RB SERIES

Digital Temperature Controller

RB100/RB400
RB500/RB700
RB900

Communication Instruction Manual

RKC® RKC INSTRUMENT INC.

IMR02C16-E3

- Modbus is a registered trademark of Schneider Electric.
- Company names and product names used in this manual are the trademarks or registered trademarks of the respective companies.

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 the 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 product is intended for use with industrial machines, test and measuring equipment. (It is not designed for use with medical equipment and nuclear energy.)
- 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 additional 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.
- When high alarm with hold action/re-hold action is used for Event function, alarm does not turn on while hold action is in operation. Take measures to prevent overheating which may occur if the control device fails.

NOTICE

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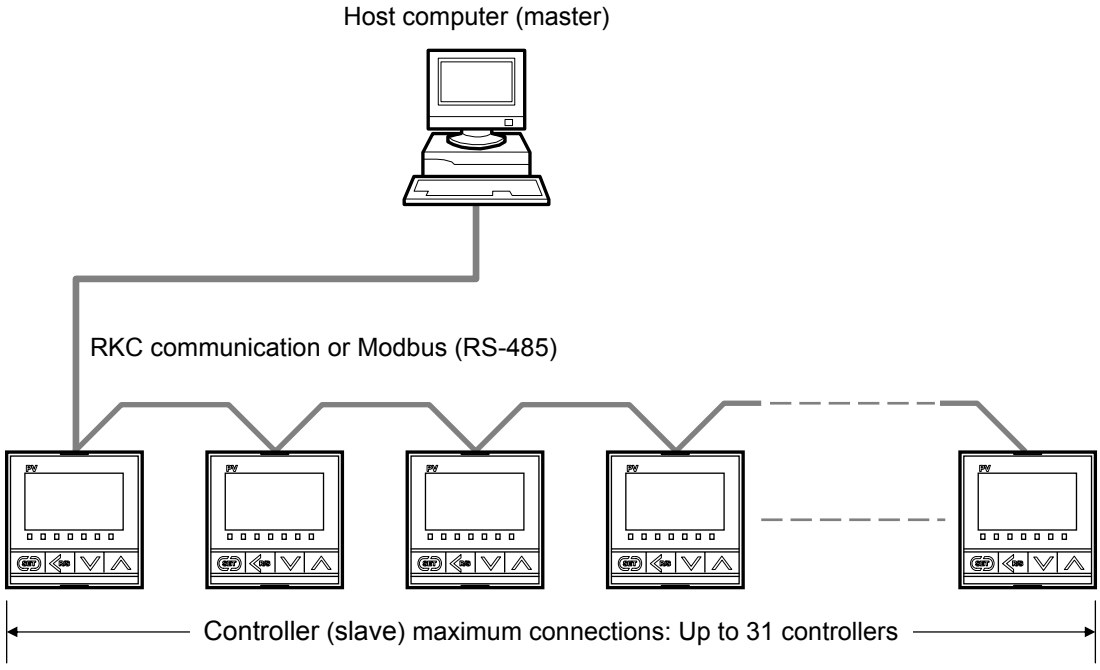
1. OUTLINE

The communication function makes it possible to monitor and set the data of the Digital Temperature Controller RB100/400/500/700/900 (hereafter called controller) from a computer. To perform communication between the computer and controller, you must create a communication program.
The controller interfaces with the host computer via Modbus or RKC communication (ANSI X3.28-1976 subcategories 2.5 and A4) protocols. The communication interface used for both protocols is RS-485.
In addition, the controller is equipped standard with a loader communication connector. Therefore, loader communication is possible. For reference purposes, the Modbus protocol identifies the host computer as master, the controller as slave.

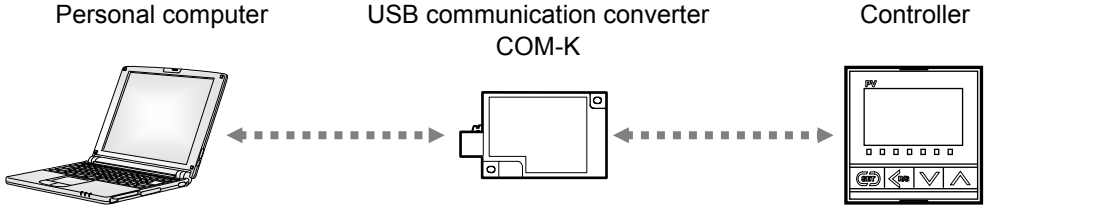
■ RKC communication and Modbus

One host computer (master) can communicate with up to 31 controllers.



■ Loader communication

Loader communication allows controller data to be set from a personal computer.
By saving data that was set using our Communication Setup Tool WinUCI-B for RB series to a computer, the data can be transferred to other controllers, allowing setup to be accomplished much more quickly than when the data is set in each controller using the front panel keys. RKC USB communication converter COM-K (sold separately) is required for the loader communication.



Maximum connections: 1 controller

The Loader port is only for parameter setup.

Loader communication can be used on a controller even when the communication function (optional) is not installed.

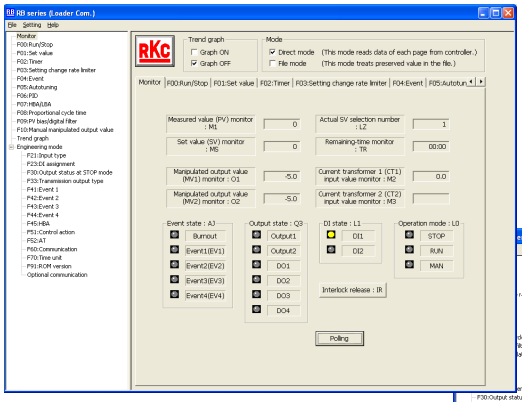
■ Communication Setup Tool WinUCI-B for RB series

The Communication Setup Tool WinUCI-B for RB series has the following features:

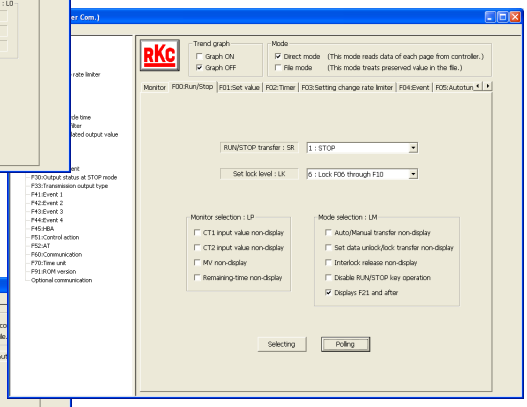
- Communication data such as measured values and set values can be monitored on a personal computer screen.
- The communication data of controller can be set by the personal computer.
- Communication data can save to a personal computer.
- Communication data saved to a personal computer can be transferred to (set in) other controllers.

WinUCI screen example

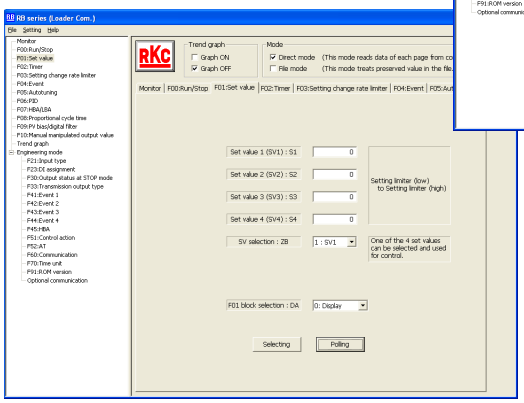
Monitoring screen



Operation screen



SV setting screen



The WinUCI-B for RB series corresponds to the RKC communication protocol.
In addition, WinUCI-B for RB series can be used for both loader communication and host communication.

The WinUCI-B for RB series can be downloaded from the RKC official website:
http://www.rkcinst.com/.

2. 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, 4800 bps, 9600 bps, 19200 bps

Data bit configuration:
Start bit: 1
Data bit: 7 or 8
Parity bit: Without, Odd or Even
Stop bit: 1 or 2

Protocol:
ANSI X3.28-1976 subcategories 2.5 and A4
RKC communication protocol
Polling/selecting type

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

Communication code: ASCII 7-bit code

Termination resistor: Externally terminal connected (Example: 120 Ω 1/2 W)

Xon/Xoff control: None

Maximum connections: Up to 31 controllers

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, 4800 bps, 9600 bps, 19200 bps

Data bit configuration:
Start bit: 1
Data bit: 8
Parity bit: Without, Odd or Even
Stop bit: 1 or 2

Protocol: Modbus

Signal transmission mode: Remote Terminal Unit (RTU) mode

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

Error check method: CRC-16

Error code:
1: Function code error
2: When the mismatched address is specified
3: When the specified number of data items in the query message exceeds the maximum number of data items available
4: Self-diagnostic error response

Termination resistor: Externally terminal connected (Example: 120 Ω 1/2 W)

Maximum connections: Up to 31 controllers

■ Loader communication

Connection method: Connection with a loader communication cable for RKC USB converter COM-K (sold separately).

Synchronous method: Start-stop synchronous type

Communication speed: 9600 bps

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

- The data bit configuration is fixed.
- The device address is fixed to "0."

Protocol: RKC communication protocol
(ANSI X3.28-1976 subcategories 2.5 and A4)

Maximum connections: 1 controller

3. WIRING

⚠ WARNING

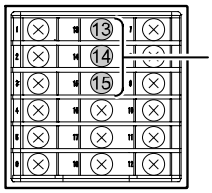
To prevent electric shock or instrument failure, turn off the power before connecting or disconnecting the instrument and peripheral equipment.

3.1 Wiring for Host Communication

The cable must be provided by the customer.

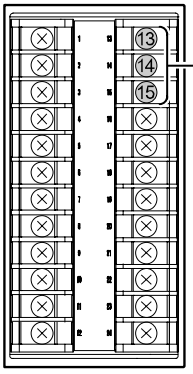
3.1.1 Communication terminal number and signal details

RB100 rear view

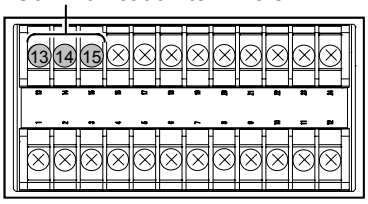


Make sure that lugs or unshielded cables of the communication terminals are not touched to the screw heads, lugs, or unshielded cables of the power supply terminals to prevent electric shock or instrument failure.
Use additional care when two lugs are screwed to one communication terminal.

RB400 rear view

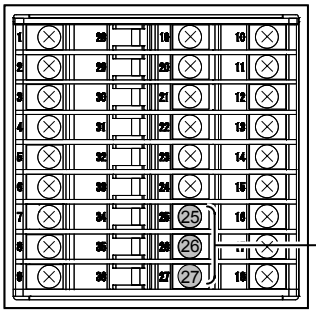


Communication terminals

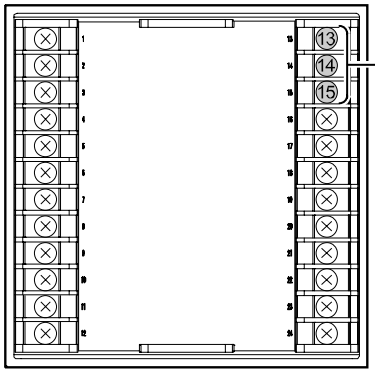


RB500 rear view

RB700 rear view



RB900 rear view

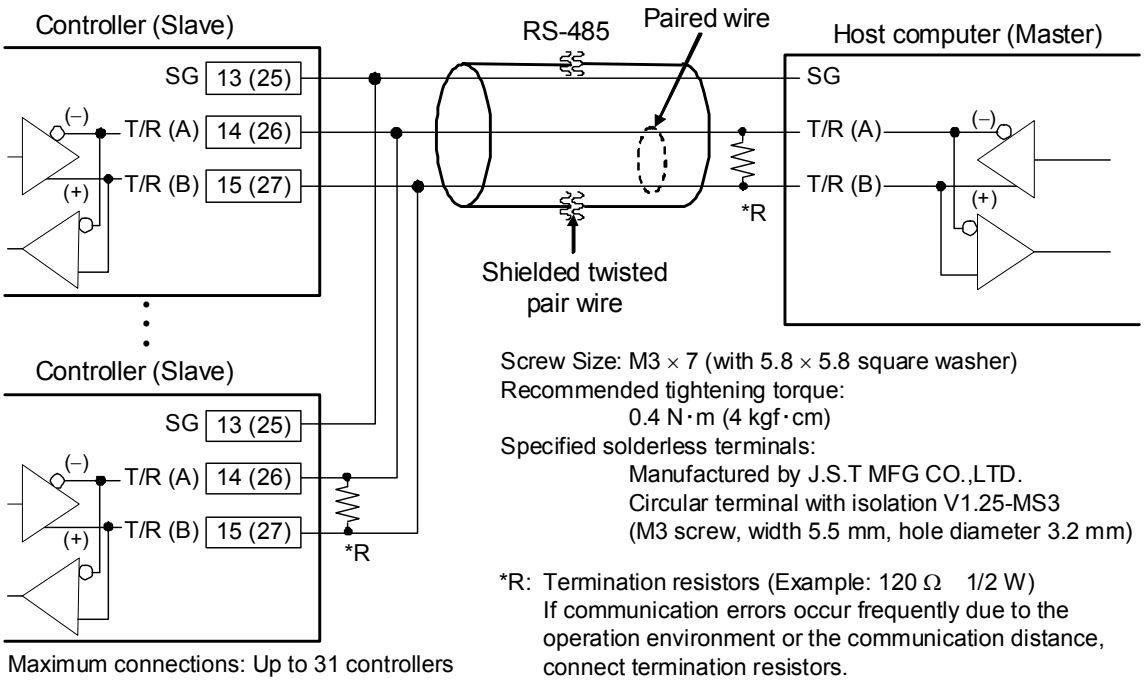


RS-485

Terminal No.		Signal name	Symbol
RB100/400/500/900	RB700		
13	25	Signal ground	SG
14	26	Send data/Receive data	T/R (A)
15	27	Send data/Receive data	T/R (B)

3.1.2 Wiring method

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



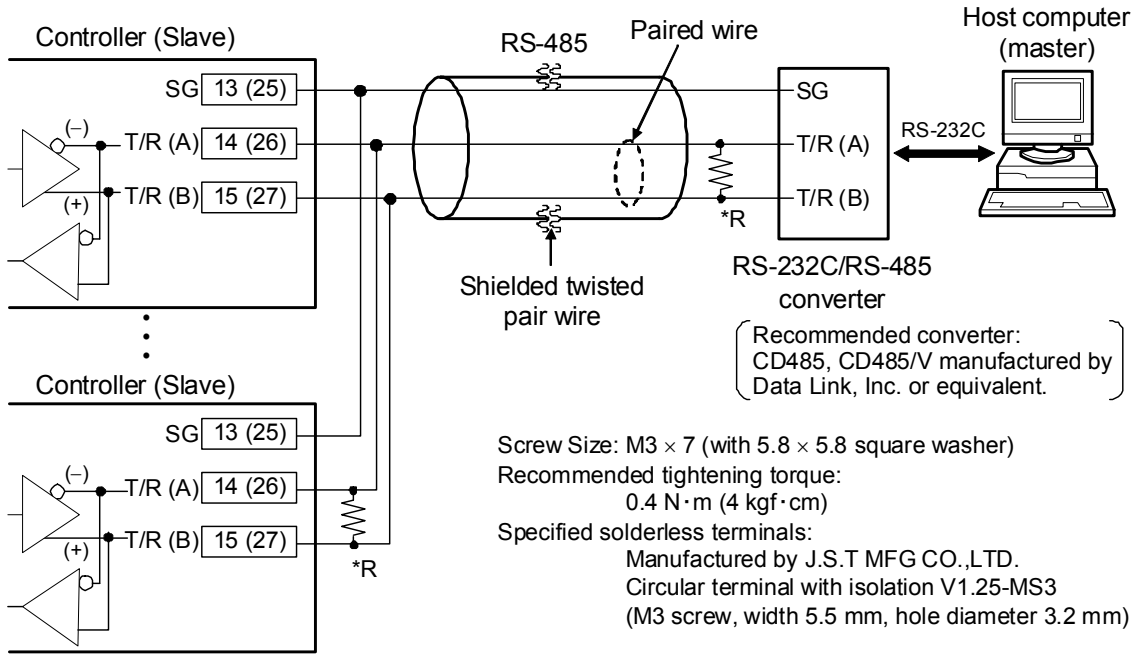
Maximum connections: Up to 31 controllers

Screw Size: M3 × 7 (with 5.8 × 5.8 square washer)
Recommended tightening torque:
0.4 N·m (4 kgf·cm)
Specified solderless terminals:
Manufactured by J.S.T MFG CO.,LTD.
Circular terminal with isolation V1.25-MS3
(M3 screw, width 5.5 mm, hole diameter 3.2 mm)

*R: Termination resistors (Example: 120 Ω 1/2 W)
If communication errors occur frequently due to the operation environment or the communication distance, connect termination resistors.

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

Use a RS-232C/RS-485 converter with an automatic send/receive transfer function.



Recommended converter:
CD485, CD485/V manufactured by Data Link, Inc. or equivalent.

