds to the following conditions:

- A minimum of dust, and an absence of corrosive gases
- No flammable, explosive gases
- No mechanical vibrations or shocks
- No exposure to direct sunlight, an ambient temperature of 0 to 50°C (32 to 122°F) that does not change rapidly
- An ambient non-condensing humidity of 35 to 85%RH
- No large capacity electromagnetic switches or cables through which large current flows
- No water, oil or chemicals or where the vapors of these substances can come into direct contact with this unit

## 5.2 External dimensions



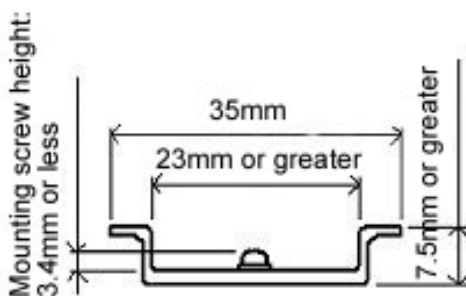
(Fig. 5.2-1)

### 5.3 Mounting to DIN rail



## Notice

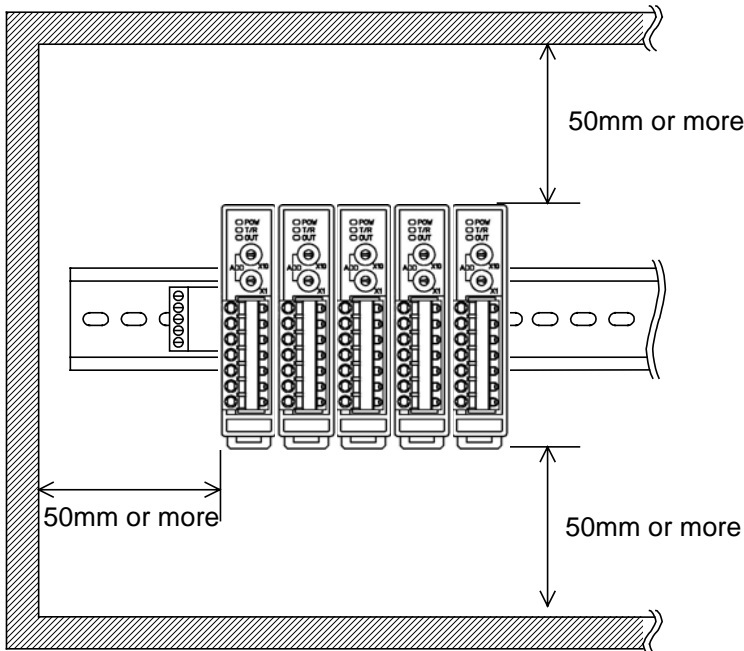
- Mount the DIN rail laterally.
- The following shows DIN rail corresponding to the NCL-13A.



Width : 35mm  
Height : 7.5mm or more  
Groove width : 23mm or more  
DIN rail mounting screw height:  
3.4mm or less (At a DIN rail height  
of 7.5mm)

(Fig. 5.3-1)

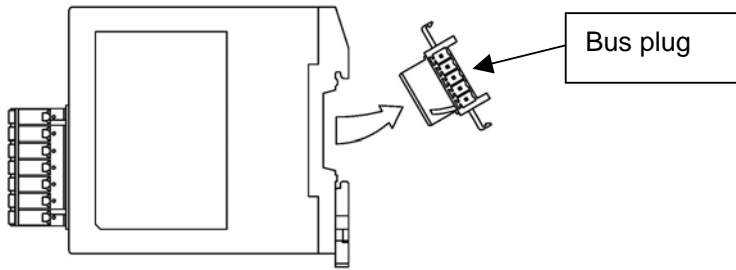
- If the DIN rail is mounted in a position susceptible to vibration or shock, be sure to use End plates (AEP-001-1, sold separately) at both ends of the unit.
- Do not confuse the top and bottom of this unit.
- When mounting to or removing the unit from the DIN rail, the units must be slanted a little.  
Therefore do not mount any other instruments within 50mm of space at the left side, upside and down side from the unit, considering radiation.



(Fig. 5.3-2)

Mount the unit by following the procedures below.

(1) Remove the bus plug from the unit.

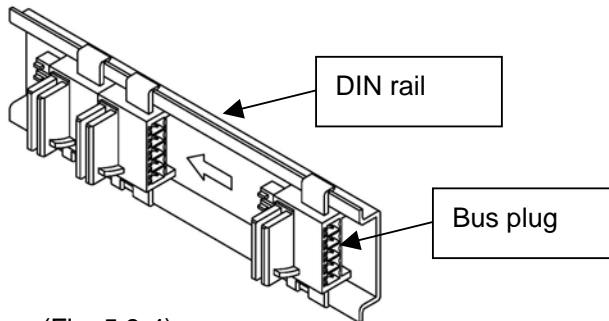


(Fig. 5.3-3)

(2) Mount the removed bus plug to the DIN rail.

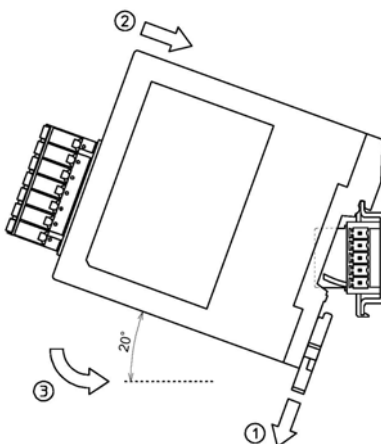
Hook the top and bottom claws of the bus plug and fit them in the DIN rail with "click" sound.

When mounting plural units, link the bus plugs as shown in (Fig. 5.3-4).



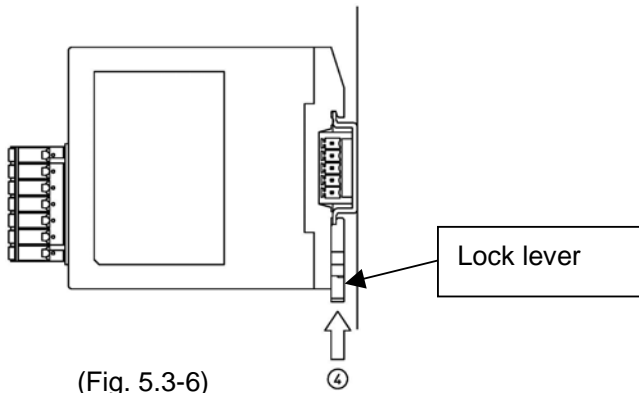
(Fig. 5.3-4)

(3) Pull the lock lever of the unit (①), hook the unit to the DIN rail at an angle of approx. 20 degrees upward (②) and mount it (③).



(Fig. 5.3-5)

(4) Push the lock lever of the unit up until a clicking sound is heard (④).



(Fig. 5.3-6)

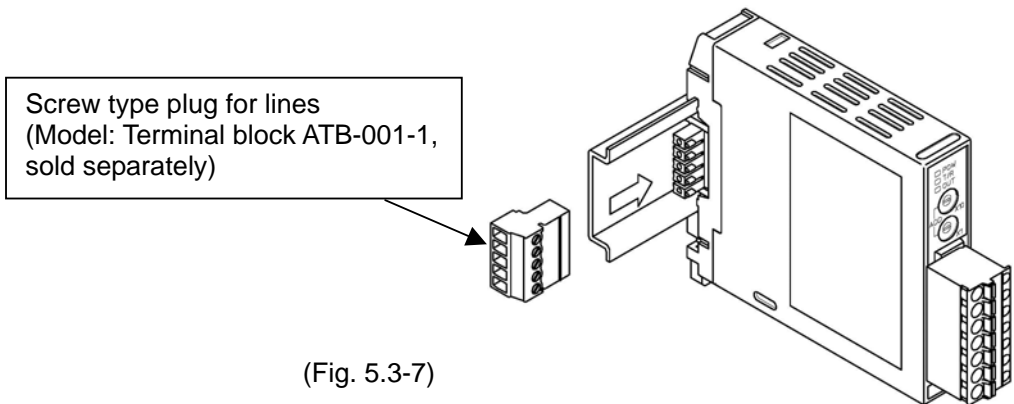


## Notice

**Check whether the NCL-33A is securely fixed on the DIN rail.**

(5) Mount the screw type plug for lines (Model: Terminal block ATB-001-1, sold separately) to the bus plug.

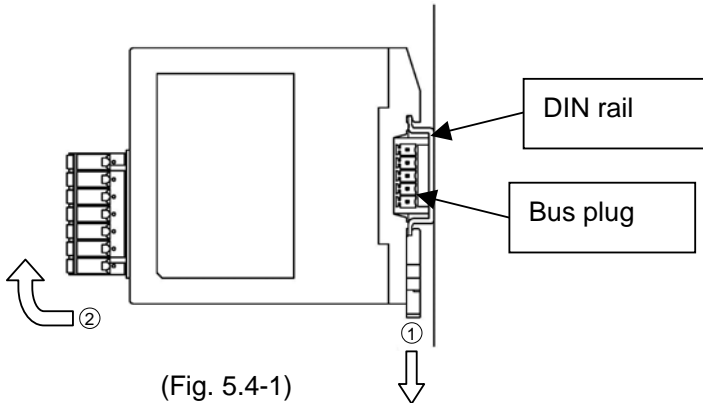
The screw type plug (Model: Terminal block ATB-001-1, sold separately) can also be mounted to the bus plug after wiring the power and communication lines.



(Fig. 5.3-7)

## 5.4 Removal from DIN rail

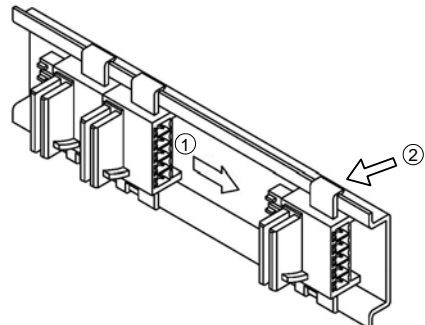
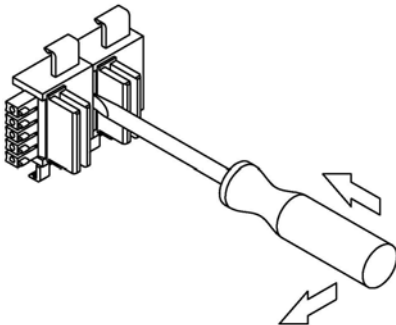
- (1) Pull the lock lever down (①), and remove the unit from the DIN rail as lifting the unit a little (②). The bus plug still remains on the DIN rail.



- (2) When multiple bus plugs are mounted, separate the linking sections first.

By inserting the flat-blade screwdriver into the slit, push the plug aside using leverage. (Fig. 5.4-2), (Fig. 5.4-3①)

Remove the bus plug from the DIN rail by lifting the upper claw of the plug a little. (Fig. 5.4-3②)



### Notice

When separating bus plugs at the linking part, do not use excessive force.

## 6. Wiring



### Warning

Turn the power supply to the unit off before wiring.  
Working or touching the terminal with the power switched on may result in severe injury or death due to Electric Shock.

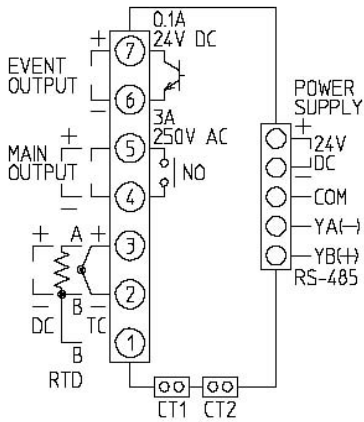


### Caution

- Do not leave wire chips in the unit, because they could cause fire, malfunction or trouble.
- When wiring terminals of the NCL-13A, use ferrules with an insulation sleeve applicable to the connecting plugs.
- A screw type plug for lines (Model: Terminal block ATB-001-1, sold separately) is required for wiring of power and communication lines. Use the ferrules with an insulation sleeve in which an M2 screw fits.
- Tighten the terminal screw within the specified torque. If excessive force is applied to the screw when tightening, the screw or case may be damaged.
- Do not apply a commercial power source to the sensor connected to the NCL-13A nor allow the power source to come into contact with the sensor, as the input circuit may be burnt out.
- Use a thermocouple, compensating lead wire and RTD (3-wire) in accordance with the input of this unit.
- With the relay contact output type, externally use a relay according to the capacity of the load to protect the built-in relay contact.
- Keep the input wire (TC, compensating lead wire, etc.), power line and load wire away from one another.
- To prevent the unit from harmful effects of unexpected level noise, it is recommended that a surge absorber be installed between the electromagnetic switch coils.
- Externally install a protecting circuit in case there is unexpected trouble due to the environment, aging, etc.
- This unit has neither a built-in power switch nor a fuse. Therefore, it is necessary to install them in the circuit near the unit externally.
- The supply voltage of this unit is 24V DC. Do not confuse the polarity.



## 6.1 Terminal arrangement



(Fig. 6.1-1)

### Bus plug, Screw type plug for lines

(Model: Terminal block ATB-001-1, sold separately)

- POWER SUPPLY (24V DC) : Power line terminals
- RS-485 [(YA (-), YB (+), COM)]: Communication line terminals

### Spring type plug

- EVENT OUTPUT: Event output terminals (\*)
- MAIN OUTPUT : Control output (OUT1) terminals
- TC, RTD, DC : Input terminals

(\*) Alarm 1 (Utilizes common output terminals with Heater burnout/Actuator short circuit alarm and Loop break alarm) or Cooling control output (OUT2)

### CT1, CT2 input connector

- CT1: CT input connector (W, W3 option)
- CT2: CT input connector (W3 option)

## 6.2 Recommended ferrules

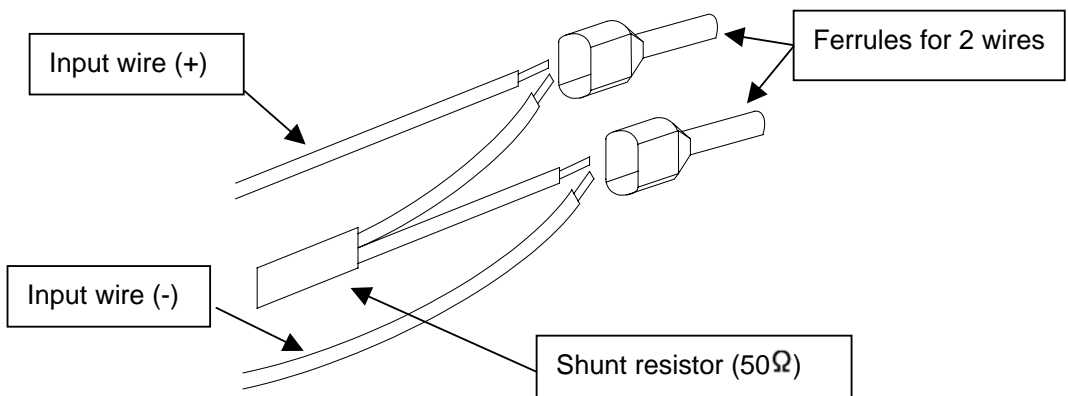
When using ferrules, use the following recommended ferrules with an insulation sleeve and crimping pliers made by Phoenix Contact GMBH & CO. (Table 6.2-1, Table 6.2-2)

(Table 6.2-1)

**Spring type plug [input, control output (OUT1), event output terminals] terminal number from ① to ⑦**

| Ferrules with insulation sleeve | Conductor cross sections    | Crimping pliers      |
|---------------------------------|-----------------------------|----------------------|
| Al 0.25-6 BU                    | 0.2 to 0.25mm <sup>2</sup>  | ZA3<br>CRIMPFOX UD 6 |
| Al 0.34-8 TQ                    | 0.25 to 0.34mm <sup>2</sup> |                      |
| Al 0.5-8 WH                     | 0.34 to 0.5mm <sup>2</sup>  |                      |
| Al 0.75-8 GY                    | 0.5 to 0.75mm <sup>2</sup>  |                      |
| Al 1.0-8 RD                     | 0.75 to 1.0mm <sup>2</sup>  |                      |
| Al 1.5-8 BK                     | 1.0 to 1.5mm <sup>2</sup>   |                      |
| Al 2.5-8 BU                     | 1.5 to 2.5mm <sup>2</sup>   |                      |

For DC current input, connect a shunt resistor (50Ω, RES-S03-050, sold separately) and input wires (+, -) with the provided ferrules for 2 wires.



