Module Type Controller

SRV

Ethernet [Modbus/TCP] Communication Instruction Manual

RKC® RKC INSTRUMENT INC. IMS01P09-E5

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- Modbus is a registered trademark of Schneider Electric.
- Windows and Microsoft Internet Explorer are registered trademark of Microsoft Corporation in the U.S.A. and other countries.
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Thank you for purchasing this RKC instrument. In order to achieve maximum performance and ensure proper operation of your new instrument, carefully read all the instructions in this manual. Please place this manual in a convenient location for easy reference.

SYMBOLS

WARNING : This mark indicates precautions that must be taken if there is danger of electric shock, fire, etc., which could result in loss of life or injury.

CAUTION : This mark indicates that if these precautions and operating procedures are not taken, damage to the instrument may result.

 : This mark indicates that all precautions should be taken for safe usage.

 : This mark indicates important information on installation, handling and operating procedures.

 : This mark indicates supplemental information on installation, handling and operating procedures.

 : This mark indicates where additional information may be located.

⚠ WARNING

- An external protection device must be installed if failure of this instrument could result in damage to the instrument, equipment or injury to personnel.
- All wiring must be completed before power is turned on to prevent electric shock, fire or damage to instrument and equipment.
- This instrument must be used in accordance with the specifications to prevent fire or damage to instrument and equipment.
- This instrument is not intended for use in locations subject to flammable or explosive gases.
- Do not touch high-voltage connections such as power supply terminals, etc. to avoid electric shock.
- RKC is not responsible if this instrument is repaired, modified or disassembled by other than factory-approved personnel. Malfunction can occur and warranty is void under these conditions.

CAUTION

- This is a Class A instrument. In a domestic environment, this instrument may cause radio interference, in which case the user may be required to take adequate measures.
- This instrument is protected from electric shock by reinforced insulation. Provide reinforced insulation between the wire for the input signal and the wires for instrument power supply, source of power and loads.
- Be sure to provide an appropriate surge control circuit respectively for the following:
  - If input/output or signal lines within the building are longer than 30 meters.
  - If input/output or signal lines leave the building, regardless the length.
- This instrument is designed for installation in an enclosed instrumentation panel. All high-voltage connections such as power supply terminals must be enclosed in the instrumentation panel to avoid electric shock by operating personnel.
- All precautions described in this manual should be taken to avoid damage to the instrument or equipment.
- All wiring must be in accordance with local codes and regulations.
- All wiring must be completed before power is turned on to prevent electric shock, instrument failure, or incorrect action.
  The power must be turned off before repairing work for input break and output failure including replacement of sensor, contactor or SSR, and all wiring must be completed before power is turned on again.
- To prevent instrument damage or failure, protect the power line and the input/output lines from high currents with a protection device such as fuse, circuit breaker, etc.
- Prevent metal fragments or lead wire scraps from falling inside instrument case to avoid electric shock, fire or malfunction.
- Tighten each terminal screw to the specified torque found in the manual to avoid electric shock, fire or malfunction.
- For proper operation of this instrument, provide adequate ventilation for heat dispensation.
- Do not connect wires to unused terminals as this will interfere with proper operation of the instrument.
- Turn off the power supply before cleaning the instrument.
- Do not use a volatile solvent such as paint thinner to clean the instrument. Deformation or discoloration will occur. Use a soft, dry cloth to remove stains from the instrument.
- To avoid damage to instrument display, do not rub with an abrasive material or push front panel with a hard object.
- Do not connect modular connectors to telephone line.

NOTICE

- This manual assumes that the reader has a fundamental knowledge of the principles of electricity, process control, computer technology and communications.
- The figures, diagrams and numeric values used in this manual are only for purpose of illustration.
- RKC is not responsible for any damage or injury that is caused as a result of using this instrument, instrument failure or indirect damage.
- RKC is not responsible for any damage and/or injury resulting from the use of instruments made by imitating this instrument.
- Periodic maintenance is required for safe and proper operation of this instrument. Some components have a limited service life, or characteristics that change over time.
- Every effort has been made to ensure accuracy of all information contained herein. RKC makes no warranty expressed or implied, with respect to the accuracy of the information. The information in this manual is subject to change without prior notice.
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CONTENTS

1. OUTLINE

This manual describes Modbus/TCP protocol communication when the temperature control module for Ethernet V-TIO-P or V-TIO-Q (hereafter called the V-TIO-P/V-TIO-Q module) for the module type controller SRV is used.

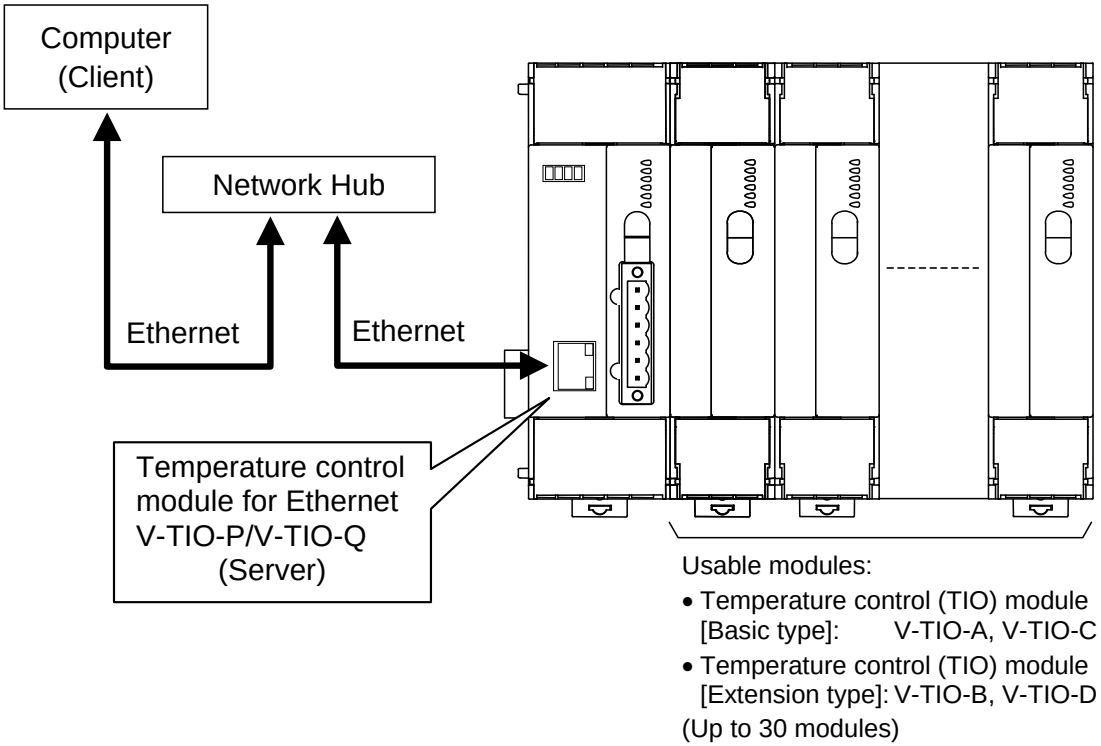
- The V-TIO-P/V-TIO-Q module has one modular connector (RJ-45) for connection to Ethernet.
- Up to 30 temperature control modules (V-TIO-A, B, C or D) can be connected to one V-TIO-P/V-TIO-Q module.

📖 Modbus/TCP is an open field network provided with the Modbus protocol on the TCP/IP protocol of Ethernet.

📖 The data request side is called “client” (such as computer) and the data response (supply) side is called “server” (SRV).

📖 Basically, one client corresponds to one server (SRV) (i.e. one to one). However, one client can communicate with two or more servers depending on the program on the client side, but two or more clients cannot communicate with one server.

☞ For specification, parts description and wiring of the V-TIO-P/V-TIO-Q module, see **Temperature Control Module for Ethernet V-TIO-P/V-TIO-Q Instruction Manual (IMS01P08-E□)**.



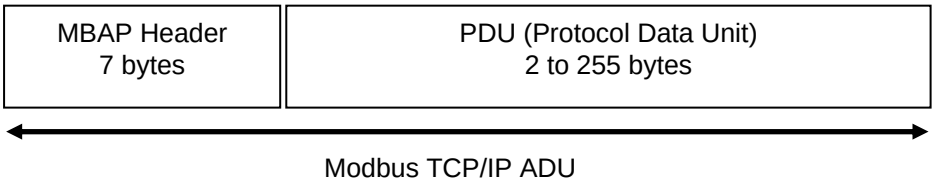
2. COMMUNICATION SPECIFICATIONS

■ Ethernet communication

Physical layer: Ethernet
10BASE-T/100BASE-TX automatic recognition
Application layer: Modbus/TCP
Communication data: Based on Modbus message format
Connector type: RJ-45
Maximum connections: Up to 30 temperature control modules can be connected to one V-TIO-P/V-TIO-Q module.
(Maximum number of temperature control point: 62 channels)

● Modbus/TCP message configuration

Modbus ADU (Application Data Unit) on TCP/IP

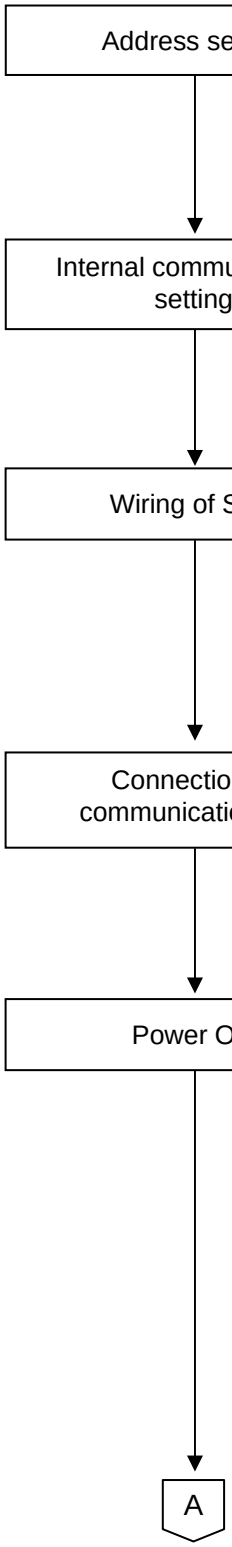


MBAP Header:
Transaction Identifier: 2 bytes
Protocol Identifier: 2 bytes
Data Length: 2 bytes
Unit Identifier: 1 byte
(MBAP: Modbus Application Protocol)

PDU (Protocol Data Unit):
Function code: 1 byte
03H: Read holding registers
06H: Write single register
08H: Diagnostics (loopback test)
10H: Write multiple registers
17H: Read/write multiple registers
Data: 1 to 254 bytes

3. SETTING PROCEDURE TO OPERATION

Conduct necessary setting before operation according to the procedure described below.



Set the module address.

☞ See **4.1 Module Address Setting (P. 6)**.

Set the communication speed and data bit configuration.

☞ See **4.2 Internal Communication Setting (P. 8)**.

Wire a power supply and input/output of SRV (server).

☞ For the V-TIO-P/V-TIO-Q module, see **APPENDIX A.1 Terminal Configuration (P. 102)**.
For other modules, see the Instruction Manual of each module.

Connect SRV (server) to client.

☞ See **5. Wiring (P. 12).**

Turn on the power supply of SRV (server) and client.
The V-TIO-P/V-TIO-Q module starts collecting data on each module connected from the time when the power is turned on. At this time, the RUN lamp corresponding to indication lamp 2 flashed at very short intervals.
After data collection is finished and communication becomes enabled *, the RUN lamp keeps lighting.

* Time required for enabling communication differs depending on the number of modules connected.

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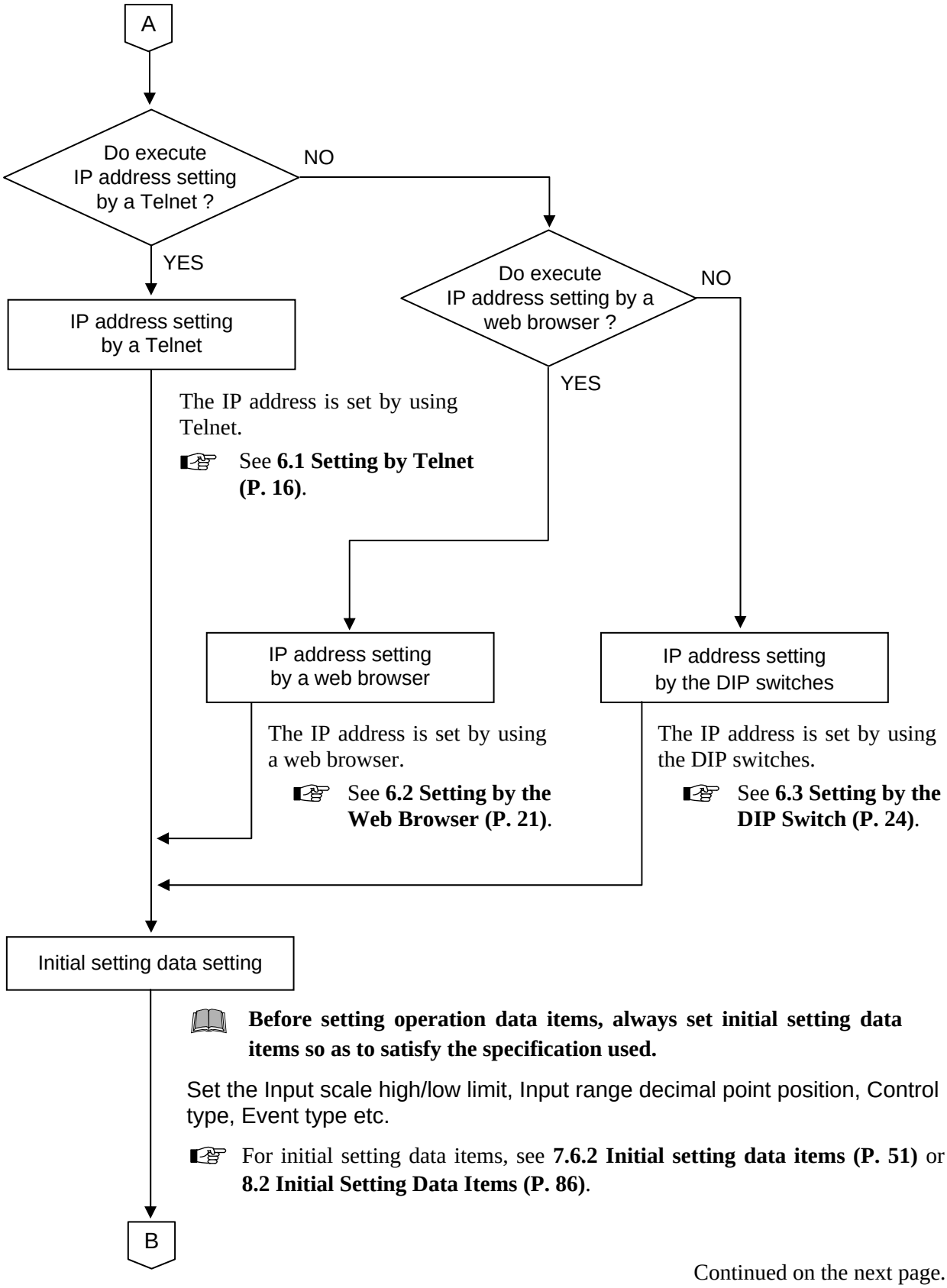

The IP address is set by using Telnet.

☞ See **6.1 Setting by Telnet (P. 16)**.

The IP address is set by using a web browser.

☞ See **6.2 Setting by the Web Browser (P. 21)**.

The IP address is set by using the DIP switches.

☞ See **6.3 Setting by the DIP Switch (P. 24)**.

Before setting operation data items, always set initial setting data items so as to satisfy the specification used.

Set the Input scale high/low limit, Input range decimal point position, Control type, Event type etc.

☞ For initial setting data items, see **7.6.2 Initial setting data items (P. 51)** or **8.2 Initial Setting Data Items (P. 86)**.

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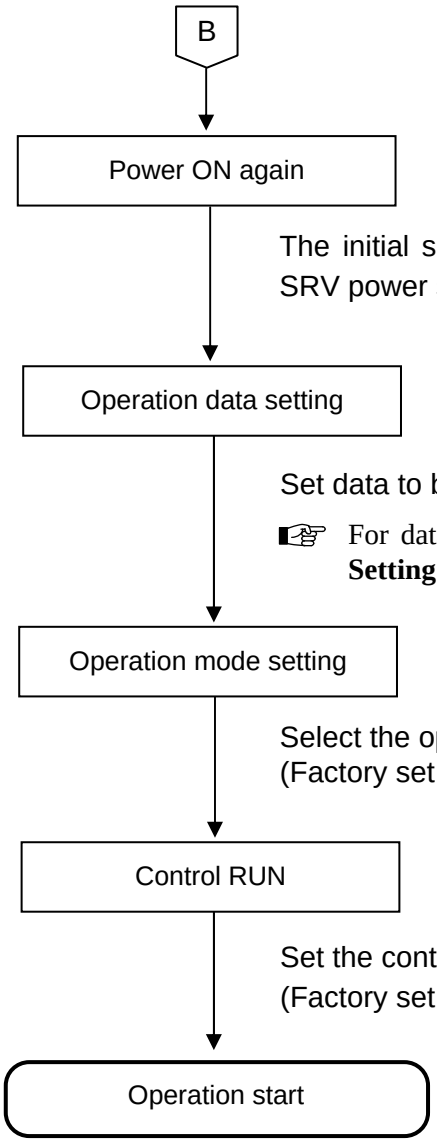


The initial setting data items thus set are registered by turning on the SRV power supply again.

Set data to be related to the control.

☞ For data, see **7.6.1 Normal setting data items (P. 43)** or **8.1 Normal Setting Data Items (P. 57)**.

Select the operation mode in the Auto/Manual transfer.
(Factory set value: AUTO)

Set the control RUN/STOP transfer to the “RUN.”
(Factory set value: STOP)

4. COMMUNICATION SETTING

⚠ WARNING

- To prevent electric shock or instrument failure, always turn off the power before setting the switch.
- To prevent electric shock or instrument failure, never touch any section other than those instructed in this manual.

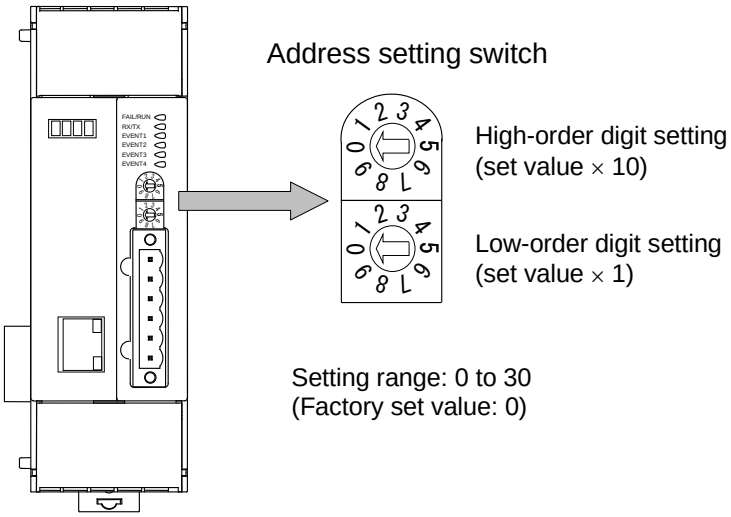
CAUTION

Do not separate the module mainframe from the terminal base with the power turned on. If separated, adjusted data may be destroyed; control be stopped, and no return can be made.

Set the following communication setting before operation.

4.1 Module Address Setting

When using two or more modules, set the desired address to each module.
Set the module address by address setting switch of front of module. For this setting, use a small blade screwdriver.



Set the module address such that it is different to the other addresses in the same unit. Otherwise, problems or malfunction may result.

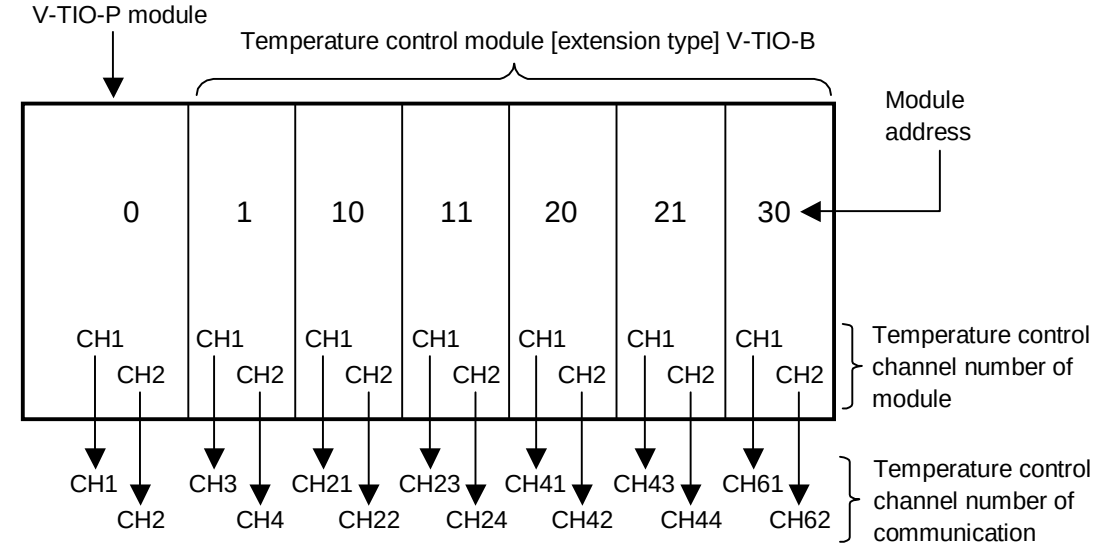
The above figure is V-TIO-P/V-TIO-Q module. The figure of other TIO module is the same as a V-TIO-P/V-TIO-Q module.

■ The channel number for the module address

The module address can be freely set with any numbers from 0 to 30.
In addition, to each module address, the relevant temperature control channel is assigned. Each temperature control channel number can be calculated from the following equation.

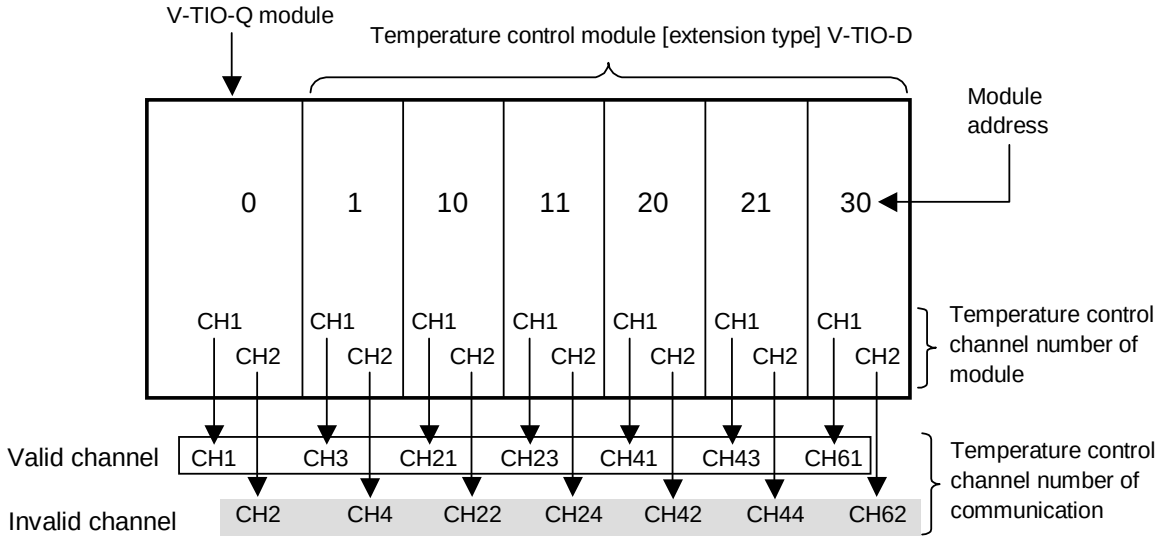
Temperature control channel number of communication
= (Module address × 2) + Temperature control channel number of module

[Setting example]



For heat/cool control, data in the second channel of each module becomes invalid.

[Example] If module addresses of one V-TIO-Q module and six V-TIO-D modules which are heat/cool temperature control modules are set as follows by the free setting, data in odd channels is used because data in even channels is invalid.
Valid channel number: 1, 3, 21, 23, 41, 43, 61
Invalid channel number: 2, 4, 22, 24, 42, 44, 62



4.2 Internal Communication Setting

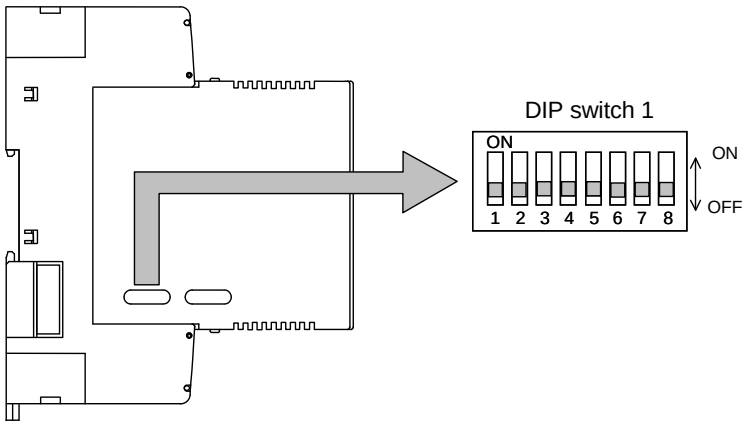
Internal communication is used for data transfer between modules within the SRV unit.
The setting is made on the Ethernet communication and temperature control sides of the V-TIO-P/V-TIO-Q module.

■ Setting of Ethernet communication side

With the DIP switch 1 which there is on the left side of V-TIO-P/V-TIO-Q module, select internal communication speed.

Switch No. 3 to 8: OFF fixed (Don't change this one)

Set the communication speed to the same value as the setting on the temperature control side (DIP switch 3).



Left side view

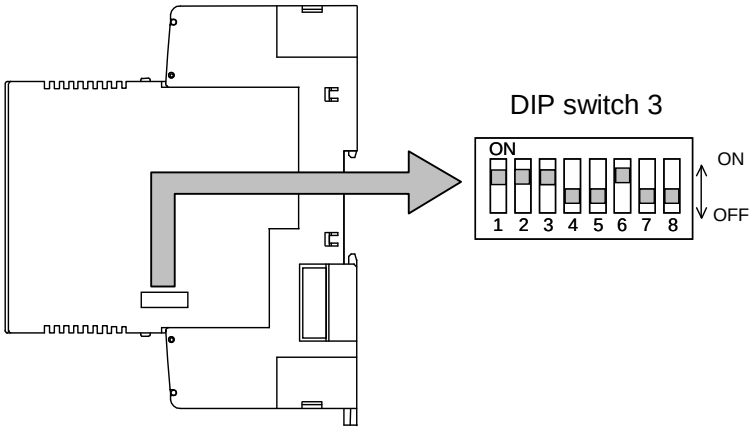
1	2	Communication speed
OFF	OFF	38400 bps
ON	OFF	9600 bps
OFF	ON	19200 bps
ON	ON	38400 bps

← Factory set value

■ Setting of temperature control side

With the DIP switch 3 which there is on the right side of V-TIO-P/V-TIO-Q module, select internal communication speed and data bit configuration.