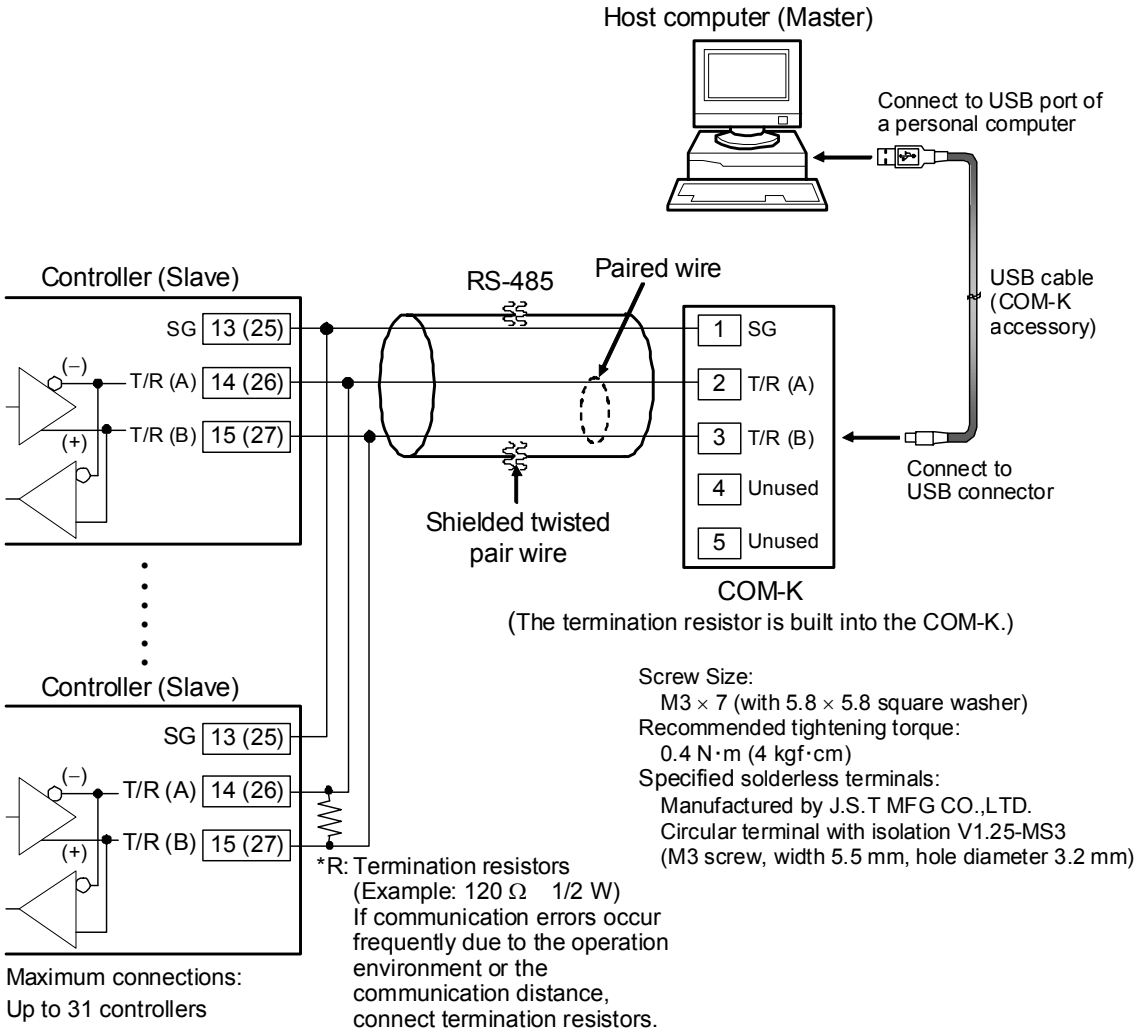
Maximum connections: Up to 31 controllers

Screw Size: M3 × 7 (with 5.8 × 5.8 square washer)
Recommended tightening torque:
0.4 N·m (4 kgf·cm)
Specified solderless terminals:
Manufactured by J.S.T MFG CO.,LTD.
Circular terminal with isolation V1.25-MS3
(M3 screw, width 5.5 mm, hole diameter 3.2 mm)

*R: Termination resistors (Example: 120 Ω 1/2 W)
If communication errors occur frequently due to the operation environment or the communication distance, connect termination resistors.

■ Connection to the USB of the host computer (master)

Connect the USB communication converter between the host computer and the controller.



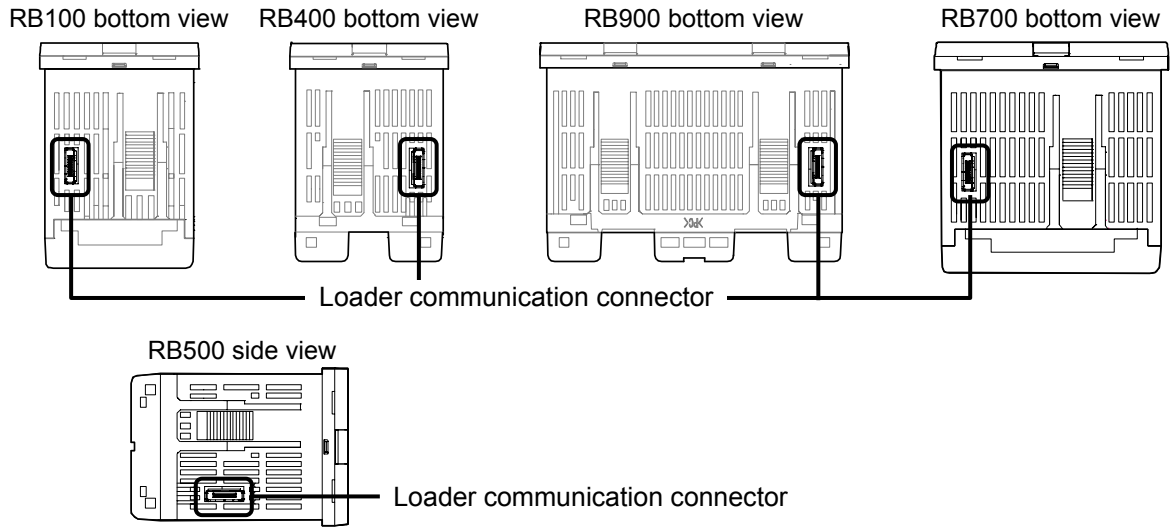
☞ For the COM-K, refer to the **COM-K Instruction Manual (IMR01Z01-E□)**.

3.2 Connections for Loader Communication

RKC USB communication converter COM-K, loader communication cable and USB cable are required for connecting this controller to the personal computer.

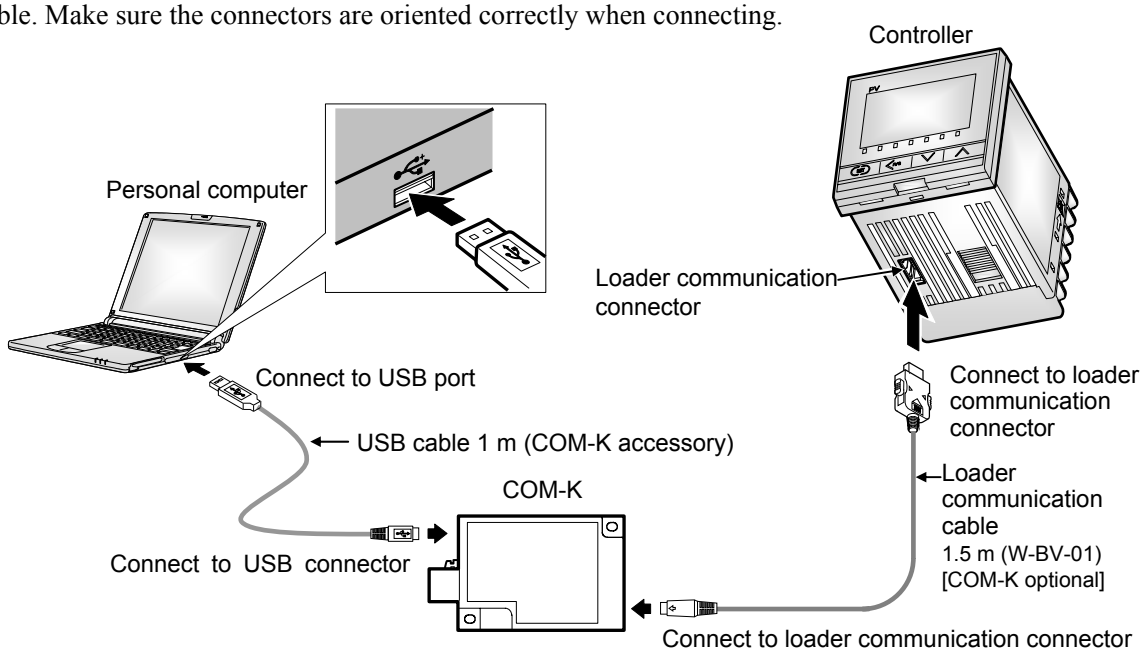
☞ For the COM-K, refer to the **COM-K Instruction Manual (IMR01Z01-E□)**.

■ Position of loader communication connector



■ Wiring method

Connect the controller, COM-K, and personal computer using a USB cable and a loader communication cable. Make sure the connectors are oriented correctly when connecting.



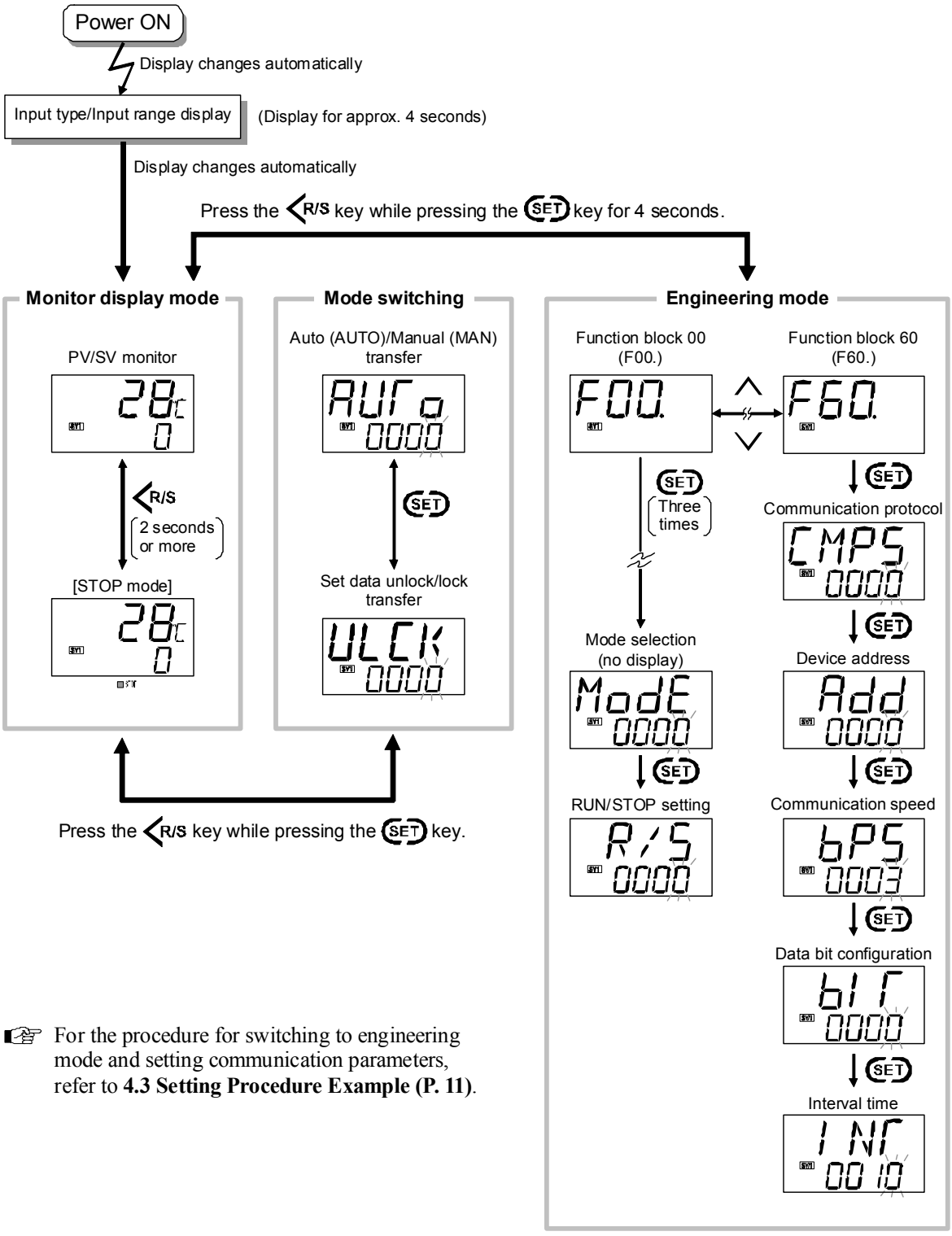
📖 When using the loader communication, USB driver for COM-K must be installed on the personal computer.

The USB driver for COM-K can be downloaded the RKC official website: http://www.rkcinst.com/.

4. SETTING

To establish communication parameters between host computer (master) and controller (slave), it is necessary to set the device address (Modbus: Slave address), communication speed, data bit configuration and interval time on each controller (slave) in the function block 60 (F60.) of engineering mode.

4.1 Display Sequence



☞ For the procedure for switching to engineering mode and setting communication parameters, refer to **4.3 Setting Procedure Example (P. 11)**.

4.2 Description of Each Parameter [Function block 60 (F60.)]

Symbol	Name	Setting range	Description	Factory set value
F60. (F60.)	Function block 60	—	This is the first parameter symbol of function block 60.	—
CMPS (CMPS)	Communication protocol	0: RKC communication 1: Modbus	Use to select a protocol of communication function.	RKC communication: 0 * Modbus: 1 *
Add (Add)	Device address (Slave address)	RKC communication: 0 to 99 Modbus: 1 to 99	Do not use the same device address for more than one controller in multi-drop connection. Each controller must have a unique address in multi-drop connection. In Modbus communication, communication is not possible when the address is 0.	RKC communication: 0 Modbus: 1
bPS (bPS)	Communication speed	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps	Set the same communication speed for both the controller (slave) and the host computer (master).	3
bIT (bIT)	Data bit configuration	RKC communication: 0 to 11 Modbus: 0 to 5 Refer to **Data bit configuration table**.	Set the same data bit configuration for both the controller (slave) and the host computer (master).	0
INT (INT)	Interval time	0 to 250 ms	The interval time for the controller should be set to provide a time for host computer to finish sending all data including stop bit and to switch the line to receive status for the host.	10
CMRM (CMRM)	Communication response monitor	0: Normal response 1: Overrun error 2: Parity error 4: Framing error 8: Receive buffer overflow	When a communication error occurs, a number is displayed to indicate the error type. If two or more errors happen, the sum of errors will be displayed.	—

* The communication protocol that was selected by means of the model code when the order was placed is set as the factory set value.

Data bit configuration table

Set value	Data bit	Parity bit	Stop bit	Settable communication
0	8	Without	1	RKC communication and Modbus
1	8	Without	2	
2	8	Even	1	
3	8	Even	2	
4	8	Odd	1	
5	8	Odd	2	

Set value	Data bit	Parity bit	Stop bit	Settable communication
6	7	Without	1	RKC communication
7	7	Without	2	
8	7	Even	1	
9	7	Even	2	
10	7	Odd	1	
11	7	Odd	2	

📖 Interval time:
The interval time for the controller should be set to provide a time for host computer to finish sending all data including stop bit and to switch the line to receive status for the host.
If the interval time between the two is too short, the controller may send data before the host computer is ready to receive it.
In this case, communication transmission cannot be conducted correctly.

📖 The device address (slave address), communication speed, data bit configuration, and interval time can also be set by loader communication using WinUCI-B for RB series.

4.3 Setting Procedure Example

This setting example shows the setting procedure when the controller settings are set to the factory set values (the state when the controller power is initially turned on).

⚠ WARNING

Parameters in the Engineering mode (F21 to F70) should be set according to the application before setting any parameter related to operation.
Once the parameters in the Engineering mode are set correctly, no further changes need to be made to parameters 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 Engineering mode.

📖 **After all the communications parameters are set, perform one of the following steps to make settings valid:**
- **The power is turned on again after turning it off once.**
- **The RUN/STOP mode is changed to RUN from STOP again after changing it to STOP once.**

📖 If you have locked the controller setting data so that it cannot be changed, the lock must be released before configuring the communication settings.

☞ To release the lock, refer to **RB series Quick Operation Manual (IMR02C39-E□)**.

📖 Press the SET key to store the new value. If the SET key is not pressed within 1 minute, the display returns to the measured value (PV)/set value (SV) monitor screen and the set value returns the previous setting.

☞ For details on changing the numeric value, refer to **RB series Quick Operation Manual (IMR02C39-E□)**.

Continued on the next page.

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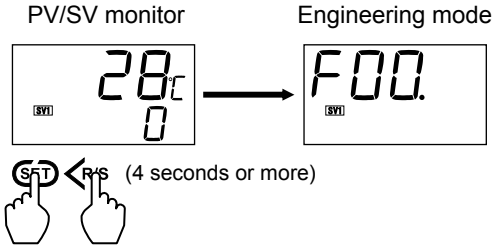
1. Turn on the power of the controller.

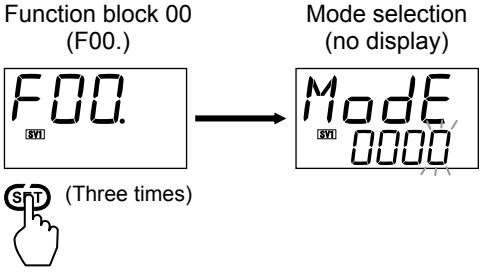
2. Go to the engineering mode.

Press the <R/S key for 4 seconds while pressing the SET key at PV/SV monitor until Engineering mode is displayed.

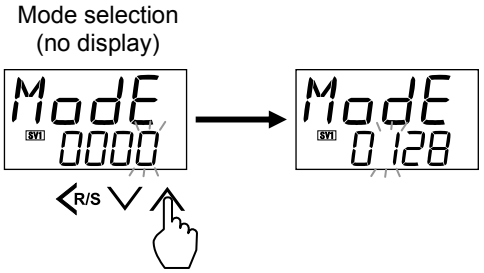


3. Enable display of function blocks 21 (F21.) to 91 (F91.).

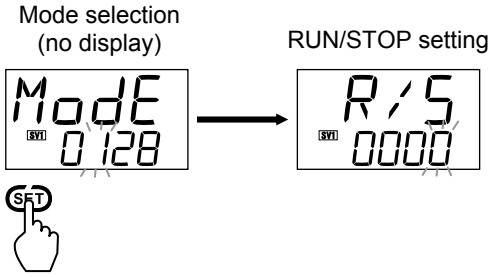
Press the SET key three times at function block 00 (F00.) until Mode selection (no display) is displayed.



Set the mode selection (no display) to "128."



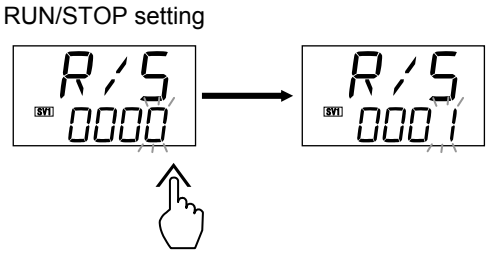
Press the SET key to store the new set value. The display goes to the RUN/STOP setting.