(Fig. 6.2-1)

(Table 6.2-2)

**Screw type plug for lines** (Model: Terminal block ATB-001-1, sold separately)  
**M2 screw (power and communication line terminals)**

| Ferrules with insulation sleeve | Conductor cross sections    | Tightening torque | Crimping pliers      |
|---------------------------------|-----------------------------|-------------------|----------------------|
| Al 0.25-6 BU                    | 0.2 to 0.25mm <sup>2</sup>  | 0.22 to 0.25N•m   | ZA3<br>CRIMPFOX UD 6 |
| Al 0.34-6 TQ                    | 0.25 to 0.34mm <sup>2</sup> |                   |                      |
| Al 0.5-6 WH                     | 0.34 to 0.5mm <sup>2</sup>  |                   |                      |
| Al 0.75-6 GY                    | 0.5 to 0.75mm <sup>2</sup>  |                   |                      |
| Al 1-6 RD                       | 0.75 to 1.0mm <sup>2</sup>  |                   |                      |
| Al 1.5-6 BK                     | 1.0 to 1.5mm <sup>2</sup>   |                   |                      |

**6.3 Connecting power and communication lines to the screw type plug for lines**

(Model: Terminal block ATB-001-1, sold separately)

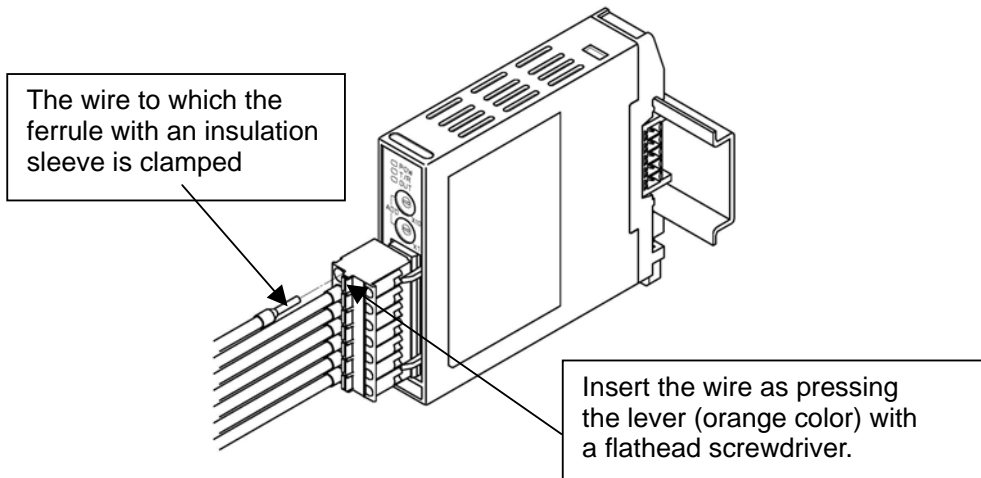
M2 screws are used for the screw type plug for lines (Model: Terminal block ATB-001-1, sold separately).

Tighten the terminal screws within the specified torque.

**6.4 Connecting input, control output (OUT1) and event output wires to the spring type plug**

Use a flat-blade screwdriver for wiring the spring type plug.

As pressing the lever (orange color) with a flat-blade screwdriver, insert the wire.



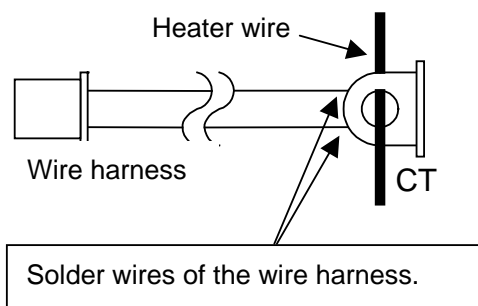
(Fig 6.4-1)

**6.5 Connecting wire from the CT with CT1, CT2 input connectors.**

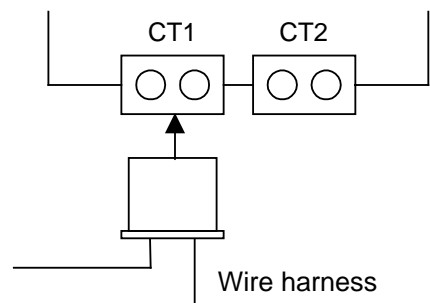
For the W option, CT1 is provided, and for the W3 option, CT1 and CT2 are provided. Pass the heater wire into the CT hole, and solder wires of the wire harness provided.

(Fig. 6.5-1)

Insert the wire harness into the CT1 input connector. (Fig. 6.5-2)

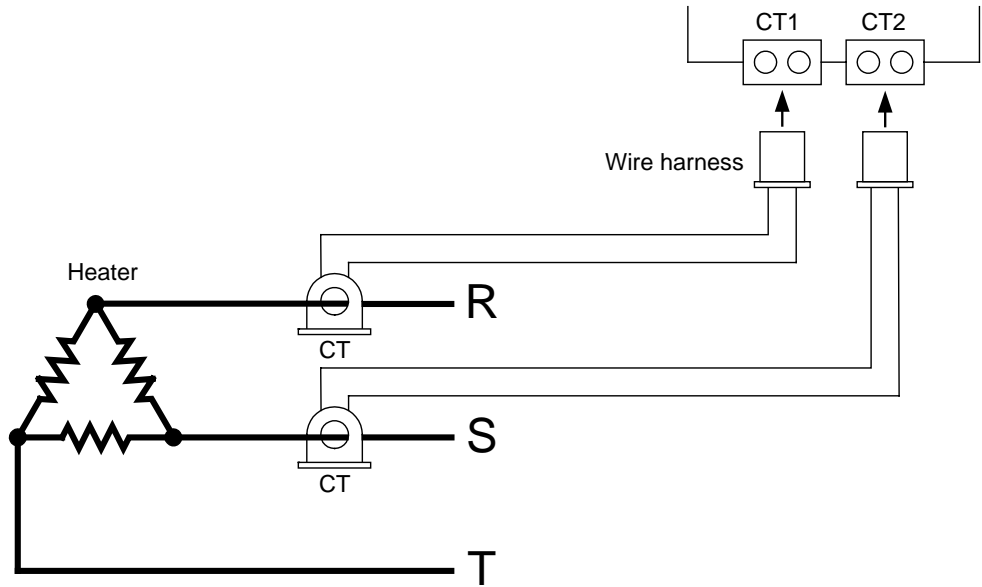


(Fig. 6.5-1)



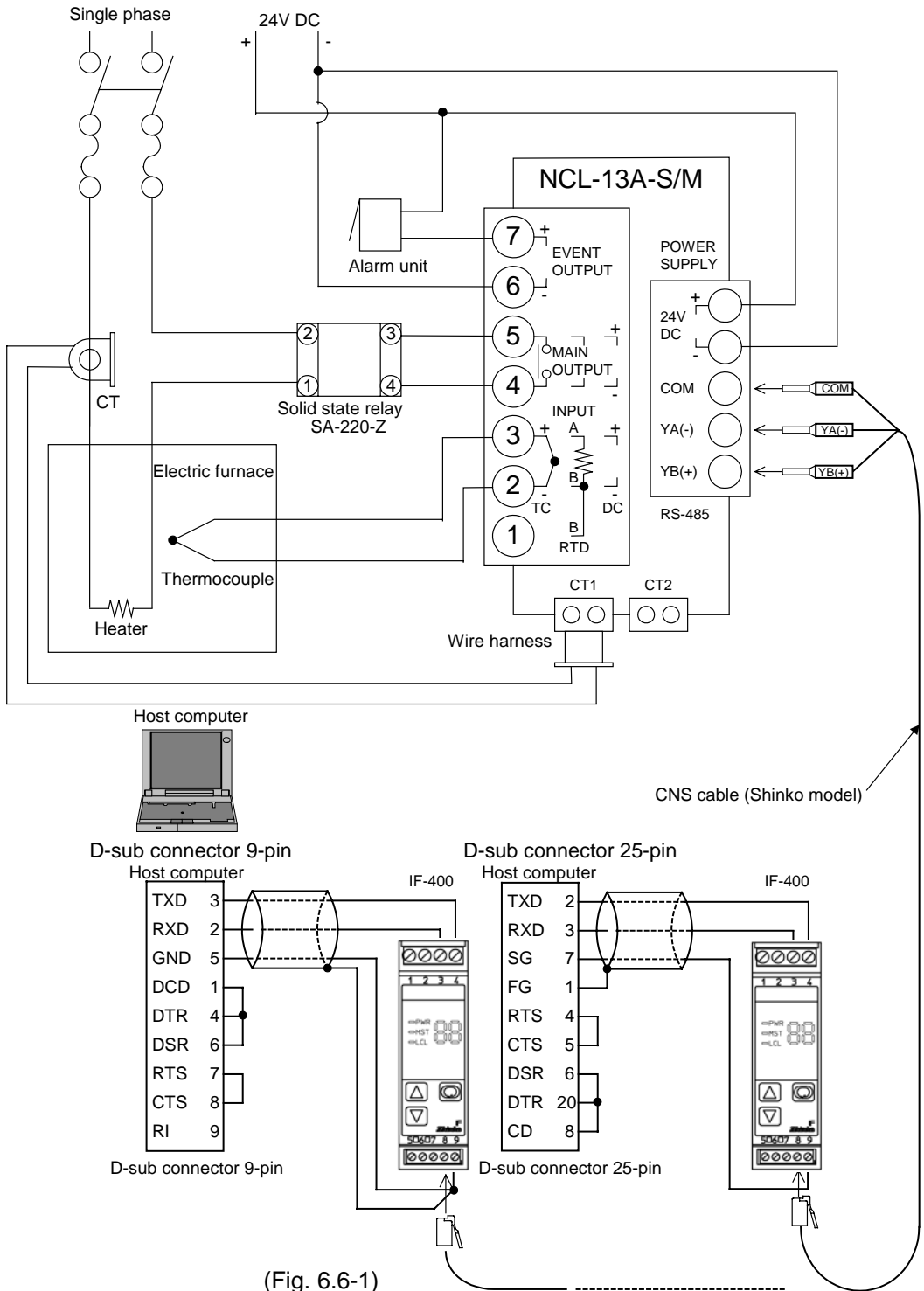
(Fig. 6.5-2)

For 3-phase, pass 2 wires out of R, S and T wires into the CT hole. (Fig. 6.5-3)  
Insert the wire harness into the CT1 and CT2 input connectors.



(Fig. 6.5-3)

## 6.6 Wiring example



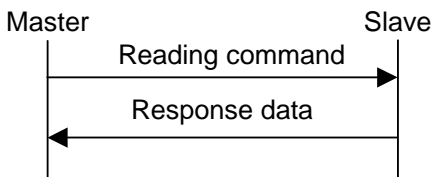
### Shield

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

# 7. Communication procedure

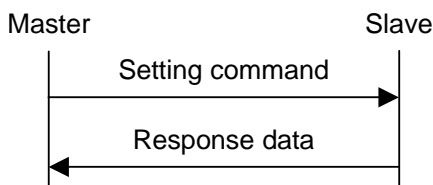
Communication starts with command transmission from the host computer (hereafter Master) and ends with the response of the NCL-13A (hereafter Slave).

- **Response with data**



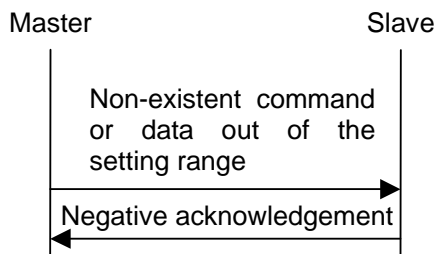
When the master sends the reading command, the slave responds with the corresponding setting value or current status.

- **Acknowledgement**



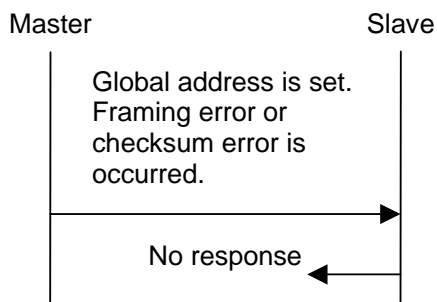
When the master sends the setting command, the slave responds by sending a acknowledgement after the processing is terminated.

- **Negative acknowledgement**



When the master sends non-existent command or a value outside the setting range, the slave returns a negative acknowledgement.

- **No response**



The slave will not respond to the master when global address is set, or when there is a framing error or checksum error (for Shinko protocol), or when LRC discrepancy (for Modbus protocol ASCII mode) or CRC discrepancy (for Modbus protocol RTU mode) is detected.

(Fig. 7-1)

## Communication timing of the RS-485 (C5 option)

### 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 the 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.

### Master side (Notice on 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.

## 8. Communication protocol

### 8.1 Shinko protocol

#### 8.1.1 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.

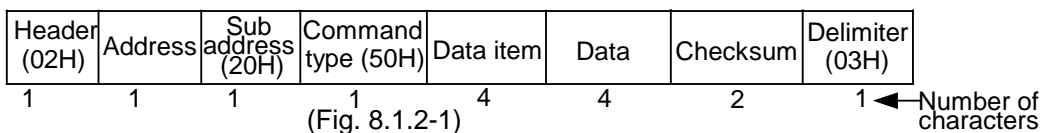
Data format            Start bit            : 1 bit  
                              Data bit                : 7 bits  
                              Parity                    : Even  
                              Stop bit                 : 1 bit  
                              Error detection: Checksum

#### 8.1.2 Command configuration

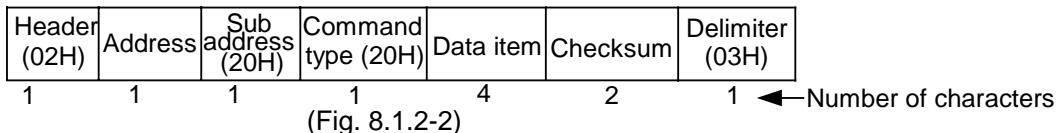
All commands are composed of ASCII. The data (setting value, decimal number) is represented by hexadecimal figures, and ASCII code is used.

The negative numbers are represented by 2's complement.

