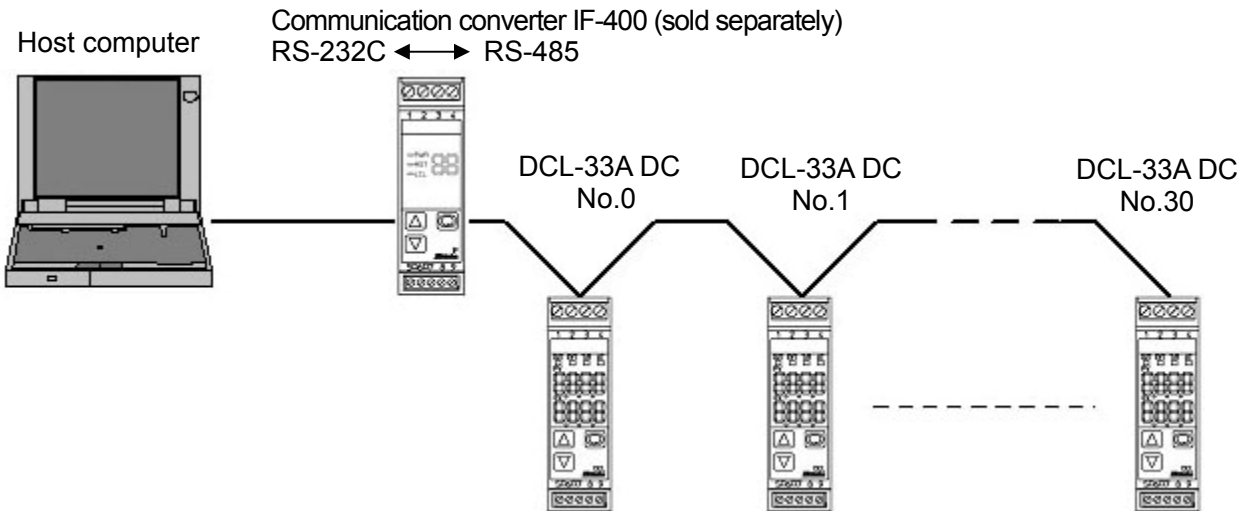


This manual contains instructions for the communication functions, operations and notes when operating the DCL-33A DC. To prevent accidents arising from the misuse of this controller, please ensure the operator receives this manual.

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

# 1. System Configuration

When using communication converter IF-400

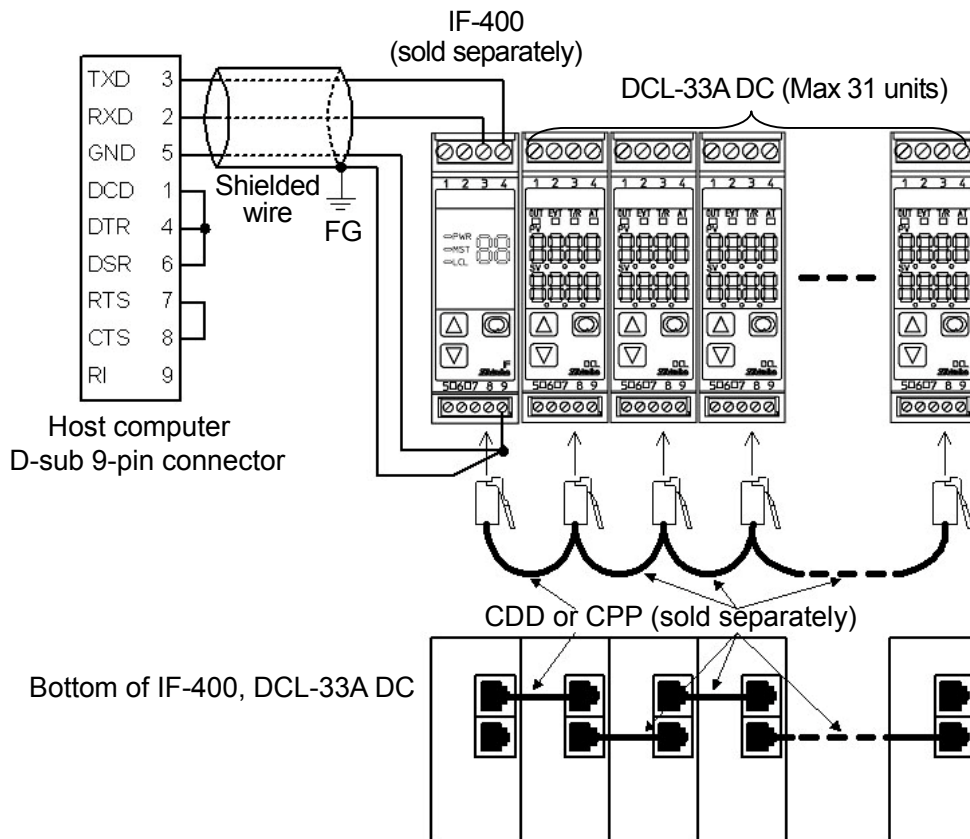


(Fig. 1-1)

