Module Type Controller

SRV

Communication Instruction Manual

RKC® RKC INSTRUMENT INC.

IMS01P01-E6

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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.
- 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.
- No portion of this document may be reprinted, modified, copied, transmitted, digitized, stored, processed or retrieved through any mechanical, electronic, optical or other means without prior written approval from RKC.

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1. OUTLINE

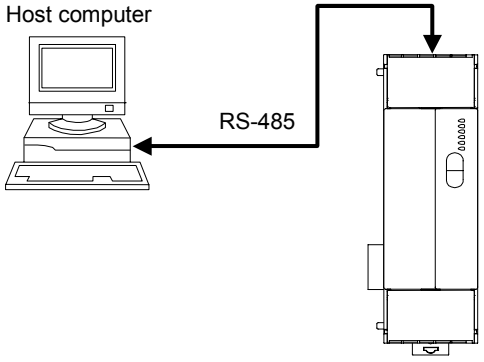
Module type controller SRV interfaces with the host computer via Modbus or RKC communication protocols. The SRV sets all of the data items via communication. Therefore before operation, it is necessary to set value of each data item via communication.

- The communication protocol (RKC communication or Modbus) is usually specified when ordering but can be change after purchasing. A user can select RKC communication or Modbus.

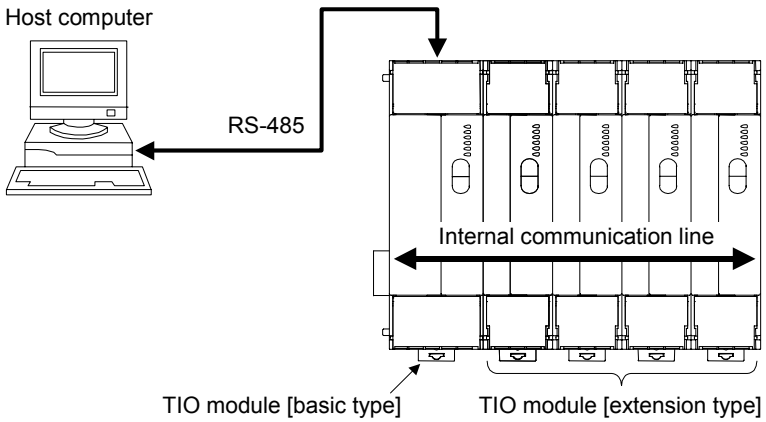
  ☞ For the change method of communication protocol, see **5.2 Protocol Selections and Communication Speed Setting (P. 15)**.

- The temperature control (TIO) module [basic type] (hereafter called TIO module [basic type]) can communicate independently with the host computer. In addition, as the temperature control (TIO) module [extension type] (hereafter called TIO module [extension type]) is not provide with power supply and host communication terminals, communication with the host computer is always made with this module connected to the TIO module [basic type].
- As the communication line passes on the internal bus when the TIO module [extension type] is connected to the TIO module [basic type], no communication wiring for each module is required, thereby being able to achieve wire saving.
- It uses RS-485 as a communication interface and also can connect up to 31 modules.

  For reference purposes, the Modbus protocol identifies the host computer as master, each module of SRV as slave.



When connected TIO module [basic type] alone



When connected one or more TIO module [extension type] to TIO module [basic type]

2. COMMUNICATION SPECIFICATIONS

■ RKC 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: 2400 bps, 9600 bps, 19200 bps, 38400 bps

Data bit configuration:
Start bit: 1
Data bit: 7 or 8
Parity bit: Without, Odd or Even
Stop bit: 1

Protocol: ANSI X3.28 subcategory 2.5, A4
Polling/selecting type

Error control: Vertical parity (With parity bit selected)
Horizontal parity (BCC check)

Communication code: ASCII 7-bit code

Termination resistor: TIO module [basic type]: Externally terminal connected
TIO module [extension type]: Select with the internal switch

Maximum connections: 32 instruments maximum including a host computer

Signal logic: RS-485

Signal voltage	Logic
V (A) – V (B) ≥ 2 V	0 (SPACE)
V (A) – V (B) ≤ –2 V	1 (MARK)

Voltage between V (A) and V (B) is the voltage of (A) terminal for the (B) terminal.

■ Modbus

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: 2400 bps, 9600 bps, 19200 bps, 38400 bps

Data bit configuration:
Start bit: 1
Data bit: 8
Parity bit: Without, Odd or Even
Stop bit: 1

Protocol: Modbus

Signal transmission mode: Remote Terminal Unit (RTU) mode

Function code: 03H (Read holding registers)
06H (Preset single register)
08H (Diagnostics: loopback test)
10H (Preset multiple registers)

Error check method: CRC-16

Error code: 1: Function code error
(An unsupported function code was specified)
2: When the mismatched address is specified.
3: • When the data written exceeds the setting range.
• When the specified number of data items in the query message exceeds the maximum number (1 to 125) of data items available

Termination resistor: TIO module [basic type]: Externally terminal connected
TIO module [extension type]: Select with the internal switch

Maximum connections: 32 instruments maximum including a host computer

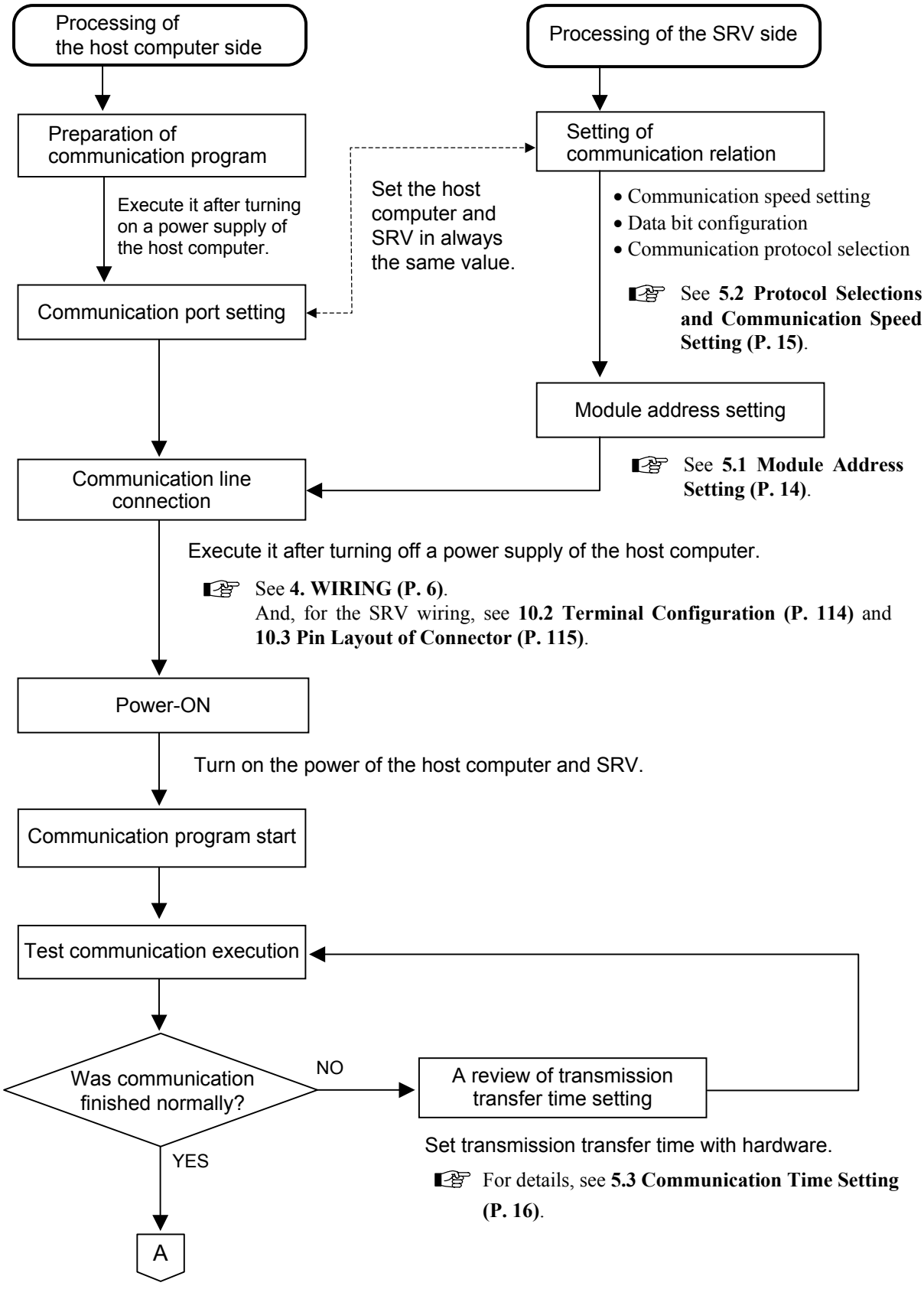
Signal logic: RS-485

Signal voltage	Logic
V (A) – V (B) ≥ 2 V	0 (SPACE)
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Voltage between V (A) and V (B) is the voltage of (A) terminal for the (B) terminal.

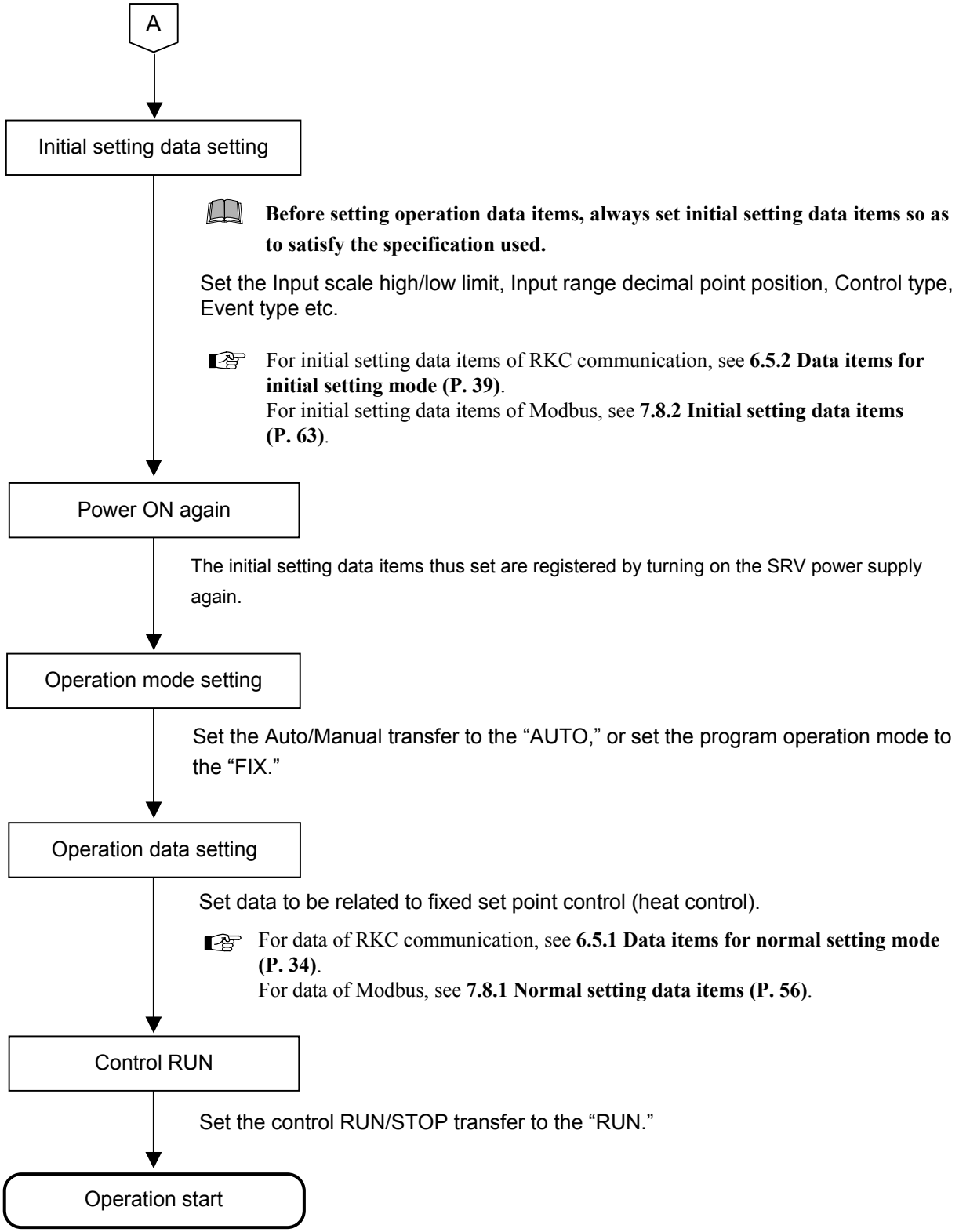
3. SETTING PROCEDURE TO OPERATION

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



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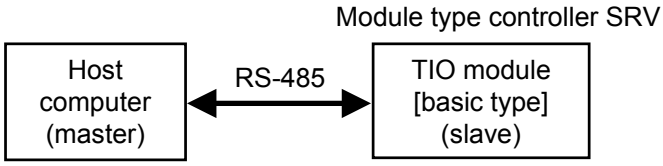
4. WIRING

⚠ WARNING

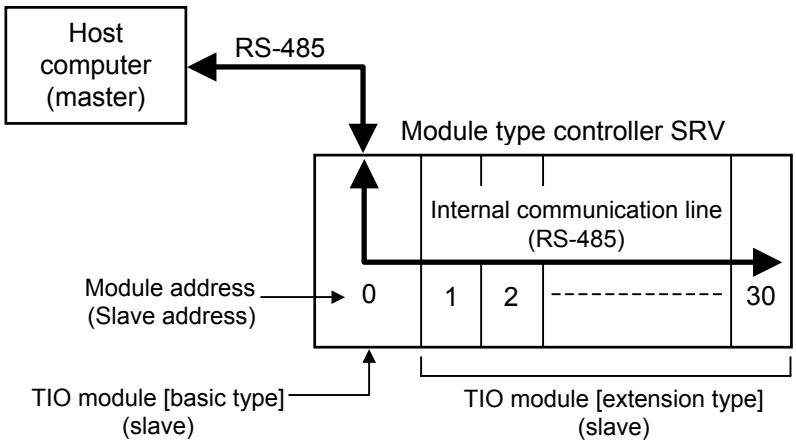
To prevent electric shock or instrument failure, turn off the power before connecting or disconnecting the instrument and peripheral equipment.

4.1 Wiring Configuration

■ **When connected TIO module [basic type] alone**

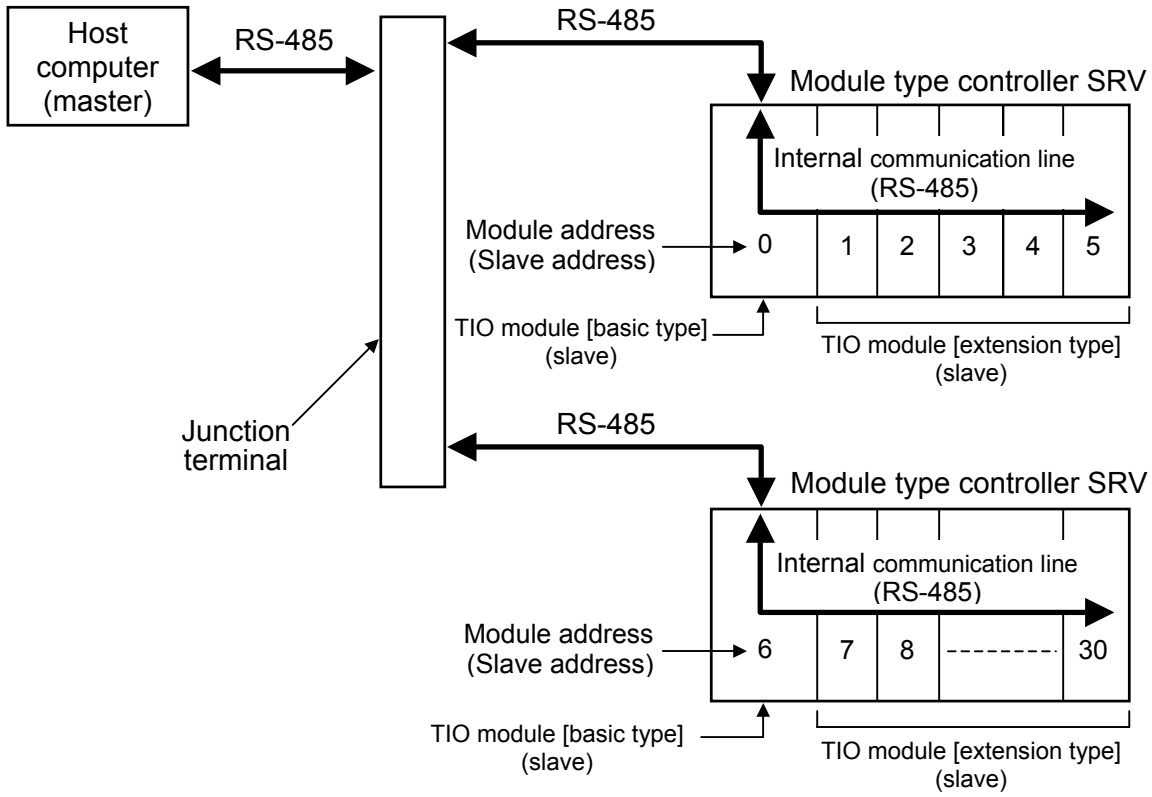


■ **When two or more TIO module [extension type] are connected to one TIO module [basic type]**



The TIO module of SRV can connect up to 31 modules.

■ When two or more SRV units are connected



One SRV unit consists of one TIO module [basic type] and several TIO modules [extension type].

The TIO module of SRV can connect up to 31 modules regardless of the number of units.

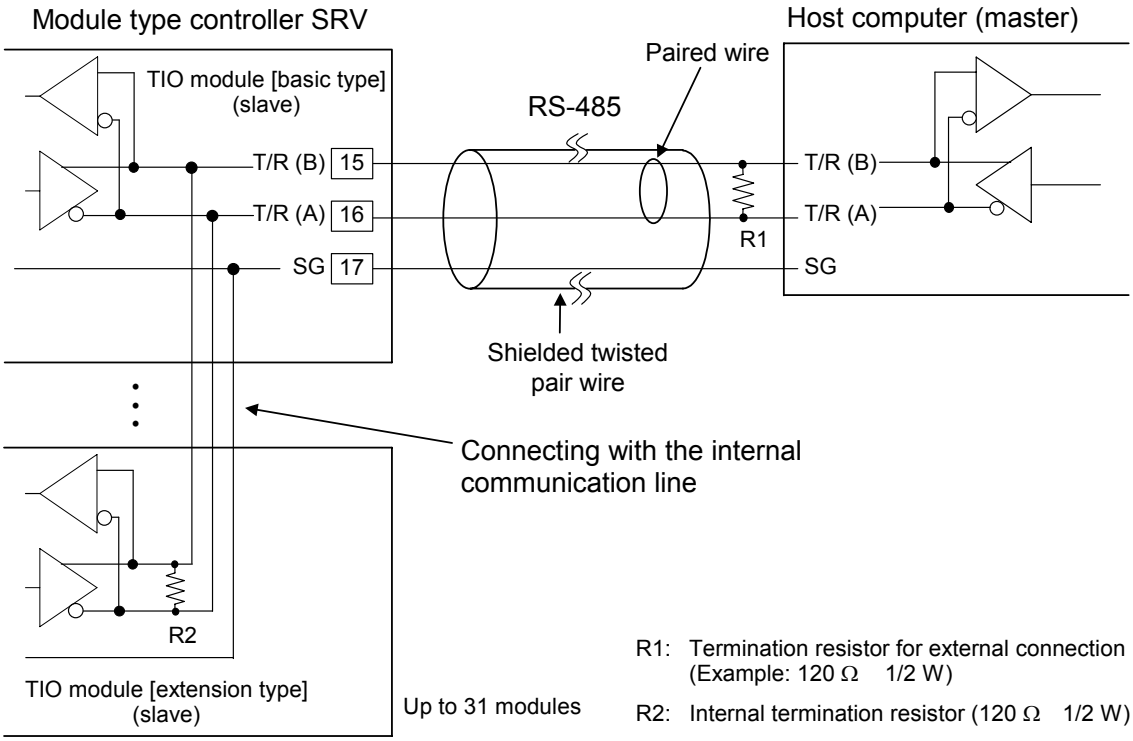
4.2 Wiring Details

■ Terminal number and signal details

Terminal No.	Signal name	Symbol
15	Send data/Receive data	T/R (B)
16	Send data/Receive data	T/R (A)
17	Signal ground	SG

■ Wiring figure

● Connection to the RS-485 port of the host computer (master)

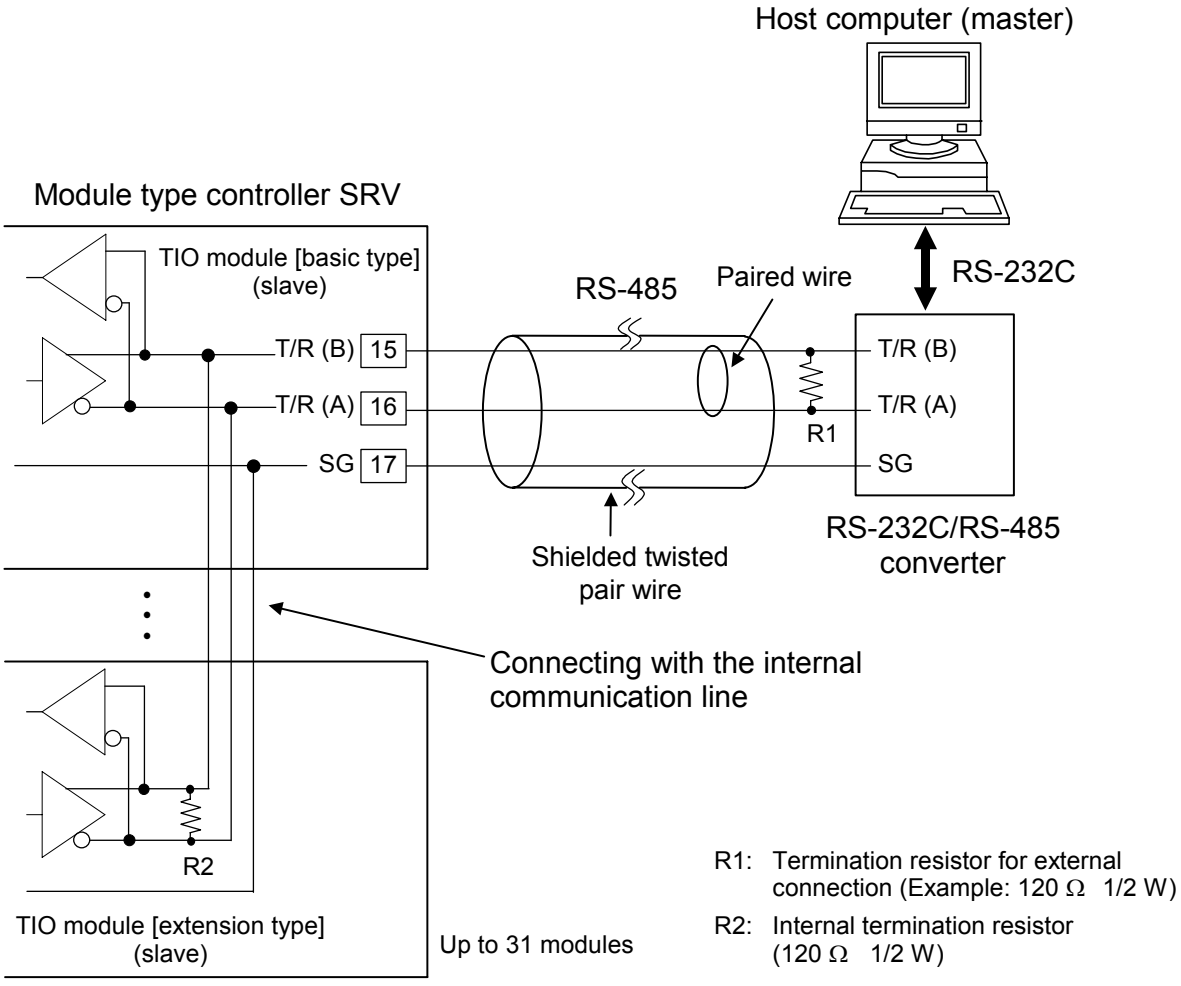


The cable is provided by the customer.