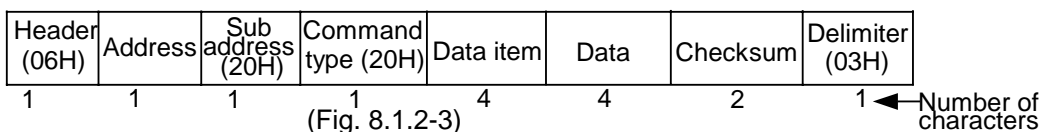
##### (1) Setting command



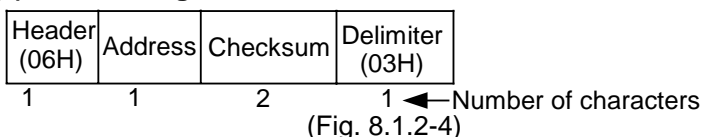
##### (2) Reading command



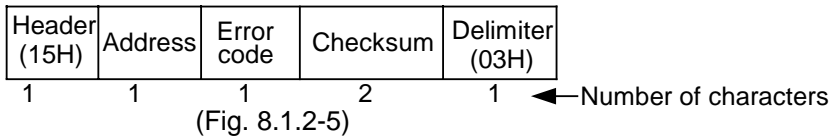
##### (3) Response with data



##### (4) Acknowledgement



## (5) Negative acknowledgement



- 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** : Numbers by which the master discerns each slave.  
Instrument number 0 to 94 (00H to 5EH) and Global address 95 (5FH)  
The numbers (20H to 7FH) are used by giving 20H of bias.  
95 (7FH) is called 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 (Refer to the Communication  
command table)
- Data** : The contents of data (setting value) differs depending on the setting  
command.  
Composed of hexadecimal 4 digits (Refer to the Communication  
command table)
- Checksum** : 2-character data to detect communication errors
- Delimiter** : Control code to represent the end of command  
(03H) fixed
- Error code** : Represents an error type. Composed of hexadecimal 1 digit.  
1 (31H)-----Non-existent command  
2 (32H)-----Not used  
3 (33H)-----Setting value outside the setting range  
4 (34H)-----Unsettable status (e.g. AT is performing)

### 8.1.3 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.

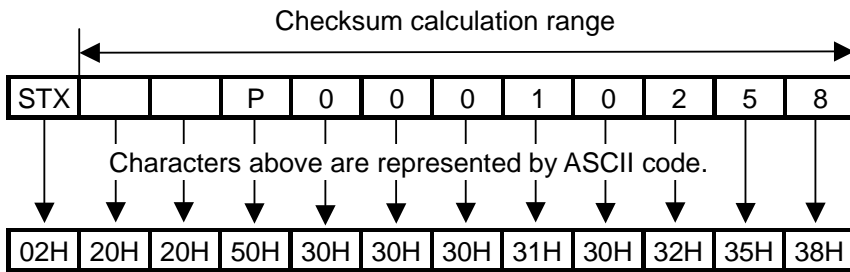
The lower 2-digits of the total value are converted to 2's complements and then to hexadecimal figures, that is, ASCII codes for the checksum.

#### Checksum calculation example

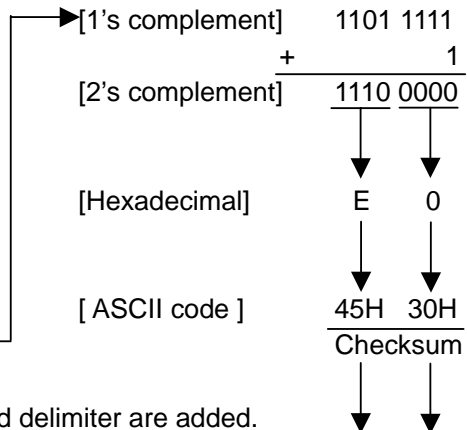
SV: 600°C (0258H)

Address (instrument number): 0 (20H)

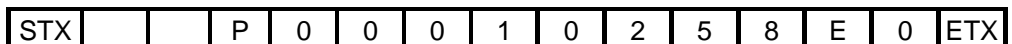
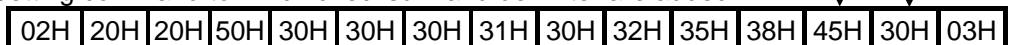
- 1's complement: Reverse each binary bit. 0 will become 1 and vice versa.
- 2's complement: Add 1 to 1's complement.



| [Hexadecimal] | [Binary]     |
|---------------|--------------|
| 20H           | 0010 0000    |
| 20H           | 0010 0000    |
| 50H           | 0101 0000    |
| 30H           | 0011 0000    |
| 30H           | 0011 0000    |
| 30H           | 0011 0000    |
| 31H           | 0011 0001    |
| 30H           | 0011 0000    |
| 32H           | 0011 0010    |
| 35H           | 0011 0101    |
| +38H          | 0011 1000    |
|               | 10 0010 0000 |



Setting command to which checksum and delimiter are added.





### 8.1.4 Contents of the command

#### Notes on the setting command and reading command

- Although the options are not applied, setting the optional items is possible by the setting command. However, they will not function.
- The memory can store up to 1,000,000 (one million) entries.  
If the number of setting times exceeds the limit, it cannot memorize the data.  
So frequent transmission via communication is not recommended.
- When connecting plural slaves, the address (instrument number) must not be duplicated.
- 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.
- The instrument number and communication speed of the slave cannot be set by communication function.

#### Setting command

- For the settable range, refer to the Communication command table of this manual.
- All commands are composed of ASCII.
- The data (setting value, decimal) is converted to hexadecimal figures, and ASCII is used.  
Negative numbers are represented by 2's complement. When the data (setting value) has a decimal point, the whole number without a decimal point is used.

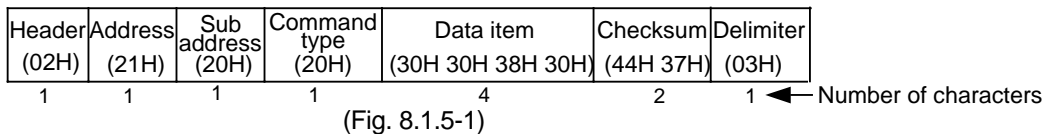
#### Reading command

- All commands are composed of ASCII.
- The data (setting value, decimal) is converted to hexadecimal figures, and ASCII is used.  
Negative numbers are represented by 2's complement. When the data (setting value) has a decimal point, the response is returned as a whole number without a decimal point.

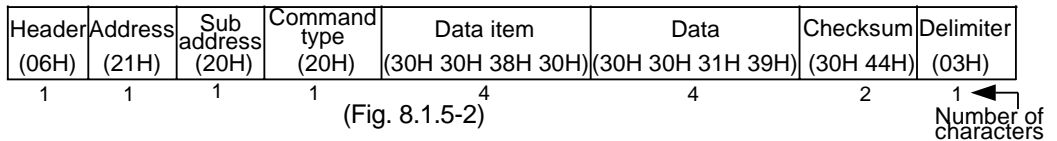
### 8.1.5 Command example

#### (1) PV reading (Address 1)

- Reading command from the master

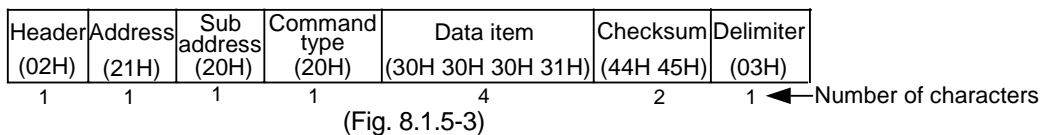


- Response from the slave in normal status [When PV=25°C (0019H)]

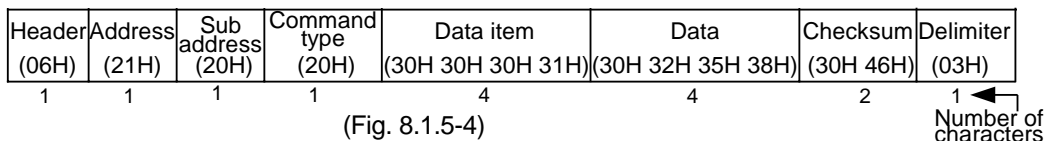


#### (2) SV reading (Address 1)

- Reading command from the master

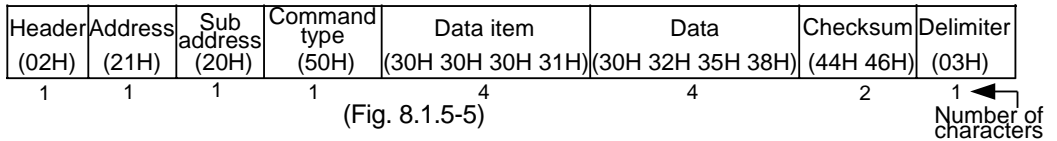


- Response from the slave in normal status [When SV=600°C (0258H)]

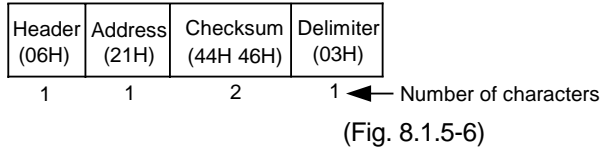


### (3) When SV is set to 600°C (0258H) (Address 1)

- Setting command from the master



- Response from the slave in normal status



## 8.2 Modbus protocol

### 8.2.1 Transmission mode

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

### 8.2.2 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  
                          Stop bit                 : 1 bit  
                          Error detection: LRC (Longitudinal Redundancy Check)  
                          Data interval        : 1 second or less

### (1) Message configuration

ASCII mode message is configured to start by [: (colon)(3AH)] and end by [CR (carriage return) (0DH) + LF (Line feed)(0AH)]. See (Fig. 8.2.2-1).

|               |                  |                  |      |                    |                   |                   |
|---------------|------------------|------------------|------|--------------------|-------------------|-------------------|
| Header<br>(:) | Slave<br>address | Function<br>code | Data | Error check<br>LRC | Delimiter<br>(CR) | Delimiter<br>(LF) |
|---------------|------------------|------------------|------|--------------------|-------------------|-------------------|

(Fig. 8.2.2-1)

### Slave address

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

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 00H (broadcast address) can identify all the slaves. However slaves do not respond.

### Function code

The function code is the command code that makes the slave to undertake the following action types (Table 8.2.2-1).

(Table 8.2.2-1)

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

A 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 to function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.)

For negative acknowledgement, exception code (Table 8.2.2-2) below is set to the data of response message and returned to the master in order to inform it that what kind of error has occurred.

(Table 8.2.2-2)

| 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 outside the setting range)     |
| 17 (11H)       | Shinko error code 4 (Unsettable status: During AT, etc.) |

## Data

Data differs depending on the function code.

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

A response message from the slave is composed of number of bytes, data and exception code in negative acknowledgement.

Only one piece of data can be dealt with per message.

Therefore the number of data for ASCII mode is fixed as (30H 30H 30H 31H).

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

## (2) ASCII mode error check

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 LRC is calculated

- 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) ASCII mode message example

### ① PV reading (Address 1)

- A request message from the master

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

| Header | Slave address | Function code | Data item         | Number of data    | Error check LRC | Delimiter |
|--------|---------------|---------------|-------------------|-------------------|-----------------|-----------|
| (3AH)  | (30H 31H)     | (30H 33H)     | (30H 30H 38H 30H) | (30H 30H 30H 31H) | (37H 42H)       | (0DH 0AH) |
| 1      | 2             | 2             | 4                 | 4                 | 2               | 2         |

(Fig. 8.2.2-2)

← Number of characters

- A response message from the slave in normal status [When PV=600°C (0258H)]  
The number of response bytes indicates the number of bytes of the data which has been read, and it is fixed as (30H 32H).

| Header<br>(3AH) | Slave address<br>(30H 31H) | Function code<br>(30H 33H) | Number of response bytes<br>(30H 32H) | Data<br>(30H 32H 35H 38H) | Error check LRC<br>(41H 30H) | Delimiter<br>(0DH 0AH) |
|-----------------|----------------------------|----------------------------|---------------------------------------|---------------------------|------------------------------|------------------------|
| 1               | 2                          | 2                          | 2                                     | 4                         | 2                            | 2                      |

(Fig.8.2.2-3)

← Number of characters

## ② SV reading (Address 1)

- Request message from the master

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

| Header<br>(3AH) | Slave address<br>(30H 31H) | Function code<br>(30H 33H) | Data item<br>(30H 30H 30H 31H) | Number of data<br>(30H 30H 30H 31H) | Error check LRC<br>(46H 41H) | Delimiter<br>(0DH 0AH) |
|-----------------|----------------------------|----------------------------|--------------------------------|-------------------------------------|------------------------------|------------------------|
| 1               | 2                          | 2                          | 4                              | 4                                   | 2                            | 2                      |

(Fig. 8.2.2-4)

← Number of characters

- A response message from the slave in normal status [When SV=600°C (0258H)]  
The number of response bytes indicates the number of bytes of the data which has been read, and it is fixed as (30H 32H).

| Header<br>(3AH) | Slave address<br>(30H 31H) | Function code<br>(30H 33H) | Number of response bytes<br>(30H 32H) | Data<br>(30H 32H 35H 38H) | Error check LRC<br>(41H 30H) | Delimiter<br>(0DH 0AH) |
|-----------------|----------------------------|----------------------------|---------------------------------------|---------------------------|------------------------------|------------------------|
| 1               | 2                          | 2                          | 2                                     | 4                         | 2                            | 2                      |

(Fig. 8.2.2-5)

← Number of characters

- A response message from the slave in exception (error) status (When non-existent data address is sent)

The function code MSB is set to 1 for the response message in exception (error) status (Value: 83H, ASCII: 38H 33H).

If an exception code (Value: 02H, ASCII: 30H 32H Non-existent data address) is returned, the error can be determined by reading this code.

| Header<br>(3AH) | Slave address<br>(30H 31H) | Function code<br>(38H 33H) | Exception code<br>(30H 32H) | Error check LRC<br>(37H 41H) | Delimiter<br>(0DH 0AH) |
|-----------------|----------------------------|----------------------------|-----------------------------|------------------------------|------------------------|
| 1               | 2                          | 2                          | 2                           | 2                            | 2                      |

(Fig. 8.2.2-6)

← Number of characters

## ③ When setting SV to 600°C (0258H) (Address 1)

- A request message from the master

| Header<br>(3AH) | Slave address<br>(30H 31H) | Function code<br>(30H 36H) | Data item<br>(30H 30H 30H 31H) | Data<br>(30H 32H 35H 38H) | Error check LRC<br>(39H 45H) | Delimiter<br>(0DH 0AH) |
|-----------------|----------------------------|----------------------------|--------------------------------|---------------------------|------------------------------|------------------------|
| 1               | 2                          | 2                          | 4                              | 4                         | 2                            | 2                      |

(Fig. 8.2.2-7)

← Number of characters

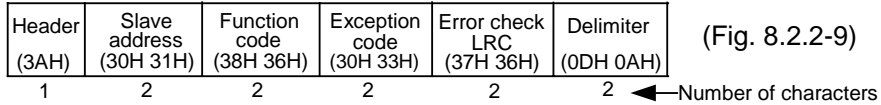
- A response message from the slave in normal status

| Header<br>(3AH) | Slave address<br>(30H 31H) | Function code<br>(30H 36H) | Data item<br>(30H 30H 30H 31H) | Data<br>(30H 32H 35H 38H) | Error check LRC<br>(39H 45H) | Delimiter<br>(0DH 0AH) |
|-----------------|----------------------------|----------------------------|--------------------------------|---------------------------|------------------------------|------------------------|
| 1               | 2                          | 2                          | 4                              | 4                         | 2                            | 2                      |

(Fig. 8.2.2-8)

← Number of characters

- A 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 (Value: 86H, ASCII: 38H 36H).  
If an exception code (Value: 03H, ASCII: 30H 33H Value out of the setting range) is returned, the error can be determined by reading this code.



### 8.2.3 RTU mode

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

Data format    Start bit            : 1 bit  
                   Data bit             : 8 bits  
                   Parity                : No parity  
                   Stop bit              : 1 bit  
                   Error detection : CRC-16 (Cyclic Redundancy Check)  
                   Data interval : 3.5 characters transmission time or less

#### (1) Message configuration

RTU mode is configured to start after idle time is processed for more than 3.5 characters transmission and end after idle time is processed for more than 3.5 characters transmission. (See Fig. 8.2.3-1)



(Fig. 8.2.3-1)

#### Slave address

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

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

#### Function code

The function code is the command code that makes the slave to undertake the following action types (Table 8.2.3-1).

(Table 8.2.3-1)

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

A 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 function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.)

For negative acknowledgement, exception code (Table 8.2.3-2) below is set to the data of response message and returned to the master in order to inform it that what kind of error has occurred.