# 2. Wiring

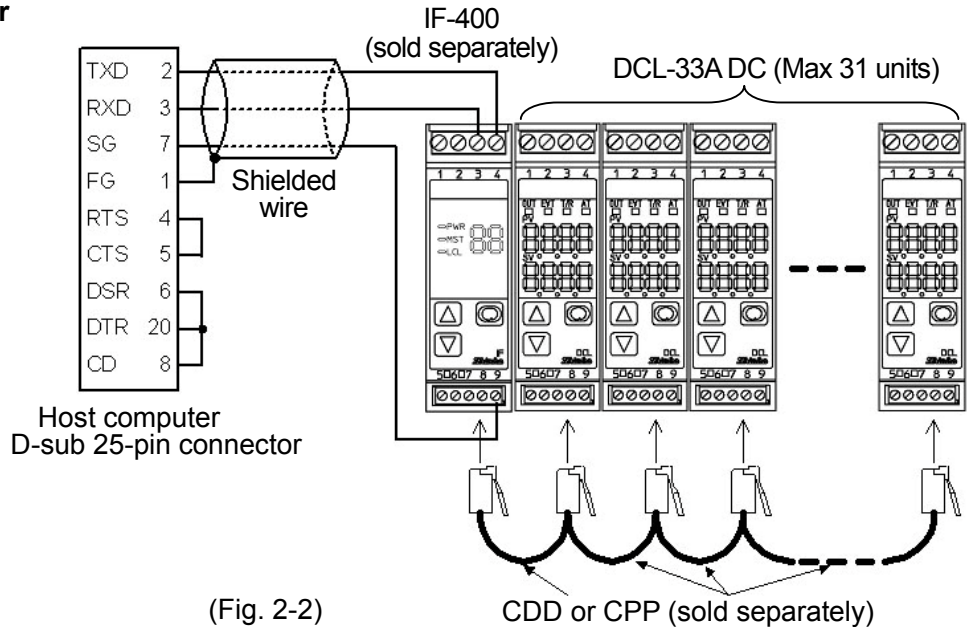
When using communication converter IF-400

- D-sub 9-pin connector:



(Fig. 2-1)

• D-sub 25-pin connector



**Shielded wire**

Be sure to ground only one end of the shielded wire so that current cannot flow to the shielded wire. If both ends of the shielded wire are grounded, the circuit will be closed between the shielded wire and the ground. As a result, current will run through the shielded wire and this may cause noise. Recommended cable: OTSC-VB 2PX0.5SQ (made by Onamba Co., Ltd.) or equivalent (Use a twisted pair cable.)

**Terminator (Terminal resistor)**

The terminator is mounted at the end of the wire when connecting a personal computer with multiple peripheral devices. The terminator prevents signal reflection and disturbance. Do not connect a terminator with the communication line because each DCL-33A DC has built-in pull-up and pull-down resistors instead of a terminator.

### 3. Communication Parameters Setting

Press and hold the key and key (in that order) together for 3 seconds.

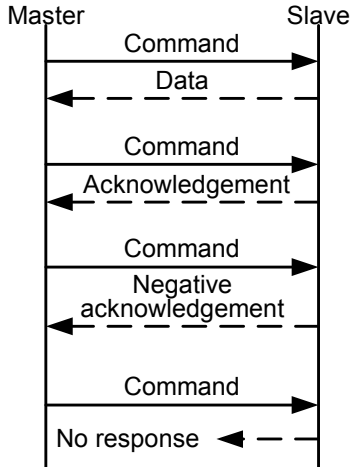
The unit enters Auxiliary function setting mode 1.

To set each setting item, use the or key, and register the set value with the key.