- **Switch No. 6: ON fixed (Don't change this one)**
  Switch No. 7, 8: OFF fixed (Don't change this one)
- **Set the communication speed to the same value as the setting on the Ethernet communication side (DIP switch 1).**
- **When connecting two or more modules (V-TIO-A, V-TIO-B, V-TIO-C or V-TIO-D) to the V-TIO-P/V-TIO-Q module, match all of their communication speed and data bit configuration settings with the internal settings of the V-TIO-P/V-TIO-Q module.**



Right side view

1	2	Communication speed	
OFF	OFF	Don't set this one	
ON	OFF	9600 bps	
OFF	ON	19200 bps	
ON	ON	38400 bps	← Factory set value

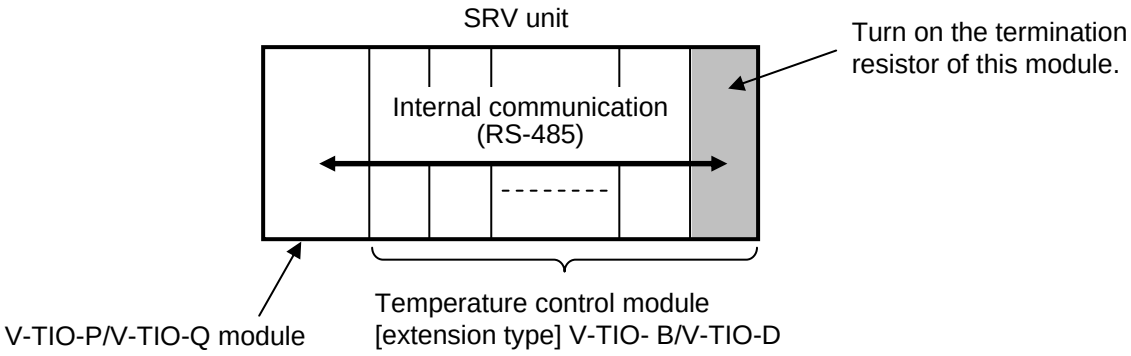
3	4	5	Data bit configuration	
OFF	OFF	OFF	Don't set this one	
OFF	OFF	ON		
OFF	ON	OFF		
OFF	ON	ON		
ON	OFF	OFF	Data 8-bit, without parity, Stop 1-bit	← Factory set value
ON	OFF	ON	Don't set this one	
ON	ON	OFF		
ON	ON	ON		

4.3 Termination Resistor Setting of Internal communication

Procedure for setting a termination resistor to internal communication (RS-485) and its setting position are described in the following.

■ Termination resistor setting position

Set a termination resistor to the communication line termination in the module located in the position farthermost from the V-TIO-P/V-TIO-Q module.

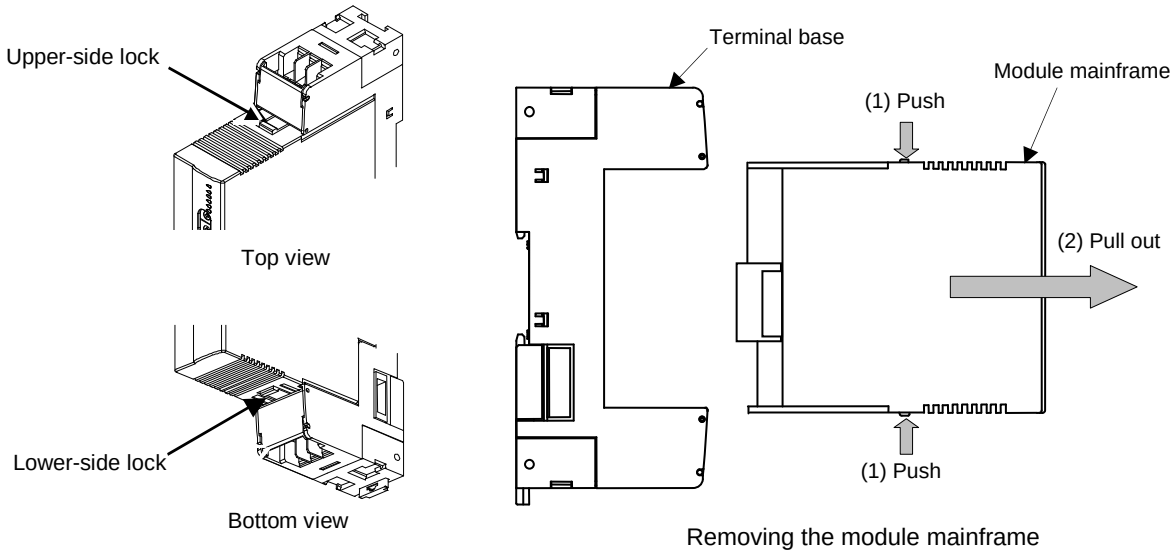


■ Setting procedure of termination resistor

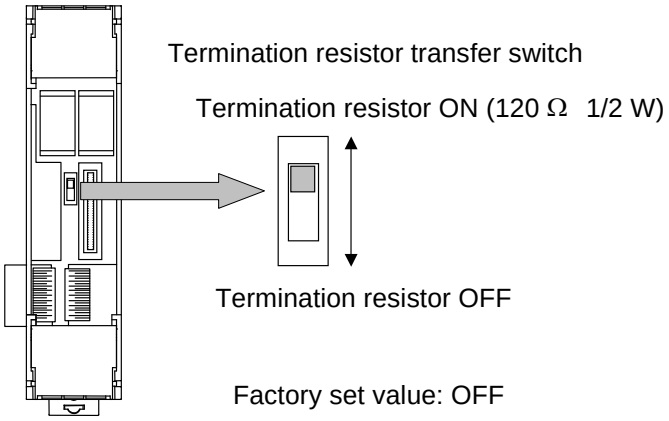
As no termination resistor is externally connected to the temperature control (TIO) module [extension type] V-TIO-B (or V-TIO-D), the termination resistor built in the module is connected by switch selection.

1. Turn off the power supply of the module.
Do not separate the module mainframe from the terminal base with the power turned on. If separated, adjusted data may be destroyed; control be stopped, and no return can be made.

2. Pull out the module mainframe itself toward you while pushing the locks at its top and bottom, and then separate it from the terminal base.

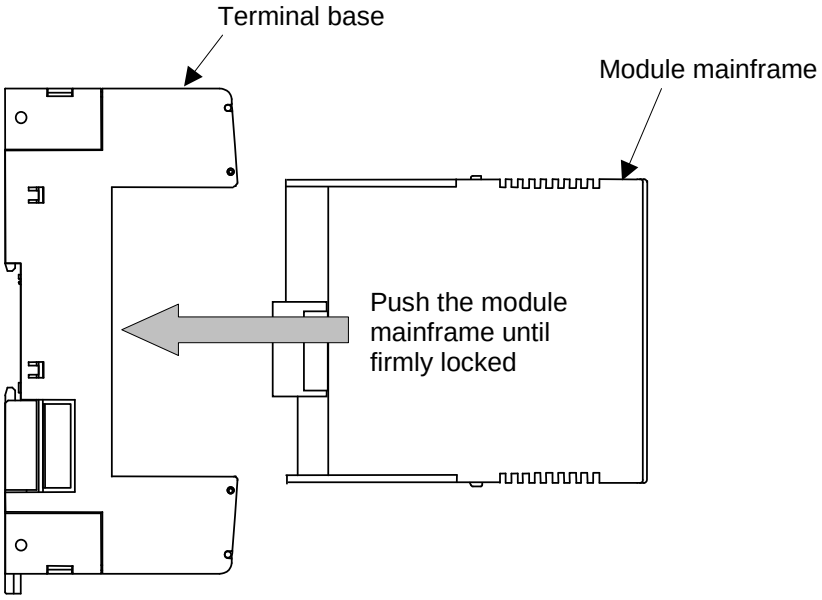


3. Turn on the termination resistor transfer switch in the terminal base.



A terminal base of the state which removed module mainframe

4. Push the module mainframe thus separated in the terminal base until firmly locked.



Mounting the module mainframe

5. WIRING

⚠ WARNING

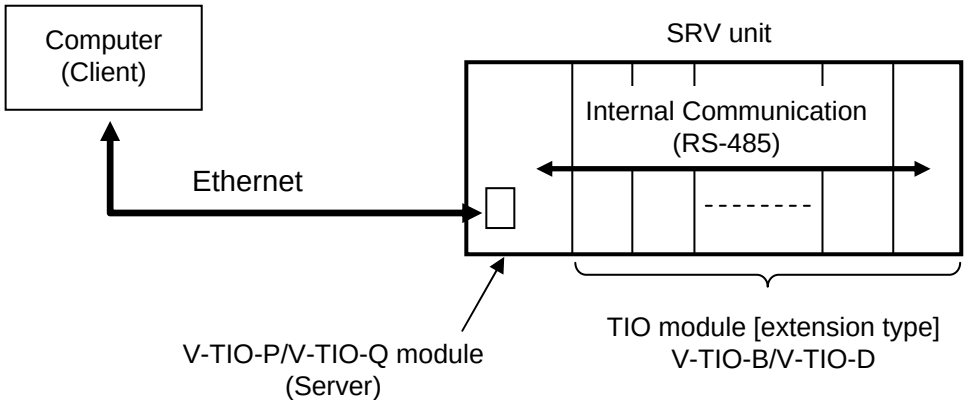
To prevent electric shock or instrument failure, turn off the power before connecting or disconnecting the instrument and peripheral equipment.

CAUTION

- Connect connectors correctly in the right position. If it is forcibly pushed in with pins in the wrong positions, the pins may be bent resulting in instrument failure.
- When connecting or disconnecting the connectors, do not force it too far to right and left or up and down, but move it on the straight. Otherwise, the connector pins may be bent, causing instrument failure.
- When disconnecting a connector, hold it by the connector itself. Disconnecting connectors by yanking on their cables can cause breakdowns.
- To prevent malfunction, never touch the contact section of a connector with bare hands or with hands soiled with oil or the like.
- To prevent malfunction, connect cable connectors securely, then firmly tighten the connector fastening screws.
- To prevent damage to cables, do not bend cables over with excessive force.
- If the instrument is easily affected by noise, use the ferrite core in the both ends of the communication cable (nearest the connector).

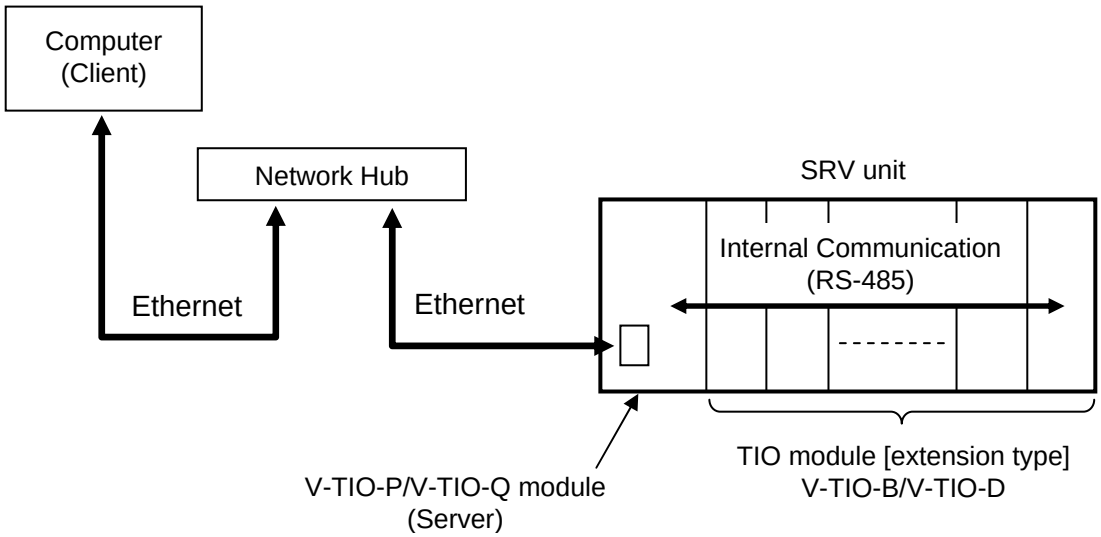
5.1 Wiring Configuration

■ When directly connected to client



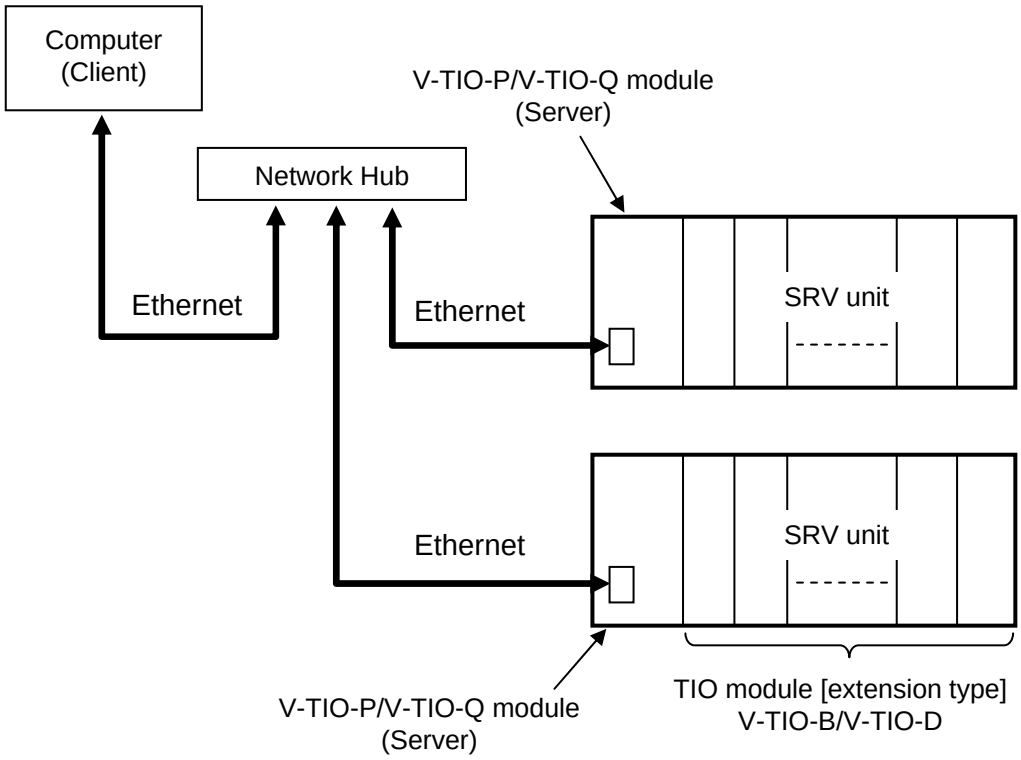
📖 Up to 30 temperature control modules can be connected to one V-TIO-P/V-TIO-Q module.

■ When use network hub



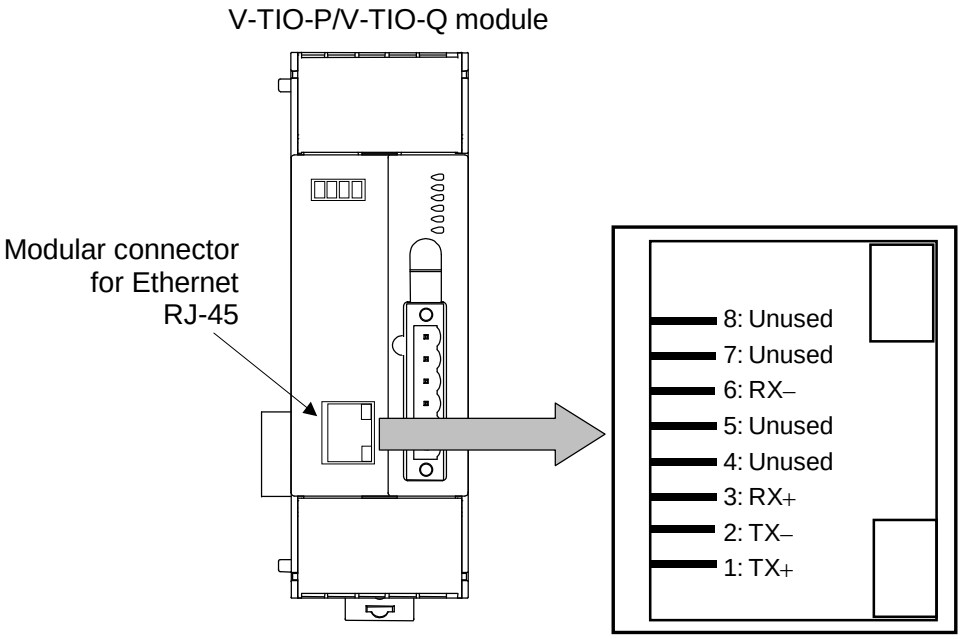
Up to 30 temperature control modules can be connected to one V-TIO-P/V-TIO-Q module.

Basically, one client corresponds to one server (SRV) (i.e. one to one). However, one client can communicate with two or more servers depending on the program on the client side, but two or more clients cannot communicate with one server.



5.2 Wiring Details

■ Pin layout of modular connector



■ Connector pin number and signal details

Pin No.	Signal name	Symbol
1	Send data +	TX+
2	Send data –	TX–
3	Receive data +	RX+
4	Unused	—
5	Unused	—
6	Receive data –	RX–
7	Unused	—
8	Unused	—

The cable is provided by the customer.

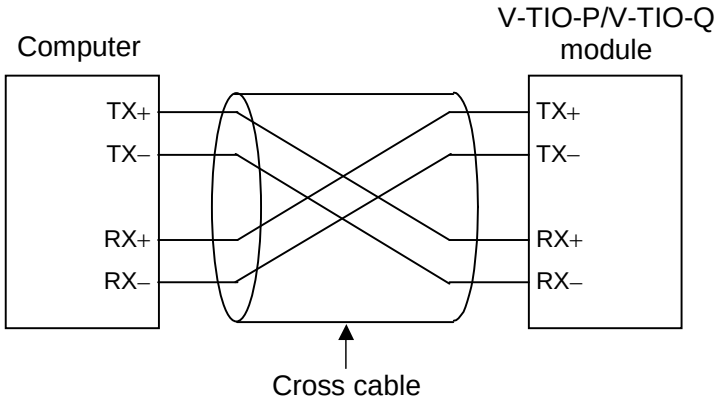
Used cable: The cable is based on the 10BASE-T or the 100BASE-TX standard of Ethernet.

Used connector: RJ-45 type

■ Wiring example

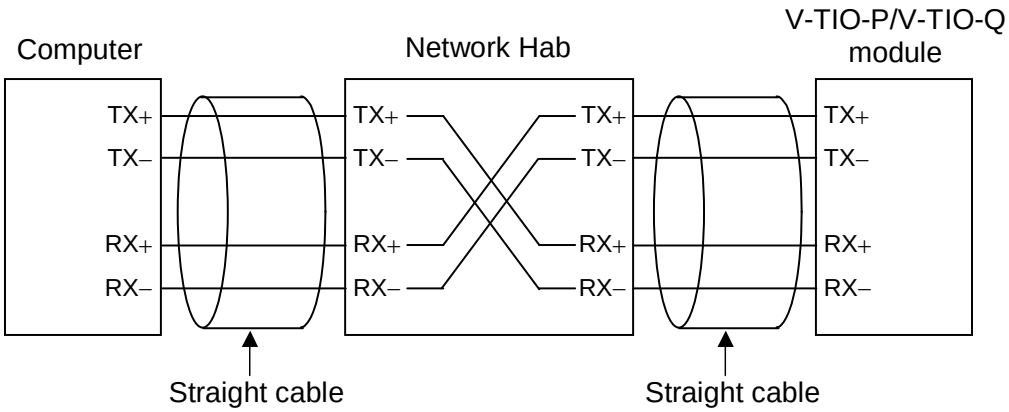
● When directly connected to client

Use a cross cable when directly connected to the client (such as computer).



● When use network hub

Use straight cables when connected to the network hub.



Cross cables may be used depending on the connecting device used. Therefore, follow the instructions for the respective device.

6. IP ADDRESS SETTING

Set an IP address of a V-TIO-P/V-TIO-Q module.
Three types of IP address setting are available: “setting by Telnet,” “setting by Web browser” and “setting by DIP switch.”

📖 **Confirm the IP address number to the network administrator of the network (LAN) to which the V-TIO-P/V-TIO-Q module is connected.**

6.1 Setting by Telnet

Set the IP address by the software “Telnet” attached to Windows.

■ Preparations before setting

When setting the IP address by Telnet, it is necessary to coincide the 1st to 3rd bytes and masking range of the IP address of the client (computer) which starts Telnet with those of the IP address of the V-TIO-P/V-TIO-Q module.

1. Connect the V-TIO-P/V-TIO-Q module and client, and then turn on the power.

☞ For wiring procedure, see **5. WIRING (P. 12)**.

2. The IP address of the V-TIO-P/V-TIO-Q module is set to a factory set value of “192.168.1.1.” As it is necessary to coincide the 1st to 3rd byte values of this IP address with those of the IP address of the client, change the IP address of the client to “192.168.1.□” (□: Any value in the range of 0 to 255, but other than 1).

3. As the subnet mask of the V-TIO-P/V-TIO-Q module is “255.255.255.0,” also change the subnet mask of the client to “255.255.255.0.”

📖 After the IP address of the server is set, return the present IP address of the client to the original address or change to the address meeting the network to be connected.

📖 It is possible to set the IP address of the V-TIO-P/V-TIO-Q module using the client already connected to the network. However, as the IP address of the client is changed, that client is disconnected from the network so far connected.
In addition, when setting the IP address by this method, confirm to the network administrator whether or not no problem arises.

■ Setting example

An example of setting the IP address to “192.168.1.3” is shown in the following.

1. Display the MS-DOS prompt (command prompt); enter the following command and then press the Enter key.

```
C:¥>telnet 192.168.1.1 9999
```

2. Device information on the module (V-TIO-P/V-TIO-Q module) whose IP address is “192.168.1.1” is displayed. Finally, as the message “Press Enter to go into Setup Mode” is displayed, press the Enter key to go into Setup Mode.

```
MAC address 00204A8064BD
Software version 01.3 (030612) XPTE

Press Enter to go into Setup Mode
```

If the timing of pressing the Enter key is late, the message “Connection with Host was cut off” is displayed and thus the client is disconnected from the V-TIO-P/V-TIO-Q module. Therefore if the message “Press Enter to go into Setup Mode” is displayed, immediately press the Enter key.
If disconnected, try again from “***1.***”

3. If entered into Setup Mode, the present Ethernet information is displayed.
Finally, eight choices are displayed as “Change Setup:.” Therefore enter “0” after “Your choice ?” and then press the Enter key.

```
*** basic parameters
Hardware: Ethernet TPI
IP addr 192.168.1.1, no gateway set,netmask 255.255.255.000

*************** Security ***************
SNMP is                 enabled
SNMP Community Name:  public
Telnet Setup is         enabled
TFTP Download is        enabled
Port 77FEh is           enabled
Web Server is           enabled
ECHO is                 disabled
Enhanced Password is    disabled

*************** Channel 1 **************
Baudrate 38400, I/F Mode 7C, Flow 00
Port 00502
Remote IP Adr: --- none ---, Port 00000
Connect  Mode: C0    Disconn Mode: 00
Flush     Mode: 80
Pack Cntrl      : 00
```

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```
********** Expert **********
TCP Keepalive       : 45s
ARP cache timeout: 600s

********** E-mail **********
Mail server: 0.0.0.0
Unit          :
Domain     :
Recipient 1:
Recipient 2:

*** Trigger 1
Serial Sequence: 00,00
CP1: X
CP2: X
CP3: X
Message:
Priority  : L
Min. notification interval: 1 s
Re-notification interval   : 0 s

*** Trigger 2
Serial Sequence: 00,00
CP1: X
CP2: X
CP3: X
Message:
Priority  : L
Min. notification interval: 1 s
Re-notification interval   : 0 s

*** Trigger 3
Serial Sequence: 00,00
CP1: X
CP2: X
CP3: X
Message:
Priority  : L
Min. notification interval: 1 s
Re-notification interval   : 0 s


Change Setup:
   0 Server configuration
   1 Channel 1 configuration
   3 E-mail settings
   5 Expert settings
   6 Security
   7 Factory defaults
   8 Exit without save
   9 Save and exit                Your choice ? 0
```

Enter “0” (Server configuration), and press the Enter key.

4. Selecting “0: Server configuration” makes ready to set the IP address.
Enter the IP address one byte by one byte.
As the following display appears, enter “192” into the first byte and then press the Enter key.

```
IP Address : (192) 192
```

Next, enter “168” into the second byte and then press the Enter key.

```
IP Address : (192) 192.(168) 168
```

Enter “1” into the third byte and then press the Enter key.

```
IP Address : (192) 192.(168) 168.(001) 1
```

Enter “3” into the fourth byte and then press the Enter key.

```
IP Address : (192) 192.(168) 168.(001) 1.(001) 3
```

5. After the IP address is entered, the following display appears. Therefore press the Enter key to proceed to the next.

```
IP Address : (192) 192.(168) 168.(001) 1.(001) 3
Set Gateway IP Address (N) N
```

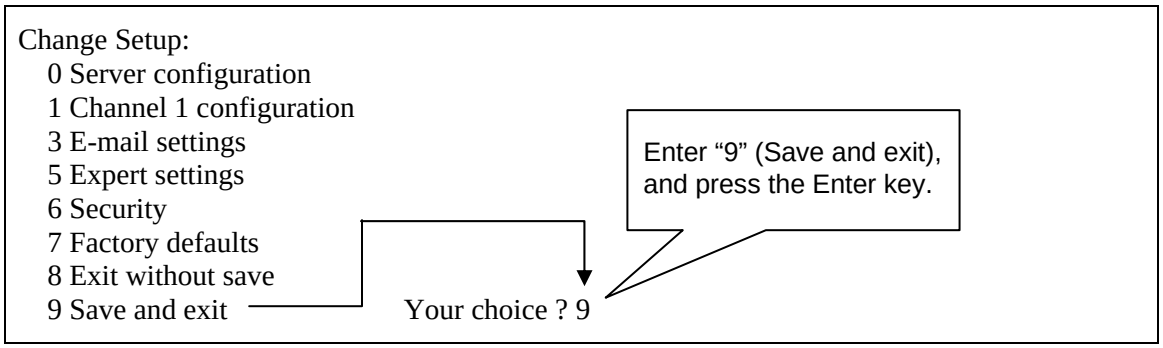
In addition, as one line is displayed, press the Enter key to proceed to the next.

```
IP Address : (192) 192.(168) 168.(001) 1.(001) 3
Set Gateway IP Address (N) N
Netmask: Number of Bits for Host Part (0=default) (16)
```

Further, as more one line is displayed, press the Enter key to proceed to the next.