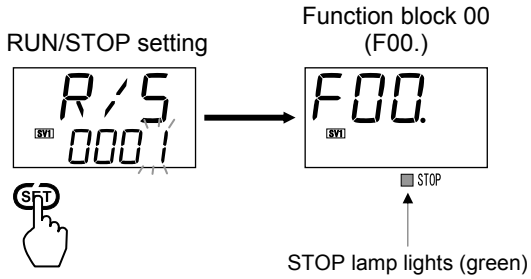
When "128" is set, display of the parameters from function block 21 (F21.) to function block 91 (F91.) is enabled.

4. Set the controller to the STOP state (control stop).

Set the RUN/STOP setting to "1: STOP."

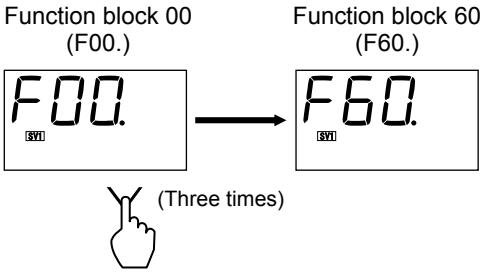


Press the SET key to store the new set value. The display goes to the function block 00 (F00.). The STOP lamp lights up and the controller enters the STOP state.



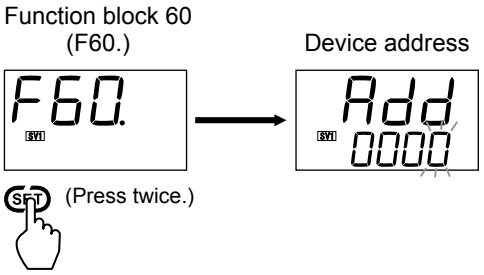
5. Go to the function block 60 (F60.).

Press the DOWN key three times at function block 00 (F00.) until function block 60 (F60.) is displayed.



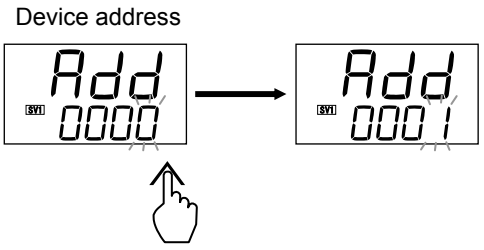
6. Set the communication parameter.

Press the SET key twice at function block 60 (F60.) until device address is displayed.

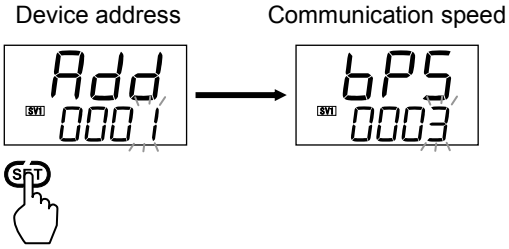


Set the device address (slave address).
Example: Setting the device address (slave address) to 1.

Setting range: 0 to 99 (RKC communication)
1 to 99 (Modbus)

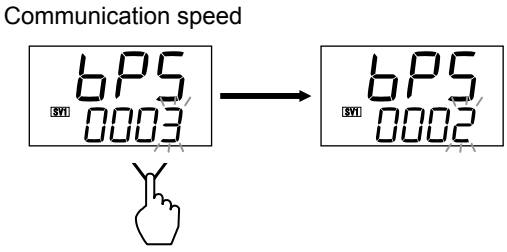


Press the SET key to store the new set value.
The display goes to the communication speed.

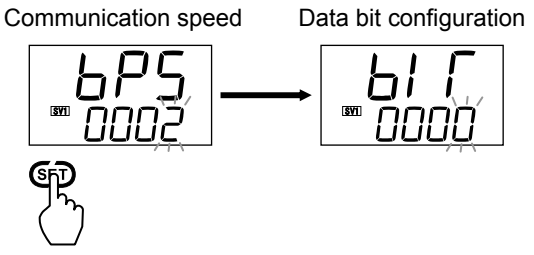


Set the communication speed.
Example: Setting the communication speed to "2 (9600 bps)."

Setting range: 0: 2400 bps
1: 4800 bps
2: 9600 bps
3: 19200 bps



Press the SET key to store the new set value.
The display goes to the data bit configuration.



Continued on the next page.

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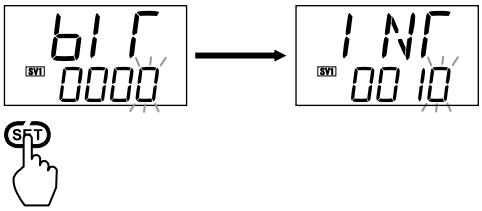
Set the data bit configuration. As an example, factory set value “0 (data bit 8, without parity bit, stop bit 1)” is set.

Data bit configuration

☞ For details of setting range, refer to **Data bit configuration table (P. 10)**.

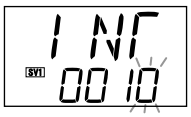
Press the SET key.
The display goes to the interval time.

Data bit configuration → Interval time



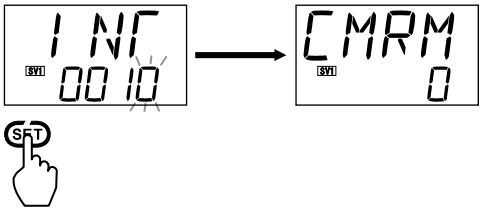
Set the interval time.
As an example, factory set value “10” is set.
Setting range: 0 to 250 ms

Interval time



Press the SET key.
The display goes to the communication response monitor.

Interval time → Communication response monitor



7. Enable communication parameter

After all the communications parameters are set, perform one of the following steps to make settings valid:

- The power is turned on again after turning it off once.
- The RUN/STOP mode is changed to RUN from STOP again after changing it to STOP once.

📖 **If you changed the communication parameters, be sure to turn the power OFF and then ON or switch from STOP to RUN.**
If this is not done, the higher level device will not be able to recognize the changed values and communication may not be possible.

4.4 Communication Requirements

■ Processing times during data send/receive

When the host computer is using either the polling or selecting procedure for communication, the following processing times are required for controller to send data:

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

Response send time is time when interval time is set at 0 ms.

RKC communication (Polling procedure) processing times

Procedure details	Time
Response send time after controller receives ENQ	60 ms max.
Response send time after controller receives ACK	60 ms max.
Response send time after controller receives NAK	60 ms max.
Response send time after controller sends BCC	52 ms max.

RKC communication (Selecting procedure) processing times

Procedure details	Time
Response send time after controller receives BCC	65 ms max.
Response wait time after controller sends ACK	52 ms max.
Response wait time after controller sends NAK	52 ms max.

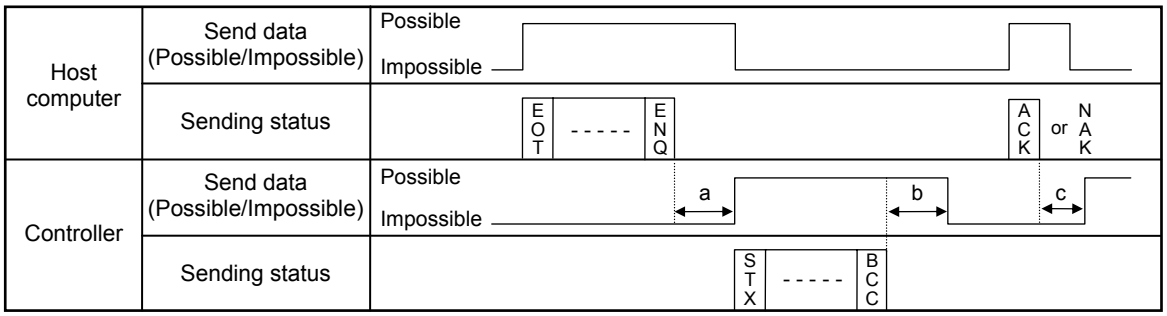
Modbus processing times

Procedure details	Time
Read holding registers [03H] Response send time after the slave receives the query message	60 ms max.
Preset single register [06H] Response send time after the slave receives the query message	65 ms max.
Diagnostics (loopback test) [08H] Response send time after the slave receives the query message	60 ms max.

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

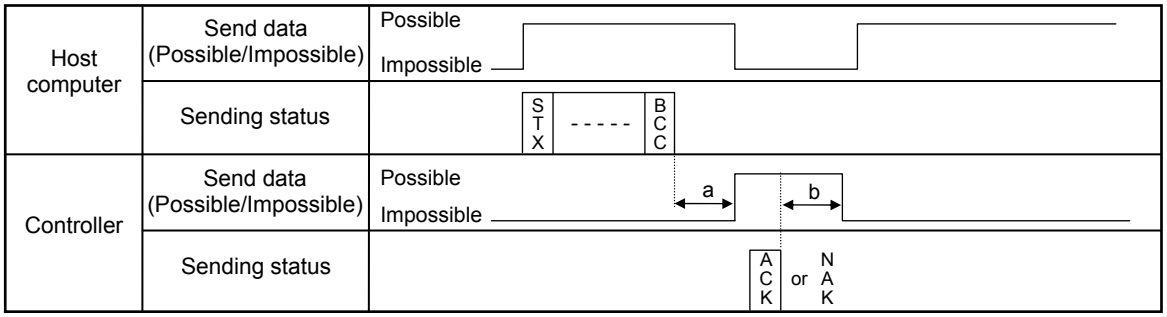
RS-485 communication is conducted through two wires, therefore, the transmission and reception of data requires precise timing.

● Polling procedure



a: Response send time after the controller receives [ENQ] + Interval time
b: Response send time after the controller sends BCC
c: Response send time after the controller receives [ACK] + Interval time or
Response send time after the controller receives [NAK] + Interval time

● Selecting procedure



a: Response send time after the controller receives BCC + Interval time
b: Response wait time after the controller sends ACK or Response wait time after the controller sends NAK

To switch the host computer from transmission to reception, send data must be on line.

The following processing times are required for the controller to process data:
- In polling procedure, Response wait time after the controller sends BCC
- In selecting procedure, Response wait time after the controller sends ACK or NAK

■ Fail-safe

A transmission error may occur if the transmission line is 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.

■ Data backup

The nonvolatile memory (EEPROM) for data backup has limitations on the number of memory rewrite times (approx. 1,000,000 times). If set values are frequently changed through communication, please select “Buffer mode” in the EEPROM mode (Identifier: EB or Register address: 001BH).

5. RKC COMMUNICATION PROTOCOL

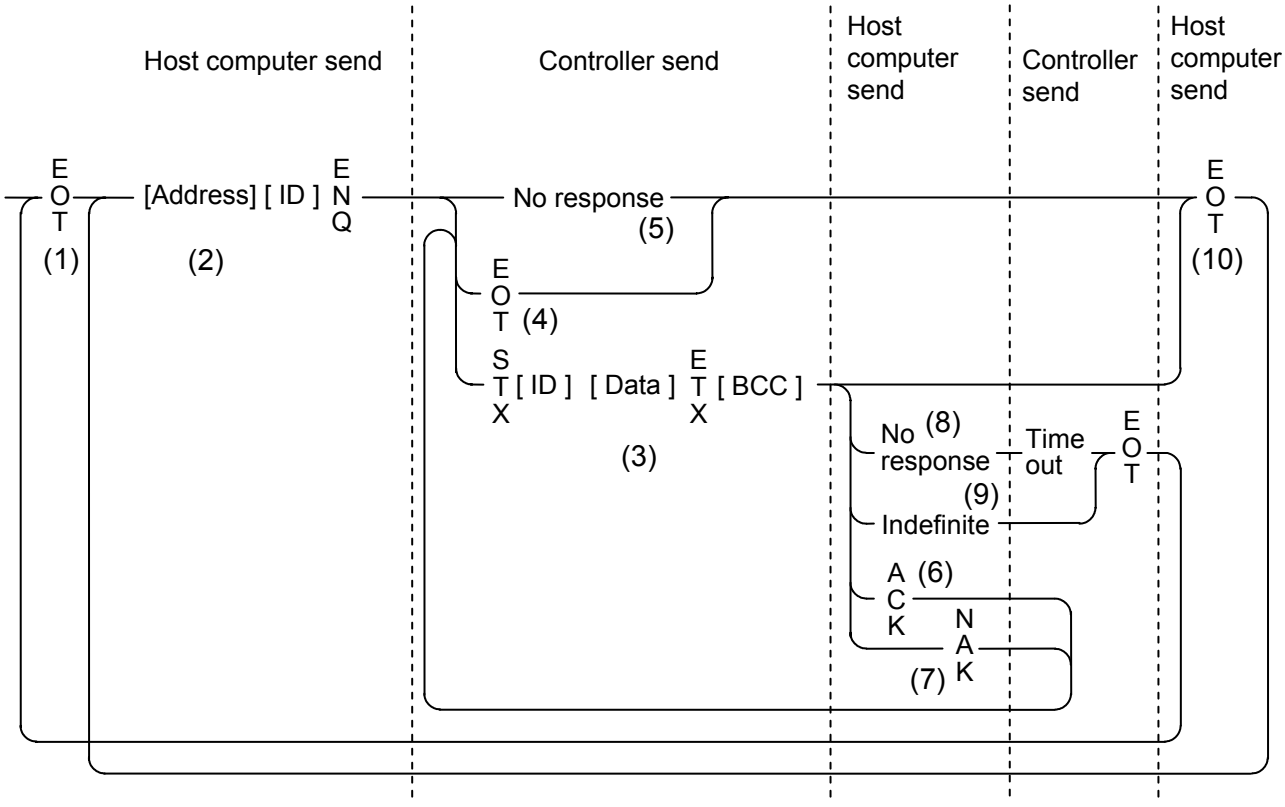
The controller uses the polling/selecting method to establish a data link.
The basic procedure is followed ANSI X3.28-1976 subcategories 2.5 and A4 basic mode data transmission control procedure (Fast selecting is the selecting method used in this controller).

- 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. The transmission control characters are EOT (04H), ENQ (05H), ACK (06H), NAK (15H), STX (02H) and ETX (03H). The figures in the parenthesis indicate the corresponding hexadecimal number.

The RKC communication data transmission/reception status can be checked by using the **Communication Monitor Tool "WinUCI-A"** and **Communication Setup Tool "WinUCI-B for RB series."**
The **WinUCI-A and WinUCI-B for RB series** can be downloaded from the official RKC website: http://www.rkcinst.com/.

5.1 Polling

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



ID: Identifier

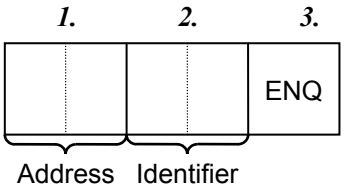
5.1.1 Polling procedures

(1) Data link initialization

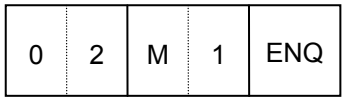
Host computer sends EOT to the controllers to initiate data link before polling sequence.

(2) Data sent from host computer - Polling sequence

The host computer sends the polling sequence in the following formats:



Example:



1. Address (2 digits)
The device address specifies the controller to be polled and each controller must have its own unique device address.
This data is a device address of the controller to be selected and must be the same as the device address set value in item **4. SETTING (P. 9)**.


The polling address which transmitted a message once becomes effective so long as data link is not initialized by transmit and receive of EOT.

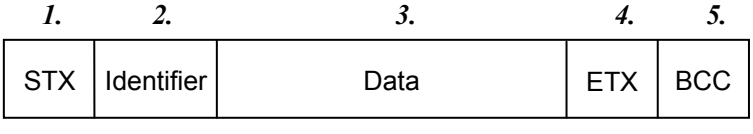
2. Identifier (2 digits)
The identifier specifies the type of data that is requested from the controller. Always attach the ENQ code to the end of the identifier.


For details, refer to **5.3 RKC Communication Identifier List (P. 27)**.

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

(3) Data sent from the controller

If the polling sequence is received correctly, the controller 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.

☞ For details, refer to **5.3 RKC Communication Identifier List (P. 27)**.

3. Data (6 digits)
Data indicated by the identifier belonging to the controller. It is expressed in decimal ASCII code including a minus sign (-) and a decimal point. Data is not zero-suppressed.

The data of "Model codes: ID" has 32 digits.
The data of "ROM version monitor: VR" has 8 digits.

The data of remaining time monitor, timer 1, timer 2, timer 3, and timer 4 are as follows:
Punctuation of time unit is expressed in colon ": (3AH)."

Example: 0 hours and 01 minutes to 99 hours and 59 minutes, and 0 minutes and 01 seconds to 99 minutes and 59 seconds
00:01 to 99:59

4. ETX
ETX is a transmission control character used to indicate the end of text transmission.

5. BCC
BCC (Block Check Character) detects error by using horizontal parity (even number).

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

Example:

STX	M	1	0	1	0	0	.	0	ETX	BCC
4DH	31H	30H	31H	30H	30H	2EH	30H	03H	← Hexadecimal numbers	

BCC = 4DH ⊕ 31H ⊕ 30H ⊕ 31H ⊕ 30H ⊕ 30H ⊕ 2EH ⊕ 30H ⊕ 03H = 60H
(⊕: *Exclusive OR*)
Value of BCC becomes 60H.

(4) EOT sent from the controller (Ending data transmission from the controller)

In the following cases, the controller makes a timeout judgment after about 3 seconds, sends EOT, and ends the data link:

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

(5) No response from the controller

The controller 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 controller receives ACK from the host computer, the controller will send any remaining data of the next identifier without additional action from the host computer.

☞ For the identifier, refer to **5.3 RKC Communication Identifier List (P. 27)**.