Character	Name, Function, Setting Range	Factory Default
Lock ----	<b>Auxiliary function setting mode 1 (Set value lock)</b> Press the  key twice. "Communication protocol" will appear.	Unlock
cñ4L noñL	<b>Communication protocol</b> • Selects communication protocol. • noñL: Shinko protocol, ñodñ: Modbus ASCII mode, ñodr: Modbus RTU mode	Shinko protocol
cñno □□□	<b>Instrument number</b> • Sets the instrument number. (The instrument numbers should be set one by one when multiple instruments are connected.) • Setting range: 0 to 95	0
cñ4P □□96	<b>Communication speed</b> • Selects a communication speed equal to that of the host computer. • □□24: 2400 bps, □□48: 4800 bps, □□96: 9600 bps, □ 192: 19200 bps	9600 bps
cñPr EñEn	<b>Parity</b> • Selects the parity. • Not available if Shinko protocol in selected in [Communication protocol]. • nonE: No parity, EñEn: Even, odd□: Odd	Even
cñ4r □□ 1	<b>Stop bit</b> • Selects the stop bit. • Not available if Shinko protocol in selected in [Communication protocol]. • Selection: 1 or 2	Stop bit 1

# 4. Communication Procedure

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



(Fig. 4-1)

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

## Communication timing between master and slave

### Master side (Take note while programming)

Set the program so that the master can disconnect the transmitter from the communication line **within a 1 character transmission period** after sending the command in preparation for reception of the response from the slave.

To avoid the collision of transmissions between the master and the slave, send the next command after carefully checking that the master has received the response.

If a response to the command is not returned due to communication errors, set the Retry Processing to send the command again. (Retry twice or more is recommended.)

### Slave side

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

The slave is arranged so as to disconnect the transmitter from the communication line **within a 1 character transmission period** after sending the response.

# 5. Shinko Protocol

## 5.1 Transmission Mode

Shinko protocol is composed of ASCII codes.

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

Data format            Start bit: 1 bit  
                               Data bit: 7 bits  
                               Parity: Even  
                               Stop bit: 1 bit

Error detection: Checksum

## 5.2 Command Configuration

All commands are composed of ASCII.

The data (set value, decimal number) is represented by a hexadecimal numbers.

The negative numbers are represented in 2's complement.

Numerals written below the command represent number of characters.

### (1) Setting command

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

### (2) Reading command

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

### (3) Response with data

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

### (4) Acknowledgement

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

### (5) Negative acknowledgement

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

**Header:** Control code to represent the beginning of the command or the response. ASCII codes are used.

Setting command, Reading command: STX (02H) fixed

Response with data, Acknowledgement: ACK (06H) fixed

Negative acknowledgement: NAK (15H) fixed

**Address (Instrument number):** Numbers by which the master discerns each slave.

Instrument number 0 to 94 and Global address 95.

ASCII codes (20H to 7FH) are used by adding 20H to instrument numbers 0 to 95 (00H to 5FH).

95 (7FH) is called Global address, which is used when the same command is sent to all the slaves connected. However, the response is not returned.

**Sub address:** 20H fixed

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

**Data item:** Classification of the command object

Composed of 4-digit hexadecimal numbers, using ASCII.

(See the Communication command table.)

**Data:** The contents of data (set value) differ depending on the setting command.

Composed of 4-digit hexadecimal numbers, using ASCII.

(See the Communication command table.)

**Checksum:** 2-character data to detect communication errors

**Delimiter:** Control code to represent the end of command

ASCII code ETX (03H) fixed

**Error code:** Represents an error type using ASCII.

1 (31H)----Non-existent command

2 (32H)----Not used

3 (33H)----Setting outside the setting range

4 (34H)----Status unable to be set (e.g. AT is performing)

5 (35H)----During setting mode by keypad operation

## 5.3 Checksum Calculation

Checksum is used to detect receiving errors in the command or data.

Set the program for the master side as well to calculate the checksum of the response data from the slaves so that communication errors can be checked.

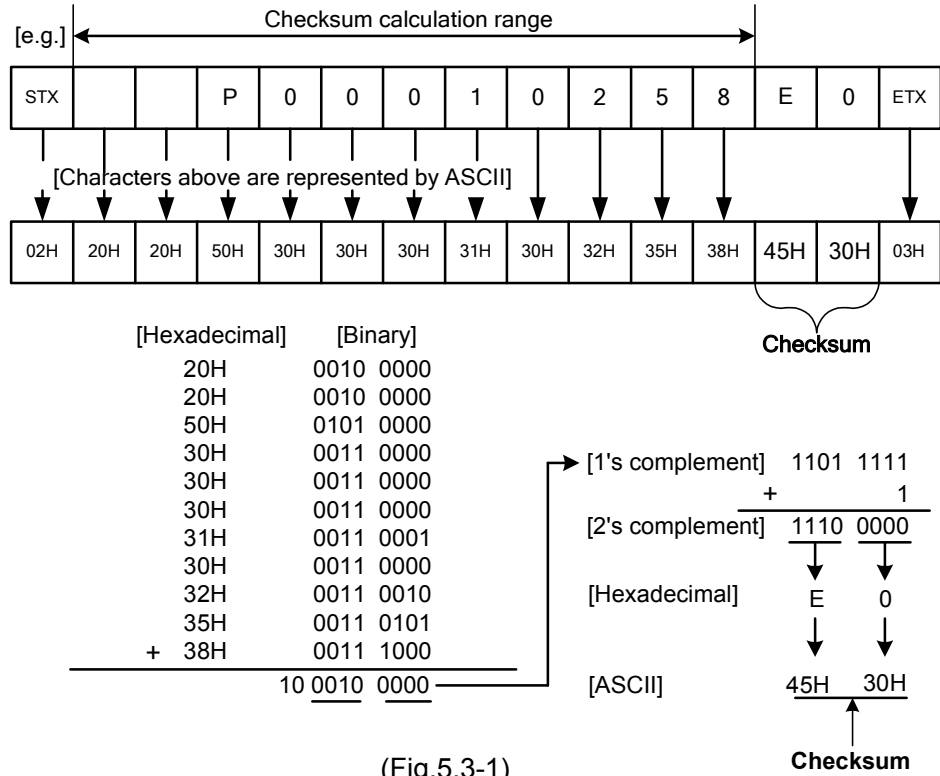
The ASCII code (hexadecimal) corresponding to the characters which range from the address to that before the checksum is converted to binary notation, and the total value is calculated.