```
IP Address : (192) 192.(168) 168.(001) 1.(001) 3
Set Gateway IP Address (N) N
Netmask: Number of Bits for Host Part (0=default) (16)
Change telnet config password (N) N
```

6. As “Change Setup:” is displayed again, enter “9” after “Your choice ?” and then press the Enter key.



7. “Parameters stored ...” is displayed and thus the setting is finished.

6.2 Setting by the Web Browser

It is possible to set the IP address by using the Web browser (such as Internet Explorer).

■ Preparations before setting

When setting the IP address by Web browser, it is necessary to coincide the 1st to 3rd bytes and masking range of the IP address of the client (computer) which starts Web browser with those of the IP address of the V-TIO-P/V-TIO-Q module.

1. Connect the V-TIO-P/V-TIO-Q module and client, and then turn on the power.

☞ For wiring procedure, see **5. WIRING (P. 12)**.

2. The IP address of the V-TIO-P/V-TIO-Q module is set to a factory set value of “192.168.1.1.” As it is necessary to coincide the 1st to 3rd byte values of this IP address with those of the IP address of the client, change the IP address of the client to “192.168.1. □” (□: Any value in the range of 0 to 255, but other than 1).

3. As the subnet mask of the V-TIO-P/V-TIO-Q module is “255.255.255.0,” also change the subnet mask of the client to “255.255.255.0.”

📖 After the IP address of the server is set, return the present IP address of the client to the original address or change to the address meeting the network to be connected.

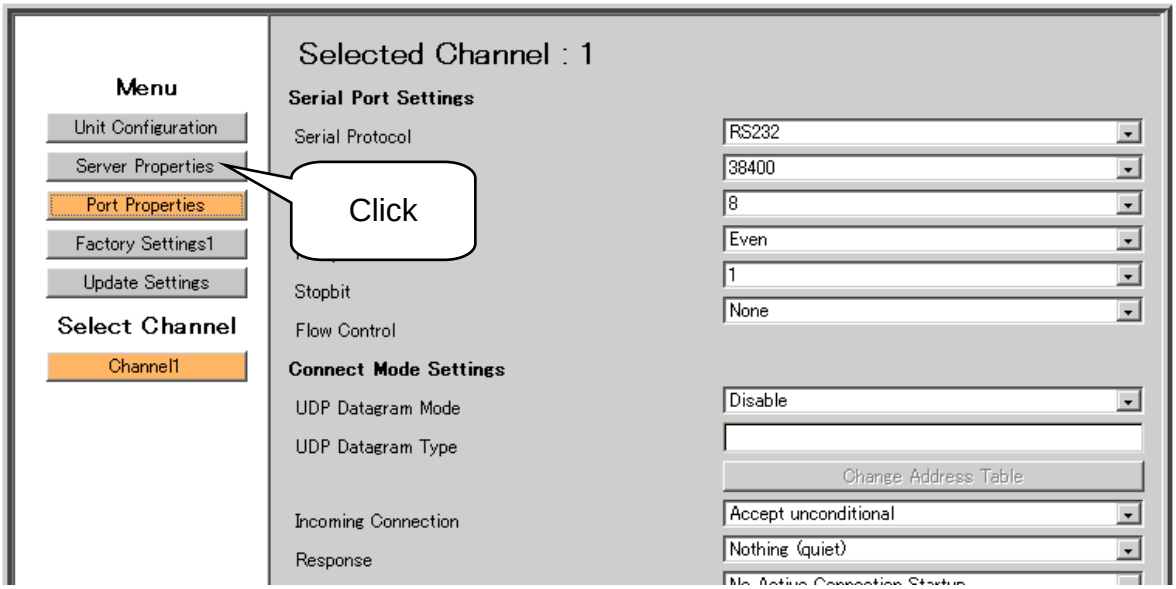
📖 It is possible to set the IP address of the V-TIO-P/V-TIO-Q module using the client already connected to the network. However, as the IP address of the client is changed, that client is disconnected from the network so far connected.
In addition, when setting the IP address by this method, confirm to the network administrator whether or not no problem arises.

■ Setting example

An example of setting the IP address to “192.168.1.3” is shown in the following.

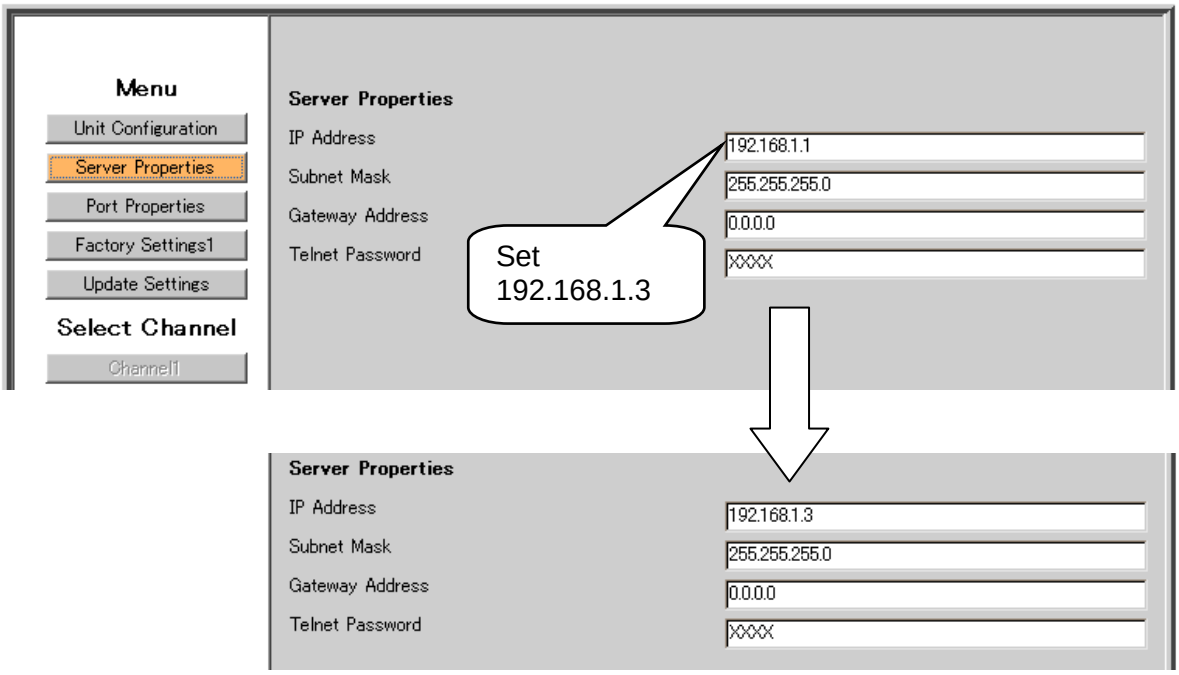
1. Start the Web browser; enter the present IP address “192.168.1.1” into the address bar and then press the Enter key.

2. The initial setting applet starts. “Selected Channel: 1” is displayed on the main display with “Port Properties” selected on the Menu display on the left side of the screen.
Under this condition, click the Server Properties button on the Menu display.



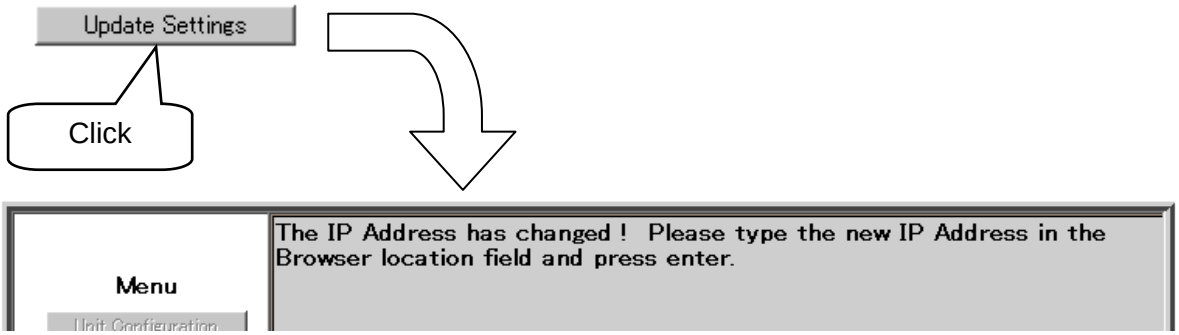
Do not change the contents of “Selected Channel: 1.” If changed, device failure or error may result.

3. Display the Server Properties screen.
Set “192.168.1.3” in IP Address.



Do not change any items other than the IP Address. If so, device failure or error may result.

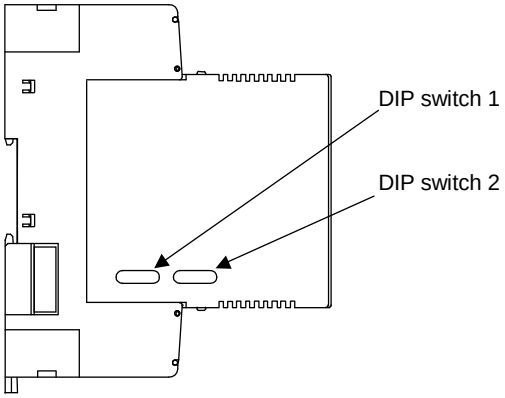
4. Clicking the Update Settings button on the Menu display updates the setting to display the following message.



5. Enter the new IP address “192.168.1.3” into the address bar as instructed by message and then press the Enter key. Thus, a new IP address setting screen appears to end the setting.

6.3 Setting by the DIP Switch

It is possible to set the IP address by DIP switch with Ethernet not connected.
DIP switches used are “DIP switch 1” and “DIP switch 2” on the left side of the module.



Left side view of V-TIO-P/V-TIO-Q module

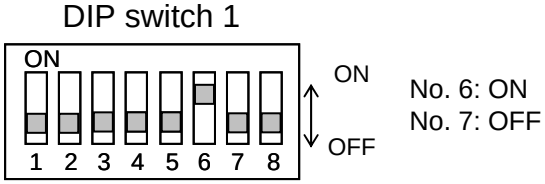
Factory set value of an IP address of a V-TIO-P/V-TIO-Q module is “192.168.1.1.”

■ Setting example

An example of setting the IP address to “192.168.1.3” is shown in the following.

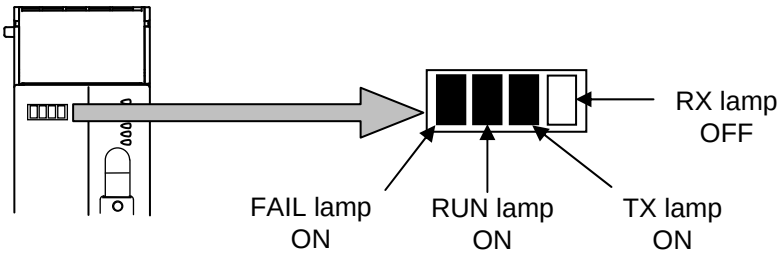
1. **Setting preparations**

Turn on No. 6 and off No. 7 of DIP switch 1 with the power turned off.
It does not matter whether Nos. 1 to 5 and No. 8 of DIP switch 1 is turned on or off.



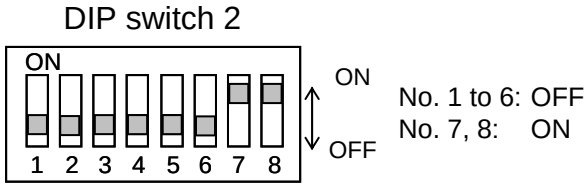
2. **Power ON**

Turning the power on goes to IP address setup mode. Thus, the FAIL lamp lights.
In addition, the first byte (most significant byte) of the IP address is set to the entry wait state.
(RUN lamp: ON, TX lamp: ON, RX lamp: OFF)



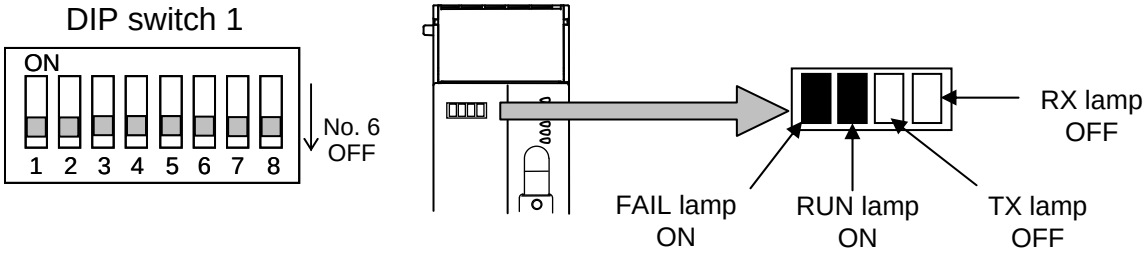
3. **Input the first byte “192”**

Enter the first byte (most significant byte) by DIP switch 2. As the first byte (most significant byte) is entered with “192,” this number corresponds to a binary number of “11000000.” Conduct the following setting with No. 8 of DIP switch 2 set to the most significant bit.



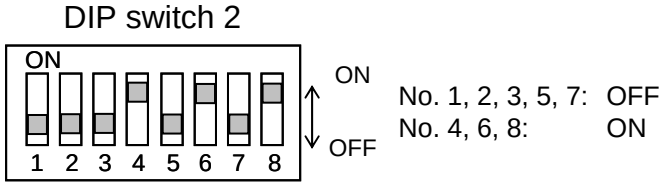
4. **Decision of the first byte input**

In order to establish the setting of DIP switch 2, turn off No. 6 of DIP switch 1.
In addition, the second byte of IP address is set to the entry wait state.
(RUN lamp: ON, TX lamp: OFF, RX lamp: OFF)



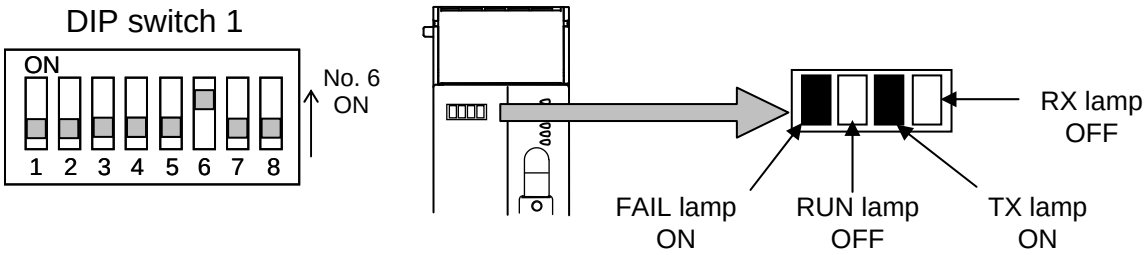
5. **Input the second byte “168”**

Enter the second byte by DIP switch 2. As the second byte is entered with “168,” this number corresponds to a binary number of “10101000.” Conduct the following setting with No. 8 of DIP switch 2 set to the most significant bit.



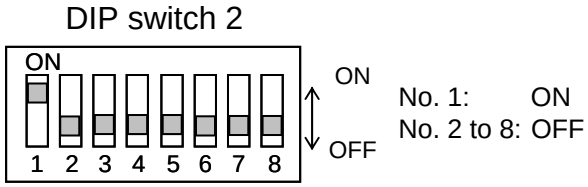
6. **Decision of the second byte input**

In order to establish the setting of DIP switch 2, turn on No. 6 of DIP switch 1.
In addition, the third byte of IP address is set to the entry wait state.
(RUN lamp: OFF, TX lamp: ON, RX lamp: OFF)



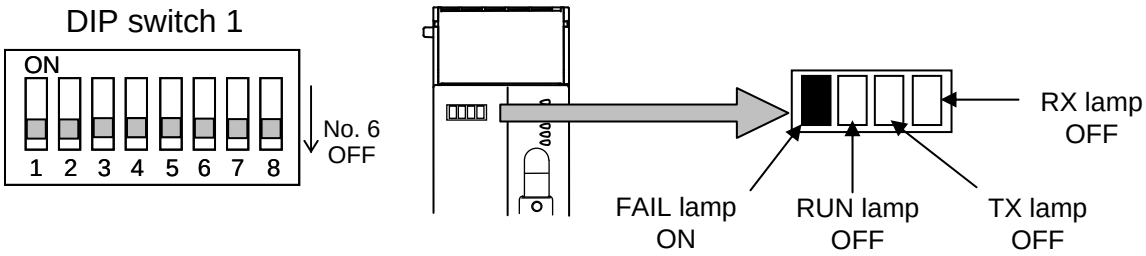
7. **Input the third byte "1"**

Enter the third byte by DIP switch 2. As the third byte is entered with "1," this number corresponds to a binary number of "00000001." Conduct the following setting with No. 8 of DIP switch 2 set to the most significant bit.



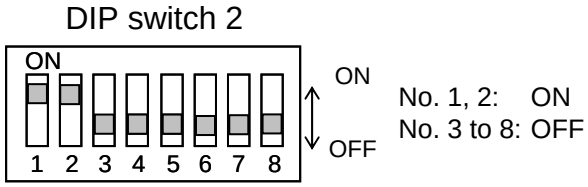
8. **Decision of the third byte input**

In order to establish the setting of DIP switch 2, turn off No. 6 of DIP switch 1.
In addition, the fourth byte of IP address is set to the entry wait state.
(RUN lamp: OFF, TX lamp: OFF, RX lamp: OFF)



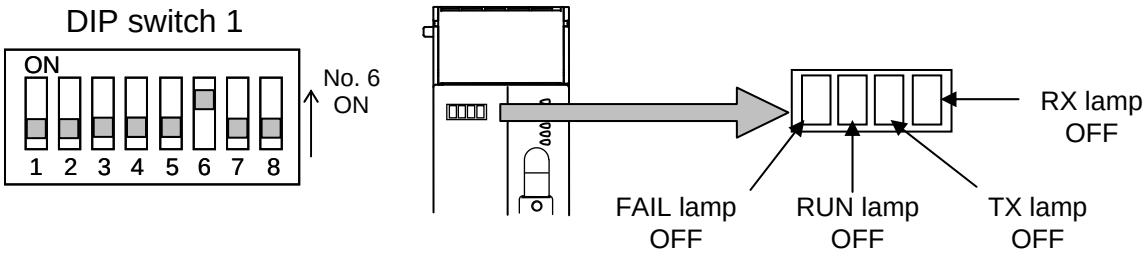
9. **Input the fourth byte "3"**

Enter the fourth byte by DIP switch 2. As the fourth byte is entered with "3," this number corresponds to a binary number of "00000011." Conduct the following setting with No. 8 of DIP switch 2 set to the most significant bit.



10. **Decision of the fourth byte input**

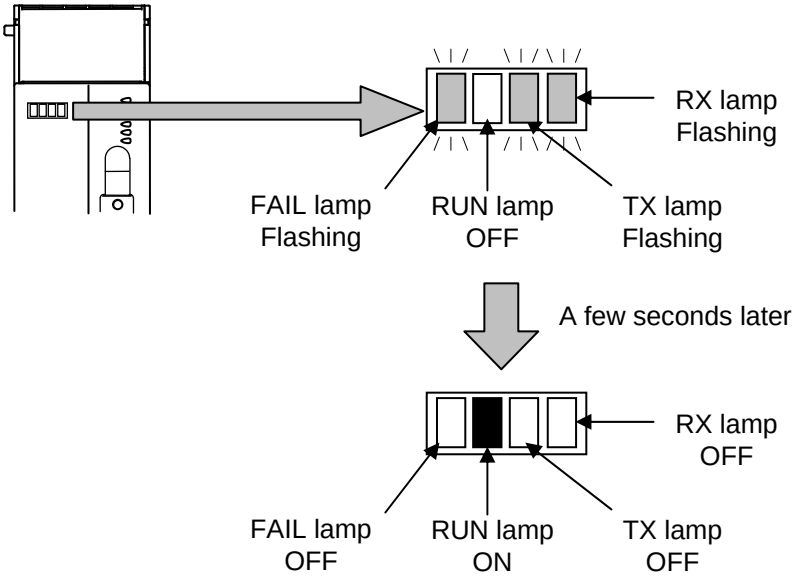
In order to establish the setting of DIP switch 2, turn on No. 6 of DIP switch 1. Thus, the IP address setting is finished and the FAIL lamp goes off.
(RUN lamp: OFF, TX lamp: OFF, RX lamp: OFF)



11. **Decision of the IP address**

After a lapse of a few seconds, the RUN lamp lights and the IP address is established.

The FAIL, TX and RX lamps flash until the IP address is established and they go off after the IP address is established.



12. **Power OFF**

Turn the power off and also turn off No. 6 of DIP switch 1. In addition, turn off all Nos. of DIP switch 2.

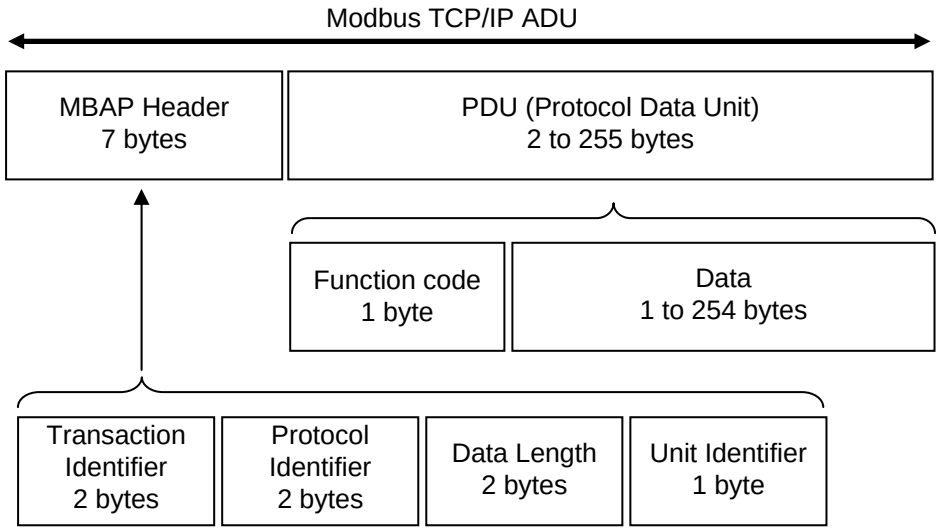
If the power is turned on, operation starts at the IP address thus set.

7. MODBUS/TCP PROTOCOL

Modbus/TCP is an open field network provided with the Modbus protocol on the TCP/IP protocol of Ethernet.
The data request side is called “client” (such as computer) and the data response (supply) side is called “server” (SRV).

7.1 Message Configuration

Modbus ADU (Application Data Unit) on TCP/IP is in the following configuration.



■ MBAP Header

MBAP (Modbus Application Protocol) header contains the following fields: Transaction Identifier, Protocol Identifier, Data Length and Unit Identifier.

Fields	Length	Request (Client)	Response (Server)
Transaction Identifier	2 bytes	Unused However, data corresponding to two bytes is sent	Returns data from the client as is
Protocol Identifier	2 bytes	“0” fixed (Modbus protocol = 0)	Returns data from the client as is
Data Length	2 bytes	The total number of bytes of Unit Identifier and PDU (256 bytes max.)	The total number of bytes of Unit Identifier and PDU (256 bytes max.)
Unit Identifier	1 byte	Unused However, data corresponding to one byte is sent	Returns data from the client as is

■ PDU

PDU (Protocol Data Unit) consists of two blocks: function codes and data.

Fields	Length	Request (Client)	Response (Server)
Function code	1 byte	03H: Read holding registers 06H: Write single register 08H: Diagnostics (loopback test) 10H: Write multiple registers 17H: Read/write multiple registers	Normal response Returns data from the client as is Error response 80H + Function code
Data	1 to 254 bytes	Data meeting the function code	Normal response Data meeting the function code Error response Exception code 01H: Illegal function code 02H: Illegal register address 03H: Illegal data value 04H: Server failure 06H: Server busy

7.2 Function Code

- **Function code contents**

Function code	Function	Contents
03H	Read holding registers	Measured value, Control output value, Current transformer input value, Event status, etc.
06H	Write single register	Set value, PID constants, event set value, etc.
08H	Diagnostics (loopback test)	Loopback test
10H	Write multiple registers	Set value, PID constants, event set value, etc.
17H	Read/write multiple registers	Measured value, Control output value, Current transformer input value, Event status, Set value, PID constants, event set value, etc.

- **Message (PDU) length of each function [Unit: byte]**

Function code	Function	Request message		Response message	
		Min	Max	Min	Max
03H	Read holding registers	5	5	4	252
06H	Write single register	5	5	5	5
08H	Diagnostics (loopback test)	5	5	5	5
10H	Write multiple registers	8	252	5	5
17H	Read/write multiple registers	12	246	4	238

7.3 Server (SRV) Responses

■ Normal response

- In the response message of the read holding registers, the server (SRV) returns the “Function code,” “Number of data items” and the “Read out data” as the response message.
- In the response message of the write single register and diagnostics (loopback test), the server (SRV) returns the same message as the request message.
- In the response message of the write multiple registers, the server (SRV) returns the “Function code,” the “Register address number” and the “Number of register” as the response message.
- In the response message of the read/write multiple registers, the server (SRV) returns the “Function code,” “Number of write data items” and the “Read out data” as the response message.

■ Defective message response

- If the request message from the client is defective, except for transmission error, the server (SRV) returns the exception response message without any action.
- If the self-diagnostic function of the server (SRV) detects an error, the server will return an exception response message to all request messages.

Function code
Exception code

Exception response message

- The function code of each exception response message is obtained by adding "80H" to the function code of the request message.

Exception code	Contents	Causes
01H	Illegal function code	An unsupported function code was specified
02H	Illegal register address	When the mismatched register address is specified.
03H	Illegal data value	• The number of specified data points was out of the following range during data read or write. Function code 03H: 1 to 125 Function code 10H: 1 to 123 Function code 17H: 1 to 118 • When the data written exceeds the setting range
04H	Server failure	State under which the server cannot normally respond (An error occurred in the server)
06H	Server busy	State under which the server cannot immediately respond (The server is being initialized)

Exception code priority order

01H > 03H > 02H > 04H > 06H

- Order of a no response in PDU data length error
  When Specified PDU data length < Received PDU data length:
  01H > No response in PDU data length error > 03H
  When Specified PDU data length > Received PDU data length:
  No response in PDU data length error > 01H
- Order when reading/writing the register contents
  When there is 02H or 03H only for read processing:
  01H > 04H > 06H > 03H > 02H
- Order when out of the setting range
  For 03H when out of the setting range: 01H > 02H > 04H > 06H > 03H

■ No response

The server (SRV) ignores the request message and does not respond when:

- The IP address does not coincide.
- The server (SRV) is not connected to the network.
- The PDU (Protocol Data Unit) data length is abnormal.
  When the PDU data length specified by the request message does not coincide with the number of bytes received as one TCP packet.
  SRV determines whether or not communication messages correspond to one packet by time-out (approx. 12 ms) between characters.

7.4 Message Format

7.4.1 Read holding registers [03H]

The request message specifies the starting register address number and quantity of register addresses to be read.
The contents of the registers are entered in the response message as data, divided into two parts: the high-order eight bits and low-order eight bits, arranged in the order of the register numbers.

Example: The contents of the three registers from 0000H to 0002H are the read out.

Request message [Client]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	06H	
Unit Identifier		00H	
Function code		03H	
Register address	High	00H	First register address
	Low	00H	
Quantity (Number of words)	High	00H	The setting must be between 1 (0001H) and 125 (007DH).
	Low	03H	

Normal response message [Server]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	09H	
Unit Identifier		00H	
Function code		03H	
Number of data (byte)		06H	→ Number of registers × 2
First register contents	High	00H	
	Low	78H	
Next register contents	High	00H	
	Low	00H	
Next register contents	High	00H	
	Low	14H	

Exception response message [Sever]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	03H	
Unit Identifier		00H	
80H + Function code		83H	
Exception code		03H	→ When the data exceeds the setting range

7.4.2 Write single register [06H]

The request message specifies data to be written into the designated register.
Write data items are arranged in the request message in order starting from the smallest register address number. In addition, each register address is assigned in the order of high-order eight bits and low-order eight bits, respectively.

Example: When 100 (64H) is written to the register 0010H

Request message [Client]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	06H	
Unit Identifier		00H	
Function code		06H	
Register address	High	00H	
	Low	10H	
Write data	High	00H	Any data within the range
	Low	64H	

Normal response message [Server]

Transaction Identifier	High	00H	Contents will be the same as request message data
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	06H	
Unit Identifier		00H	
Function code		06H	
Register address	High	00H	
	Low	10H	
Write data	High	00H	
	Low	64H	

Exception response message [Sever]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	03H	
Unit Identifier		00H	
80H + Function code		86H	
Exception code		03H	→ When the data exceeds the setting range

7.4.3 Diagnostics (Loopback test) [08H]

The client's request message will be returned as the response message from the server.
This function checks the communication system between the client and server.

Example: Loopback test

Request message [Client]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	06H	
Unit Identifier		00H	
Function code		08H	
Test code	High	00H	Test code must be set to *00H*
	Low	00H	
Data	High	1FH	Any pertinent data
	Low	34H	

Normal response message [Server]

Transaction Identifier	High	00H	Contents will be the same as request message data
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	06H	
Unit Identifier		00H	
Function code		08H	
Test code	High	00H	
	Low	00H	
Data	High	1FH	
	Low	34H	

Exception response message [Sever]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	03H	
Unit Identifier		00H	
80H + Function code		88H	
Exception code		06H	→ When server is busy

7.4.4 Write multiple registers [10H]

Each data is written to registers in specified quantities starting from the specified register address.
Write data items are arranged in the request message in order starting from the smallest register address number. In addition, each register address is assigned in the order of high-order eight bits and low-order eight bits, respectively.

Example: When 100 (64H) and 30 (1EH) are written to the register 0010H and 0011H (two in total)

Request message [Client]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	0BH	
Unit Identifier		00H	
Function code		10H	
Register address	High	00H	First register address
	Low	10H	
Quantity (Number of words)	High	00H	The setting must be between 1 (0001H) and 123 (007BH).
	Low	02H	
Number of data (byte)		04H	→ Number of registers × 2
Data to first register	High	00H	
	Low	64H	
Data to next register	High	00H	
	Low	1EH	

Normal response message [Server]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	06H	
Unit Identifier		00H	
Function code		10H	
Register address	High	00H	First register address
	Low	10H	
Quantity (Number of words)	High	00H	
	Low	02H	

Exception response message [Sever]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	03H	
Unit Identifier		00H	
80H + Function code		90H	
Exception code		03H	→ When the data exceeds the setting range

7.4.5 Read/write multiple registers [17H]

The contents of consecutive registers in specified quantities are read starting from the specified register address. Each data is written to registers in specified quantities starting from the specified register address.

Example: When data is read from the register 0000H (one in total) and then 100 (64H) and 30 (1EH) are written to the register 0010H and 0011H (two in total)

Request message [Client]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	0FH	
Unit Identifier		00H	
Function code		17H	
Read register address	High	00H	First read register address
	Low	00H	
Read quantity (Number of words)	High	00H	The setting must be between 1 (0001H) and 118 (0076H).
	Low	01H	
Write register address	High	00H	First write register address
	Low	10H	
Write quantity (Number of words)	High	00H	The setting must be between 1 (0001H) and 118 (0076H).
	Low	02H	
Number of write data (byte)		04H	→ Number of write registers × 2
Written data to first register	High	00H	
	Low	64H	
Written data to next register	High	00H	
	Low	1EH	

Normal response message [Server]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	05H	
Unit Identifier		00H	
Function code		17H	
Number of write data (byte)		04H	→ Number of write registers × 2
Read register contents	High	00H	
	Low	78H	

Exception response message [Sever]

Transaction Identifier	High	00H	MBAP Header
	Low	00H	
Protocol Identifier	High	00H	
	Low	00H	
Data Length	High	00H	
	Low	03H	
Unit Identifier		00H	
80H + Function code		97H	
Exception code		03H	→ When the data exceeds the setting range

7.5 Data Configuration

The numeric range of data used in this protocol is 0000H to FFFFH. Only the set value within the setting range is effective.

FFFFH represents –1.

7.5.1 Data processing with decimal points

■ Data without decimal points

Comprehensive event state
Burnout state
Error code
Event 1 state
Event 2 state
Heater break alarm state
Control loop break alarm (LBA) state
Temperature rise completion state
Integral time
Derivative time
Control response parameters
Operation mode
PID/AT transfer
Auto/Manual transfer
Heat-side proportional cycle time
Cool-side proportional cycle time
Digital filter
Number of heater break alarm delay times
Control RUN/STOP transfer
Input error determination point (high)
Input error determination point (low)
AT differential gap time
Event LED mode setting
DI setting
DI state
DO1 setting
DO2 setting
DO state
Event interlock release
Temperature rise completion soak time
TIO state
V-TIO-P/V-TIO-Q module error code
Number of connected TIO modules
Number of connected TIO channels
Initial setting mode
Control loop break alarm (LBA) use selection