For installation method of termination resistor of the SRV side, see **4.3 Installation of Termination Resistor for Host Communication (P. 10)**.

- **Connection to the RS-232C port of the host computer (master)**

A RS-232C/RS-485 converter is required.



When the host computer (master) uses Windows 95/98/Me/NT/2000/XP, use a RS-232C/RS-485 converter with an automatic send/receive transfer function. Recommended: CD485, CD485/V manufactured by Data Link, Inc. or equivalent.

The cable is provided by the customer.

For installation method of termination resistor of the SRV side, see **4.3 Installation of Termination Resistor for Host Communication (P. 10)**.

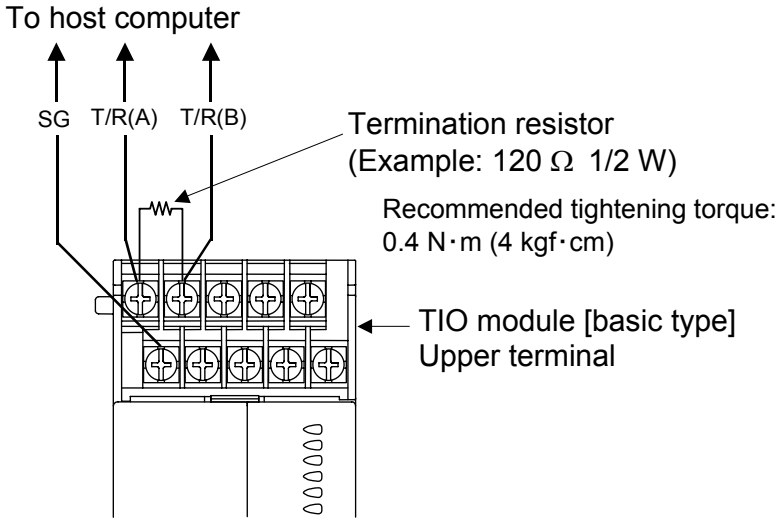
4.3 Installation of Termination Resistor for Host Communication

When a termination resistor is connected to both ends of the RS-485 communication line, a procedure for connecting the termination resistor on the SRV side is described.

For the termination resistor on the host computer side, connect it so as to satisfy the host computer used.

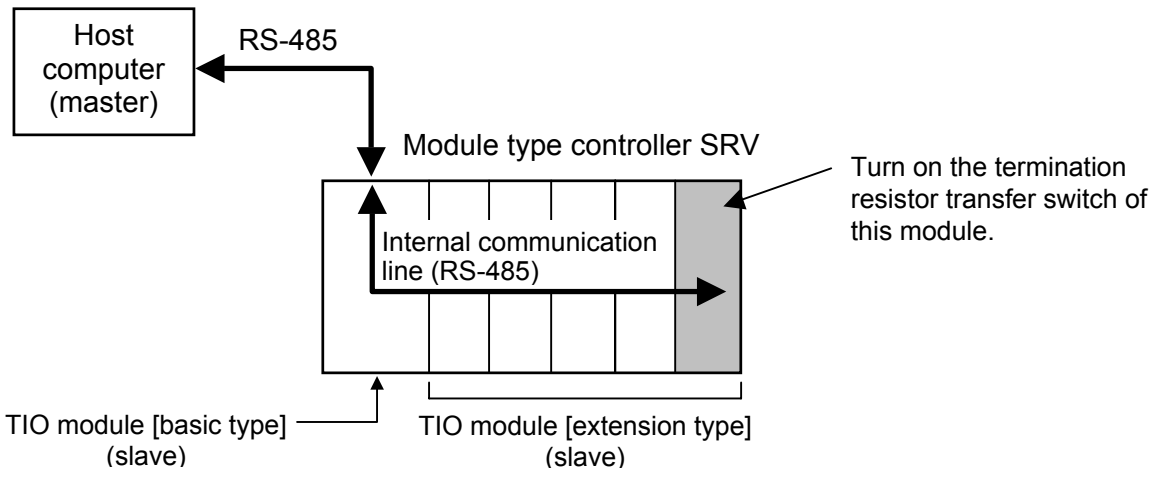
■ When connected TIO module [basic type] alone

Install termination resistor in terminal directly.



■ When two or more TIO module [extension type] are connected to one TIO module [basic type]

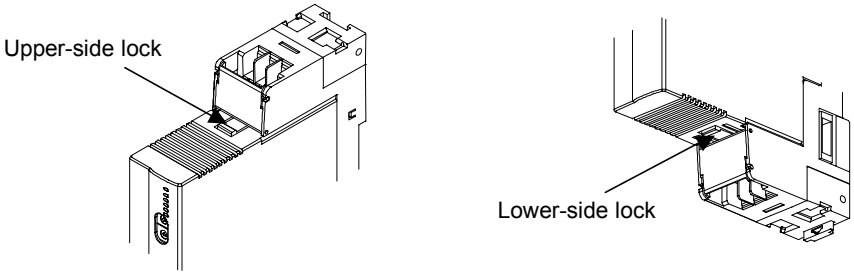
When the extension module is connected to the basic module, connect a termination resistor to the termination of the communication line in the extension module at the extreme end.
As a termination resistor is not externally connected to the TIO module [extension type], a termination resistor built in the module is switch-selected.

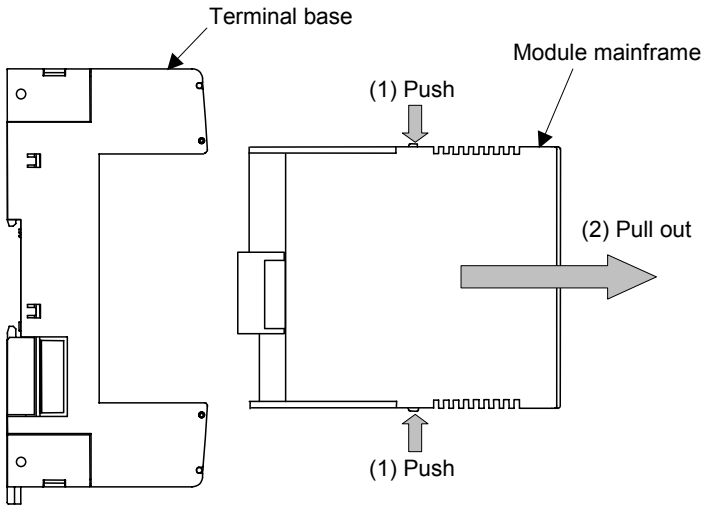


● Transfer procedure of internal termination resistor

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.

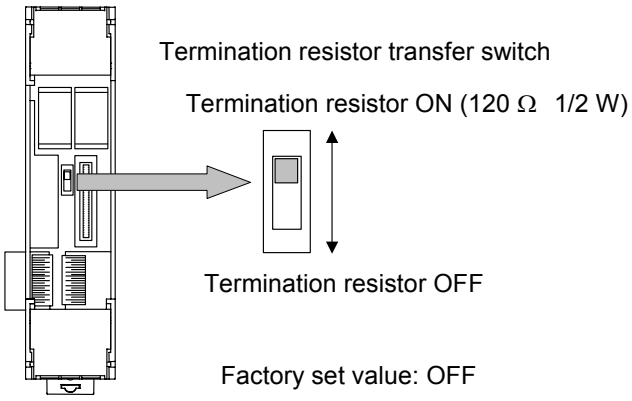
2. Pull out the module mainframe itself toward you while pushing the locks at its top and bottom, and then separate it from the terminal base.





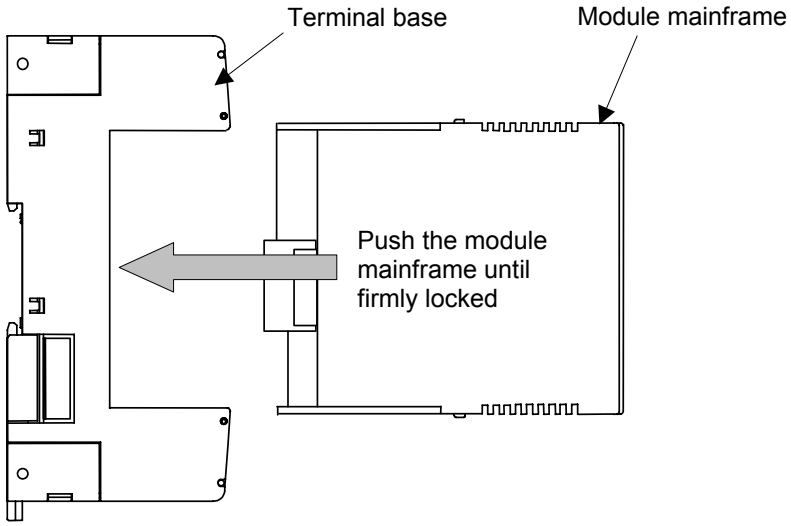
Removing the module mainframe

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



A terminal base of the state which removed module mainframe

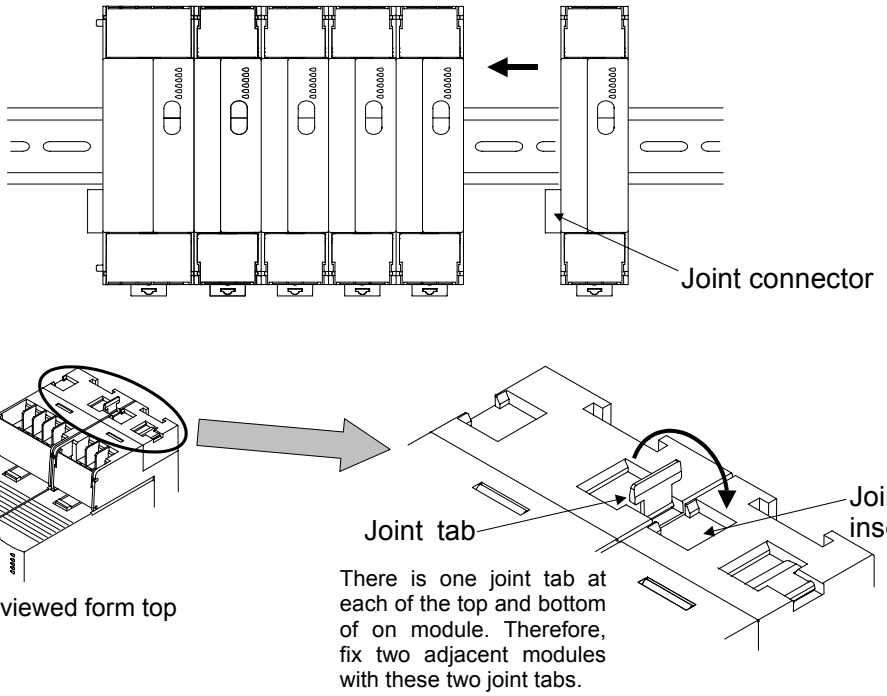
4. Push the module mainframe thus separated in the terminal base until firmly locked.



Mounting the module mainframe

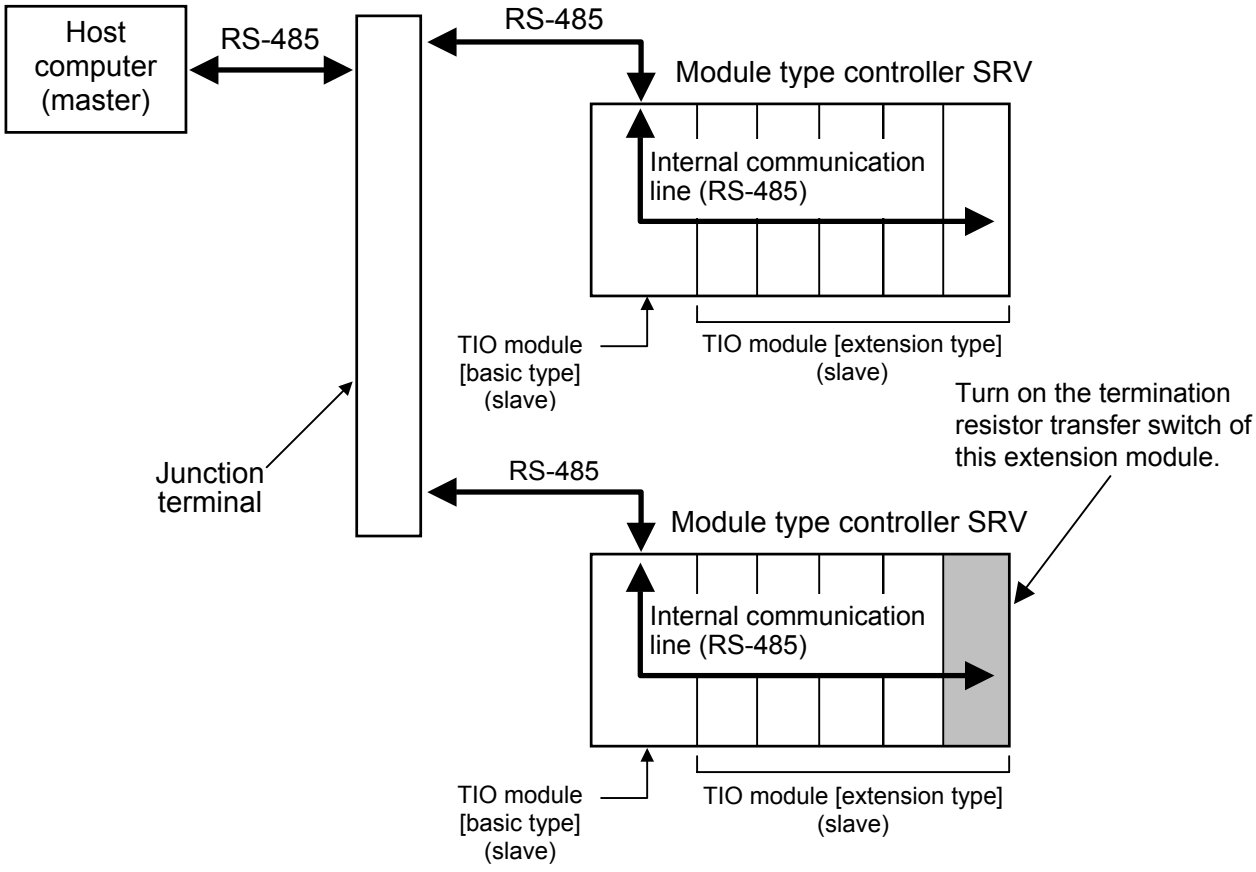
5. Connect the module whose termination resistor transfer switch is turned to the ON position to the right end.

Connect each module using joint connector while sliding the module. And, lift each of the joint tabs located at the top and bottom of the module and then insert it in the slot of the adjacent module to fix these two modules.



■ When two or more SRV units are connected

When two or more SRV units (consisting of one TIO module [basic type] and several TIO modules [extension type]) are connected, it is necessary to connect a termination resistor to the termination of the communication line in the module located most distantly from the host computer (master).
A termination resistor is built in the TIO module [extension type] and it can be connected to the circuit by selecting the switch.



☞ For the termination resistor installation, see ■ **When two or more TIO module [extension type] are connected to one TIO module [basic type] (P. 10)**.

5. 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.

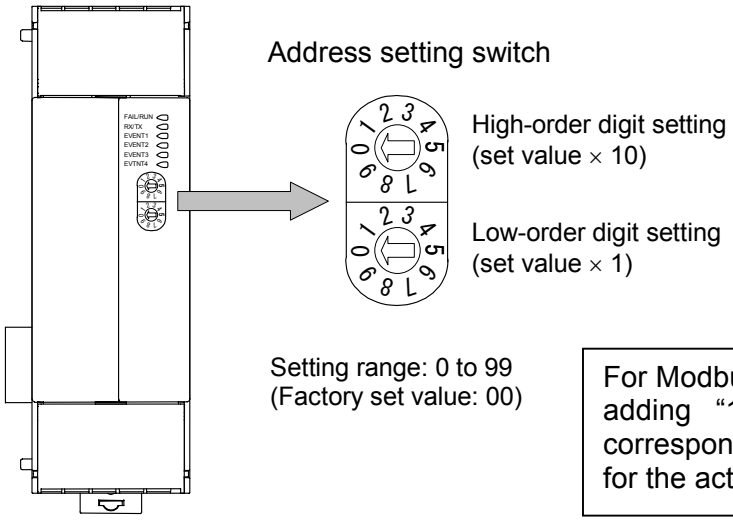
CAUTION

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.

5.1 Module Address Setting

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



Setting range: 0 to 99
(Factory set value: 00)

For Modbus, the value obtained by adding "1" to the set address corresponds to the address used for the actual program.

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

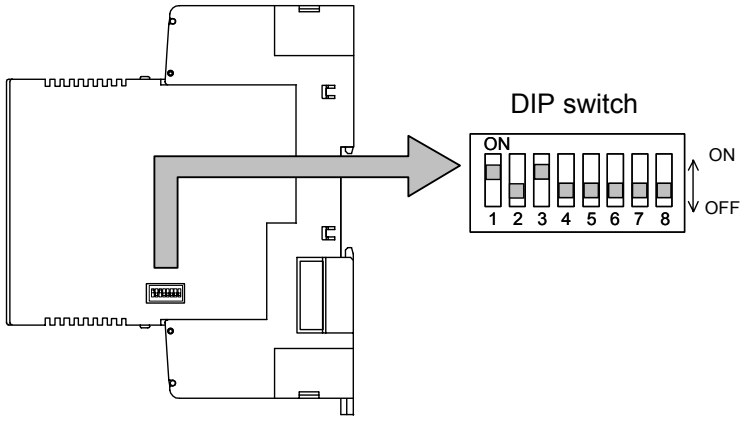
When two or more TIO module [extension type] are connected to one TIO module [basic type], set the smallest address number to that TIO module [basic type].

The above figure is TIO module [basic type]. The figure of TIO module [expansion type] is the same as a TIO module [basic type].

5.2 Protocol Selections and Communication Speed Setting

With the DIP switch which there is on the right side of module, select communication speed, data bit configuration and protocol.

When two or more modules are connected on the same line, turn each switch in the DIP switches of all of the modules to the same position. Otherwise the module may fail or malfunction.



Right side view

1	2	Communication speed
OFF	OFF	2400 bps
ON	OFF	9600 bps
OFF	ON	19200 bps
ON	ON	38400 bps

Factory set value: RKC communication: 9600 bps
Modbus: 38400 bps

3	4	5	Data bit configuration
OFF	OFF	OFF	Data 7-bit, without parity *
OFF	OFF	ON	Data 7-bit, Even parity *
OFF	ON	ON	Data 7-bit, Odd parity *
ON	OFF	OFF	Data 8-bit, without parity
ON	OFF	ON	Data 8-bit, Even parity
ON	ON	ON	Data 8-bit, Odd parity

Setting range of Modbus

Setting range of RKC communication

* When the Modbus communication protocol selected, this setting becomes invalid. (Stop 1-bit: fixed)
Factory set value: Data 8-bit, without parity

6	Protocol selection
OFF	RKC communication
ON	Modbus

Factory set value: Specify when ordering

Switch No. 7, 8: OFF fixed (Do not change this one)

5.3 Communication Time Setting

The DIP switch on the right side of the module enables the setting of "transmission transfer time" and "data interval extension time (during Modbus communication)" by hardware.

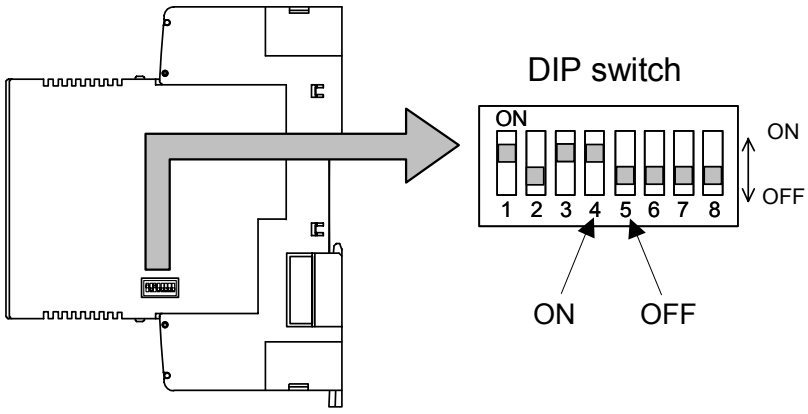
Transmission transfer time: The sending and receiving of RS-485 communication is conducted through two wires; consequently, the transmission and reception of data requires precise timing. Then, set the desired transmission transfer time to secure the time until the transmission line is changed to data receiving after the host computer ends its sending.
(Factory set value: 6 ms)

☞ See **5.4 Communication Requirements (P. 18)**.

Data interval extension time: For Modbus, a data time interval is set to less than 24 bits' time. However, it may become more than 24 bits' time depending on the type of master. In that case, extend the data time interval in the range of 0 to 99 ms.
(Factory set value: 0 ms)

- **Setting procedure of communication time**

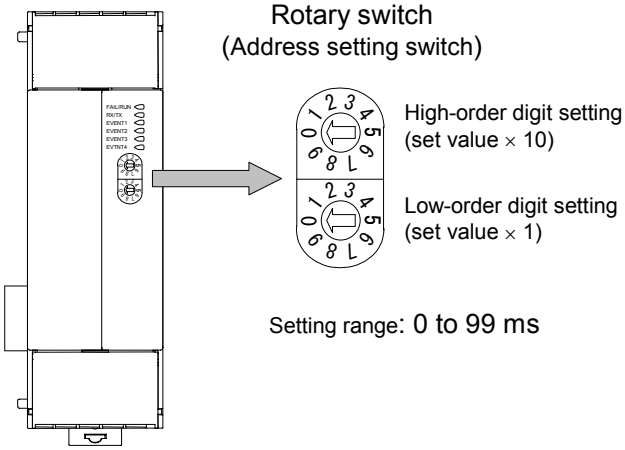
1. Set the module to the communication time setting mode by turning No. 4 switch in the DIP switch at the right side to the ON position and No. 5 switch in the same DIP switch to the OFF position with the power supply turned off. At this time the module is set to the transmission transfer time setting mode with No. 6 switch turned to the OFF position or to the data interval extension time setting mode with No. 6 switch turned to the ON position.
Switch Nos. other than Nos. 4, 5 and 6 may be turned to any of ON/OFF positions.



Right side view

4	5	6	Communication Time Setting
ON	OFF	OFF	Transmission transfer time
		ON	Data interval extension time

2. Set "Transmission transfer time" or "Data interval extension time" by the rotary switches (address setting switches) at the front. Set the tens digit by the upper rotary switch, while units digit, by the lower rotary switch.