The lower one byte of the total value is converted to 2's complement, and then to hexadecimal numbers, that is, ASCII code for the checksum.

### Checksum calculation example

SV (desired value): 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.



### 5.4 Command Example

Numerals written below the command represent number of characters.

#### (1) Reading (Address 1, PV)

- Reading command from the master

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

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

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

#### (2) Reading (Address 1, SV)

- Reading command from the master

Header	Address	Sub address	Command type	Data item [0001H]	Checksum	Delimiter
(02H)	(21H)	(20H)	(20H)	(30H 30H 30H 31H)	(44H 45H)	(03H)
1	1	1	1	4	2	1

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

Header	Address	Sub address	Command type	Data item [0001H]	Data [0258H]	Checksum	Delimiter
(06H)	(21H)	(20H)	(20H)	(30H 30H 30H 31H)	(30H 32H 35H 38H)	(30H 46H)	(03H)
1	1	1	1	4	4	2	1

### (3) Setting [Address 1, SV=600 °C (0258H)]

- Setting command from the master

Header (02H)	Address (21H)	Sub address (20H)	Command type (50H)	Data item [0001H] (30H 30H 30H 31H)	Data [0258H] (30H 32H 35H 38H)	Checksum (44H 46H)	Delimiter (03H)
1	1	1	1	4	4	2	1

- A response from the slave in normal status

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

## 6. Modbus Protocol

### 6.1 Transmission Mode

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

### 6.2 ASCII Mode

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

Data format     Start bit: 1 bit  
                     Data bit: 7 bits  
                     Parity: Even/No/Odd (Selectable)  
                     Stop bit: 1 bit/2 bits (Selectable)

Error detection: LRC (Longitudinal Redundancy Check)

Data interval: 1 second or less

#### (1) Message configuration

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

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

#### (2) Slave address

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

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

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

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

#### (3) Function code

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

(Table 6.2-1)

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

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

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

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

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

For negative acknowledgement, the exception codes below are set to the data of response message, and returned to the master in order to inform it of what kind of error has occurred. (Table 6.2-2)

(Table 6.2-2)

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

#### (4) Data

Data differs depending on the function code.

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

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

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

#### (5) Error check of ASCII mode

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

##### How to calculate LRC

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

#### (6) Message example of ASCII mode

Numerals written below the command represent number of characters.

##### ① Reading (Slave address 1, SV)

- A request message from the master

Amount of data means how many data items are to be read. It is fixed as (30H 30H 30H 31H).

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

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

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

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

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

The function code MSB is set to 1 for the response message in exception (error) status (83H).

The exception code 02H (Non-existent data address) is returned (error).

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

##### ② Setting [Slave address 1, SV=600 °C (0258H)]

- A request message from the master

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

- Response message from the slave in normal status

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

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

The function code MSB is set to 1 for the response message in exception (error) status (86H).

The exception code 03H (Value out of the setting range) is returned (error).

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

### 6.3 RTU Mode

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

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

Error detection : CRC-16 (Cyclic Redundancy Check)

Data interval: 3.5 character transmission times or less

#### (1) Message configuration

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

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

#### (2) Slave address

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

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

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

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

#### (3) Function code

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

**(Table 6.3-1)**

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

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

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

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

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

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

**(Table 6.3-2)**

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

#### (4) Data

Data differs depending on the function code.

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

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

#### (5) Error check of RTU mode

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



## How to calculate CRC-16

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

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

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

## (6) Message example of RTU mode

Numerals written below the command represent number of characters.