Control loop break alarm (LBA) time
Input rang number
Input range decimal point position
Temperature unit selection
Control type selection
Event 1 type selection
Event 2 type selection
Event 1 action selection
Event 2 action selection
Event delay timer
TIO module internal communication Transmission transfer time setting
Operation mode holding setting

Example: When input range number is 18, 18 = 12H

Input range number	High	00H
	Low	12H

■ Data with decimal points

This protocol does not recognize data with decimal points during communication.

Data with one decimal place

Heat-side manipulated output value	Manual output value
Cool-side manipulated output value	Output limiter (high)
Current transformer input measured value	Output limiter (low)
Heater break alarm set value	Manipulated output value at input error

Example: When heater break alarm set value 1 is 20.0 A, 20.0 is processed as 200,
200 = C8H

Heater break alarm set value	High	00H
	Low	C8H

■ Data whose decimal point's presence and/or position depends on input range

The position of the decimal point changes depending on the input range type because this protocol does not recognize data with decimal points during communication.

Type of decimal points position
Temperature input: No decimal place and one decimal place
Voltage/current input: No decimal place, one decimal place, two decimal places, and thee decimal places

Input measured value (PV)	Input error determination point (low)
Set value (SV)	AT bias
Set value monitor	Control loop break alarm (LBA) deadband
Heat-side proportional band	Temperature rise completion range
Cool-side proportional band	Input scale high limit
Overlap/Deadband	Input scale low limit
Setting change rate limiter	ON/OFF control differential gap (upper)
PV bias	ON/OFF control differential gap (lower)
Event 1 set value	Event 1 differential gap
Event 2 set value	Event 2 differential gap
Input error determination point (high)	

Example: When the set value is –20.0 °C, –20.00 is processed as –200,
–200 = 0000H – 00C8H = FF38H

Set value	High	FFH
	Low	38H

7.5.2 Data processing precautions

- With this protocol, the maximum number of channels is 62.
- If data range or address error occurs during data writing, the data written before error is in effect.
- Some communication data may become invalid depending on the module selection or the configuration of the server (SRV).
  Under conditions listed below, no error response message will occur.
  - When ON/OFF control, proportional band, integral time and derivative time are invalid.
  - When current/voltage output, proportioning cycle time are invalid.
  - When only the heater break alarm function is provided, current transformer input measured value, heater break alarm status, heater break alarm set value and number of heater break alarm delay times are valid.
  - When only the control loop break alarm (LBA) function is provided, control loop break alarm (LBA) status, use selection, time and deadband are valid.

Do not write data to any address which is not described in a list of data maps.

7.6 Data Map

For heat/cool control, data in the second channel of temperature control module becomes invalid.

Register address numbers which are not described are those unused.

7.6.1 Normal setting data items

RO: Read only R/W: Read and Write

Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
Measured value (PV)	0000 : 003D	0 : 61	62	RO	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	—	57
Comprehensive event state	0040 : 007D	64 : 125	62	RO	Bit data b0: Burnout b1: Event 1 state b2: Event 2 state b3: Heater break alarm (HBA) state b4: Control loop break alarm (LBA) state b5 to b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 31]	—	57
Heat-side manipulated output value	0080 : 00BD	128 : 189	62	RO	–5.0 to +105.0 %	—	58
Set value monitor	00C0 : 00FD	192 : 253	62	RO	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	—	58

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Name	Register address		No. of data	Attri-bute	Data range	Factory set value	Refer-ence page
	HEX	DEC					
Error code (Data of each module)	0100 : 011E	256 : 286	31	RO	Bit data b0: Memory backup error b1: Unused b2: Internal communication error b3: Adjustment data error b4: Input error b5: Current transformer (CT) input error b6: Temperature compensation error b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 127]	—	59
Cool-side manipulated output value	0140 : 017D	320 : 381	62	RO	–5.0 to +105.0 %	—	58
Current transformer (CT) input value	0180 : 01BD	384 : 445	62	RO	0.0 to 30.0 A or 0.0 to 100.0 A	—	59
Burnout state	0200 : 023D	512 : 573	62	RO	0: OFF 1: ON	—	59
Event 1 state	0240 : 027D	576 : 637	62	RO	0: OFF 1: ON	—	60
Event 2 state	0280 : 02BD	640 : 701	62	RO	0: OFF 1: ON	—	60
Heater break alarm (HBA) state	02C0 : 02FD	704 : 765	62	RO	0: OFF 1: Heater break 2: Relay welding	—	60
Control loop break alarm (LBA) state	0300 : 033D	768 : 829	62	RO	0: OFF 1: ON	—	61
Temperature rise completion state	0340 : 037D	832 : 893	62	RO	0: Temperature rise not complete 1: Temperature rise completion	—	61
Operation mode	03C0 : 03FD	960 : 1021	62	R/W	0: Unused 1: Monitor 1 2: Monitor 2 3: Control	3	62

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Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
Set value (SV)	0400 ⋮ 043D	1024 ⋮ 1085	62	R/W	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	0 (0.0)	62
Heat-side proportional band	0440 ⋮ 047D	1088 ⋮ 1149	62	R/W	TC/RTD input: 0 (0.0) to Input span Voltage (V)/Current (I) input: 0.0 to 100.0 % of input span 0 (0.0): ON/OFF action	TC/RTD: 30 °C (30.0 °C) or 30 °F (30.0 °F) V/I: 30.0 % of input span	63
Integral time	0480 ⋮ 04BD	1152 ⋮ 1213	62	R/W	1 to 3600 seconds	240	64
Derivative time	04C0 ⋮ 04FD	1216 ⋮ 1277	62	R/W	0 to 3600 seconds 0: Derivative action OFF (PI action)	60	64
Control response parameters	0500 ⋮ 053D	1280 ⋮ 1341	62	R/W	0: Slow 1: Medium 2: Fast	0	65
PV bias	0540 ⋮ 057D	1344 ⋮ 1405	62	R/W	–Input span to +Input span	0	65
Event 1 set value	0580 ⋮ 05BD	1408 ⋮ 1469	62	R/W	Deviation high/Deviation low: –Input span to +Input span Deviation high/low, Band: 0 (0.0) to Input span Process high/Process low: TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	0	66
Event 2 set value	05C0 ⋮ 05FD	1472 ⋮ 1533	62	R/W		0	66

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Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
Cool-side proportional band	0700 : 073D	1792 : 1853	62	R/W	TC/RTD input: 1 (0.1) to Input span Voltage (V)/Current (I) input: 0.1 to 100.0 % of input span	TC/RTD: 30 °C (30.0 °C) or 30 °F (30.0 °F) V/I: 30.0 % of input span	63
Overlap/Deadband	0780 : 07BD	1920 : 1981	62	R/W	–Input span to +Input span	0 (0.0)	66
Setting change rate limiter	07C0 : 07FD	1984 : 2045	62	R/W	0 (0.0) to Input span/minute 0 (0.0): Setting change rate limiter OFF	0 (0.0)	67
PID/AT transfer	0800 : 083D	2048 : 2109	62	R/W	0: PID control operation 1: AT (Autotuning) operation	0	68
Auto/Manual transfer	0840 : 087D	2112 : 2173	62	R/W	0: Auto mode 1: Manual mode	0	69
Manual output value	0880 : 08BD	2176 : 2237	62	R/W	–5.0 to +105.0 %	0.0	69
Output limiter (high)	08C0 : 08FD	2240 : 2301	62	R/W	Output limiter (low) to 105.0 %	100.0	69
Output limiter (low)	0900 : 093D	2304 : 2365	62	R/W	–5.0 % to Output limiter (high)	0.0	69
Heat-side proportional cycle time	0940 : 097D	2368 : 2429	62	R/W	1 to 100 seconds	Relay contact output: 20 Voltage pulse output: 2	70
Cool-side proportional cycle time	0980 : 09BD	2432 : 2493	62	R/W	1 to 100 seconds		70
Digital filter	09C0 : 09FD	2496 : 2557	62	R/W	0 to 100 seconds 0: Digital filter OFF	0	70
Heater break alarm (HBA) set value	0A00 : 0A3D	2560 : 2621	62	R/W	0.0 to 30.0 A or 0.0 to 100.0 A	0.0	71

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Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
Number of heater break alarm (HBA) delay times	0A40 : 0A7D	2624 : 2685	62	R/W	1 to 255 times	5	72
Control RUN/STOP transfer (Data of each module)	0C00 : 0C1E	3072 : 3102	31	R/W	0: Control STOP 1: Control RUN	0	73
Input error determination point (high)	0C40 : 0C7D	3136 : 3197	62	R/W	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	TC/RTD: Input range high limit V/I: Input scale high limit	73
Input error determination point (low)	0C80 : 0CBD	3200 : 3261	62	R/W	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	TC/RTD: Input range low limit V/I: Input scale low limit	73
Action at input error (high)	0CC0 : 0CFD	3264 : 3325	62	R/W	0: Normal control 1: Manipulated output value at input error	0	74
Action at input error (low)	0D00 : 0D3D	3328 : 3389	62	R/W	0: Normal control 1: Manipulated output value at input error	0	74
Manipulated output value at input error	0D40 : 0D7D	3392 : 3453	62	R/W	–105.0 to +105.0 %	0.0	74
AT differential gap time	0D80 : 0DBD	3456 : 3517	62	R/W	0 to 100 seconds	1	75
AT bias	0E00 : 0E3D	3584 : 3645	62	R/W	–Input span to +Input span	0 (0.0)	76
Event LED mode setting (Data of each module)	0F00 : 0F1E	3840 : 3870	31	R/W	1: Mode 1 2: Mode 2 3: Mode 3 Except the above (within 0 to 255): Unused	0	76

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Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
DI setting (Data of each module)	0F40 : 0F5E	3904 : 3934	31	R/W	1: Control RUN/STOP 2: Event interlock release Except the above (within 0 to 20): Unused	Specify when ordering	77
DI state (Data of each module)	0F80 : 0F9E	3968 : 3998	31	RO	0: Contact open (OFF) 1: Contact close (ON)	—	77
DO1 setting (Data of each module)	0FC0 : 0FDE	4032 : 4062	31	R/W	1: CH1 Event 1 state 2: CH2 Event 1 state 3: CH1 Event 2 state 4: CH2 Event 2 state 5: CH1 Heater break alarm state 6: CH2 Heater break alarm state 7: CH1 Control loop break alarm state	Specify when ordering	78
DO2 setting (Data of each module)	1000 : 101E	4096 : 4126	31	R/W	8: CH2 Control loop break alarm state 9: CH1 Burnout state 10: CH2 Burnout state 11: CH1 Temperature rise completion 12: CH2 Temperature rise completion Except the above (within 0 to 20): Unused	Specify when ordering	78
DO state (Data of each module)	1040 : 105E	4160 : 4190	31	R/W	0: DO1: Contact open (OFF) DO2: Contact open (OFF) 1: DO1: Contact close (ON) DO2: Contact open (OFF) 2: DO1: Contact open (OFF) DO2: Contact close (ON) 3: DO1: Contact close (ON) DO2: Contact close (ON)	0	78

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Name	Register address		No. of data	Attri-bute	Data range	Factory set value	Refer-ence page
	HEX	DEC					
Event interlock release (Data of each module)	1080 ⋮ 109E	4224 ⋮ 4254	31	R/W	0: Normal state 1: Event interlock release execution	0	79
Temperature rise completion zone	10C0 ⋮ 10FD	4288 ⋮ 4349	62	R/W	0 (0.0) to Input span 0 (0.0): Unused	0 (0.0)	80
Temperature rise completion soak time	1100 ⋮ 113D	4352 ⋮ 4413	62	R/W	0 to 360 minutes	0	81
TIO state	7600 ⋮ 763D	30208 ⋮ 30296	62	RO	Bit data b0: Burnout b1: Event 1 state b2: Event 2 state b3: Heater break alarm (HBA) state b4: Control loop break alarm (LBA) state b5: Unused b6: Unused b7: Unused b8: DI state b9: DO1 state b10: DO2 state b11: Temperature rise completion state b12: Control RUN/STOP state b13: Module error b14: Setting error b15: Error code Data 0: OFF 1: ON [Decimal numbers expression: 0 to 65535]	—	82
V-TIO-P/V-TIO-Q module error code (Data of each unit)	7D08	32008	1	RO	Bit data b0: Memory backup error b1: Unused b2: Module configuration error b3 to b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 7]	—	84

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Name	Register address		No. of data	Attri-bute	Data range	Factory set value	Refer-ence page
	HEX	DEC					
Number of connected TIO modules (Data of each unit)	7D0A	32010	1	RO	0 to 31	—	84
Number of connected TIO channels (Data of each unit)	7D0B	32011	1	RO	0 to 62 CH	—	84
Initial setting mode (Data of each unit)	7D20	32032	1	R/W	0: Normal setting mode 1: Initial setting mode	0	85

7.6.2 Initial setting data items

⚠ WARNING

The Initial setting data should be set according to the application before setting any parameter related to operation. Once the Initial setting data is set correctly, those data is not necessary to be changed for the same application under normal conditions. If they are changed unnecessarily, it may result in malfunction or failure of the instrument. RKC will not bear any responsibility for malfunction or failure as a result of improper changes in the Initial setting.

- **Transfer to initial setting mode.**

Transfer to initial setting mode sets in "1" with register address 7D20H (normally setting mode).

📖 **The instrument cannot be changed to the initial setting mode state at control start (during control). If it needs to be changed to the above state, first stop the control by "Control RUN/STOP transfer."**

📖 **No control can be started during initial setting mode. If the control needs to be re-started, first change the instrument the normal setting mode state (set register address 7D20H by 0).**

Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
Control loop break alarm (LBA) use selection	6A40 : 6A7D	27200 : 27261	62	R/W	0: Unused 1: Used	0	86
Control loop break alarm (LBA) time	6A80 : 6ABD	27264 : 27325	62	R/W	1 to 7200 seconds	480	87
Control loop break alarm (LBA) deadband	6AC0 : 6AFD	27328 : 27389	62	R/W	0 (0.0) to Input span	0 (0.0)	88
Input range number *	7000 : 703D	28672 : 28733	62	R/W	TC input 0: K −200 to +1372 °C −328 to +2501 °F 1: K 0 to 800 °C 32 to 1472 °F 2: K 0 to 400 °C 32 to 752 °F 3: K −200.0 to +400.0 °C −328.0 to +752.0 °F	Specify when ordering	89

* These items become valid by turning off the power of the V-TIO-P/V-TIO-Q module once, and then turning it on again after the settings are changed.

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Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
Input range number *	7000 ⋮ 703D	28672 ⋮ 28733	62	R/W	TC input 4: K 0.0 to 400.0 °C 32.0 to 752.0 °F 5: J −200 to +1200 °C −328 to +2192 °F 6: J 0 to 800 °C 32 to 1472 °F 7: J 0 to 400 °C 32 to 752 °F 8: J −200.0 to +400.0 °C −328.0 to +752.0 °F 9: J 0.0 to 400.0 °C 32.0 to 752.0 °F 10: T −200 to +400 °C −328 to +752 °F 11: T 0 to 400 °C 32 to 752 °F 12: T 0 to 200 °C 32 to 392 °F 13: T −200.0 to +400.0 °C −328.0 to +752.0 °F 14: T 0.0 to 400.0 °C 32.0 to 752.0 °F 15: S 0 to 1768 °C 32 to 3214 °F 16: R 0 to 1768 °C 32 to 3214 °F 17: PLII 0 to 1390 °C 32 to 2534 °F 18: N 0 to 1300 °C 32 to 2372 °F 19: W5Re/W26Re 0 to 2300 °C 32 to 4172 °F 20: E 0 to 1000 °C 32 to 1832 °F 21: E 0 to 800 °C 32 to 1472 °F 22: B 0 to 1800 °C 32 to 3272 °F RTD input: 23: Pt100: 0 to 850 °C 32 to 1562 °F 24: Pt100: 0 to 400 °C 32 to 752 °F	Specify when ordering	89

* These items become valid by turning off the power of the V-TIO-P/V-TIO-Q module once, and then turning it on again after the settings are changed.

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Name	Register address		No. of data	Attribute	Data range	Factory set value	Reference page
	HEX	DEC					
Input range number *	7000 ⋮ 703D	28672 ⋮ 28733	62	R/W	RTD input: 25: Pt100: −200.0 to +400.0 °C −328.0 to +752.0 °F 26: Pt100: 0.0 to 400.0 °C 32.0 to 752.0 °F 27: JPt100: 0 to 600 °C 32 to 1112 °F 28: JPt100: 0 to 400 °C 32 to 752 °F 29: JPt100: −200.0 to +400.0 °C −328.0 to +752.0 °F 30: JPt100: 0.0 to 400.0 °C 32.0 to 752.0 °F Voltage/Current input: 31: 0 to 100 mV DC 32: Unused 33: 0 to 5 V DC 34: 1 to 5 V DC 35: 0 to 10 V DC 36: 0 to 20 mA DC 37: 4 to 20 mA DC	Specify when ordering	89
Input scale high limit *	7040 ⋮ 707D	28736 ⋮ 28797	62	R/W	Input scale low limit to 10000 (Valid only for voltage/current input)	100.0	90
Input scale low limit *	7080 ⋮ 70BD	28800 ⋮ 28861	62	R/W	−2000 to Input scale high limit (Valid only for voltage/current input)	0.0	90
Input range decimal point position *	70C0 ⋮ 70FD	28864 ⋮ 28925	62	R/W	0: No decimal place 1: One decimal place 2: Two decimal places 3: Three decimal places (Valid only for voltage/current input)	1	90
Temperature unit selection	7100 ⋮ 713D	28928 ⋮ 28989	62	R/W	0: °C 1: °F	0	91

* These items become valid by turning off the power of the V-TIO-P/V-TIO-Q module once, and then turning it on again after the settings are changed.

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Name	Register address HEX	Register address DEC	No. of data	Attribute	Data range	Factory set value	Reference page
Control type selection	7140 : 717D	28992 : 29053	62	R/W	0: Heat control: direct action 1: Heat control: reverse action 2: Heat/cool control: water cooling 3: Heat/cool control: air cooling	Specify when ordering	91
ON/OFF control differential gap (upper)	7180 : 71BD	29056 : 29117	62	R/W	0 to Input span	TC/RTD: 1.0 °C or 1.0 °F	92
ON/OFF control differential gap (lower)	71C0 : 71FD	29120 : 29181	62	R/W		V/I: 0.1 % of input span	92
Event 1 differential gap	7200 : 723D	29184 : 29245	62	R/W	0 to Input span	TC/RTD: 2.0 °C or 2.0 °F	93
Event 2 differential gap	7240 : 727D	29248 : 29309	62	R/W		V/I: 0.2 % of input span	93
Event 1 type selection	7280 : 72BD	29312 : 29373	62	R/W	0: Not provided 1: Process high 2: Process low 3: Deviation high 4: Deviation low 5: Deviation high/low 6: Band	Specify when ordering	94
Event 2 type selection	72C0 : 72FD	29376 : 29437	62	R/W		Specify when ordering	94
Event 1 action selection	7300 : 733D	29440 : 29501	62	R/W	Bit data b0: Hold action b1: Re-hold action b2: Interlock action b3: Event action at input error b4: Hold action at control start b5 to b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 31]	b0 to b2: Specify when ordering b3 to b7: 0	96
Event 2 action selection	7340 : 737D	29504 : 29565	62	R/W		b0 to b2: Specify when ordering b3 to b7: 0	96

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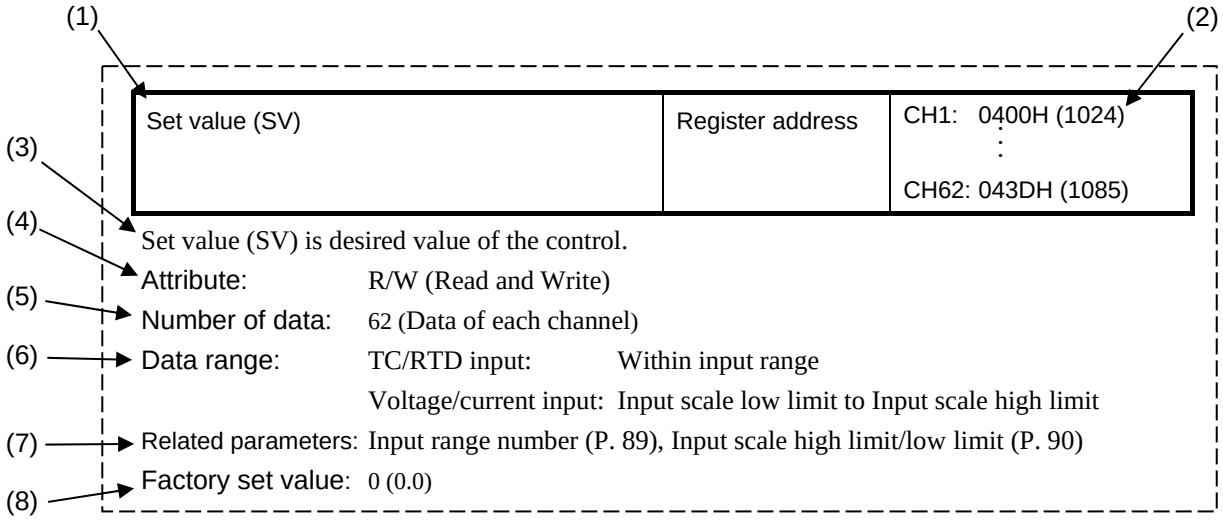
Name	Register address		No. of data	Attri-bute	Data range	Factory set value	Refer-ence page
	HEX	DEC					
Event delay timer	7380 ⋮ 73BD	29568 ⋮ 29629	62	R/W	0 to 9999 seconds	0	98
TIO module internal communication Transmission transfer time setting (Data of each module)	73C0 ⋮ 73DE	29632 ⋮ 29662	31	R/W	0 to 100 ms	6	98
Operation mode holding setting (Data of each module)	7440 ⋮ 745E	29760 ⋮ 29790	31	R/W	0: Not hold 1: Hold	1	98

8. COMMUNICATION DATA DESCRIPTION

■ Reference to communication data contents



(1) Name: Communication data name is written.

(2) Register address: Communication data register addresses are written.
These register addresses are written using both of hexadecimal and decimal (in parentheses) numbers.

(3) Description: A short description of the communication data item is written.

(4) Attribute: A method of how communication data items are read or written when viewed from the client is described.

RO: Only reading data is possible.

Data direction
Client ← Server (SRV)

R/W: Reading and writing data is possible.

Data direction
Client ↔ Server (SRV)

(5) Number of data: The number of data points is written.
Number of each channel data: 62
Number of each module data: 31
Number of the unit data: 1

(6) Data range: The reading range or the writing range of communication data is written.

(7) Related parameters: A name and a page of relational items are written.

(8) Factory set value: The factory set value of communication data is written.

📖 There is item including the functional description.

8.1 Normal Setting Data Items

Measured value (PV)	Register address	CH1: 0000H (0) ⋮ CH62: 003DH (61)

Measured value (PV) is the input value of SRV. There are thermocouple input, resistance temperature detector input, voltage input and current input.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: TC/RTD input: Within input range
Voltage/currentinput: Input scale low limit to Input scale high limit
Factory set value: —

Comprehensive event state	Register address	CH1: 0040H (64) ⋮ CH62: 007DH (125)

Each event state such as burnout, heater break alarm or control loop break alarm is expressed in bit data items.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: 0 to 31 (bit data)
