



Temperature Controller

SA100

***Communication
Instruction Manual***

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 explanation purpose.
- 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.


- Windows is a trademark of Microsoft Corporation.
- 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.


Safety Precautions


■ Pictorial Symbols (safety symbols)

Various pictorial symbols are used in this manual to ensure safe use of the product, to protect you and other people from harm, and to prevent damage to property. The symbols are described below.

Be sure you thoroughly understand the meaning of the symbols before reading this manual.

 **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.

WARNING

- To prevent injury to persons, damage to the instrument and the equipment, a suitable external protection device shall be required.
- All wiring must be completed before power is turned on to prevent electric shock, fire or damage to the instrument and the equipment.
- This instrument must be used in accordance with the specifications to prevent fire or damage to the instrument and the 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 may 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 plant.)
- 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 to operating personnel.
- All precautions described in this manual should be taken to avoid damage to the instrument or equipment.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.
- 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 as a result of failure, protect the power line and the input/output lines from high currents with a suitable overcurrent protection device with adequate breaking capacity such as a fuse, circuit breaker, etc.
- A malfunction in this product may occasionally make control operations impossible or prevent alarm outputs, resulting in a possible hazard. Take appropriate measures in the end use to prevent hazards in the event of malfunction.
- 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 dissipation.
- 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 may occur. Use a soft, dry cloth to remove stains from the instrument.
- To avoid damage to the instrument display, do not rub with an abrasive material or push the front panel with a hard object.

For Proper Disposal

When disposing of each part used for this instrument, always follows the procedure for disposing of industrial wastes stipulated by the respective local community.

Symbols

■ Pictorial Symbols (safety symbols)



NOTE : 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.

■ Character Symbols

7-segment character

0	1	2	3	4	5	6	7	8	9	Minus	Period
0	1	2	3	4	5	6	7	8	9	-	.
A	B (b)	C	c	D (d)	E	F	G	H	I	J	K
A	b	C	c	d	E	F	G	H	I	J	K
L	M	N (n)	O (o)	P	Q	R	S	T	t	U	u
L	n	n	o	P	q	r	S	T	t	U	u
V	W	X	Y	Z	Degree	/	Prime	*	(Asterisk)		
V	W	X	Y	Z	°	/	'	*			

■ Abbreviation symbols

These abbreviations are used in this manual:

Abbreviation symbols	Name	Abbreviation symbols	Name
PV	Measured value	I	Integral time
SV	Set value	D	Derivative time
SV1	Set value	ARW	Anti-reset windup
SV2	STEP set value	AHS	Transmission output scale high
MV	Heat-side manipulated output value	ALS	Transmission output scale low
MV2	Cool-side manipulated output value	SLH	Setting limiter [high limit]
LBA	Control loop break alarm	SLL	Setting limiter [low limit]
LBD	LBA deadband	TC (input)	Thermocouple (input)
ALM1	Alarm 1	RTD (input)	Resistance temperature detector (input)
ALM2	Alarm 2	V (input)	Voltage (input)
AT	Autotuning	I (input)	Current (input)
ST	Self-tuning	OUT (1, 2)	Output (1, 2)
P	Heat-side proportional band		

Document Configuration

There are four manuals pertaining to this product. Please be sure to read all manuals specific to your application requirements.

The following manuals can be downloaded from the official RKC website:

<https://www.rkcinst.co.jp/english/download-center/>

Manual	Manual Number	Remarks
SA100 Installation Manual	IMR01J09-X□	This manual is enclosed with instrument. This manual explains the mounting and wiring.
SA100 Quick Operation Manual	IMR01J10-E□	This manual is enclosed with instrument. This manual explains the basic key operation, mode menu, and data setting.
SA100 Instruction Manual	IMR01J11-E□	This manual you are reading now. This manual describes installation, wiring, operation of each function, and troubleshooting.
SA100 Communication Instruction Manual	IMR01J12-E1	This manual you are reading now. This manual explains RKC communication protocol (ANSI X3.28-1976) and Modbus relating to communication parameters setting.



Read this manual carefully before operating the instrument. Please place the manual in a convenient location for easy reference.

About This Manual

This manual consists of 7 chapters and an appendix. If you are looking for topics concerning the host communication, you may be able to find one in the following table.

	What do you want to do?	See the following section for more details
<input type="checkbox"/>	I want to know the features of the host communication	1. OUTLINE
<input type="checkbox"/>	I want to know how to connect to the host computer	2. WIRING
<input type="checkbox"/>	I want to know how to set up the communication parameters	3. PARAMETER SETTING
<input type="checkbox"/>	I want to know the content of RKC communication protocol	4. RKC COMMUNICATION PROTOCOL
<input type="checkbox"/>	I want to know the content of Modbus protocol	5. MODBUS PROTOCOL
<input type="checkbox"/>	I want to know how to read the table	4.3.1 How to read the RKC communication identifier list 5.8.1 Reference to Modbus communication identifier list
<input type="checkbox"/>	I want to check RKC communication/Modbus [identifier, data register address, data attribute, data range and factory set values]	4.3.2 RKC communication identifier list 5.8.2 Modbus communication data list
<input type="checkbox"/>	I want to know how to cope with errors	6. TROUBLESHOOTING
<input type="checkbox"/>	I want to know the specification of the host communication	7. SPECIFICATIONS
<input type="checkbox"/>	I want to see the table of ASCII/JIS 7-bit code	A. APPENDIX
<input type="checkbox"/>	I want to see the input range table	A. APPENDIX

Contents

	Page
NOTICE	
Safety Precautions	i-1
■ Pictorial Symbols (safety symbols).....	i-1
WARNING	i-1
CAUTION	i-2
For Proper Disposal.....	i-2
Symbols	i-3
■ Pictorial Symbols (safety symbols).....	i-3
■ Character Symbols	i-3
■ Abbreviation symbols.....	i-4
Document Configuration.....	i-5
About This Manual.....	i-6

1. OUTLINE..... 1-1

Chapter 1 describes the host communication of SA100.

2. WIRING 2-1

Chapter 2 describes how to connect to the host computer.

2.1 Connecting Cautions	2-2
2.2 Connections for Host Communication	2-3
■ Connector pin number and signal details	2-3
■ Wiring method	2-3
■ Wiring example	2-4

3. PARAMETER SETTING 3-1

Chapter 3 describes how to set up parameters necessary for the host communication.

3.1 Communication Setting Mode.....	3-2
3.2 Setting the Communication Parameters	3-3
3.3 Device Address (Slave Address) Setting.....	3-4
3.4 Communication Speed Setting	3-6
3.5 Data Bit Configuration Setting	3-7
3.6 Interval Time Setting.....	3-9
3.7 Communication Protocol Setting	3-11
3.8 Communication Requirements	3-13

4. RKC COMMUNICATION PROTOCOL.....4-1

Chapter 4 describes the RKC communication protocol.

4.1 Polling.....	4-2
4.1.1 Polling procedures	4-3
4.1.2 Polling procedure example.....	4-6
4.2 Selecting.....	4-7
4.2.1 Selecting procedures	4-7
4.2.2 Selecting procedure example.....	4-10
4.3 RKC Communication Identifier List.....	4-11
4.3.1 How to read the RKC communication identifier list.....	4-11
4.3.2 RKC communication identifier list	4-12

5. MODBUS PROTOCOL5-1

Chapter 5 describes the Modbus protocol.

5.1 Message Format.....	5-2
5.2 Function Code	5-3
5.3 Communication Mode.....	5-3
5.4 Slave Responses.....	5-4
5.5 Calculating CRC-16.....	5-5
5.6 Message Format.....	5-7
5.6.1 Read holding registers [03H].....	5-7
5.6.2 Preset single register [06H].....	5-8
5.6.3 Diagnostics (loopback test) [08H]	5-9
5.7 Data Configuration.....	5-10
5.7.1 Data range	5-10
5.7.2 Data processing precautions	5-13
5.8 Modbus Communication Data List.....	5-14
5.8.1 Reference to Modbus communication identifier list	5-14
5.8.2 Modbus communication data list.....	5-15

6. TROUBLESHOOTING.....6-1

Chapter 6 describes how to cope with errors during the communication.

6.1 RKC Communication.....	6-3
6.2 Modbus	6-4

	Page
7. SPECIFICATIONS	7-1

Chapter 7 describes the specification of the host communication.

7.1 RKC Communication.....	7-2
7.2 Modbus	7-3

A. APPENDIX.....	A-1
-------------------------	------------

A.1 ASCII 7-Bit Code Table	A-2
A.2 Input Type Table	A-3
A.3 Input Range Code Tables	A-4

MEMO

OUTLINE



1

This chapter describes the host communication of SA100.

The communication function makes it possible to monitor and set the data of the Temperature Controller SA100 from a host computer. The SA100 interfaces with the host computer via Modbus or RKC communication (ANSI X3.28-1976 subcategories 2.5 and A4) protocols. Communication function is available only when optional communication function has been specified at the time of ordering.

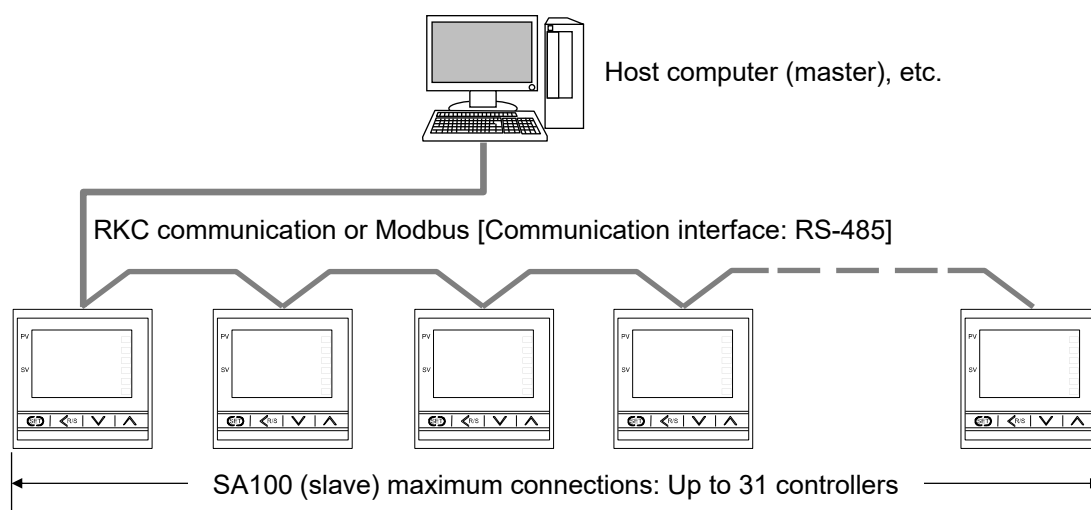
For reference purposes, the Modbus protocol identifies the host computer as master, the controller as slave.

■ Host communication (RKC communication, Modbus) [Optional]

Communication interface: RS-485

● Multi-drop connection

One host computer (master) can communicate with up to 31 SA100s.



■ Communication Tool PROTEM2

PROTEM2 is an integrated configuration support software to manage parameter setting and measured values of our controllers (including SA100).

The PROTEM2 can be downloaded from the official RKC website.

Check our website for more details and operating environment of the PROTEM2.



PROTEM2 requires Microsoft .NET Framework 4.5 or later to be installed on the computer.



PROTEM2 can be used with RKC communication protocol and Modbus protocol.

WIRING

2

This chapter describes how to connect to the host computer.

2.1 Connecting Cautions



WARNING

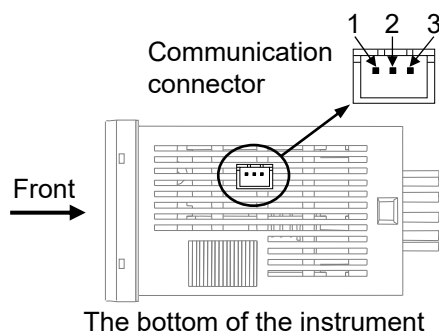
To prevent electric shock or instrument failure, do not turn on the power until all wiring is completed. Make sure that the wiring is correct before applying power to the instrument.