3. Under the above condition, turn on the SRV power supply. The FAIL/RUN lamp lights in green to make the time thus set valid.

4. Turn the power supply off, and then return the DIP and rotary switches to their original positions to end the setting.

5.4 Communication Requirements

■ Processing times during data send/receive

The SRV requires the following processing times during data send/receive.
Whether the host computer is using either the polling or selecting procedure for communication, the following processing times are required for SRV to send data:

-Response wait time after SRV sends BCC in polling procedure
-Response wait time after SRV sends ACK or NAK in selecting procedure

RKC communication (Polling procedure)

Procedure details	Time
Response send time after SRV receives ENQ	15 ms max.
Response send time after SRV receives ACK	15 ms max.
Response send time after SRV receives NAK	15 ms max.
Response wait time after SRV sends BCC	1 ms max.

RKC communication (Selecting procedure)

Procedure details	Time
Response send time after SRV receives BCC	15 ms max.
Response wait time after SRV sends ACK	1 ms max.
Response wait time after SRV sends NAK	1 ms max.

Modbus

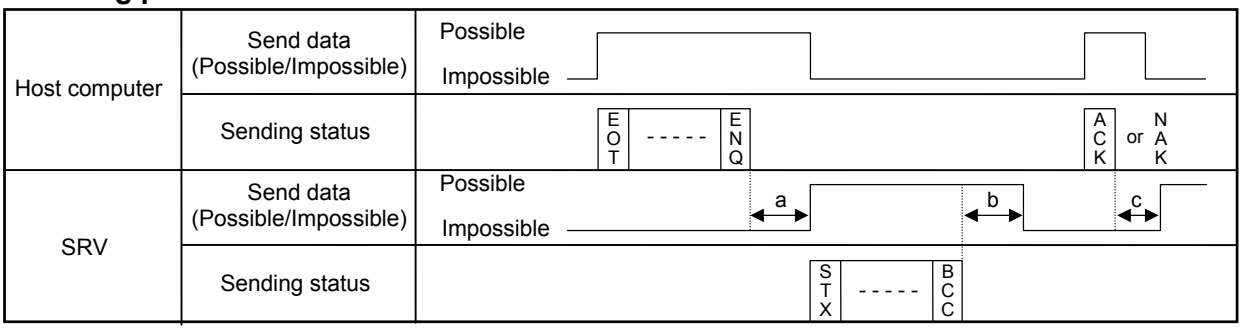
Procedure details	Time
Read holding registers [03H] Response send time after the slave receives the query message	15 ms max.
Preset single register [06H] Response send time after the slave receives the query message	15 ms max.
Diagnostics (loopback test) [08H] Response send time after the slave receives the query message	15 ms max.
Preset multiple register [10H] Response send time after the slave receives the query message	15 ms max.

Only 1 port uses communication port, and response send time is time at having set transmission transfer time in 0 ms.

■ RS-485 (2-wire system) send/receive timing

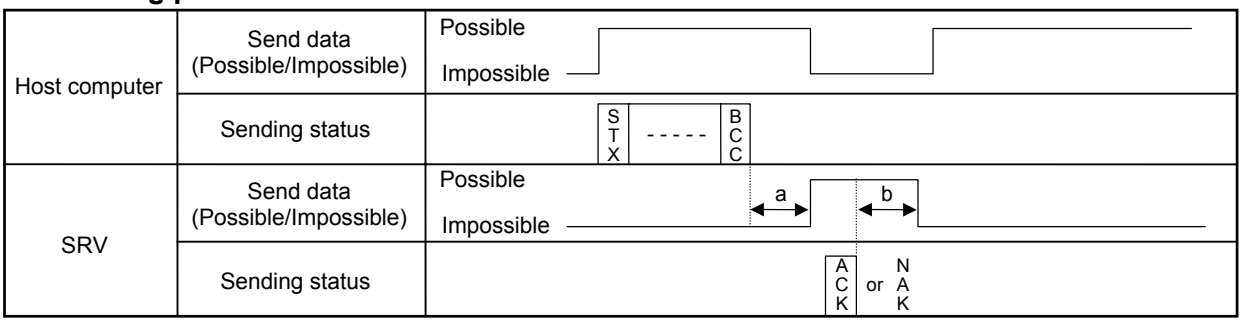
The sending and receiving of RS-485 communication is conducted through two wires; consequently, the transmission and reception of data requires precise timing.

● Polling procedure



a: Response send time after SRV receives ENQ + Transmission transfer time
b: Response wait time after SRV sends BCC
c: Response send time after SRV receives ACK + Transmission transfer time or
Response send time after SRV receives NAK + Transmission transfer time

● Selecting procedure



a: Response send time after SRV receives BCC + Transmission transfer time
b: Response wait time after SRV sends ACK or Response wait time after SRV sends NAK


To switch the host computer from transmission to reception, send data must be on line. To check if data is on line, do not use the host computer's transmission buffer but confirm it by the shift register.


Whether the host computer is using either the polling or selecting procedure for communication, the following processing times are required for SRV to send data:
-Response wait time after SRV sends BCC in polling procedure
-Response wait time after SRV sends ACK or NAK in selecting procedure

■ Fail-safe

A transmission error may occur with the transmission line disconnected, shorted or set to the high-impedance state. In order to prevent the above error, it is recommended that the fail-safe function be provided on the receiver side of the host computer. The fail-safe function can prevent a framing error from its occurrence by making the receiver output stable to the MARK (1) when the transmission line is in the high-impedance state.

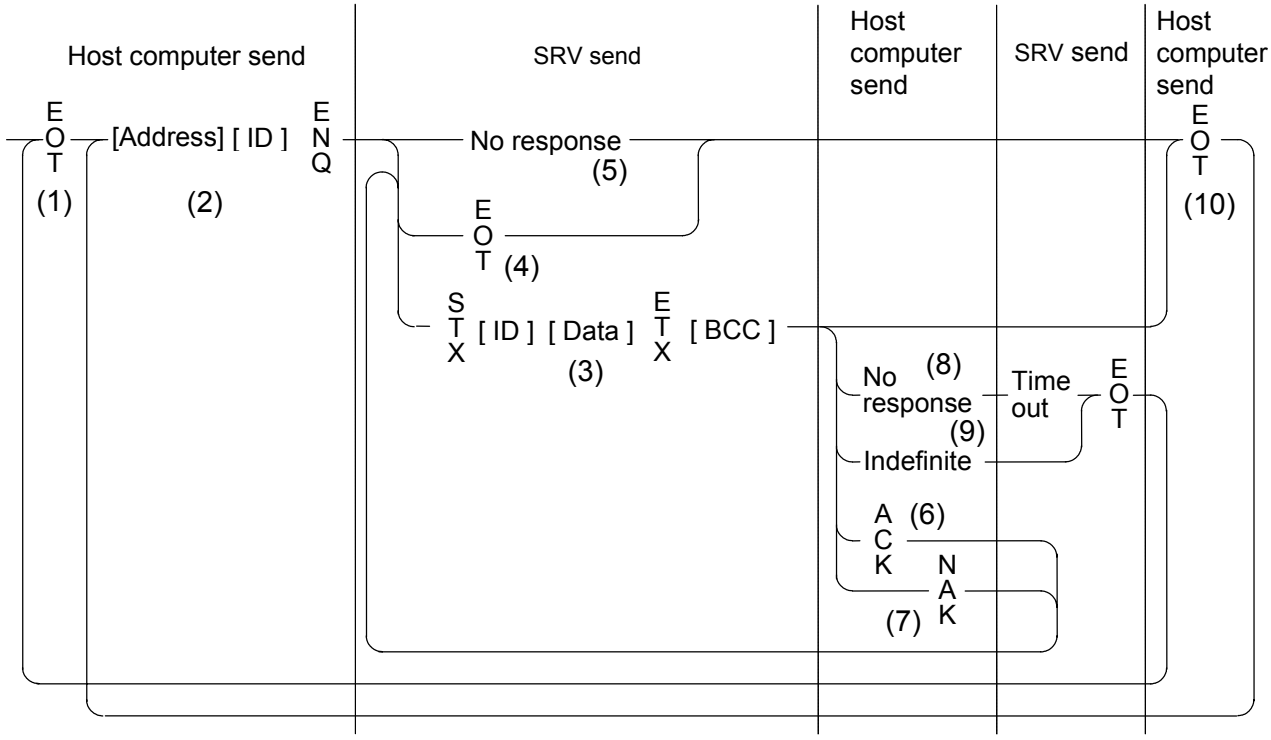
6. RKC COMMUNICATION PROTOCOL

RKC communication uses the polling/selecting method to establish a data link. The basic procedure is followed ANSI X3.28 subcategory 2.5, A4 basic mode data transmission control procedure (Fast selecting is the selecting method used in SRV).

- The polling/selecting procedures are a centralized control method where the host computer controls the entire process. The host computer initiates all communication so the controller responds according to queries and commands from the host.
- The code use in communication is 7-bit ASCII code including transmission control characters.
  Transmission control characters used in SRV:
  EOT (04H), ENQ (05H), ACK (06H), NAK (15H), STX (02H), ETX (03H)
  ( ): Hexadecimal

6.1 Polling

Polling is the action where the host computer requests one of the connected SRV to transmit data. An example of the polling procedure is shown below:



ID: Identifier

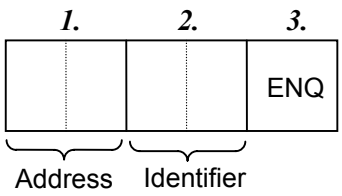
6.1.1 Polling procedures

(1) Data link initialization

Host computer sends EOT to the controllers to initiate data link before polling sequence.

(2) Data sent from host computer - Polling sequence

Host computer sends polling sequence with the format shown below:



Example:

0	2	M	1	ENQ

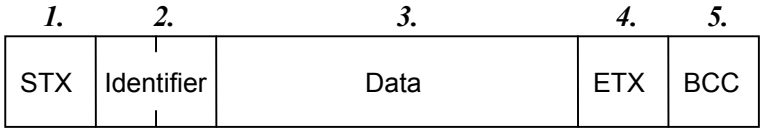
1. Address (2 digits)
This data is a module address of the SRV for polled and must be the same as the module address set value in item **5.1 Module Address Setting (P. 14).**

2. Identifier (2 digits)
The identifier specifies the type of data that is requested from the SRV. Always attach the ENQ code to the end of the identifier.
☞ See **6.5 Communication Identifier List (P. 34)**.

3. ENQ
The ENQ is the transmission control character that indicates the end of the polling sequence. The host computer then must wait for a response from the SRV.

(3) Data sent from the SRV

If the polling sequence is received correctly, the SRV sends data in the following format:



1. STX
STX is the transmission control character which indicates the start of the text transmission (identifier and data).

2. Identifier (2 digits)
The identifier indicates the type of data (measured value, status and set value) sent to the host computer.
☞ See **6.5 Communication Identifier List (P. 34)**

Continued on the next page.

3. Data

Data which is indicated by an identifier of SRV, consisting of channel numbers, data, etc. Each channel number and data are delimited by a space (20H). The data and the next channel number are delimited by a comma.

- Channel number: 2-digit ASCII code, not zero-suppressed. Channels without channel numbers may exist depending on the type of identifier.
- Data: ASCII code, zero-suppressed with spaces (20H). The number of digits varies depending on the type of identifier.

☞ See **6.3 Communication Data Structure (P. 29)**

4. ETX

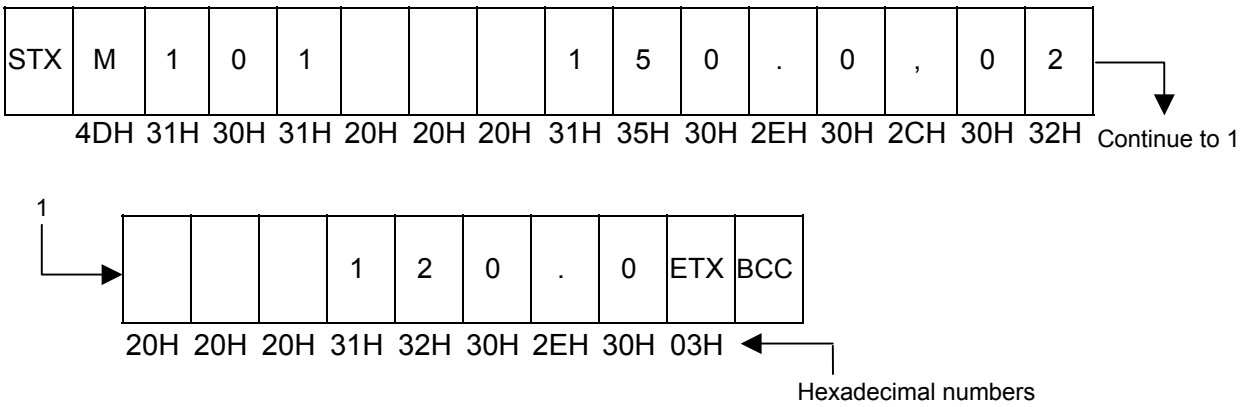
Transmission control character indicating the end of the text.

5. BCC

BCC (Block Check Character) detects error using horizontal parity and is calculated by horizontal parity (even number).

Calculation method of BCC: *Exclusive OR* all data and characters from STX through ETX, not including STX.

Example:



BCC = 4DH ⊕ 31H ⊕ 30H ⊕ 31H ⊕ 20H ⊕ 20H ⊕ 20H ⊕ 31H ⊕ 35H ⊕ 30H ⊕ 2EH ⊕ 30H ⊕ 2CH ⊕ 30H ⊕ 32H ⊕ 20H ⊕ 20H ⊕ 20H ⊕ 31H ⊕ 32H ⊕ 30H ⊕ 2EH ⊕ 30H ⊕ 03H

= 57H

(⊕: *Exclusive OR*)

Value of BCC becomes 57H

(4) EOT send (Ending data transmission from the SRV)

In the following cases, the SRV sends EOT to terminate the data link:

- When the specified identifier is invalid
- When there is an error in the data format
- When all the data has been sent

(5) No response from the SRV

The SRV will not respond if the polling address is not received correctly. It may be necessary for the host computer to take corrective action such as a time-out.

(6) ACK (Acknowledgment)

An acknowledgment ACK is sent by the host computer when data received is correct. When the SRV receives ACK from the host computer, the SRV will send any remaining data of the next identifier without additional action from the host computer. When ACK was sent in succession, identifier data item down to "No.56 Initial setting mode" in the communication identifier list are sent.

☞ For the identifier, see **6.5 Communication Identifier List (P. 34)**.

When host computer determines to terminate the data link, EOT is sent from the host computer.

(7) NAK (Negative acknowledge)

If the host computer does not receive correct data from the SRV, it sends a negative acknowledgment NAK to the SRV. The SRV will re-send the same data when NAK is received. This cycle will go on continuously until either recovery is achieved or the data link is corrected at the host computer.

(8) No response from host computer

When the host computer does not respond within approximately three seconds after the SRV sends data, the SRV sends EOT to terminate the data link (time-out time: about 3 seconds).

(9) Indefinite response from host computer

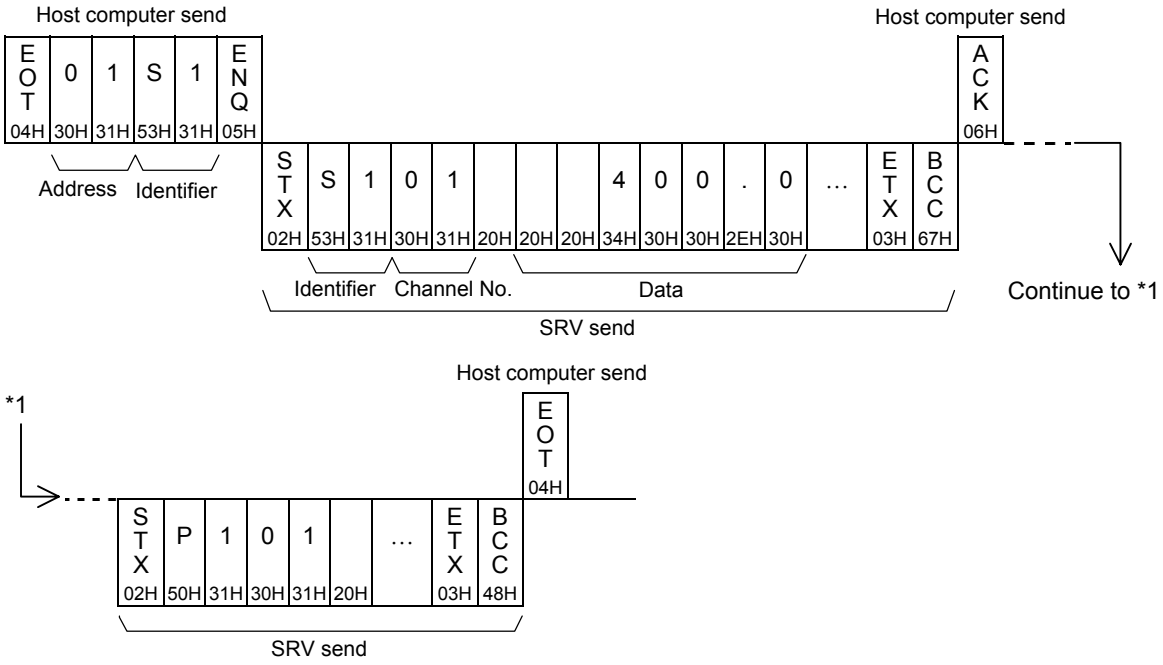
The SRV sends EOT to terminate the data link when the host computer response is indefinite.

(10) EOT (Data link termination)

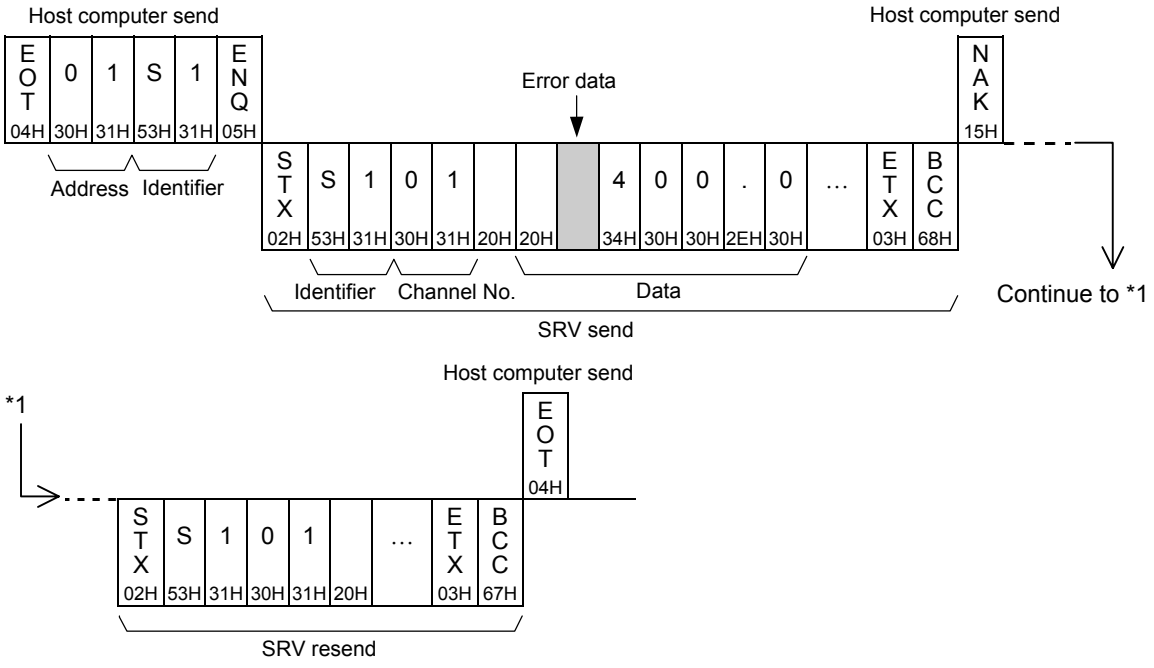
The host computer sends EOT message when it is necessary to suspend communication with the SRV or to terminate the data link due lack of response from the SRV.

6.1.2 Polling procedure example (When the host computer requests data)

- **Normal transmission**

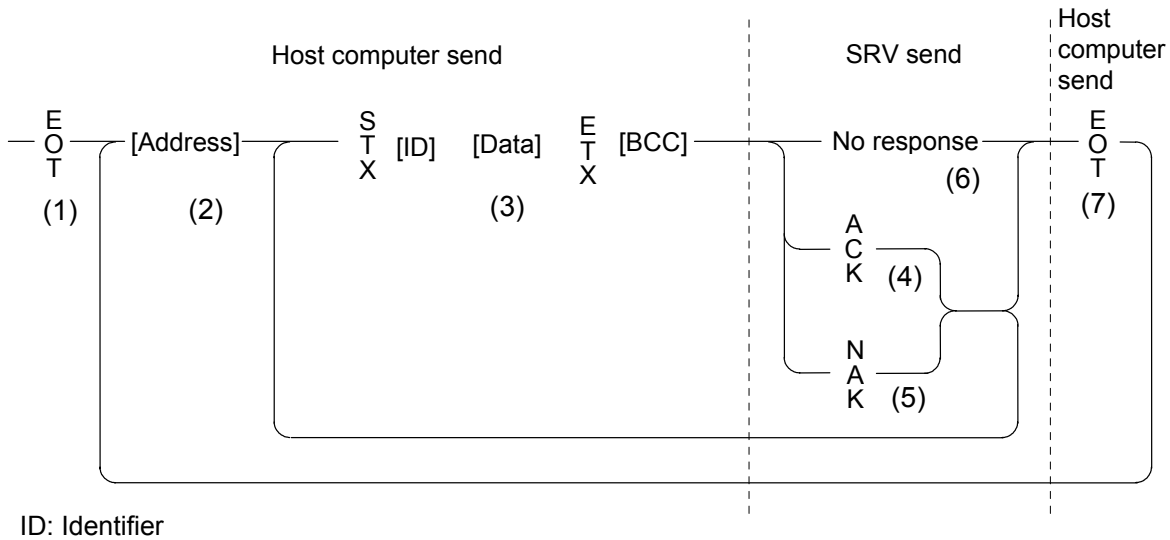


- **Error transmission**



6.2 Selecting

Selecting is the action where the host computer requests one of the connected SRV to receive data. An example of the selecting procedure is shown below:



ID: Identifier

6.2.1 Selecting procedures

(1) Data link initialization

Host computer sends EOT to the SRV to initiate data link before selecting sequence.

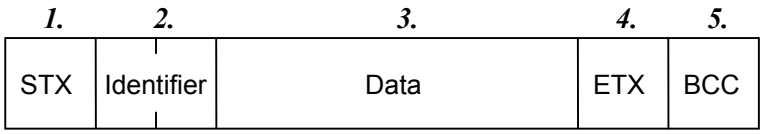
(2) Sending selecting address from the host computer

Host computer sends selecting address for the selecting sequence.

Address (2 digits):
This data is a unit address of the SRV to be selected and must be the same as the unit address set value in item **5.1 Module Address Setting (P. 14)**.

(3) Data sent from the host computer

The host computer sends data for the selecting sequence with the following format:



☞ Details for *1* to *5*, see **6.1 Polling (P. 20)**.