(Table 8.2.3-2)

| 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 (Unsettable status: During AT, etc.) |

## 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 number of bytes, data and exception code in negative acknowledgement.

Only one piece of data can be dealt with per message. Therefore the number of data for RTU mode is fixed as 1 (0001H).

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

## (2) RTU mode error check

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 message in sequence from low order to high order.

### How CRC is calculated

In the CRC system, the information is divided by a polynomial series.

The remainder is added to the end of the information and then transmitted.

The generation of the polynomial series is as follows.

(Generation of the 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) RTU mode message example

### ① PV reading (Address 1)

- Request message from the master

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

|                     |                        |                        |                      |                           |                               |                        |
|---------------------|------------------------|------------------------|----------------------|---------------------------|-------------------------------|------------------------|
| 3.5 idle characters | Slave address<br>(01H) | Function code<br>(03H) | Data item<br>(0080H) | Number of data<br>(0001H) | Error check<br>CRC<br>(85E2H) | 3.5 idle characters    |
|                     | 1                      | 1                      | 2                    | 2                         | 2                             | ← Number of characters |

(Fig. 8.2.3-2)

- Response message from the slave in normal status [When PV=600°C (0258H)]

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

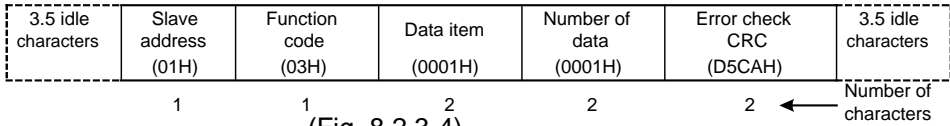
|                     |                        |                        |                                   |                 |                               |                        |
|---------------------|------------------------|------------------------|-----------------------------------|-----------------|-------------------------------|--------------------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

(Fig. 8.2.3-3)

② **SV reading (Address 1)**

- Request message from the master

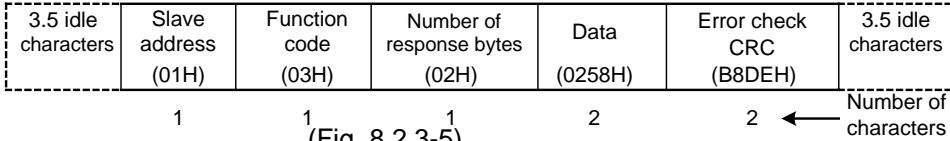
The number of data indicates the data item to be read, and it is fixed as 1 (0001H).



(Fig. 8.2.3-4)

- Response message from the slave in normal status [SV=600°C (0258H)]

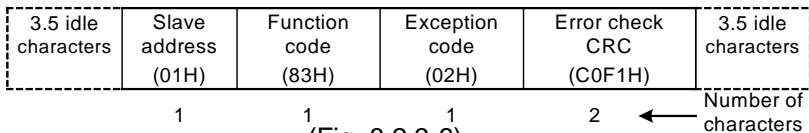
The number of response bytes indicates number of bytes of the data which has been read, and it is fixed as (02H).



(Fig. 8.2.3-5)

- Response message from the slave in exception (error) status (When non-existent data address is sent)
- The function code MSB is set to 1 for the response message in exception (error) status (83H).

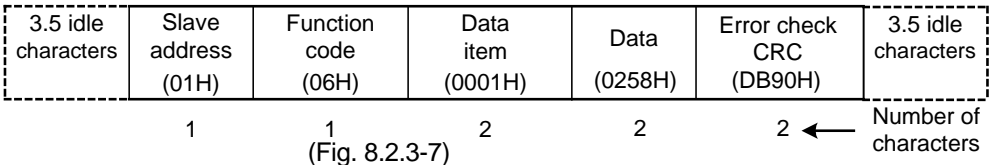
If an exception code (02H: Non-existent data address) is returned, the error can be determined by reading this code.



(Fig. 8.2.3-6)

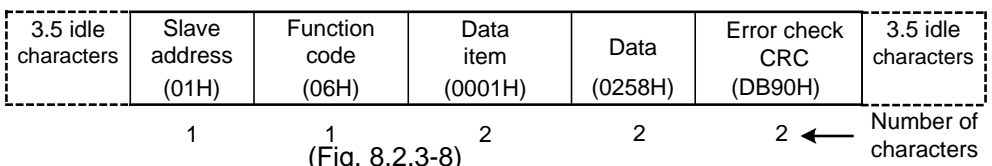
③ **When SV is set to 600°C (0258H) (Address 1)**

- Request message from the master



(Fig. 8.2.3-7)

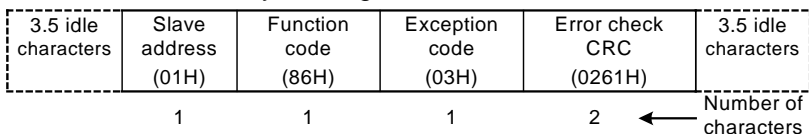
- Response message from the slave in normal status



(Fig. 8.2.3-8)

- 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).

If an exception code (03H: Value out of the setting range) is returned, the error can be determined by reading this code.



(Fig. 8.2.3-9)

# 9. Communication command table

## Setting/Reading command

| Shinko command type | Modbus function code | Data item  | Data   |
|---------------------|----------------------|--|--|
| 20H/50H             | 03H/06H              | 0001H: SV  | Set value, Decimal point ignored                                 |
|                     |                      | 0002H: Not used                                  |  |
| 20H/50H             | 03H/06H              | 0003H: AT setting                                | 0000H: Cancel<br>0001H: Perform                                  |
| 20H/50H             | 03H/06H              | 0004H: OUT1 proportional band                    | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 0005H: OUT2 proportional band                    | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 0006H: Integral time setting                     | Set value  |
| 20H/50H             | 03H/06H              | 0007H: Derivative time setting                   | Set value  |
| 20H/50H             | 03H/06H              | 0008H: OUT1 proportional cycle                   | Set value  |
| 20H/50H             | 03H/06H              | 0009H: OUT2 proportional cycle                   | Set value  |
| 20H/50H             | 03H/06H              | 000AH: Manual reset setting                      | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 000BH: A1 (Alarm 1) setting                      | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 000CH: A2 (Alarm 2) setting                      | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 000DH: A3 (Alarm 3) setting                      | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 000EH: A4 (Alarm 4) setting                      | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 000FH: Heater burnout alarm 1 setting            | Set value  |
| 20H/50H             | 03H/06H              | 0010H: Loop break alarm time setting             | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 0011H: Loop break alarm span setting             | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 0012H: Non-volatile memory data saving selection | 0000H: Save 0001H: Save<br>0002H: Save<br>0003H: Unable to save  |
|                     |                      | 0013H: Not used                                  |  |
|                     |                      | 0014H: Not used                                  |  |
| 20H/50H             | 03H/06H              | 0015H: Sensor correction value setting           | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 0016H: Overlap/Dead band                         | Set value, Decimal point ignored                                 |
|                     |                      | 0017H: Not used                                  |  |
| 20H/50H             | 03H/06H              | 0018H: Scaling high limit setting                | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 0019H: Scaling low limit setting                 | Set value, Decimal point ignored                                 |
|                     |                      | 001AH: Not used                                  |  |
| 20H/50H             | 03H/06H              | 001BH: PV filter time constant setting           | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 001CH: OUT1 high limit setting                   | Set value  |
| 20H/50H             | 03H/06H              | 001DH: OUT1 low limit setting                    | Set value  |
| 20H/50H             | 03H/06H              | 001EH: OUT1 ON/OFF action hysteresis setting     | Set value, Decimal point ignored                                 |
| 20H/50H             | 03H/06H              | 001FH: OUT2 action mode selection                | 0000H: Air cooling<br>0001H: Oil cooling<br>0002H: Water cooling |
| 20H/50H             | 03H/06H              | 0020H: OUT2 high limit setting                   | Set value  |
| 20H/50H             | 03H/06H              | 0021H: OUT2 low limit setting                    | Set value  |
| 20H/50H             | 03H/06H              | 0022H: OUT2 ON/OFF action hysteresis setting     | Set value, Decimal point ignored                                 |



|         |         |  |  |
|---------|---------|--|--|
| 20H/50H | 03H/06H | 0023H: A1 action selection (*1)                                  | 0000H: No alarm action<br>0001H: High limit alarm<br>0002H: Low limit alarm<br>0003H: High/Low limits alarm<br>0004H: High/Low limit range alarm<br>0005H: Process high alarm<br>0006H: Process low alarm<br>0007H: High limit alarm with standby<br>0008H: Low limit alarm with standby<br>0009H: High/Low limits alarm with standby                                  |
| 20H/50H | 03H/06H | 0024H: A2 action selection (*1)                                  | The same as A1 action selection  |
| 20H/50H | 03H/06H | 0025H: A1 hysteresis setting                                     | Set value, Decimal point ignored   |
| 20H/50H | 03H/06H | 0026H: A2 hysteresis setting                                     | Set value, Decimal point ignored   |
| 20H/50H | 03H/06H | 0027H: A3 hysteresis setting                                     | Set value, Decimal point ignored   |
| 20H/50H | 03H/06H | 0028H: A4 hysteresis setting                                     | Set value, Decimal point ignored   |
| 20H/50H | 03H/06H | 0029H: A1 action delayed timer setting                           | Set value  |
| 20H/50H | 03H/06H | 002AH: A2 action delayed timer setting                           | Set value  |
| 20H/50H | 03H/06H | 002BH: A3 action delayed timer setting                           | Set value  |
| 20H/50H | 03H/06H | 002CH: A4 action delayed timer setting                           | Set value  |
| 20H/50H | 03H/06H | 0037H: Control Allowed/<br>Prohibited selection                  | 0000H: Control Prohibited<br>0001H: Control Allowed  |
| 20H/50H | 03H/06H | 0038H: Control Allowed/<br>Prohibited selection<br>when power-on | 0000H: Control Prohibited<br>when power-on<br>0001H: Control Allowed when<br>power-on  |
| 20H/50H | 03H/06H | 0040H: Alarm 1 action Energized<br>/Deenergized selection        | 0000H: Energized<br>0001H: Deenergized   |
|         |         | 0041H: Not used  |  |
| 20H/50H | 03H/06H | 0042H: A1 Hold function  | 0000H: Alarm Not holding<br>0001H: Alarm Holding   |
| 20H/50H | 03H/06H | 0043H: A2 Hold function  | 0000H: Alarm Not holding<br>0001H: Alarm Holding   |
| 20H/50H | 03H/06H | 0044H: Input type selection                                      | 0000H: K [-200 to 1370°C]<br>0001H: K [-199.9 to 500.0°C]<br>0002H: J [-200 to 1000°C]<br>0003H: R [0 to 1760°C]<br>0004H: S [0 to 1760°C]<br>0005H: B [0 to 1820°C]<br>0006H: E [-200 to 800°C]<br>0007H: T [-199.9 to 400.0°C]<br>0008H: N [-200 to 1300°C]<br>0009H: PL-II [0 to 1390°C]<br>000AH: C (W/Re5-26)<br>[0 to 2315°C]<br>000BH: Pt100[-199.9 to 850.0°C] |

|         |         |   |  |
|---------|---------|---|--|
| 20H/50H | 03H/06H | 0044H: Input type selection                             | 000CH: JPt100<br>[−199.9to 500.0°C]<br>000DH: Pt100 [−200 to 850°C]<br>000EH: JPt100 [−200 to 500°C]<br>000FH: K [−320 to 2500°F]<br>0010H: K [−199.9 to 932.0°F]<br>0011H: J [−320 to 1800°F]<br>0012H: R [0 to 3200°F]<br>0013H: S [0 to 3200°F]<br>0014H: B [0 to 3300°F]<br>0015H: E [−320 to 1500°F]<br>0016H: T [−199.9 to 750.0°F]<br>0017H: N [−320 to 2300°F]<br>0018H: PL-II [0 to 2500°F]<br>0019H: C (W/Re5-26)<br>[0 to 4200°F]<br>001AH: Pt100<br>[−199.9 to 999.9°F]<br>001BH: JPt100<br>[−199.9 to 900.0°F]<br>001CH: Pt100 [−300 to 1500°F]<br>001DH: JPt100 [−300 to 900°F]<br>001EH: 4 to 20mA DC<br>[−1999 to 9999]<br>001FH: 0 to 20mA DC<br>[−1999 to 9999]<br>0020H: 0 to 1V DC<br>[−1999 to 9999]<br>0021H: 0 to 5V DC<br>[−1999 to 9999]<br>0022H: 1 to 5V DC<br>[−1999 to 9999]<br>0023H: 0 to 10V DC<br>[−1999 to 9999] |
| 20H/50H | 03H/06H | 0045H: Direct/Reverse action selection                  | 0000H: Reverse action(Heating)<br>0001H: Direct action (Cooling)   |
|         |         | 0046H: Not used   |  |
| 20H/50H | 03H/06H | 0047H: AT bias setting                                  | Set value, Decimal point ignored   |
| 20H/50H | 03H/06H | 0048H: ARW (anti-reset windup)                          | Set value  |
| 20H/50H | 03H/06H | 0049H: A3 action selection (*1)                         | The same as Alarm 1 action selection (p.33)  |
| 20H/50H | 03H/06H | 004AH: A4 action selection (*1)                         | The same as Alarm 1 action selection (p.33)  |
| 20H/50H | 03H/06H | 004BH: A3 Hold function                                 | 0000H: Alarm Not holding<br>0001H: Alarm Holding   |
| 20H/50H | 03H/06H | 004CH: A4 Hold function                                 | 0000H: Alarm Not holding<br>0001H: Alarm Holding   |
| 20H/50H | 03H/06H | 004DH: Heater burnout alarm 2                           | Set value, Decimal point ignored   |
| 20H/50H | 03H/06H | 0050H: Output status selection when input abnormal (*2) | 0000H: Output OFF<br>0001H: Output ON  |
| 50H     | 06H     | 0051H: Alarm hold reset                                 | 0000H: Alarm status flag and standby reset (*3)<br>0001H: Alarm status flag reset  |

## Reading command

| Shinko command type | Modbus function code | Data item              | Data   |
|---------------------|----------------------|------------------------|--|
| 20H                 | 03H                  | 0080H: PV reading      | Current PV, Decimal point ignored  |
| 20H                 | 03H                  | 0081H: OUT1 MV reading | OUT1 MV, Decimal point ignored   |
| 20H                 | 03H                  | 0082H: OUT2 MV reading | OUT2 MV, Decimal point ignored   |
| 20H                 | 03H                  | 0085H: Status flag     | <p>2<sup>0</sup> digit: Control output (OUT1)<br/>0: OFF 1: ON<br/>(DC current output: Not decided)</p> <p>2<sup>1</sup> digit: Cooling output (OUT2)<br/>0: OFF 1: ON</p> <p>2<sup>2</sup> digit: A1 output<br/>0: OFF 1: ON</p> <p>2<sup>3</sup> digit: A2 output<br/>0: OFF 1: ON</p> <p>2<sup>4</sup> digit: A3 output<br/>0: OFF 1: ON</p> <p>2<sup>5</sup> digit: A4 output<br/>0: OFF 1: ON</p> <p>2<sup>6</sup> digit: Heater burnout alarm output 1<br/>0: OFF 1: ON<br/>(When sensor is burnt out, 0: OFF)</p> <p>2<sup>7</sup> digit: Loop break alarm output<br/>0: OFF 1: ON</p> <p>2<sup>8</sup> digit: Overscale<br/>0: OFF 1: ON</p> <p>2<sup>9</sup> digit: Underscale<br/>0: OFF 1: ON</p> <p>2<sup>10</sup> digit: Actuator short circuit alarm output 1<br/>0: OFF 1: ON</p> <p>2<sup>11</sup> digit: During AT<br/>0: OFF 1: AT</p> <p>2<sup>12</sup> digit: Heater burnout alarm output 2<br/>0: OFF 1: ON<br/>(When sensor is burnt out, 0: OFF)</p> <p>2<sup>13</sup> digit: Actuator short circuit alarm output 2<br/>0: OFF 1: ON</p> <p>2<sup>14</sup> digit: Not used (Always 0)</p> <p>2<sup>15</sup> digit: Memory defect (EEPROM ERROR)<br/>0: Normal 1: Defect</p> |
| 20H                 | 03H                  | 0088H: CT1 input value | CT1 input value, Decimal point ignored   |
| 20H                 | 03H                  | 0089H: CT2 input value | CT2 input value, Decimal point ignored   |

|     |     |                                       |   |
|-----|-----|---------------------------------------|---|
| 20H | 03H | 00A1H: Instrument information reading | $2^0$ digit: Alarm 1<br>0: Not applied 1: Applied<br>$2^1$ digit: Alarm 2<br>0: Not applied 1: Applied<br>$2^2$ digit: Alarm 3<br>0: Not applied 1: Applied<br>$2^3$ digit: Alarm 4<br>0: Not applied 1: Applied<br>$2^4$ digit: Loop break alarm<br>0: Not applied 1: Applied<br>$2^5$ digit: Heater burnout alarm 1<br>0: Not applied 1: Applied<br>$2^6$ digit: Heater burnout alarm 2<br>0: Not applied 1: Applied<br>$2^7$ digit: Heater burnout alarm rating<br>0: 100A 1: 20A<br>$2^8$ digit: Heating/Cooling function<br>0: Not applied 1: Applied<br>$2^9$ to $2^{15}$ digit: Not used<br>(Always 0) |
|-----|-----|---------------------------------------|---|

### Setting data

- When the data (setting value) has a decimal point, the decimal point is removed. The data is represented as a whole number, and expressed in hexadecimal figures.