### ① Reading (Slave address 1, SV)

- A request message from the master

Amount of data means how many data items are to be read. It is fixed as 0001H.

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

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

The number of response bytes means the number of bytes of the data which has been read. It is fixed as 02H.

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

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

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

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

### ② Setting [Slave address 1, SV=600 °C (0258H)]

- A request message from the master

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

- Response message from the slave in normal status

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

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

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

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

# 7. Communication Command Table

## ● Data

### Notes about setting, reading command

- The data (set value, decimal) is converted to hexadecimal numbers.  
A negative number is represented in 2's complement.
- When connecting multiple slaves, the address (instrument number) must not be duplicated.
- Do not use undefined Data items. If they are used, negative acknowledgement will be returned or a random value will be set or read, resulting in malfunction.
- Modbus protocol uses Holding Register addresses. The Holding Register addresses are created as follows. A Shinko command data item is converted to decimal number, and the offset of 40001 is added. The result is the Holding Register address.  
Using Data item 0001H (SV) as an example: Data item in the sending message is 0001H, however, Modbus protocol Holding Register address is 40002 (1 + 40001).

### Setting command

- Setting range of each item is the same as that of keypad operation.
- When the data (set value) has a decimal point, a whole number (hexadecimal) without a decimal point is used.
- Settings via software communication are possible while in Set value lock status.
- When Lock 3 is selected in [Set value lock], set values are not saved in the non-volatile IC memory. Therefore, they revert to their previous value after the power is turned off.
- If the alarm type is changed at Data item 0023H (Alarm type), Data item 000BH (Alarm value) will default to 0 (zero). Also alarm output status will be initialized.
- Even if options are not ordered, setting items for options is possible using the setting command, however, they will not function.
- The Communication Protocol, Instrument Numbers, Communication Speed, Parity and Stop Bit of the slave cannot be set by the software communication function. They can only be set via the keypad.
- When sending a command by Global address [95 (7FH), Shinko protocol] or Broadcast address [0 (00H), Modbus protocol], the same command is sent to all the slaves connected. However, the response is not returned.
- Up to 1,000,000 (one million) entries can be stored in non-volatile IC memory.  
If the number of settings exceeds the limit, the data will not be saved. So, do not change the set values frequently via software communication. (If a value set via software communication is the same as the value before the setting, the value will not be written in non-volatile IC memory.)

### Reading Command

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

## ● Negative acknowledgement

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

- When AT Perform/Cancel (0003H) is selected during PI control or ON/OFF control action.

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

- If 0000H (Cancel) is selected at 0003H (AT Perform/Cancel) while Auto-tuning is being cancelled.
- If 0001H (Perform) is selected at 0003H (AT Perform/Cancel) while Auto-tuning is performing.

Shinko command type	Modbus function code	Data item	Data
20H/50H	03H/06H	0001H: SV	SV
20H/50H	03H/06H	0003H: AT Perform/Cancel	0000H: Cancel    0001H: Perform
20H/50H	03H/06H	0004H: OUT1 proportional band	Set value
20H/50H	03H/06H	0005H: OUT2 proportional band	Set value
20H/50H	03H/06H	0006H: Integral time	Set value
20H/50H	03H/06H	0007H: Derivative time	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	Set value
20H/50H	03H/06H	000BH: Alarm value	Set value
20H/50H	03H/06H	000FH: Heater burnout alarm value	Set value
20H/50H	03H/06H	0010H: Loop break alarm time	Set value
20H/50H	03H/06H	0011H: Loop break alarm span	Set value
20H/50H	03H/06H	0012H: Set value lock	0000H: Unlock    0001H: Lock 1 0002H: Lock 2    0003H: Lock 3
20H/50H	03H/06H	0015H: Sensor correction value	Set value
20H/50H	03H/06H	0016H: Overlap/Dead band	Set value
20H/50H	03H/06H	0018H: Scaling high limit	Set value
20H/50H	03H/06H	0019H: Scaling low limit	Set value
20H/50H	03H/06H	001AH: Decimal point place	0000H: XXXX (No decimal point) 0001H: XXX.X (1 digit after decimal point) 0002H: XX.XX (2 digits after decimal point) 0003H: X.XXX (3 digits after decimal point)
20H/50H	03H/06H	001BH: PV filter time constant	Set value
20H/50H	03H/06H	001CH: OUT1 high limit	Set value
20H/50H	03H/06H	001DH: OUT1 low limit	Set value
20H/50H	03H/06H	001EH: OUT1 ON/OFF hysteresis	Set value
20H/50H	03H/06H	001FH: OUT2 action mode	0000H: Air cooling (linear characteristic) 0001H: Oil cooling (1.5th power of the linear characteristic) 0002H: Water cooling (2nd power of the linear characteristic)
20H/50H	03H/06H	0020H: OUT2 high limit	Set value
20H/50H	03H/06H	0021H: OUT2 low limit	Set value
20H/50H	03H/06H	0022H: OUT2 ON/OFF hysteresis	Set value
20H/50H	03H/06H	0023H: Alarm type	0000H: No alarm action 0001H: High limit alarm 0002H: Low limit alarm 0003H: High/Low limits alarm 0004H: High/Low limit range alarm 0005H: Process high alarm 0006H: Process low alarm 0007H: High limit alarm with standby 0008H: Low limit alarm with standby 0009H: High/Low limits alarm with standby
20H/50H	03H/06H	0025H: Alarm hysteresis	Set value
20H/50H	03H/06H	0029H: Alarm action delay time	Set value
20H/50H	03H/06H	0040H: Alarm action Energized/De-energized	0000H: Energized 0001H: De-energized
20H/50H	03H/06H	0042H: Alarm HOLD function	0000H: Alarm Not Holding 0001H: Alarm Holding