- **About numerical data**

The data that receipt of letter is possible

- Zero-suppressed data can be received with the SRV. (Number of digits: Within 7 digits)

  <Example> When data send −001.5, −01.5, or −1.5 at the time of "−1.5," the SRV can receive a data. However, when data send with −1.50, or −1.500, the SRV sends NAK so that after the decimal point number of digits is different.

- The SRV receives value in accordance with decided place after the decimal point. The value below the decided place after the decimal point is cut off.

  <Example> When setting range is −10.00 to +10.00, the SRV receives as a following.

Send data	−.5	.05	−0
Receive data	−0.50	0.05	0.00

The data that receipt of letter is impossible

The SRV sends NAK when received a following data.

+	Plus sign and the data that gained plus sing
−	Only minus sign (there is no figure)
.	Only decimal point (period)
−.	Only minus sign and decimal point (period)

(4) ACK (Acknowledgment)

An acknowledgment ACK is sent by the SRV when data received is correct. When the host computer receives ACK from the SRV, the host computer will send any remaining data. If there is no more data to be sent to SRV, the host computer sends EOT to terminate the data link.

(5) NAK (Negative acknowledge)

In the following cases, the SRV sends NAK. Then the appropriate recovery processing steps should be taken, such as resending the data on the host computer side.

- When an error occurs on the line (parity error, framing error, etc.)
- When a BCC check error occurs
- When the specified identifier is invalid
- When there is an error in the data format
- When receive data exceeds the setting range

(6) No response from SRV

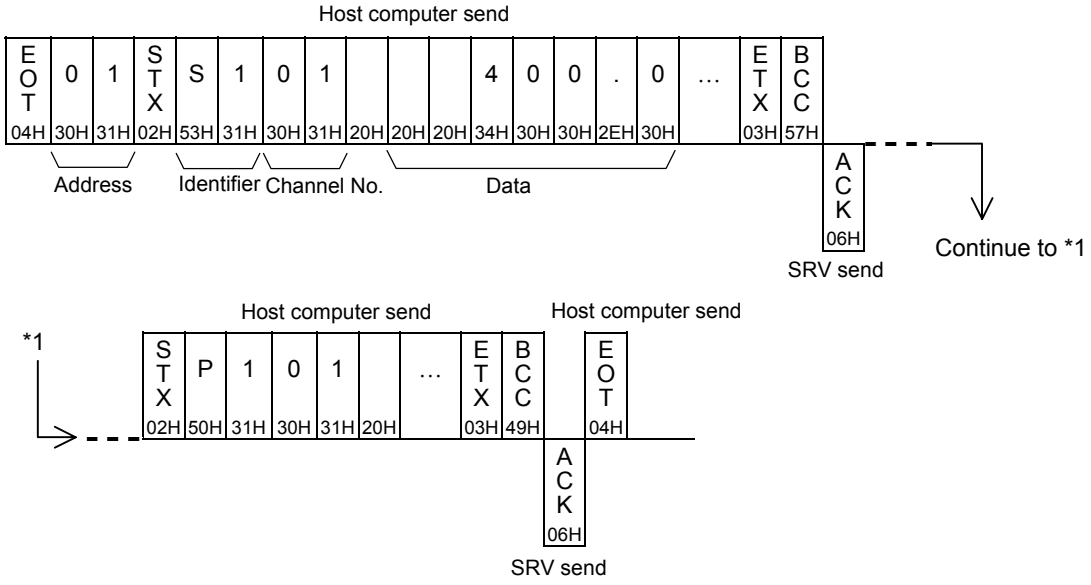
The SRV does not respond when it cannot receive the selecting address, STX, ETX or BCC.

(7) EOT (Data link termination)

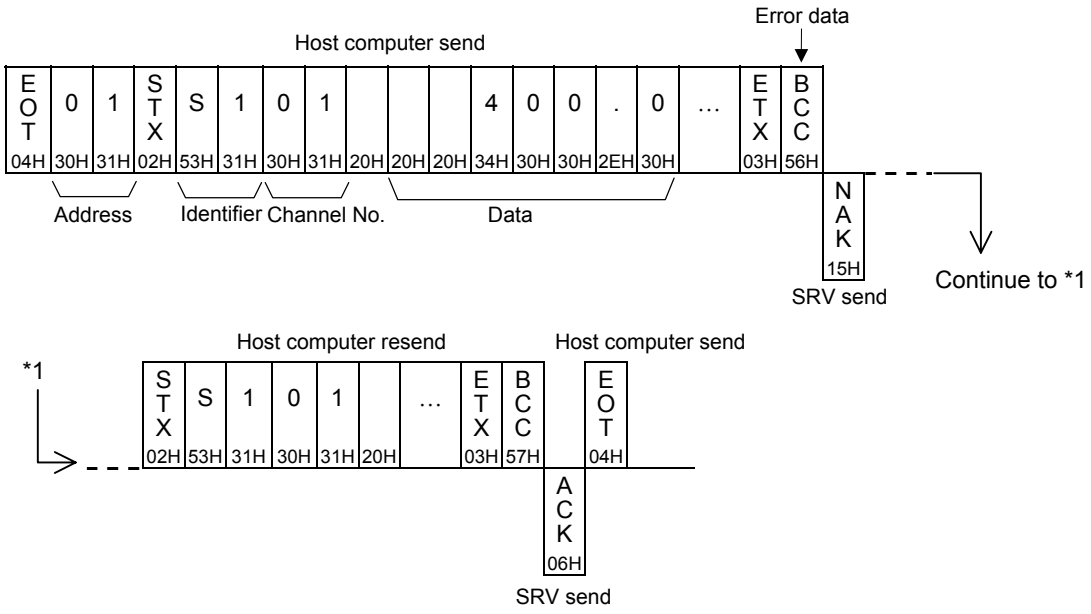
The host computer sends EOT when there is no more data to be sent from the host computer or there is no response from the SRV.

6.2.2 Selecting procedure example (When the host computer sends data)

- **Normal transmission**

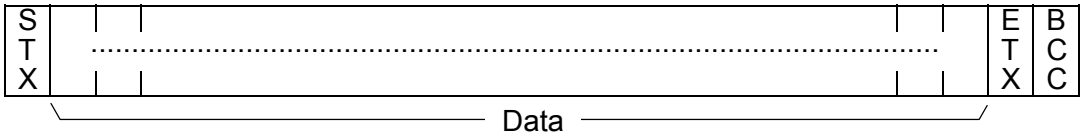


- **Error transmission**



6.3 Communication Data Structure

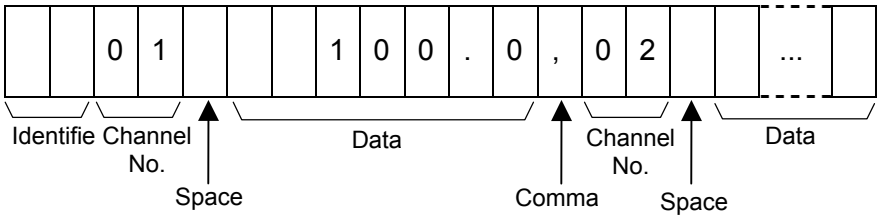
■ Data description (Transmission/receive data structure)



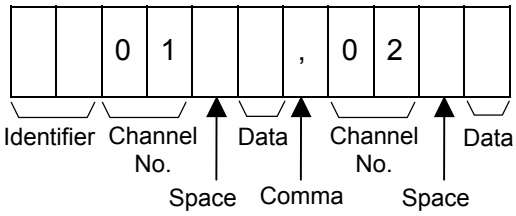
Part of the data above is shown below.

- **Data for each channel**

Data length 7 digits

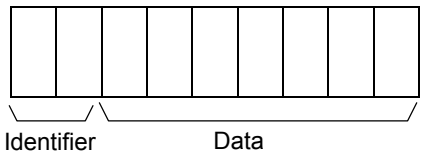


Data length 1 digit

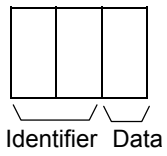


- **Data for each module (Without channel)**

Data length 7 digits



Data length 1 digit



6.4 Examples of Polling and Selecting Check Programs

The following is the sample program for NEC PC-9800 series computers in BASIC language for carrying out polling and selecting checking by RS-232C specification. There will be some differences in the computer languages according to the type of computer. Before executing the program, confirm that there is no mistake in the wiring of the communications cable and check that the instrument data bit configuration is set to *8* for data bit and *Without* for parity bit. In addition, the communications speed setting should be set to match the host computer speed setting.

When this program example is used for RS-485, the automatic sending/receiving selection type of RS-232C/RS-485 is required.
(Recommended: CD485, CD485/V manufactured by Data Link, Inc. or equivalent.)

6.4.1 Example of temperature set values polling check program

```
1000 '---------- Identifier setting ----------                    Identifier setting
1010   ID$="S1"
1020 '
1030 '---------- Communications initial setting ----------
1040 CM$="N81NN"                                                  Communications data configuration setting
1050 INPUT " Module address=";ADD$                                Module address input
1060 STX$=CHR$(&H2) : EOT$=CHR$(&H4) : ENQ$=CHR$(&H5)             Communications character setting
1070 ACK$=CHR$(&H6) : NAK$=CHR$(&H15): ETX$=CHR$(&H3)
1080 OPEN "COM1:"+CM$   AS #1                                     Open RS-232C circuit
1090 CONSOLE ,,,1
1100 COLOR 7:CLS 3
1110 '
1120 '---------- Program main routine ----------
1130 *POL
1140      PRINT "            (Polling check)            "
1150      PRINT "********** Receiving the set values **********"
1160      PRINT "                                                "
1170      DT$=EOT$+ADD$+ID$+ENQ$                                  Data configuration setting
1180      GOSUB *TEXT
1190      GOSUB *RXDT
1200 '
1210 *J10
1220      J=0
1230 '
1240 *IF1
1250      IF LOC(1)=0 THEN J=J+1:IF J<500 THEN *IF1 ELSE PRINT "  Setting of the receiving waiting time *
TIME OUT ":END                                                    (Timeout processing)
1260 '
1270      K$=INPUT$(1,#1)
1280           IF K$=ETX$ GOTO *ETXRX                             Communications condition checking
1290           IF K$=NAK$ THEN PRINT "     NAK":END
1300           IF K$=EOT$ THEN PRINT "     EOT":END
1310           IF K$=ACK$ THEN PRINT "     ACK":END
```

* Setting of the receiving waiting time:
  If time out occurs in using high speed computer (Except no response), the numeral value of *500* in the program should be changed to an appropriately-sized numeral value.

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```
1320 '
1330      DT$=DT$+K$
1340      GOTO *J10
1350 '
1360 *ETXRX
1370      DT$=DT$+K$
1380            BCCRX$=INPUT$(1,#1)
1390            BCCRX=ASC(BCCRX$)                    BCC checking
1400            GOSUB *BCCCH
1410      IF BCC<>BCCRX THEN GOSUB *NAKTX
1420      IF BCC<>BCCRX THEN GOSUB *RXDT: GOTO *J10
1430 '
1440      PRINT "Data has been correctly received"   Display of received data and
1450      PRINT "Received data=";DT$ : END           closing of RS-232C circuit
1460 '
1470 '---------------------- Sub-routine ----------------------
1480 '
1490 *NAKTX                                          Processing on occurrence of a BCC error
1500      PRINT "BCC error"
1510      DT$=NAK$
1520            GOSUB *TEXT
1530      RETURN
1540 '
1550 *RXDT
1560      DT$=""                                     Clearing of circuit buffer
1570      RETURN
1580 '
1590 *TEXT
1600      PRINT #1,DT$;                              Transfer of polling identifier
1610      RETURN
1620 '
1630 *BCCCH                                          BCC calculation
1640      FOR II=1 TO LEN(DT$)
1650            BCCA$=MID$(DT$,II,1)
1660            IF BCCA$=STX$ THEN BCC=0 : GOTO *IINEXT
1670            BCC=BCC XOR ASC(BCCA$)
1680 *IINEXT
1690      NEXT II
1700      RETURN
```

6.4.2 Example of temperature set values selecting checking program

```
1000 '---------- Identifier setting ----------                    
1010   ID$="S1"                                                   Identifier setting
1020 '
1030 '---------- Communications initial setting ----------
1040 CM$="N81NN"                                                  Communications data configuration setting
1050 STX$=CHR$(&H2) : EOT$=CHR$(&H4) : ENQ$=CHR$(&H5)             Communications character setting
1060 ACK$=CHR$(&H6) : NAK$=CHR$(&H15): ETX$=CHR$(&H3)
1070 OPEN "COM1:"+CM$    AS #1                                    Opening of RS-232C circuit
1080 CONSOLE ,,,1
1090 COLOR 7:CLS 3
1100 '
1110 '---------- Program main routine ----------
1120 *SEL
1130      PRINT "          (Selection check)          "
1140      PRINT "********** Transmission of set values **********"
1150      PRINT "
1160      INPUT "Module No.=";ADD$:INPUT "Channel No.=";C$         Input of the Module and channel number,
          :INPUT "Set value=";S$                                   and the temperature set value
1170      DT$=EOT$+ADD$+STX$+Z$+C$+" "+S$+ETX$                     Data configuration setting 1
1180      PRINT "Transmitting data=";DT$                           Display of transmitting data
1190      GOSUB *BCCCH
1200      DT$=DT$+CHR$(BCC)                                        Data configuration setting 2
1210      GOSUB *TEXT
1220      GOSUB *RXDT
1230 '
1240 *J20
1250      J=0
1260 '
1270 *IF2
1280      IF LOC(1)=0 THEN J=J+1:IF J<500 THEN *IF2 ELSE PRINT " TIME  Setting of the receiving waiting time *
          OUT ":END                                                (Timeout processing)
1290 '
1300      K$=INPUT$(1,#1)                                          Communications condition check,
1310      IF K$=NAK$ THEN PRINT "      NAK":END                    Display of communication result,
1320      IF K$=ACK$ THEN PRINT "Module has received the data"     and closing of RS-232C circuit
          :END
1330 '
1340 '
1350 '
```

* Setting of the receiving waiting time:
  If time out occurs in using high speed computer (Except no response), the numeral value of *500* in the program should be changed to an appropriately-sized numeral value.

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```
1360 '---------------------- Sub-routine ----------------------
1370 '
1380 *RXDT'
1390       DT$=""                                                    Clearing of circuit buffer
1400       RETURN
1410 '
1420 *TEXT
1430       PRINT #1,DT$;
1440       RETURN                                                    Transfer of selection data
1450 '
1460 *BCCCH                                                          BCC calculation
1470       FOR II=1 TO LEN(DT$)
1480             BCCA$=MID$(DT$,II,1)
1490             IF BCCA$=STX$ THEN BCC=0 : GOTO *IINEXT
1500             BCC=BCC XOR ASC(BCCA$)
1510 *IINEXT
1520       NEXT II
1530       RETURN
```

6.5 Communication Identifier List

6.5.1 Data items for normal setting mode

RO: Read only R/W: Read and Write

No.	Name	Identifier	Attribute	Data range	Factory set value	Reference page
1	Measured value (PV)	**M1**	RO	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	—	P. 68
2	Comprehensive event state	**AJ**	RO	Bit data b0: Burnout b1: Event 1 state b2: Event 2 state b3: Heater break alarm state b4: Control loop break alarm (LBA) state b5 to b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 31]	—	P. 68
3	Burnout state	**B1**	RO	0: OFF 1: ON	—	P. 69
4	Event 1 state	**AA**	RO	0: OFF 1: ON	—	P. 69
5	Event 2 state	**AB**	RO	0: OFF 1: ON	—	P. 69
6	Heater break alarm (HBA) state	**AC**	RO	0: OFF 1: Heater break 2: Relay welding	—	P. 70
7	Control loop break alarm (LBA) state	**AP**	RO	0: OFF 1: ON	—	P. 70
8	Heat-side manipulated output value	**O1**	RO	−5.0 to +105.0 %	—	P. 71
9	Cool-side manipulated output value	**O2**	RO	−5.0 to +105.0 %	—	P. 71
10	Current transformer input measured value	**M3**	RO	0.0 to 30.0 A or 0.0 to 100.0 A	—	P. 71
11	Set value monitor	**MS**	RO	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	—	P. 72

Continued on the next page.

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No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
12	Error code (Data of each module)	**ER**	RO	Bit data b0: Memory backup error b1: Unused b2: Internal communication error b3: Adjustment data error b4: Input error b5: Current transformer input error b6: Temperature compensation error b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 127]	—	P. 72
13	Temperature rise completion state	**HE**	RO	0: Temperature rise not complete 1: Temperature rise completion	—	P. 73
14	Set value (SV)	**S1**	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)	P. 73
15	Heat-side proportional band	**P1**	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 span	P. 74
16	Cool-side proportional band	**P2**	R/W	TC/RTD input: 1 (0.1) to Input span Voltage (V)/Current (I) input: 0.1 to 100.0 % of input span		P.74
17	Integral time	**I1**	R/W	1 to 3600 seconds	240	P. 75
18	Derivative time	**D1**	R/W	0 to 3600 seconds 0: Derivative action OFF (PI action)	60	P. 75
19	Control response parameters	**CA**	R/W	0: Slow 1: Medium 2: Fast	0	P. 76
20	Overlap/Deadband	**V1**	R/W	–Input span to +Input span	0 (0.0)	P. 76
21	Setting change rate limiter	**HH**	R/W	0 (0.0) to Input span/minute 0 (0.0): Setting change rate limiter OFF	0 (0.0)	P. 77

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No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
22	PV bias	**PB**	R/W	–Input span to +Input span	0 (0.0)	P. 77
23	Event 1 set value	**A1**	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 (0.0)	P. 78
24	Event 2 set value	**A2**	R/W		0 (0.0)	P. 78
25	Operation mode	**EI**	R/W	0: Unused 1: Monitor 1 2: Monitor 2 3: Control	3	P. 78
26	PID/AT transfer	**G1**	R/W	0: PID control operation 1: AT (Autotuning) operation	0	P. 79
27	Auto/Manual transfer	**J1**	R/W	0: Auto mode 1: Manual mode	0	P. 80
28	Manual output value	**ON**	R/W	–5.0 to +105.0 %	0.0	P. 80
29	Output limiter (high)	**OH**	R/W	Output limiter (low) to 105.0 %	100.0	P. 81
30	Output limiter (low)	**OL**	R/W	–5.0 % to Output limiter (high)	0.0	P. 81
31	Heat-side proportional cycle time	**T0**	R/W	1 to 100 seconds	Relay contact output: 20 Voltage pulse output: 2	P. 81
32	Cool-side proportional cycle time	**T1**	R/W	1 to 100 seconds		P. 81
33	Digital filter	**F1**	R/W	0 to 100 seconds 0: Digital filter OFF	0	P. 82
34	Heater break alarm (HBA) set value	**A3**	R/W	0.0 to 30.0 A or 0.0 to 100.0 A	0.0	P. 82
35	Number of heater break alarm (HBA) delay times	**DH**	R/W	1 to 255 times	5	P. 84
36	Control RUN/STOP transfer (Data of each module)	**SR**	R/W	0: Control STOP 1: Control RUN	0	P. 84

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No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
37	Input error determination point (high)	**AV**	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	P. 85
38	Input error determination point (low)	**AW**	R/W		TC/RTD: Input range low limit V/I: Input scale low limit	P. 85
39	Action at input error (high)	**WH**	R/W	0: Normal control 1: Manipulated output value at input error	0	P. 86
40	Action at input error (low)	**WL**	R/W	0: Normal control 1: Manipulated output value at input error	0	P. 86
41	Manipulated output value at input error	**OE**	R/W	–105.0 to +105.0 %	0.0	P. 87
42	AT differential gap time	**GH**	R/W	0 to 100 seconds	1	P. 88
43	AT bias	**GB**	R/W	–Input span to +Input span	0 (0.0)	P. 89
44	Event LED mode setting (Data of each module)	**XH**	R/W	1: Mode 1 2: Mode 2 3: Mode 3 Except the above (within 0 to 255): Unused	0	P. 90
45	Control loop break alarm (LBA) use selection	**HP**	R/W	0: Unused 1: Used	0	P. 90
46	Control loop break alarm (LBA) time	**C6**	R/W	1 to 7200 seconds	480	P. 91
47	Control loop break alarm (LBA) deadband	**V2**	R/W	0 (0.0) to Input span	0 (0.0)	P. 92
48	DI setting (Data of each module)	**E1**	R/W	1: Control RUN/STOP 2: Event interlock release Except the above (within 0 to 20): Unused	Specify when ordering	P. 93

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No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
49	DI state (Data of each module)	**L1**	RO	0: Contact open (OFF) 1: Contact close (ON)	—	P. 93
50	DO1 setting (Data of each module)	**QA**	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 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	P. 94
51	DO2 setting (Data of each module)	**QB**	R/W		Specify when ordering	P. 94
52	DO state (Data of each module)	**Q1**	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) Data write is possible only when the DO1 and DO2 setting values are "0."	0	P. 94
53	Event interlock release (Data of each module)	**AR**	R/W	0: Normal state 1: Event interlock release execution	0	P. 95
54	Temperature rise completion zone	**HD**	R/W	0 (0.0) to Input span 0 (0.0): Unused	0 (0.0)	P. 96
55	Temperature rise completion soak time	**T3**	R/W	0 to 360 minutes	0	P. 97
56	Initial setting mode (Data of each module)	**IN**	R/W	0: Normal setting mode 1: Initial setting mode	0	P. 97

6.5.2 Data items for initial setting mode

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 identifier IN (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 identifier "IN" by 0).