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 controller, it sends a negative acknowledgment NAK to the controller. The controller 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 controller sends data, the controller sends EOT to terminate the data link. (Time out: 3 seconds)

(9) Indefinite response from host computer

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

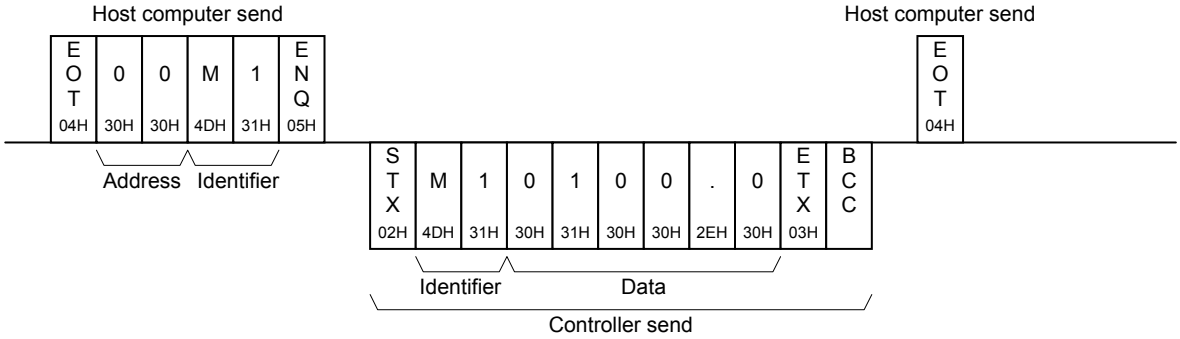
(10) EOT (Data link termination)

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

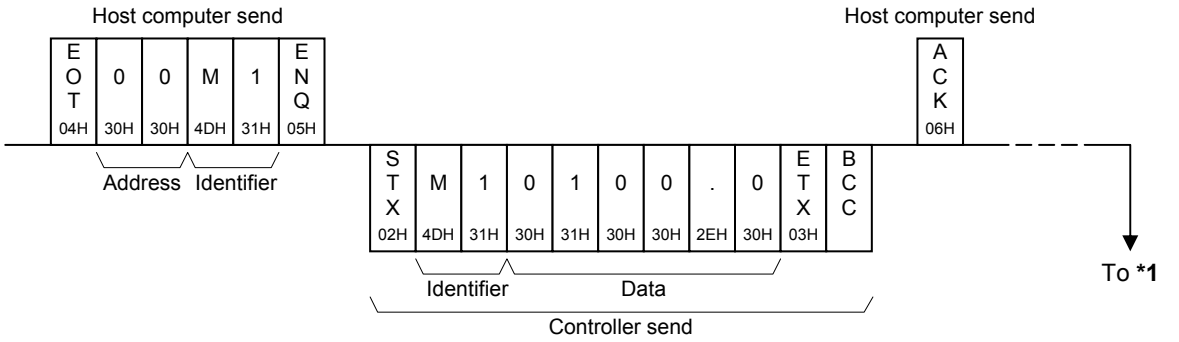
5.1.2 Polling procedure example (When the host computer requests data)

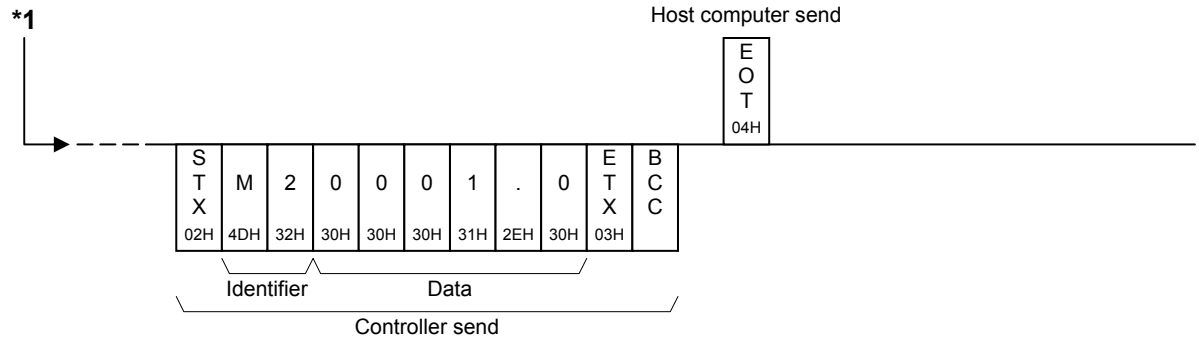
■ Normal transmission

(1) When the measured value (PV) monitor (identifier: M1) is polled

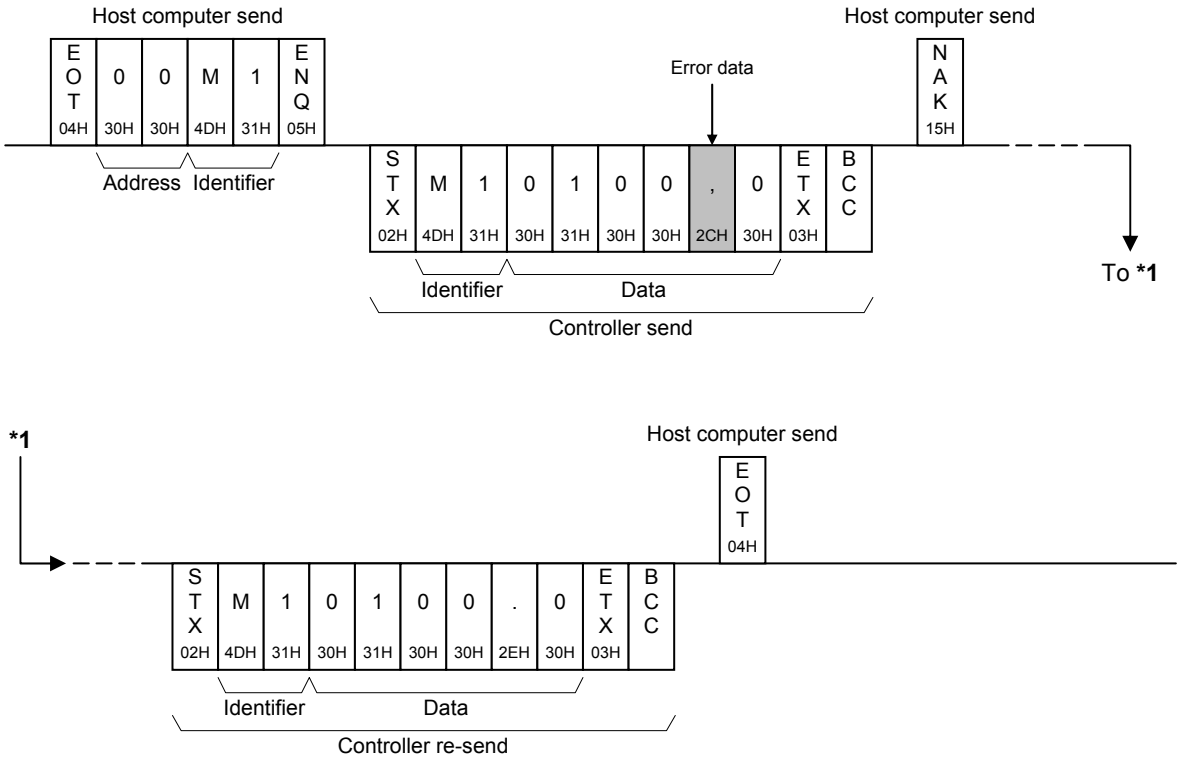


(2) Polling the next identifier with ACK (acknowledgment) after polling ends



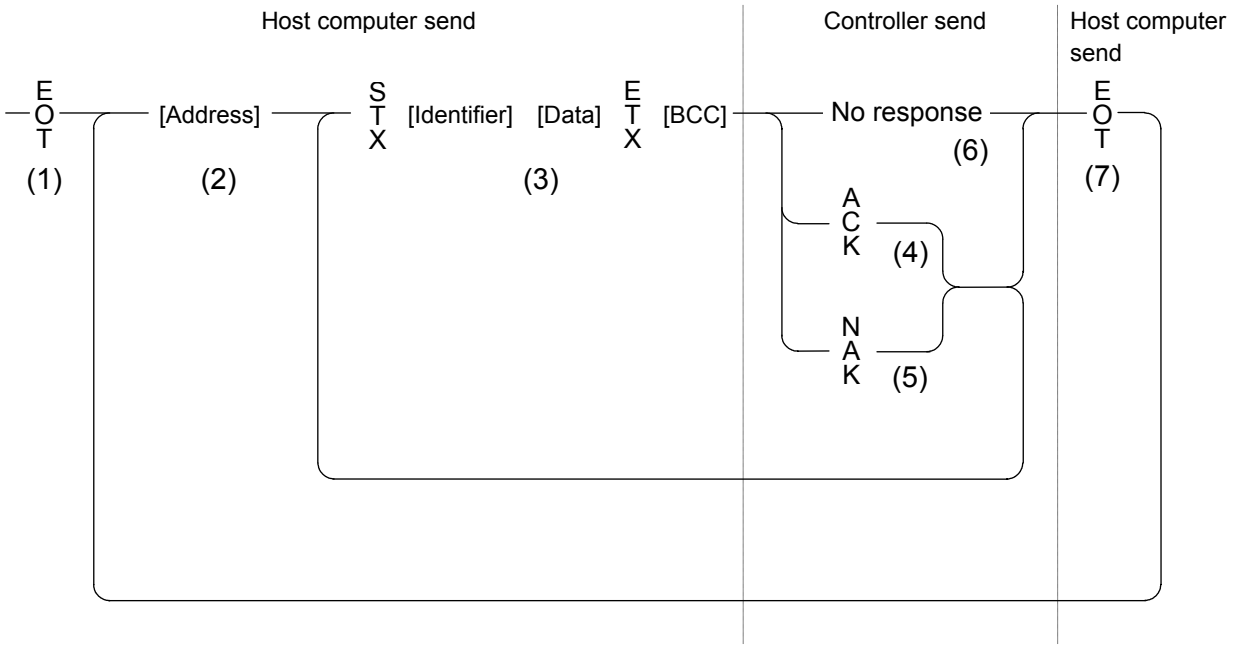


■ Error transmission



5.2 Selecting

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



5.2.1 Selecting procedures

(1) Data link initialization

Host computer sends EOT to the controllers 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 device address of the controller to be selected and must be the same as the device address set value in item **4. SETTING (P. 9)**.

As long as the data link is not initialized by sending or receiving EOT, the selecting address once sent becomes valid.

(3) Data sent from the host computer

	1.	*2.*		
STX	Identifier	Data	ETX	BCC

☞ For the STX, ETX and BCC, refer to **5.1 Polling (P. 17)**.

1. Identifier (2 digits)
The identifier specifies the type of data that is requested from the controller, such as set value.

☞ For details, refer to **5.3 RKC Communication Identifier List (P. 27)**.

2. Data
Data which is indicated by an identifier of the controller is expressed in decimal ASCII code including a minus sign (-) and a decimal point. The channel number can be zero-suppressed.
The number of digits varies depending on the type of identifier. (Within 6 digits)

📖 Set timer 1, timer 2, timer 3, and timer 4 as shown below.
Use ": (3AH) in ASCII 7 Bit Code Table" to divide hour from minute, or minute from second.

Example: 0 hours and 01 minutes to 99 hours and 59 minutes, and 0 minutes and 01 seconds to 99 minutes and 59 seconds
00:01 to 99:59

- **About numerical data**

Numerical data which the controller can receive

- Data with numbers below the decimal point omitted or zero-suppressed data can be received. (Number of digits: Within 6 digits)

<Example> When data send with −001.5, −01.5, −1.5, −1.50, −1.500 at the time of −1.5, controller can receive data.

- When the host computer sends data containing a decimal point to an item without a decimal point, the controller receives a message rounded down to the nearest whole number.

<Example> When setting range is 0 to 200, the controller will receive as follows:

Send data	0.5	100.5
Receive data	0	100

- The controller receives the value based on the decided number of places after decimal point. Any number beyond the established number of decimal points will be cut off.

<Example> When setting range is −10.00 to +10.00, the controller will receives as follows:

Send data	−.5	−.058	.05	−0
Receive data	−0.50	−0.05	0.05	0.00

Numerical data which the controller can not receive

When the host computer sends abnormal character data, the controller returns NAK as a response.

<Example> Only minus sign (there is no figure)
Only decimal point (period)

(4) ACK (Acknowledgment)

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

(5) NAK (Negative acknowledge)

If the controller does not receive correct data from the host computer, it sends a negative acknowledgment NAK to the host computer. Corrections, such as re-send, must be made at the host computer. The controller will send NAK in the following cases:

- When an error occurs on communication the line (parity, framing error, etc.)
- When a BCC check error occurs
- When the specified identifier is invalid
- When receive data exceeds the setting range
- When receive data is the identifier of RO (read only)

(6) No response from controller

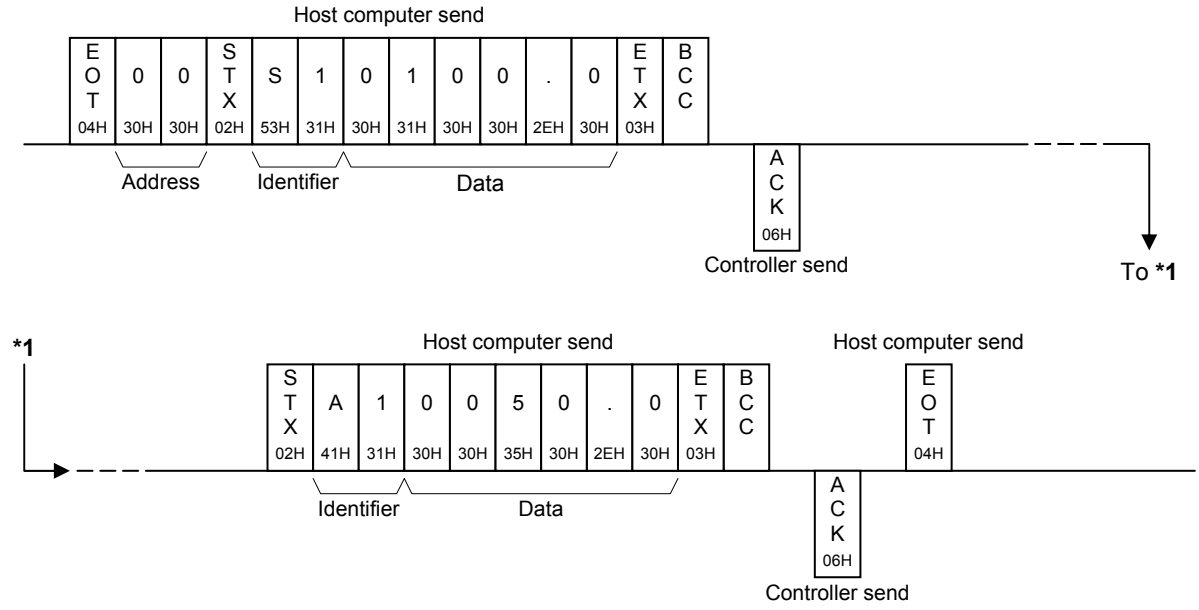
The controller does not respond when it cannot receive the selecting address, STX, ETX or BCC.

(7) EOT (Data link termination)

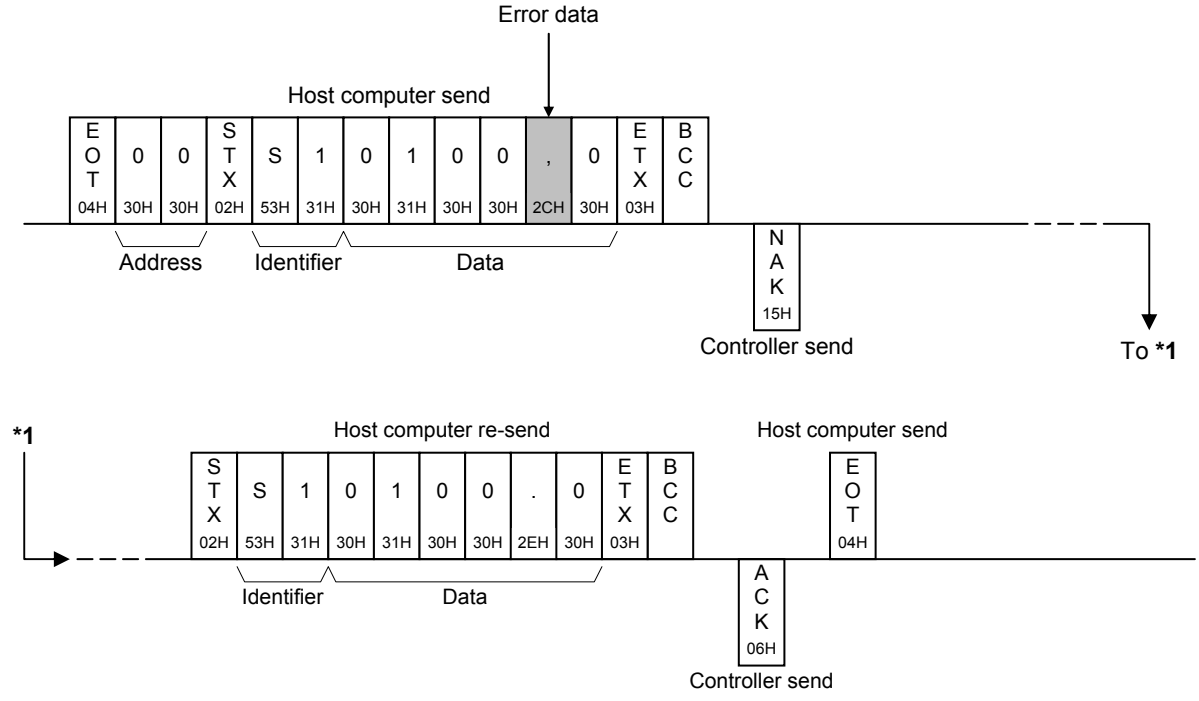
The host computer sends EOT when there is no more data to be sent from the host computer or there is no response from the controller.