- Connect connectors correctly in the right position. If it is forcibly pushed in with pins in the wrong positions, the pins may be bent resulting in instrument failure.
- When connecting or disconnecting the connectors, do not force it too far to right and left or up and down, but move it on the straight. Otherwise, the connector pins may be bent, causing instrument failure.
- When disconnecting a connector, hold it by the connector itself. Disconnecting connectors by yanking on their cables can cause breakdowns.
- To prevent malfunction, never touch the contact section of a connector with bare hands or with hands soiled with oil or the like.
- To prevent damage to cables, do not bend cables over with excessive force.

2.2 Connections for Host Communication

■ Connector pin number and signal details

Pin No.	Signal name	Symbol
1	Signal ground	SG
2	Send data/Receive data	T/R (A)
3	Send data/Receive data	T/R (B)



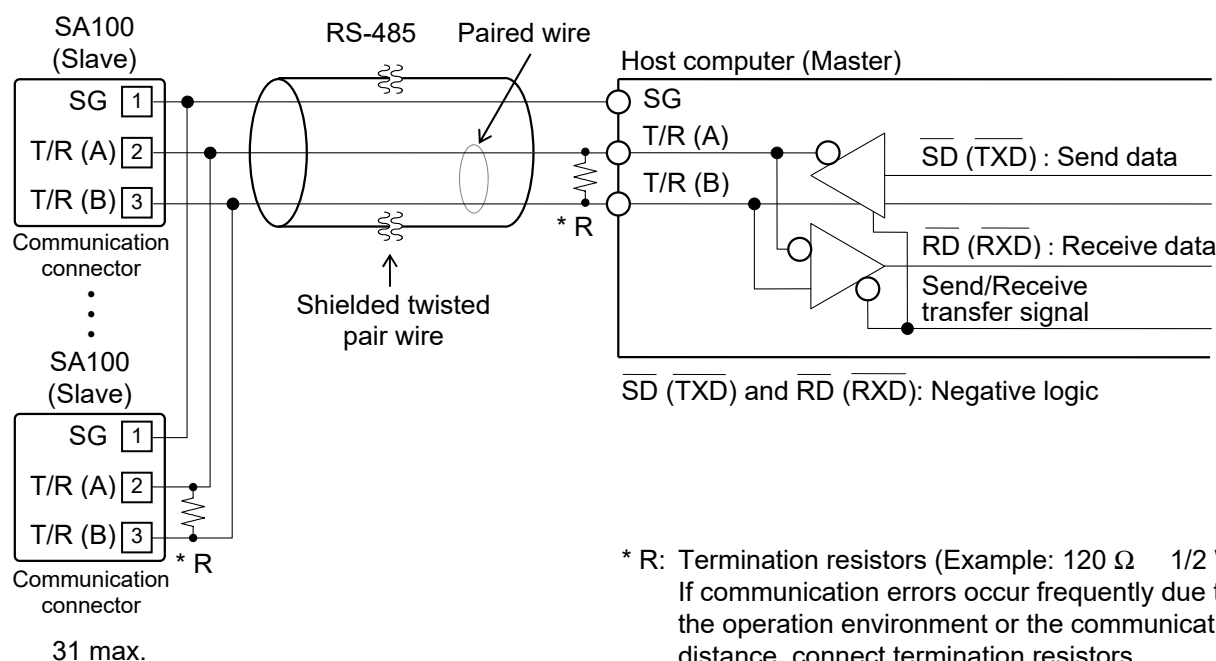
A connector and connector cable for connecting the input block is necessary to be prepared by the customer.

Housing: XHP-3 (J.S.T. Mfg. Co., Ltd. product)

Recommended cable size: AWG 30 to 22

■ Wiring method

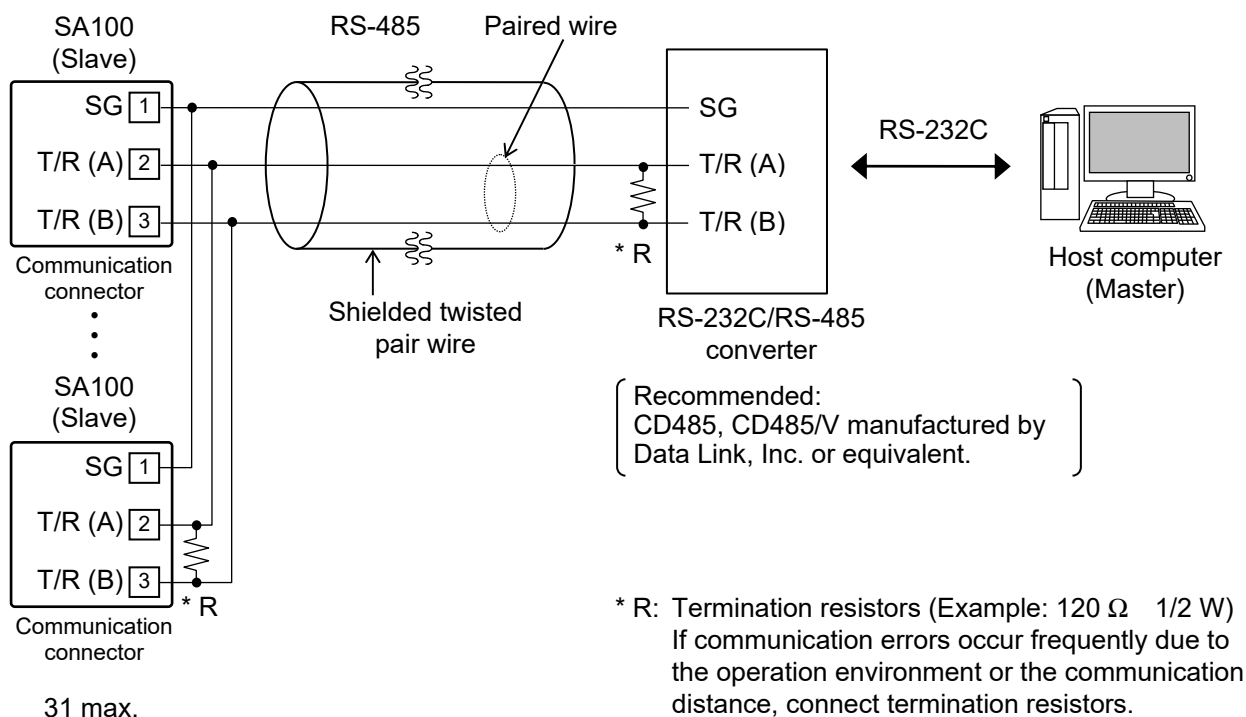
● Connection to the RS-485 port of the host computer (master)



The communication cable and termination resistor(s) must be provided by the customer.

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

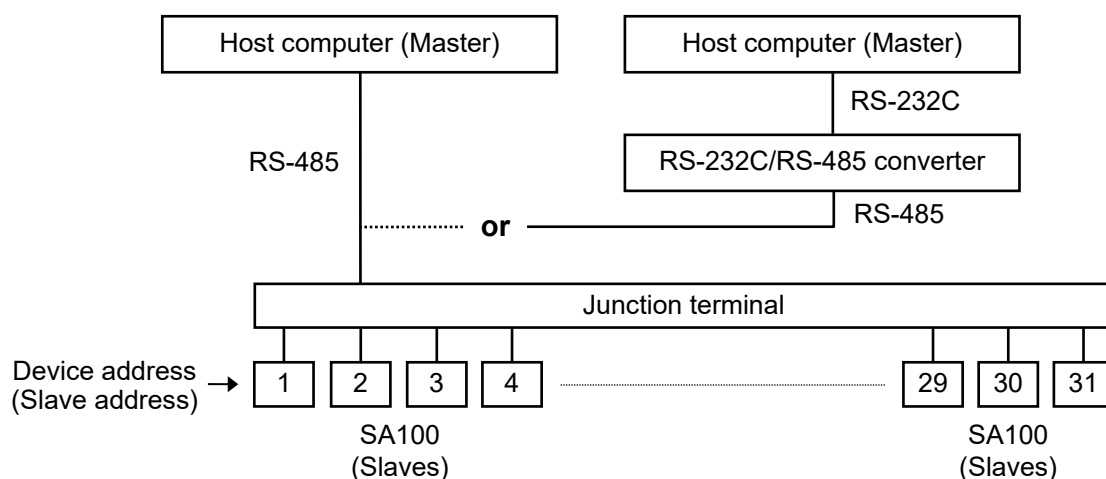
Use a RS-232C/RS-485 converter with an automatic send/receive transfer function.



The communication cable and termination resistor(s) must be provided by the customer.

■ Wiring example

● Connection with up to 31 SA100 (slaves) and one host computer (master)



PARAMETER SETTING

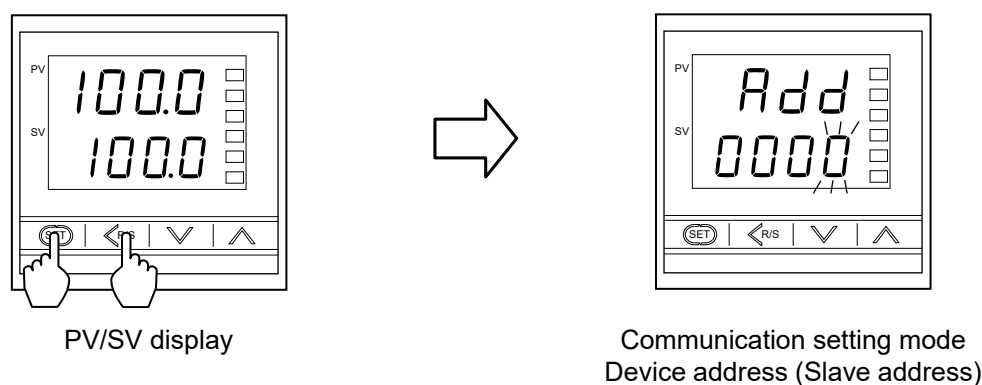
3

This chapter describes how to set up parameters necessary for the host communication.

To establish communication parameters between host computer (master) and SA100 (slave), it is necessary to set the device address (slave address), Communication speed, Data bit configuration and Interval time on each SA100 (slave) in the communication mode.

3.1 Communication Setting Mode

1. When the power to the SA100 is turned on, the input type, input range and PV/SV display will be automatically displayed in that order.
2. To go to the Communication setting mode, you must be in PV/SV display. Press and hold the SET key and press the <R/S key at the same time to initiate communication settings. The first parameter to be displayed will be the Device address (slave address), *Add*.