Each event state is assigned as a bit image in binary numbers.
However, send data from the SRV be changed to decimal ASCII code from the bit image in binary numbers for RKC communication.

Bit image: 00000
bit 4 ····· bit 0

Bit data: 0: OFF 1: ON

bit 0: Burnout
bit 1: Event 1 state
bit 2: Event 2 state
bit 3: Heater break alarm (HBA) state
bit 4: Control loop break alarm (LBA) state

Related parameters: Event LED mode setting (P. 76)
Factory set value: —

Heat-side manipulated output value	Register address	CH1: 0080H (128) ⋮ CH62: 00BDH (189)
Cool-side manipulated output value	Register address	CH1: 0140H (320) ⋮ CH62: 017DH (381)

Heat-side manipulated output value and cool-side manipulated output value are the output value of SRV.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: –5.0 to +105.0 %
Related parameters: Manual output value (P. 69), Output limiter (high/low) (P. 69), Event LED mode setting (P. 76)
Factory set value: —

📖 The manipulated output value on the cool-side is valid only during heat/cool control.

📖 Only odd channels are valid when in heat/cool control.

Set value monitor	Register address	CH1: 00C0H (192) ⋮ CH62: 00FDH (253)

This item is monitor of the set value (SV) which is the desired value for control.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: TC/RTD input: Within input range
Voltage/currentinput: Input scale low limit to Input scale high limit
Factory set value: —

Error code	Register address	Module 1: 00C0H (192) : Module 31: 00FDH (253)

Error state of TIO module is expressed as a bit image in decimal number.

Attribute: RO (Read only)
Number of data: 31 (Data of each module)
Data range: 0 to 127 (bit data)
Each error state is assigned as a bit image in binary numbers.

Bit image: 00000000
bit 7 ····· bit 0

Bit data: 0: OFF 1: ON

bit 0: Memory backup error
bit 1: Unused
bit 2: Internal communication error
bit 3: Adjustment data error
bit 4: Input A/D error
bit 5: Current transformer (CT) input A/D error
bit 6: Temperature compensation A/D error
bit 7: Unused

Factory set value: —

Current transformer (CT) input value	Register address	CH1: 0180H (384) : CH62: 01BDH (445)

This item is current transformer (CT) input value to use by a heater break alarm (HBA) function.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: 0.0 to 30.0 A (CT type: CTL-6-P-N)
0.0 to 100.0 A (CT type: CTL-12-S56-10L-N)
Related parameters: Heater break alarm (HBA) state (P. 60),
Heater break alarm (HBA) set value (P. 71),
Number of heater break alarm (HBA) delay times (P. 72)
Factory set value: —

Burnout state	Register address	CH1: 0200H (512) : CH62: 023DH (573)

Monitor a state in input break.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: 0: OFF
1: ON
Factory set value: —

Event 1 state	Register address	CH1: 0240H (576) ⋮ CH62: 027DH (637)
Event 2 state	Register address	CH1: 0280H (640) ⋮ CH62: 02BDH (701)

Monitor an ON/OFF state of the event.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: 0: OFF
1: ON
Related parameters: Event set value (P. 66), Event LED mode setting (P. 76),
Event differential gap (P. 93), Event type selection (P. 94),
Event action selection (P. 96), Event delay timer (P. 98)
Factory set value: —

Heater break alarm (HBA) state	Register address	CH1: 02C0H (704) ⋮ CH62: 02FDH (765)

Monitor a state of heater break alarm.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: 0: OFF
1: Heater break
2: Relay welding
Related parameters: Current transformer (CT) input value (P. 59),
Heater break alarm (HBA) set value (P. 71),
Number of heater break alarm (HBA) delay times (P. 72)
Factory set value: —

Heater break alarm function can not be used when control output is voltage/current output.

Control loop break alarm (LBA) state	Register address	CH1: 0300H (768) : CH62: 033DH (829)

Load (heater) break, faulty external actuaters (electromagnetic relays, etc.) or failure in control system (control loop) caused by input (sensor) break is indicated by the output state or control loop break alarm (LBA) time.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: 0: OFF
1: ON
Related parameters: Control loop break alarm (LBA) use selection (P. 86),
Control loop break alarm (LBA) time (P. 87),
Control loop break alarm (LBA) deadband (P. 88)
Factory set value: —

Temperature rise completion state	Register address	CH1: 0340H (832) : CH62: 037DH (893)

Monitor a state of temperature rise completion state.

Attribute: RO (Read only)
Number of data: 62 (Data of each channel)
Data range: 0: Temperature rise not complete
1: Temperature rise completion
Related parameters: Temperature rise completion zone (P. 80),
Temperature rise completion soak time (P. 81)
Factory set value: 0

- A temperature rise is complete just when the temperature rise completion soak time elapses after the measured value (PV) enters the temperature rise completion zone.
- Any channel which does not use temperature rise completion completes its temperature rise just when started.
- In order to cancel the temperature rise completion state, set “Control RUN/STOP transfer” to “STOP” or turn the power off.

Operation mode	Register address	CH1: 03C0H (960) : CH62: 03FDH (1021)

Use to selects Unused, Monitor or Control for each channel.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: Unused: Execute neither monitor nor the control
1: Monitor 1: Execute only data monitor
2: Monitor 2: Execute data monitor and an event action (include HBA and LBA)
3: Control: Execute the control
Related parameters: Event LED mode setting (P. 76), Operation mode holding setting (P. 98)
Factory set value: Heat control CH1 3: Control
CH2 3: Control
Heat/cool control CH1 3: Control
CH2 0: Unused

Set value (SV)	Register address	CH1: 0400H (1024) : CH62: 043DH (1085)

Set value (SV) is desired value of the control.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: TC/RTD input: Within input range
Voltage/current input: Input scale low limit to Input scale high limit
Related parameters: Input range number (P. 89), Input scale high limit/low limit (P. 90)
Factory set value: 0 (0.0)

Heat-side proportional band	Register address	CH1: 0440H (1088) : CH62: 047DH (1149)
Cool-side proportional band	Register address	CH1: 0700H (1792) : CH62: 073DH (1853)

Use to set the proportional band of the PI and PID control.

Attribute: R/W (Read and Write)

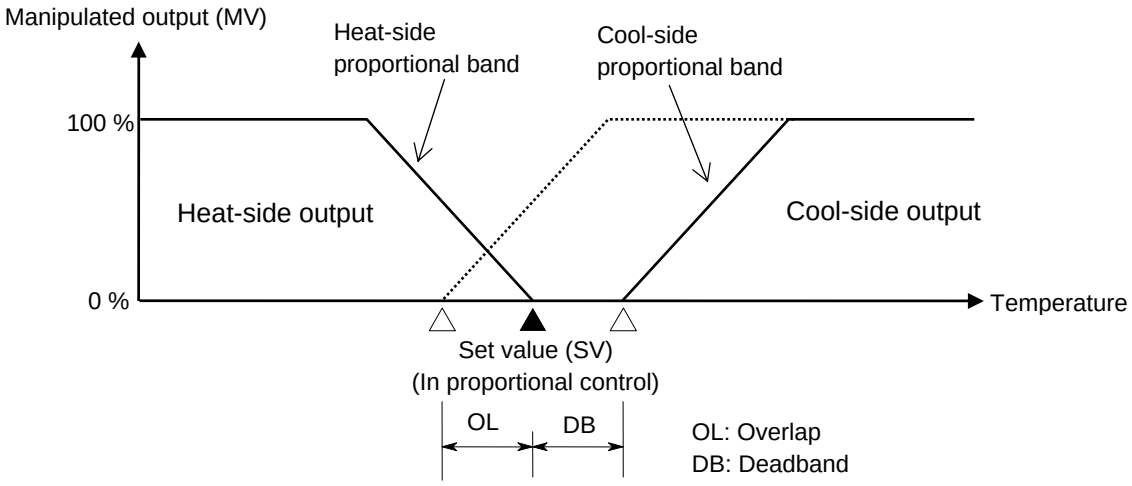
Number of data: 62 (Data of each channel)

Data range:
- Heat-side proportional band
  - TC/RTD input: 0 (0.0) to Input span
  - Voltage/current input: 0.0 to 100.0 % of input span
  - 0 (0.0): ON/OFF action
- Cool-side proportional band
  - TC/RTD input: 1 (0.1) to Input span
  - Voltage/current input: 0.1 to 100.0 % of input span

Related parameters: Overlap/Deadband (P. 66), ON/OFF control differential gap (upper/lower) (P. 92)

Factory set value: TC/RTD input: 30 °C (30.0 °C)
Voltage/current input: 30.0 % of input span

Function: In heat/cool control, only one module enables heat and cool control. For example, this is effective when cool control is required in extruder cylinder temperature control.



The proportional band on the cool-side is valid only during heat/cool control.

Only odd channels are valid when in heat/cool control.

Integral time	Register address	CH1: 0480H (1152) ⋮ CH62: 04BDH (1213)

Integral action is to eliminate offset between set value (SV) and measured value (PV) by proportional action. The degree of Integral action is set by time in seconds.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 1 to 3600 seconds
Factory set value: 240

Derivative time	Register address	CH1: 04C0H (1216) ⋮ CH62: 04FDH (1277)

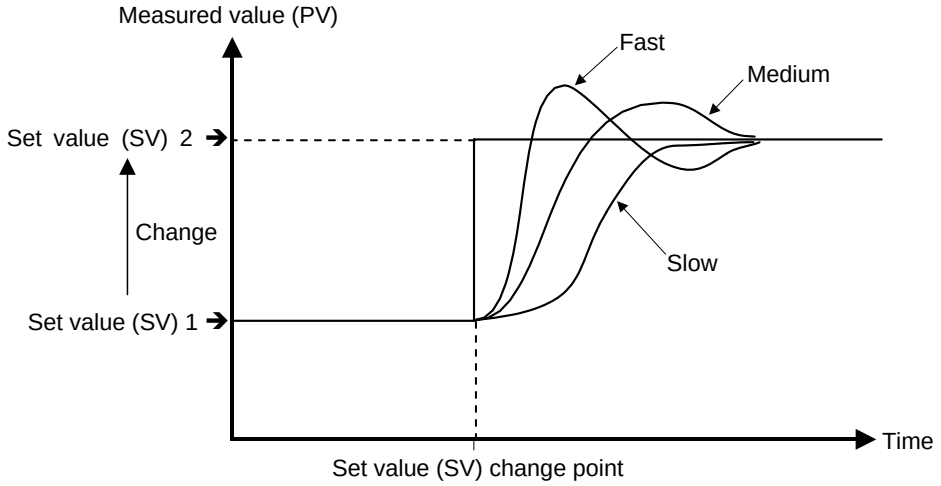
Derivative action is to prevent rippling and make control stable by monitoring output change. The degree of Derivative action is set by time in seconds.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to 3600 seconds
0: Derivative action OFF (PI action)
Factory set value: 60

Control response parameters	Register address	CH1: 0500H (1280) ⋮ CH62: 053DH (1341)

The control response for the set value (SV) change can be selected among Slow, Medium, and Fast.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: Slow
1: Medium
2: Fast
Factory set value: 0: Slow
Function: The control response for the set value (SV) change can be selected among **Slow**, **Medium**, and **Fast**. If a fast response is required, Fast is chosen. Fast may cause overshoot. If overshoot is critical, Slow is chosen.



PV bias	Register address	CH1: 0540H (1344) ⋮ CH62: 057DH (1405)

PV bias adds bias to the measured value (PV). The PV bias is used to compensate the individual variations of the sensors or correct the difference between the measured value (PV) of other instruments.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: −Input span to +Input span
Factory set value: 0 (0.0)

Event 1 set value	Register address	CH1: 0580H (1408) ⋮ CH62: 05BDH (1469)
Event 2 set value	Register address	CH1: 05C0H (1472) ⋮ CH62: 05FDH (1533)

Use to set setting value of an event action.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: Deviation high/Deviation low: –Input span to +Input span
Deviation high/low, Band: 0 (0.0) to Input span
Process high/Process low: TC/RTD input: Within input range
Voltage/current input: Input scale low limit to Input scale high limit
Related parameters: Event state (P. 60), Event differential gap (P. 93), Event type selection (P. 94), Event action selection (P. 96), Event delay timer (P. 98)
Factory set value: 0 (0.0)

Overlap/Deadband	Register address	CH1: 0780H (1920) ⋮ CH62: 07BDH (1981)

Deadband: Control deadband between heat-side and cool-side proportional bands.
Minus (–) setting results in overlap.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: –Input span to +Input span
Related parameters: Heat-side proportional band/Cool-side proportional band (P. 63)
Factory set value: 0 (0.0)

Setting change rate limiter	Register address	CH1: 07C0H (1984) : CH62: 07FDH (2045)

This function is to allow the set value (SV) to be automatically changed at specific rates when a new set value (SV).

Attribute: R/W (Read and Write)

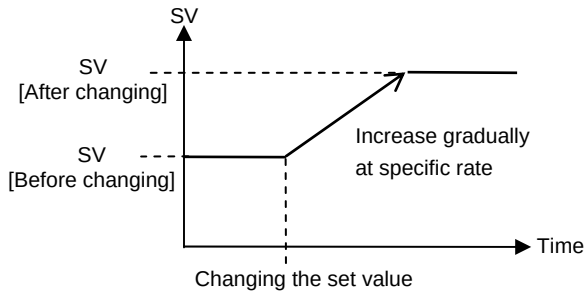
Number of data: 62 (Data of each channel)

Data range: 0 (0.0) to Input span/minute
0 (0.0): Setting change rate limiter OFF

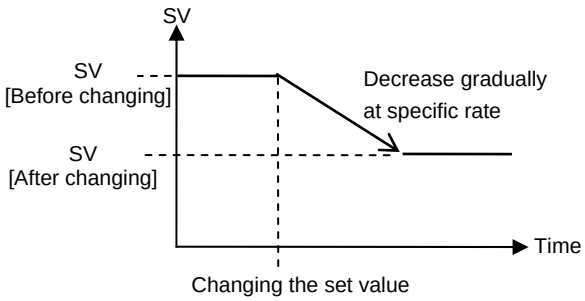
Factory set value: 0 (0.0)

Function: **Application examples of setting change rate limiter:**

● **Increasing the SV to a higher value**



● **Decreasing the SV to a lower value**



When the setting change rate limiter is used, the SV will also ramp up or ramp down by the function at power-on and operation mode change from STOP to RUN.

If the autotuning (AT) function is activated while the SV is ramping up or ramping down by the setting change rate limiter, AT will starts after the SV finishes ramp-up or ramp-down by the limiter, and the controller is in PID control mode until AT starts.

If the rate of setting change limiter is set to any value other than “0.0: OFF (Unused),” the event re-hold action to be taken by a set value (SV) change becomes invalid.

PID/AT transfer	Register address	CH1: 0800H (2048) : CH62: 083DH (2109)

Use to transfers PID control and autotuning (AT).

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: PID control operation
1: AT (Autotuning) operation
Related parameters: AT differential gap time (P. 75), AT bias (P. 76)
Factory set value: 0: PID control operation
Function: Autotuning (AT) function automatically measures, calculates and sets the optimum PID constants. The followings are the conditions necessary to carry out autotuning and the conditions which will cause the autotuning to stop.

Requirements for AT start

Start the autotuning when all following conditions are satisfied:

- Operation mode conditions are as follows:
  – Auto/Manual transfer → Auto mode
  – PID/AT transfer → PID control mode
  – Control RUN/STOP transfer → Control RUN mode
- The measured value (PV) is without input error range [Input error determination point (high) > Measured value (PV) > Input error determination point (low)].
- The output limiter high limit is 0.1 % higher and the output limiter low limit is 99.9 % or less.
- When operation mode is set to “Control.”

When the autotuning is finished, the controller will automatically returns to “0: PID control operation.”

AT cancellation

The autotuning is canceled if any of the following conditions exist:

- When the temperature set value (SV) is changed.
- When the PV bias value is changed.
- When the AT bias value is changed.
- When the Auto/Manual mode is changed to the Manual mode.
- When the measured value (PV) goes to input error range [Measured value (PV) ≥ Input error determination point (high) or Input error determination point (low) ≥ Measured value (PV)].
- When the power is turned off.
- When the module is in the FAIL state.
- When the PID/AT transfer is changed to the PID control.
- When operation mode is set to “Unused,” “Monitor 1” or “Monitor 2.”
- When the Control RUN/STOP function is changed to the “Control STOP.”

If the AT is canceled, the controller immediately changes to PID control. The PID values will be the same as before AT was activated.

Caution for using the Autotuning (AT)
When a temperature change (UP and/or Down) is 1 °C (1 °F) or less per minute during Autotuning, Autotuning may be cancelled before calculating PID values. In that case, adjust the PID values manually. It is possible to happen when the set value is around the ambient temperature or is close to the maximum temperature achieved by the load.

When control loop break alarm (LBA) is used, control loop break alarm (LBA) time is automatically calculated by AT. However, the calculated data becomes valid by changing to the initial setting mode once after AT is executed.

Auto/Manual transfer	Register address	CH1: 0840H (2112) ⋮ CH62: 087DH (2173)

Use to transfers the automatic (AUTO) control and the manual (MAN) control.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: Auto mode
1: Manual mode
Factory set value: 0: Auto mode

No manual mode can be set for heat/cool control.

Manual output value	Register address	CH1: 0880H (2176) ⋮ CH62: 08BDH (2237)

Use to set the output value in the manual control.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: –5.0 to +105.0 %
(However, the actual output value is within output limiter range.)
Related parameters: Output limiter (high/low) (P. 69)
Factory set value: 0.0

Manual output value cannot be output in heat/cool control.

Output limiter (high)	Register address	CH1: 08C0H (2240) ⋮ CH62: 08FDH (2301)
Output limiter (low)	Register address	CH1: 0900H (2304) ⋮ CH62: 093DH (2365)

Use to set the high limit value (or low limit value) of manipulated output.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: [Heat control] Output limiter (high): Output limiter (low) to 105.0 %
Output limiter (low): –5.0 % to Output limiter (high)
[Heat/cool control] Heat-side output limiter (high): –5.0 to +105.0 %
Cool-side output limiter (high): –5.0 to +105.0 %
Output limiter (low) (For both control heat and cool): –5.0 % (fixed)
Related parameters: Manipulated output value (P. 58)
Factory set value: Output limiter (high): 100.0
Output limiter (low): 0.0

For the heat/cool control, the cool-side output limiter (high) is set by using the identifier or register address of the output limiter (low).

Heat-side proportional cycle time	Register address	CH1: 0940H (2368) ⋮ CH62: 097DH (2429)
Cool-side proportional cycle time	Register address	CH1: 0980H (2432) ⋮ CH62: 09BDH (2493)

Proportional cycle time is to set control cycle time for time based control output such as voltage pulse output and relay contact output.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 1 to 100 seconds
Factory set value: Relay contact output: 20
Voltage pulse output: 2

 The invalidity in case of the voltage/current outputs.

 The cool-side proportional cycle time is valid only during heat/cool control.

Digital filter	Register address	CH1: 09C0H (2496) ⋮ CH62: 09FDH (2557)

This item is the time of the first-order lag to eliminate noise against the measured input.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to 100 seconds
0: Digital filter OFF
Factory set value: 0

Heater break alarm (HBA) set value	Register address	CH1: 0A00H (2560) ⋮ CH62: 0A3DH (2621)

This item is setting value of heater break alarm (HBA). HBA set value is set by referring to current transformer (CT) input value.

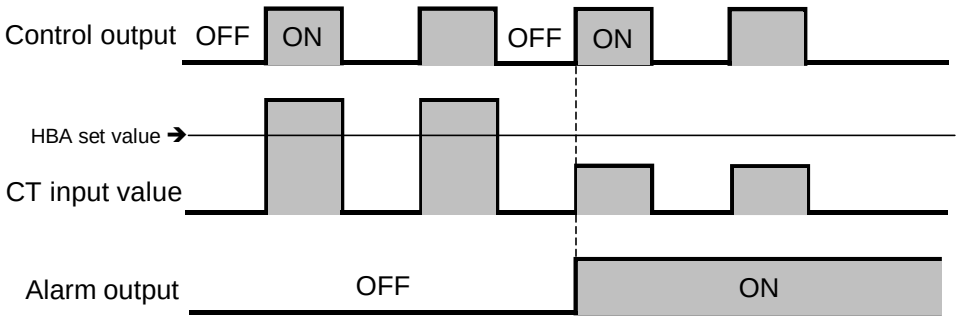
Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0.0 to 30.0 A (CT type: CTL-6-P-N)
0.0 to 100.0 A (CT type: CTL-12-S56-10L-N)

Set HBA set value to a value about 85 % of current transformer (CT) input value. However, when power supply variations are large, set the HBA set value to a slightly smaller value. In addition, when two or more heaters are connected in parallel, set the HBA set value to a slightly larger value so that it is activated even with only one heater is broken (However, within the CT input value).

Related parameters: Current transformer (CT) input value (P. 59),
Heater break alarm (HBA) state (P. 60),
Number of heater break alarm (HBA) delay times (P. 72)
Factory set value: 0.0
Function: The heater break alarm (HBA) function detects a fault in the heating or cooling circuit and displays actual amperage on the display by monitoring the current draw of the load by the current transformer (CT).

- **When no heater current flows:** Heater break or faulty operating unit, etc.

  When the control output is on and the CT input value is equal to or less than the HBA set value, an alarm status is produced. However, heater break alarm does not action when control output ON time is 0.1 second or less.



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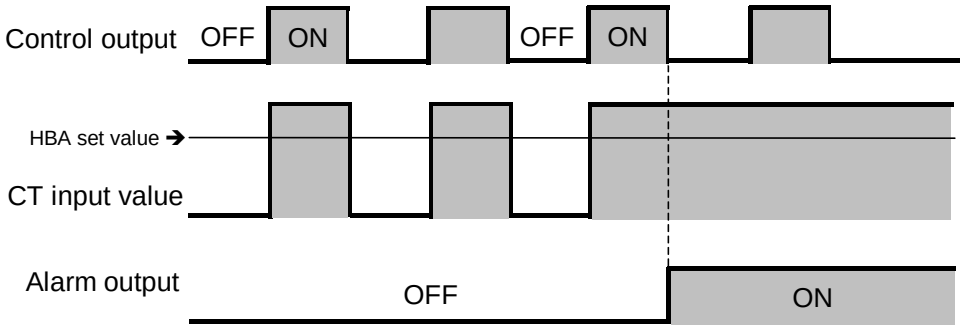
- **When the heater current can not be turned off:** Welded realy contact, etc.
  When the control output is off and the CT input value is equal to greater than the HBA set value, an alarm status is produced. However, heater break alarm does not action when control output OFF time is 0.1 second or less.



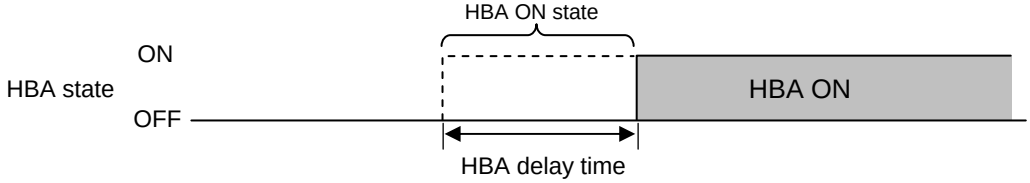
Heater break alarm function can not be used when control output is voltage/current output.

Number of heater break alarm (HBA) delay times	Register address	CH1: 0A40H (2624) ⋮ CH62: 0A7DH (2685)

It the number of heater break alarm (HBA) times continues its preset times (the number of sampling times), the heater break alarm is turned on.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 1 to 255 times
Related parameters: Current transformer (CT) input value (P. 59),
Heater break alarm (HBA) state (P. 60),
Heater break alarm (HBA) set value (P. 71)
Factory set value: 5
Function: Heater break alarm (HBA) delay time = Number of delay times × Sampling time (Sampling time: 1 second)

[Example] When the number of delay times is 5 times:
HBA delay time = 5 times × 500 ms = 2500 ms = 2.5 seconds



Heater break alarm function can not be used when control output is voltage/current output.

Control RUN/STOP transfer	Register address	Module 1: 0C00H (3072) : Module 31: 0C1EH (3102)

Use to transfers RUN and STOP of the control.

Attribute: R/W (Read and Write)
Number of data: 31 (Data of each module)
Data range: 0: Control STOP
1: Control RUN
Related parameters: DI setting (P. 77)
Factory set value: 0

When the optional digital input is "Control RUN/STOP," the instrument cannot be changed to the RUN by communication, if the instrument is STOP state by the contact input. (The "STOP" has priority.)

RUN/STOP state by DI	RUN/STOP transfer by communication	Instrument state
RUN (Contact close)	RUN	RUN
	STOP	STOP
STOP (Contact open)	RUN	STOP
	STOP	STOP