5.2.2 Selecting procedure example (When the host computer sends the set values)

■ Normal transmission



■ Error transmission



5.3 RKC Communication Identifier List

■ Reference to RKC communication identifier list

(1) (2) (3) (4) (5) (6)

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
1	Measured value (PV) monitor	**M1**	6	RO	Within input range Varies with the setting of the Decimal point position. Refer to ■ **Input range table (P. 42)**.	—
2	Current transformer 1 (CT1) input value monitor [1]	**M2**	6	RO	0.0 to 100.0 A	—
3	Current transformer 2 (CT2) input value monitor [1]	**M3**	6	RO		—

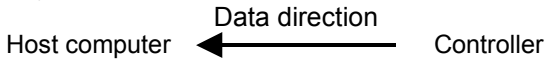
(1) Name: Communication data name

(2) RKC identifier: Communication identifier of RKC communication

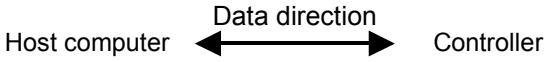
(3) No. of digits: The number of maximum digits

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

RO: Read only data

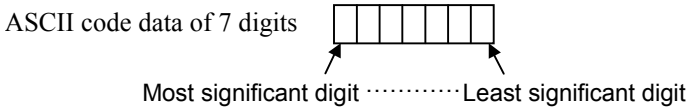


R/W: Read and Write data



(5) Data range: Read or write range of communication data

RKC communication



(6) Factory set value: Factory set value of communication data

☞ For details of data, refer to the **RB series Instruction Manual (IMR02C15-E□)**.

For data corresponding to No. 89 to 146 (other than No. 102 AO full scale adjustment value and No. 103 AO zero adjustment value), its attribute becomes RO (Only reading data is possible) during RUN (control).
When setting data corresponding to No. 89 to 146 (other than No. 102 and No. 103), write the data after STOP (control stop) is selected.

■ RKC communication identifier list

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
1	Measured value (PV) monitor	**M1**	6	RO	Within input range Varies with the setting of the Decimal point position. Refer to ■ **Input range table (P. 42)**.	—
2	Current transformer 1 (CT1) input value monitor [1]	**M2**	6	RO	0.0 to 100.0 A	—
3	Current transformer 2 (CT2) input value monitor [1]	**M3**	6	RO		—
4	Event 1 state monitor [2]	**AA**	6	RO	0: Event 1 OFF 1: Event 1 ON	—
5	Event 2 state monitor [3]	**AB**	6	RO	0: Event 2 OFF 1: Event 2 ON	—
6	Burnout state monitor	**B1**	6	RO	0: OFF 1: ON (burnout)	—
7	Error code	**ER**	6	RO	1: Adjustment data error 2: Data back-up error 4: A/D conversion error (Including temperature compensation error)	—
8	RUN/STOP transfer	**SR**	6	R/W	0: RUN 1: STOP	0
9	Set value 1 (SV1)	**S1**	6	R/W	Setting limiter low to Setting limiter high Varies with the setting of the Decimal point position.	0
10	Event 1 set value (EV1) [2, 4, 5, 6] (Event 1 set value (EV1) [high])	**A1**	6	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0

[1] Current transformer (CT) input must be provided.

[2] When the Digital output 1 (DO1) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 1 type (identifier: XA).

[3] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (identifier: XB).

[4] Data is invalid if any of the following Event functions are selected:
- Heater break alarm (HBA)
- Control loop break alarm (LBA)
- FAIL
- Monitor during RUN
- Output of the communication monitoring result

[5] If any of the following Event functions are selected, this data will be Event 1 set value (EV1) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[6] For the deviation action, input value action and set value action, refer to **8.2 Deviation Action, Input Value Action and Set Value Action (P. 74).**

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
11	Event 2 set value (EV2) [1, 2, 3, 4] (Event 2 set value (EV2) [high])	**A2**	6	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0
12	Heater break alarm 1 (HBA1) set value [5, 6]	**A3**	6	R/W	0.0 to 100.0 A	0.0
13	Heater break alarm 2 (HBA2) set value [5, 6]	**A4**	6	R/W	0.0 to 100.0 A	0.0
14	Control loop break alarm (LBA) time [5, 7]	**A5**	6	R/W	0 to 7200 seconds (0: Unused)	480
15	LBA deadband (LBD) [5, 7]	**A6**	6	R/W	0 to Input span Varies with the setting of the Decimal point position.	0
16	Autotuning (AT)	**G1**	6	R/W	0: PID control 1: AT start	0
17	Unused	**G2**	6	R/W	Must be always “0”	—
18	Proportional band [heat-side]	**P1**	6	R/W	TC/RTD inputs: 1 (0.1) to Input span (Unit: °C [°F]) Varies with the setting of the Decimal point position. Voltage (V)/current (I) inputs: 0.1 to 100.0 % of Input span 0 (0.0): ON/OFF action	TC/RTD: 30 (30.0) V/I: 3.0
19	Integral time	**I1**	6	R/W	1 to 3600 seconds (0: PD action)	240
20	Derivative time	**D1**	6	R/W	1 to 3600 seconds (0: PI action)	60
21	Anti-reset windup (ARW)	**W1**	6	R/W	1 to 100 % of proportional band [heat-side] (0: Integral action is always OFF)	100

[1] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when “0: None” is set for Event 2 type (identifier: XB).

[2] Data is invalid if any of the following Event functions are selected:
- Heater break alarm (HBA)
- Monitor during RUN
- Control loop break alarm (LBA)
- Output of the communication monitoring result
- FAIL

[3] If any of the following Event functions are selected, this data will be Event 2 set value (EV2) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[4] For the deviation action, input value action and set value action, refer to **8.2 Deviation Action, Input Value Action and Set Value Action (P. 74)**.

[5] Digital output (DO) must be provided.

[6] Current transformer (CT) input must be provided and Heater break alarm (HBA) must be selected as an Event function.

[7] Control loop break alarm (LBA) must be selected as an Event function.
The data is invalid when the control action is Heat/Cool PID action with autotuning (AT).

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
22	Proportional cycle time [heat-side] [1]	**T0**	6	R/W	0 to 100 seconds (0: Setting below 1 second is possible for Proportional cycle time [heat-side] (identifier: TA).)	Relay contact output: 20 Voltage pulse output, triac output, open collector output: 2
23	Proportional band [cool-side] [3]	**P2**	6	R/W	1 to 1000 % of proportional band [heat-side] (ON/OFF control of cool-side only is not possible)	100
24	Overlap/Deadband [3]	**V1**	6	R/W	TC/RTD inputs: –10 (–10.0) to +10 (+10.0) °C [°F] Varies with the setting of the Decimal point position. Voltage (V)/current (I) inputs: –10.0 to +10.0 % of Input span	0 (0.0)
25	Proportional cycle time [cool-side] [1, 2, 3]	**T1**	6	R/W	0 to 100 seconds (0: Setting below 1 second is possible for Proportional cycle time [cool-side] (identifier: TB).)	Relay contact output: 20 Voltage pulse output, triac output, open collector output: 2
26	PV bias	**PB**	6	R/W	TC/RTD inputs: –1999 (–199.9) to +9999 (+999.9) °C [°F] Voltage (V)/current (I) inputs: –Input span to +Input span Varies with the setting of the Decimal point position.	0 (0.0)
27	Set lock level	**LK**	6	R/W	0: All parameter can be changed 1: Lock "Parameter Group" F01 through F10 2: Lock "Parameter Group" F02 through F10 3: Lock "Parameter Group" F03 through F10 4: Lock "Parameter Group" F04 through F10 5: Lock "Parameter Group" F05 through F10 6: Lock "Parameter Group" F06 through F10 7: Lock "Parameter Group" F07 through F10 8: Lock "Parameter Group" F08 through F10 9: Lock "Parameter Group" F09 through F10 10: Lock "Parameter Group" F10	0

[1] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.

[2] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.

[3] When the control action is PID action with autotuning (AT), this data is invalid.

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
28	EEPROM mode	**EB**	6	R/W	0: Backup mode (Set values stored to the EEPROM when set values are changed.) 1: Buffer mode (No set values stored to the EEPROM when set values are changed.)	0
29	EEPROM state	**EM**	6	RO	0: The content of the EEPROM does not coincide with that of the RAM. 1: The content of the EEPROM coincides with that of the RAM.	—
30	Interlock release	**IR**	6	R/W	To release the interlock, write "0 (zero)."	0
31	Event 1 timer [1]	**TD**	6	R/W	0 to 600 seconds Data can be written only in STOP mode.	0
32	Event 2 timer [2]	**TG**	6	R/W		0
33	Manipulated output value (MV1) monitor [heat-side]	**O1**	6	RO	Within output limiter range	—
34	Manipulated output value (MV2) monitor [cool-side] [3]	**O2**	6	RO		—
35	Manipulated output ON/OFF state monitor [heat-side] [4]	**Q1**	6	RO	0: Output OFF 1: Output ON	—
36	Manipulated output ON/OFF state monitor [cool-side] [3, 5, 6]	**Q2**	6	RO		—
37	Model code	**ID**	32	RO	Model code (character)	—
38	ROM version monitor	**VR**	8	RO	ROM version	—
39	Comprehensive event state	**AJ**	6	RO	Least significant digit: Event 1 (EV1) 2nd digit: Event 2 (EV2) 3rd digit: Event 3 (EV3) 4th digit: Event 4 (EV4) 5th digit: Burnout Most significant digit: Unused Data 0: OFF 1: ON	—
40	Digital input (DI) state [7]	**L1**	6	RO	Least significant digit: DI1 2nd digit: DI2 3rd digit to Most significant digit: Unused Data 0: OFF 1: ON	—

[1] When the Digital output 1 (DO1) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 1 type (identifier: XA).

[2] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (identifier: XB).

[3] When the control action is PID action with autotuning (AT), this data is invalid.

[4] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.

[5] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.

[6] When the Output 2 (OUT2) is used as the transmission output, this data is invalid.

[7] When the Digital input (DI) is not provided, this data is invalid.
The data is also invalid when the DI function is set to "Unused".

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
41	Output state monitor	**Q3**	6	RO	Least significant digit: Output 1 (OUT1) 2nd digit: Output 2 (OUT2) 3rd digit: Digital output 1 (DO1) 4th digit: Digital output 2 (DO2) 5th digit: Digital output 3 (DO3) Most significant digit: Digital output 4 (DO4) Data 0: OFF 1: ON	—
42	Set value (SV) display while the setting change rate limiter is working	**MS**	6	RO	Setting limiter low to Setting limiter high Varies with the setting of the Decimal point position.	—
43	Remaining time monitor	**TR**	6	RO	00:00 to 99:59 (min : sec or hour : min)	—
44	Event 3 state monitor [1]	**AC**	6	RO	0: Event 3 OFF 1: Event 3 ON	—
45	Event 4 state monitor [2]	**AD**	6	RO	0: Event 4 OFF 1: Event 4 ON	—
46	Operation mode state monitor	**L0**	6	RO	Least significant digit: STOP 2nd digit: RUN 3rd digit: Manual (During RUN) 4th digit to Most significant digit: Unused Data 0: OFF 1: ON	—
47	Actual SV selection number	**LZ**	6	RO	1 to 4 SV number in Timer 3 and Timer 4 functions.	—
48	Auto (AUTO)/Manual (MAN) transfer	**J1**	6	R/W	0: Auto (AUTO) mode 1: Manual (MAN) mode	0
49	Monitor selection (no display)	**LP**	6	R/W	0 to 15 (Decimal) Set the bit data in decimal. Bit 0: Current transformer1 (CT1) input value monitor Bit 1: Current transformer 2 (CT2) input value monitor Bit 2: Manipulated output value (MV) monitor [a] Bit 3: Remaining time monitor Bit 4 to Bit 7: Unused Data 0: Display 1: No display [a] The manipulated output value (MV1) monitor [heat-side] and the manipulated output value (MV2) monitor [cool-side] are both "No display."	0

[1] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 3 type (identifier: VC).

[2] When the Digital output 4 (DO4) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 4 type (identifier: XD).

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
50	Mode selection (no display)	**LM**	6	R/W	0 to 255 (Decimal) Set the bit data in decimal. Bit 0: Auto (AUTO)/Manual (MAN) transfer [a] Bit 1: Set data unlock/lock transfer [a] Bit 2: Interlock release [a] Bit 3: Disable <R/S key operation [b] Bit 4 to Bit 6: Unused Bit 7: Displays F21 and after [c] [a] Data 0: OFF (Display) 1: ON (No display) [b] Data 0: Enable <R/S key operation 1: Disable <R/S key operation [c] Data 0: No display F21 through F91. 1: Display F21 through F91.	0
51	Set value 2 (SV2)	**S2**	6	R/W	Setting limiter low to Setting limiter high Varies with the setting of the Decimal point position.	0
52	Set value 3 (SV3)	**S3**	6	R/W		0
53	Set value 4 (SV4)	**S4**	6	R/W		0
54	SV selection	**ZB**	6	R/W	1 to 4	1
55	F01 block selection (no display)	**DA**	6	R/W	0: Display 1: No display	1
56	Timer 1	**TH**	6	R/W	00:01 to 99:59 (min : sec or hour : min)	00:01
57	Timer 2	**TI**	6	R/W		00:01
58	Timer 3	**TJ**	6	R/W		00:01
59	Timer 4	**TK**	6	R/W		00:01
60	Timer function	**ZC**	6	R/W	0: Unused 1: Timer function 1 2: Timer function 2 3: Timer function 3 4: Timer function 4	0
61	Repeat execution times	**RR**	6	R/W	0 to 9999 (9999: Infinite times)	0
62	F02 block selection (no display)	**DK**	6	R/W	0: Display 1: No display	1

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
63	Setting change rate limiter (up)	**HH**	6	R/W	0 to Input span (Unit: °C [°F]/unit time) Varies with the setting of the Decimal point position.	0 (0.0)
64	Setting change rate limiter (down)	**HL**	6	R/W		0 (0.0)
65	F03 block selection (no display)	**DL**	6	R/W	0: Display 1: No display	1
66	Event 1 set value (EV1') [low] [1, 2]	**BT**	6	R/W	–Input span to +Input span Varies with the setting of the Decimal point position.	TC/RTD: −50 (−50.0) V/I: −5.0
67	Event 2 set value (EV2') [low] [2, 3]	**BU**	6	R/W		TC/RTD: −50 (−50.0) V/I: −5.0
68	Event 3 set value (EV3) [4, 5, 6, 7] Event 3 set value (EV3) [high]	**A7**	6	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0
69	Event 3 set value (EV3') [low] [2, 4]	**BV**	6	R/W	–Input span to +Input span Varies with the setting of the Decimal point position.	TC/RTD: −50 (−50.0) V/I: −5.0

[1] When the Digital output 1 (DO1) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 1 type (identifier: XA).

[2] Data is valid if any of the following Event functions are selected:
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[3] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (identifier: XB).

[4] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 3 type (identifier: VC).

[5] Data is invalid if any of the following Event functions are selected:
- Heater break alarm (HBA)
- Control loop break alarm (LBA)
- FAIL
- Monitor during RUN
- Output of the communication monitoring result

[6] If any of the following event functions are selected, this data will be Event 3 set value (EV3) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[7] For the deviation action, input value action and set value action, refer to **8.2 Deviation Action, Input Value Action and Set Value Action (P. 74)**.

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
70	Event 4 set value (EV4) [1, 2, 3, 4] (Event 4 set value (EV4) [high])	**A8**	6	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0
71	Event 4 set value (EV4') [low] [1, 5]	**BW**	6	R/W	–Input span to +Input span Varies with the setting of the Decimal point position.	TC/RTD: −50 (−50.0) V/I: −5.0
72	F04 block selection (no display) [6]	**DM**	6	R/W	0: Display 1: No display	0
73	Startup tuning (ST)	**ST**	6	R/W	0: ST unused 1: Execute once * 2: Execute always * When the Startup tuning (ST) is finished, the setting will automatically returns to "0: ST unused."	0
74	F05 block selection (no display)	**DN**	6	R/W	0: Display 1: No display	0
75	Fine tuning setting	**CB**	6	R/W	–3 to +3 (0: Unused)	0

[1] When the Digital output 4 (DO4) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 4 type (identifier: XD).

[2] Data is invalid if any of the following Event functions are selected:
- Heater break alarm (HBA)
- Control loop break alarm (LBA)
- FAIL
- Monitor during RUN
- Output of the communication monitoring result

[3] If any of the following Event functions are selected, this data will be Event 4 set value (EV4) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[4] For the deviation action, input value action and set value action, refer to **8.2 Deviation Action, Input Value Action and Set Value Action (P. 74)**.

[5] Data is valid if any of the following Event functions are selected:
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[6] Data is invalid in the following cases:
- When the Digital output (DO) is not provided
- When Event 1 type (identifier: XA), Event 2 type (identifier: XB), Event 3 type (identifier: VC), and Event 4 type (identifier: XD) are all set to "0: None."
- When Event 1 type (identifier: XA), Event 2 type (identifier: XB), Event 3 type (identifier: VC), and Event 4 type (identifier: XD) are set to the Event functions "Heater break alarm (HBA)," "Control loop break alarm (LBA)," "FAIL," "Monitor during RUN," and "Output of the communication monitoring result."

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
76	F06 block selection (no display)	**DO**	6	R/W	0: Display 1: No display	0
77	F07 block selection (no display) [1]	**DQ**	6	R/W	0: Display 1: No display	0
78	Minimum ON/OFF time of proportioning cycle [heat-side] [2]	**VI**	6	R/W	0 to 1000 ms	0
79	Output limiter high [Heat-side output limiter (high)]	**OH**	6	R/W	PID control: Output limiter low to 105.0 % Heat/Cool PID control: 0.0 to 105.0 %	105.0
80	Output limiter low [Cool-side output limiter (high)]	**OL**	6	R/W	PID control: −5.0 % to Output limiter high [Output limiter high > Output limiter low] Heat/Cool PID control: 0.0 to 105.0 %	PID control: −5.0 Heat/Cool PID control: 105.0
81	Minimum ON/OFF time of proportioning cycle [cool-side] [3, 4]	**VJ**	6	R/W	0 to 1000 ms	0
82	F08 block selection (no display)	**DR**	6	R/W	0: Display 1: No display	0
83	PV digital filter	**F1**	6	R/W	0 to 100 seconds (0: Unused)	1
84	F09 block selection (no display)	**DS**	6	R/W	0: Display 1: No display	0
85	Manual manipulated output value (MV)	**ON**	6	R/W	PID control: Output limiter low to Output limiter high Heat/Cool PID control: −Cool-side output limiter (high) to +Heat-side output limiter (high)	0.0
86	F10 block selection (no display)	**DT**	6	R/W	0: Display 1: No display	1
87	Holding peak value ambient temperature monitor	**HP**	6	RO	−10 to +100 °C (14 to 212 °F)	—
88	Integrated operating time monitor	**UT**	6	RO	0 to 9999 hours	—

[1] Data is invalid in the following cases:
- When the Current transformer (CT) input is not provided, this data is invalid.
- When Event 1 type (identifier: XA), Event 2 type (identifier: XB), Event 3 type (identifier: VC), and Event 4 type (identifier: XD) are all set to "0: None."
- When any of Event 1 type (identifier: XA), Event 2 type (identifier: XB), Event 3 type (identifier: VC), or Event 4 type (identifier: XD) are not set to "Heater break alarm (HBA)" or "Control loop break alarm (LBA)."