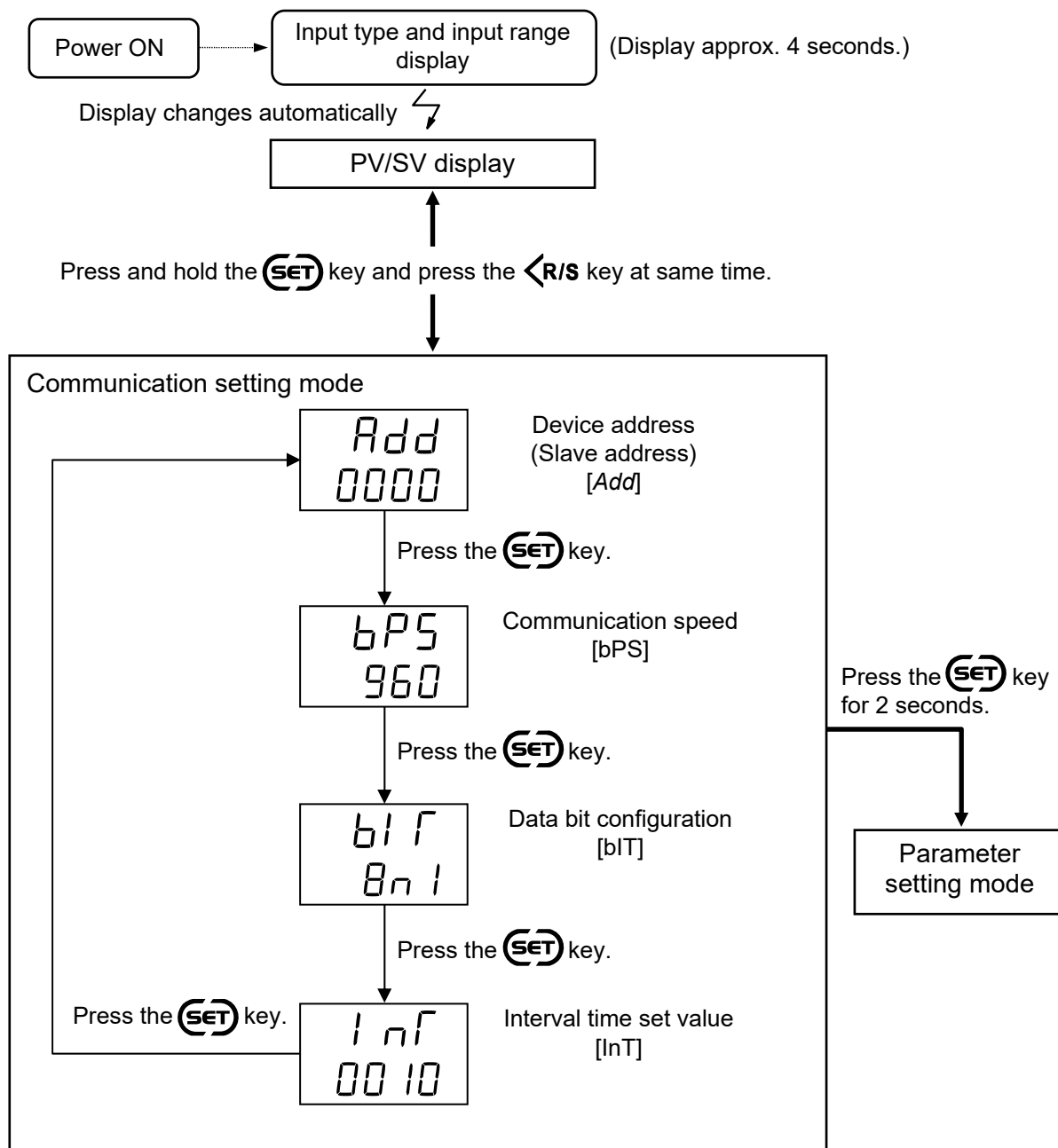


To return to the PV/SV display, press and hold the SET key and press the <R/S key at the same time. When the Communication setting mode is done, the display changes to the PV/SV display.

3.2 Setting the Communication Parameters

To select parameters in communication setting mode, press the SET key. The parameters are displayed and sequenced in the order of Device address (slave address), *Add*, Communication speed, *bPS*, Data bit configuration, *bIT* and Interval time set value, *InT*.

■ Display flowchart



The Communication protocol is set as specified at the time of ordering. If necessary, the factory set value can be changed. The Communication protocol can be changed by the “Communication protocol selection” in the Engineering mode. (See P. 3-11)

3.3 Device Address (Slave Address) Setting

The Device address (slave address) must be set before communication can begin. The Device address (slave address) number is set with numbers from 0 to 99.

Symbol	Name	Setting range	Description	Factory set value
<i>Add</i>	Device address (Slave address)	0 to 99	Set the SA100 device address (slave address).	0
Add				



NOTE

- If the slave address is set to 0 in Modbus communication, two-way communication cannot be performed.
- When the communication parameter is changed, turn the power on and off again or switch from STOP to RUN to refresh and make the new value effective. If neither action is taken, the SA100 will maintain the set value prior to change.



All device address (slave address) settings must be stored by pressing the SET key. If changes are made and the SET key is not pressed within one minute, the display will automatically return to the PV/SV display and the device address (slave address) will return to the value prior to set change.

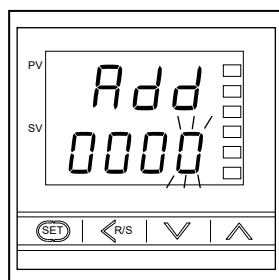
■ Setting procedure

Example: When setting the Device address (slave address) to 15.

1. Go to the Communication setting mode so that Device address (slave address), *Add*, is displayed.

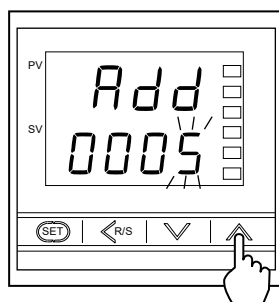


Refer to **3.1 Communication Setting Mode (P. 3-2)**, **3.2 Setting the Communication Parameters (P. 3-3)**.

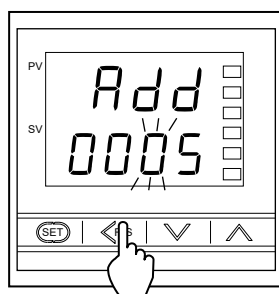


Device address (Slave address)

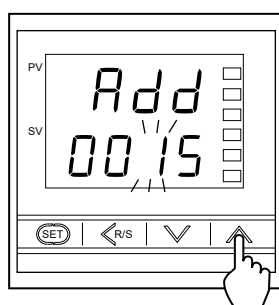
2. Press the UP key to enter 5 at the first digit from the right.



3. Press the <R/S key to blink the second digit from the right.



4. Press the UP key to enter *l* at the second digit from the right.



5. Press the SET key to store the new Device address (slave address). The display automatically goes to the next communication parameter, *bPS*.

3.4 Communication Speed Setting

The Communication speed of 2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps or 57600 bps is selectable. To select the speed of the *bPS* setting, press the UP or DOWN key.

Symbol	Name	Setting range	Description	Factory set value
<i>bPS</i>	Communication speed	240: 2400 bps	Select the communication speed	960
bPS		480: 4800 bps 960: 9600 bps 1920: 19200 bps 3840: 38400 bps 5760: 57600 bps		



NOTE

- Set the same communication speed for both the SA100 (slave) and the host computer (master).
- When the Communication parameter is changed, turn the power on and off again or switch from STOP to RUN to refresh and make the new value effective. If neither action is taken, the SA100 will maintain the set value prior to change.



All Communication speed settings must be stored by pressing the SET key. If changes are made and the SET key is not pressed within one minute, the display will automatically return to the PV/SV display and the Communication speed will return to the value prior to set change.

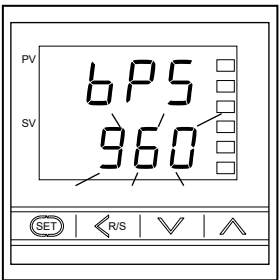
■ Setting procedure

Example: Setting Communication speed 480: 4800 bps.

1. Go to the Communication setting mode so that slave address, *Add*, is displayed. Then, press the SET key twice, so the communication speed symbol, *bPS*, appears.

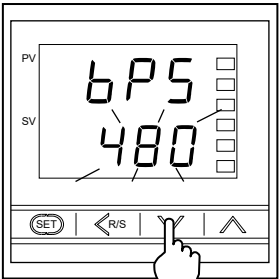


Refer to **3.1 Communication Setting Mode (P. 3-2)**, **3.2 Setting the Communication Parameters (P. 3-3)**.



Communication speed

2. Press the DOWN key to set *480*.



3. Press the SET key to store the new Communication speed. The display automatically goes to the next communication parameter, *bIT*.

3.5 Data Bit Configuration Setting

To select the Data bit configuration setting, press the UP or DOWN key.

Symbol	Name	Setting range	Description	Factory set value
	Data bit configuration	Refer to Data bit configuration table .	Select Data bit configuration during communication	8n1
bIT				

Data bit configuration table

Setting	Data bit	Parity bit	Stop bit
7n1 (7n1)	7	None	1
7n2 (7n2)	7	None	2
7E1 (7E1)	7	Even	1
7E2 (7E2)	7	Even	2
7o1 (7o1)	7	Odd	1
7o2 (7o2)	7	Odd	2
8n1 (8n1)	8	None	1
8n2 (8n2)	8	None	2
8E1 (8E1)	8	Even	1
8E2 (8E2)	8	Even	2
8o1 (8o1)	8	Odd	1
8o2 (8o2)	8	Odd	2

: Not settable for Modbus

NOTE

- Set the same Data bit configuration for both the SA100 (slave) and the host computer (master).
- When the communication parameter is changed, turn the power on and off again or switch from STOP to RUN to refresh and make the new value effective. If neither action is taken, the SA100 will maintain the set value prior to change.



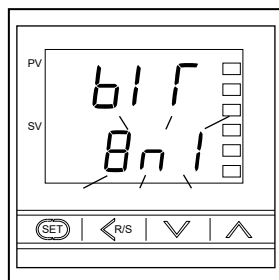
All Data bit configuration settings must be stored by pressing the SET key. If changes are made and the SET key is not pressed within one minute, the display will automatically return to the PV/SV display and the Data bit configuration will return to the value prior to set change.

■ Setting procedure

Example: When setting the Data bit configuration to “Data bit: 8, Parity bit: Odd, Stop bit: 1.”

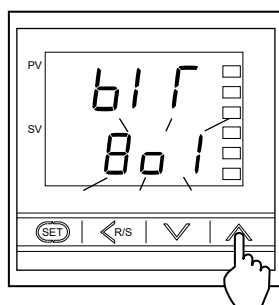
1. Go to the Communication setting mode so that Device address (slave address), *Add*, is displayed. Then, press the SET key once, so the Data bit configuration symbol, *bIT*, appears.

☞ Refer to **3.1 Communication Setting Mode (P. 3-2)**, **3.2 Setting the Communication Parameters (P. 3-3)**.



Data bit configuration


2. Press the Up key to set “8o1.”



3. Press the SET key to store the new Data bit configuration. The display automatically goes to the next communication parameter, *InT*.

3.6 Interval Time Setting

The interval time is set with numbers from 0 to 250 ms. To shift the digit, press the <R/S key. To change the number of the digit, press the UP or DOWN key.

Symbol	Name	Setting range	Description	Factory set value
 InT	Interval time set value	0 to 250 ms	Set the value to set the interval time	10



NOTE

When the communication parameter is changed, turn the power on and off again or switch from STOP to RUN to refresh and make the new value effective. If neither action is taken, the SA100 will maintain the set value prior to change.



All interval times must be stored by pressing the SET key. If changes are made and the SET key is not pressed within one minute, the display will automatically return to the PV/SV display and the interval time will return to the value prior to set change.

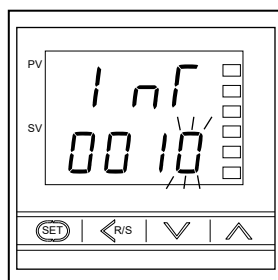
■ Setting procedure

Example: When setting the Interval time set value to “25.”

1. Go to the Communication setting mode so that slave address, *Add*, is displayed. Press the SET key until the interval time symbol, *InT*, appears.

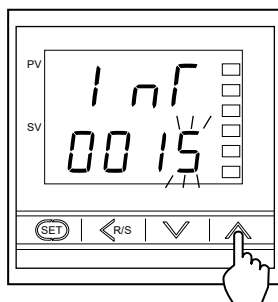


Refer to 3.1 Communication Setting Mode (P. 3-2), 3.2 Setting the Communication Parameters (P. 3-3).

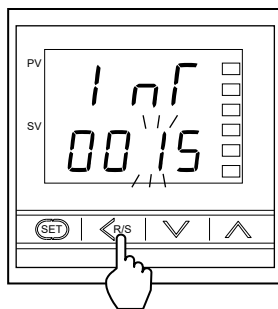


Interval time set value

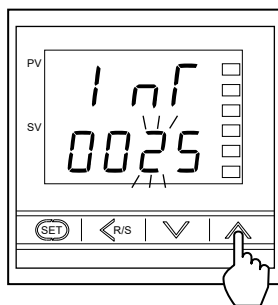
2. Press the UP key to enter 5 at the first digit from the right.



3. Press the <R/S key to blink the second digit from the right.



4. Press the UP key to enter 2 at the second digit from the right.



5. Press the SET key to store the new Interval time set value. The display automatically goes to the next communication parameter, *Add*.

3.7 Communication Protocol Setting

WARNING

The communication protocol is shipped setting the communication protocol specified by the customer at the time of ordering.
The communication protocol does not need to be changed in normal use.
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.

There are two types of communication protocols. Either RKC communication or Modbus can be selected.