When used together with RKC panel mounted controllers (HA400/900/401/901, CB100/400/700/900, etc.), be careful that the numbers of indicating "Control RUN/STOP" of this instrument are opposite from those of the above controllers (0: ControlRUN and 1: Control STOP).

Input error determination point (high)	Register address	CH1: 0C40H (3136) : CH62: 0C7DH (3197)
Input error determination point (low)	Register address	CH1: 0C80H (3200) : CH62: 0CBDH (3261)

Use to set input error determination point (high or low). Input error determination function is activated when a measured value reaches the limit, and control output value selected by action at input error will be output.

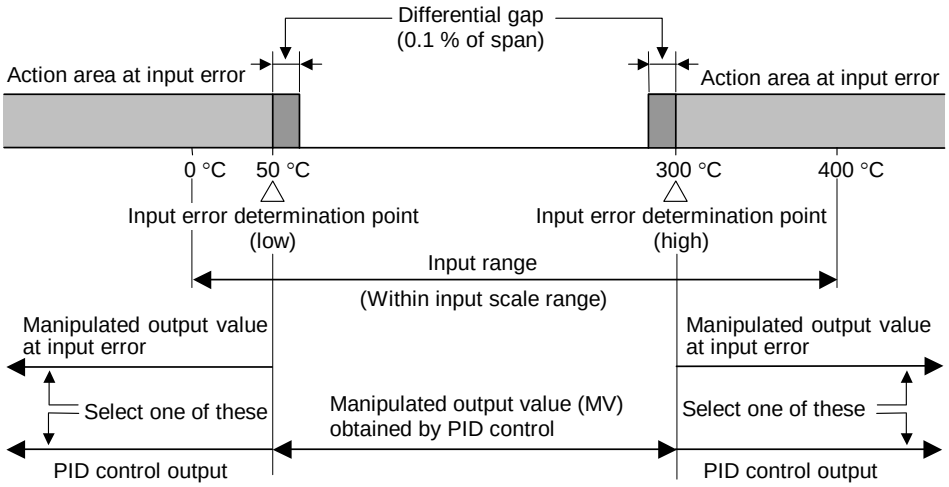
Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: TC/RTD input: Within input range
Voltage/current input: Input scale low limit to Input scale high limit
Related parameters: Action at input error (high/low) (P. 74),
Manipulated output value at input error (P. 74)
Factory set value: Input error determination point (high):
TC/RTD input: Input range high limit
Voltage/current input: Input scale high limit
Input error determination point (low):
TC/RTD input: Input range low limit
Voltage/current input: Input scale low limit

Action at input error (high)	Register address	CH1: 0CC0H (3264) : CH62: 0CFDH (3325)
Action at input error (low)	Register address	CH1: 0D00H (3328) : CH62: 0D3DH (3389)

Use to selects the action when input measured value reaches the input error determination point (high or low).

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: Normal control (The present output)
1: Manipulated output value at input error
Related parameters: Input error determination point (high/low) (P. 73),
Manipulated output value at input error (P. 74)
Factory set value: 0: Normal control (The present output)
Function: An example of the following explains input error determination point and action at input error.

[Example] Input range: 0 to 400 °C
Input error determination point (high): 300 °C
Input error determination point (low): 50 °C



Manipulated output value at input error	Register address	CH1: 0D40H (3392) : CH62: 0D7DH (3453)

When the measured value reaches input error determination point and action at input error is set to "1," this manipulated value is output.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: −105.0 to +105.0 %
(However, the actual output value is within output limiter range.)
Related parameters: Input error determination point (high/low) (P. 73),
Action at input error (high/low) (P. 74)
Factory set value: 0.0

AT differential gap time	Register address	CH1: 0D80H (3456) ⋮ CH62: 0DBDH (3517)

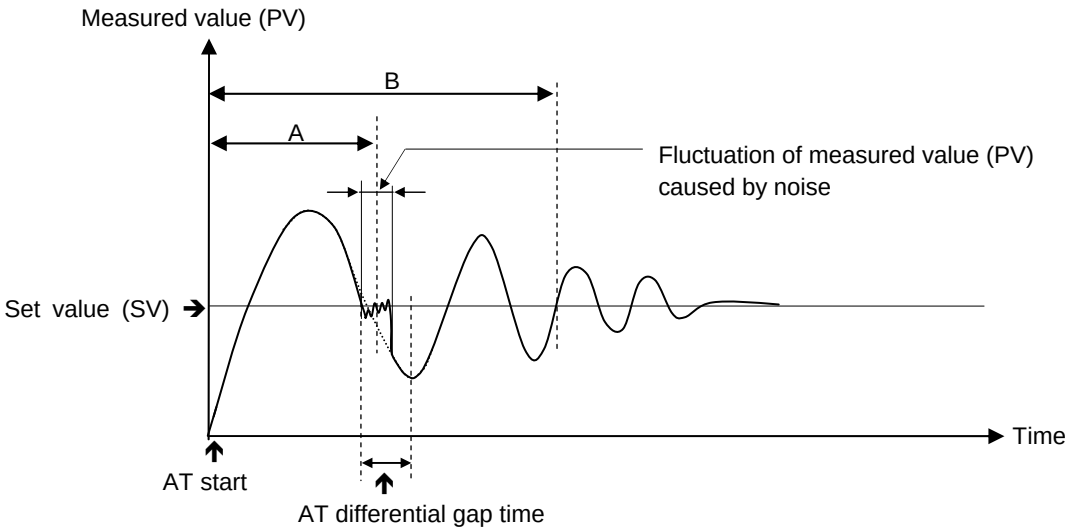
Use to set an ON/OFF action differential gap time for autotuning. This function prevents the AT function from malfunctioning caused by noise.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to 100 seconds
Related parameters: PID/AT transfer (P. 68)
Factory set value: 1
Function: In order to prevent the output from chattering due to the fluctuation of a measured value (PV) caused by noise during autotuning, the output on or off state is held until "AT differential gap time" has passed after the output on/off state is changed to the other. Set "AT differential gap time" to "1/100 × Time required for temperature rise."

[Example]

A: AT cycle time when the AT differential gap time is set to 0.00 second
The output chatters due to the fluctuation of the measured value (PV) caused by noise, and autotuning function is not able to monitor appropriate cycles to calculate suitable PID values.

B: AT cycle time when the AT differential gap time is set to "Time corresponding to 0.25 cycles"
The fluctuation of a measured value (PV) caused by noise is ignored and as a result autotuning function is able to monitor appropriate cycles to calculate suitable PID values.



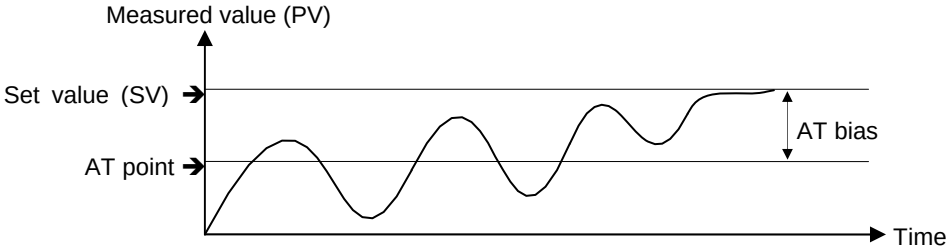
The AT cycle of SRV is 2 cycles.

AT bias	Register address	CH1: 0E00H (3584) ⋮ CH62: 0E3DH (3645)

Use to set a bias to move the set value only when autotuning is activated.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: –Input span to +Input span
Related parameters: PID/AT transfer (P. 68)
Factory set value: 0
Function: The AT bias is used to prevent overshoot during autotuning in the application which does not allow overshoot even during autotuning. RKC autotuning method uses ON/OFF control at the set value to calculate the PID values. However, if overshoot is a concern during autotuning, the desired AT bias should be set to lower the set point during autotuning so that overshoot is prevented.

- When AT bias is set to the minus (–) side



Event LED mode setting	Register address	Module 1: 0F00H (3840) ⋮ Module 31: 0F1EH (3870)

This item is for selecting the indicating details of 4 EVENT lamps located at the front of the module.

Attribute: R/W (Read and Write)
Number of data: 31 (Data of each module)
Data range: 0: Unused (No display)
1: Mode 1
2: Mode 2
3: Mode 3
Except the above (within 0 to 255): Unused
Factory set value: 0 (No display)
Function: Relationship between the content of each mode and each EVENT lamp

Mode	EVENT 1 lamp	EVENT 2 lamp	EVENT 3 lamp	EVENT 4 lamp
1	ch1 Event 1	ch1 Event 2	ch2 Event 1	ch2 Event 2
2	ch1 Comprehensive event [1]	ch2 Comprehensive event [1]	ch1 Output state [2]	ch2 Output state [2]
3	ch1 Comprehensive event [1]	ch2 Comprehensive event [1]	ch1 Control state [3]	ch2 Control state [3]

[1] If any one of burnout, event 1, event 2, heater break alarm and control loop break alarm is turned on, the comprehensive event is turned on (lit).
[2] For voltage output/current output, it is always turned off (extinguished).
[3] When "Control RUN/STOP" is set to "Control RUN" and the operation mode is set to "Control," it is turned on (lit).

DI setting	Register address	Module 1: 0F40H (3904) ⋮ Module 31: 0F5EH (3934)

Sets the content of optional digital input.

Attribute: R/W (Read and Write)

Number of data: 31 (Data of each module)

Data range: 0: Unused
1: Control RUN/STOP
2: Event interlock release
Except the above (within 0 to 20): Unused

Related parameters: Control RUN/STOP transfer (P. 73), DI state (P. 77),
Event interlock release (P. 79), Event action selection (P. 96)

Factory set value: Factory set value is as the event input (DI: optional) specified when ordering.
- When "N: None" is selected: 0
- When "1: Control RUN/STOP" is selected: 1
- When "2: Event interlock release" is selected: 2

Function:
- Control RUN/STOP
  Contact open: Control STOP Contact close: Control RUN
- Event interlock release
  Contact close: Event interlock release

When the DI setting is "Control RUN/STOP," the instrument cannot be changed to the RUN by communication, if the instrument is STOP state by the contact input. (The "STOP" has priority.)

RUN/STOP state by DI	RUN/STOP transfer by communication	Instrument state
RUN (Contact close)	RUN	RUN
	STOP	STOP
STOP (Contact open)	RUN	STOP
	STOP	STOP

In order to make contact activation valid, it is necessary to maintain the same contact state for more than 125 ms. Otherwise, that contact state is ignored.

In order to validate the event interlock function, it is necessary to set bit 2 to "1" in item "Event action selection."

DI state	Register address	Module 1: 0F80H (3968) ⋮ Module 31: 0F9EH (3998)

Monitors the optional digital input contact state.

Attribute: RO (Read only)

Number of data: 31 (Data of each module)

Data range: 0: Contact open
1: Contact close

Related parameters: DI setting (P. 77)

Factory set value: —

DO1 setting	Register address	Module 1: 0FC0H (4032) ⋮ Module 31: 0FDEH (4062)
DO2 setting	Register address	Module 1: 1000H (4096) ⋮ Module 31: 101EH (4126)

Sets the content of optional digital output.

Attribute: R/W (Read and Write)
Number of data: 31 (Data of each module)
Data range:
0: Unused
1: CH1 Event 1 state
2: CH2 Event 1 state
3: CH1 Event 2 state
4: CH2 Event 2 state
5: CH1 Heater break alarm state
6: CH2 Heater break alarm state
7: CH1 Control loop break alarm state
8: CH2 Control loop break alarm state
9: CH1 Burnout state
10: CH2 Burnout state
11: CH1 Temperature rise completion
12: CH2 Temperature rise completion
Except the above (within 0 to 20): Unused
Related parameters: Burnout state (P. 58), Event state (P. 60), Heater break alarm (HBA) state (P. 60), Control loop break alarm (LBA) state (P. 61), Temperature rise completion state (P. 61)
Factory set value: Specify when ordering

☞ The content of the event is set by the **Event type selection (P. 94)**.

DO state	Register address	Module 1: 1040H (4160) ⋮ Module 31: 105EH (4190)

Monitors the optional digital output contact state.

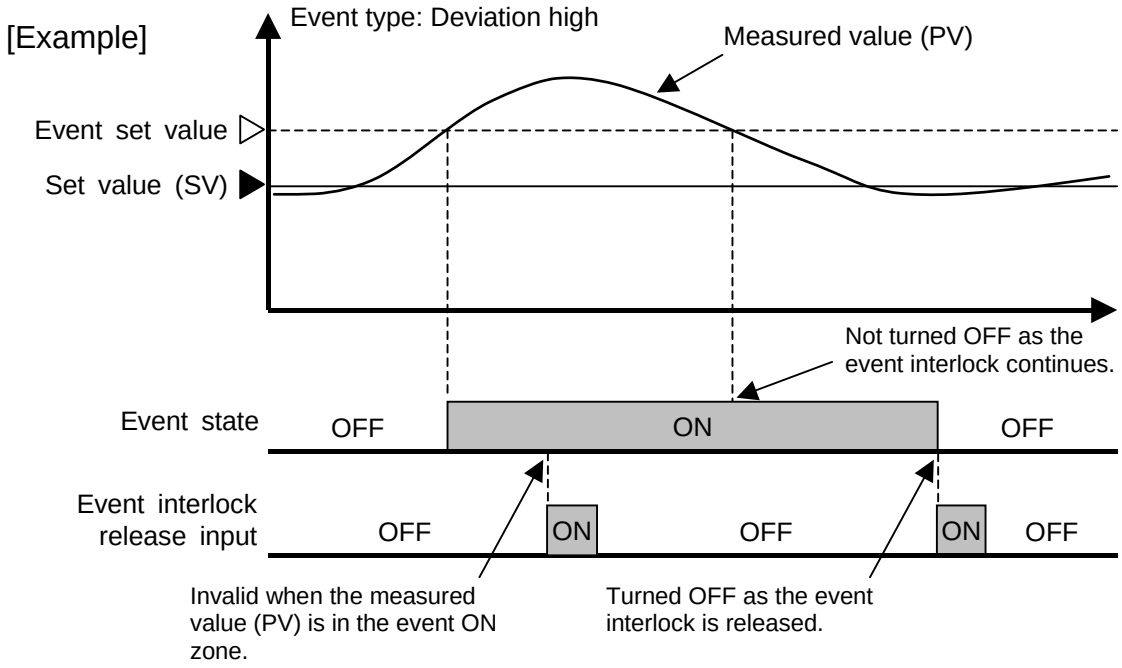
Attribute: R/W (Read and Write)
Number of data: 31 (Data of each module)
Data range:
0: DO1: Contact open (OFF), DO2: Contact open (OFF)
1: DO1: Contact close (ON), DO2: Contact open (OFF)
2: DO1: Contact open (OFF), DO2: Contact close (ON)
3: DO1: Contact close (ON), DO2: Contact close (ON)
Related parameters: DO setting (P. 78)
Factory set value: 0

📖 Data write is possible only when the DO1 and DO2 setting values are “0.”

Event interlock release	Register address	Module 1: 1080H (4224) : Module 31: 109EH (4254)

The event state is turned OFF when the event ON state is continued by the event interlock function.

Attribute: R/W (Read and Write)
Number of data: 31 (Data of each module)
Data range: 0: Normal state
1: Event interlock release execution
Related parameters: DI setting (P. 77), Event action selection (P. 96)
Factory set value: 0
Function: The following example shows how the event interlock is released.

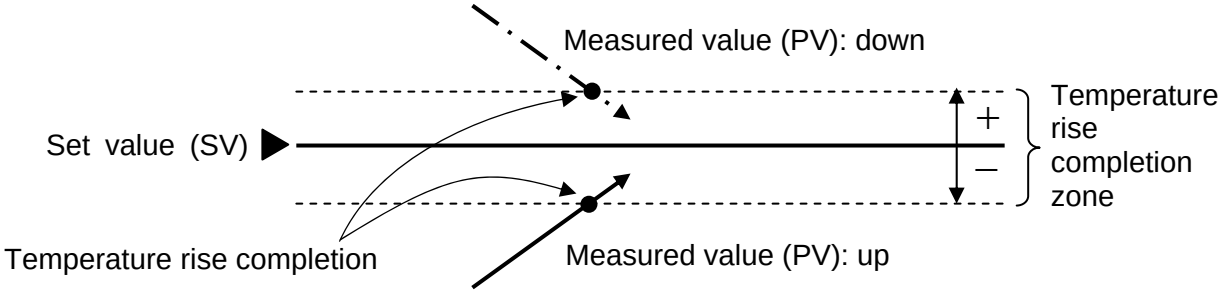


In order to validate the event interlock function, it is necessary to set bit 2 to "1" in item "Event action selection."

Temperature rise completion zone	Register address	CH1: 10C0H (4288) : CH62: 10FDH (4349)

Zone where the measured value (PV) complete its temperature rise.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 (0.0) to Input span
0 (0.0): Unused
Related parameters: Temperature rise completion state (P. 61),
Temperature rise completion soak time (P. 81)
Factory set value: 0 (0.0)
Function: Equal zone widths are set above and below the set value (SV) and the temperature rise is complete if the measured value (PV) enters any of these zone widths. Each of these zone widths corresponds to the temperature rise completion zone.
During the sampling of temperature input, when the measured value (PV) comes within the temperature rise completion zone, the temperature rise completion will occur. Further in considering the case that where the temperature rise completion zone has been set in a narrow zone, etc., even if the measured value (PV) passes through the temperature rise completion zone in the time between the sampling periods (Previous sampling period – This time sampling period), it is also judged as the temperature rise completion.



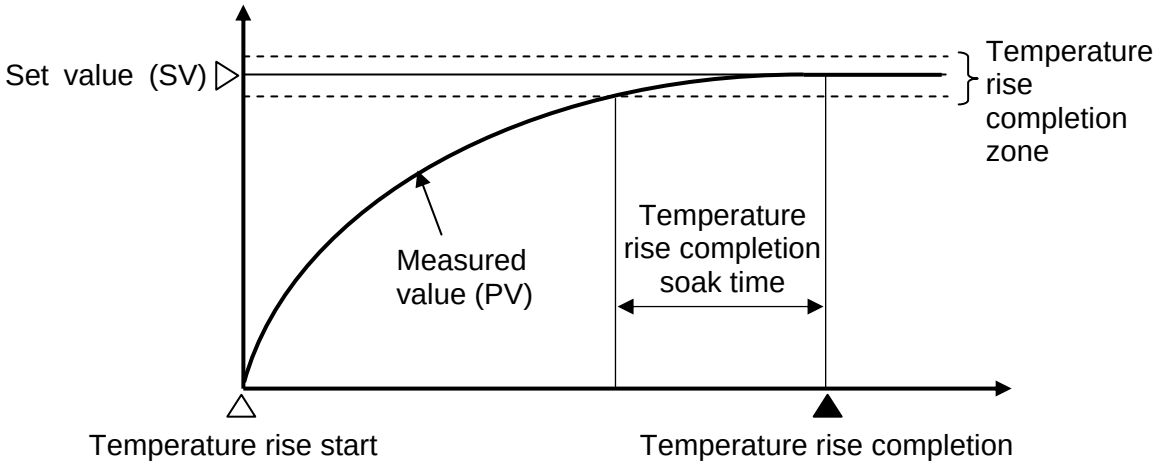
A temperature rise is complete just when the temperature rise completion soak time elapses after the measured value (PV) enters the temperature rise completion zone.

Any channel which does not use temperature rise completion completes its temperature rise just when started.

Temperature rise completion soak time	Register address	CH1: 1100H (4352) : CH62: 113DH (4413)

The time until the temperature rise is complete after the measured value (PV) enters the temperature rise completion zone.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to 360 minutes
Related parameters: Temperature rise completion state (P. 61),
Temperature rise completion zone (P. 80)
Factory set value: 0
Function: The time until the temperature rise is complete after the measured value (PV) enters the temperature rise completion zone corresponds to the temperature rise completion soak time.



TIO state	Register address	CH1: 7600H (30208) : CH62: 763DH (30296)

Monitor a state of each TIO modules.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to 65535 (bit data)
Each TIO state is assigned as a bit image in binary numbers.

Bit image: 0000000000000000
bit 15 ·····bit 0

Bit data: 0: OFF 1: ON

bit 0: Burnout
bit 1: Event 1 state
bit 2: Event 2 state
bit 3: Heater break alarm (HBA) state
bit 4: Control loop break alarm (LBA) state
bit 5: Unused
bit 6: Unused
bit 7: Unused
bit 8: DI state *
bit 9: DO1 state *
bit 10: DO2 state *
bit 11: Temperature rise completion state
bit 12: Control RUN/STOP state *
bit 13: Module error
bit 14: Setting error
bit 15: Error code *

* As DI state, DO1 state, DO2 state, Control RUN/STOP state and Error code are data values for each module, only odd channels become valid.

Related parameters: Comprehensive event state (P. 57), Error code (P. 59), Burnout state (P. 59), Event state (P. 60), Heater break alarm (HBA) state (P. 60), Control loop break alarm (LBA) state (P. 61), Temperature rise completion state (P. 61), Control RUN/STOP transfer (P. 73), DI state (P. 77), DO sate (P. 78)
Factory set value: —
Function: Contents of each bits

b0: Burnout
Become ON in input break.

b1, b2: Event 1 state, Event 2 state
Can change an event type by initial setting mode.
Event type: Deviation high, Deviation low, Deviation high/low, Band, Process high, Process low

b3: Heater break alarm (HBA) state
This is valid only when heater break alarm (HBA) function is used. However, heater break alarm function cannot be used when control output is voltage/current output.

Continued on the next page.

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b4: Control loop break alarm (LBA) state
This is valid only when control loop break alarm (LBA) function is used. The Use/Unuse of the control loop break alarm (LBA) is selected and control loop break alarm (LBA) related settings are made via initial setting mode.

b5 to b7: Unused

b8: DI state
Valid only when there is optional event input (DI).

b9, b10: DO1 state, DO2 state
Valid only when there is optional event output (DO).

b11: Temperature rise completion state
A temperature rise is complete just when the temperature rise completion soak time elapses after the measured value (PV) enters the temperature rise completion zone. The setting relating to temperature rise completion is made via host communication.

b12: Control RUN/STOP state
Control RUN/STOP can be executed via communication or by DI. In this Control RUN/STOP state, the present control state is displayed regardless of the execution via communication or by DI.

When the DI setting is "Control RUN/STOP," the instrument cannot be changed to the RUN by communication, if the instrument is STOP state by the contact input. (The "STOP" has priority.)

RUN/STOP state by DI	RUN/STOP transfer by communication	Instrument state
RUN (contact close)	RUN	RUN
	STOP	STOP
STOP (contact open)	RUN	STOP
	STOP	STOP

b13: Module error
To be turned on when no communication with the relevant module (channel) can be conducted (no response).

b14: Setting error
To be turned on when the setting of the relevant channel exceeds the data range.

b15: Error code
To be turned on when the value becomes more than 1 as any error occurs in the host communication error code (register addresss: 0100H to 011EH).

V-TIO-P/V-TIO-Q module error code	Register address	7D08H (32008)

Error state of V-TIO-P/V-TIO-Q module is expressed as a bit image in decimal number.

Attribute: RO (Read only)
Number of data: 1 (Data of each unit)
Data range: 0 to 255 (bit data)
Each error state is assigned as a bit image in binary numbers.

Bit image: 00000000
bit 7 ····· bit 0

Bit data: 0: OFF 1: ON

bit 0: Memory backup error
bit 1: Unused
bit 2: Module configuration error
bit 3 to 7:
Unused

Factory set value: —

Number of connected TIO modules	Register address	7D0AH (32010)

Indicates the number of temperature control (TIO) modules connected per unit.

Attribute: RO (Read only)
Number of data: 1 (Data of each unit)
Data range: 0 to 31
Factory set value: —

Number of connected TIO channels	Register address	7D0BH (32011)

Indicates the number of temperature control (TIO) channels per unit.

Attribute: RO (Read only)
Number of data: 1 (Data of each unit)
Data range: 0 to 62 CH
Factory set value: —

Initial setting mode	Register address	7D20H (32032)

It is necessary to transfer the initial setting mode when read and write the initial setting data.

Attribute: R/W (Read and Write)
Number of data: 1 (Data of each unit)
Data range: 0: Normal setting mode
1: Initial setting mode
Factory set value: 0: Normal setting mode


When “Control RUN/STOP” is set to “Control RUN,” no initial set mode can be set.


For initial setting data, see **8.2 Initial Setting Data Items (P. 86)**.

8.2 Initial Setting Data Items

⚠ WARNING

The Initial setting data should be set according to the application before setting any parameter related to operation. Once the Initial setting data is set correctly, those data is not necessary to be changed for the same application under normal conditions. If they are changed unnecessarily, it may result in malfunction or failure of the instrument. RKC will not bear any responsibility for malfunction or failure as a result of improper changes in the Initial setting.

■ Setting procedure of initial setting data items

Transfer to initial setting mode sets in "1" with register address 7D20H (normally setting mode).

The instrument cannot be changed to the initial setting mode state at control start (during control). If it needs to be changed to the above state, first stop the control by "Control RUN/STOP transfer."

No control can be started during initial setting mode. If the control needs to be re-started, first change the instrument the normal setting mode state (set register address 7D20H by 0).

■ Data description

Control loop break alarm (LBA) use selection	Register address	CH1: 6A40H (27200) : CH62: 6A7DH (27261)

This item is for selecting the use/unused of control loop break alarm.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: Unused
1: Used
Related parameters: Control loop break alarm (LBA) state (P. 61),
Control loop break alarm (LBA) time (P. 87),
Control loop break alarm (LBA) deadband (P. 88)
Factory set value: 0: Unused
Function: The control loop break alarm (LBA) function is used to detect a load (heater) break or a failure in the external actuator (power controller, magnet relay, etc.), or a failure in the control loop caused by an input (sensor) break.
The LBA function is activated when control output reaches 0% (low limit with output limit function) or 100% (high limit with output limit function). LBA monitors variation of the measured value (PV) for the length of LBA time, and when the LBA time has passed and the PV is still within the alarm determination range, the LBA will be output.

Continued on the next page.

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[Alarm action]

LBA determination range: Temperature input: 2 °C [2 °F] fixed
Voltage/current input: 0.2% fixed

- **Heat control**

	When the output reaches 0 % (low limit with output limit function)	**When the output exceeds 100 % (high limit with output limit function)**
For reverse action	When the LBA time has passed and the PV has not fallen below the alarm determination range, the alarm will be turned on.	When the LBA time has passed and the PV has not risen beyond the alarm determination range, the alarm will be turned on.
For direct action	When the LBA time has passed and the PV has not risen beyond the alarm determination range, the alarm will be turned on.	When the LBA time has passed and the PV has not risen beyond the alarm determination range, the alarm will be turned on.

- **Heat/cool control**

When the heat-side output exceeds 100 % (high limit with heat-side output limit function) and the cool-side output reaches 0 %	**When the heat-side output reaches 0 % and the cool-side output exceeds 100 % (high limit with cool-side output limit function)**