[2] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.

[3] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.

[4] When the control action is PID action with autotuning (AT), this data is invalid.

Write the following data (excluding No. 102 and 103) after you have switched to STOP (control stop).

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
89	Input type	**XI**	6	R/W	TC/RTD inputs: 0 to 31 Voltage (V)/current (I) inputs: 33 to 38 Refer to ■ **Input rang table (P. 42)**.	Based on model code
90	Decimal point position	**XU**	6	R/W	0: No decimal place 1: One decimal place 2: Two decimal place 3: Three decimal places TC/RTD inputs: 0 to 1 Voltage (V)/current (I) inputs: 0 to 3	Based on model code
91	Burnout direction	**BS**	6	R/W	0: Upscale 1: Downscale Valid only when the TC input is selected.	0
92	Input scale high	**XV**	6	R/W	Input scale low to Maximum value of the selected input range Varies with the setting of the Decimal point position.	Maximum value of the selected input range
93	Input scale low	**XW**	6	R/W	Minimum value of the selected input range to Input scale high Varies with the setting of the Decimal point position.	Minimum value of the selected input range
94	Setting limiter high	**SH**	6	R/W	Setting limiter low to Input scale high Varies with the setting of the Decimal point position.	Input scale high
95	Setting limiter low	**SL**	6	R/W	Input scale low to Setting limiter high Varies with the setting of the Decimal point position.	Input scale low
96	PV flashing display at input error	**DU**	6	R/W	0: Flashing 1: Non-flashing display	0
97	DI assignment [1]	**H2**	6	R/W	0 to 7 Refer to ■ **DI assignment table (P. 43)**.	Based on model code
98	Output action at STOP mode [2, 3]	**SS**	6	R/W	0: Both event output and transmission output (AO) are off. 1: Event output remains unchanged, and transmission output (AO) is off. 2: Event output is off, and transmission output (AO) remains unchanged. 3: Both event output and transmission output (AO) remain unchanged.	0
99	Transmission output type [3]	**LB**	6	R/W	0: Manipulated output value (MV1) 1: Measured value (PV) 2: Set value (SV)	1
100	Transmission output scale high [3]	**CV**	6	R/W	When MV1 is selected: Transmission output scale low to +105.0 % When PV or SV is selected: Transmission output scale low to Input scale high Varies with the setting of the Decimal point position.	High-limit value of input span

[1] Digital input (DI) must be provided.

[2] When the Digital output (DO) is not provided, the Event output action setting is invalid.
The Event output action setting is also invalid when there is no Event function.

[3] Transmission output must be provided.

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
101	Transmission output scale low [1]	**CW**	6	R/W	When MV1 is selected: –5.0 % to Transmission output scale high When PV or SV is selected: Input scale low to Transmission output scale high Varies with the setting of the Decimal point position.	Low-limit value of input span
102	AO full scale adjustment value [1, 2]	**JK**	6	R/W	–10.0 to +10.0 %	Adjustment value
103	AO zero adjustment value [1, 2]	**JL**	6	R/W	–10.0 to +10.0 %	Adjustment value
104	Event 1 type [3]	**XA**	6	R/W	0 to 23 (Refer to page 44.)	Based on model code
105	Event 1 hold action [3]	**WA**	6	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code
106	Event 1 differential gap [3]	**HA**	6	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2
107	Event 1 output action at input burnout [3]	**OA**	6	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
108	Energized/De-energized of Event 1 output [3]	**Z1**	6	R/W	0: Energized 1: De-energized	0
109	Event 1 interlock [3]	**LF**	6	R/W	0: Unused 1: Used	0
110	Event 2 type [4]	**XB**	6	R/W	0 to 23 (Refer to page 44.)	Based on model code
111	Event 2 hold action [4]	**WB**	6	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code

[1] Transmission output must be provided.

[2] This data can also be written in the RUN state.

[3] When the Digital output 1 (DO1) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 1 type (identifier: XA).

[4] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (identifier: XB).

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
112	Event 2 differential gap [1]	**HB**	6	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2
113	Event 2 output action at input burnout [1]	**OB**	6	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
114	Energized/De-energized of Event 2 output [1]	**NB**	6	R/W	0: Energized 1: De-energized	0
115	Event 2 interlock [1]	**LG**	6	R/W	0: Unused 1: Used	0
116	Event 3 type [2]	**VC**	6	R/W	0 to 23 (Refer to page 44.)	Based on model code
117	Event 3 hold action [2]	**WC**	6	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code
118	Event 3 differential gap [2]	**HC**	6	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2
119	Event 3 output action at input burnout [2]	**OC**	6	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
120	Energized/De-energized of Event 3 output [2]	**NC**	6	R/W	0: Energized 1: De-energized	0
121	Event 3 timer [2]	**TE**	6	R/W	0 to 600 seconds	0
122	Event 3 interlock [2]	**LH**	6	R/W	0: Unused 1: Used	0

[1] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (identifier: XB).

[2] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 3 type (identifier: VC).

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
123	Event 4 type [1]	**XD**	6	R/W	0 to 23 (Refer to page 44.)	Based on model code
124	Event 4 hold action [1]	**WD**	6	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code
125	Event 4 differential gap [1]	**HD**	6	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2
126	Event 4 output action at input burnout [1]	**OD**	6	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
127	Energized/De-energized of Event 4 output [1]	**ND**	6	R/W	0: Energized 1: De-energized	0
128	Event 4 timer [1]	**TF**	6	R/W	0 to 600 seconds	0
129	Event 4 interlock [1]	**LI**	6	R/W	0: Unused 1: Used	0
130	CT ratio [2] (Number of turns)	**XR**	6	R/W	1 to 1000	CTL-6-P-N: 800 CTL-12-S56-10L-N: 1000
131	Number of HBA delay times [2]	**EH**	6	R/W	0 to 255 times	3
132	Direct/Reverse action [3]	**CA**	6	R/W	0: Direct action 1: Reverse action	Based on model code
133	Cool action [4]	**XQ**	6	R/W	0: Air cooling 1: Water cooling 2: Cooling gain linear	Based on model code

[1] When the Digital output 4 (DO4) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 4 type (identifier: XD).

[2] Current transformer (CT) input must be provided.

[3] When the control action is Heat/Cool PID action with autotuning (AT), this data is invalid.

[4] When the control action is PID action with autotuning (AT), this data is invalid.

No.	Name	RKC Identifier	No. of digits	Attribute	Data range	Factory set value
134	ON/OFF action differential gap (upper)	**IV**	6	R/W	TC/RTD inputs: 0 (0.0) to 100 (100.0) °C [°F] Varies with the setting of the Decimal point position. Voltage (V)/Current (I) inputs: 0.0 to 10.0 % of Input span	TC/RTD: 1 (1.0) V/I: 0.1
135	ON/OFF action differential gap (lower)	**IW**	6	R/W		TC/RTD: 1 (1.0) V/I: 0.1
136	Control output at burnout	**WH**	6	R/W	0: Result of control computation 1: Low output limiter value (Output OFF) * * On Heat/Cool PID control type, both heating and cooling outputs are off.	0
137	Bumpless mode setting	**OT**	6	R/W	0: Without bumpless 1: With bumpless	1
138	Derivative action	**KA**	6	R/W	0: Measured value derivative 1: Deviation derivative	0
139	AT cycles	**G3**	6	R/W	0: 1.5 cycles 1: 2.5 cycles	0
140	AT differential gap time	**GH**	6	R/W	0 to 50 seconds	10
141	ST start condition	**SU**	6	R/W	0: Activate the ST function when the power is turned on; when transferred from STOP to RUN; or when the set value (SV) is changed. 1: Activate the ST function when the power is turned on; or when transferred from STOP to RUN. 2: Activate the ST function when the set value (SV) is changed.	0
142	Setting change rate limiter unit time	**HU**	6	R/W	0: Minute 1: Hours	0
143	Timer time unit	**RU**	6	R/W	0: Min. : sec. 1: Hour : min.	0
144	STOP display selection	**DX**	6	R/W	0: STOP on PV display + STOP lamp (green) lights 1: STOP on SV display + STOP lamp (green) lights 2: STOP lamp (green) lights	1
145	Time setting of proportional cycle time [heat-side] [1, 3]	**TA**	6	R/W	0: 0.1 seconds (fixed) 1: 0.25 seconds (fixed) 2: 0.5 seconds (fixed)	2
146	Time setting of proportional cycle time [cool-side] [2, 4, 5]	**TB**	6	R/W		2

[1] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.

[2] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.

[3] When Proportional cycle time [heat-side] (identifier: T0) is set to 0 seconds, this setting data becomes valid for the Proportional cycle time [heat-side].

[4] When the control action is PID action with autotuning (AT), this data is invalid.

[5] When Proportional cycle time [cool-side] (identifier: T1) is set to 0 seconds, this setting data becomes valid for the Proportional cycle time [cool-side].

■ Input range table

Do not set to any number which is not described in the input type table. This may cause malfunctioning.

Set value	Input type		
0	TC input	K	–199.9 to +400.0 °C
1		K	0.0 to 800.0 °C
2		K	–200 to +1372 °C
3		J	–199.9 to +300.0 °C
4		J	–200 to +1200 °C
5		T	–199.9 to +300.0 °C
6		T	0.0 to 400.0 °C
8		S	0 to 1769 °C
9		R	0 to 1769 °C
10		E	0 to 1000 °C
11		B	0 to 1820 °C
12		N	0 to 1300 °C
13		PLII	0 to 1390 °C
14		W5Re/W26Re	0 to 2320 °C
15	RTD input	Pt100	–199.9 to +649.0 °C
16		JPt100	–199.9 to +649.0 °C
17	TC input	K	–100.0 to +752.0 °F
18		K	–328 to +2501 °F
19		J	–199.9 to +555.0 °F
20		J	–328 to +2192 °F
21		T	–199.9 to +300.0 °F
22		T	0.0 to 600.0 °F
23		T	–328 to +752 °F
24		S	0 to 3216 °F
25		R	0 to 3216 °F
26		E	0 to 1832 °F
27		B	0 to 3308 °F
28		N	0 to 2372 °F
29		PLII	0 to 2534 °F
30		W5Re/W26Re	0 to 4208 °F
31	RTD input	Pt100	–199.9 to +900.0 °F
33	Voltage input	0 to 1 V DC	Programmable range –1999 to +9999 [The decimal point position is selectable] (Factory set value: 0.0 to 100.0)
34		0 to 5 V DC	
35		0 to 10 V DC	
36		1 to 5 V DC	
37	Current input	0 to 20 mA DC	
38		4 to 20 mA DC	

■ DI assignment

Set value	DI1	DI2
0	Unused (No DI assignment)	
1	SV selection function (SV1 to SV4) [1]	
2	SV selection function (SV1 to SV2) [2]	RUN/STOP transfer [3]
3	SV selection function (SV1 to SV2) [2]	AUTO/MAN transfer [4]
4	SV selection function (SV1 to SV2) [2]	Interlock release [5]
5	RUN/STOP transfer [3]	AUTO/MAN transfer [4]
6	RUN/STOP transfer [3]	Interlock release [5]
7	AUTO/MAN transfer [4]	Interlock release [5]

[1] SV selection function (SV1 to SV4)

	SV1	SV2	SV3	SV4
DI1	Contact open	Contact closed	Contact open	Contact closed
DI2	Contact open	Contact open	Contact closed	Contact closed

(Data is determined in two seconds after DI1 and DI2 have changed.)

[2] SV selection function (SV1 to SV2):
Contact open state: SV1 Contact closed state: SV2

[3] RUN/STOP transfer:
Contact open state: STOP Contact closed state: RUN

[4] AUTO/MAN transfer:
Contact open state: MAN Contact closed state: AUTO

[5] Interlock release:
Interlock is released at the time of contact status change (from open to close) by edge monitoring.

Relation between key operations/communication and DI status

Mode select from key operation or communication		DI switched *	Actual state	Indication lamp
SV selection function	Example: In case of SV selection function (SV1 to SV2) SV1 is selected	SV2 is selected (Contact closed)	Switched to SV2	SV1 lamp turns off SV2 lamp lights
RUN/STOP transfer	RUN	RUN (Contact closed)	RUN	STOP lamp turns off
		STOP (Contact open)	STOP	STOP lamp lights
	STOP	RUN (Contact closed)		
		STOP (Contact open)		
AUTO/MAN transfer	AUTO mode	AUTO (Contact closed)	AUTO mode	MAN lamp turns off
		MAN (Contact open)	MAN mode	MAN lamp lights
	MAN mode	AUTO (Contact closed)		
		MAN (Contact open)		

* Selected status by DI is not back up by EEPROM.

■ Relation between Event types and Event function related items

✓: Set values of Event function related items valid. —: Set values of Event function related items invalid.

	Set value	Event type	Related items except event types				
			Event 1 hold action *	Event 1 differential gap *	Event 1 output action at input burnout *	Energized/ De-energized of Event 1 output *	Event 1 interlock *
Event 1 type *	0	None	—	—	—	—	—
	1	Deviation high [1, 3]	✓	✓	✓	✓	✓
	2	Deviation low [1, 3]	✓	✓	✓	✓	✓
	3	Deviation high/low [1, 3]	✓	✓	✓	✓	✓
	4	Band [1]	✓	✓	✓	✓	✓
	5	Deviation high/low [High/Low individual setting] [1, 3]	✓	✓	✓	✓	✓
	6	Band [High/Low individual setting] [1]	—	✓	✓	✓	✓
	7	SV high [1]	—	✓	✓	✓	✓
	8	SV low [1]	—	✓	✓	✓	✓
	9	Process high [4]	✓ (Except re-hold)	✓	✓	✓	✓
	10	Process low [4]	✓ (Except re-hold)	✓	✓	✓	✓
	11	Control loop break alarm (LBA) [5]	—	—	✓	✓	✓
	12	Monitor during RUN	—	—	✓	✓	✓
	13	FAIL (Fixed at de-energized: Contact open when error occurs)	—	—	✓	— (always de-energized)	✓
	14	Deviation high [2, 3]	✓	✓	✓	✓	✓
	15	Deviation low [2, 3]	✓	✓	✓	✓	✓
	16	Deviation high/low [2, 3]	✓	✓	✓	✓	✓
	17	Band [2]	✓	✓	✓	✓	✓
	18	Deviation high/low [High/Low individual setting] [2, 3]	✓	✓	✓	✓	✓
	19	Band [High/Low individual setting] [2]	—	✓	✓	✓	✓
	20	SV high [2]	—	✓	✓	✓	✓
	21	SV low [2]	—	✓	✓	✓	✓
	22	Heater break alarm (HBA)	—	—	✓	✓	✓
	23	Output of the communication monitoring result (Event signal is turned on when communication is not properly made for 10 seconds.)	—	—	✓	✓	✓

*: The above table explains the relation in the case of Event 1, however, the relations in the case of Event 2 to Event 4 are the same.

[1] Using SV monitor value
[2] Using local SV
[3] This alarm function can add the hold action or re-hold action.
[4] This alarm function can add a hold action.
[5] Precautions for Control loop break alarm (LBA) setting:

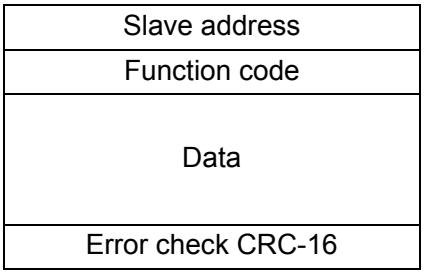
- The control loop break alarm (LBA) function cannot be activated when AT function is turned on.
- Normally the control loop break alarm (LBA) time of parameter setting mode should be set to approximately twice the integral time.
- If the LBA time is too short or does not match the controlled object requirements, LBA may turn ON or OFF at inappropriate time or remain OFF. Change the LBA time based on the malfunction.

6. 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.

6.1 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 1 to 99 manually set at the front key panel of the controller.

☞ For details, refer to **4. SETTING (P. 9)**.

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, refer to **6.2 Function Code (P. 46)**.

■ 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, refer to **6.6 Register Read and Write (P. 51)**, **6.7 Data Configuration (P. 54)** and **6.8 Modbus Communication Data List (P. 55)**.

■ Error check

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

☞ For details, refer to **6.5 Calculating CRC-16 (P. 48)**.

6.2 Function Code

Function code contents

Function code (Hexadecimal)	Function	Contents
03H	Read holding registers	Measured value (PV), Event status and Monitor, etc.
06H	Preset single register	Set value (SV), Event set value, PID constants and PV bias, etc.
08H	Diagnostics (loopback test)	Loopback test

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

6.3 Communication Mode

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

Items	Contents
Data bit length	8-bit (Binary)
Start mark of message	Unused
End mark of message	Unused
Message length	Refer to **6.2 Function code**
Data time interval	Less than 24-bit 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-bit time. If time intervals become time longer than the 24-bit time the relevant slave assumes that message sending from the master is terminated and there is no response.

6.4 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, the slave returns the same message as the query message.
- In the response message of the Diagnostics (Loopback test), the slave returns the same message as the 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.

Slave address
Function code
Error code
Error check CRC-16

Error response message

- 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.

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

(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 CRC code 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.
- Data time interval in the query message from the master exceeds 24-bit time.

6.5 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 FFFFH to a 16-bit CRC register.

2. *Exclusive OR* (⊕) the first byte (8 bits) 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***.