■ Setting procedure

Example: Change the communication protocol from the RKC communication to Modbus



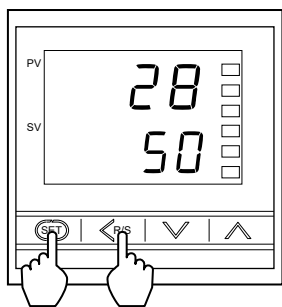
NOTE

The Parameters in the Engineering mode can be changed in the STOP state.

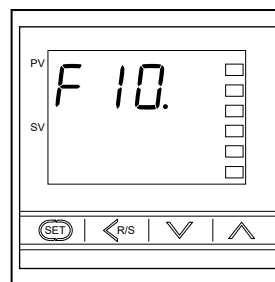


To go to the Engineering mode, refer to **SA100 Quick Operation Manual (IMR01J10-E□)**.

1. Press the <R/S key while pressing the SET key for 2 seconds or more in the PV/SV display mode until the Engineering mode is displayed.
Press the <R/S key while pressing the SET key for 2 seconds or more at PV/SV display mode until Engineering mode is displayed.

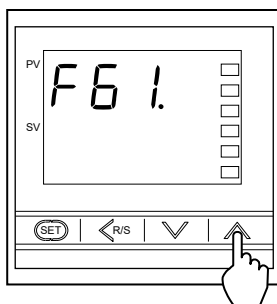


PV/SV display mode



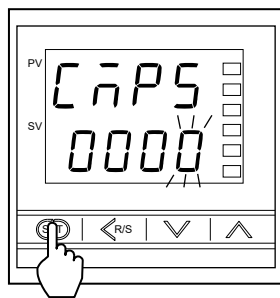
Engineering mode

2. Press the down key several times until Function block 61 will be displayed.



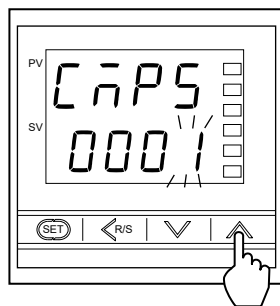
Function block 61

3. Press the SET key to change to the communication protocol selection display.



Communication protocol selection

4. Press the UP key to enter 1 at the least significant digit.



Setting range:
0000: RKC communication
0001: Modbus

5. Press the SET key to store the new communication protocol. The display automatically goes to the next communication parameter, *F61*.

3.8 Communication Requirements

■ Processing times during data send/receive

The SA100 requires the following processing times during data send/receive.

Whether the host computer is using either the polling or selecting procedure for communication, the following processing times are required for SA100 to send data:

- Response wait time after SA100 sends BCC in polling procedure
- Response wait time after SA100 sends ACK or NAK in selecting procedure



Response send time is time at having set interval time in 0 ms.

RKC communication (Polling procedure)

Procedure details	Time (ms)		
	MIN	TYP	MAX
Response send time after SA100 receives ENQ	1.6	4.0	12
Response send time after SA100 receives ACK	1.6	–	10
Response send time after SA100 receives NAK	1.6	–	10
Response send time after SA100 sends BCC	–	–	1.0

RKC communication (Selecting procedure)

Procedure details	Time (ms)		
	MIN	TYP	MAX
Response send time after SA100 receives BCC	1.6	3.0	10
Response wait time after SA100 sends ACK	–	–	1.0
Response wait time after SA100 sends NAK	–	–	1.0

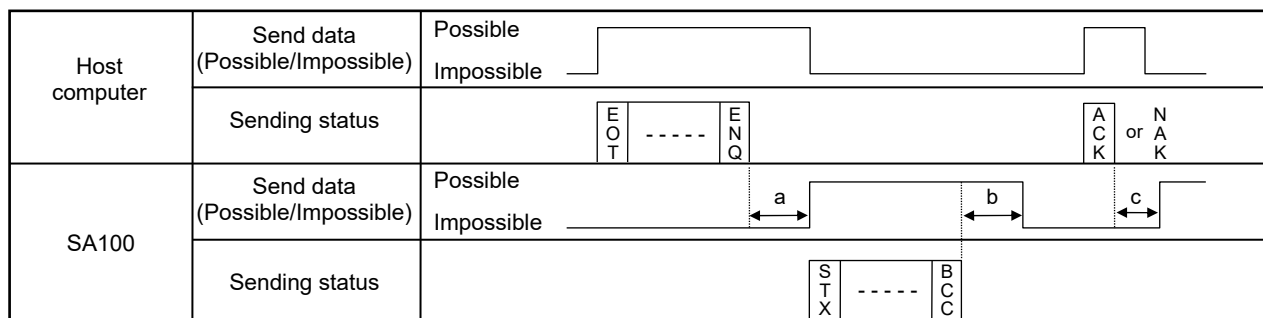
Modbus

Procedure details	Time (ms)
Read holding registers [03H] Response transmission time after the slave receives the query message	13 ms max.
Preset single register [06H] Response transmission time after the slave receives the query message	6 ms max.
Diagnostics (loopback test) [08H] Response transmission time after the slave receives the query message	6 ms max.

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

The sending and receiving of RS-485 communication is conducted through two wires; consequently, the transmission and reception of data requires precise timing. Typical polling and selecting procedures between the host computer and SA100 are described below:

● Polling procedure

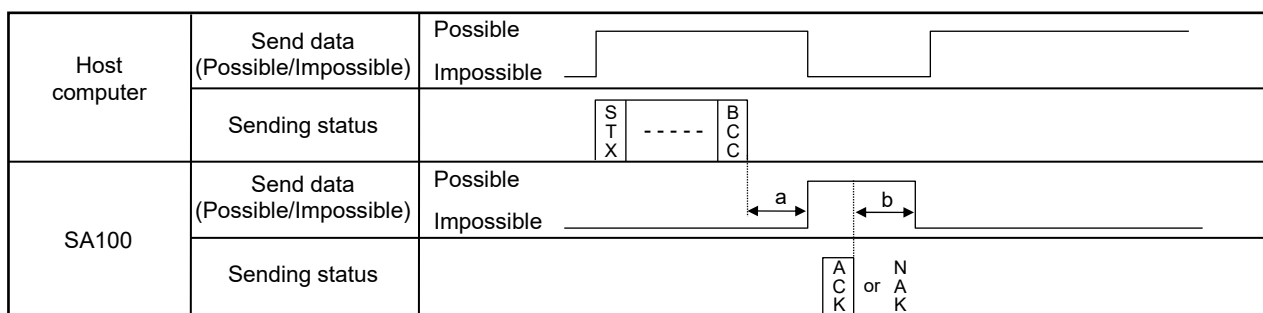


(a): Response send time after the SA100 receives ENQ + Interval time

(b): Response send time after the SA100 sends BCC

(c): Response send time after the SA100 receives ACK + Interval time or
Response send time after the SA100 receives NAK + Interval time

● Selecting procedure



(a): Response send time after the SA100 receives BCC + Interval time

(b): Response wait time after the SA100 sends ACK or Response wait time after SA100 sends NAK



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



Whether the host computer is using either the polling or selecting procedure for communication, the following processing times are required for SA100 to send data:

- Response wait time after SA100 sends BCC in polling procedure
- Response wait time after SA100 sends ACK or NAK in selecting procedure

■ Fail-safe

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

RKC COMMUNICATION PROTOCOL

4

This chapter describes the RKC communication protocol.

The temperature controller SA100 (hereinafter, 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.



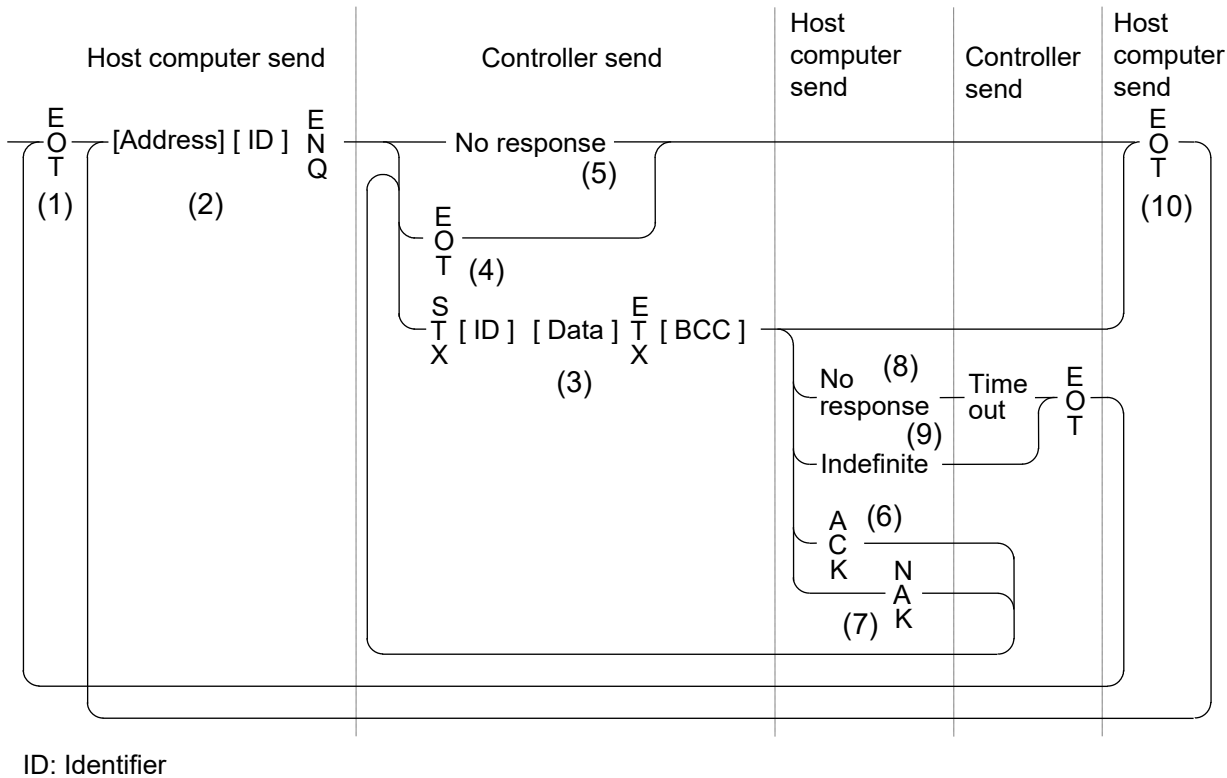
Data send/receive state (communication data monitoring and setting) of RKC communication can be checked by using the following software:

- Communication Tool “PROTEM2”

The PROTEM2 can be downloaded from the official RKC website.

4.1 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:



4.1.1 Polling procedures

(1) Data link initialization

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

(2) Data sent from host computer - Polling sequence

Host computer sends polling sequence with the format shown below:



1. Device address (2 digits)
The device address specifies the controller to be polled and each controller must have its own unique device address.
👉 Refer to **3.3 Device Address (Slave Address) Setting (P. 3-4)**.
2. Identifier (2 digits)
The identifier specifies the type of data that is requested from the controller.
👉 Refer to **4.3 RKC Communication Identifier List (P. 4-11)**.
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.
👉 Refer to **4.3 RKC Communication Identifier List (P. 4-11)**.
3. Data (6 digits [Expect model code.])
Data is the information being sent from the controller. It is expressed in decimal ASCII code including a minus sign (–) and a decimal point. No zero suppression is made.

4. ETX

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

5. BCC

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

Calculation method of BCC:

Exclusive OR all data and characters from STX through ETX, not including STX.

Example:

STX	M	1	0	0	0	5	0	0	ETX	BCC
4DH	31H	30H	30H	30H	35H	30H	30H	03H	←	Hexadecimal numbers

$$\text{BCC} = 4\text{DH} \oplus 31\text{H} \oplus 30\text{H} \oplus 30\text{H} \oplus 30\text{H} \oplus 35\text{H} \oplus 30\text{H} \oplus 30\text{H} \oplus 03\text{H} = 7\text{AH}$$

Value of BCC becomes 7AH.

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

In the following cases, the controller sends EOT to terminate 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 details of identifier, Refer to **4.3 RKC Communication Identifier List (P. 4-11)**.

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.