No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
1	Input range number	**XI**	R/W	TC input 0: K −200 to +1372 °C or −328 to +2501 °F 1: K 0 to 800 °C or 32 to 1472 °F 2: K 0 to 400 °C or 32 to 752 °F 3: K −200.0 to +400.0 °C or −328.0 to +752.0 °F 4: K 0.0 to 400.0 °C or 32.0 to 752.0 °F 5: J −200 to +1200 °C or −328 to +2192 °F 6: J 0 to 800 °C or 32 to 1472 °F 7: J 0 to 400 °C or 32 to 752 °F 8: J −200.0 to +400.0 °C or −328.0 to +752.0 °F 9: J 0.0 to 400.0 °C or 32.0 to 752.0 °F 10: T −200 to +400 °C or −328 to +752 °F 11: T 0 to 400 °C or 32 to 752 °F	Specify when ordering	P. 99

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No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
1	Input range number	**XI**	R/W	TC input 12: T 0 to 200 °C or 32 to 392 °F 13: T −200.0 to +400.0 °C or −328.0 to +752.0 °F 14: T 0.0 to 400.0 °C or 32.0 to 752.0 °F 15: S 0 to 1768 °C or 32 to 3214 °F 16: R 0 to 1768 °C or 32 to 3214 °F 17: PLII 0 to 1390 °C or 32 to 2534 °F 18: N 0 to 1300 °C or 32 to 2372 °F 19: W5Re/W26Re 0 to 2300 °C or 32 to 4172 °F 20: E 0 to 1000 °C or 32 to 1832 °F 21: E 0 to 800 °C or 32 to 1472 °F 22: B 0 to 1800 °C or 32 to 3272 °F RTD input: 23: Pt100 0 to 850 °C or 32 to 1562 °F 24: Pt100 0 to 400 °C or 32 to 752 °F 25: Pt100 −200.0 to +400.0 °C or −328.0 to +752.0 °F 26: Pt100 0.0 to 400.0 °C or 32.0 to 752.0 °F 27: JPt100 0 to 600 °C or 32 to 1112 °F 28: JPt100 0 to 400 °C or 32 to 752 °F 29: JPt100 −200.0 to +400.0 °C or −328.0 to +752.0 °F 30: JPt100 0.0 to 400.0 °C or 32.0 to 752.0 °F	Specify when ordering	P. 99

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No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
1	Input range number	**XI**	R/W	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	P. 99
2	Input scale high limit	**XV**	R/W	Input scale low limit to 10000 (Effective only for voltage/current input)	100.0	P. 100
3	Input scale low limit	**XW**	R/W	–2000 to Input scale high limit (Effective only for voltage/current input)	0.0	P. 100
4	Input range decimal point position	**XU**	R/W	0: No decimal place 1: One decimal place 2: Two decimal places 3: Three decimal places (Effective only for voltage/current input)	1	P. 100
5	Temperature unit selection	**PU**	R/W	0: °C 1: °F	0	P. 101
6	Control type selection	**XE**	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	P. 101
7	ON/OFF control differential gap (upper)	**IV**	R/W	0 to Input span	TC/RTD: 1.0 °C or 1.0 °F V/I: 0.1 % of input span	P. 102
8	ON/OFF control differential gap (lower)	**IW**	R/W			P. 102
9	Event 1 differential gap	**HA**	R/W	0 to Input span	TC/RTD: 2.0 °C or 2.0 °F V/I: 0.2 % of input span	P. 103
10	Event 2 differential gap	**HB**	R/W			P. 103

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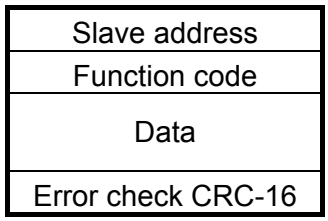
No.	Name	Iden-tifier	Attri-bute	Data range	Factory set value	Refer-ence page
11	Event 1 type selection	**XA**	R/W	0: Not provided 1: Process high 2: Process low 3: Deviation high 4: Deviation low 5: Deviation high/low 6: Band	Specify when ordering	P. 104
12	Event 2 type selection	**XB**	R/W		Specify when ordering	P. 104
13	Event 1 action selection	**WA**	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	P. 106
14	Event 2 action selection	**WB**	R/W		b0 to b2: Specify when ordering b3 to b7: 0	P. 106
15	Event delay timer	**TD**	R/W	0 to 9999 seconds	0	P. 108
16	Transmission transfer time setting (Data of each module)	**ZX**	R/W	0 to 100 ms	6	P. 108
17	Operation mode holding setting (Data of module unit)	**X2**	R/W	0: Not hold 1: Hold	1	P. 108

7. MODBUS COMMUNICATION PROTOCOL

The master controls communication between master and slave. A typical message consists of a request (query message) sent from the master followed by an answer (response message) from the slave. When master begins data transmission, a set of data is sent to the slave in a fixed sequence. When it is received, the slave decodes it, takes the necessary action, and returns data to the master.

7.1 Message Format

The message consists of four parts: slave address, function code, data, and error check code which are always transmitted in the same sequence.



Message format

■ Slave address

The slave address is a number from 0 to 99 manually set at the module address setting switch located at the front of the SRV module. Although all connected slave units receive the query message sent from the master, only the slave with the slave address coinciding with the query message will accept the message.

■ Function code

The function codes are the instructions set at the master and sent to the slave describing the action to be executed. The function codes are included when the slave responds to the master.

☞ For details, see **7.2 Function Code (P. 44)**.

■ Data

The data to execute the function specified by the function code is sent to the slave and corresponding data returned to the master from the slave.

☞ For details, see **7.6 Message Format (P. 49)**, **7.7 Data Configuration (P. 53), 7.8 Data Map (P. 56)** and **8. COMMUNICATION DATA DESCRIPTION (P. 67)**.

■ Error check

An error checking code (CRC-16: Cyclic Redundancy Check) is used to detect an error in the signal transmission.

☞ For details, see **7.5 Calculating CRC-16 (P. 46).**

7.2 Function Code

- **Function code contents**

Function code (Hexadecimal)	Function	Contents
03H	Read holding registers	Measured value, control output value, current transformer input measured value, Event status, etc.
06H	Preset single register	Set value, PID constants, event set value, etc.
08H	Diagnostics (loopback test)	Loopback test
10H	Preset multiple registers	Set value, PID constants, event set value, etc.

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

Function code (Hexadecimal)	Function	Query message		Response message	
		Min	Max	Min	Max
03H	Read holding registers	8	8	7	255
06H	Preset single register	8	8	8	8
08H	Diagnostics (loopback test)	8	8	8	8
10H	Preset multiple registers	11	255	8	8

7.3 Communication Mode

Signal transmission between the master and slaves is conducted in Remote Terminal Unit (RTU) mode.

RTU mode

Items	Contents
Data bit length	8-bit (Binary)
Start mark of message	Unused
End mark of message	Unused
Message length	See **7.2 Function code**
Data time interval	Less than 24 bits' time *
Error check	CRC-16 (Cyclic Redundancy Check)

* When sending a command message from the master, set intervals of data configuring one message to time shorter than the 24 bits' time or the 24 bits' time plus a few milliseconds. If time intervals become time longer than the 24 bits' time or the 24 bits' time plus a few milliseconds, the relevant slave assumes that message sending from the master is terminated to deform the message format. As a result, the slave does not make a response.

A data time interval may become more than 24 bits depending on the type of master used. In that case, the data time interval can be extended in the range of 1 to 99 ms.
For setting procedure, see **5.3 Communication Time Setting (P. 16)**.

7.4 Slave Responses

(1) Normal response

- In the response message of the Read Holding Registers, the slave returns the read out data and the number of data items with the same slave address and function code as the query message.
- In the response message of the Preset Single Register and Diagnostics (Loopback test), the slave returns the same message as the query message.
- In the response message of the Preset Multiple Registers, the slave returns the slave address, the function code, starting number, and number of holding registers in the multi-query message.

(2) Defective message response

- If the query message from the master is defective, except for transmission error, the slave returns the error response message without any action.
- If the self-diagnostic function of the slave detects an error, the slave will return an error response message to all query messages.
- The function code of each error response message is obtained by adding 80H to the function code of the query message.

Slave address
Function code
Error code
Error check CRC-16

Error response message

Error code	Contents
1	Function code error (An unsupported function code was specified)
2	When the mismatched address is specified.
3	When the data written exceeds the setting range When the specified number of data items in the query message exceeds the maximum number (1 to 125) of data items available

(3) No response

The slave ignores the query message and does not respond when:

- The slave address in the query message does not coincide with any slave address settings.
- The transmission parameter of the master does not coincide with that of the slave.
- Transmission error such as overrun, framing, parity and etc., is found in the query message.
- 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.
- If data time interval in the query message from the master is following
  24 bits' time or more
  24 bits' time plus a few milliseconds or more

7.5 Calculating CRC-16

The Cyclic Redundancy Check (CRC) is a 2 byte (16-bit) error check code. After constructing the data message, not including start, stop, or parity bit, the master calculates a CRC code and appends this to the end of the message. The slave will calculate a CRC code from the received message, and compare it with the CRC code from the master. If they do not coincide, a communication error has occurred and the slave does not respond.

The CRC code is formed in the following sequence:

1. Load a 16-bit CRC register with FFFFH.

2. *Exclusive OR* (⊕) the first byte (8-bit) of the message with the CRC register. Return the result to the CRC register

3. Shift the CRC register 1-bit to the right.

4. If the carry flag is *1*, *exclusive OR* the CRC register with A001 hexadecimal and return the result to the CRC register. If the carry flag is *0*, repeat step ***3***.

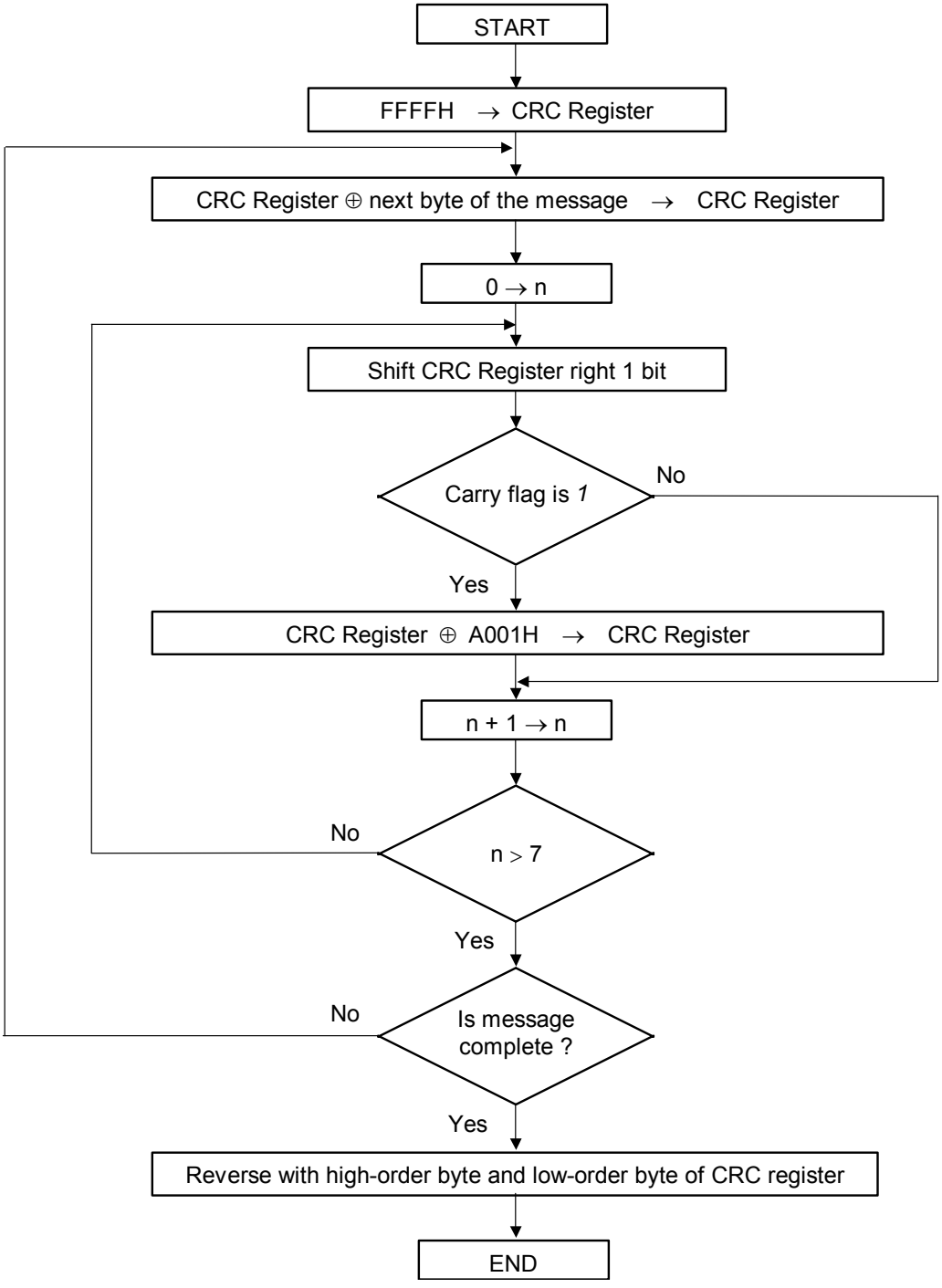
5. Repeat step ***3*** and ***4*** until there have been 8 shifts.

6. *Exclusive OR* the next byte (8-bit) of the message with the CRC register.

7. Repeat step ***3*** through ***6*** for all bytes of the message (except the CRC).

8. The CRC register contains the 2 byte CRC error code. When they are appended to the message, the low-order byte is appended first, followed by the high-order byte.

■ The flow chart of CRC-16



The ⊕ symbol indicates an *exclusive OR* operation. The symbol for the number of data bits is *n*.

■ Example of a CRC calculation in the 'C' language

This routine assumes that the data types 'uint16' and 'uint8' exists. Theses are unsigned 16-bit integer (usually an 'unsigned short int' for most compiler types) and unsigned 8-bit integer (unsigned char). 'z_p' is a pointer to a Modbus message, and z_messaage_length is its length, excluding the CRC. Note that the Modbus message will probably contain NULL characters and so normal C string handling techniques will not work.

uint16 calculate_crc （byte *z_p, unit16 z_message_length）

```
/* CRC runs cyclic Redundancy Check Algorithm on input z_p   */
/* Returns value of 16 bit CRC after completion and          */
/* always adds 2 crc bytes to message                        */
/* returns 0 if incoming message has correct CRC             */

{
    uint16 CRC= 0xffff;
    uint16 next;
    uint16 carry;
    uint16 n;
    uint8 crch, crcl;

    while (z_messaage_length--) {
        next = (uint16) *z_p;
        CRC ^= next;
        for (n = 0; n < 8; n++) {
            carry = CRC & 1;
            CRC >>= 1;
            if (carry) {
              CRC ^= 0xA001;
            }
        }
        z_p++;
    }
    crch = CRC / 256;
    crcl = CRC % 256
    z_p [z_messaage_length++] = crcl;
    z_p [z_messaage_length] = crch;
    return CRC;
}
```

7.6 Message Format

7.6.1 Read holding registers [03H]

The query message specifies the starting register address and quantity of registers to be read.
The contents of the holding registers are entered in the response message as data, divided into two parts: the high-order 8-bit and the low-order 8-bit, arranged in the order of the register numbers.

Example: The contents of the three holding registers from 0000H to 0002H are the read out from slave address 2.

Query message

Slave address		02H	
Function code		03H	
Starting No.	High	00H	First holding register address
	Low	00H	
Quantity	High	00H	The setting must be between 1 (0001H) and 125 (007DH).
	Low	03H	
CRC-16	High	05H	
	Low	F8H	

Normal response message

Slave address		02H	
Function code		03H	
Number of data		06H	→ Number of holding registers × 2
First holding register contents	High	00H	
	Low	78H	
Next holding register contents	High	00H	
	Low	00H	
Next holding register contents	High	00H	
	Low	14H	
CRC-16	High	95H	
	Low	80H	

Error response message

Slave address		02H
80H + Function code		83H
Error code		03H
CRC-16	High	F1H
	Low	31H

7.6.2 Preset single register [06H]

The query message specifies data to be written into the designated holding register. The write data is arranged in the query message with high-order 8-bit first and low-order 8-bit next. Only R/W holding registers can be specified.

Example: Data is written into the holding register 0010H of slave address 1.

Query message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	10H
Write data	High	00H
	Low	64H
CRC-16	High	89H
	Low	E4H

} Any data within the range

Normal response message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	10H
Write data	High	00H
	Low	64H
CRC-16	High	89H
	Low	E4H

} Contents will be the same as query message data

Error response message

Slave address		01H
80H + Function code		86H
Error code		03H
CRC-16	High	02H
	Low	61H

7.6.3 Diagnostics (Loopback test) [08H]

The master's query message will be returned as the response message from the slave.
This function checks the communication system between the master and slave.

Example: Loopback test for slave address 1

Query message

Slave address		01H	
Function code		08H	
Test code	High	00H	Test code must be set to *00*
	Low	00H	
Data	High	1FH	Any pertinent data
	Low	34H	
CRC-16	High	E9H	
	Low	ECH	

Normal response message

Slave address		01H	Contents will be the same as query message data
Function code		08H	
Test code	High	00H	
	Low	00H	
Data	High	1FH	
	Low	34H	
CRC-16	High	E9H	
	Low	ECH	

Error response message

Slave address		01H
80H + Function code		88H
Error code		03H
CRC-16	High	06H
	Low	01H

7.6.4 Preset multiple registers [10H]

The query message specifies the starting register address and quantity of registers to be written.
The write data is arranged in the query message with high-order 8-bit first and low-order 8-bit next.
Only R/W holding registers can be specified.

Example: Data is written into the two holding registers from 0010H to 0011H of slave address 1.

Query message

Slave address		01H	
Function code		10H	
Starting number	High	00H	First holding register address
	Low	10H	
Quantity	High	00H	The setting must be between 1 (0001H) and 123 (007BH).
	Low	02H	
Number of data		04H	→ Number of holding registers × 2
Data to first register	High	00H	
	Low	64H	
Data to next register	High	00H	
	Low	1EH	
CRC-16	High	33H	
	Low	74H	

Normal response message

Slave address		01H
Function code		10H
Starting number	High	00H
	Low	10H
Quantity	High	00H
	Low	02H
CRC-16	High	40H
	Low	0DH

Error response message

Slave address		01H
80H + Function code		90H
Error code		02H
CRC-16	High	CDH
	Low	C1H

7.7 Data Configuration

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

FFFFH represents −1.

7.7.1 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
Control loop break alarm (LBA) use selection
Control loop break alarm (LBA) time
DI setting
DI state
DO1 setting
DO2 setting
DO state
Event interlock release
Temperature rise completion soak time
Initial setting mode
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
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

The Modbus 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 the Modbus 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

7.7.2 Data processing precautions

- With Modbus protocol, the maximum number of channels per slave address is 2.
- 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 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.
- Send the next command message at time intervals of 30 bits after the master receives the response message.



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

7.8 Data Map

7.8.1 Normal setting data items

RO: Read only R/W: Read and Write

Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Measured value (PV)	0000	1000	0	4096	RO	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	—	P. 68
Comprehensive event state	0001	1001	1	4097	RO	Bit data b0: Burnout b1: Event 1 state b2: Event 2 state b3: Heater break alarm state b4: Control loop break alarm (LBA) state b5 to b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 31]	—	P. 68
Heat-side manipulated output value	0002	1002	2	4098	RO	−5.0 to +105.0 %	—	P. 71
Set value monitor	0003	1003	3	4099	RO	TC/RTD input: Within input range Voltage (V)/Current (I) input: Input scale low limit to Input scale high limit	—	P. 72
Error code (Data of each module)	0004		4		RO	Bit data b0: Memory backup error b1: Unused b2: Internal communication error b3: Adjustment data error b4: Input error b5: Current transformer input error b6: Temperature compensation error b7: Unused Data 0: OFF 1: ON [Decimal numbers expression: 0 to 127]	—	P. 72

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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Cool-side manipulated output value	0005	1005	5	4101	RO	−5.0 to +105.0 %	—	P. 71
Current transformer input measured value	0006	1006	6	4102	RO	0.0 to 30.0 A or 0.0 to 100.0 A	—	P. 71
Unused	0007	1007	7	4103	—	—	—	—
Burnout state	0008	1008	8	4104	RO	0: OFF 1: ON	—	P. 69
Event 1 state	0009	1009	9	4105	RO	0: OFF 1: ON	—	P. 69
Event 2 state	000A	100A	10	4106	RO	0: OFF 1: ON	—	P. 69
Heater break alarm (HBA) state	000B	100B	11	4107	RO	0: OFF 1: Heater break 2: Relay welding	—	P. 70
Control loop break alarm (LBA) state	000C	100C	12	4108	RO	0: OFF 1: ON	—	P. 70
Temperature rise completion state	000D	100D	13	4109	RO	0: Temperature rise not complete 1: Temperature rise completion	—	P. 73
Unused	000E	100E	14	4110	—	—	—	—
Operation mode	000F	100F	15	4111	R/W	0: Unused 1: Monitor 1 2: Monitor 2 3: Control	3	P. 78
Set value (SV)	0010	1010	16	4112	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)	P. 73
Heat-side proportional band	0011	1011	17	4113	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 span	P. 74

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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Integral time	0012	1012	18	4114	R/W	1 to 3600 seconds	240	P. 75
Derivative time	0013	1013	19	4115	R/W	0 to 3600 seconds 0: Derivative action OFF (PI action)	60	P. 75
Control response parameters	0014	1014	20	4116	R/W	0: Slow 1: Medium 2: Fast	0	P. 76
PV bias	0015	1015	21	4117	R/W	–Input span to +Input span	0	P. 77
Event 1 set value	0016	1016	22	4118	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	P. 78
Event 2 set value	0017	1017	23	4119	R/W		0	P. 78
Unused	0018 ⋮ 001B	1018 ⋮ 101B	24 ⋮ 27	4120 ⋮ 4123	—	—	—	—
Cool-side proportional band	001C	101C	28	4124	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 span	P. 74
Unused	001D	101D	29	4125	—	—	—	—
Overlap/Deadband	001E	101E	30	4126	R/W	–Input span to +Input span	0 (0.0)	P. 76
Setting change rate limiter	001F	101F	31	4127	R/W	0 (0.0) to Input span/minute 0 (0.0): Setting change rate limiter OFF	0 (0.0)	P. 77

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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
PID/AT transfer	0020	1020	32	4128	R/W	0: PID control operation 1: AT (Autotuning) operation	0	P. 79
Auto/Manual transfer	0021	1021	33	4129	R/W	0: Auto mode 1: Manual mode	0	P. 80
Manual output value	0022	1022	34	4130	R/W	–5.0 to +105.0 %	0.0	P. 80
Output limiter (high)	0023	1023	35	4131	R/W	Output limiter (low) to 105.0 %	100.0	P. 81
Output limiter (low)	0024	1024	36	4132	R/W	–5.0 % to Output limiter (high)	0.0	P. 81
Heat-side proportional cycle time	0025	1025	37	4133	R/W	1 to 100 seconds	Relay contact output: 20	P. 81
Cool-side proportional cycle time	0026	1026	38	4134	R/W	1 to 100 seconds	Voltage pulse output: 2	P. 81
Digital filter	0027	1027	39	4135	R/W	0 to 100 seconds 0: Digital filter OFF	0	P. 82
Heater break alarm (HBA) set value	0028	1028	40	4136	R/W	0.0 to 30.0 A or 0.0 to 100.0 A	0.0	P. 82
Number of heater break alarm (HBA) delay times	0029	1029	41	4137	R/W	1 to 255 times	5	P. 84
Unused	002A ⋮ 002F	102A ⋮ 102F	42 ⋮ 47	4138 ⋮ 4143	—	—	—	—
Control RUN/STOP transfer (Data of each module)	0030		48		R/W	0: Control STOP 1: Control RUN	0	P. 84
Input error determination point (high)	0031	1031	49	4145	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	P. 85

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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Input error determination point (low)	0032	1032	50	4146	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	P. 85
Action at input error (high)	0033	1033	51	4147	R/W	0: Normal control 1: Manipulated output value at input error	0	P. 86
Action at input error (low)	0034	1034	52	4148	R/W	0: Normal control 1: Manipulated output value at input error	0	P. 86
Manipulated output value at input error	0035	1035	53	4149	R/W	–105.0 to +105.0 %	0.0	P. 87
AT differential gap time	0036	1036	54	4150	R/W	0 to 100 seconds	1	P. 88
Unused	0037	1037	55	4151	—	—	—	—
AT bias	0038	1038	56	4152	R/W	–Input span to +Input span	0	P. 89
Unused	0039 ⋮ 003B	1039 ⋮ 103B	57 ⋮ 59	4153 ⋮ 4155	—	—	—	—
Event LED mode setting (Data of each module)	003C		60		R/W	1: Mode 1 2: Mode 2 3: Mode 3 Except the above (within 0 to 255): Unused	0	P. 90
DI setting (Data of each module)	003D		61		R/W	1: Control RUN/STOP 2: Event interlock release Except the above (within 0 to 20): Unused	Specify when ordering	P. 93

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Name	Register address				Attri-bute	Data range	Factory set value	Refer-ence page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
DI state (Data of each module)	003E		62		RO	0: Contact open (OFF) 1: Contact close (ON)	—	P. 93
DO1 setting (Data of each module)	003F		63		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	P. 94
DO2 setting (Data of each module)	0040		64		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	P. 94
DO state (Data of each module)	0041		65		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) Data write is possible only when the DO1 and DO2 setting values are “0.”	0	P. 94

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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Event interlock release (Data of each module)	0042		66		R/W	0: Normal state 1: Event interlock release execution	0	P. 95
Temperature rise completion zone	0043	1043	67	4163	R/W	0 (0.0) to Input span 0 (0.0): Unused	0 (0.0)	P. 96
Temperature rise completion soak time	0044	1044	68	4164	R/W	0 to 360 minutes	0	P. 97
Unused	0045 ⋮ 0858	1045 ⋮ 1858	69 ⋮ 2136	4165 ⋮ 6232	—	—	—	—
Control loop break alarm (LBA) use selection	0859	1859	2137	6233	R/W	0: Unused 1: Used	0	P. 90
Control loop break alarm (LBA) time	085A	185A	2138	6234	R/W	1 to 7200 seconds	480	P. 91
Control loop break alarm (LBA) deadband	085B	185B	2139	6235	R/W	0 (0.0) to Input span	0 (0.0)	P. 92
Unused	085C ⋮ 085F	185C ⋮ 185F	2140 ⋮ 2143	6236 ⋮ 6239	—	—	—	—
Initial setting mode (Data of each module)	0860		2144		R/W	0: Normal setting mode 1: Initial setting mode	0	P. 97
Unused	0861 ⋮ 086F	1861 ⋮ 186F	2145 ⋮ 2159	6241 ⋮ 6255	—			

7.8.2 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.