### Data item

- (\*1) When the alarm action type is changed during Alarm 1, 2, 3, 4 action selection, the alarm setting value returns to the default value.  
The alarm output (A1) and status flag (A1, A2, A3, A4) are also initialized.
- (\*2) Selects whether to turn the control output (OUT1) and cooling output (OUT2) ON or OFF when the PV goes outside the control range.
- (\*3) In the case High limit alarm with standby, Low limit alarm with standby or High/Low limit alarm with standby is selected during Alarm action selection, and when alarm output is on, the alarm status returns to the standby again by selecting (0001H: Alarm status flag and standby reset), and the alarm status flag is also initialized.

### Note

Setting of OUT1 (OUT2) high limit or low limit value during standby or warm-up status is not effective.

# 10. Running

## 10.1 Setup



### Notice

Before setup, check communication parameter setting, mounting and wiring, referring to chapters “4 Communication parameter setting”, “5 Mounting” and “6 Wiring”.

#### (1) Switch power to the unit ON.

The power indicator (POW) lights up and the unit will be in command waiting status.

#### (2) Set up the unit.

The input type, alarm action and control action, etc. have to be set according to the users' using conditions before using this unit.

Perform setup from the host computer through communication function.

Shaded portions  are setup items.

If the NCL-13A is incorporated into other industrial equipment after setting has been completed, or if the user's specification is the same as the default value of the NCL-13A, then it is not necessary to set up.

Proceed to Section “10.2 Start running”.

(Table 10.1-1)

| Setting item                    | Setting range  | Default value                  |
|---------------------------------|--|--------------------------------|
| SV                              | Scaling low limit value to<br>Scaling high limit value   | 0°C                            |
| AT setting                      | 0000H: Cancel<br>0001H: Perform                          | 0000H: Cancel                  |
| OUT1 proportional band setting  | 0.0 to 110.0%  | 2.5%                           |
| OUT2 proportional band setting  | 0.0 to 10.0 times OUT1 proportional band                 | 1.0 times                      |
| Integral time setting           | 0 to 1000s   | 200s                           |
| Derivative time setting         | 0 to 300s  | 50s                            |
| ARW setting                     | 0 to 100%  | 50%                            |
| OUT1 proportional cycle setting | 1 to 120s  | R/M: 30s<br>S/M: 3s<br>C/M: 3s |
| OUT2 proportional cycle setting | 1 to 120s  | 3s                             |
| Manual reset setting            | ±Proportional band converted value                       | 0.0°C                          |
| Alarm 1 setting                 | Refer to (Table 10.1-2).                                 | 0°C                            |
| Alarm 2 setting                 | Refer to (Table 10.1-2).                                 | 0°C                            |
| Alarm 3 setting                 | Refer to (Table 10.1-2).                                 | 0°C                            |
| Alarm 4 setting                 | Refer to (Table 10.1-2).                                 | 0°C                            |
| Heater burnout alarm 1 setting  | 0.0 to 100.0A<br>(Setting to 0.0 disables the function.) | 0.0A                           |
| Heater burnout alarm 2 setting  | 0.0 to 100.0A<br>(Setting to 0.0 disables the function.) | 0.0A                           |
| Loop break alarm time setting   | 0 to 200 min.  | 0 minutes                      |

|  |   |   |
|--|---|---|
| Loop break alarm span setting                  | 0 to 150°C(°F) or 0.0 to 150.0°C(°F)<br>For DC input: 0 to 1500   | 0°C                                     |
| Non-volatile memory data saving selection      | 0000H: } Data save<br>0001H: }<br>0002H: }<br>0003H: Unable to save   | 0000H: Data save                        |
| Sensor correction setting                      | -100.0 to 100.0°C(°F)<br>For DC input: -1000 to 1000  | 0.0°C                                   |
| Scaling high limit setting                     | Scaling low limit value to<br>Input range high limit value  | 1370°C                                  |
| Scaling low limit setting                      | Input range low limit value to<br>Scaling high limit value  | -200°C                                  |
| Alarm 1 action selection                       | 0000H: No alarm action<br>0001H: High limit alarm<br>0002H: Low limit alarm<br>0003H: High/Low limits alarm<br>0004H: High/Low limit range alarm<br>0005H: Process high alarm<br>0006H: Process low alarm<br>0007H: High limit alarm with standby<br>0008H: Low limit alarm with standby<br>0009H: High/Low limits alarm with standby | 0000H: No alarm action                  |
| Alarm 2 action selection                       | The same as Alarm 1 action selection  | 0000H: No alarm                         |
| Alarm 3 action selection                       | The same as Alarm 1 action selection  | 0000H: No alarm                         |
| Alarm 4 action selection                       | The same as Alarm 1 action selection  | 0000H: No alarm                         |
| Alarm 1 hysteresis setting                     | 0.1 to 100.0°C(°F)<br>For DC input: 1 to 1000   | 1.0°C                                   |
| Alarm 2 hysteresis setting                     | 0.1 to 100.0°C(°F)<br>For DC input: 1 to 1000   | 1.0°C                                   |
| Alarm 3 hysteresis setting                     | 0.1 to 100.0°C(°F)<br>For DC input: 1 to 1000   | 1.0°C                                   |
| Alarm 4 hysteresis setting                     | 0.1 to 100.0°C(°F)<br>For DC input: 1 to 1000   | 1.0°C                                   |
| Alarm 1 action delayed timer setting           | 0 to 9999s  | 0s                                      |
| Alarm 2 action delayed setting                 | 0 to 9999s  | 0s                                      |
| Alarm 3 action delayed setting                 | 0 to 9999s  | 0s                                      |
| Alarm 4 action delayed setting                 | 0 to 9999s  | 0s                                      |
| Control Allowed/Prohibited                     | 0000H: Control Prohibited<br>0001H: Control Allowed   | 0000H: Control prohibited               |
| Control Allowed/Prohibited when power-on       | 0000H: Control Prohibited when power-on<br>0001H: Control Allowed when power-on   | 0000H: Control Prohibited when power-on |
| Alarm 1 action Energized/Deenergized selection | 0000H: Energized<br>0001H: Deenergized  | 0000H: Energized                        |

|                                 |  |                           |
|---------------------------------|--|---------------------------|
| Alarm 1 Hold function selection | 0000H: Alarm Not holding<br>0001H: Alarm Holding   | 0000H: Alarm Not holding  |
| Alarm 2 Hold function selection | 0000H: Alarm Not holding<br>0001H: Alarm Holding   | 0000H: Alarm Not holding  |
| Alarm 3 Hold function selection | 0000H: Alarm Not holding<br>0001H: Alarm Holding   | 0000H: Alarm Not holding  |
| Alarm 4 Hold function selection | 0000H: Alarm Not holding<br>0001H: Alarm Holding   | 0000H: Alarm Not holding  |
| Input type selection (*1)       | 0000H: K [-200 to 1370°C]<br>0001H: K [-199.9 to 500.0°C]<br>0002H: J [-200 to 1000°C]<br>0003H: R [0 to 1760°C]<br>0004H: S [0 to 1760°C]<br>0005H: B [0 to 1820°C]<br>0006H: E [-200 to 800°C]<br>0007H: T [-199.9 to 400.0°C]<br>0008H: N [-200 to 1300°C]<br>0009H: PL-II [0 to 1390°C]<br>000AH: C(W/Re5-26) [0 to 2315°C]<br>000BH: Pt100 [-199.9 to 850.0°C]<br>000CH: JPt100 [-199.9 to 500.0°C]<br>000DH: Pt100 [-200 to 850°C]<br>000EH: JPt100 [-200 to 500°C]<br>000FH: K [-320 to 2500°F]<br>0010H: K [-199.9 to 932.0°F]<br>0011H: J [-320 to 1800°F]<br>0012H: R [0 to 3200°F]<br>0013H: S [0 to 3200°F]<br>0014H: B [0 to 3300°F]<br>0015H: E [-320 to 1500°F]<br>0016H: T [-199.9 to 750.0°F]<br>0017H: N [-320 to 2300°F]<br>0018H: PL-II [0 to 2500°F]<br>0019H: C (W/Re5-26) [0 to 4200°F]<br>001AH: Pt100 [-199.9 to 999.9°F]<br>001BH: JPt100 [-199.9 to 900.0°F]<br>001CH: Pt100 [-300 to 1500°F]<br>001DH: JPt100 [-300 to 900°F]<br>001EH: 4 to 20mA DC [-1999 to 9999]<br><br>001FH: 0 to 20mA DC [-1999 to 9999]<br><br>0020H: 0 to 1V DC [-1999 to 9999]<br>0021H: 0 to 5V DC [-1999 to 9999]<br>0022H: 1 to 5V DC [-1999 to 9999]<br>0023H: 0 to 10V DC [-1999 to 9999] | 0000H: K [-200 to 1370°C] |
| PV filter time constant setting | 0.0 to 10.0s   | 0.0s (*2)                 |
| OUT1 high limit setting         | OUT1 low limit value to 100%<br>(A/M: OUT1 low limit value to 105%)  | 100%                      |
| OUT1 low limit setting          | 0% to OUT1 high limit value<br>(A/M: -5% to OUT1 high limit value)   | 0%                        |

(\*1) For DC current input, connect 50Ω shunt resistor (sold separately).

(\*2) If setting value is too large, it affects control result due to the delay of the response.

|   |   |                          |
|---|---|--------------------------|
| OUT1 ON/OFF action hysteresis setting       | 0.1 to 100.0°C(°F)<br>For DC input: 1 to 1000   | 1.0°C                    |
| OUT2 action mode selection                  | 0000H: Air cooling (linear characteristic)<br>0001H: Oil cooling (1.5th power of the linear characteristic)<br>0002H: Water cooling (2nd power of the linear characteristic ) | 0000H: Air cooling       |
| OUT2 high limit setting                     | OUT2 low limit value to 100%<br>(A/M: OUT2 low limit value to 105%)   | 100%                     |
| OUT2 low limit setting                      | 0% to OUT2 high limit value<br>(A/M: -5% to OUT2 high limit value)  | 0%                       |
| OUT2 ON/OFF action hysteresis setting       | -100.0 to 100.0°C (°F)<br>For DC input: -1000 to 1000   | 1.0°C                    |
| Overlap/Dead band setting                   | 0.1 to 100.0°C (°F)<br>For DC input: 1 to 1000  | 0.0°C                    |
| Direct/Reverse action selection             | 0000H: Reverse (Heating) action<br>0001H: Direct (Cooling) action   | 0000H: Reverse (Heating) |
| AT bias setting                             | 0 to 50°C (0 to 100°F) or<br>0.0 to 50.0°C (0.0 to 100.0°F)<br>For DC input: Not available  | 20°C                     |
| Output status selection when input abnormal | 0000H: Output OFF<br>0001H: Output ON   | 0000H: Output OFF        |

(Table 10.1-2)

| Alarm action                       | Setting range                                 |
|------------------------------------|---|
| High limit alarm                   | - (Scaling span) to Scaling span              |
| Low limit alarm                    | - (Scaling span) to Scaling span              |
| High/Low limits alarm              | 0 to Scaling span                             |
| High/Low limit range alarm         | 0 to Scaling span                             |
| Process high alarm                 | Scaling low limit to Scaling high limit value |
| Process low alarm                  | Scaling low limit to Scaling high limit value |
| High limit alarm with standby      | - (Scaling span) to Scaling span              |
| Low limit alarm with standby       | - (Scaling span) to Scaling span              |
| High/Low limits alarm with standby | 0 to Scaling span                             |

- The negative minimum setting value: -199.9 or -1999  
The positive maximum value: 999.9 or 9999
- Setting to 0 or 0.0 disables the function.



- ① **Command example: When input type “Pt100 [-199.9 to 850.0°C]: 000BH” is selected**  
(Shinko protocol, Address 1)



## Caution

**When changing the input from DC voltage to other inputs, remove the sensor connected to this unit first, then change for the input.**

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 34H 34H) | Data<br>(30H 30H 30H 42H) | Checksum<br>(44H 35H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1                  |

(Fig. 10.1-1) Number of characters

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1                  |

(Fig. 10.1-2) Number of characters

- ② **Command example: When Alarm 1 action “High limit: 0001H” is selected**  
(Shinko protocol, Address 1)

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 32H 33H) | Data<br>(30H 30H 30H 31H) | Checksum<br>(45H 39H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1                  |

(Fig. 10.1-3) Number of characters

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1                  |

(Fig. 10.1-4) Number of characters

## 10.2 Start running.



### Notice

Before starting running, check communication parameter setting, mounting and wiring, referring to chapters “4 Communication parameter setting”, “5 Mounting” and “6 Wiring”.

#### (1) Turn the power to the unit ON.

The power indicator (POW) lights up and the unit will be in command waiting status.

#### (2) Set the value.

Set each value, referring to “9 Communication command table”.

- ① **Command example: When SV is set to 600°C (0258H)**  
(Shinko protocol, Address 1)

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 30H 31H) | Data<br>(30H 32H 35H 38H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1                  |

(Fig. 10.2-1) Number of characters ←

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1                  |

(Fig. 10.2-2) Number of characters ←

- ② **Command example: When Alarm 1 value is set to 10°C (000AH)**  
(Shinko protocol, Address 1)

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 30H 42H) | Data<br>(30H 30H 30H 41H) | Checksum<br>(43H 43H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1                  |

(Fig. 10.2-3) Number of characters ←

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1                  |

(Fig. 10.2-4) Number of characters ←

#### (3) Turn the load circuit power ON.

During running or when the power to the unit is turned on, Control Allowed/Prohibited can be selected.

If Control Allowed is selected during Control Allowed/Prohibited selection when power-on (0038H), control starts so as to maintain the control target at the SV.

If Control Prohibited is selected, the unit switches to standby status and does not perform control action after the power is turned on.

During running, when Control Allowed is selected during Control Allowed/Prohibited selection (0037H), control starts so as to maintain the control target at the SV.

When Control Prohibited is selected, the unit switches to the standby and control stops.