Shinko command type	Modbus function code	Data item	Data
20H/50H	03H/06H	0044H: Input type	0000H: K [-200 to 1370°C] 0001H: K [-199.9 to 400.0°C] 0002H: J [-200 to 1000°C] 0003H: R [0 to 1760°C] 0004H: S [0 to 1760°C] 0005H: B [0 to 1820°C] 0006H: E [-200 to 800°C] 0007H: T [-199.9 to 400.0°C] 0008H: N [-200 to 1300°C] 0009H: PL-II [0 to 1390°C] 000AH: C (W/Re5-26) [0 to 2315°C] 000BH: Pt100 [-199.9 to 850.0°C] 000CH: JPt100 [-199.9 to 500.0°C] 000DH: Pt100 [-200 to 850°C] 000EH: JPt100 [-200 to 500°C] 000FH: K [-320 to 2500°F] 0010H: K [-199.9 to 750.0°F] 0011H: J [-320 to 1800°F] 0012H: R [0 to 3200°F] 0013H: S [0 to 3200°F] 0014H: B [0 to 3300°F] 0015H: E [-320 to 1500°F] 0016H: T [-199.9 to 750.0°F] 0017H: N [-320 to 2300°F] 0018H: PL-II [0 to 2500°F] 0019H: C (W/Re5-26) [0 to 4200°F] 001AH: Pt100 [-199.9 to 999.9°F] 001BH: JPt100 [-199.9 to 900.0°F] 001CH: Pt100 [-300 to 1500°F] 001DH: JPt100 [-300 to 900°F] 001EH: 4 to 20mA DC [-1999 to 9999] 001FH: 0 to 20mA DC [-1999 to 9999] 0020H: 0 to 1V DC [-1999 to 9999] 0021H: 0 to 5V DC [-1999 to 9999] 0022H: 1 to 5V DC [-1999 to 9999] 0023H: 0 to 10V DC [-1999 to 9999]
20H/50H	03H/06H	0045H: Direct/Reverse control action	0000H: Heating (Reverse) control 0001H: Cooling (Direct)control
20H/50H	03H/06H	0047H: AT bias	Set value
20H/50H	03H/06H	0048H: ARW	Set value
20H/50H	03H/06H	006FH: Key Lock	0000H: Key enabled 0001H: Key Lock
50H	06H	0070H: Key operation change flag clearing	0000H: No action 0001H: Clear all
20H	03H	0080H: PV	Current PV
20H	03H	0081H: OUT1 MV	Current OUT1 MV
20H	03H	0082H: OUT2 MV	Current OUT2 MV

Shinko command type	Modbus function code	Data item	Data
20H	03H	0085H: Status flag	0000 0000 0000 0000 $2^{15}$ to $2^0$ $2^0$ digit: OUT1 0: OFF 1: ON $2^1$ digit: OUT2 0: OFF 1: ON $2^2$ digit: Alarm output 0: OFF 1: ON $2^3$ to $2^5$ digit: Not used (Always 0) $2^6$ digit: Heater burnout alarm output 0: OFF 1: ON (Sensor burnout, 0: OFF) $2^7$ digit: Loop break alarm output 0: OFF 1: ON $2^8$ digit: Overscale 0: OFF 1: ON $2^9$ digit: Underscale 0: OFF 1: ON $2^{10}$ digit: Not used (Always 0) $2^{11}$ digit: AT 0: OFF 1: During AT $2^{12}$ digit: Not used (Always 0) $2^{13}$ digit: Converter function 0: Controller 1: Converter $2^{14}$ digit: Not used (Always 0) $2^{15}$ digit: Change in key operation 0: No 1: Yes
20H	03H	0086H: Heater current (ampere) value	Heater current (ampere) value (HOLD value when OUT1 output is ON)

● **Notes about programming monitoring software**

**How to speed up the scan time**

When monitoring plural units of DCL-33A DC, set the program so that requisite minimum pieces of data such as Data item 0080H (PV), Data item 0081H (OUT1 MV), Data item 0082H (OUT2 MV), Data item 0085H (Status flag), etc. can be read. For other data, set the program so that they can be read only when their set value has been changed. This will speed up the scan time.