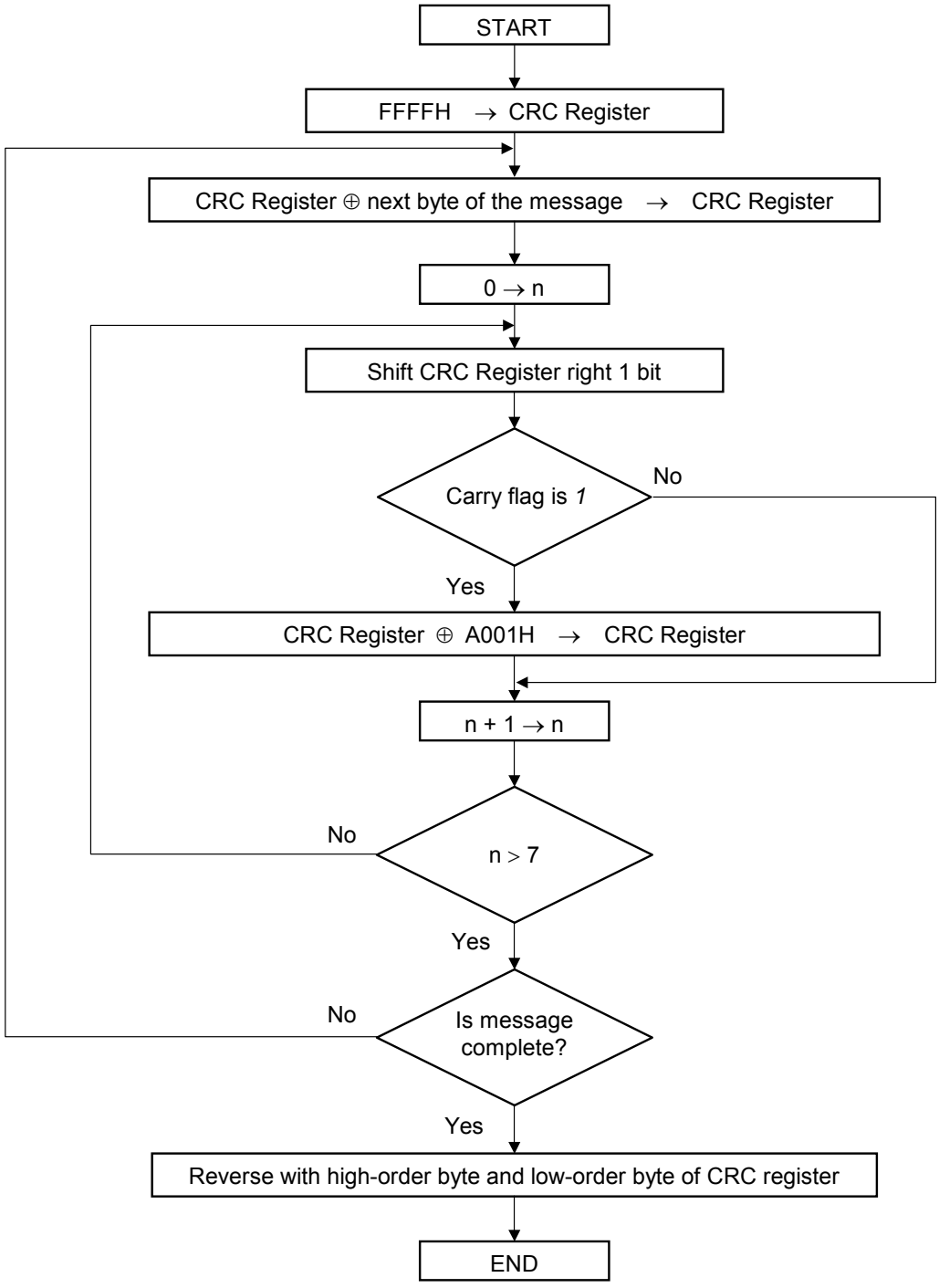
5. Repeat step ***3*** and ***4*** until there have been 8 shifts.