(9) Indefinite response from host computer

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

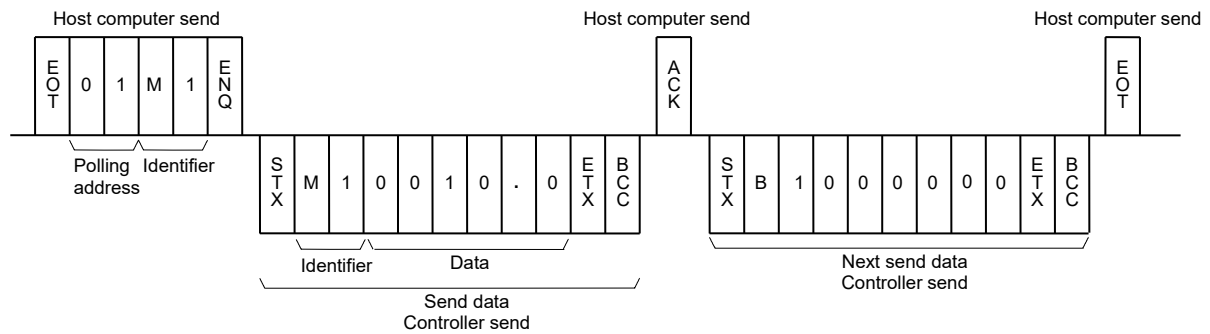
(10) EOT (Data link termination)

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.

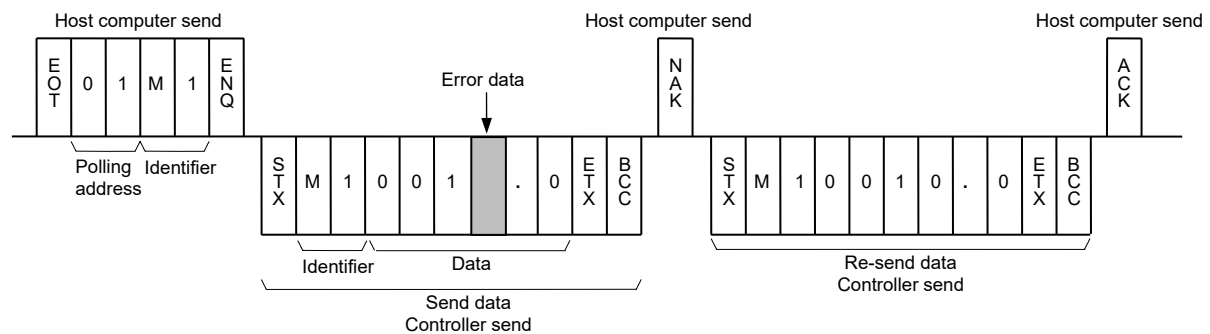
4.1.2 Polling procedure example

Example: When the Measured value (identifier: M1) is polled

■ Normal transmission

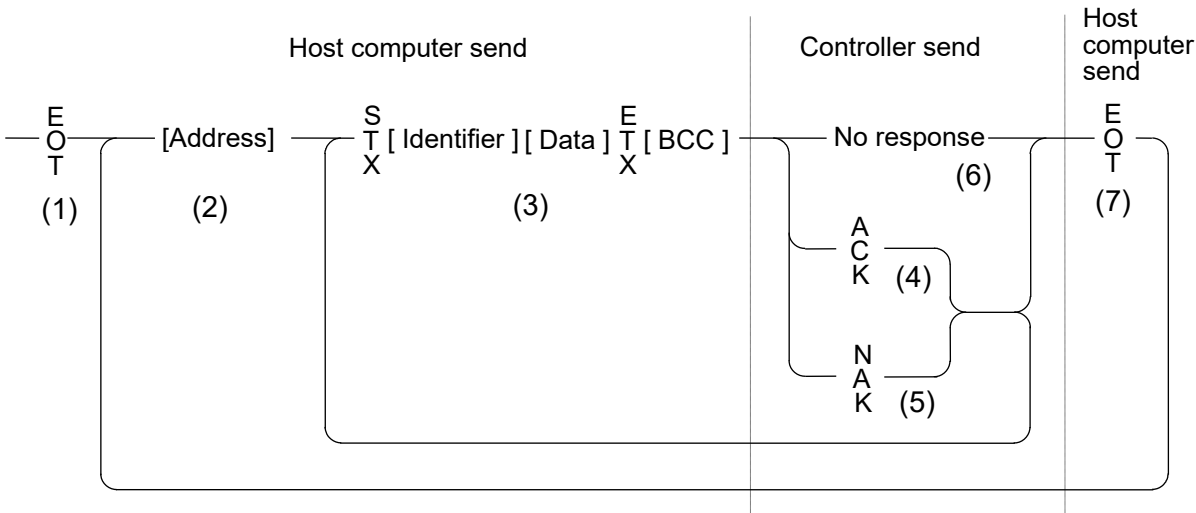


■ Error transmission



4.2 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:



4.2.1 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.

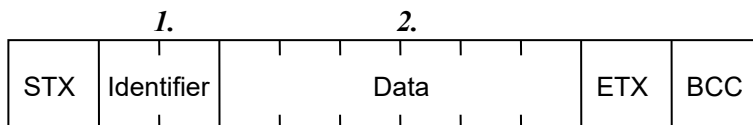
Device address (2 digits)

The device address specifies the controller to be selected and each controller must have its own unique device address.

 Refer to **3.3 Device Address (Slave Address) Setting (P. 3-4)**.

(3) Data sent from the host computer

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



 For the STX, ETX and BCC, refer to item **4.1 Polling (P. 4-2)**.

1. Identifier (2 digits)

The identifier specifies the type of data that is requested from the controller, such as set value.

 Refer to **4.3 RKC Communication Identifier List (P. 4-11)**.

2. Data (Maximum 6 digits)

Data is the information being sent to the controller. It is expressed in decimal ASCII code including a minus sign (–) and a decimal point (period).

● About numerical data

The data that receipt of letter is possible

- Data with numbers below the decimal point omitted or zero suppressed data can be received.

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

- When the host computer send data with decimal point to item of without decimal point, controller receives a message with the value which cut off below the decimal point.

<Example> When setting range is 0 to 200, controller receives as a following.

Send data	0.5	100.5
Receive data	0	100

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

<Example> When setting range is -10.00 to +10.00, controller receives as a following.

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

The data that receipt of letter is impossible

Controller sends NAK when received a following data.

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

(4) ACK (Acknowledgment)

An acknowledgment ACK is sent by the 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 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 error, framing error, etc.)
- When a BCC check error occurs
- When the specified identifier is invalid
- When receive data exceeds the setting range

(6) No response from controller

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

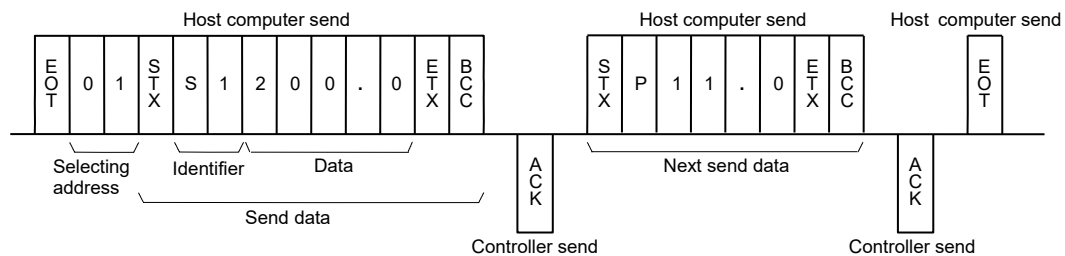
(7) EOT (Data link termination)

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.

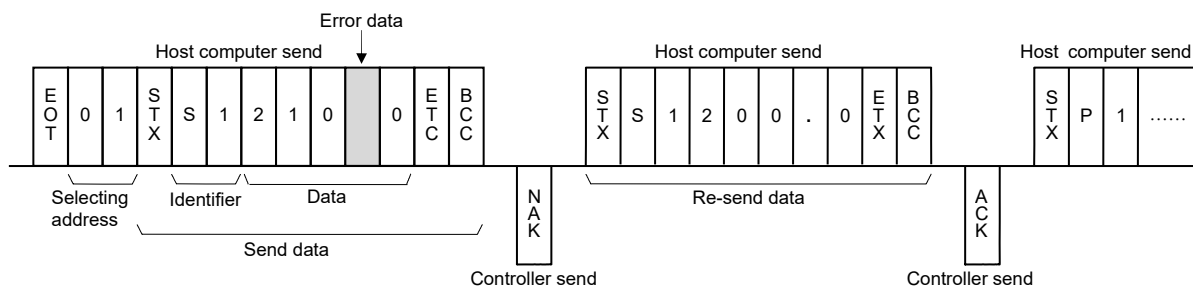
4.2.2 Selecting procedure example

Example: When the Set value (identifier: S1) is selected

■ Normal transmission



■ Error transmission



4.3 RKC Communication Identifier List

4.3.1 How to read the RKC communication identifier list

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
1	Model code	ID	32	RO	Model code (character)	—
2	Measured value (PV) display	M1	6	RO	Within input range. [Setting limiter [low limit] – (5 % of span) to Setting limiter [high limit] + (5 % of span)] Varies with the setting of the Decimal point position.	—

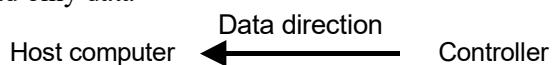
(1) Name: Communication data name

(2) Identifier: Communication identifier of RKC communication

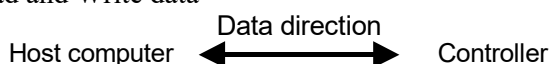
(3) Digits: The number of maximum digits

(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

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

4.3.2 RKC communication identifier list

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
1	Model code	ID	32	RO	Model code (character)	—
2	Measured value (PV) display	M1	6	RO	Within input range. [Setting limiter [low limit] – (5 % of span) to Setting limiter [high limit] + (5 % of span)] Varies with the setting of the Decimal point position.	—
3	Burnout	B1	6	RO	0: OFF 1: ON	—
4	Alarm 1 status	AA	6	RO	0: OFF 1: ON	—
5	Alarm 2 status	AB	6	RO	0: OFF 1: ON	—
6	Heat-side manipulated output value (MV)	O1	6	RO	–5.0 to +105.0 %	—
7	Cool-side manipulated output value (MV2)	O2	6	RO	–5.0 to +105.0 %	—
8	Error code ¹	ER	6	RO	0: No error 1: Adjustment data 2: EEPROM error 4: A/D conversion error 8: RAM check error 128: Watchdog timer error When multiple items are applicable, they are summed up.	—
9	RUN/STOP function	SR	6	R/W	0: RUN 1: STOP	0
10	Autotuning (AT)	G1	6	R/W	0: AT end or cancel 1: AT start or execution After AT is completed, setting will automatically change to 0.	0
11	Self-tuning (ST)	G2	6	R/W ²	0: Self-tuning OFF 1: Self-tuning ON	0
12	Set value (SV) setting	S1	6	R/W	Within input range. (Setting limiter [low limit] to Setting limiter [high limit]) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
13	Alarm 1 (ALM1)	A1	6	R/W ³	Process alarm, SV alarm: Same as input range (Setting limiter [low limit] to Setting limiter [high limit])	TC/RTD inputs: 50 (50.0) Voltage/Current inputs: 5.0
14	Alarm 2 (ALM2)	A2	6	R/W ⁴	Deviation alarm: –Span to +Span (However, within –1999 to +9999 digits) Varies with the setting of the Decimal point position.	TC/RTD inputs: 50 (50.0) Voltage/Current inputs: 5.0

¹ Any number other than 0 indicates errors (RAM write error, etc.) detected by the controller selfdiagnosis function. Please contact RKC sales office or the agent.

² If the Heat/Cool PID control with autotuning (water cooling/air cooling) is selected, or the set value of any one of the Heat/Cool proportional band, Integral time, Derivative time and Anti-reset windup is set to 0, the attribute becomes RO.

³ If “No alarm” is selected for Alarm 1 [ALM1] or if “Control loop break alarm (LBA)” is selected for Alarm 1 [ALM1], the attribute becomes RO.

⁴ If “No alarm” for Alarm 2 [ALM2] is selected, the attribute becomes RO.