■ Transfer to initial setting mode.

Transfer to initial setting mode sets in "1" with register address 0860H (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 "0860H" by 0).

Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Input range number	0870	1870	2160	6256	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 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	Specify when ordering	P. 99

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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Input range number	0870	1870	2160	6256	R/W	TC input 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 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	Specify when ordering	P. 99

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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Input range number	0870	1870	2160	6256	R/W	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	P. 99
Input scale high limit	0871	1871	2161	6257	R/W	Input scale low limit to 10000 (Effective only for voltage/ current input)	Depend on input range	P. 100
Input scale low limit	0872	1872	2162	6258	R/W	–2000 to Input scale high limit (Effective only for voltage/ current input)	Depend on input range	P. 100
Input range decimal point position	0873	1873	2163	6259	R/W	0: No decimal place 1: One decimal place 2: Two decimal places 3: Three decimal places (Effective only for voltage/ current input)	1	P. 100
Temperature unit selection	0874	1874	2164	6260	R/W	0: °C 1: °F	0	P. 101
Control type selection	0875	1875	2165	6261	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	P. 101
ON/OFF control differential gap (upper)	0876	1876	2166	6262	R/W	0 to Input span	TC/ RTD: 1.0 °C (1.0 °F)	P. 102
ON/OFF control differential gap (lower)	0877	1877	2167	6263	R/W		V/I: 0.1 % of input span	P. 102

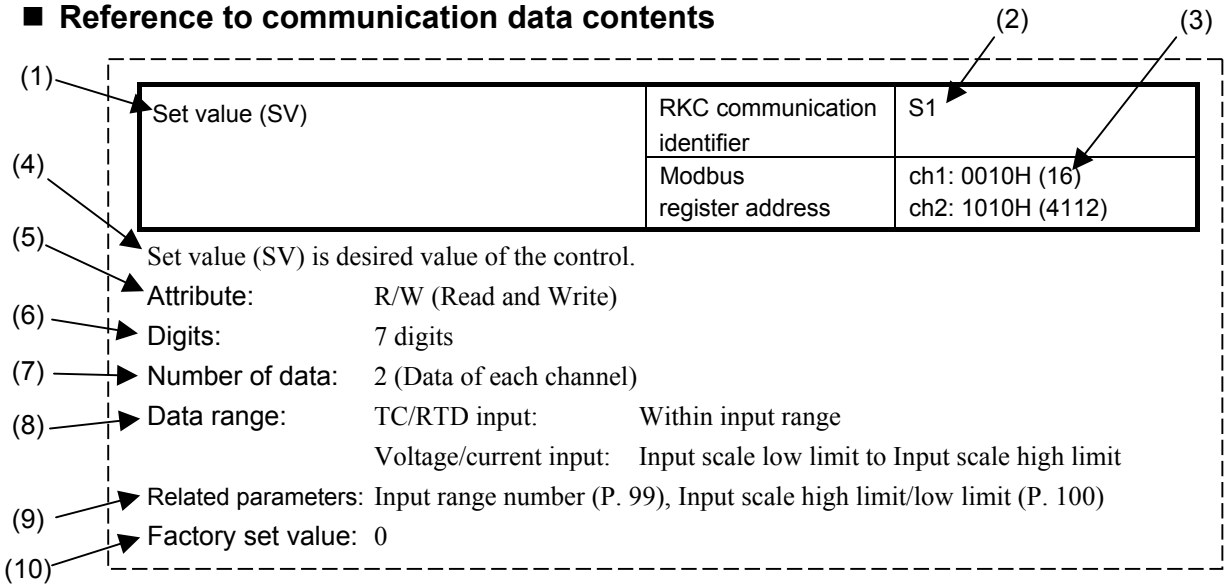
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Name	Register address				Attribute	Data range	Factory set value	Reference page
	Hexadecimal		Decimal					
	CH1	CH2	CH1	CH2				
Event 1 differential gap	0878	1878	2168	6264	R/W	0 to Input span	TC/RTD: 2.0 °C (2.0 °F) V/I: 0.2 % of input span	P. 103
Event 2 differential gap	0879	1879	2169	6265	R/W			P. 103
Event 1 type selection	087A	187A	2170	6266	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	P. 104
Event 2 type selection	087B	187B	2171	6267	R/W		Specify when ordering	P. 104
Event 1 action selection	087C	187C	2172	6268	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	P. 106
Event 2 action selection	087D	187D	2173	6269	R/W		b0 to b2: Specify when ordering b3 to b7: 0	P. 106
Event delay timer	087E	187E	2174	6270	R/W	0 to 9999 seconds	0	P. 108
Transmission transfer time setting (Data of each module)	087F		2175		R/W	0 to 100 ms	6	P. 108
Unused	0880	1880	2176	6272	—	—	—	—
Operation mode holding setting (Data of each module)	0881		2177		R/W	0: Not hold 1: Hold	1	P. 108

8. COMMUNICATION DATA DESCRIPTION

■ **Reference to communication data contents**



(1) Name: Communication data name is written.

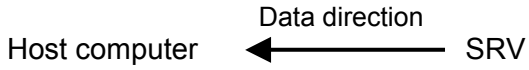
(2) RKC communication identifier:
Communication identifier of RKC communication is written.

(3) Modbus register address:
Modbus communication data register addresses are written for each channel. These register addresses are written using both of hexadecimal and decimal (in parentheses) numbers.

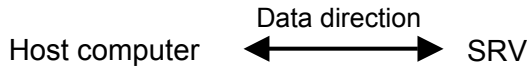
(4) Description: A short description of the communication data item is written.

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

RO: Only reading data is possible.



R/W: Reading and writing data is possible.



(6) Digits: The data number of digits in communication is written.

(7) Number of data: The number of data points is written.
Number of each channel data: 2
Number of each module data: 1

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

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

(10) 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)	RKC communication identifier	M1
	Modbus register address	ch1: 0000H (0) ch2: 1000H (4096)

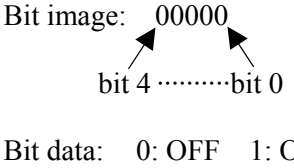
Measured value (PV) is the input value of SRV. There are thermocouple input, resistance temperature detector input, voltage input and current input.

Attribute: RO (Read only)
Digits: 7 digits
Number of data: 2 (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	RKC communication identifier	AJ
	Modbus register address	ch1: 0001H (1) ch2: 1001H (4097)

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

Attribute: RO (Read only)
Digits: 7 digits
Number of data: 2 (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 0: Burnout
bit 1: Event 1 status
bit 2: Event 2 status
bit 3: Heater break alarm (HBA) status
bit 4: Control loop break alarm (LBA) status

Related parameters: Event LED mode setting (P. 90)
Factory set value: —

Burnout state	RKC communication identifier	B1
	Modbus register address	ch1: 0008H (8) ch2: 1008H (4104)

Monitor a state in input break.

Attribute: RO (Read only)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: OFF
1: ON
Factory set value: —

Event 1 state	RKC communication identifier	AA
	Modbus register address	ch1: 0009H (9) ch2: 1009H (4105)
Event 2 state	RKC communication identifier	AB
	Modbus register address	ch1: 000AH (10) ch2: 100AH (4106)

Monitor an ON/OFF state of the event.

Attribute: RO (Read only)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: OFF
1: ON
Related parameters: Event set value (P. 78), Event LED mode setting (P. 90), Event differential gap (P. 103), Event type selection (P. 104), Event action selection (P. 106), Event delay timer (P. 108)
Factory set value: —

Heater break alarm (HBA) state	RKC communication identifier	AC
	Modbus register address	ch1: 000BH (11) ch2: 100BH (4107)

Monitor a state of heater break alarm.

Attribute: RO (Read only)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: OFF
1: Heater break
2: Relay welding
Related parameters: Current transformer input measured value (P. 71), Heater break alarm (HBA) set value (P. 82), Number of heater break alarm (HBA) delay times (P. 84)
Factory set value: —

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

Control loop break alarm (LBA) state	RKC communication identifier	AP
	Modbus register address	ch1: 000CH (12) ch2: 100CH (4108)

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)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: OFF
1: ON
Related parameters: Control loop break alarm (LBA) use selection (P. 90), Control loop break alarm (LBA) time (P. 91), Control loop break alarm (LBA) deadband (P. 92)
Factory set value: —

Heat-side manipulated output value	RKC communication identifier	O1
	Modbus register address	ch1: 0002H (2) ch2: 1002H (4098)
Cool-side manipulated output value	RKC communication identifier	O2
	Modbus register address	ch1: 0005H (5) ch2: 1005H (4101)

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

Attribute: RO (Read only)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: −5.0 to +105.0 %
Related parameters: Manual output value (P. 80), Output limiter (high/low) (P. 81), Event LED mode setting (P. 90)
Factory set value: —

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

Current transformer input measured value	RKC communication identifier	M3
	Modbus register address	ch1: 0006H (6) ch2: 1006H (4102)

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

Attribute: RO (Read only)
Digits: 7 digits
Number of data: 2 (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. 70), Heater break alarm (HBA) set value (P. 82), Number of heater break alarm (HBA) delay times (P. 84)
Factory set value: —

Set value monitor	RKC communication identifier	MS
	Modbus register address	ch1: 0003H (3) ch2: 1003H (4099)

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

Attribute: RO (Read only)
Digits: 7 digits
Number of data: 2 (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	RKC communication identifier	ER
	Modbus register address	0004H (4)

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

Attribute: RO (Read only)
Digits: 7 digits
Number of data: 1 (Data of each module)
Data range: 0 to 127 (bit data)
Each error 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: 00000000
bit 7 ····· bit 0

Bit data: 0: OFF 1: ON

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

Factory set value: —

Temperature rise completion state	RKC communication identifier	HE
	Modbus register address	ch1: 000DH (13) ch2: 100DH (4109)

Monitor a state of temperature rise completion state.

Attribute: RO (Read only)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: Temperature rise not complete
1: Temperature rise completion
Related parameters: Temperature rise completion zone (P. 96), Temperature rise completion soak time (P. 97)
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.

Set value (SV)	RKC communication identifier	S1
	Modbus register address	ch1: 0010H (16) ch2: 1010H (4112)

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

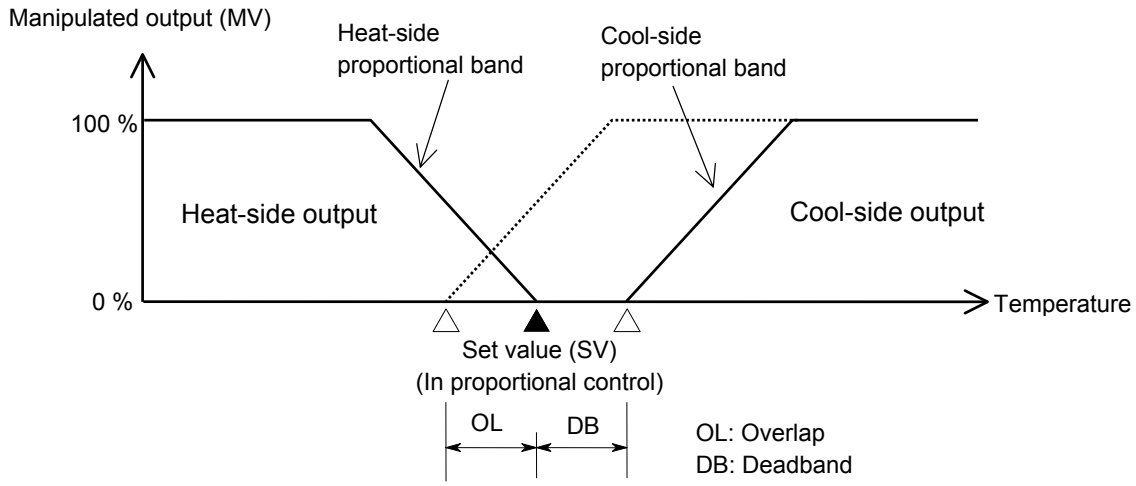
Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: TC/RTD input: Within input range
Voltage/current input: Input scale low limit to Input scale high limit
Related parameters: Input range number (P. 99), Input scale high limit/low limit (P. 100)
Factory set value: 0

Heat-side proportional band	RKC communication identifier	P1
	Modbus register address	ch1: 0011H (17) ch2: 1011H (4113)
Cool-side proportional band	RKC communication identifier	P2
	Modbus register address	ch1: 001CH (28) ch2: 101CH (4124)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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. 76), ON/OFF control differential gap (upper/lower) (P. 102)
Factory set value: TC/RTD input: 30 °C (30.0 °C)
Voltage/current input: 30.0 % of 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.



Integral time	RKC communication identifier	I1
	Modbus register address	ch1: 0012H (18) ch2: 1012H (4114)

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)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 1 to 3600 seconds
Factory set value: 240

Derivative time	RKC communication identifier	D1
	Modbus register address	ch1: 0013H (19) ch2: 1013H (4115)

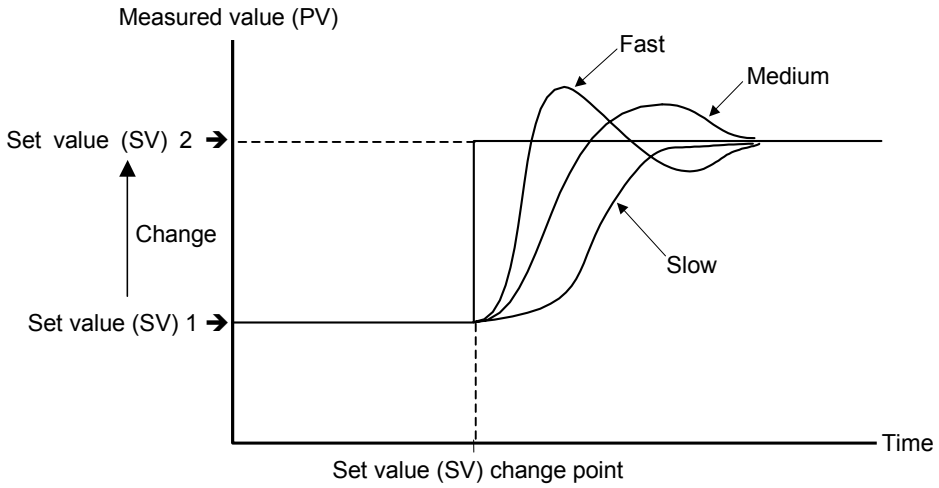
Derivative action is to prevent rippling and make control stable by monitoring output change. The degree of Derivative action is set by time in seconds.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 to 3600 seconds
0: Derivative action OFF (PI action)
Factory set value: 60

Control response parameters	RKC communication identifier	CA
	Modbus register address	ch1: 0014H (20) ch2: 1014H (4116)

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

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (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.



Overlap/Deadband	RKC communication identifier	V1
	Modbus register address	ch1: 001EH (30) ch2: 101EH (4126)

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

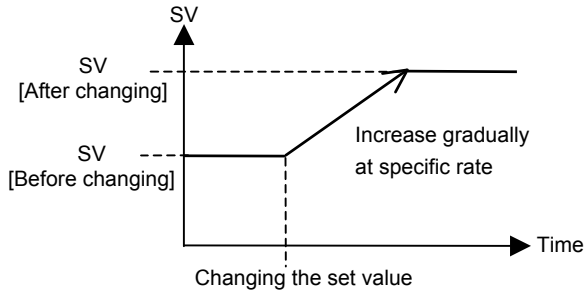
Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: –Input span to +Input span
Related parameters: Heat-side proportional band/Cool-side proportional band (P. 74)
Factory set value: 0 (0.0)

Setting change rate limiter	RKC communication identifier	HH
	Modbus register address	ch1: 001FH (31) ch2: 101FH (4127)

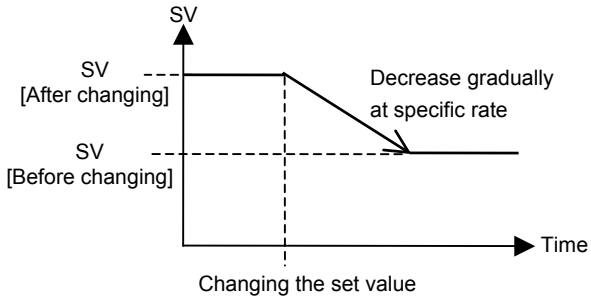
This function is to allow the set value (SV) to be automatically changed at specific rates when a new set value (SV).

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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.

PV bias	RKC communication identifier	PB
	Modbus register address	ch1: 0015H (21) ch2: 1015H (4117)

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)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: –Input span to +Input span
Factory set value: 0 (0.0)

Event 1 set value	RKC communication identifier	A1
	Modbus register address	ch1: 0016H (22) ch2: 1016H (4118)
Event 2 set value	RKC communication identifier	A2
	Modbus register address	ch1: 0017H (23) ch2: 1017H (4119)

Use to set setting value of an event action.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: Deviation high/Deviation low: –Input span to +Input span
Deviation high/low, Band: 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. 69), Event differential gap (P. 103), Event type selection (P. 104), Event action selection (P. 106), Event delay timer (P. 108)
Factory set value: 0 (0.0)

Operation mode	RKC communication identifier	EI
	Modbus register address	ch1: 000FH (15) ch2: 100FH (4111)

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

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (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. 90), Operation mode holding setting (P. 108)
Factory set value: Heat control CH1 3: Control
CH2 3: Control
Heat/cool control CH1 3: Control
CH2 0: Unused

PID/AT transfer	RKC communication identifier	G1
	Modbus register address	ch1: 0020H (32) ch2: 1020H (4128)

Use to transfers PID control and autotuning (AT).

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: PID control operation
1: AT (Autotuning) operation
Related parameters: AT differential gap time (P. 88), AT bias (P. 89)
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 (Identifier J1) → Auto mode
  – PID/AT transfer (Identifier G1) → PID control mode
  – Control RUN/STOP transfer (Identifier SR) → 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.

Auto/Manual transfer	RKC communication identifier	J1
	Modbus register address	ch1: 0021H (33) ch2: 1021H (4129)

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

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (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	RKC communication identifier	ON
	Modbus register address	ch1: 0022H (34) ch2: 1022H (4130)

Use to set the output value in the manual control.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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. 81)
Factory set value: 0.0

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

Output limiter (high)	RKC communication identifier	OH
	Modbus register address	ch1: 0023H (35) ch2: 1023H (4131)
Output limiter (low)	RKC communication identifier	OL
	Modbus register address	ch1: 0024H (36) ch2: 1024H (4132)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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. 71)
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	RKC communication identifier	T0
	Modbus register address	ch1: 0025H (37) ch2: 1025H (4133)
Cool-side proportional cycle time	RKC communication identifier	T1
	Modbus register address	ch1: 0026H (38) ch2: 1026H (4134)

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)
Digits: 7 digits
Number of data: 2 (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	RKC communication identifier	F1
	Modbus register address	ch1: 0027H (39) ch2: 1027H (4135)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 to 100 seconds
0: Digital filter OFF
Factory set value: 0

Heater break alarm (HBA) set value	RKC communication identifier	A3
	Modbus register address	ch1: 0028H (40) ch2: 1028H (4136)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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)

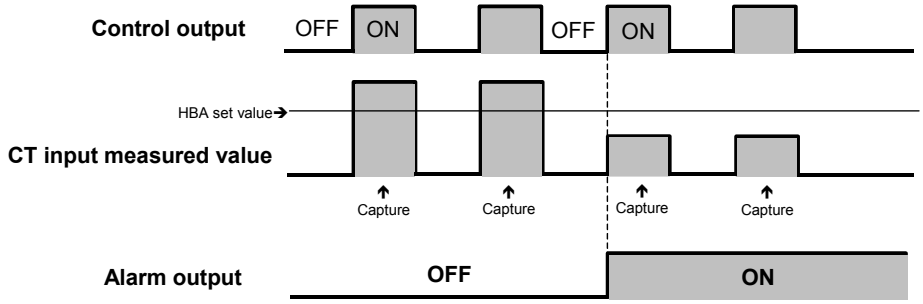
Set HBA set value to a value about 85 % of current transformer input measured value (CT). However, when power supply variations are large, set the HBA to a slightly smaller value. In addition, when two or more heaters are connected in parallel, set the HBA to a slightly larger value so that it is activated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

Related parameters: Heater break alarm (HBA) state (P. 70), Current transformer input measured value (P. 71), Number of heater break alarm (HBA) delay times (P. 84)
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.

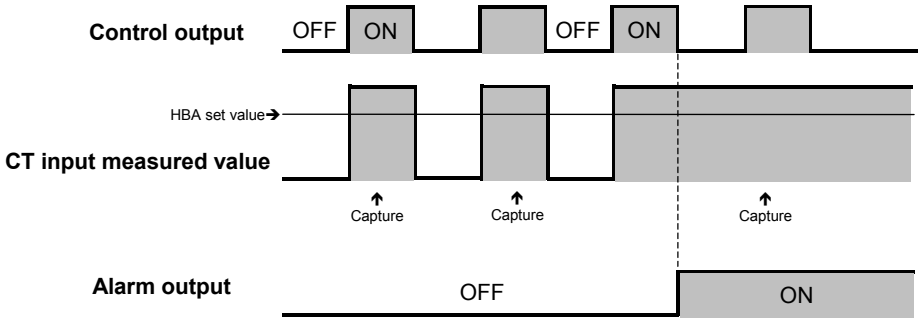
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- **When no heater current flows:** Heater break or faulty operating unit, etc.
  When the control output is on and the current transformer (CT) input measured value is equal to or less than the HBA set value, an alarm status is produced. However, heater break alarm does not action when control output ON time is 0.1 second or less.



- **When the heater current can not be turned off:** Welded realy contact, etc.
  When the control output is off and the current transformer (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	RKC communication identifier	DH
	Modbus register address	ch1: 0029H (41) ch2: 1029H (4137)

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.