**How to read the set value changes made by front keypad operation**

If any set value is changed by keypad operation, the instrument sets [0085H (Status flag)  $2^{15}$ : Change in key operation] to 1 (Yes).

There are 2 methods of reading the set value changes made by the front keypad.

**Reading method 1**

- (1) On the software side, check that [0085H (Status flag)  $2^{15}$ : Change in key operation] has been set to 1 (Yes), then read all set values.
- (2) Clear [0085H (Status flag)  $2^{15}$ : Change in key operation], by setting Data item 0070H (Key operation change flag clearing) to 0001H (Clear all).  
 If 0070H (Key operation change flag clearing) is set to 0001H (Clear all) during the setting mode of the instrument, Error code 5 (35H, Shinko protocol) or Exception Code 18 (12H, Modbus protocol) will be returned as a negative acknowledgement. And [0085H (Status flag)  $2^{15}$ : Change in key operation] cannot be cleared.  
 Set a program so that all set values can be read when a negative acknowledgement is returned.
- (3) Read all set values again after acknowledgement is returned.

## Reading method 2

(1) On the software side, check that [0085H (Status flag) 2<sup>15</sup>: Change in key operation] has been set to 1 (Yes), then set 0070H (Key operation change flag clearing) to 0001H (Clear all).

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

When acknowledgement is returned:

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

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

Consider it as still in setting mode, and read the requisite minimum pieces of data such as 0080H (PV), 0081H (OUT1 MV), 0082H (OUT2 MV), 0085H (Status flag), etc., then return to step (1).

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

## How to read PID parameters after auto-tuning finishes

The DCL-33A DC sets [0085H (Status flag) 2<sup>11</sup>: AT] to 1 (During AT) while auto-tuning is performing.

After auto-tuning is finished, PID parameters are updated.

On the software side, read the parameters such as P, I, D, ARW after checking that [0085H (Status flag) 2<sup>11</sup>: AT] has been set to 0 (OFF).

## Note when sending all set values simultaneously

- When changing alarm type at 0023H (Alarm type), alarm value will default to 0 (zero).

First, send the selected alarm type, then send the alarm value.

- When changing input type at 0044H (Input type), set values such as SV, OUT1 proportional band, Alarm value, etc. will be initialized.

First, send the selected input type, then send other set values.

## ● When communicating with a PLC

To communicate with a PLC, use a Shinko PLC interface unit SIF-600.

No programming is needed for connection.