When the LBA time has passed and the PV has not risen beyond the alarm determination range, the alarm will be turned on.	When the LBA time has passed and the PV has not fallen below the alarm determination range, the alarm will be turned on.

If the autotuning function is used, the LBA time is automatically set twice as large as the integral time. The LBA setting time will not be changed even if the integral time is changed.

Control loop break alarm (LBA) time	Register address	CH1: 6A80H (27264) : CH62: 6ABDH (27325)

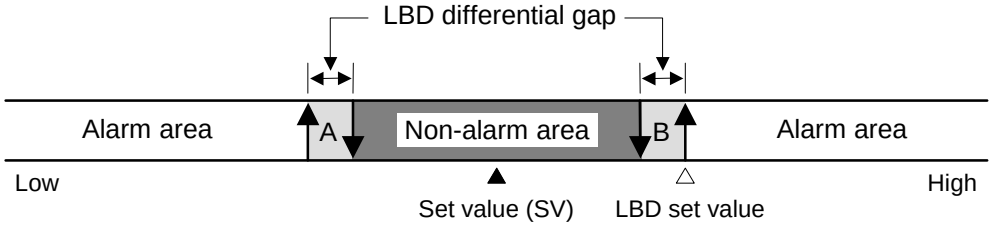
The LBA time sets the time required for the LBA function to determine there is a loop failure. When the LBA is output (under alarm status), the LBA function still monitors the measured value (PV) variation at an interval of the LBA time.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 1 to 7200 seconds
Related parameters: Control loop break alarm (LBA) state (P. 61),
Control loop break alarm (LBA) use selection (P. 86),
Control loop break alarm (LBA) deadband (P. 88)
Factory set value: 480

Control loop break alarm (LBA) deadband	Register address	CH1: 6AC0H (27328) : CH62: 6AFDH (27389)

Control loop break alarm (LBA) deadband gives a neutral zone to prevent the control loop break alarm (LBA) from malfunctioning caused by disturbance.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 (0.0) to Input span
Related parameters: Control loop break alarm (LBA) state (P. 61),
Control loop break alarm (LBA) use selection (P. 86),
Control loop break alarm (LBA) time (P. 87)
Factory set value: 0 (0.0)
Function: The LBA may malfunction due to external disturbance from outside even when the control does not have any problem. To prevent malfunctioning due to external disturbance, LBA deadband (LBD) sets a neutral zone in which LBA is not activated.
When the measured value (PV) is within the LBD area, LBA will not be activated. If the LBD setting is not correct, the LBA will not work correctly.



A: During temperature rise: Alarm area
During temperature fall: Non-alarm area
B: During temperature rise: Non-alarm area
During temperature fall: Alarm area

LBD differential gap: TC/RTD input: 0.8 °C (0.8 °F)
Voltage/current input: 0.8 % of span

- If the LBA function detects an error occurring in the control loop, but cannot specify the location, a check of the control loop in order. The LBA function does not detect a location which causes alarm status. If LBA alarm is ON, check each device or wiring of the control loop.
- When AT function is activated or the controller is in STOP mode, the LBA function is not activated.
- If the LBA setting time match the controlled object requirements, the LBA setting time should be adjusted. If setting time is not correct, the LBA will malfunction by turning on or off at inappropriate time or not turning on at all.
- While the LBA is ON (under alarm status), the following conditions cancel the alarm status and LBA will be OFF.
  - The measured value (PV) rises beyond (or falls below) the LBA determination range within the LBA time.
  - The measured value (PV) enters within the LBA deadband.

Input range number	Register address	CH1: 7000H (28672) ⋮ CH62: 703DH (28733)

Input range number is a number to indicate an input type and input range.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: See input range table

[Input range table]

Input type	Input range		Data	Hardware type
K	−200 to +1372 °C	−328 to +2501 °F	0	Voltage (low) input group
	0 to 800 °C	32 to 1472 °F	1	
	0 to 400 °C	32 to 752 °F	2	
	−200.0 to +400.0 °C	−328.0 to +752.0 °F	3	
	0.0 to 400.0 °C	32.0 to 752.0 °F	4	
J	−200 to +1200 °C	−328 to +2192 °F	5	
	0 to 800 °C	32 to 1472 °F	6	
	0 to 400 °C	32 to 752 °F	7	
	−200.0 to +400.0 °C	−328.0 to +752.0 °F	8	
	0.0 to 400.0 °C	32.0 to 752.0 °F	9	
T	−200 to +400 °C	−328 to +752 °F	10	
	0 to 400 °C	32 to 752 °F	11	
	0 to 200 °C	32 to 392 °F	12	
	−200.0 to +400.0 °C	−328.0 to +752.0 °F	13	
	0.0 to 400.0 °C	32.0 to 752.0 °F	14	
S	0 to 1768 °C	32 to 3214 °F	15	
R	0 to 1768 °C	32 to 3214 °F	16	
PLII	0 to 1390 °C	32 to 2534 °F	17	
N	0 to 1300 °C	32 to 2372 °F	18	
W5Re/W26Re	0 to 2300 °C	32 to 4172 °F	19	
E	0 to 1000 °C	32 to 1832 °F	20	
	0 to 800 °C	32 to 1472 °F	21	
B	0 to 1800 °C	32 to 3272 °F	22	
Pt100	0 to 850 °C	32 to 1562 °F	23	RTD input group
	0 to 400 °C	32 to 752 °F	24	
	−200.0 to +400.0 °C	−328.0 to +752.0 °F	25	
	0.0 to 400.0 °C	32.0 to 752.0 °F	26	
JPt100	0 to 600 °C	32 to 1112 °F	27	
	0 to 400 °C	32 to 752 °F	28	
	−200.0 to +400.0 °C	−328.0 to +752.0 °F	29	
	0.0 to 400.0 °C	32.0 to 752.0 °F	30	
0 to 100 mV DC	Programmable		31	Voltage (low) input group
0 to 5 V DC	Programmable		33	Voltage (high) input group
1 to 5 V DC			34	
0 to 10 V DC			35	
0 to 20 mA DC	Programmable		36	Current input group
4 to 20 mA DC			37	

An input type change may only be made within the hardware groups as shown above.

Related parameters: Input scale high limit/Input scale low limit (P. 90),
Input range decimal point position (P. 90), Temperature unit selection (P. 91)
Factory set value: Specify when ordering.

These items become valid by turning off the power of the V-TIO-P/V-TIO-Q module once, and then turning it on again after the settings are changed.

Input scale high limit	Register address	CH1: 7040H (28736) ⋮ CH62: 707DH (28797)
Input scale low limit	Register address	CH1: 7080H (28800) ⋮ CH62: 70BDH (28861)

Use to set the high/low limit value of input scale range.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: Input scale high limit: Input scale low limit to 10000
Input scale low limit: –2000 to Input scale high limit
However, a span is 12000 or less.
Related parameters: Input range number (P. 89), Input range decimal point position (P. 90)
Factory set value: Input scale high limit: 100.0
Input scale low limit: 0.0

- The input scale can be set only when voltage/current is input.
- The decimal point position varies with the setting of the input range decimal point position.
- These items become valid by turning off the power of the V-TIO-P/V-TIO-Q module once, and then turning it on again after the settings are changed.

Input range decimal point position	Register address	CH1: 70C0H (28864) ⋮ CH62: 70FDH (28925)

Use to select the decimal point position of input range.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: No decimal place
1: One decimal place
2: Two decimal places
3: Three decimal places
Related parameters: Input range number (P. 89), Input scale high limit/Input scale low limit (P. 90)
Factory set value: 1

- The input range decimal point position can be set only when voltage/current is input.
- These items become valid by turning off the power of the V-TIO-P/V-TIO-Q module once, and then turning it on again after the settings are changed.

Temperature unit selection	Register address	CH1: 7100H (28928) ⋮ CH62: 713DH (28989)

Use to select the temperature unit for thermocouple (TC) and RTD inputs.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: °C
1: °F
Factory set value: 0

Control type selection	Register address	CH1: 7140H (28992) ⋮ CH62: 717DH (29053)

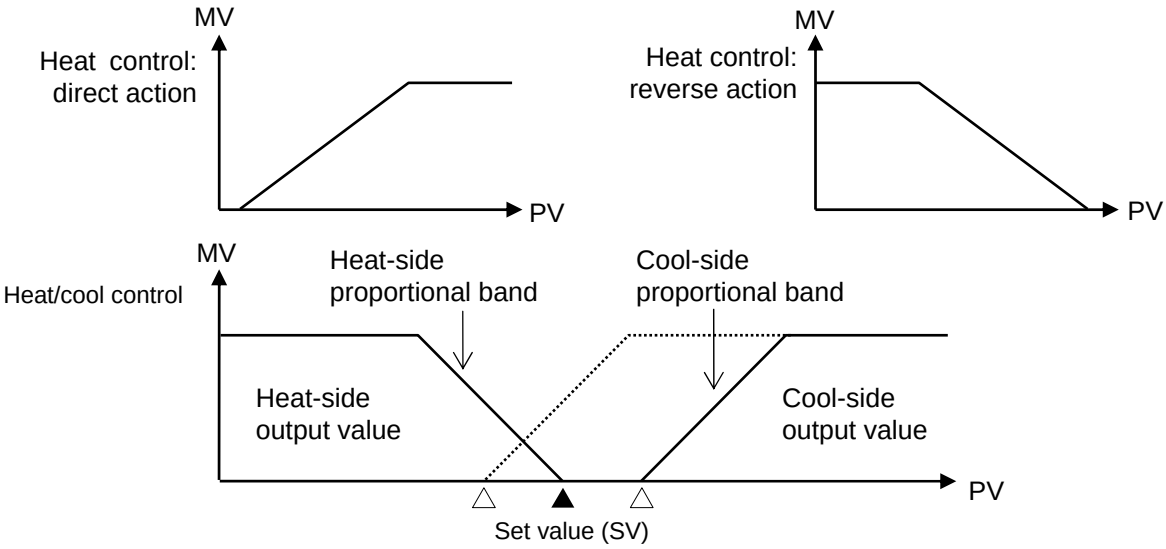
Use to select control action.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: Heat control: direct action
1: Heat control: reverse action
2: Heat/cool control: water cooling
3: Heat/cool control: air cooling
Factory set value: Specify when ordering
Function:

[Heat control: direct action] The manipulated output value (MV) increases as the measured value (PV) increases.

[Heat control: reverse action] The manipulated output value (MV) decreases as the measured value (PV) increases.

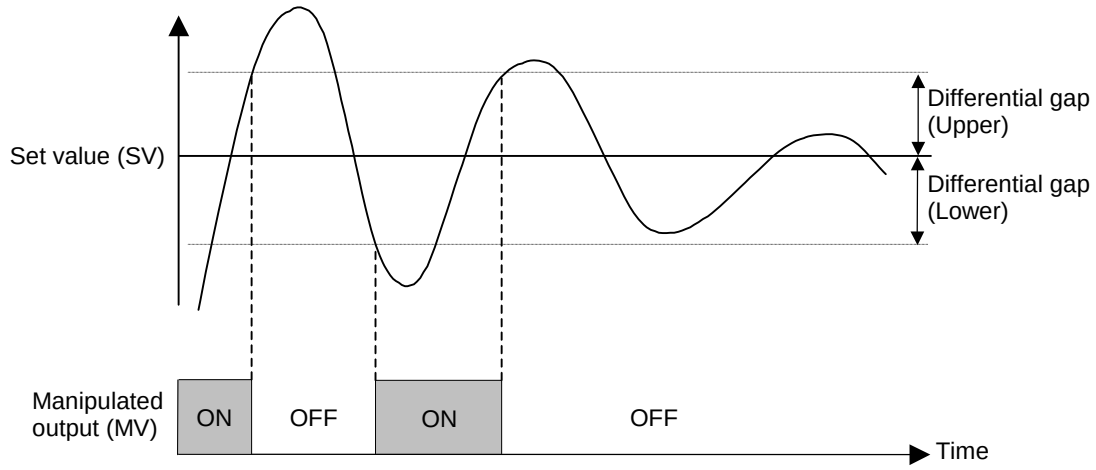
[Heat/cool control] Heat control and cool control are performed in one control channel in combination of the direct action with the reverse action.



ON/OFF control differential gap (upper)	Register address	CH1: 7180H (29056) ⋮ CH62: 71BDH (29117)
ON/OFF control differential gap (lower)	Register address	CH1: 71C0H (29120) ⋮ CH62: 71FDH (29181)

Use to set the ON/OFF control differential gap.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to Input span
Related parameters: Heat-side/cool-side proportional band (P. 63)
Factory set value: Thermocouple/RTD input: 1.0 °C or 1.0 °F
Voltage/Current input: 0.1 % of input span
Function: ON/OFF control is possible when the proportional band is set to "0" or "0.0." In ON/OFF control with Reverse action, when the measured value (PV) is smaller than the set value (SV), the manipulated output (MV) is 100% or ON. When the PV is higher than the SV, the MV is 0% or OFF. Differential gap setting prevents control output from repeating ON and OFF too frequently.

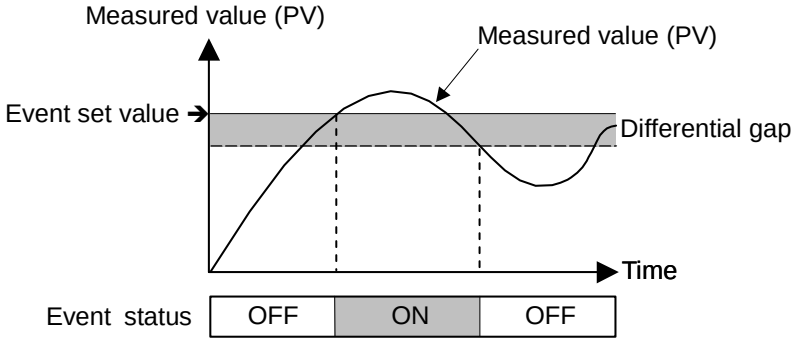


Event 1 differential gap	Register address	CH1: 7200H (29184) ⋮ CH62: 723DH (29245)
Event 2 differential gap	Register address	CH1: 7240H (29248) ⋮ CH62: 727DH (29309)

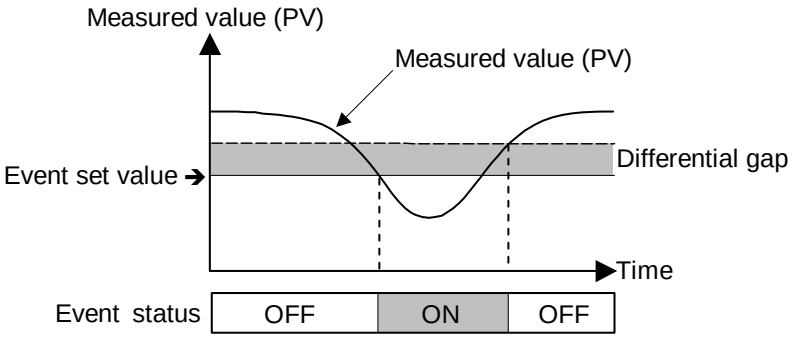
Use to set the event differential gap.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to Input span (Input span: Input scale low limit to Input scale high limit)
Related parameters: Event state (P. 60), Event set value (P. 66), Event type selection (P. 94), Event action selection (P. 96), Event delay timer (P. 98)
Factory set value: Thermocouple/RTD input: 2.0 °C or 2.0 °F
Voltage/Current input: 0.2 % of input span
Function: It prevents chattering of event output due to the measured value fluctuation around the event set value.

[Event high]



[Event low]



Event 1 type selection	Register address	CH1: 7280H (29312) ⋮ CH62: 72BDH (29373)
Event 2 type selection	Register address	CH1: 72C0H (29376) ⋮ CH62: 72FDH (29437)

Use to select the event type.

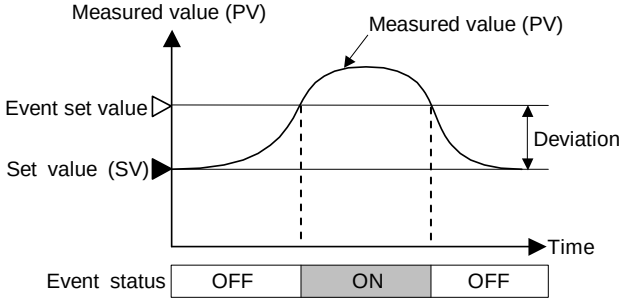
Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0: Not provided 3: Deviation high 6: Band
1: Process high 4: Deviation low
2: Process low 5: Deviation high/low
Related parameters: Event state (P. 60), Event set value (P. 66), Event differential gap (P. 93), Event action selection (P. 96), Event delay timer (P. 98)
Factory set value: Specify when ordering
Function: There are two types of event: deviation and input value

Deviation:
If the deviation [Measured value (PV) − Set value (SV)] reaches the event set value, the event state is set up. Consequently, if the set value (SV) changes, the event action point will also change.

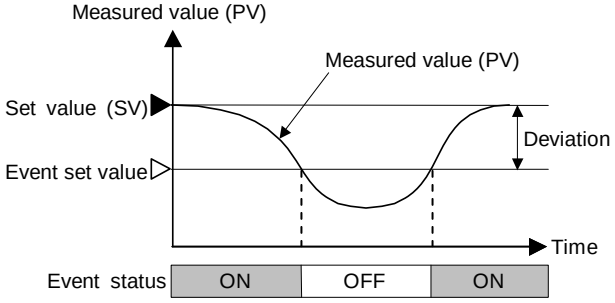
- **Deviation high**

When the deviation (PV−SV) is the event set value or more, the event status is set up.

[When the event set value is on the positive side]



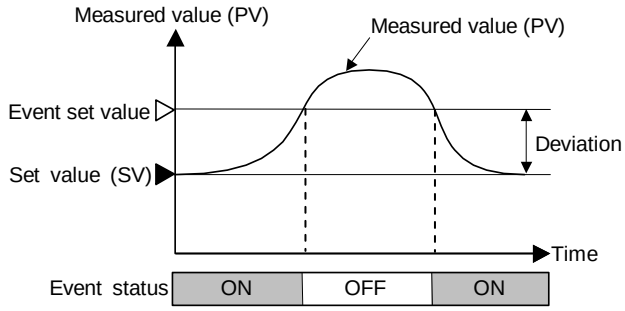
[When the event set value is on the negative side]



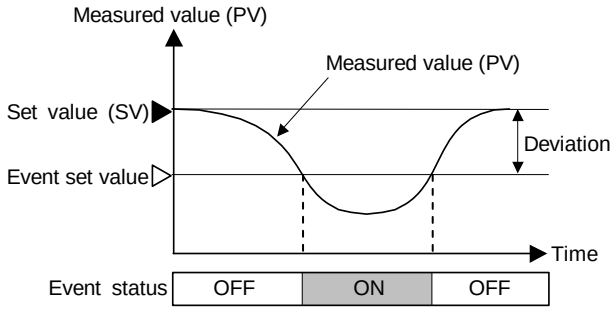
- **Deviation low**

When the deviation (PV−SV) is the event set value or less, the event status is set up.

[When the event set value is on the positive side]



[When the event set value is on the negative side]



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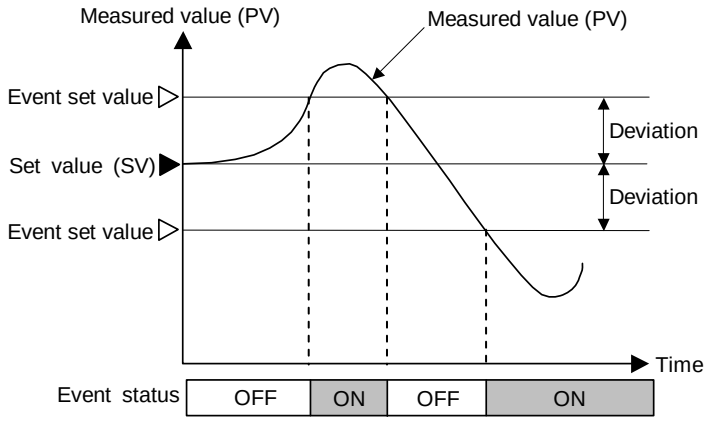
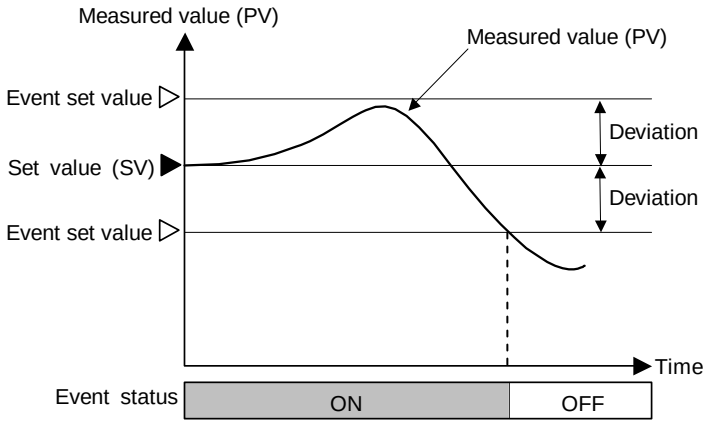
● Deviation high/low

When the absolute deviation (|PV−SV|) is the event set value or more/less, the event status is set up.



● Band

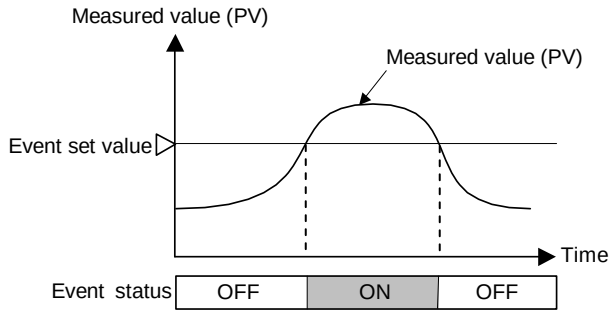
When the absolute deviation (|PV−SV|) is within the event set values, the event status is set up.



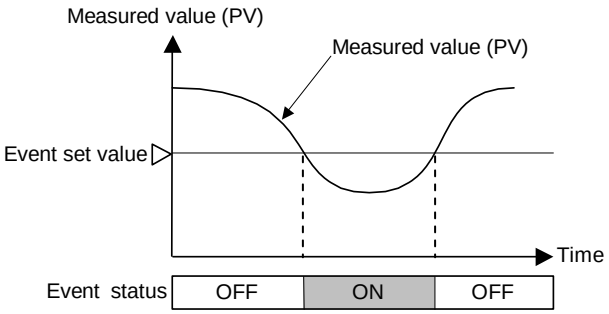
Process:

When the measured value (PV) reaches the event set value, the event status is set up.

● Process high



● Process low



Event 1 action selection	Register address	CH1: 7300H (29440) ⋮ CH62: 733DH (29501)
Event 2 action selection	Register address	CH1: 7340H (29504) ⋮ CH62: 737DH (29565)

Use to select the event action.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to 31 (bit data)
Each error state is assigned as a bit image in binary numbers.

Bit image: 00000000
bit 7 ····· bit 0

Bit data: 0: OFF 1: ON

bit 0: Hold action
bit 1: Re-hold action
bit 2: Interlock action
bit 3: Event action at input error
bit 4: Hold action at control start
bit 5 to 7:
Unused

Related parameters: Event state (P. 60), Event set value (P. 66), DI setting (P. 77), Event interlock release (P. 79), Event differential gap (P. 93), Event type selection (P. 94), Event delay timer (P. 98)

Factory set value:
bit 0: Factory set value is as the event output (DO: optional) specified when ordering.
- When "Action with hold function" is selected: 1
- When "Any action other than hold function" is selected: 0

bit 1: Factory set value is as the event output (DO: optional) specified when ordering.
- When "Action with re-hold function" is selected: 1
- When "Any action other than re-hold function" is selected: 0

bit 2: Factory set value is as the event input (DI: optional) specified when ordering.
- When "2: Event interlock release" is selected: 1
- When "Any item other than 2: Event interlock release" is selected: 0

bit 3 to bit 7: 0

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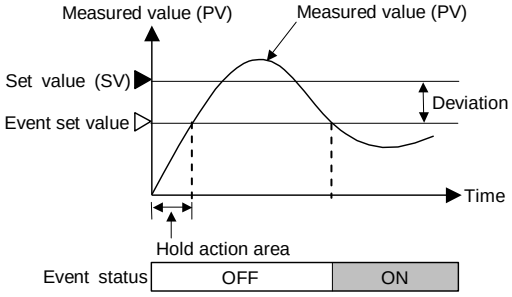
Function: Show it to the following hold action and re-hold action.

- **Hold action**

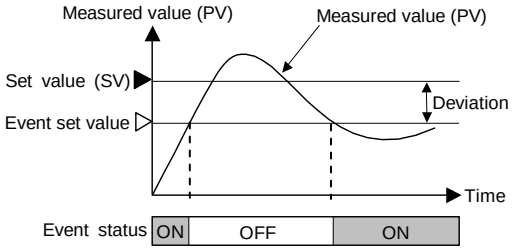
When hold action is ON, the event action is suppressed at start-up and control start until the measured value has entered the non-event range.

In order to activate the hold action just when control is started, it is necessary to set "bit 4: Hold action at control start" to "1: ON."

[With hold action]



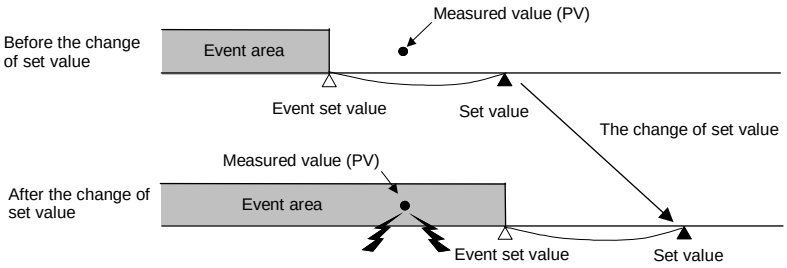
[Without hold action]



- **Re-hold action**

When re-hold action is ON, the event action is also suppressed at the control set value change as well as start-up and STOP to RUN until the measured value has entered the non-event range. However, if the rate of setting change limiter is set to any function other than "0.0: OFF (Unused)," the re-hold action becomes invalid.

[Example] When re-hold action is OFF and event output type is deviation, the event output is produced due to the set value change. The re-hold action suppresses the alarm output until the measured value has entered the non-event range again.



- **Interlock action**

This is the action of holding the event ON state even if the measured value is out of the event zone after entering the event zone once to be set to the event ON state. This interlock is released via communication or by inputting the optional contact.

For details, see **Event interlock release (P. 79)**.

- **Event action at input error**

This is the action of forcibly turning ON the event when the measured value is above or below the high or low limit of the input error determination point.

[Example] If the measured value is above or below the high or low limit of the input error determination point with the "Event 1 action selection" provided with the event action when an input error occurs, the "Event 1 state" is turned ON.

If there is the optional event output (DO) and the "Event state" is selected as the content of the DO setting, it is possible to output the event state when an input error occurs.

Event delay timer	Register address	CH1: 7380H (29568) ⋮ CH62: 73BDH (29629)

The number of event delay times as an event generation filter is set.

Attribute: R/W (Read and Write)
Number of data: 62 (Data of each channel)
Data range: 0 to 9999 seconds
Related parameters: Event state (P. 60), Event set value (P. 66), Event differential gap (P. 93), Event type selection (P. 94), Event action selection (P. 96)
Factory set value: 0
Function: When an event condition becomes ON status, the event ON state is suppressed until the Event Delay Timer set time elapses. After the time is up, if the event state is still ON status, the output will be produced.

TIO module internal communication Transmission transfer time setting	Register address	Module 1: 73C0H (29632) ⋮ Module 31: 73DEH (29662)

RS-485 sets the transmission transfer time to accurately assure the sending/receiving selection timing.

Attribute: R/W (Read and Write)
Number of data: 31 (Data of each module)
Data range: 0 to 100 ms
Factory set value: 6

Operation mode holding setting	Register address	Module 1: 7440H (29760) ⋮ Module 31: 745EH (29790)

It is set whether or not the operation mode before the power supply is turned off is held when the power supply is turned on or power failure recovers.

Attribute: R/W (Read and Write)
Number of data: 31 (Data of each module)
Data range: 0: Not hold (Operation mode: Monitor 1)
1: Hold
Related parameters: Operation mode (P. 62)
Factory set value: 1

9. TROUBLESHOOTING

This section explains probable causes and treatment procedures if any abnormality occurs in the instrument. For any inquiries, please contact RKC sales office or the agent, to confirm the specifications of the product.

If it is necessary to replace a device, always strictly observe the warnings below.

⚠ WARNING

- To prevent electric shock or instrument failure, always turn off the system power before replacing the instrument.
- To prevent electric shock or instrument failure, always turn off the power before mounting or removing the instrument.
- To prevent electric shock or instrument failure, do not turn on the power until all the wiring is completed.
- To prevent electric shock or instrument failure, do not touch the inside of the instrument.
- All wiring must be performed by authorized personnel with electrical experience in this type of work.

CAUTION

All wiring must be completed before power is turned on to prevent electric shock, instrument failure, or incorrect action. The power must be turned off before repairing work for input break and output failure including replacement of sensor, contactor or SSR, and all wiring must be completed before power is turned on again.

When replacing the module with a new one, always use the module with the same model code. If the module is replaced, it is necessary to re-set each data item.

■ V-TIO-P/ V-TIO-Q module

Problem	Probable cause	Solution
FAIL/RUN lamp does not light up (temperature control side) RUN lamp does not light up (Ethernet communication side)	Power not being supplied	Check external breaker etc.
	Appropriate power supply voltage not being supplied	Check the power supply
	Power supply terminal contact defect	Retighten the terminals
	Power supply section defect	Replace V-TIO-P/V-TIO-Q module
RUN lamp flashes rapidly (Ethernet communication side)	Data collection just after the power is turned on	After data collection, the lamp goes on, if normal
RUN lamp flashes slowly (Ethernet communication side)	Module configuration error Disconnection of the module connection or disconnection of the module mainframe from terminal base	Confirm the module connection condition and connect correctly
	Input error The IP address was not normally set by DIP switch	Confirm the IP address setting and set this correctly
RX/TX lamp does not flash (temperature control side)	Disconnection of the module connection or imperfect contact of the junction connector	Confirm the connection condition or connector and connect correctly
	CPU section defect	Replace V-TIO-P/V-TIO-Q module
FAIL/RUN lamp is lit (red): FAIL status (temperature control side)	CPU section or power section defect	Replace V-TIO-P/V-TIO-Q module
FAIL lamp is lit (Ethernet communication side)	CPU section defect	Replace V-TIO-P/V-TIO-Q module

■ Communication

Problem	Probable cause	Solution
• Can not set the IP address • The client and the server are not in the connected state (the client cannot recognize the server)	The IP address class and subnet mask of the client do not coincide with those of the server	Coincide the IP address class and subnet mask of the client with those of the server
	The network related software was started before the connection of the Ethernet cable	First connect the Ethernet cable and then start the network related software