**Note: When the power is turned on, Control Allowed/Prohibited selection (0038H) has priority.**

### 10.3 Output MV (manipulated variable) reading

#### In the case of OUT1 MV reading (Address 1)

- Reading command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(20H) | Data item<br>(30H 30H 38H 31H) | Checksum<br>(44H 36H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 2                     | 1 ←                |

(Fig. 10.3-1)

- Response of the slave in normal status (OUT1 MV: 50.0% [01F4H])

| Header<br>(06H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(20H) | Data item<br>(30H 30H 38H 31H) | Data<br>(30H 31H 46H 34H) | Checksum<br>(46H 42H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1 ←                |

(Fig. 10.3-2)

The NCL-13A returns 500 as a response, ignoring the decimal point in 50.0% from the OUT1 MV.

### 10.4 Control Allowed/Prohibited selection

#### Command example: When Control Allowed is selected (Shinko protocol, Address 1)

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 33H 37H) | Data<br>(30H 30H 30H 31H) | Checksum<br>(45H 34H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1 ←                |

(Fig. 10.4-1)

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1 ←                |

(Fig. 10.4-2)

#### Command example: When Control Prohibited is selected (Shinko protocol, Address 1)

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 33H 37H) | Data<br>(30H 30H 30H 30H) | Checksum<br>(45H 35H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1 ←                |

(Fig. 10.4-3)

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1 ←                |

(Fig. 10.4-4)

## 10.5 Auto-tuning Perform/Cancel.

### Notice

- Perform the auto-tuning during the trial run.
- Auto-tuning can be performed in PID action with the status of Control Allowed.
- During PID auto-tuning, none of the setting items can be set.  
If setting command is sent, Negative acknowledgement [NAK: Error code 4 (Unsettable status)] is returned.
- If auto-tuning is canceled during process, P, I, D and ARW values return to values set before the auto-tuning was performed.  
If auto-tuning has not finished 4 hours after it has started, it is automatically finished.
- If power failure occurs during PID auto-tuning, the auto-tuning stops.

#### Command example: When Auto-tuning Perform is selected (Shinko protocol, Address 1)

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 30H 33H) | Data<br>(30H 30H 30H 31H) | Checksum<br>(45H 42H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1 ←                |

(Fig. 10.4-1) Number of characters

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1 ←                |

(Fig. 10.4-2) Number of characters

#### Command example: When Auto-tuning Cancel is selected (Shinko protocol, Address 1)

- Setting command from the master

| Header<br>(02H) | Address<br>(21H) | Sub<br>address<br>(20H) | Command<br>type<br>(50H) | Data item<br>(30H 30H 30H 33H) | Data<br>(30H 30H 30H 30H) | Checksum<br>(45H 43H) | Delimiter<br>(03H) |
|-----------------|------------------|-------------------------|--------------------------|--------------------------------|---------------------------|-----------------------|--------------------|
| 1               | 1                | 1                       | 1                        | 4                              | 4                         | 2                     | 1 ←                |

(Fig. 10.4-3) Number of characters

- Response from the slave in normal status

| Header<br>(06H) | Address<br>(21H) | Checksum<br>(44H 46H) | Delimiter<br>(03H) |
|-----------------|------------------|-----------------------|--------------------|
| 1               | 1                | 2                     | 1 ←                |

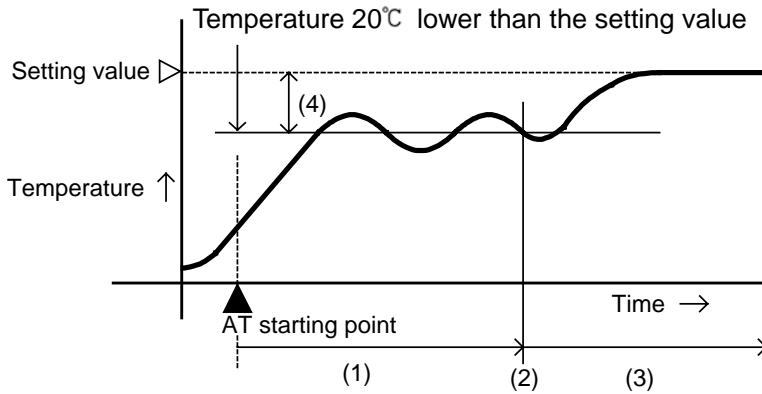
(Fig. 10.4-4) Number of characters

## Auto-tuning (AT)

In order to decide each value of P, I, D and ARW automatically, the auto-tuning process should be made to fluctuate to obtain an optimal value.

### (1) In the case of a large difference between the setting value and processing temperature as the temperature is rising.

When AT bias is set to 20°C, the AT process will fluctuate at the temperature 20°C lower than the setting value.

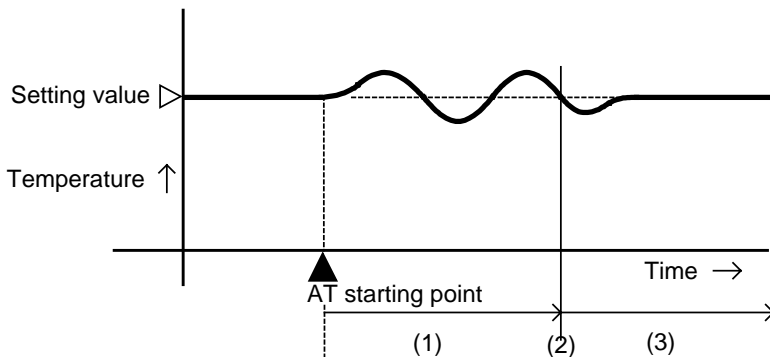


- (1) Calculating PID constant
- (2) PID constant calculated
- (3) Controlled by the PID constant set by auto-tuning.
- (4) AT bias value

(Fig. 10.5-1)

### (2) In the case of a stable control

The AT process will fluctuate around the setting value.

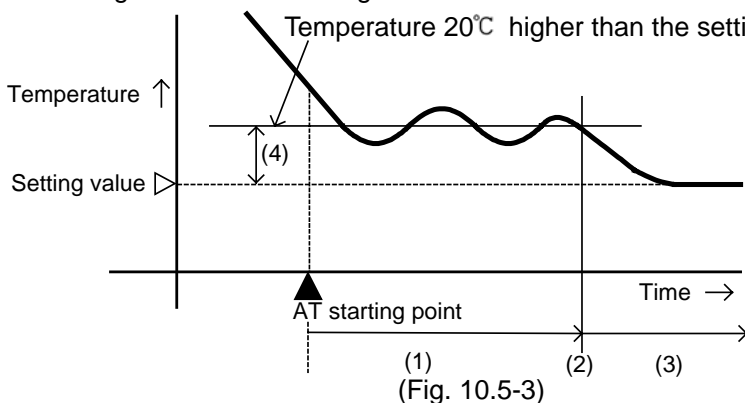


- (1) Calculating PID constant
- (2) PID constant calculated
- (3) Controlled by the PID constant set by auto-tuning.

(Fig. 10.5-2)

### (3) In the case of a large difference between the setting value and processing temperature as the temperature is falling

When AT bias is set to 20°C, the AT process will fluctuate at the temperature 20°C higher than the setting value.



- (1) Calculating PID constant
- (2) PID constant calculated
- (3) Controlled by the PID constant set by auto-tuning.
- (4) AT bias value

(Fig. 10.5-3)

For DC input, AT process will fluctuate around the setting value under conditions described in (1), (2) and (3).

# 11. Control action explanation

## 11.1 P, I, D and ARW

### (1) Proportional band (P)

Proportional action is the action which the control output varies in proportion to the deviation between the setting value and the processing temperature.

If the proportional band is narrowed, even if the output changes by a slight variation of the processing temperature, better control results can be obtained as the offset decreases.

However, if the proportional band is narrowed too much, even slight disturbances may cause variation in the processing temperature, control action changes to ON/OFF action and the so-called hunting phenomenon occurs.

Therefore, when the processing temperature comes to the balanced position near the setting value and a constant temperature is maintained, the most suitable value is selected by gradually narrowing the proportional band while observing the control results.

### (2) Integral time (I)

Integral action is used to eliminate offset. When the integral time is shortened, the returning speed to the setting point is accelerated. However, the cycle of oscillation is also accelerated and the control becomes unstable.

### (3) Derivative time (D)

Derivative action is used to restore the change in the processing temperature according to the rate of change. It reduces the amplitude of overshoot and undershoot width.

If the derivative time is shortened, restoring value becomes small, and if the derivative time is extended, an excessive returning phenomenon may occur and the control system may oscillate.

### (4) Anti-reset windup (ARW)

ARW (Anti-reset windup) prevents overshoot caused by the integral action. The smaller the ARW value, the less the overshoot caused by the integral action in the transition status, however it takes time until stabilization.

When setting ARW manually, set it to the closest MV (manipulated variable) when the control is stabilized.

If MV is not determined, perform trial run at default value (50%)

**P, I, D and ARW values are automatically set if auto-tuning is performed.**


## 11.2 Control output (OUT1) action

|                                | Heating (Reverse) action                                |  |  | Cooling (Direct) action                                 |  |  |
|--------------------------------|---|--|--|---|--|--|
| Control action                 |   |  |  |   |  |  |
| Relay contact output R/M       | <p>Cycle action is performed according to deviation</p> |  |  | <p>Cycle action is performed according to deviation</p> |  |  |
| Non-contact voltage output S/M | <p>Cycle action is performed according to deviation</p> |  |  | <p>Cycle action is performed according to deviation</p> |  |  |
| DC current output A/M          | <p>Changes continuously according to deviation</p>      |  |  | <p>Changes continuously according to deviation</p>      |  |  |
| Open collector output C/M      | <p>Cycle action is performed according to deviation</p> |  |  | <p>Cycle action is performed according to deviation</p> |  |  |
| Indicator (OUT) Green          |   |  |  |   |  |  |

: Acts ON (lit) or OFF (unlit).

### 11.3 Control output (OUT1) ON/OFF action

|                                | Heating (Reverse) action |  | Cooling (Direct) action |  |
|--------------------------------|--------------------------|--|-------------------------|--|
| Control action                 |                          |  |                         |  |
| Relay contact output R/M       |                          |  |                         |  |
| Non-contact voltage output S/M |                          |  |                         |  |
| DC current output A/M          |                          |  |                         |  |
| Open collector output C/M      |                          |  |                         |  |
| Indicator (OUT) Green          |                          |  |                         |  |

 : Acts ON (lit) or OFF (unlit).



### 11.4 Heating/Cooling control action (DC option)

|                                |   |  |  |
|--------------------------------|---|--|--|
| Control action                 | <p>OUT1 P-band      OUT2 P-band</p> <p>ON ——— Heating action ——— ON</p> <p>OFF - - - - - Cooling action - - - - - OFF</p> <p>SV setting</p>   |  |  |
| Relay contact output R/M       | <p>Cycle action is performed according to deviation.</p>  |  |  |
| Non-contact voltage output S/M | <p>12V DC      12/0V DC      0V DC</p> <p>Cycle action is performed according to deviation.</p>   |  |  |
| DC current output A/M          | <p>20mA DC      20 to 4mA DC      4mA DC</p> <p>Changes continuously according to deviation.</p>  |  |  |
| Open collector output C/M      | <p>ON      ON/OFF      OFF</p> <p>Cycle action is performed according to deviation.</p>   |  |  |
| DC                             | <p>OFF      OFF/ON      ON</p> <p>Cycle action is performed according to deviation.</p> <p>OUT2 action mode selection</p> <p>- - - - - : Air cooling (linear)</p> <p>- · - · - · : Oil cooling (1.5th power of the linear)</p> <p>- · · - · · : Water cooling (2nd power of the linear)</p> <p>OUT2 P-band</p> <p>ON</p> <p>SV setting</p> <p>OFF</p> <p>Cooling action</p> |  |  |
| Indicator (OUT) Green          | <p>Lit      Unlit</p>   |  |  |

- : Acts ON (lit) or OFF (unlit).
- : Represents heating control action.
- - - - - : Represents cooling control action.

## When setting dead band

|                                |  |  |  |   |       |
|--------------------------------|--|--|--|---|-------|
| Control action                 |  |  |  | ON  | ON    |
|                                |  |  |  | OFF   | OFF   |
| Relay contact output R/M       |  |  |  | Cycle action is performed according to deviation. |       |
| Non-contact voltage output S/M |  |  |  | Cycle action is performed according to deviation. |       |
| DC current output A/M          |  |  |  | Changes continuously according to deviation.      |       |
| Open collector output C/M      |  |  |  | Cycle action is performed according to deviation. |       |
| DC                             |  |  |  |   |       |
| Indicator (OUT) Green          |  |  |  | Lit   | Unlit |

: Acts ON (lit) or OFF (unlit).

: Represents heating control action.

: Represents cooling control action.

## When setting overlap band

|   |  |  |  |
|---|--|--|--|
| <p>Control action</p>                     | <p>The diagram shows a control action graph. The y-axis represents the control signal, with 'ON' at the top and 'OFF' at the bottom. A solid line represents the heating action, which starts at 'ON' and decreases as the setpoint (SV) is approached. A dashed line represents the cooling action, which starts at 'OFF' and increases as the setpoint is approached. The setpoint is marked as 'SV setting' with a triangle. Two P-bands are shown: 'OUT1 P-band' and 'OUT2 P-band'. The 'Overlap band' is the region where both heating and cooling actions are active simultaneously.</p> |  |  |
| <p>Relay contact output<br/>R/M</p>       | <p>Three diagrams show relay contact outputs for R/M mode. Each diagram has terminals 4 and 5. The first shows a normally open contact between 4 and 5. The second shows a normally closed contact between 4 and 5. The third shows a normally open contact between 4 and 5, with a dashed line indicating a transition to normally closed.</p> <p>Cycle action is performed according to deviation.</p>   |  |  |
| <p>Non-contact voltage output<br/>S/M</p> | <p>Three diagrams show non-contact voltage outputs for S/M mode. Each diagram has terminals 4 and 5. The first shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with '12V DC' between them. The second shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with '12/0V DC' between them. The third shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with '0V DC' between them.</p> <p>Cycle action is performed according to deviation.</p>   |  |  |
| <p>DC current output<br/>A/M</p>          | <p>Three diagrams show DC current outputs for A/M mode. Each diagram has terminals 4 and 5. The first shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with '20mA DC' between them. The second shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with '20 to 4mA DC' between them. The third shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with '4mA DC' between them.</p> <p>Changes continuously according to deviation.</p>   |  |  |
| <p>Open collector output<br/>C/M</p>      | <p>Three diagrams show open collector outputs for C/M mode. Each diagram has terminals 4 and 5. The first shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with 'ON' between them. The second shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with 'ON/OFF' between them. The third shows a positive terminal (+) at 5 and a negative terminal (-) at 4, with 'OFF' between them.</p> <p>Cycle action is performed according to deviation.</p>  |  |  |
| <p>DC</p>                                 | <p>Three diagrams show DC outputs. Each diagram has terminals 6 and 7. The first shows a positive terminal (+) at 7 and a negative terminal (-) at 6, with 'OFF' between them. The second shows a positive terminal (+) at 7 and a negative terminal (-) at 6, with 'OFF/ON' between them. The third shows a positive terminal (+) at 7 and a negative terminal (-) at 6, with 'ON' between them.</p> <p>Cycle action is performed according to deviation.</p>   |  |  |
| <p>Indicator<br/>(OUT) Green</p>          | <p>A horizontal bar representing the indicator status. The left portion is solid black and labeled 'Lit'. The middle portion is hatched and labeled 'Lit' above and 'Unlit' below. The right portion is white and labeled 'Unlit'.</p>   |  |  |

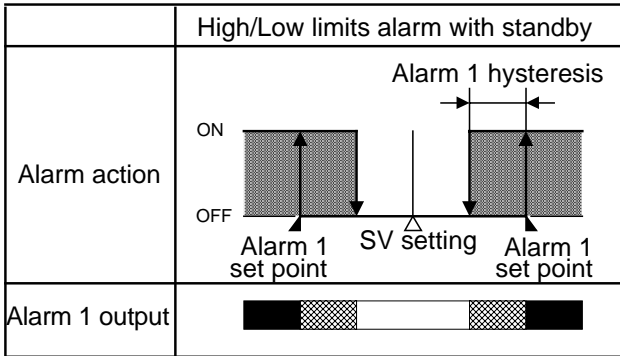
: Acts ON (lit) or OFF (unlit).