### PLCs Corresponding to SIF-600

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

(\*) Models with compatible QR/QW communication commands

# 8. Set Value Digital Transmission

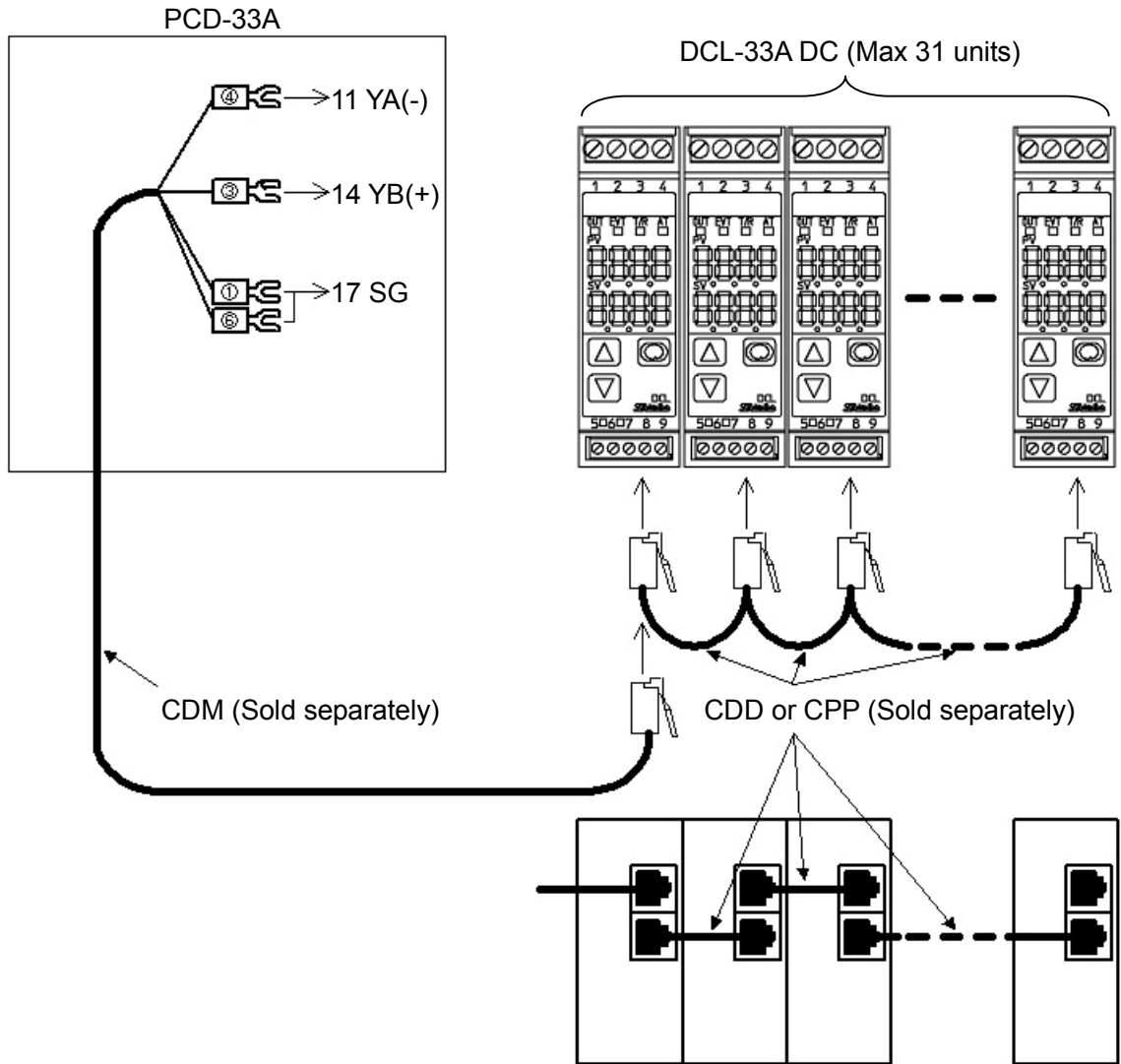
Set values can be received from Shinko programmable controllers PC-900, PCD-33A for which Set value digital transmission (SVTC option) is ordered.

## 8.1 Wiring

When connecting the PCD-33A to DCL-33A DC, connect YA (-) to YA (-), YB (+) to YB (+), and SG to COM respectively for the Set value digital transmission.

A maximum of 31 units of the DCL-33A DC can be connected.

The following shows an example of connection between the PCD-33A and DCL-33A DC.



(Fig. 8.1-1)

## 8.2 Communication Parameters Setting

### (1) Setting the PCD-33A

If the SVTC option is ordered, it is not necessary to set any item.

Check if Set value digital transmission [] is selected in [Communication protocol (通信プロトコル)] in Auxiliary function setting mode 1.

### (2) Setting the DCL-33A DC

Check the following settings.

- Communication protocol is Shinko protocol.
- Communication speed of the DCL-33A DC is identical with that of the PCD-33A.

### (3) Set value digital transmission starts.

Enter the Program values (step SV, step time, etc) on the PCD-33A.

If the Program is initiated by pressing the RUN key, PCD-33A Set values will be transmitted to the DCL-33A DC.

During Program standby mode, 0 (zero) is sent to the DCL-33A DC.

# 9. Specifications

Cable length: Max. communication distance 1.2 km

Cable resistance: Within 50 Ω (Terminators are not necessary, but if used, use 120 Ω or more on one side.)

Communication line: EIA RS-485

Communication method: Half-duplex communication

Communication speed: 2400/4800/9600/19200 bps (Selectable by keypad) (Default: 9600 bps)

Synchronization method: Start-stop synchronization

Code form: ASCII, binary

Communication protocol: Shinko protocol/Modbus ASCII/Modbus RTU (Selectable by keypad)  
(Default: Shinko protocol)

Data format:

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

Error correction: Command request repeat system

Error detection: Parity, checksum (Shinko protocol), LRC (Modbus ASCII), CRC-16 (Modbus RTU)

# 10. Troubleshooting

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

• **Problem: Communication failure**

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

• **Problem: Although communication is occurring, the response is 'NAK'.**

Check if any of the following have occurred:
A non-existent command code has been sent
The setting command data exceeds the setting range of the slave.
The controller cannot be set when functions such as AT are performing.
The DCL-33A DC is in the front keypad operation setting mode.

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

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