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
15	Control loop break alarm (LBA)	A5	6	R/W ¹	0.0 to 200.0 minutes (0.0: OFF)	8.0
16	LBA deadband (LBD) ²	A6	6	R/W ¹	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
17	Heat-side proportional band (P)	P1	6	R/W	0 (0.0) to Span (However, 9999 digits or less) 0 (0.0): ON/OFF action Varies with the setting of the Decimal point position. Cannot be written while the self-tuning (ST) function is on, only Read is available.	TC/RTD inputs: 30 (30.0) Voltage/Current inputs: 3.0
18	Integral time (I)	I1	6	R/W	0 to 3600 seconds (0: PD action) Cannot be written while the self-tuning (ST) function is on, only Read is available.	240
19	Derivative time (D)	D1	6	R/W	0 to 3600 seconds (0: PI action) Cannot be written while the self-tuning (ST) function is on, only Read is available.	60
20	Anti-reset windup (ARW)	W1	6	R/W	0 to 100 % of heat-side proportional band (0: Integral action OFF) Cannot be written while the self-tuning (ST) function is on, only Read is available.	100
21	Heat-side proportioning cycle time	T0	6	R/W	1 to 100 seconds	Relay contact output: 20 Voltage pulse output: 2
22	Cool-side proportional band	P2	6	R/W ³	1 to 1000 % of heat-side proportional band	100
23	Overlap/Deadband	V1	6	R/W ³	–Span to +Span (However, within –1999 to +9999 digits) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
24	Cool-side proportioning cycle time	T1	6	R/W ³	1 to 100 seconds	Relay contact output: 20 Voltage pulse output: 2
25	PV bias	PB	6	R/W	–Span to +Span (However, within –1999 to +9999 digits) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
26	Digital filter	F1	6	R/W	0 to 100 seconds (0: Digital filter OFF)	0

¹ If “Control loop break alarm (LBA)” for Alarm 1 (ALM1) is not selected, the attribute becomes RO.

² Abbreviation of “Control loop break alarm deadband”

³ If Heat/Cool PID control with autotuning (water cooling/air cooling) for control type is not selected, the attribute becomes RO.

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
27	Set data lock (LCK)	LK	6	R/W	0 to 15 ¹	0
28	EEPROM storage mode ²	EB	6	R/W	0: Backup mode (Set values are store to the EEPROM) 1: Buffer mode (No set values are store to the EEPROM)	0

¹ Details of set data lock function

×: Settable-Data unlocked

–: Unsettable-Data locked

Set data	Setting items of Engineering mode	Set value (SV)	Alarm set value (Alarm 1, Alarm 2)	Other setting items
0	–	×	×	×
1	–	×	×	–
2	–	×	–	×
3	–	×	–	–
4	–	–	×	×
5	–	–	×	–
6	–	–	–	×
7	–	–	–	–
8	×	×	×	×
9	×	×	×	–
10	×	×	–	×
11	×	×	–	–
12	×	–	×	×
13	×	–	×	–
14	×	–	–	×
15	×	–	–	–

The data lock function only prevents setting changes being made from the front keys. Setting changes can still be made through communication transmission.

² The non-volatile memory (EEPROM) has limitations on the number of memory rewrite times. If the buffer mode is selected as an EEPROM storage mode, all of the set values changed are not written to the EEPROM and thus a problem of limitations on the number of memory rewrite times can be solved. When the memory is used to frequently change the set value via communication, select the buffer mode.

When selecting any EEPROM storage mode, take notice of the following.

- If power failure occurs while the buffer mode is selected, the set value returns to the value before the storage mode is selected.
- If the buffer mode is changed to the backup mode, all of the set values at that time are stored to the EEPROM. If necessary to backup the final value of each set item, select the backup mode.
- When the power is turned on, the backup mode is always set.

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
29	EEPROM storage status ¹	EM	6	RO	0: Mismatch 1: Match	—
30	PV ratio (Pr)	PR	6	R/W ²	0.500 to 1.500 times	1.000
31	Transmission output (AO) specification	LA	6	R/W ³	0: Measured value (PV) 1: Set value (SV) 2: Deviation (DEV) 3: Manipulated output value (MV)	0
32	Transmission output scale high (AHS)	HV	6	R/W ³	Measured value (PV), Set value (SV): Same as input range * [Transmission output scale low to Setting limiter (high limit)] Deviation (DEV): –Span to +Span * (However, within –1999 to +9999 digits) [Transmission output scale low to +Span] Manipulated output value (MV): 0.0 to 100.0 % [Transmission output scale low to 100.0 %] Varies with the setting of the Decimal point position.	TC/RTD inputs: Input range (high limit) Voltage/Current inputs: 100.0
33	Transmission output scale low (ALS)	HW	6	R/W ³	Measured value (PV), Set value (SV): Same as input range * [Setting limiter (low limit) to Transmission output scale high] Deviation (DEV): –Span to +Span * (However, within –1999 to +9999 digits) [–Span to Transmission output scale high] Manipulated output value (MV): 0.0 to 100.0 % [0.0 % to Transmission output scale high] * Varies with the setting of the Decimal point position.	TC/RTD inputs: Input range (low limit) Voltage/Current inputs: 0.0
34	Setting change rate limiter (Up)	HH	6	R/W ⁴	TC/RTD inputs: 0 (0.0) to Span °C [°F]/unit time (However, 9999 digits or less) Voltage/Current inputs: 0 (0.0) to Span/unit time (However, 9999 digits or less)	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
35	Setting change rate limiter (Down)	HL	6	R/W ⁴	0 (0.0): Limiter OFF Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0

¹ The contents of the buffer memory and those of the EEPROM can be checked.

When data is 0: The contents of the buffer memory do not match with those of the EEPROM.

- As data is being written to the EEPROM in backup mode, do not turn the power off. If turned off, no set values are stored.
- If the set value is changed after the backup mode is changed to the buffer mode, 0 is set (mismatch). As the set value changed is not backup, select the backup mode if necessary.

When data is 1: The contents of the buffer memory match with those of the EEPROM.
(Data write to the EEPROM is completed.)

² If the PV ratio function selection is not set to “PV ratio function enabled,” attribute becomes RO.

³ If the Output 1 (OUT1) is a transmission output, the attribute is R/W and is RO for all other cases.

⁴ If the Setting change rate limiter Used/Unused is not set to “Used,” the attribute becomes RO.

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
36	Set value (SV) display while the setting change rate limiter function	MS	6	RO	Within input range. (Setting limiter [low limit] to Setting limiter [high limit]) Varies with the setting of the Decimal point position.	—
37	Alarm interlock release (ILr)	IR	6	R/W	0: Alarm interlock release state ¹	—
38	STOP display screen selection ²	DX	6	R/W	0: It makes display “STOP” in PV display. 1: It makes display “STOP” in SV display. 2: No selection from RUN to STOP by the front key can be made.	0
39	Monitor display configuration selection ²	DW	6	R/W	0: PV/SV display 1: Only PV display 2: Only SV display	0
40	MV display selection ²	DV	6	R/W	0: MV display not provided 1: MV display provided	0
41	Input type selection ²	XI	6	R/W	0: Thermocouple K ³ 1: Thermocouple J ³ 2: Thermocouple R ³ 3: Thermocouple S ³ 4: Thermocouple B ³ 5: Thermocouple E ³ 6: Thermocouple N ³ 7: Thermocouple T ³ 8: Thermocouple C (W5Re/W26Re) ³ 9: Thermocouple PL II ³ 10: Thermocouple U ³ 11: Thermocouple L ³ 12: RTD Pt100 ³ 13: RTD JPt100 ³ 14: Voltage 0 to 5 V DC or Current 0 to 20 mA DC ^{3,4} 15: Voltage 1 to 5 V DC or Current 4 to 20 mA DC ^{3,4} 16: Voltage 0 to 10 V DC ³	Factory set value varies depending on the instrument specification.
42	Display unit selection ²	PU	6	R/W	0: °C 1: °F	0
43	Decimal point position setting ²	XU	6	R/W	0: No digit below decimal point 1: 1 digit below decimal point 2: 2 digits below decimal point 3: 3 digits below decimal point	Factory set value varies depending on the instrument specification.
44	Setting limiter [high limit] ²	XV	6	R/W	–1999 to +9999 • Set the Setting limiter by referring to the “A.3 Input Range Code Tables” (P. A-4). • This instrument sets the input range with the Setting limiter. Please note that changing the Setting limiter will also change the input range.	Factory set value varies depending on the instrument specification.
45	Setting limiter [low limit] ²	XW	6	R/W		Factory set value varies depending on the instrument specification.

¹ The interlock is released by setting the “0.” In the read state, becomes “1.”



NOTE

Release the alarm interlock with the alarm OFF state.

² This communication data will be RO when this instrument is in the RUN state.

³ Input type (TC/RTD to voltage/current inputs or voltage/current inputs to TC/RTD) cannot be changed because the hardware is different.

⁴ For the current input specification, a resistor of 250 Ω must be connected between the input terminals.

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
46	Selection of output logic calculation ¹ (Output logic operation selection)	LO		R/W	1: OUT1: Control output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (Energized) 2: OUT1: Heat-side control output OUT2: Cool-side control output 3: OUT1: Control output OUT2: Alarm 1 output (De-energized) ⁴ 4: OUT1: Control output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (Energized) 5: OUT1: Control output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (De-energized) 6: OUT1: Control output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (De-energized) 7: OUT1: Control output OUT2: Not output ³ 8: OUT1: Control output OUT2: Alarm 1 output only (Energized) ⁴ 9: OUT1: Alarm 1 output (Energized) OUT2: Alarm 2 output (Energized) 10: OUT1: Alarm 1 output (Energized) OUT2: Alarm 2 output (De-energized) 11: OUT1: Alarm 1 output (De-energized) OUT2: Alarm 2 output (De-energized) 12: OUT1: Transmission output OUT2: Control output 13: OUT1: Transmission output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (Energized) 14: OUT1: Transmission output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (De-energized) 15: OUT1: Transmission output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (Energized) 16: OUT1: Transmission output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (De-energized) 17: OUT1: Transmission output OUT2: Alarm 1 output (Energized) 18: OUT1: Transmission output OUT2: Alarm 1 output (De-energized) 19: OUT1: Cool-side control output (In case of direct action or reverse action, it is OFF). OUT2: Heat-side control output	Factory set value varies depending on the instrument specification. ²

¹ This communication data will be RO when this instrument is in the RUN state.

² Factory set value when an Output assignment code is not specified at the time of ordering:

The output assignment code is set to either of the following according to the control action specified at the time of ordering.

- PID action with autotuning: 1
- Heat/Cool PID action with autotuning: 2

³ The alarm can be checked via communication or by lamp lighting.

⁴ ALM2 can be checked via communication or by lamp lighting.

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
47	Alarm 1 type selection *	XA	6	R/W	0: Alarm not provided 1: SV high alarm 2: SV low alarm 3: Process high alarm 4: Process low alarm 5: Deviation high alarm 6: Deviation low alarm 7: Deviation high/low alarm 8: Band alarm 9: Control loop break alarm (LBA)	Factory set value varies depending on the instrument specification.
48	Alarm 1 differential gap setting *	HA	6	R/W	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 2 (2.0) Voltage/Current inputs: 0.2
49	Alarm 1 process abnormality action selection *	OA	6	R/W	0: Normal processing 1: Forcibly turned on when abnormal	Alarm 1 not provided or LBA: 0 Alarm 1 provided: 1
50	Alarm 1 hold action selection *	WA	6	R/W	0: Without alarm hold action 1: To wait only when STOP changes to RUN at power on. 2: To wait again when STOP changes to RUN at power on or set value (SV) is changed.	Factory set value varies depending on the instrument specification.
51	Alarm 2 type selection *	XB	6	R/W	0: Alarm not provided 1: SV high alarm 2: SV low alarm 3: Process high alarm 4: Process low alarm 5: Deviation high alarm 6: Deviation low alarm 7: Deviation high/low alarm 8: Band alarm	Factory set value varies depending on the instrument specification.
52	Alarm 2 differential gap setting *	HB	6	R/W	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 2 (2.0) Voltage/Current inputs: 0.2
53	Alarm 2 process abnormality action selection *	OB	6	R/W	0: Normal processing 1: Forcibly turned on when abnormal	Alarm 2 not provided: 0 Alarm 2 provided: 1

* This communication data will be RO when this instrument is in the RUN state.