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Problem	Probable cause	Solution
No response	Wrong connection, no connection or disconnection of the communication cable	Confirm the connection method or condition and connect correctly
	Breakage, wrong wiring, or imperfect contact of the communication cable	Confirm the wiring or connector and repair or replace the wrong one
	Wrong IP address setting	Confirm the settings and set them correctly
	There is length of query message exceeds set range	
	The number of data points is not twice the specified number of data points at the time of data write	
Error code: 01H	Function code error (Specifying nonexistent function code)	Confirm the function code
Error code: 02H	When the mismatched address is specified	Confirm the address of holding register
Error code: 03H	When the data written exceeds the setting range	Confirm the setting data
	When the number of specified data points was out of a range of 1 to 125 during data read (function code: 03H)	
	When the number of specified data points was out of a range of 1 to 123 during data write (function code: 10H)	
	When the number of specified data points was out of a range of 1 to 118 during data read/write (function code: 17H)	
Error code: 04H	State under which the server (SRV) cannot normally respond [An error occurred in the server (SRV)]	Remove the cause of the error occurring in the server (SRV).
Error code: 06H	State under which the server (SRV) cannot immediately respond [The server (SRV) is being initialized]	Conduct communication again after initialization is finished.

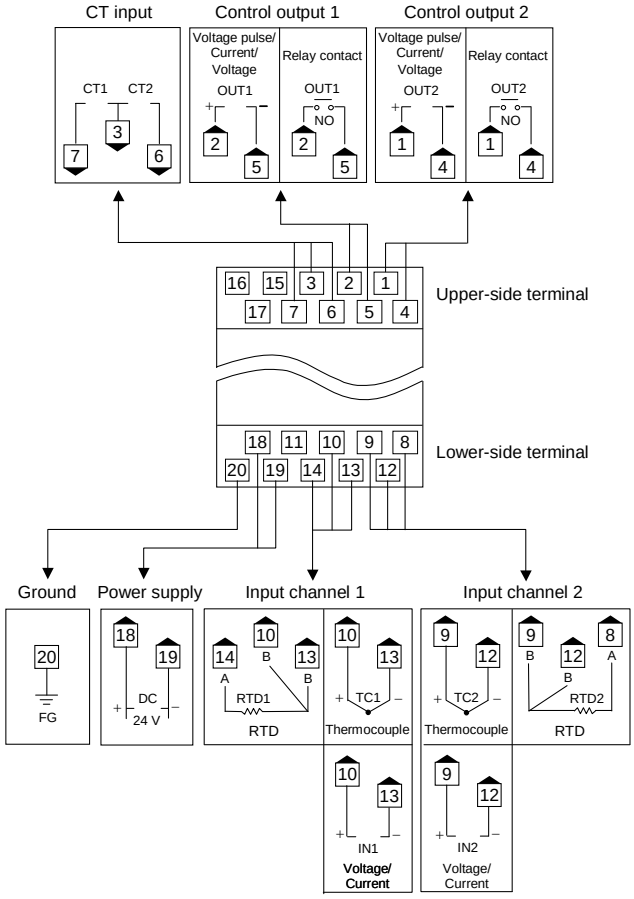
APPENDIX A. HARDWARE

A.1 Terminal Configuration

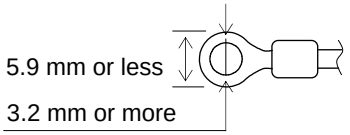
■ Wiring cautions

- For thermocouple input, use the appropriate compensation wire.
- For RTD input, use low resistance lead wire with no difference in resistance between the three lead wires.
- To avoid noise induction, keep input signal wire away from instrument power line, load lines and power lines of other electric equipment.
- If there is electrical noise in the vicinity of the instrument that could affect operation, use a noise filter.
  - Shorten the distance between the twisted power supply wire pitches to achieve the most effective noise reduction.
  - Always install the noise filter on a grounded panel. Minimize the wiring distance between the noise filter output and the instrument power supply terminals to achieve the most effective noise reduction.
  - Do not connect fuses or switches to the noise filter output wiring as this will reduce the effectiveness of the noise filter.
- Power supply wiring must be twisted and have a low voltage drop.
- For an instrument with 24 V power supply, supply power from a SELV circuit.

■ V-TIO-P/V-TIO-Q



- Terminal No. 11, 15, 16 and 17 are not used.
  Do not connect to these terminals.
- Use the solderless terminals appropriate to the screw size (M3).

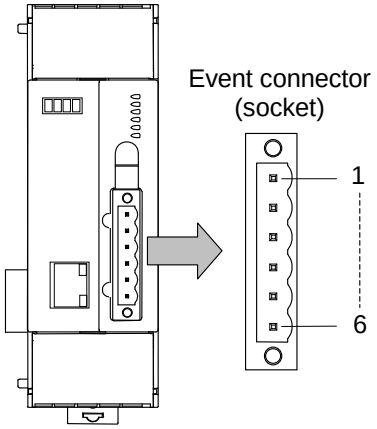


Recommended tightening torque:
0.4 N·m (4 kgf·cm)

- **For heat/cool PID control (V-TIO-Q), Input channel 2 becomes unused.**
- **For heat/cool PID control (V-TIO-Q), Control output 1 corresponds to the heating output and Control output 2 corresponds to the cooling output.**

A.2 Pin Layout of Connector

■ When there is the event input/output

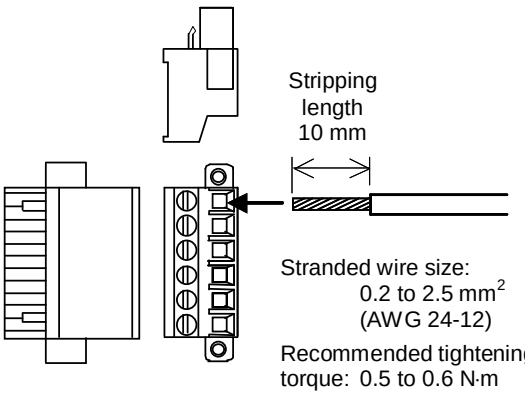


Pin No.	Description
1	Digital input (DI) (–)
2	Digital input (DI) (+)
3	Digital output (DO) 1 (Relay contact output)
4	
5	Digital output (DO) 2 (Relay contact output)
6	

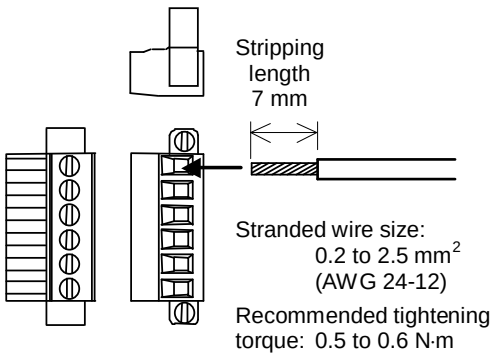
■ Attention in connector (plug) wiring

- Use the following connector (plug) as that connected to the event input/output connector. Connector (plug) is sold separately.
  SRVP-01 (Front-screw type)
  SRVP-02 (Side-screw type)
- The lead wires use the stranded wire.
- Use the stranded wire from size 0.2 to 2.5 mm^2 (AWG 24-12).
- Stripping length is as follows.
  SRVP-01: 10 mm
  SRVP-02: 7 mm
- Recommended tightening torque of the lead wire in the connector (plug):
  0.5 to 0.6 N·m (5 to 6 kgf·cm)
  (Screw size SRVP-01: M2.5
  SRVP-02: M3)

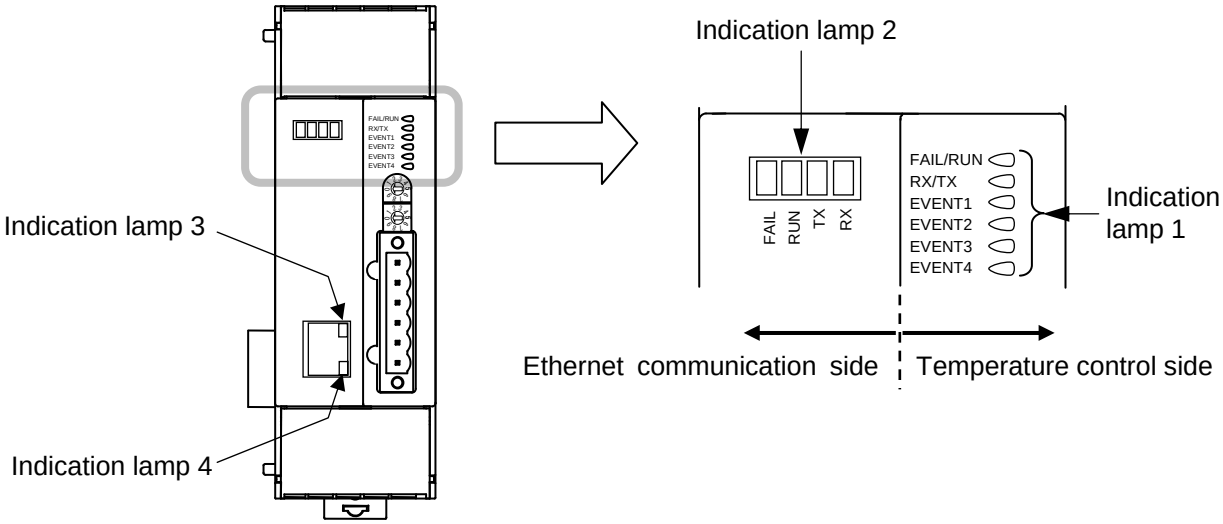
[SRVP-01] Front-screw type



[SRVP-02] Side-screw type



A.3 Indication Lamp



V-TIO-P/V-TIO-Q module

[Indication lamp 1]

- **FAIL/RUN (for temperature control)**
  During normal operation: Green lamp: ON (RUN)
  During error: Red lamp: ON (FAIL)
  During self-diagnostic error: Green lamp: flashing
- **RX/TX (for internal communication)**
  During data send or receive: Green lamp: ON
- **EVENT 1 to 4**
  Display various states by setting.
  Display contents: Event 1 state, Event 2 state, Comprehensive event state, Output state, Control state

[Indication lamp 2]

- **FAIL (for Ethernet communication)**
  During normal operation: Red lamp: OFF
  During error: Red lamp: ON
- **RUN (for Ethernet communication)**
  During normal operation: Green lamp: ON
  During error [Module configuration error, input error]:
  Green lamp: slow flashing
  During data collection after power ON:
  Green lamp: rapid flashing
- **TX (for Ethernet communication)**
  During data send: Green lamp: flashing
- **RX (for Ethernet communication)**
  During data receive: Green lamp: flashing

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[Indication lamp 3]

- **Link**

10BASE-T link:	Amber lamp: ON
100BASE-TX link:	Green lamp: ON

[Indication lamp 4]

- **Activity**

Half-duplex; activity:	Amber lamp: Momentary ON
Full-duplex; activity:	Green lamp: Momentary ON

A.4 Product Specifications

■ Input

Measured input:

Number of inputs: 2 points (For heat/cool PID control, input channel 2 becomes unused.)
Isolated between each input channel:
Thermocouple input, Voltage (low)
Not isolated between each input channel:
RTD input, Voltage (high) input, Current input

Input type:
- Thermocouple: K, J, T, S, R, E, B, N (JIS-C1602-1995)
  PLII (NBS)
  W5Re/W26Re (ASTM-E988-96)
- Resistance temperature detector (RTD) input (3-wire system):
  Pt100 (JIS-C1604-1997)
  JPt100 (JIS-C1604-1989, Pt100 of JIS-C1604-1981)
- Voltage (low): 0 to 100 mV
- Voltage (high): 0 to 5 V, 1 to 5 V, 0 to 10 V
- Current: 0 to 20 mA, 4 to 20 mA (Input impedance: 250 Ω)

The type of input needs to be specified when ordering and then fixed.

Input range:

- Temperature input (Thermocouple/RTD input)

Input type	Input range
K	0 to 400 °C, 0 to 800 °C, –200 to +1372 °C, 0.0 to 400.0 °C, –200.0 to +400.0 °C 32 to 752 °F, 32 to 1472 °F, –328 to +2501 °F, 32.0 to 752.0 °F, –328.0 to +752.0 °F
J	0 to 400 °C, 0 to 800 °C, –200 to +1200 °C, 0.0 to 400.0 °C, –200.0 to +400.0 °C 32 to 752 °F, 32 to 1472 °F, –328 to +2192 °F, 32.0 to 752.0 °F, –328.0 to +752.0 °F
R	0 to 200 °C, 0 to 400 °C, –200 to +400 °C, 0.0 to 400.0 °C, –200.0 to +400.0 °C 32 to 392 °F, 32 to 752 °F, –328 to +752 °F, 32.0 to 752.0 °F, –328.0 to +752.0 °F
S	0 to 1768 °C, 32 to 3214 °F
B	0 to 1768 °C, 32 to 3214 °F
E	0 to 1390 °C, 32 to 2534 °F
N	0 to 1300 °C, 32 to 2372 °F
T	0 to 2300 °C, 32 to 4172 °F
W5Re/W26Re	0 to 800 °C, 0 to 1000 °C, 32 to 1472 °F, 32 to 1832 °F
PLII	0 to 1800 °C, 32 to 3272 °F
Pt100	0 to 400 °C, 0 to 850 °C, 0.0 to 400.0 °C, –200.0 to +400.0 °C 32 to 752 °F, 32 to 1562 °F, 32.0 to 752.0 °F, –328.0 to +752.0 °F
JPt100	0 to 400 °C, 0 to 600 °C, 0.0 to 400.0 °C, –200.0 to +400.0 °C 32 to 752 °F, 32 to 1112 °F, 32.0 to 752.0 °F, –328.0 to +752.0 °F

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- Voltage/Current input
  Programmable range
  Input scale high limit: Input scale low limit to 10000
  Input scale low limit: −2000 to Input scale high limit
  However, a span is 12000 or less.

Accuracy (At the ambient temperature 23 °C ±2 °C):

- Thermocouple input (K, J, T, PLII, E)
  Less than −100 °C: ±2.0 °C
  −100 °C to less than +334 °C: ±1.0 °C
  334 °C or more: ± (0.3 % of reading + 1digit)
- Thermocouple input (R, S, N, W5Re/W26Re)
  −50 °C to less than +667 °C: ±2.0 °C
  667 °C or more: ± (0.3 % of reading + 1digit)
- Thermocouple input (B)
  Less than 400 °C: ±70.0 °C
  400 °C to less than 667 °C: ±2.0 °C
  667 °C or more: ± (0.3 % of reading + 1digit)
- RTD input
  Less than 267 °C: ±0.8 °C
  267 °C or more: ± (0.3 % of reading + 1digit)
- Voltage/Current input
  ± 0.3 % of span
- Cold junction temperature compensation accuracy
  ±1.0 °C (Ambient temperature 23 °C ±2 °C)
  Within ±1.5 °C between −10 to +50 °C of ambient temperature

Sampling cycle: 500 ms

Input resolution:
Thermocouple input: 1 °C or 0.1 °C
RTD input: 1 °C or 0.1 °C
Voltage/Current input: 1 to 0.0001 (programmable)

RTD sensor current: Approx. 0.25 mA

Action at input break:
Thermocouple input: Upscale
RTD input: Upscale
Voltage input
0 to 100 mV: Upscale
0 to 5 V, 1 to 5 V, 0 to 10 V: Indicates value near 0 V
Current input
0 to 20 mA, 4 to 20 mA: Indicates value near 0 mA

Action at input short circuit: Downscale (Only for RTD input)

Signal source resistance effect:
0.15 μV/Ω (Only for thermocouple input)

Allowable influence of input lead:
10 Ω or less per wire (Only for RTD input)

Input digital filter: First order lag digital filter
Time constant: 1 to 100 seconds (Setting 0: Filter OFF)

PV bias: ±Input range span

Normal mode rejection ratio (NMRR):
60 dB or more

CT input:

Number of inputs:	2 points
Sampling cycle:	1 second (Data update cycle)
Resolution of A/D transfer:	10-bit or more
Input current:	0.0 to 30.0 A (CTL-6-P-N)
	0.0 to 100.0 A (CTL-12-S56-10L-N)
Current measuring accuracy:	±5 % of input value or ±2 A
	(The value whichever is greater)

■ Output

Number of outputs: 2 points
Isolated between input and output and between output and power supply. Not isolated between each output channel.

Output type: The type of output needs to be specified when ordering and then fixed. (The type of output can be selected independently for each channel.)

- Relay contact output
  Contact type: 1a contact
  250 V AC 3 A (Resistive load)
  Electrical life: 300,000 times or more (Rated load)
- Voltage pulse output
  Output voltage: 0/12 V DC
  Allowable load resistance: 600 Ω or more
- Current output
  Output type: 0 to 20 mA DC, 4 to 20 mA DC
  Allowable load resistance: 600 Ω or less
  Output resolution: 11-bit or more
- Voltage output
  Output voltage: 0 to 5 V DC, 1 to 5 V DC, 0 to 10 V DC
  Allowable load resistance: 1 kΩ or more
  Output resolution: 11-bit or more

■ Indication lamp

Number of indicates: 10 points

Indication contents:

Temperature control side

- Operation state indication [RUN/FAIL] (1 point)
  During normal operation: Green lamp: ON (RUN)
  During error: Red lamp: ON (FAIL)
  During self-diagnostic error: Green lamp: flashing
- Communication state indication [RX/TX] (1 point)
  During data send or receive: Green lamp: ON
- Event display [EVENT1 to 4] (4 points)
  Various states are displayed depending on setting.
  Display contents: Event 1 state, Event 2 state, Comprehensive event state, Output state, Control state

Ethernet communication side

- Operation state indication [RUN, FAIL] (2points)
  During normal operation: Green lamp: ON (RUN)
  During error: Red lamp: ON (FAIL)
  During data collection after power ON:
  Green lamp: rapid flashing (RUN)
  During self-diagnostic error: Green lamp: slow flashing (RUN)
- Communication state indication [TX, RX] (2 points)
  During data send: Green lamp: flashing (TX)
  During data receive: Green lamp: flashing (RX)

■ Setting

Setting method: Setting by communication

Setting range: Same as input range

Setting resolution: Same as input resolution

■ Control

Number of controls: 2 points

Control method: Brilliant PID control
Correspond to the heat control direct action, the heat control reverse action and the heat/cool control.

Additional functions: Autotuning function
With output limiter function

Setting range: Proportional band (heat-side/cool-side):
Temperature input: 0 (0.0) to Input span
Voltage/Current input: 0.0 to 100.0 % of Input span
(0 or 0.0: ON/OFF action)
Integral time: 1 to 3600 seconds
Derivative time: 0 to 3600 seconds (0: PI action)

Control response parameter: Slow, Medium, Fast

Output limiter (high): Heat control: Output limiter (low) to +105.0 %
Heat/cool control: –5.0 to +105.0 % (For both control heat and cool)

Output limiter (low): Heat control: –5.0 % to Output limiter (high)
Heat/cool control: –5.0 % (fixed) (For both control heat and cool)
For the heat/cool control, the cool-side output limiter (high) is set by using the register address of the output limiter (low).

Overlap/Deadband: –Input span to +Input span
Minus (–) setting results in overlap.

Setting change rate limiter: 0 (0.0) to Input span/minute
0 (0.0): Setting change rate limiter OFF

Proportioning cycle time: 1 to 100 seconds (heat-side/cool-side)

Direct/Reverse action selection:
Direct action, Reverse action

AUTO/MAN selection: Auto mode (AUTO), Manual mode (MAN)

Manual output setting: –5.0 to +105.0 %
However, the actual output value is within output limiter range.

PID/AT transfer: PID control, Autotuning (AT)

AT bias: ±Input span

■ Event function

Number of events: 2 points/channel

Event type: Deviation high, Deviation low, Deviation high/low, Band,
Process high, Process low

Additional function: Hold action, Re-hold action, Interlock action
Event delay timer: 0 to 9999 seconds

Setting range: Deviation high, Deviation low: –Input span to +Input span
Deviation high/low, Band: 0 (0.0) to Input span
Process high, Process low: Within input range

Differential gap: 0 to Input span

Event state: Output the event state as communication data.

■ Heater break alarm (HBA) function

Heater break alarm function cannot be used when control output is voltage/current output.

Number of HBA: 2 points

Setting range: 0.0 to 30.0 A (Current transformer: CTL-6-P-N)
0.0 to 100.0 A (Current transformer: CTL-12-S56-10L-N)
(0.0 A: HBA OFF)

Additional function: Number of event delay times: 1 to 255 times

HBA state: Output the HBA state as communication data.

■ Control loop break alarm (LBA) function

Number of LBA: 2 points

LBA time: 1 to 7200 seconds

LBA deadband (LBD) setting: 0 to Input span

LBA state: Output the LBA state as communication data.

■ Comprehensive event state

Event state: Bit data items are expressed in decimal number from 0 to 31.

Burnout:	bit 0
Event 1 state:	bit 1
Event 2 state:	bit 2
Heater break alarm (HBA) state:	bit 3
Control loop break alarm (LBA) state:	bit 4

■ Control action selection function at input error

Function: This function is used to change to the manual mode when the input is abnormal [Input error determination point (low) ≥ PV ≥ Input error determination point (high)] in the control state.

Action selection: It is selected whether or not the manual output is changed independently of the high limit and low limit.

Setting range: Input error determination point (high): Within input range
Input error determination point (low): Within input range
Manipulated output value at input error: –105.0 to +105.0 %
(However, the actual output value is within output limiter range.)

■ Control RUN/STOP function

Function: RUN/STOP action is taken simultaneously for two channels.
The function and output in the control stop state are the same as those when the power supply is turned off.
Control STOP: 0
Control RUN: 1

■ Ethernet communication

Physical layer: Ethernet
10BASE-T/100BASE-TX automatic recognition

Application layer: Modbus/TCP

Communication data: Based on Modbus message format

Connector type: RJ-45

Maximum connections: Up to 30 temperature control modules can be connected to one V-TIO-P/V-TIO-Q module.

■ Internal communication

Interface: Based on RS-485, EIA standard

Connection method: 2-wire system, half-duplex multi-drop connection

Synchronous method: Start/stop synchronous type

Communication speed: 38400 bps

Data bit configuration: Start bit: 1
Data bit: 8
Parity bit: Without
Stop bit: 1

Protocol: Modbus

Maximum connections: Up to 30 temperature control modules can be connected to one V-TIO-P/V-TIO-Q module.

■ Self-diagnostic function

Check item (error code): Bit data items in the error state are expressed in decimal numbers from 0 to 255.

Memory backup error:	bit 0
Internal communication error:	bit 2
Adjustment data error:	bit 3
Input A/D error:	bit 4
Current transformer input A/D error:	bit 5
Temperature compensation A/D error:	bit 6
	(bit 1 and bit 7: Unused)

■ Optional function

Event input:	Number of inputs:	1 point
	Input type:	Dry contact input
	Input voltage:	24 V DC (Rated)
	Input current:	Approx. 6 mA
	Isolated method:	Photocoupler
	Input details:	Control RUN/STOP, Event interlock release (Specify when ordering)
Event output:	Number of outputs:	2 points
	Output type:	Relay contact output 250 V AC, 1 A (Resistive load), 1a contact Electrical life: 300,000 times or more (Rated load)
	Output details:	Temperature event, Heater break alarm, Control loop break alarm, Burnout, Temperature rise completion (Specify when ordering)

■ General specifications

Power supply:	Power supply voltage:	24 V DC
	Power supply voltage range:	21.6 to 26.4 V DC
	Current consumption:	With event input/output (option): 220 mA max./module Without event input/output (option): 200 mA max./module
	Rush current:	12 A or less/module
Insulation resistance:	20 MΩ or more at 500 V DC (Between each insulation block)	
Withstand voltage:	600 V AC for 1 minute (Between each insulation block)	
Power failure effect:	No influence even under power failure of 20 ms or less.	
Memory backup:	Backed up by EEPROM.	
	Number of write times:	Approx. 100,000 times
	Data storage period:	Approx. 10 years

Working environment conditions:

Allowable ambient temperature:	−10 to +50 °C
Allowable ambient humidity:	5 to 95 %RH (Non-condensing) Absolute humidity: MAX.W.C 29 g/m^3 dry air at 101.3 kPa

■ Mounting and structure

Mounting procedure:	DIN rail mounting
Case color:	Terminal base: Black Module mainframe: Bluish white
Dimensions:	40.5 (W) ×125.0 (H) ×110.0 (D) mm
Weight:	With event input/output (option): Approx. 270 g Without event input/output (option): Approx. 260 g

■ Standard

Safety standard:	UL: UL61010-1 cUL: CAN/CSA-C22.2 No.61010-1
CE marking:	LVD: EN61010-1 OVERVOLTAGE CATEGORYII, POLLUTION DEGREE 2, Class II (Reinforced insulation) EMC: EN61326-1
RCM:	EN55011

APPENDIX B. DATA PROCESSING TIME

The following communication time is required for the SRV.

■ Internal communication data updating cycle

This is the data updating time required for internal communication.

Internal communication data updating cycle = 100 ms × Number of connected TIO channels

(However, it becomes as follows in the initial setting mode.
Internal communication data updating cycle = 200 ms × Number of connected TIO channels)

[Example]
When the number of connected TIO channels is 62 (the maximum number of connected channel)
Internal communication data updating cycle = 100 ms × 62 = 6.2 seconds

The number of actual control channels corresponding to temperature control modules connected to the V-TIO-P/V-TIO-Q module is entered in the number of connected TIO channels.

■ Connected module recognition time

This is the time required until the V-TIO-P/V-TIO-Q module recognizes the temperature control module connected after the power is turned on.

Connected module recognition time
= 7 seconds + (Number of connected TIO channels × 0.25 seconds)
+ (Number of nonexistent addresses × 0.7 seconds)

"Number of nonexistent addresses" means the number of addresses which are not actually used from among connectable module address from 0 to 30.

[Example]
When the number of connected TIO channels is two channels (only address 0)
Connected module recognition time
= 7 seconds + (2 × 0.25 seconds) + (30 × 0.7 seconds) = 28.5 seconds

MEMO

INDEX OF DATA ITEMS

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