6. *Exclusive OR* the next byte (8 bits) 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;
}
```

6.6 Register Read and Write

6.6.1 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 four holding registers from 0000H [Measured value (PV) monitor] to 0003H [Event 1 state monitor] are the read out from slave address 2.

Query message

Slave address		02H
Function code		03H
Starting No.	High	00H
	Low	00H
Quantity	High	00H
	Low	04H
CRC-16	High	44H
	Low	3AH

First holding register address

The setting must be between 1 (0001H) and 125 (007DH).

Normal response message

Slave address		02H
Function code		03H
Number of data		08H
First holding register contents	High	00H
	Low	19H
Next holding register contents	High	00H
	Low	00H
Next holding register contents	High	00H
	Low	00H
Next holding register contents	High	00H
	Low	00H
CRC-16	High	12H
	Low	52H

→ Number of holding registers × 2

Error response message

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

6.6.2 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 0006H [Set value 1 (SV1)] of slave address 1.

Query message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	06H
Write data	High	00H
	Low	32H
CRC-16	High	E8H
	Low	1EH

} Any data within the range

Normal response message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	06H
Write data	High	00H
	Low	32H
CRC-16	High	E8H
	Low	1EH

} Contents will be the same as query message data.

Error response message

Slave address		01H
80H + Function code		86H
Error code		02H
CRC-16	High	C3H
	Low	A1H

6.6.3 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 (the controller).

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

6.7 Caution for Handling Communication Data

- 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.

- The Modbus protocol does not recognize data with decimal points during communication.

  Example: When Manipulated output value (MV1) monitor [heat-side] is 5.0 %,
  5.0 is processed as 50,
  50 = 0032H

Manipulated output value (MV1) monitor [heat-side]	High	00H
	Low	32H

- If data (holding register) exceeding the accessible address range is accessed, an error response message is returned.
- Read data of unused item is a default value.
- Any attempt to write to an unused item is not processed as an error. Data cannot be written into an unused item.
- An attribute of the item for functions which are not in the controller is RO (read only). If read action to this item is performed, the read data will be “0.” If write action to this item is performed, no error message is indicated and no data is written.
- Commands should be sent at time intervals of 24 bits after the master receives the response message.

6.8 Modbus Communication Data List

■ Reference to communication data list

(1) (2) (3) (4) (5)

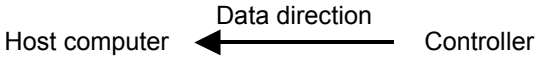
No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
1	Measured value (PV) monitor	0000	0	RO	Within input range Varies with the setting of the Decimal point position. Refer to ■ **Input range table (P. 42)**.	—
2	Current transformer 1 (CT1) input value monitor [1]	0001	1	RO	0.0 to 100.0 A	—
3	Current transformer 2 (CT2) input value monitor [1]	0002	2	RO		—

(1) Name: Communication data name

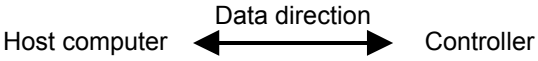
(2) Register address: Modbus communication data register addresses
HEX: Hexadecimal
DEC: Decimal

(3) 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.

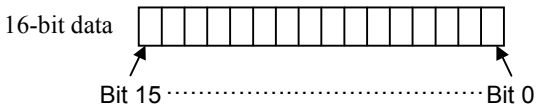


R/W: Reading and writing data is possible.



(4) Data range: Read or write range of communication data

Bit data



(5) Factory set value: Factory set value of communication data

☞ For details of data, refer to the **RB series Instruction Manual (IMR02C15-E□)**.

For data corresponding to No. 85 to 144 (other than No. 98 AO full scale adjustment value and No. 99 AO zero adjustment value), its attribute becomes RO (Only reading data is possible) during RUN (control).
When setting data corresponding to No. 85 to 144 (other than No. 98 and No. 99), write the data after STOP (control stop) is selected.

■ Communication data

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
1	Measured value (PV) monitor	0000	0	RO	Within input range Varies with the setting of the Decimal point position. Refer to ■ **Input range table (P. 42)**.	—
2	Current transformer 1 (CT1) input value monitor [1]	0001	1	RO	0.0 to 100.0 A	—
3	Current transformer 2 (CT2) input value monitor [1]	0002	2	RO		—
4	Event 1 state monitor [2]	0003	3	RO	0: Event 1 OFF 1: Event 1 ON	—
5	Event 2 state monitor [3]	0004	4	RO	0: Event 2 OFF 1: Event 2 ON	—
6	Burnout state monitor	0005	5	RO	0: OFF 1: ON (burnout)	—
7	Set value 1 (SV1)	0006	6	R/W	Setting limiter low to Setting limiter high Varies with the setting of the Decimal point position.	0
8	Event 1 set value (EV1) [2, 4, 5, 6] Event 1 set value (EV1) [high]	0007	7	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0
9	Event 2 set value (EV2) [3, 4, 6, 7] Event 2 set value (EV2) [high]	0008	8	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0

[1] Current transformer (CT) input must be provided.

[2] When the Digital output 1 (DO1) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 1 type (address: 0070H).

[3] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (address: 0077H).

[4] Data is invalid if any of the following Event functions are selected:
- Heater break alarm (HBA)
- Monitor during RUN
- Control loop break alarm (LBA)
- Output of the communication monitoring result
- FAIL

[5] If any of the following Event functions are selected, this data will be Event 1 set value (EV1) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[6] For the deviation action, input value action and set value action, refer to **8.2 Deviation Action, Input Value Action and Set Value Action (P. 74).**

[7] If any of the following Event functions are selected, this data will be Event 2 set value (EV2) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
10	Heater break alarm 1 (HBA1) set value [1, 2]	0009	9	R/W	0.0 to 100.0 A	0.0
11	Heater break alarm 2 (HBA2) set value [1, 2]	000A	10	R/W	0.0 to 100.0 A	0.0
12	Control loop break alarm (LBA) time [1, 3]	000B	11	R/W	0 to 7200 seconds (0: Unused)	480
13	LBA deadband (LBD) [1, 3]	000C	12	R/W	0 to Input span Varies with the setting of the Decimal point position.	0
14	Autotuning (AT)	000D	13	R/W	0: PID control 1: AT start	0
15	Unused	000E	14	—	—	—
16	Proportional band [heat-side]	000F	15	R/W	TC/RTD inputs: 1 (0.1) to Input span (Unit: °C [°F]) Varies with the setting of the Decimal point position. Voltage (V)/current (I) inputs: 0.1 to 100.0 % of Input span 0 (0.0): ON/OFF action	TC/RTD: 30 (30.0) V/I: 3.0
17	Integral time	0010	16	R/W	1 to 3600 seconds (0: PD action)	240
18	Derivative time	0011	17	R/W	1 to 3600 seconds (0: PI action)	60
19	Anti-reset windup (ARW)	0012	18	R/W	1 to 100 % of proportional band [heat-side] (0: Integral action is always OFF)	100
20	Proportional cycle time [heat-side] [4]	0013	19	R/W	0 to 100 seconds (0: Setting below 1 second is possible for Proportional cycle time [heat-side] (address: 009BH).)	Relay contact output: 20 Voltage pulse output, triac output, open collector output: 2
21	Proportional band [cool-side] [5]	0014	20	R/W	01 to 1000 % of proportional band [heat- side] (ON/OFF control of cool-side only is not possible)	100
22	Overlap/Deadband [5]	0015	21	R/W	TC/RTD inputs: −10 (−10.0) to +10 (+10.0) °C [°F] Varies with the setting of the Decimal point position. Voltage (V)/current (I) inputs: −10.0 to +10.0 % of Input span	0 (0.0)

[1] Digital output (DO) must be provided.

[2] Current transformer (CT) input must be provided and Heater break alarm (HBA) must be selected as an Event function.

[3] Control loop break alarm (LBA) must be selected as an Event function.
The data is invalid when the control action is Heat/Cool PID action with autotuning (AT).

[4] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.

[5] When the control action is PID action with autotuning (AT), this data is invalid.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
23	Proportional cycle time [cool-side] [1, 2]	0016	22	R/W	0 to 100 seconds (0: Setting below 1 second is possible for Proportional cycle time [cool-side] (address: 009CH).)	Relay contact output: 20 Voltage pulse output, triac output, open collector output: 2
24	PV bias	0017	23	R/W	TC/RTD inputs: −1999 (−199.9) to +9999 (+999.9) °C [°F] Voltage (V)/current (I) inputs: − Input span to + Input span Varies with the setting of the Decimal point position.	0 (0.0)
25	Set lock level	0018	24	R/W	0: All parameter can be changed 1: Lock "Parameter Group" F01 through F10 2: Lock "Parameter Group" F02 through F10 3: Lock "Parameter Group" F03 through F10 4: Lock "Parameter Group" F04 through F10 5: Lock "Parameter Group" F05 through F10 6: Lock "Parameter Group" F06 through F10 7: Lock "Parameter Group" F07 through F10 8: Lock "Parameter Group" F08 through F10 9: Lock "Parameter Group" F09 through F10 10: Lock "Parameter Group" F10	0
26	RUN/STOP transfer	0019	25	R/W	0: RUN 1: STOP	0
27	Unused	001A	26	—	—	—
28	EEPROM mode	001B	27	R/W	0: Backup mode (Set values stored to the EEPROM when set values are changed.) 1: Buffer mode (No set values stored to the EEPROM when set values are changed.)	0
29	EEPROM state	001C	28	RO	0: The content of the EEPROM does not coincide with that of the RAM. 1: The content of the EEPROM coincides with that of the RAM.	—
30	Manipulated output value (MV1) monitor [heat-side]	001D	29	RO	Within output limiter range	—

[1] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.
[2] When the control action is PID action with autotuning (AT), this data is invalid.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
31	Manipulated output value (MV2) monitor [cool-side] [1]	001E	30	RO	Within output limiter range	—
32	Unused	001F ⋮ 002C	31 ⋮ 44	—	—	—
33	Manipulated output ON/OFF state monitor [heat-side] [2]	002D	45	RO	0: Output OFF 1: Output ON	—
34	Manipulated output ON/OFF state monitor [cool-side] [1, 3, 4]	002E	46	RO		—
35	Comprehensive event state	002F	47	RO	Bit data Bit 0: Event 1 (EV1) Bit 1: Event 2 (EV2) Bit 2: Event 3 (EV3) Bit 3: Event 4 (EV4) Bit 4: Burnout Bit 5 to Bit 15: Unused Data 0: OFF 1: ON [Decimal number: 0 to 31]	—
36	Digital input (DI) state [5]	0030	48	RO	Bit data Bit 0: DI1 Bit 1: DI2 Bit 2 to Bit 15: Unused Data 0: OFF 1: ON [Decimal number: 0 to 3]	—
37	Output state monitor	0031	49	RO	Bit data Bit 0: Output 1 (OUT1) Bit 1: Output 2 (OUT2) Bit 2: Digital output 1 (DO1) Bit 3: Digital output 2 (DO2) Bit 4: Digital output 3 (DO3) Bit 5: Digital output 4 (DO4) Bit 6 to Bit 15: Unused Data 0: OFF 1: ON [Decimal number: 0 to 63]	—
38	Set value (SV) display while the setting change rate limiter is working	0032	50	RO	Setting limiter low to Setting limiter high Varies with the setting of the Decimal point position.	—
39	Remaining time monitor	0033	51	RO	0 to 5999 (sec or min)	—
40	Event 3 state monitor [6]	0034	52	RO	0: Event 3 OFF 1: Event 3 ON	—

[1] When the control action is PID action with autotuning (AT), this data is invalid.
[2] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.
[3] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.
[4] When the Output 2 (OUT2) is used as the transmission output, this data is invalid.
[5] When the Digital input (DI) is not provided, this data is invalid.
The data is also invalid when the DI function is set to "Unused."
[6] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 3 type (address: 007EH).

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
41	Event 4 state monitor *	0035	53	RO	0: Event 4 OFF 1: Event 4 ON	—
42	Error code	0036	54	RO	Bit data Bit 0: Adjustment data error Bit 1: Data back-up error Bit 2: A/D conversion error (Including temperature compensation error) Bit 3 to Bit 15: Unused Data 0: OFF 1: ON [Decimal number: 0 to 7]	—
43	Operation mode state monitor	0037	55	RO	Bit data Bit 0: STOP Bit 1: RUN Bit 2: Manual (During RUN) Bit 3 to Bit 15: Unused Data 0: OFF 1: ON [Decimal number: 0 to 7]	—
44	Actual SV selection number	0038	56	RO	1 to 4 SV number in Timer 3 and Timer 4 functions.	—
45	Auto (AUTO)/Manual (MAN) transfer	0039	57	R/W	0: Auto (AUTO) mode 1: Manual (MAN) mode	0
46	Interlock release	003A	58	R/W	To release the interlock, write “0 (zero).”	0
47	Monitor selection (no display)	003B	59	R/W	Bit data Bit 0: Current transformer1 (CT1) input value monitor Bit 1: Current transformer2 (CT2) input value monitor Bit 2: Manipulated output value (MV) monitor [a] Bit 3: Remaining time monitor Bit 4 to Bit 15: Unused [a] The manipulated output value (MV1) monitor [heat-side] and the manipulated output value (MV2) monitor [cool-side] are both “No display.” Data 0: Display 1: No display [Decimal number: 0 to 15]	0

* When the Digital output 4 (DO4) is not provided, this data is invalid.
The data is also invalid when “0: None” is set for Event 4 type (address: 0085H).

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
48	Mode selection (no display)	003C	60	R/W	Bit data Bit 0: Auto (AUTO)/Manual (MAN) transfer [a] Bit 1: Set data unlock/lock transfer [a] Bit 2: Interlock release [a] Bit 3: Disable <R/S key operation [b] Bit 4 to Bit 6: Unused Bit 7: Displays F21 and after [c] Bit 8 to Bit 15: Unused [a] Data 0: Display 1: No display [b] Data 0: Enable <R/S key operation 1: Disable <R/S key [c] Data 0: No display F21 through F91. 1: Display F21 through F91. [Decimal number: 0 to 255]	0
49	Set value 2 (SV2)	003D	61	R/W	Setting limiter low to Setting limiter high	0
50	Set value 3 (SV3)	003E	62	R/W	Varies with the setting of the Decimal point position.	0
51	Set value 4 (SV4)	003F	63	R/W		0
52	SV selection	0040	64	R/W	1 to 4	1
53	F01 block selection (no display)	0041	65	R/W	0: Display 1: No display	1
54	Timer 1	0042	66	R/W	1 to 5999 (second or minute)	1
55	Timer 2	0043	67	R/W		1
56	Timer 3	0044	68	R/W		1
57	Timer 4	0045	69	R/W		1
58	Timer function	0046	70	R/W	0: Unused 1: Timer function 1 2: Timer function 2 3: Timer function 3 4: Timer function 4	0
59	Repeat execution times	0047	71	R/W	0 to 9999 (9999: Infinite times)	0
60	F02 block selection (no display)	0048	72	R/W	0: Display 1: No display	1

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
61	Setting change rate limiter (up)	0049	73	R/W	0 to Input span (Unit:°C [°F]/unit time) Varies with the setting of the Decimal point position.	0 (0.0)
62	Setting change rate limiter (down)	004A	74	R/W		0 (0.0)
63	F03 block selection (no display)	004B	75	R/W	0: Display 1: No display	1
64	Event 1 set value (EV1') [low] [1, 2]	004C	76	R/W	–Input span to +Input span Varies with the setting of the Decimal point position.	TC/RTD: –50 (–50.0) V/I: –5.0
65	Event 2 set value (EV2') [low] [2, 3]	004D	77	R/W		TC/RTD: –50 (–50.0) V/I: –5.0
66	Event 3 set value (EV3) [4, 5, 6, 7] (Event 3 set value (EV3) [high])	004E	78	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0
67	Event 3 set value (EV3') [low] [2, 4]	004F	79	R/W	–Input span to +Input span Varies with the setting of the Decimal point position.	TC/RTD: –50 (–50.0) V/I: –5.0

[1] When the Digital output 1 (DO1) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 1 type (address: 0070H).

[2] Data is valid if any of the following Event functions are selected:
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[3] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (address: 0077H).

[4] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 3 type (address: 007EH).

[5] Data is invalid if any of the following Event functions are selected:
- Heater break alarm (HBA)
- Control loop break alarm (LBA)
- FAIL
- Monitor during RUN
- Output of the communication monitoring result

[6] If any of the following Event functions are selected, this data will be Event 3 set value (EV3) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[7] For the deviation action, input value action and set value action, refer to **8.2 Deviation Action, Input Value Action and Set Value Action (P. 74)**.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
68	Event 4 set value (EV4) [1, 2, 3, 4] (Event 4 set value (EV4) [high])	0050	80	R/W	Deviation action: –Input span to +Input span Input value or set value action: Same as input range Varies with the setting of the Decimal point position.	TC/RTD: 50 (50.0) V/I: 5.0
69	Event 4 set value (EV4') [low] [1, 5]	0051	81	R/W	–Input span to +Input span Varies with the setting of the Decimal point position.	TC/RTD: −50 (−50.0) V/I: −5.0
70	F04 block selection (no display) [6]	0052	82	R/W	0: Display 1: No display	0
71	Startup tuning (ST)	0053	83	R/W	0: ST unused 1: Execute once * 2: Execute always * When the Startup tuning (ST) is finished, the setting will automatically returns to "0: ST unused."	0
72	F05 block selection (no display)	0054	84	R/W	0: Display 1: No display	0
73	Fine tuning setting	0055	85	R/W	–3 to +3 (0: Unused)	0

[1] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 4 type (address: 0085H).

[2] Data is invalid if any of the following Event functions are selected:
- Heater break alarm (HBA)
- Control loop break alarm (LBA)
- FAIL
- Monitor during RUN
- Output of the communication monitoring result

[3] If any of the following Event functions are selected, this data will be Event 4 set value (EV4) [high].
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[4] For the deviation action, input value action and set value action, refer to **8.2 Deviation Action, Input Value Action and Set Value Action (P. 74)**.

[5] Data is valid if any of the following Event functions are selected:
- Band (High/Low individual setting)
- Deviation high/low (High/Low individual setting)
- Deviation high/low with hold action (High/Low individual setting)
- Deviation high/low with re-hold action (High/Low individual setting)

[6] Data is invalid in the following cases:
- When the Digital output (DO) is not provided.
- When Event 1 type (address: 0070H), Event 2 type (address: 0077H), Event 3 type (address: 007EH), and Event 4 type (address: 0085H) are all set to "0: None."
- When Event 1 type (address: 0070H), Event 2 type (address: 0077H), Event 3 type (address: 007EH), and Event 4 type (address: 0085H) are set to the Event functions "Heater break alarm (HBA)," "Control loop break alarm (LBA)," "FAIL," "Monitor during RUN," and "Output of the communication monitoring result."

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
74	F06 block selection (no display)	0056	86	R/W	0: Display 1: No display	0
75	F07 block selection (no display) [1]	0057	87	R/W	0: Display 1: No display	0
76	Minimum ON/OFF time of proportioning cycle [heat-side] [2]	0058	88	R/W	0 to 1000 ms	0
77	Output limiter high [Heat-side output limiter (high)]	0059	89	R/W	PID control: Output limiter low to 105.0 % Heat/Cool PID control: 0.0 to 105.0 %	105.0
78	Output limiter low [Cool-side output limiter (high)]	005A	90	R/W	PID control: −5.0 % to Output limiter high [Output limiter high > Output limiter low] Heat/Cool PID control: 0.0 to 105.0 %	PID control: −5.0 Heat/Cool PID control: 105.0
79	Minimum ON/OFF time of proportioning cycle [cool-side] [3, 4]	005B	91	R/W	0 to 1000 ms	0
80	F08 block selection (no display)	005C	92	R/W	0: Display 1: No display	0
81	PV digital filter	005D	93	R/W	0 to 100 seconds (0: Unused)	1
82	F09 block selection (no display)	005E	94	R/W	0: Display 1: No display	0
83	Manual manipulated output value (MV)	005F	95	R/W	PID control: Output limiter low to Output limiter high Heat/Cool PID control: − Cool-side output limiter (high) to + Heat-side output limiter (high)	0.0
84	F10 block selection (no display)	0060	96	R/W	0: Display 1: No display	1

[1] Data is invalid in the following cases:
- When the Current transformer (CT) input is not provided, this data is invalid.
- When Event 1 type (address: 0070H), Event 2 type (address: 0077H), Event 3 type (address: 007EH), and Event 4 type (address: 0085H) are all set to "0: None."
- When any of Event 1 type (address: 0070H), Event 2 type (address: 0077H), Event 3 type (address: 007EH), or Event 4 type (address: 0085H) are not set to "Heater break alarm (HBA)" or "Control loop break alarm (LBA)."

[2] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.

[3] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.

[4] When the control action is PID action with autotuning (AT), this data is invalid.

Write the following data (excluding No. 102 and 103) after you have switched to STOP (control stop).

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
85	Input type	0061	97	R/W	TC/RTD inputs: 0 to 31 Voltage (V)/current (I) inputs: 33 to 38 Refer to ■ **Input rang table (P. 42)**.	Based on model code
86	Decimal point position	0062	98	R/W	0: No decimal place 1: One decimal place 2: Two decimal place 3: Three decimal places TC/RTD inputs: 0 to 1 Voltage (V)/current (I) inputs: 0 to 3	Based on model code
87	Burnout direction	0063	99	R/W	0: Upscale 1: Downscale Valid only when the TC input is selected.	0
88	Input scale high	0064	100	R/W	Input scale low to Maximum value of the selected input range Varies with the setting of the Decimal point position.	Maximum value of the selected input range
89	Input scale low	0065	101	R/W	Minimum value of the selected input range to Input scale high Varies with the setting of the Decimal point position.	Minimum value of the selected input range
90	Setting limiter high	0066	102	R/W	Setting limiter low to Input scale high Varies with the setting of the Decimal point position.	Input scale high
91	Setting limiter low	0067	103	R/W	Input scale low to Setting limiter high Varies with the setting of the Decimal point position.	Input scale low
92	PV flashing display at input error	0068	104	R/W	0: Flashing 1: Non-flashing display	0
93	DI assignment [1]	0069	105	R/W	0 to 7 Refer to ■ **DI assignment table (P. 43)**.	Based on model code
94	Output action at STOP mode [2, 3]	006A	106	R/W	0: Both event output and transmission output (AO) are off. 1: Event output remains unchanged, and transmission output (AO) is off. 2: Event output is off, and transmission output (AO) remains unchanged. 3: Both event output and transmission output (AO) remain unchanged.	0
95	Transmission output type [3]	006B	107	R/W	0: Manipulated output value (MV1) 1: Measured value (PV) 2: Set value (SV)	1

[1] Digital input (DI) must be provided.

[2] When the Digital output (DO) is not provided, the Event output action setting is invalid.
The Event output action setting is also invalid when there is no Event function.

[3] Transmission output must be provided.

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
96	Transmission output scale high [1]	006C	108	R/W	When MV1 is selected: Transmission output scale low to +105.0 % When PV or SV is selected: Transmission output scale low to Input scale high Varies with the setting of the Decimal point position.	High-limit value of input span
97	Transmission output scale low [1]	006D	109	R/W	When MV1 is selected: −5.0 % to Transmission output scale high When PV or SV is selected: Input scale low to Transmission output scale high Varies with the setting of the Decimal point position.	Low-limit value of input span
98	AO full scale adjustment value[1, 2]	006E	110	R/W	−10.0 to +10.0 %	Adjustment value
99	AO zero adjustment value[1, 2]	006F	111	R/W	−10.0 to +10.0 %	Adjustment value
100	Event 1 type [3]	0070	112	R/W	0 to 23 (Refer to page 44.)	Based on model code
101	Event 1 hold action [3]	0071	113	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code
102	Event 1 differential gap [3]	0072	114	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2
103	Event 1 output action at input burnout [3]	0073	115	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
104	Energized/De-energized of Event 1 output [3]	0074	116	R/W	0: Energized 1: De-energized	0
105	Event 1 timer [3]	0075	117	R/W	0 to 600 seconds	0
106	Event 1 interlock [3]	0076	118	R/W	0: Unused 1: Used	0

[1] Transmission output must be provided.

[2] This data can also be written in the RUN state.

[3] When the Digital output 1 (DO1) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 1 type (address: 0070H).

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
107	Event 2 type [1]	0077	119	R/W	0 to 23 (Refer to page 44.)	Based on model code
108	Event 2 hold action [1]	0078	120	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code
109	Event 2 differential gap [1]	0079	121	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2
110	Event 2 output action at input burnout [1]	007A	122	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
111	Energized/De-energized of Event 2 output [1]	007B	123	R/W	0: Energized 1: De-energized	0
112	Event 2 timer [1]	007C	124	R/W	0 to 600 seconds	0
113	Event 2 interlock [1]	007D	125	R/W	0: Unused 1: Used	0
114	Event 3 type [2]	007E	126	R/W	0 to 23 (Refer to page 44.)	Based on model code
115	Event 3 hold action [2]	007F	127	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code
116	Event 3 differential gap [2]	0080	128	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2

[1] When the Digital output 2 (DO2) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 2 type (address: 0077H).

[2] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 3 type (address: 007EH).

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
117	Event 3 output action at input burnout [1]	0081	129	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
118	Energized/De-energized of Event 3 output [1]	0082	130	R/W	0: Energized 1: De-energized	0
119	Event 3 timer [1]	0083	131	R/W	0 to 600 seconds	0
120	Event 3 interlock [1]	0084	132	R/W	0: Unused 1: Used	0
121	Event 4 type [2]	0085	133	R/W	0 to 23 (Refer to page 44.)	Based on model code
122	Event 4 hold action [2]	0086	134	R/W	0: OFF 1: Hold action ON (When power turned on; when transferred from STOP to RUN) 2: Re-hold action ON (When power turned on; when transferred from STOP to RUN; SV changed)	Based on model code
123	Event 4 differential gap [2]	0087	135	R/W	0 to Input span Varies with the setting of the Decimal point position.	TC/RTD: 2 (2.0) V/I: 0.2
124	Event 4 output action at input burnout [2]	0088	136	R/W	0: Event output is not forcibly turned ON when the burnout function is activated. 1: ON at over-scale; no action at underscale 2: ON at underscale; no action at over-scale 3: ON at over-scale or underscale 4: OFF at over-scale or underscale	0
125	Energized/De-energized of Event 4 output [2]	0089	137	R/W	0: Energized 1: De-energized	0
126	Event 4 timer [2]	008A	138	R/W	0 to 600 seconds	0
127	Event 4 interlock [2]	008B	139	R/W	0: Unused 1: Used	0

[1] When the Digital output 3 (DO3) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 3 type (address: 007EH).

[2] When the Digital output 4 (DO4) is not provided, this data is invalid.
The data is also invalid when "0: None" is set for Event 4 type (address: 0085H).

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
128	CT ratio [1] (Number of turns)	008C	140	R/W	1 to 1000	CTL-6-P-N: 800 CTL-12-S56-10L-N: 1000
129	Number of HBA delay times [1]	008D	141	R/W	0 to 255 times	3
130	Direct/Reverse action [2]	008E	142	R/W	0: Direct action 1: Reverse action	Based on model code
131	Cool action [3]	008F	143	R/W	0: Air cooling 1: Water cooling 2: Cooling gain linear	Based on model code
132	ON/OFF action differential gap (upper)	0090	144	R/W	TC/RTD inputs: 0 (0.0) to 100 (100.0) °C [°F] Varies with the setting of the Decimal point position. Voltage (V)/Current (I) inputs: 0.0 to 10.0 % of Input span	TC/RTD: 1 (1.0) V/I: 0.1
133	ON/OFF action differential gap (lower)	0091	145	R/W		TC/RTD: 1 (1.0) V/I: 0.1
134	Control output at burnout	0092	146	R/W	0: Result of control computation 1: Low output limiter value (Output OFF) * * On Heat/Cool PID control type, both heating and cooling outputs are off.	0
135	Bumpless mode setting	0093	147	R/W	0: Without bumpless 1: With bumpless	1
136	Derivative action	0094	148	R/W	0: Measured value derivative 1: Deviation derivative	0
137	AT cycles	0095	149	R/W	0: 1.5 cycles 1: 2.5 cycles	0
138	AT differential gap time	0096	150	R/W	0 to 50 seconds	10
139	ST start condition	0097	151	R/W	0: Activate the ST function when the power is turned on; when transferred from STOP to RUN; or when the set value (SV) is changed. 1: Activate the ST function when the power is turned on; or when transferred from STOP to RUN. 2: Activate the ST function when the set value (SV) is changed.	0
140	Setting change rate limiter unit time	0098	152	R/W	0: Minute 1: Hours	0
141	Timer time unit	0099	153	R/W	0: Min. : Sec. 1: Hour : Min.	0

[1] Current transformer (CT) input must be provided.
[2] When the control action is Heat/Cool PID action with autotuning (AT), this data is invalid.
[3] When the control action is PID action with autotuning (AT), this data is invalid.

No.	Name	Register address		Attri-bute	Data range	Factory set value
		HEX	DEC			
142	STOP display selection	009A	154	R/W	0: STOP on PV display + STOP lamp (green) lights 1: STOP on SV display + STOP lamp (green) lights 2: STOP lamp (green) lights	1
143	Time setting of proportional cycle time [heat-side] [1, 3]	009B	155	R/W	0: 0.1 seconds (fixed) 1: 0.25 seconds (fixed) 2: 0.5 seconds (fixed)	2
144	Time setting of proportional cycle time [cool-side] [2, 4, 5]	009C	156	R/W		2

[1] When the heat-side control output is continuous output (voltage output or current output), this data is invalid.
[2] When the cool-side control output is continuous output (voltage output or current output), this data is invalid.
[3] When Proportional cycle time [heat-side] (address: 0013H) is set to 0 seconds, this setting data becomes valid for the Proportional cycle time [heat-side].
[4] When the control action is PID action with autotuning (AT), this data is invalid.
[5] When Proportional cycle time [cool-side] (address: 0016H) is set to 0 seconds, this setting data becomes valid for the Proportional cycle time [cool-side].

7. TROUBLESHOOTING

⚠ 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 wiring is completed. Make sure that the wiring is correct before applying power to the instrument.
- 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.

This section lists some of the main causes and solutions for communication problems.
If you can not solve a problem, please contact RKC sales office or the agent, on confirming the type name and specifications of the product.

■ RKC communication

Problem	Possible 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 computer	Confirm the settings and set them correctly
	Wrong address setting	
	The communication settings (device address, communication speed, data bit configuration, etc.) were not enabled after being changed.	After all communication parameters are set, perform one of the following operations. • The power is turned on again after turning it off once • The RUN/STOP mode is changed in RUN from STOP again after changing it in STOP
	Error in the data format	Re-examine the communication program
	Transmission line is not set to the receive state after data send (for RS-485)	

Continued on the next page.

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Problem	Possible cause	Solution
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 occurs on the line (parity bit error, framing error, etc.)	Confirm the cause of error, and solve the problem appropriately. (Confirm the transmitting data, and resend data)
	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	Possible 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 computer	Confirm the settings and set them correctly
	Wrong address setting	
	The communication settings (device address, communication speed, data bit configuration, etc.) were not enabled after being changed.	After all communication parameters are set, perform one of the following operations. • The power is turned on again after turning it off once • The RUN/STOP mode is changed in RUN from STOP again after changing it in STOP
	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, exceeding 24-bit time	
Error code 1	Function cod error (Specifying nonexistent function code)	Confirm the function code
Error code 2	When any address other than 0000H to 00DFH, 0500H to 0515H, 1000H to 100FH and 1500H to 150FH are specified	Confirm the address of holding register
Error code 3	When the specified number of data items in the query message exceeds the maximum number of data items available	Confirm the setting data
Error code 4	Self-diagnostic error	Turn off the power to the instrument. If the same error occurs when the power is turned back on, please contact RKC sales office or the agent.

8. APPENDIX

8.1 ASCII 7-Bit Code Table

This table is only for use with RKC communication.

					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 to 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

8.2 Deviation Action, Input Value Action and Set Value Action

The table below indicates whether each event function is classified as a deviation action, input value action, or set value action.

Event function type	Action type
Deviation high	Deviation action
Deviation low	
Deviation high/low	
Band	
Deviation high with hold action	
Deviation low with hold action	
Deviation high/low with hold action	
Deviation high with re-hold action	
Deviation low with re-hold action	
Deviation high/low with re-hold action	
Band (High/Low individual setting)	
Deviation high/low (High/Low individual setting)	
Deviation high/low with hold action (High/Low individual setting)	
Deviation high/low with re-hold action (High/Low individual setting)	
Process high	Input value action
Process low	
Process high with hold action	
Process low with hold action	
SV high	Set value action
SV low	

The following event functions are not classified as a deviation action, input value action, or set value action.

- Heater break alarm (HBA)
- Control loop break alarm (LBA)
- FAIL
- Monitor during RUN
- Output of the communication monitoring result

The first edition: OCT. 2008 [IMQ00]
The third edition: DEC. 2011 [IMQ00]

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IMR02C16-E3 **DEC. 2011**