No.	Name	Identifier	Digits	Attribute	Data range	Factory set value
54	Alarm 2 hold action selection *	WB	6	R/W	0: Without alarm hold action 1: To wait only when STOP changes to RUN at power on. 2: To wait again when STOP changes to RUN at power on or set value (SV) is changed.	Factory set value varies depending on the instrument specification.
55	Control action type selection *	XE	6	R/W	0: PID action with autotuning (Direct action) [D type] 1: PID action with autotuning (Reverse action) [F type] 2: Heat/Cool PID action with autotuning (Water cooling) [W type] 3: Heat/Cool PID action with autotuning (Air cooling) [A type]	Factory set value varies depending on the instrument specification.
56	ON/OFF action differential gap setting *	MH	6	R/W	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 2 (2.0) Voltage/Current inputs: 0.2
57	Setting change rate limiter Used/Unused *	ZG	6	R/W	0: Unused 1: Used	0
58	Setting change rate limiter time *	TA	6	R/W	1 to 3600 seconds	60
59	Sampling cycle *	TZ	6	R/W	0: 250 ms (0.25 seconds) 1: 500 ms (0.5 seconds)	1
60	Peak hold	HP	6	RO	Within input range (Setting limiter [low limit] to Setting limiter [high limit])	—
61	Bottom hold	HQ	6	RO	Varies with the setting of the Decimal point position.	—
62	Hold reset	HR	6	R/W	0: Hold reset execution If 0 is written, the hold value is reset to return to 1.	1
63	PV ratio function selection *	Z2	6	R/W	0: Disable PV ratio function 1: Enable PV ratio function	0
64	Contact input logic operation selection *	XK	6	R/W	0: DI1: STEP function DI2: RUN/STOP transfer 1: DI1: STEP function DI2: Alarm interlock release 2: DI1: Alarm interlock release DI2: RUN/STOP transfer	0
65	Alarm 1 interlock function selection *	QA	6	R/W	0: Disable Alarm 1 interlock function 1: Enable Alarm 1 interlock function	0
66	Alarm 2 interlock function selection *	QB	6	R/W	0: Disable Alarm 2 interlock function 1: Enable Alarm 2 interlock function	0

* This communication data will be RO when this instrument is in the RUN state.

MEMO

MODBUS PROTOCOL

5

This chapter describes the Modbus protocol.

In this chapter a host computer is called Master and SA100 is called Slave.

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.



Data send/receive state (communication data monitoring and setting) of Modbus can be checked by using the following software:

- Communication Tool “PROTEM2”

The PROTEM2 can be downloaded from the official RKC website.

5.1 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.

Slave address
Function code
Data
Error check CRC-16

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 **3.3 Device Address (Slave Address) Setting (P. 3-4)**.

Although all connected slaves 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 **5.2 Function Code (P. 5-3)**.

■ 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 **5.6 Message Format (P. 5-7), 5.8 Modbus Communication Data List (P. 5-14)**.

■ 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 **5.5 Calculating CRC-16 (P. 5-5)**.

5.2 Function Code

Function code contents

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

5.3 Communication Mode

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

RTU mode

Items	Contents
Data bit length	8 bit (Binary)
Start mark of message	Unused
End mark of message	Unused
Message length	Refer to 5.2 Function Code (P. 5-3)
Data time interval	24 bit's time or less*
Error check	CRC-16 (Cyclic Redundancy Check)

*The data time intervals in one query message from the master must be 24 bit's time or less. If the data time interval exceeds 24 bit's time, the slave regards the transmission as ended and because the message format is incomplete, the slave does not respond.

5.4 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 (Specifying nonexistent function code)
2	When the mismatched address is specified.
3	When the data written exceeds the setting range, When the specified number of data items in the query message exceeds the maximum number of data items available
4	Self-diagnostic error response

- Order of determination of error

Error code 1 > Error code 3 > Error code 2 > Error code 4

(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's time.

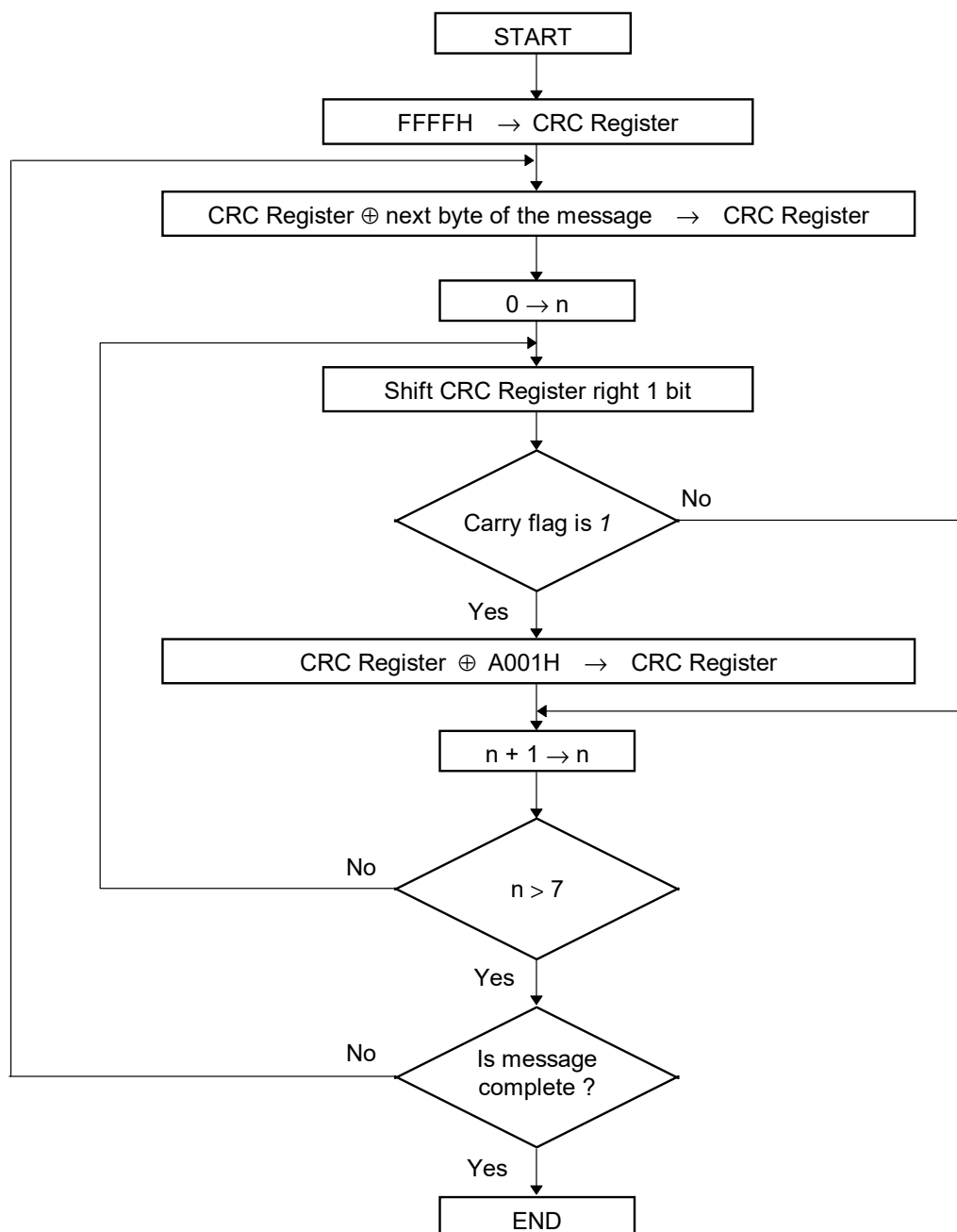
5.5 Calculating CRC-16

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

The CRC code is formed in the following sequence:

1. Load a 16-bit CRC register with FFFFH.
2. *Exclusive OR* (\oplus) 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 \oplus symbol indicates an *exclusive OR* operation. The symbol for the number of data bits is n .

5.6 Message Format

5.6.1 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 bits and the low-order 8 bits, arranged in the order of the register numbers.

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

Query message

Slave address		02H	} First holding register address
Function code		03H	
Starting number	High	00H	
	Low	00H	
Quantity	High	00H	} The setting must be between 1 (0001H) and 125 (007DH).
	Low	03H	
CRC-16	High	05H	
	Low	F8H	

Normal response message

Slave address		02H	→ Number of holding registers × 2
Function code		03H	
Number of data		06H	
First 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	35H	
	Low	85H	

Error response message

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

5.6.2 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 bits first and low-order 8 bits next. Only R/W holding registers can be specified.

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

Query message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	10H
Write data	High	01H
	Low	02H
CRC-16	High	08H
	Low	5EH

} Any data within the range

Normal response message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	10H
Write data	High	01H
	Low	02H
CRC-16	High	08H
	Low	5EH

} 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

5.6.3 Diagnostics (loopback test) [08H]

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

Example: Loopback test for slave address 1

Query message

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

Normal response message

Slave address		01H	
Function code		08H	
Test code	High	00H	} Contents will be the same as query message data.
	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

5.7 Data Configuration

5.7.1 Data range

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.

■ Data processing with decimal points

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

● Data with one decimal place

Control loop break alarm (LBA)

Heat-side manipulated output value (MV)

Cool-side manipulated output value (MV2)

Manipulated output value (MV) of Transmission output scale high (AHS)

Manipulated output value (MV) of Transmission output scale low (ALS)

Example: When the control loop break alarm set value is 8.0 minutes; 8.0 is processed as 80,
80 = 0050H

Control loop break alarm (LBA)	High	00H
	Low	50H

● Data with three decimal places

PV ratio (Pr)

Example: When the PV ratio (Pr) is 0.555 minutes; 0.555 is processed as 555,
555 = 022BH

PV ratio (Pr)	High	02H
	Low	2BH

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

The position of the decimal point changes depending on the Input range type and the decimal point position setting, because the Modbus protocol does not recognize data with decimal points during communication.

[Type of decimal points position]

Temperature input: No decimal place, One decimal place, Two decimal places

Voltage/Current input: No decimal place, One decimal place, Two decimal places, Three decimal places, Four decimal places



For details, refer to **A.3 Input Range Code Tables (P. A-4)**.

Measured value (PV) display

Set value (SV) setting

Alarm 1 (ALM1)

Alarm 2 (ALM2)

LBA deadband (LBD)

Heat-side proportional band (P)

Overlap/Deadband

PV bias

Measured value (PV), Set value (SV) and Deviation (DEV) of Transmission output scale high (AHS)

Measured value (PV), Set value (SV) and Deviation (DEV) of Transmission output scale low (ALS)

Setting change rate limiter (Up)

Setting change rate limiter (Down)

Set value (SV) display while the setting change rate limiter function

Input value (actual measured value)

Setting limiter [high limit]

Setting limiter [low limit]

Alarm 1 differential gap setting

Alarm 2 differential gap setting

ON/OFF action differential gap setting

Peak hold

Bottom hold

Example: When the temperature set value is $-20.0\text{ }^{\circ}\text{C}$; -20.0 is processed as -200 ,
 $-200 = 0000\text{H} - 00\text{C8H} = \text{FF}38\text{H}$

Set value (SV) setting	High	FFH
	Low	38H

● Data without decimal points

Alarm 1 status	MV display selection
Alarm 2 status	Input type selection
Burnout	Display unit selection
Autotuning (AT)	Decimal point position setting
Self-tuning (ST)	Selection of output logic calculation *
Integral time (I)	Alarm 1 type selection
Derivative time (D)	Alarm 1 process abnormality action selection
Anti-reset windup (ARW)	Alarm 1 hold action selection
Heat-side proportioning cycle time	Alarm 2 type selection
Cool-side proportional band	Alarm 2 process abnormality action selection
Cool-side proportional cycle time	Alarm 2 hold action selection
Set data lock (LCK)	Control action type selection
RUN/STOP function	Setting change rate limiter Used/Unused
Digital filter	Setting change rate limiter time
EEPROM storage mode	Sampling cycle
EEPROM storage status	Hold reset
Transmission output (AO) specification selection	PV ratio function selection
Alarm interlock release (ILr)	Contact input logic operation selection
STOP display screen selection	Alarm 1 interlock function selection
Monitor display configuration selection	Alarm 2 interlock function selection

* Output logic operation selection

Example: When integral time is 50 seconds; 50 is processed as 50, 50 = 0032H

Integral time (I)	High	00H
	Low	32H

5.7.2 Data processing precautions

- Definitions of registers

- ① Undefined register

Reserved register for extension within the data map range defined in Specification.