: Represents heating control action.

: Represents cooling control action.

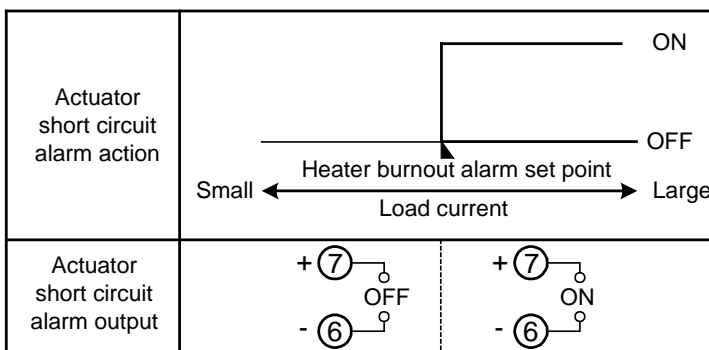
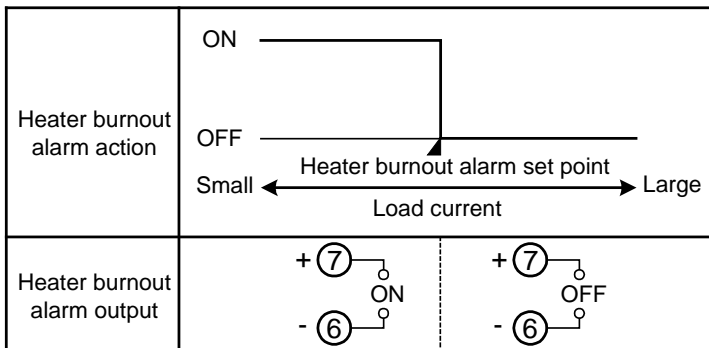
### 11.5 Alarm 1, Alarm 2, Alarm 3 and Alarm 4 actions

|                | High limit alarm              | Low limit alarm              |
|----------------|-------------------------------|------------------------------|
| Alarm action   |                               |                              |
| Alarm 1 output |                               |                              |
|                | High/Low limits alarm         | High/Low limit range alarm   |
| Alarm action   |                               |                              |
| Alarm 1 output |                               |                              |
|                | Process high alarm            | Process low alarm            |
| Alarm action   |                               |                              |
| Alarm 1 output |                               |                              |
|                | High limit alarm with standby | Low limit alarm with standby |
| Alarm action   |                               |                              |
| Alarm 1 output |                               |                              |



- : A1 output terminals 6 and 7 are connected (ON).
- : A1 output terminals 6 and 7 are connected (ON) or disconnected (OFF).
- : A1 output terminals 6 and 7 are disconnected (OFF).
- : Standby functions.

### 11.6 Heater burnout alarm/Actuator short circuit alarm action (W, W3 option)



Heater burnout alarm and Actuator short circuit alarm use Event output terminals for their outputs.

Alarm 1 and Loop break alarm (LA option) use common output terminals.

If Heating/Cooling control output (DC option) is applied, Event output terminals are used as a cooling output. Therefore, Heater burnout alarm/Actuator short circuit alarm cannot be outputted.

# 12. Attached functions

## 12.1 Self-diagnosis

The CPU is monitored by a watchdog timer, and when any abnormal status is found on the CPU, the instrument is switched to warm-up status.

## 12.2 Automatic cold junction temperature compensation (Thermocouple input type)

This detects the temperature at the connecting terminal between thermocouple and the instrument, and always keeps it on the same status as when the reference junction is located at 0°C (32°F).

## 12.3 Burnout

When the thermocouple or RTD input is burnt out, control output (OUT1) and cooling output (OUT2) are turned off. For DC current output type, control output (OUT1) outputs OUT1 low limit value.

## 12.4 Output status selection when input abnormal

Selects control output (OUT1) and cooling output (OUT2) ON or OFF when the PV goes outside the control range.

## 12.5 Input abnormality

- Relay contact output (-R/M), Non-contact voltage output (-S/M) and Open collector output (-C/M) (Table 12.5-1)

|   |   | Output status               |                             |                             |                             |
|---|---|-----------------------------|-----------------------------|-----------------------------|-----------------------------|
| Output status selection when input abnormal | Input value                                 | OUT1                        |                             | OUT2                        |                             |
|   |   | Direct action               | Reverse action              | Direct action               | Reverse action              |
| ON  | When exceeding Control range high limit     | Outputs corresponding to MV | Outputs corresponding to MV | Outputs corresponding to MV | Outputs corresponding to MV |
| OFF   |   | OFF                         | OFF                         | OFF                         | OFF                         |
| ON  | When dropping below Control range low limit | Outputs corresponding to MV | Outputs corresponding to MV | Outputs corresponding to MV | Outputs corresponding to MV |
| OFF   |   | OFF                         | OFF                         | OFF                         | OFF                         |

When input is abnormal, control output (OUT1) and cooling output (OUT2) status have no relation to OUT1 (OUT2) high limit value and OUT1 (OUT2) low limit value.

- DC current output (-A/M) (Table 12.5-2)

|   |   | Output status                 |                               |                             |                             |
|---|---|-------------------------------|-------------------------------|-----------------------------|-----------------------------|
| Output status selection when input abnormal | Input value                                 | OUT1                          |                               | OUT2                        |                             |
|   |   | Direct action                 | Reverse action                | Direct action               | Reverse action              |
| ON  | When exceeding Control range high limit     | Outputs corresponding to MV   | Outputs corresponding to MV   | Outputs corresponding to MV | Outputs corresponding to MV |
| OFF   |   | OFF or (OUT1 low limit value) | OFF or (OUT1 low limit value) | OFF                         | OFF                         |
| ON  | When dropping below Control range low limit | Outputs corresponding to MV   | Outputs corresponding to MV   | Outputs corresponding to MV | Outputs corresponding to MV |
| OFF   |   | OFF or (OUT1 low limit value) | OFF or (OUT1 low limit value) | OFF                         | OFF                         |

When input is abnormal, control output (OUT1) status has relation to the OUT1 high limit value and OUT1 low limit value. However, the cooling output (OUT2) status has no relation to OUT2 high limit value and OUT2 low limit value.

## Thermocouple and RTD input

Control range

- Range without a decimal point except for the RTD input:  
Input range low limit value – 50°C (100°F) to Input range high limit value + 50°C (100°F)
- Range with a decimal point including the RTD input without a decimal point:  
–(Input span x 1%) °C (°F) to Input range high limit value + 50°C (100°F)

## DC input

Control range: [Scaling low limit value – Scaling span x 1%] to [Scaling high limit value + Scaling span x 10%]

## DC input disconnection

(Table 12.5-3)

| DC input type            | Value when DC input is disconnected                     |
|--------------------------|---|
| 4 to 20mA DC, 1 to 5V DC | (Scaling low limit value – Scaling span x 1%) or less   |
| 0 to 1V DC               | (Scaling high limit value + Scaling span x 10%) or more |
| 0 to 20mA DC             | PV corresponding to 0mA DC                              |
| 0 to 5V DC, 0 to 10V DC  | PV corresponding to 0V DC                               |

## 12.6 Sensor correction

The PV is corrected when the temperatures in the controlled location differs from those of the sensor location.

This is effective within the input rated range regardless of the sensor correction value.

## 12.7 PV filter

Reduces the effect of noise by including a first order lag filter in the PV.

## 12.8 Power failure countermeasure

The setting data is backed up in the non-volatile IC memory.

## 12.9 Non-volatile memory data saving selection

If Non-volatile memory data [Unable to save] is selected during Non-volatile memory data saving selection, all setting values except for the input type selection can be changed temporarily. However, when the power to the unit is turned on again, those values revert to the values set before the Non-volatile memory data [Unable to save] was selected.

# 13. Specifications

## 13.1 Standard specifications

Rating

Rated scale

(Table 13.1-1)

| Input          |             | Scale range       |                   | Resolution |
|----------------|-------------|-------------------|-------------------|------------|
| M              | K           | -200 to 1370 °C   | -320 to 2500 °F   | 1°C(°F)    |
|                |             | -199.9 to 500.0°C | -199.9 to 932.0°F | 0.1°C(°F)  |
|                | J           | -200 to 1000 °C   | -320 to 1800 °F   | 1°C(°F)    |
|                | R           | 0 to 1760 °C      | 0 to 3200 °F      | 1°C(°F)    |
|                | S           | 0 to 1760 °C      | 0 to 3200 °F      | 1°C(°F)    |
|                | B           | 0 to 1820 °C      | 0 to 3300 °F      | 1°C(°F)    |
|                | E           | -200 to 800 °C    | -320 to 1500 °F   | 1°C(°F)    |
|                | T           | -199.9 to 400.0°C | -199.9 to 750.0°F | 0.1°C(°F)  |
|                | N           | -200 to 1300 °C   | -320 to 2300 °F   | 1°C(°F)    |
|                | PL-II       | 0 to 1390 °C      | 0 to 2500 °F      | 1°C(°F)    |
|                | C(W/Re5-26) | 0 to 2315 °C      | 0 to 4200 °F      | 1°C(°F)    |
|                | Pt100       | -199.9 to 850.0°C | -199.9 to 999.9°F | 0.1°C(°F)  |
|                |             | -200 to 850 °C    | -300 to 1500 °F   | 1°C(°F)    |
|                | JPt100      | -199.9 to 500.0°C | -199.9 to 900.0°F | 0.1°C(°F)  |
| -200 to 500 °C |             | -300 to 900 °F    | 1°C(°F)           |            |

|           |                   |   |
|-----------|-------------------|---|
| 4 to 20mA | -1999 to 9999 (*) | 1 |
| 0 to 20mA | -1999 to 9999 (*) | 1 |
| 0 to 1V   | -1999 to 9999     | 1 |
| 0 to 5V   | -1999 to 9999     | 1 |
| 1 to 5V   | -1999 to 9999     | 1 |
| 0 to 10V  | -1999 to 9999     | 1 |

(\*) For DC current input, externally connect 50Ω shunt resistor (RES-S03-050, sold separately).

**Input** Thermocouple : K, J, R, S, B, E, T, N, PL-II, C (W/Re5-26)

External resistance, 100Ω or less  
(However, for B input: 40Ω or less)

RTD : Pt100, JPt100, 3-wire system

Allowable input lead wire resistance (10Ω or less per wire)

DC current (mA): 0 to 20mA DC, 4 to 20mA DC

Input impedance: 50Ω

Connect 50Ω shunt resistor (RES-S03-050, sold separately)  
between input terminals.

Allowable input current: 50mA DC or less [when using the  
shunt resistor (sold separately)]

DC voltage (V) : 0 to 1V DC

Input impedance (1MΩ or more)

Allowable input voltage (5V DC or less)

Allowable signal source resistance (2kΩ or less)

: 0 to 5V DC, 1 to 5V DC, 0 to 10V DC

Input impedance (100kΩ or more)

Allowable input voltage (15V DC or less)

Allowable signal source resistance (100Ω or less)

**Supply voltage** : 24V DC

Allowable voltage fluctuation: 20 to 28V DC

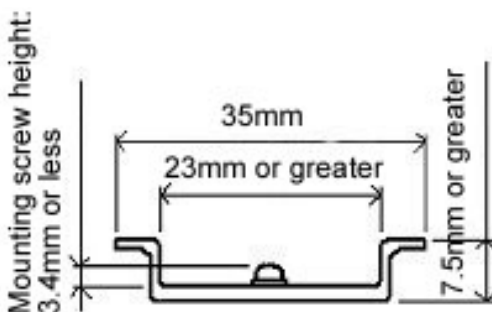
Ripple voltage, 5%p-p or less

### General structure

**External dimensions** : 17.5 x 75 x 85mm (W x H x D)

**Mounting method** : DIN rail mounting

**Applicable DIN rail specifications**: Top hat type rail TH35 JIS C 2812-1998



Width : 35mm

Height : 7.5mm or more

Groove width : 23mm or more

DIN rail mounting screw height:

3.4mm or less (at a DIN rail height  
of 7.5mm)

(Fig. 13.1-1)

**Case** : Flame resistant resin, Color: Light gray

**Base** : Flame resistant resin, Color: Light gray

**Bus plug, Spring type plug**: Polyamide resin, Color: Green



## Input performance

### Input accuracy

- Thermocouple : Within  $\pm 0.2\%$  of each input span  $\pm 1$  digit or within  $\pm 2^\circ\text{C}$  ( $4^\circ\text{F}$ ), whichever is greater  
However, for R, S input, 0 to  $200^\circ\text{C}$  (0 to  $400^\circ\text{F}$ ): Within  $\pm 6^\circ\text{C}$  ( $12^\circ\text{F}$ )  
B input, 0 to  $300^\circ\text{C}$  (0 to  $600^\circ\text{F}$ ): Accuracy is not guaranteed.  
K, J, E, T, N inputs, less than  $0^\circ\text{C}$  ( $32^\circ\text{F}$ ): Within  $\pm 0.4\%$  of input span  $\pm 1$  digit
- RTD : Within  $\pm 0.1\%$  of each input span  $\pm 1$  digit, or within  $\pm 1^\circ\text{C}$  ( $2^\circ\text{F}$ ), whichever is greater
- DC current and voltage: Within  $\pm 0.2\%$  of each input span  $\pm 1$  digit

**Input sampling period** : 0.25 seconds

## Control performance

### Control action

- PID action (with auto-tuning function)  
PI action: When derivative time is set to 0  
PD action (with manual reset function): When integral time is set to 0  
P action (with manual reset function): When integral and derivative times are set to 0  
ON/OFF action: When proportional band is set to 0
- OUT1 proportional band (P) : 0.0 to 110.0% (Default value: 2.5%)  
Integral time (I) : 0 to 1000s (Off when set to 0) (Default value: 200s)  
Derivative time (D) : 0 to 300s (Off when set to 0) (Default value: 50s)  
OUT1 proportional cycle : 1 to 120s [Default value: -R/M (30s), -S/M (3s) -C/M (3s), -A/M (Not available)]
- ARW : 0 to 100% (Default value: 50%)  
Manual reset :  $\pm$ Proportional band converted value (Default: 0.0)  
OUT1 ON/OFF hysteresis :  $0.1$  to  $100.0^\circ\text{C}$  ( $^\circ\text{F}$ ) (Default value:  $1.0^\circ\text{C}$ )  
DC input: 1 to 1000
- OUT1 high limit, OUT1 low limit: 0 to 100% (DC current output: -5 to 105%)  
(Not available for ON/OFF action)  
(Default: OUT1 low limit: 0%, OUT1 high limit: 100%)

### Control output (OUT1)

- Relay contact (-R/M) : 1a  
Control capacity, 3A 250V AC (resistive load)  
1A 250V AC (inductive load  $\cos\phi=0.4$ )  
Electrical life: 100,000 times
- Non-contact voltage (-S/M):  $12^{+2}_0\text{V}$  DC (for SSR drive)  
Maximum 40mA DC (short circuit protected)
- DC current (-A/M) : 4 to 20mA DC  
Load resistance: Maximum  $550\Omega$   
Output accuracy: Within  $\pm 0.3\%$  of output span  
Resolution: 12000
- Open collector (-C/M) : 0.1A 24V DC (maximum), Isolation type

## Alarm

### Alarm 1 output

When Alarm 1 action is set as Energized, the alarm action point is set by  $\pm$  deviation from the SV (except Process value alarm).