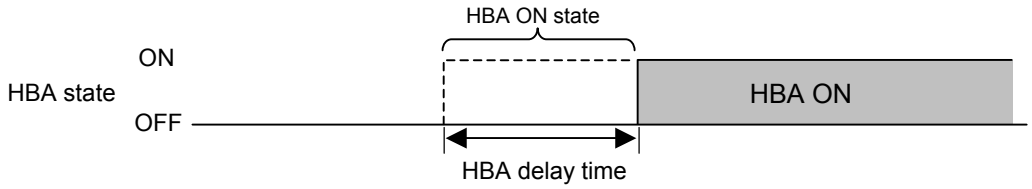
Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 1 to 255 times
Related parameters: Heater break alarm (HBA) state (P. 70), Current transformer input measured value (P. 71), Heater break alarm (HBA) set value (P. 82)
Factory set value: 5

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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	RKC communication identifier	SR
	Modbus register address	0030H (48)

Use to transfers RUN and STOP of the control.

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 1 (Data of each module)
Data range: 0: Control STOP
1: Control RUN
Related parameters: DI setting (P. 93)
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)	RKC communication identifier	AV
	Modbus register address	ch1: 0031H (49) ch2: 1031H (4145)

Use to set input error determination point (high). 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)
Digits: 7 digits
Number of data: 2 (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 error determination point (low) (P. 85), Action at input error (high/low) (P. 86), Manipulated output value at input error (P. 87)
Factory set value: TC/RTD input: Input range high limit
Voltage/current input: Input scale high limit

Input error determination point (low)	RKC communication identifier	AW
	Modbus register address	ch1: 0032H (50) ch2: 1032H (4146)

Use to set input error determination point (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.

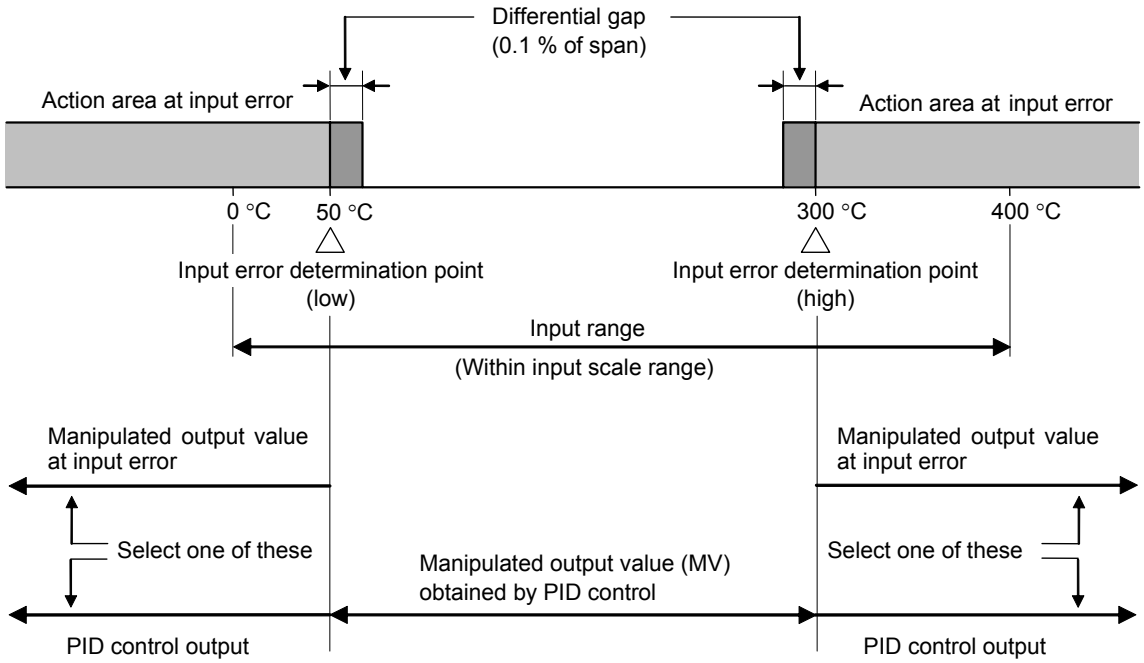
Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: TC/RTD input: Within input range
Voltage/current input: Input scale low limit to Input scale high limit
Related parameters: Input error determination point (high) (P. 85), Action at input error (high/low) (P. 86), Manipulated output value at input error (P. 87)
Factory set value: TC/RTD input: Input range low limit
Voltage/current input: Input scale low limit

Action at input error (high)	RKC communication identifier	WH
	Modbus register address	ch1: 0033H (51) ch2: 1033H (4147)
Action at input error (low)	RKC communication identifier	WL
	Modbus register address	ch1: 0034H (52) ch2: 1034H (4148)

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

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (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. 85), Manipulated output value at input error (P. 87)
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	RKC communication identifier	OE
	Modbus register address	ch1: 0035H (53) ch2: 1035H (4149)

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)
Digits: 7 digits
Number of data: 2 (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. 85), Action at input error (high/low) (P. 86)
Factory set value: 0.0

AT differential gap time	RKC communication identifier	GH
	Modbus register address	ch1: 0036H (54) ch2: 1036H (4150)

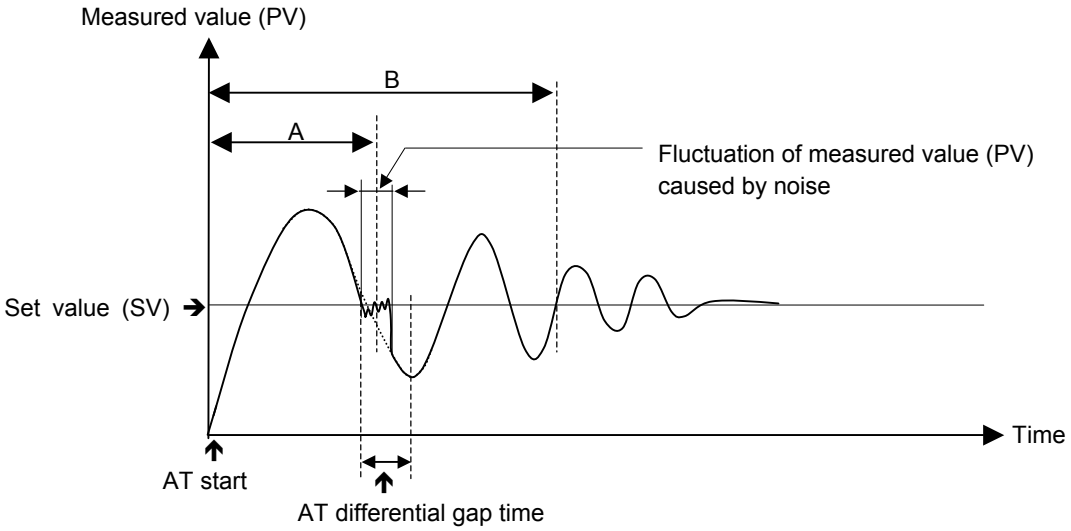
Use to set an ON/OFF action differential gap time for autotuning. This function prevents the AT function from malfunctioning caused by noise.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 to 100 seconds
Related parameters: PID/AT transfer (P. 79)
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.



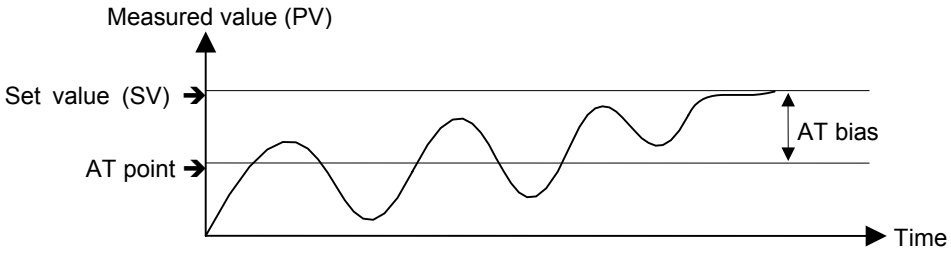
The AT cycle of SRV is 2 cycles.

AT bias	RKC communication identifier	GB
	Modbus register address	ch1: 0038H (56) ch2: 1038H (4152)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: −Input span to +Input span
Related parameters: PID/AT transfer (P. 79)
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	RKC communication identifier	XH
	Modbus register address	003CH (60)

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)
Digits: 7 digits
Number of data: 1 (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).

Control loop break alarm (LBA) use selection	RKC communication identifier	HP
	Modbus register address	ch1: 0859H (2137) ch2: 1859H (6233)

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

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: Unused
1: Used
Related parameters: Control loop break alarm (LBA) state (P. 70), Control loop break alarm (LBA) time (P. 91), Control loop break alarm (LBA) deadband (P. 92)
Factory set value: 0: Unused

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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.

[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	RKC communication identifier	C6
	Modbus register address	ch1: 085AH (2138) ch2: 185AH (6234)

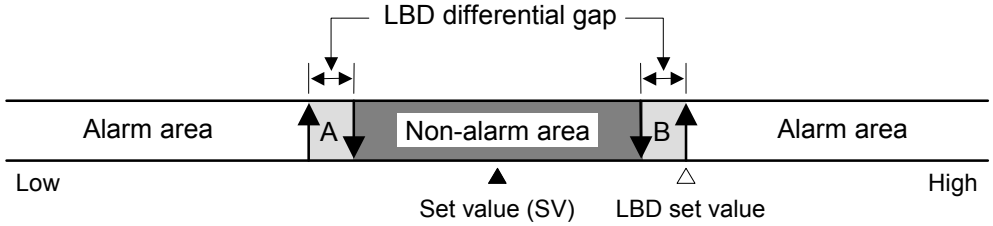
The LBA time sets the time required for the LBA function to determine there is a loop failure. When the LBA is output (under alarm status), the LBA function still monitors the measured value (PV) variation at an interval of the LBA time.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 1 to 7200 seconds
Related parameters: Control loop break alarm (LBA) state (P. 70), Control loop break alarm (LBA) use selection (P. 90), Control loop break alarm (LBA) deadband (P. 92)
Factory set value: 480

Control loop break alarm (LBA) deadband	RKC communication identifier	V2
	Modbus register address	ch1: 085BH (2139) ch2: 185BH (6235)

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)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 (0.0) to Input span
Related parameters: Control loop break alarm (LBA) state (P. 70), Control loop break alarm (LBA) use selection (P. 90), Control loop break alarm (LBA) time (P. 91)
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.

DI setting	RKC communication identifier	E1
	Modbus register address	003DH (61)

Sets the content of optional digital input.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 1 (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. 84), DI state (P. 93),
Event interlock release (P. 95), Event action selection (P. 106)
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	RKC communication identifier	L1
	Modbus register address	003EH (62)

Monitors the optional digital input contact state.

Attribute: RO (Read only)
Digits: 1 digit
Number of data: 1 (Data of each module)
Data range: 0: Contact open
1: Contact close
Related parameters: DI setting (P. 93)
Factory set value: —

DO1 setting	RKC communication identifier	QA
	Modbus register address	003FH (63)
DO2 setting	RKC communication identifier	QB
	Modbus register address	0040H (64)

Sets the content of optional digital output.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 1 (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. 69), Event 1 state (P. 69), Event 2 state (P. 69), Heater break alarm (HBA) state (P. 70), Control loop break alarm (LBA) state (P. 70)
Factory set value: Specify when ordering

☞ The content of the event is set by the **Event type selection (P. 104)**.

DO state	RKC communication identifier	Q1
	Modbus register address	0041H (65)

Monitors the optional digital output contact state.

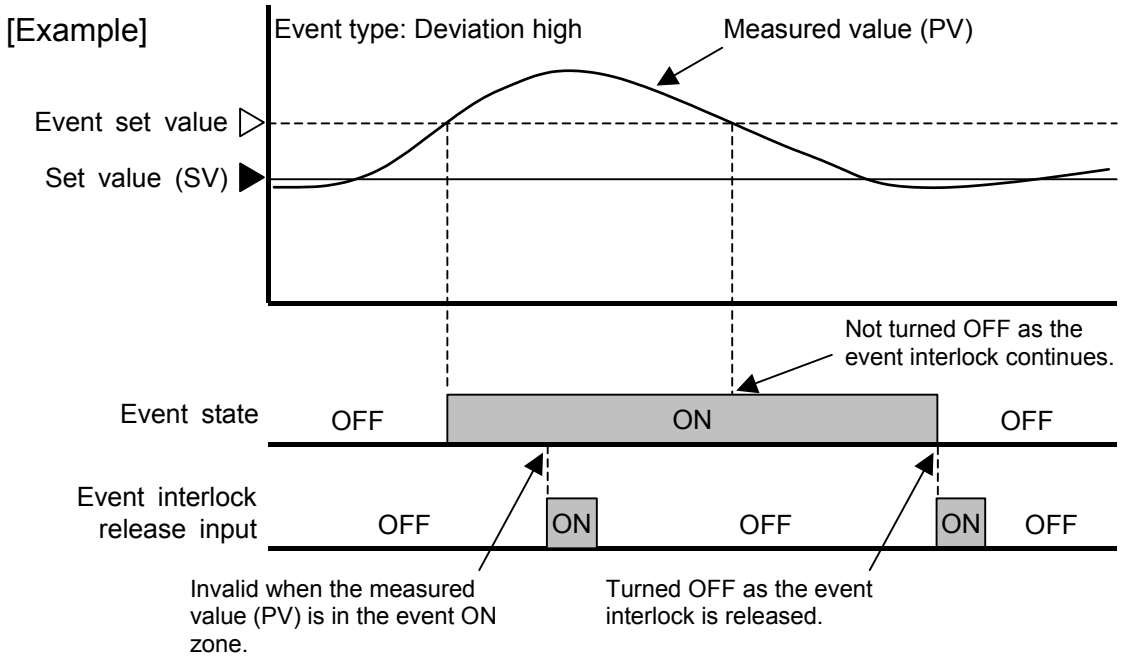
Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 1 (Data of each module)
Data range:
0: DO1: Contact open (OFF), DO2: Contact open (OFF)
1: DO1: Contact close (ON), DO2: Contact open (OFF)
2: DO1: Contact open (OFF), DO2: Contact close (ON)
3: DO1: Contact close (ON), DO2: Contact close (ON)
Related parameters: DO setting (P. 94)
Factory set value: 0

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

Event interlock release	RKC communication identifier	AR
	Modbus register address	0042H (66)

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

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 1 (Data of each module)
Data range: 0: Normal state
1: Event interlock release execution
Related parameters: DI setting (P. 93), Event action selection (P. 106)
Factory set value: 0
Function: The following example shows how the event interlock is released.

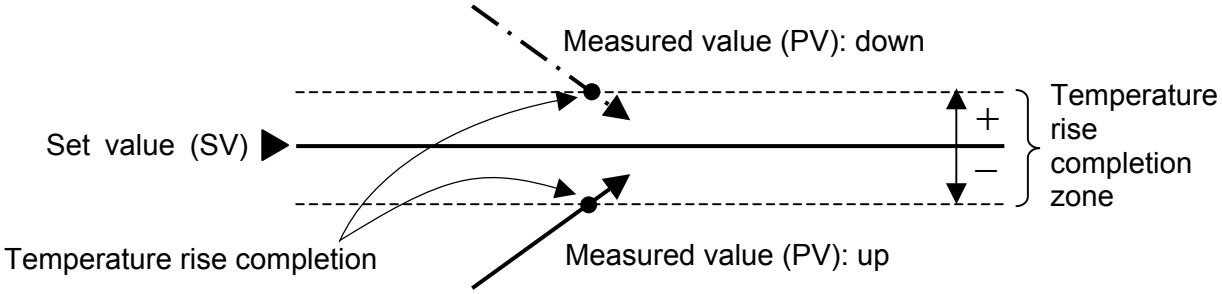


In order to validate the event interlock function, it is necessary to set bit 2 to "1" in item "Event action selection."

Temperature rise completion zone	RKC communication identifier	HD
	Modbus register address	ch1: 0043H (67) ch2: 1043H (4163)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 (0.0) to Input span
0 (0.0): Unused
Related parameters: Temperature rise completion state (P. 73), Temperature rise completion soak time (P. 97)
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.



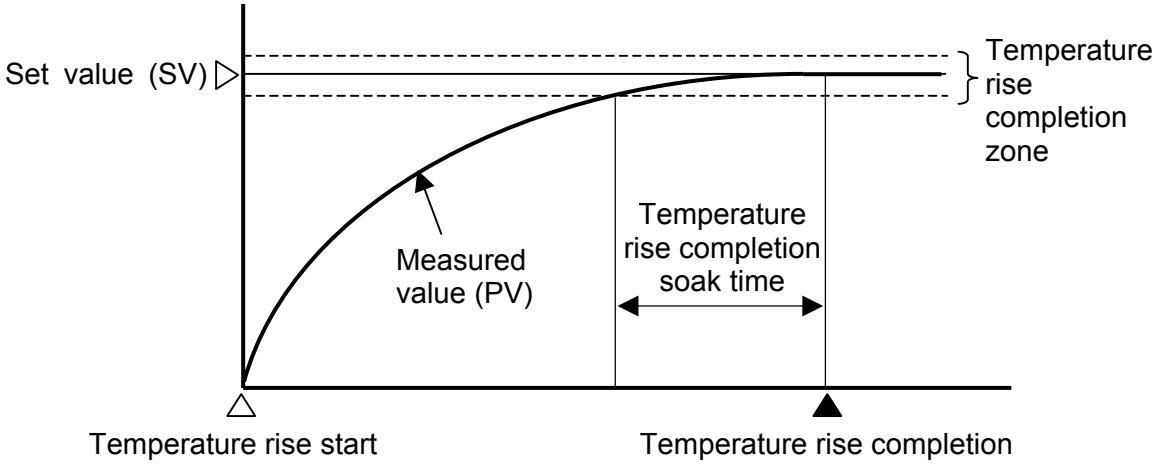
A temperature rise is complete just when the temperature rise completion soak time elapses after the measured value (PV) enters the temperature rise completion zone.

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

Temperature rise completion soak time	RKC communication identifier	T3
	Modbus register address	ch1: 0044H (68) ch2: 1044H (4164)

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)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 to 360 minutes
Related parameters: Temperature rise completion state (P. 73), Temperature rise completion zone (P. 96)
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.



Initial setting mode	RKC communication identifier	IN
	Modbus register address	0860H (2144)

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

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

Initial setting mode is valid only when RKC communication is used.

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. 98)**.

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

The initial setting data items can be set by changing to the initial setting mode. Transfer to initial setting mode sets in "1" with identifier IN or register address 0860H (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 identifier "IN" or register address "0860H" by 0).

■ Data description

Input range number	RKC communication identifier	XI
	Modbus register address	ch1: 0870H (2160) ch2: 1870H (6256)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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.

Continued on the next page.

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Related parameters: Input scale high limit/Input scale low limit (P. 100), Input range decimal point position (P. 100)
Factory set value: Specify when ordering.

Input scale high limit	RKC communication identifier	XV
	Modbus register address	ch1: 0871H (2161) ch2: 1871H (6257)
Input scale low limit	RKC communication identifier	XW
	Modbus register address	ch1: 0872H (2162) ch2: 1872H (6258)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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. 99), Input range decimal point position (P. 100)
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.

Input range decimal point position	RKC communication identifier	XU
	Modbus register address	ch1: 0873H (2163) ch2: 1873H (6259)

Use to select the decimal point position of input range.

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (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. 99), Input scale high limit/Input scale low limit (P. 100)
Factory set value: 1


The input range decimal point position can be set only when voltage/current is input.

Temperature unit selection	RKC communication identifier	PU
	Modbus register address	ch1: 0874H (2164) ch2: 1874H (6260)

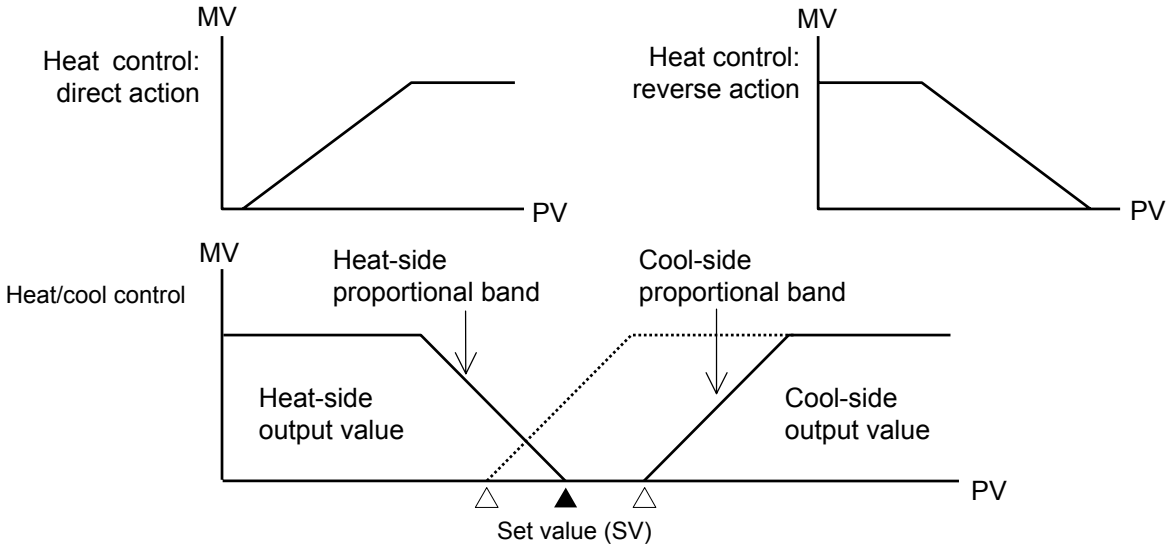
Use to select the temperature unit for thermocouple (TC) and RTD inputs.

Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: °C
1: °F
Factory set value: 0

Control type selection	RKC communication identifier	XE
	Modbus register address	ch1: 0875H (2165) ch2: 1875H (6261)

Use to select control action.

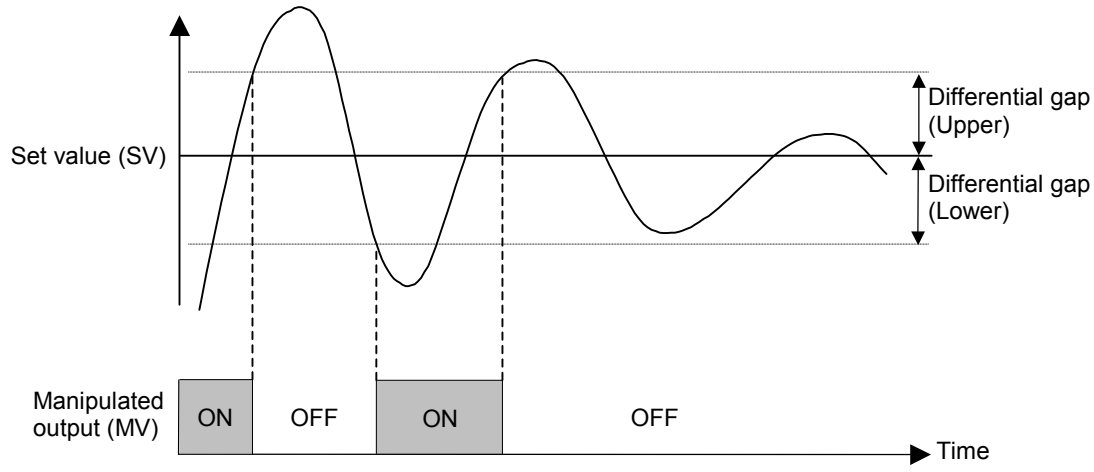
Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: Heat control: direct action
1: Heat control: reverse action
2: Heat/cool control: water cooling
3: Heat/cool control: air cooling
Factory set value: Specify when ordering
Function: [Heat control: direct 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)	RKC communication identifier	IV
	Modbus register address	ch1: 0876H (2166) ch2: 1876H (6262)
ON/OFF control differential gap (lower)	RKC communication identifier	IW
	Modbus register address	ch1: 0877H (2167) ch2: 1877H (6263)

Use to set the ON/OFF control differential gap.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 to Input span
Related parameters: Heat-side/cool-side proportional band (P. 74)
Factory set value: Thermocouple/RTD input: 1.0 °C
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.

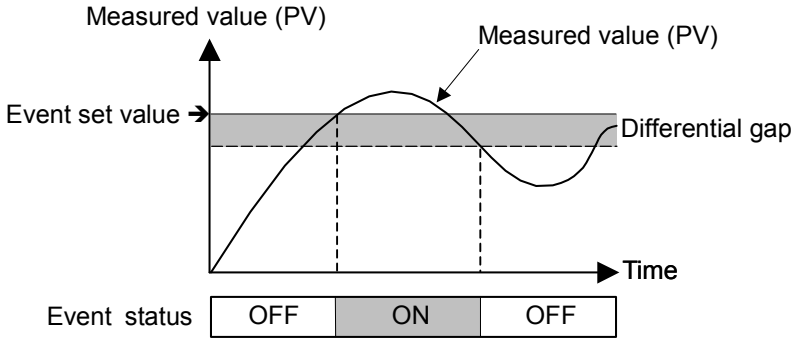


Event 1 differential gap	RKC communication identifier	HA
	Modbus register address	ch1: 0878H (2168) ch2: 1878H (6264)
Event 2 differential gap	RKC communication identifier	HB
	Modbus register address	ch1: 0879H (2169) ch2: 1879H (6265)

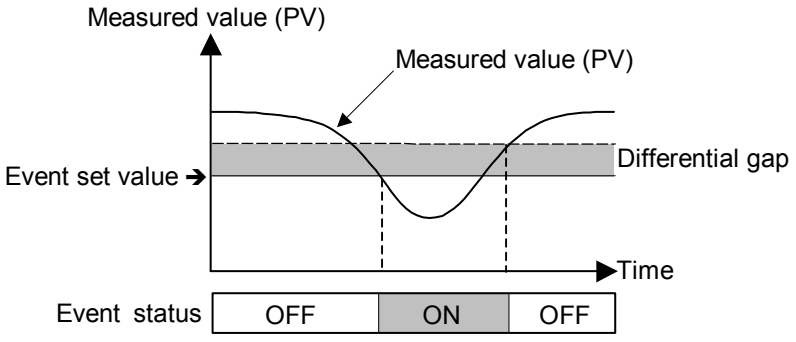
Use to set the event differential gap.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (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. 69), Event set value (P. 78), Event type selection (P. 104), Event action selection (P. 106), Event delay timer (P. 108)
Factory set value: Thermocouple/RTD input: 2.0 °C
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	RKC communication identifier	XA
	Modbus register address	ch1: 087AH (2170) ch2: 187AH (6266)
Event 2 type selection	RKC communication identifier	XB
	Modbus register address	ch1: 087BH (2171) ch2: 187BH (6267)

Use to select the event type.

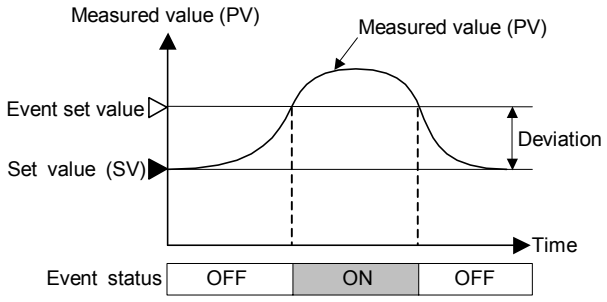
Attribute: R/W (Read and Write)
Digits: 1 digit
Number of data: 2 (Data of each channel)
Data range: 0: Not provided 3: Deviation high 6: Band
1: Process high 4: Deviation low
2: Process low 5: Deviation high/low
Related parameters: Event state (P. 69), Event set value (P. 78), Event differential gap (P. 103), Event action selection (P. 106), Event delay timer (P. 108)
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.

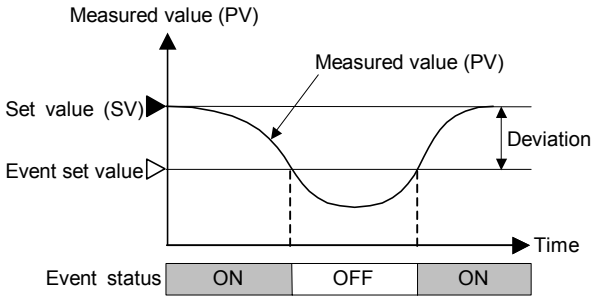
- **Deviation high**

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]



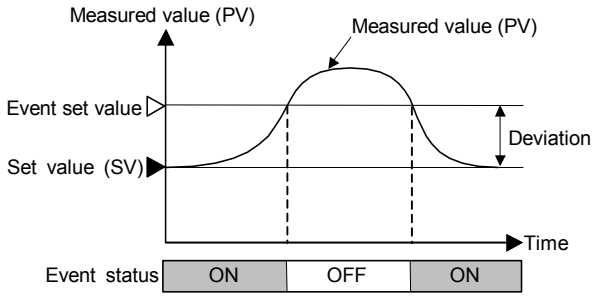
[When the event set value is on the negative side]



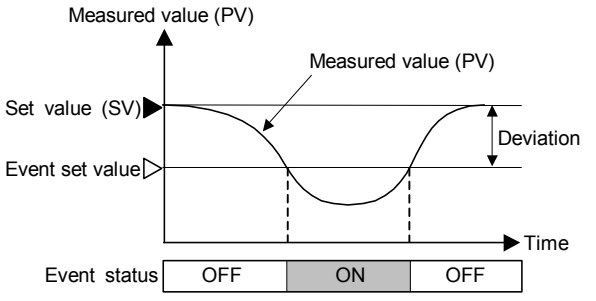
- **Deviation low**

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]

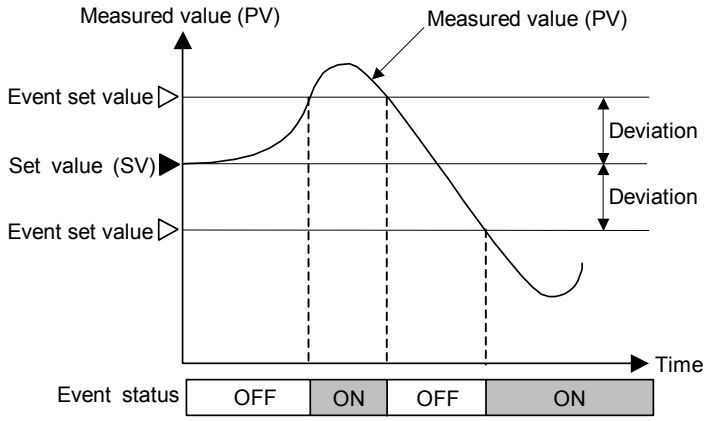


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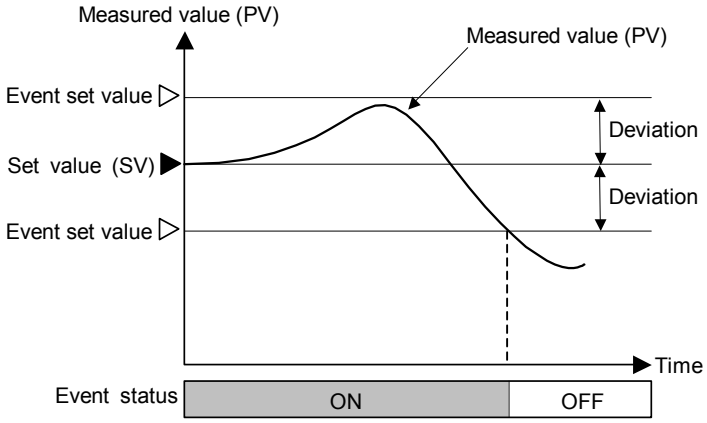
● **Deviation high/low**

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



● **Band**

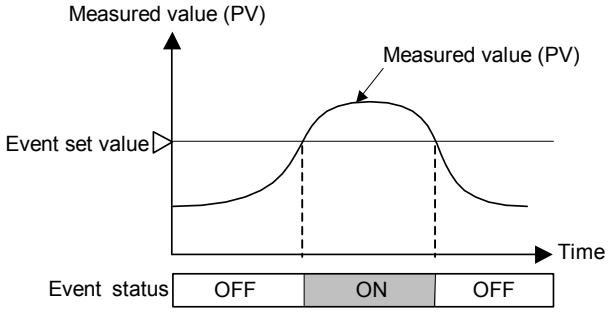
When the absolute deviation (|PV−SV|) is within the event set values, the event status is set up.



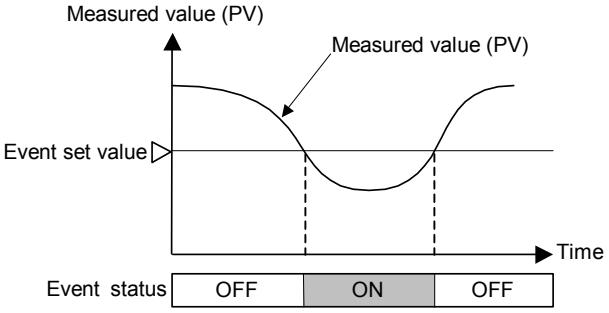
Process:

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

● **Process high**



● **Process low**



Event 1 action selection	RKC communication identifier	WA
	Modbus register address	ch1: 087CH (2172) ch2: 187CH (6268)
Event 2 action selection	RKC communication identifier	WB
	Modbus register address	ch1: 087DH (2173) ch2: 187DH (6269)

Use to select the event action.

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 to 31 (bit data)
Each error 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: 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. 69), Event set value (P. 78), Event differential gap (P. 103), Event type selection (P. 104), Event delay timer (P. 108)

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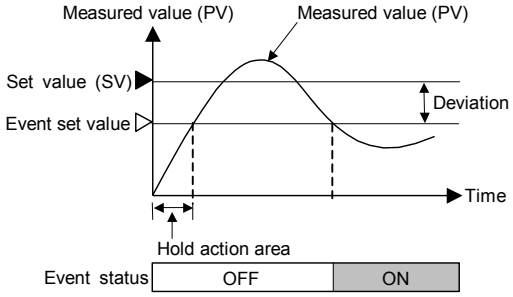
Function: Show it to the following hold action and re-hold action.

● Hold action

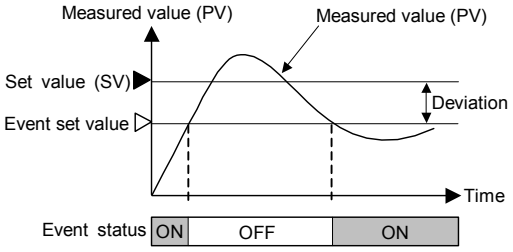
When hold action is ON, the event action is suppressed at start-up and control start until the measured value has entered the non-event range.

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]



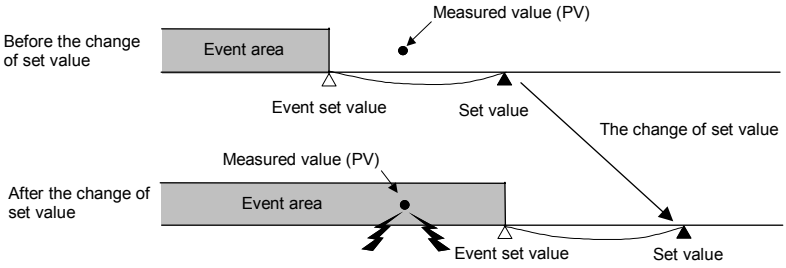
[Without hold action]



● 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. 95)**.

● 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	RKC communication identifier	DF
	Modbus register address	ch1: 087EH (2174) ch2: 187EH (6270)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 2 (Data of each channel)
Data range: 0 to 9999 seconds
Related parameters: Event state (P. 69), Event set value (P. 78), Event differential gap (P. 103), Event type selection (P. 104), Event action selection (P. 106)
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.

Transmission transfer time setting	RKC communication identifier	ZX
	Modbus register address	087FH (2175)

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

Attribute: R/W (Read and Write)
Digits: 7 digits
Number of data: 1 (Data of each module)
Data range: 0 to 100 ms
Factory set value: 6

☞ For detail, see **5.4 Communication Requirements (P. 18)**.

Operation mode holding setting	RKC communication identifier	X2
	Modbus register address	0881H (2177)

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)
Digits: 1 digit
Number of data: 1 (Data of each module)
Data range: 0: Not hold (Operation mode: Monitor 1)
1: Hold
Related parameters: Operation mode (P. 78)
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-☐ module

Problem	Probable cause	Solution
FAIL/RUN lamp does not light up	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-☐ module
RX/TX lamp does not flash	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
	CPU section defect	Replace V-TIO-☐ module
The FAIL/RUN lamp is lit (red): FAIL status	CPU section or power section defect	Replace V-TIO-☐ module

■ RKC communication

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
	Mismatch of the setting data of communication speed and data bit configuration with those of the host	Confirm the settings and set them correctly
	Wrong address setting	
	Error in the data format	Reexamine the communication program
	Transmission line is not set to the receive state after data send (for RS-485)	
EOT return	The specified identifier is invalid	Confirm the identifier is correct or that with the correct function is specified. Otherwise correct it
	Error in the data format	Reexamine the communication program
NAK return	Error in the data format	Reexamine the communication program
	BCC error	
	The data exceeds the setting range	Confirm the setting range and transmit correct data
	The specified identifier is invalid	Confirm the identifier is correct or that with the correct function is specified. Otherwise correct it

■ Modbus

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
	Mismatch of the setting data of communication speed and data bit configuration with those of the host	Confirm the settings and set them correctly
	Wrong address setting	
	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	
	A transmission error (overrun error, framing error, parity error or CRC-16 error) is found in the query message	Re-transmit after time-out occurs or verify communication program
	The time interval between adjacent data in the query message is too long, 24-bit time (or 24-bit time + a few ms) or more	Re-transmit after time-out occurs or verify communication program
Error code 1	Function cod error (Specifying nonexistent function code)	Confirm the function code
Error code 2	When the mismatched address is specified	Confirm the address of holding register
Error code 3	When the data written exceeds the setting range	Confirm the setting data
	When the specified number of data items in the query message exceeds the maximum number of data items available	

10. APPENDIX

10.1 ASCII 7-bit Code Table

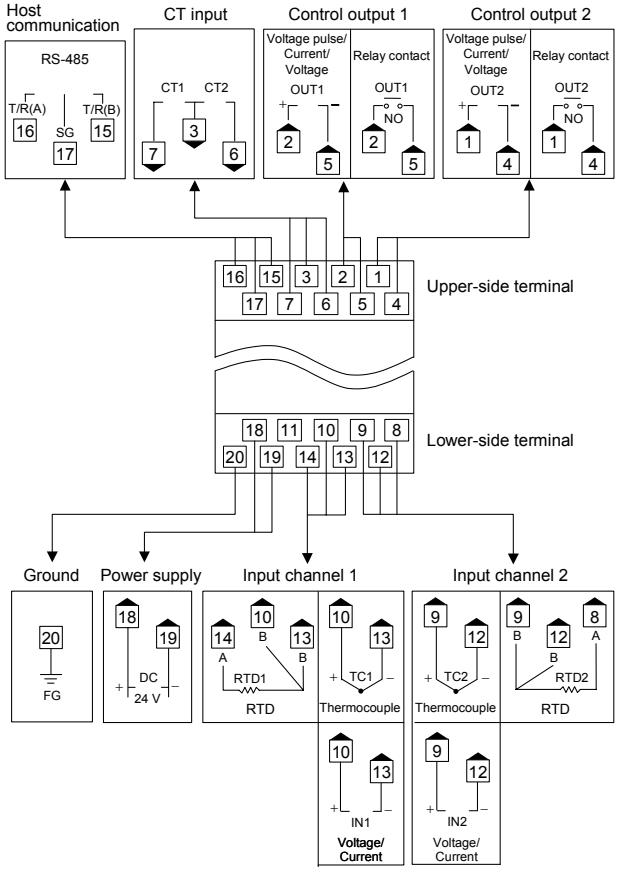
					b7	0	0	0	0	1	1	1	1
					b6	0	0	1	1	0	0	1	1
					b5	0	1	0	1	0	1	0	1
b5～b7	b4	b3	b2	b1	＼	0	1	2	3	4	5	6	7
	0	0	0	0	0	NUL	DLE	SP	0	@	P	‘	p
	0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
	0	0	1	0	2	STX	DC2	”	2	B	R	b	r
	0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
	0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
	0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
	0	1	1	0	6	ACK	SYM	&	6	F	V	f	v
	0	1	1	1	7	BEL	ETB	’	7	G	W	g	w
	1	0	0	0	8	BS	CAN	(	8	H	X	h	x
	1	0	0	1	9	HT	EM	)	9	I	Y	i	y
	1	0	1	0	A	LF	SUB	*	:	J	Z	j	z
	1	0	1	1	B	VT	ESC	+	;	K	[	k	{
	1	1	0	0	C	FF	FS	,	<	L	¥	l	|
	1	1	0	1	D	CR	GS	–	=	M	]	m	}
	1	1	1	0	E	SO	RS	.	>	N	^	n	~
	1	1	1	1	F	SI	US	/	?	O	_	o	DEL

10.2 Terminal Configuration

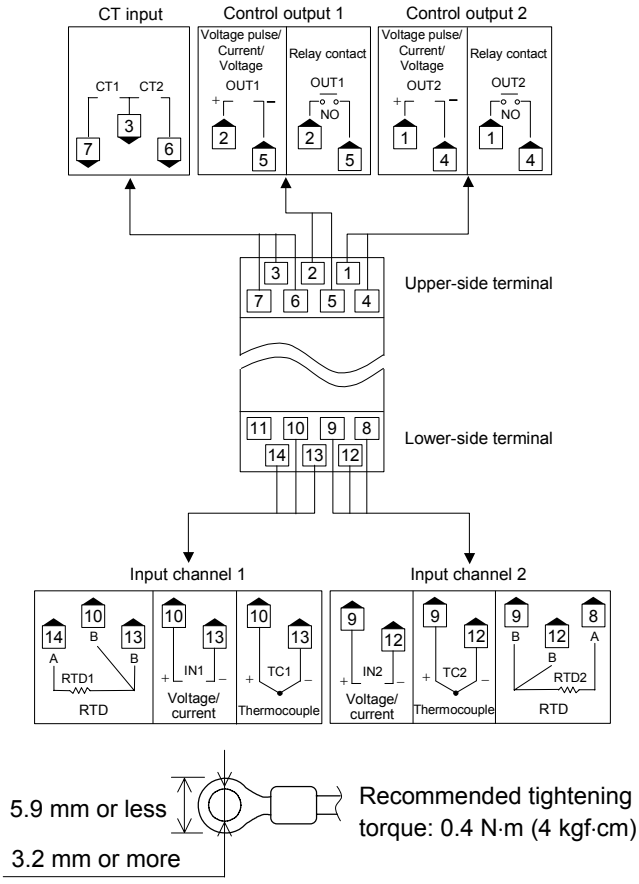
■ Wiring cautions

- 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-A/V-TIO-C (Basic type)



■ V-TIO-B/V-TIO-D (Extension type)



• For heat/cool PID control (V-TIO-C/V-TIO-D), input channel 2 becomes unused.

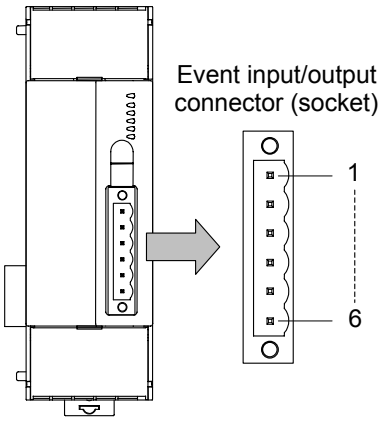
• For heat/cool PID control (V-TIO-C/V-TIO-D), Control output 1 corresponds to the heating output and Control output 2 corresponds to the cooling output.

• Terminal No. 11 is not used.

• Use the solderless terminals appropriate to the screw size (M3).

10.3 Pin Layout of Connector

■ When there is the event input/output

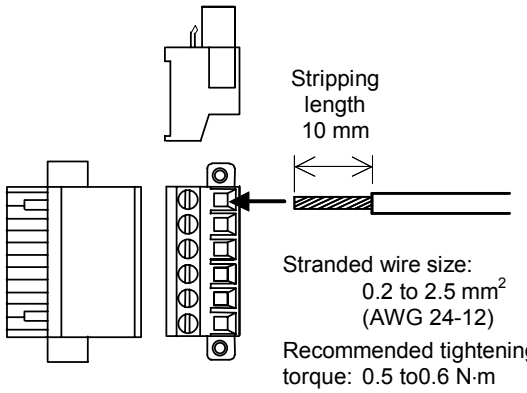


Pin No.	Description
1	Digital input (DI) (–)
2	Digital input (DI) (+)
3	Digital output (DO) 1 (Relay contact output)
4	
5	Digital output (DO) 2 (Relay contact output)
6	

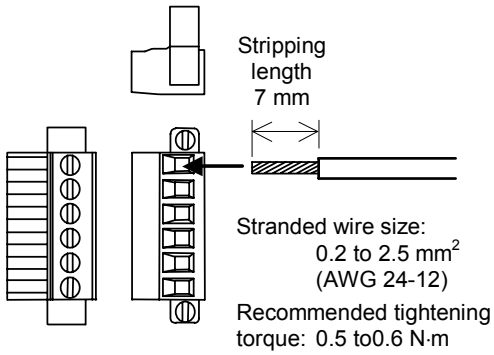
■ Attention in connector (plug) wiring

- 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



10.4 Product Specifications

■ Input

Measuring 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) (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

- 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 (in 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: 6 points

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

■ 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 identifier or 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 can not 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: 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

■ Communication function

Number of communications: 1 point

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: 2400 bps, 9600 bps, 19200 bps, 38400 bps

Data bit configuration:

Start bit:	1
Data bit:	7 or 8 (RKC communication) 8 (Modbus)
Parity bit:	Without or 1 (Odd or Even)
Stop bit:	1

Protocol: RKC communication (ANSI X3.28 subcategory 2.5, A4)
Modbus
(Selectable)

Error control: RKC communication: Vertical parity, Horizontal parity
Modbus: CRC-16

Maximum connections: Up to 32 modules including a host computer

■ 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
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, bit2 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
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): 120 mA max./module
Without event input/output (option): 90 mA max./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. 1 million 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:
Basic type: 40.5 (W) ×125.0 (H) ×110.0 (D) mm
Extension type: 30.0 (W) ×125.0 (H) ×110.0 (D) mm

Weight:
Basic type: With event input/output (option): Approx. 210 g
Without event input/output (option): Approx. 200 g
Extension type: With event input/output (option): Approx. 180 g
Without event input/output (option): Approx. 170 g

■ Standard

Safety standard:
UL: UL61010A-1
CSA: CAN/CSA-C22.2 No1010.1

CE marking:
LVD: EN61010-1
EMC: EN55011, EN61326-1

C-Tick: AS/NZS CISPR 11 (equivalent to EN55011)

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