When the input goes out of the range, the Event output turns ON or OFF (High/Low limit range alarm).

When the alarm action is set as Deenergized, the output acts conversely.

### Alarm type

One alarm can be selected from a choice of: High limit alarm, Low limit alarm, High/Low limits alarm, High/Low limit range alarm, Process high alarm, Process low alarm, High limit alarm with standby, Low limit alarm with standby, High/Low limits alarm with standby and No alarm action (10 types). (Default value: No alarm action) Alarm 1 output Energized or Deenergized can be selected as well.

Alarm 1 uses common output terminals with Loop break alarm, Heater burnout alarm/Actuator short circuit alarm (W, W3 option).

When Heating/Cooling control output (DC option) is applied, Event output becomes cooling output (OUT2). Therefore, Alarm 1, Loop break alarm and Heater burnout alarm/Actuator short circuit alarm cannot be outputted.

#### Setting range

|                               |   |
|-------------------------------|---|
| High limit alarm              | -(Scaling span) to Scaling span               |
| Low limit alarm               | -(Scaling span) to Scaling span               |
| High/Low limits alarm         | 0 to Scaling span                             |
| High/Low limit range alarm    | 0 to Scaling span                             |
| Process high alarm            | Scaling low limit to Scaling high limit value |
| Process low alarm             | Scaling low limit to Scaling high limit value |
| High limit alarm with standby | -(Scaling span) to Scaling span               |
| Low limit alarm with standby  | -(Scaling span) to Scaling span               |
| H/L limits alarm with standby | 0 to Scaling span                             |

Setting to 0 or 0.0 disables the alarm action (excluding Process high alarm, Process low alarm).

The negative minimum value is -199.9 or -1999, and the positive maximum value is 999.9 or 9999.

For High limit alarm, High/Low limits alarm and Process high alarm, Alarm 1 is activated in overscale, and the standby function of the alarms with standby is released.

For Low limit alarm, High/Low limits alarm and Process low alarm, Alarm 1 is activated in underscale, and the standby function of the alarms with standby is released.

**Setting value** : Initial value is zero (0).

**Setting accuracy**: The same as the input accuracy

**Action** : ON/OFF action

**Alarm hysteresis setting range**: 0.1 to 100.0°C (°F) (Default value: 1.0°C)  
DC input: 1 to 1000

**Output** : Open collector  
Control capacity, 0.1A 24V DC

## Alarm 2, Alarm 3, Alarm 4

The alarm type and action are the same as those of Alarm 1.

However, There are no outputs to these alarms, and Alarm Energized/Deenergized action selection are not available.

Alarm status can be accessed by reading the status flag in serial communication.

## Loop break alarm

Detects actuator trouble (heater burnout, sensor burnout).

This alarm uses common output terminals with Alarm 1, Heater burnout alarm/ Actuator short circuit alarm (W, W3 option).

When Heating/Cooling control output (DC option) is added, the Event output becomes cooling output (OUT2). Therefore, Alarm 1, Loop break alarm and Heater burnout alarm/Actuator short circuit alarm cannot be outputted.

**Setting range** Loop break alarm time: 0 to 200 minutes (Default: 0 minutes)

Loop break alarm span: 0 to 150°C (°F) or 0.0 to 150.0°C (°F)  
(Default: 0°C)

DC input: 0 to 1500

**Output** Open collector: Control capacity, 0.1A 24V DC

## Serial communication

Cable length : 1.2km (Maximum)

Cable resistance: Within 50Ω (The terminator is not necessary or 120Ω or more on one side of the cable.)

Communication line : Based on EIA RS-485

Communication method : Half-duplex communication

Communication speed : 9600bps (4800, 9600, 19200bps)  
Selectable by DIP switch

Synchronous system : Start-stop synchronous

Instrument number : Address 0 (0 to 95), Selectable by two Rotary switches

Communication protocol: Shinko protocol, Modbus ASCII, Modbus RTU  
Selectable by DIP switch

The contents set by the DIP and Rotary switch will take effect when the power to the unit is turned on.

Therefore, settings changed after the power-on will not take effect.

Code form : ASCII, binary (\*)

Error detection : Parity check, Checksum (LRC), CRC (\*)

Error correction : Command request repeat system

Data format

Start bit : 1

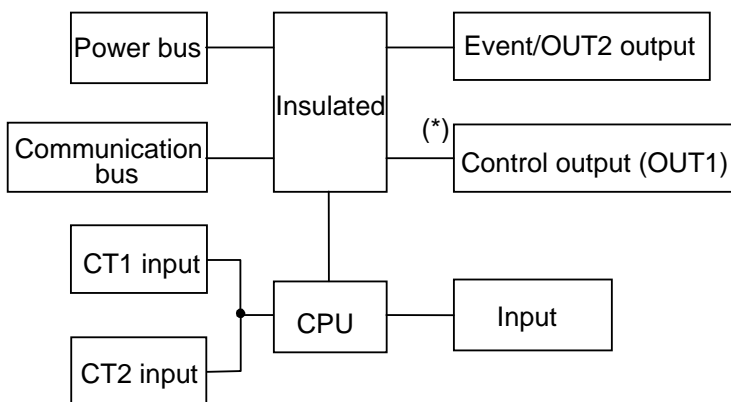
Data bit : 7, 8 (\*)

Parity : Even, Odd, No parity (\*)

Stop bit : 1

(\*): Automatically selected upon selecting the communication protocol.

**Insulation, Dielectric strength**  
**Circuit insulation configuration**



(\*) When the control output (OUT1) is non-contact voltage or DC current output, Control output (OUT1) is not insulated from Communication bus.

**Insulation resistance**

10MΩ or more, at 500V DC

**Dielectric strength**

For Non-contact voltage (-S/M), DC current (-A/M), Open collector output (-C/M)

Between input terminal and power terminal, 0.5kV AC for 1 minute

Between control output (OUT1) terminal and power terminal, 0.5kV AC for 1 minute

For Relay contact output (-R/M)

Between input terminal and power terminal, 0.5kV AC for 1 minute

Between control output (OUT1) terminal and power terminal, 1.5kV AC for 1 minute

**Others**

**Power consumption** : Approx. 2W

**Ambient temperature**: 0 to 50°C (32 to 122°F)

**Ambient humidity** : 35 to 85%RH (no condensation)

**Weight** : Approx. 85g

**Accessories**

- : Instruction manual 1 copy
- For W (20A) option : Wire harness 3m 1 length
- CT (CTL-6S) 1 piece
- For W (100A) option : Wire harness 3m 1 length
- CT (CTL-12-S36-10L1) 1 piece
- For W3 (20A) option : Wire harness 3m 2 lengths
- CT (CTL-6S) 2 pieces
- For W3 (100A) option: Wire harness 3m 2 lengths
- CT (CTL-12-S36-10L1) 2 pieces

**13.2 Optional specifications**

**Heater burnout alarm/Actuator short circuit alarm [Option code: W (single phase), W3 (3-phase)]**

This alarm cannot be applied to DC current output.

This alarm is also activated in overscale and underscale.

This alarm uses common output terminals with Alarm 1 and Loop break alarm.

When Heating/Cooling control output (DC option) is applied, Event output is used for a cooling output. Therefore, Alarm 1, Loop break alarm and Heater burnout alarm/Actuator short circuit alarm are not outputted.

Rating : 20A [W(20A), W3(20A),], 100A [W(100A), W3(100A)]  
 (Must be specified)

Setting range : 20A ; 0.0 to 20.0A (Off when set to 0.0)  
 100A ; 0.0 to 100.0A (Off when set to 0.0)

Setting accuracy: Within ±5% of the rated value

Action point : Setting value  
 Action : ON/OFF action  
 Output : Open collector, Control capacity 0.1A 24V DC

Heater burnout alarm 1 (W, W3 option)

When control output is ON, and if CT1 input value (detected current) is lower than Heater burnout alarm 1 set value, this alarm is activated

If CT1 input value (detected current) is higher than Heater burnout alarm 1 set value, this alarm will not be activated.

Heater burnout alarm 2 (W3 option)

When control output is ON, and if CT2 input value (detected current) is lower than Heater burnout alarm 2 set value, this alarm is activated.

If CT2 input value (detected current) is higher than Heater burnout alarm 2 set value, this alarm will not be activated.

Actuator short circuit alarm 1 (W, W3 option)

When control output is OFF, and if CT1 input value (detected current) is higher than Heater burnout alarm 1 set value, this alarm is activated.

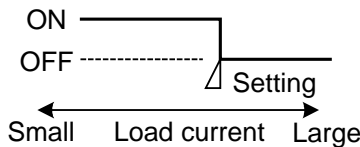
If CT1 input value (detected current) is lower than Heater burnout alarm 1 set value, this alarm will not be activated.

Actuator short circuit alarm 2 (W3 option)

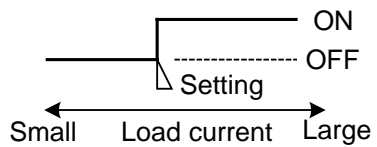
When control output is OFF, and if CT2 input value (detected current) is higher than Heater burnout alarm 2 set value, this alarm is activated.

If CT2 input value (detected current) is lower than Heater burnout alarm 2 set value, this alarm will not be activated.

- Heater burnout alarm 1 (2)
- Actuator short circuit alarm 1 (2)

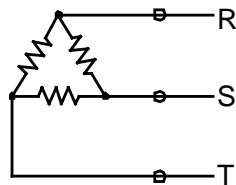


(Fig. 13.2-1)



(Fig. 13.2-2)

- CT connection for the W3 option



(Fig. 13.2-3)

Pass two wires out of R, S, T through the CT hole.

**Heating/Cooling control output (Option code: DC)**

If this option is applied, Event output becomes cooling output (OUT2). Therefore, Alarm 1, Loop break alarm and Heater burnout alarm/Actuator short circuit alarm are not outputted.

OUT2 proportional band (P): 0.0 to 10.0 times OUT1 proportional band  
 (ON/OFF action when set to 0.0)

OUT2 integral time (I) : The same as that of OUT1.

OUT2 derivative time (D) : The same as that of OUT1.

OUT2 proportional cycle : 1 to 120 seconds (Default value: 3 seconds)

Overlap band/Dead band : -100.0 to 100.0°C (°F) (Default value: 0.0°C)

DC input: -1000 to 1000 (The placement of the decimal point follows the selection)

- OUT2 ON/OFF action hysteresis setting: 0.1 to 100.0°C (°F) (Default value: 1.0°C)  
 DC input: 1 to 1000
- OUT2 high limit, OUT2 low limit: 0 to 100% (Not available for ON/OFF action)  
 (Default value: OUT2 low limit: 0%, OUT2 high limit: 100%)
- OUT2 action mode selection:  
 Air cooling (Linear characteristic) (Default value)  
 Oil cooling (1.5th power of the linear characteristic)  
 Water cooling (2nd power of the linear characteristic)

## 14. Troubleshooting

If any malfunction occurs, refer to the following items after checking the power supply to the master and the slave (NCL-13A).

### 14.1 Communication

| Problem  | Presumed cause and solution  |
|--|--|
| Communication failure                                    | <ul style="list-style-type: none"> <li>• The connection or wiring of communication is not secure.</li> <li>• Burnout on the communication cable or imperfect contact with the connector.</li> <li>• Communication speed of the slave does not coincide with that of the master.</li> <li>• The data bit, parity and stop bit of the master do not accord with those of the slave.</li> <li>• The instrument number (address) of the slave does not coincide with that of the command</li> <li>• The instrument number (address) of the slave is duplicated in multiple slaves</li> </ul> |
| Though it is able to communicate, the response is "NAK". | <ul style="list-style-type: none"> <li>• Check whether a non-existent command code has been sent.</li> <li>• The setting command data goes outside the setting range of the slave.</li> <li>• The unit cannot be set when functions such as AT is performing.</li> </ul>   |

### 14.2 Control

| Problem                                      | Presumed cause and solution   |
|--|---|
| PV (Process variable) does not rise.         | <ul style="list-style-type: none"> <li>• The sensor is out of order.<br/>Replace the sensors.</li> <li>• Sensor is not securely connected to the instrument input terminals, or actuator is not securely connected to the instrument output terminal.</li> <li>• Ensure that the wiring of sensor terminals or actuator terminals are correct.</li> </ul> |
| The control output remains in an ON status.  | <ul style="list-style-type: none"> <li>• OUT1 (OUT2) low limit value is set to 100% or higher.<br/>Set it to a suitable value.</li> </ul>   |
| The control output remains in an OFF status. | <ul style="list-style-type: none"> <li>• OUT1 (OUT2) high limit value is set to 0% or less.<br/>Set it to a suitable value.</li> </ul>  |

### 14.3 PV

| Problem   | Presumed cause and solution  |
|---|--|
| PV is high.   | <ul style="list-style-type: none"> <li>• Thermocouple, RTD or DC voltage (0 to 1V DC) is burnt out.<br/>Change each sensor.<br/>How to check whether the sensor is burnt out<br/>[Thermocouple]<br/>If the input terminal of the instrument is shorted and if a value around room temperature is indicated, the instrument is likely to be operating normally, however, the sensor may be burnt out.</li> <li>[RTD]<br/>If approximate 100Ω of resistance is connected to the input terminals between A-B of the instrument and between B-B is shorted, and if approximate 0°C (32°F) is indicated, the instrument is likely to be operating normally, however, the sensor may be burnt out.</li> <li>[DC voltage (0 to 1V DC)]<br/>If the input terminal of the instrument is shorted and if a scaling low limit value is indicated, the instrument is likely to be operating normally, however, the signal wire may be disconnected.</li> <li>• Check whether the input signal wires of thermocouple, RTD or DC voltage (0 to 1V DC) are securely connected to the instrument input terminals.<br/>Ensure that the sensor terminals are connected to the instrument input terminals securely.</li> </ul> |
| PV is low.  | <ul style="list-style-type: none"> <li>• Check whether the input signal source for DC voltage (1 to 5V DC) or DC current (4 to 20mA DC) is disconnected.<br/><b>How to check whether the input signal wire is disconnected</b><br/>[DC voltage (1 to 5V DC)]<br/>If the input to the input terminals of the instrument is 1V DC and if a scaling low limit value is indicated, the instrument is likely to be operating normally, however, the signal wire may be disconnected.</li> <li>[DC current (4 to 20mA DC)]<br/>If the input to the input terminals of the instrument is 4mA DC and if a scaling low limit value is indicated, the instrument is likely to be operating normally, however, the signal wire may be disconnected.</li> <li>• Check whether the input signal wire for DC voltage (1 to 5V DC) or DC current (4 to 20mA DC) is securely connected to the instrument input terminals.</li> <li>• Check whether the polarity of thermocouple or compensating lead wire is correct.<br/>Check whether codes (A, B, B) of the RTD agree with the instrument terminals.<br/>Ensure that they are wired properly.</li> </ul>  |
| The indication of PV display is abnormal or unstable. | <ul style="list-style-type: none"> <li>• The sensor input or temperature unit (°C or °F) setting is improper.<br/>Set the sensor input and the temperature unit properly.</li> <li>• Sensor correcting value is unsuitable.<br/>Set it to a suitable value.</li> </ul>   |

|  |   |
|--|---|
| <p>The indication of PV display is abnormal or unstable.</p> | <ul style="list-style-type: none"> <li>• AC may be leaking into the sensor circuit.<br/>Change the sensor for the ungrounded type.</li> <li>• There may be equipment that interferes with or makes noise near the control unit.<br/>Keep equipment that interferes with or makes noise away from the control unit.</li> </ul> |
|--|---|

For further inquiries, please consult our agency or the shop where you purchased the unit.

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