- ② Illegal register

Register outside of the data map range defined in Specification.

- ③ Unused register

Register that can be used/unused depending on the selected function and that is set to unused.

- Register handling

- (1) Reading register

Register types contained in communication data	Action at the time of reading
① Undefined register	Return 0000h only for undefined register.
② Illegal register	Error code 2* is returned if illegal register is included. When the communication data is sequentially read, an error code 0000H may be returned if an incorrect register is included.
③ Unused register	A factory set value is returned for an unused register.
④ Registers except the above	Register can be read.

- (2) Preset single register

Register types contained in communication data	Action at the time of writing
① Undefined register	Destroy write data.
② Illegal register	Return error code 2* and destroy write data.
③ Write-protected register (Read-only register)	
④ Write a value outside the setting range	Return error code 3* and destroy write data.
⑤ Unused register	Destroy write data.
⑥ Registers except the above	Capable of writing into register.

* When an error with higher error code determination is active, priority is given to it.

- For 03H (read holding register), an error response message (error code 2) is returned when the starting number (start address) of the query message is larger than 004EH.
- For 06H (preset single register), an error message (error code 2) is returned when the write address is larger than 004EH.
- If data range or address error occurs during data writing, the data written before error is in effect.

5.8 Modbus Communication Data List

5.8.1 Reference to Modbus communication identifier list

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
1	Measured value (PV) display	0000	0	RO	Within input range. [Setting limiter [low limit] – (5 % of span) to Setting limiter [high limit] + (5 % of span)] Varies with the setting of the Decimal point position.	—
2	Undefined	0001	1	—	—	—

(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.

Host computer ← Data direction → Controller

R/W: Reading and writing data is possible.

Host computer ↔ Data direction ↔ Controller

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

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

5.8.2 Modbus communication data list

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
1	Measured value (PV) display	0000	0	RO	Within input range. [Setting limiter [low limit] – (5 % of span) to Setting limiter [high limit] + (5 % of span)] Varies with the setting of the Decimal point position.	—
2	Undefined	0001	1	—	—	—
3	Undefined	0002	2	—	—	—
4	Alarm 1 status	0003	3	RO	0: OFF 1: ON	—
5	Alarm 2 status	0004	4	RO	0: OFF 1: ON	—
6	Burnout	0005	5	RO	0: OFF 1: ON	—
7	Set value (SV) setting	0006	6	R/W	Within input range. (Setting limiter [low limit] to Setting limiter [high limit]) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
8	Alarm 1 (ALM1)	0007	7	R/W ¹	Process alarm, SV alarm: Same as input range (Setting limiter [low limit] to Setting limiter [high limit])	TC/RTD inputs: 50 (50.0) Voltage/Current inputs: 5.0
9	Alarm 2 (ALM2)	0008	8	R/W ²	Deviation alarm: –Span to +Span (However, within –1999 to +9999 digits) Varies with the setting of the Decimal point position.	TC/RTD inputs: 50 (50.0) Voltage/Current inputs: 5.0
10	Undefined	0009	9	—	—	—
11	Undefined	000A	10	—	—	—
12	Control loop break alarm (LBA)	000B	11	R/W ³	0.0 to 200.0 minutes (0.0: OFF)	8.0
13	LBA deadband (LBD) ⁴	000C	12	R/W ³	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
14	Autotuning (AT)	000D	13	R/W	0: AT end or cancel 1: AT start or execution After AT is completed, setting will automatically change to 0.	0

¹ If “No alarm” is selected for Alarm 1 [ALM1] or if “Control loop break alarm (LBA)” is selected for Alarm 1 [ALM1], the attribute becomes RO.

² If “No alarm” for Alarm 2 [ALM2] is selected, the attribute becomes RO.

³ If “Control loop break alarm (LBA)” for Alarm 1 (ALM1) is not selected, the attribute becomes RO.

⁴ Abbreviation of “Control loop break alarm deadband”

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
15	Self-tuning (ST)	000E	14	R/W ¹	0: Self-tuning OFF 1: Self-tuning ON	0
16	Heat-side proportional band (P)	000F	15	R/W	0 (0.0) to Span (However, 9999 digits or less) 0 (0.0): ON/OFF action Varies with the setting of the Decimal point position. Cannot be written while the self-tuning (ST) function is on, only Read is available.	TC/RTD inputs: 30 (30.0) Voltage/Current inputs: 3.0
17	Integral time (I)	0010	16	R/W	0 to 3600 seconds (0: PD action) Cannot be written while the self-tuning (ST) function is on, only Read is available.	240
18	Derivative time (D)	0011	17	R/W	0 to 3600 seconds (0: PI action) Cannot be written while the self-tuning (ST) function is on, only Read is available.	60
19	Anti-reset windup (ARW)	0012	18	R/W	0 to 100 % of heat-side proportional band (0: Integral action OFF) Cannot be written while the self-tuning (ST) function is on, only Read is available.	100
20	Heat-side proportioning cycle time	0013	19	R/W	1 to 100 seconds	Relay contact output: 20 Voltage pulse output: 2
21	Cool-side proportional band	0014	20	R/W ²	1 to 1000 % of heat-side proportional band	100
22	Overlap/Deadband	0015	21	R/W ²	–Span to +Span (However, within –1999 to +9999 digits) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
23	Cool-side proportioning cycle time	0016	22	R/W ²	1 to 100 seconds	Relay contact output: 20 Voltage pulse output: 2
24	PV bias	0017	23	R/W	–Span to +Span (However, within –1999 to +9999 digits) Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0

¹ If the Heat/Cool PID control with autotuning (water cooling/air cooling) is selected, or the set value of any one of the Heat/Cool proportional band, Integral time, Derivative time and Anti-reset windup is set to 0, the attribute becomes RO.

² If Heat/Cool PID control with autotuning (water cooling/air cooling) for control type is not selected, the attribute becomes RO.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
25	Set data lock (LCK)	0018	24	R/W	0 to 15 *	0
26	RUN/STOP function	0019	25	R/W	0: RUN 1: STOP	0
27	Digital filter	001A	26	R/W	0 to 100 seconds (0: Digital filter OFF)	0

* Details of set data lock function

×: Settable-Data unlocked

—: Unsettable-Data locked

Set data	Setting items of Engineering mode	Set value (SV)	Alarm set value (Alarm 1, Alarm 2)	Other setting items
0	—	×	×	×
1	—	×	×	—
2	—	×	—	×
3	—	×	—	—
4	—	—	×	×
5	—	—	×	—
6	—	—	—	×
7	—	—	—	—
8	×	×	×	×
9	×	×	×	—
10	×	×	—	×
11	×	×	—	—
12	×	—	×	×
13	×	—	×	—
14	×	—	—	×
15	×	—	—	—

The data lock function only prevents setting changes being made from the front keys. Setting changes can still be made through communication transmission.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
28	EEPROM storage mode ¹	001B	27	R/W	0: Backup mode (Set values are store to the EEPROM) 1: Buffer mode (No set values are store to the EEPROM)	0
29	EEPROM storage status ²	001C	28	RO	0: Mismatch 1: Match	—
30	Heat-side manipulated output value (MV)	001D	29	RO	–5.0 to +105.0 %	—
31	Cool-side manipulated output value (MV2)	001E	30	RO	–5.0 to +105.0 %	—
32	Transmission output (AO) specification	001F	31	R/W ³	0: Measured value (PV) 1: Set value (SV) 2: Deviation (DEV) 3: Manipulated output value (MV)	0
33	Transmission output scale high (AHS)	0020	32	R/W ³	Measured value (PV), Set value (SV): Same as input range * [Transmission output scale low to Setting limiter (high limit)] Deviation (DEV): –Span to +Span * (However, within –1999 to +9999 digits) [Transmission output scale low to +Span] Manipulated output value (MV): 0.0 to 100.0 % [Transmission output scale low to 100.0 %] Varies with the setting of the Decimal point position.	TC/RTD inputs: Input range (high limit) Voltage/Current inputs: 100.0

¹ The non-volatile memory (EEPROM) has limitations on the number of memory rewrite times. If the buffer mode is selected as an EEPROM storage mode, all of the set values changed are not written to the EEPROM and thus a problem of limitations on the number of memory rewrite times can be solved. When the memory is used to frequently change the set value via communication, select the buffer mode.

When selecting any EEPROM storage mode, take notice of the following.

- If power failure occurs while the buffer mode is selected, the set value returns to the value before the storage mode is selected.
- If the buffer mode is changed to the backup mode, all of the set values at that time are stored to the EEPROM. If necessary to backup the final value of each set item, select the backup mode.
- When the power is turned on, the backup mode is always set.

² The contents of the buffer memory and those of the EEPROM can be checked.

When data is 0: The contents of the buffer memory do not match with those of the EEPROM.

- As data is being written to the EEPROM in backup mode, do not turn the power off. If turned off, no set values are stored.
- If the set value is changed after the backup mode is changed to the buffer mode, 0 is set (mismatch). As the set value changed is not backup, select the backup mode if necessary.

When data is 1: The contents of the buffer memory match with those of the EEPROM.
(Data write to the EEPROM is completed.)

³ If the Output 1 (OUT1) is a retransmission output, the attribute is R/W and is RO for all other cases.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
34	Transmission output scale low (ALS)	0021	33	R/W ¹	Measured value (PV), Set value (SV): Same as input range * [Setting limiter (low limit) to Transmission output scale high] Deviation (DEV): –Span to +Span * (However, within –1999 to +9999 digits) [–Span to Transmission output scale high] Manipulated output value (MV): 0.0 to 100.0 % [0.0 % to Transmission output scale high] * Varies with the setting of the Decimal point position.	TC/RTD inputs: Input range (low limit) Voltage/Current inputs: 0.0
35	Setting change rate limiter (Up)	0022	34	R/W ²	TC/RTD inputs: 0 (0.0) to Span °C [°F]/unit time (However, 9999 digits or less) Voltage/Current inputs: 0 (0.0) to Span/unit time (However, 9999 digits or less)	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
36	Setting change rate limiter (Down)	0023	35	R/W ²	0 (0.0): Limiter OFF Varies with the setting of the Decimal point position.	TC/RTD inputs: 0 (0.0) Voltage/Current inputs: 0.0
37	Set value (SV) display while the setting change rate limiter function	0024	36	RO	Within input range. (Setting limiter [low limit] to Setting limiter [high limit]) Varies with the setting of the Decimal point position.	—
38	PV ratio (Pr)	0025	37	R/W ³	0.500 to 1.500 times	1.000
39	Input value (actual measured value)	0026	38	RO	Within input range (–1999 to +9999)	—
40	Undefined	0027 ⋮ 0029	39 ⋮ 41	—	—	—
41	Alarm interlock release (ILr)	002A	42	R/W	0: Alarm interlock release ⁴	—
42	Undefined	002B ⋮ 002F	43 ⋮ 47	—	—	—

¹ If the Output 1 (OUT1) is a retransmission output, the attribute is R/W and is RO for all other cases.

² If the Setting change rate limiter Used/Unused is not set “Used,” the attribute becomes RO.

³ If the PV ratio function selection is not set “PV ratio function enabled,” attribute becomes RO.

⁴ The interlock is released by setting the “0.” In the read state, becomes “1.”



NOTE

Release the alarm interlock with the alarm OFF state.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
43	STOP display screen selection ¹	0030	48	R/W	0: It makes display “STOP” in PV display. 1: It makes display “STOP” in SV display. 2: No selection from RUN to STOP by the front key can be made.	0
44	Monitor display configuration selection ¹	0031	49	R/W	0: PV/SV display 1: Only PV display 2: Only SV display	0
45	MV display selection ¹	0032	50	R/W	0: MV display not provided 1: MV display provided	0
46	Input type selection ¹	0033	51	R/W	0: Thermocouple K ² 1: Thermocouple J ² 2: Thermocouple R ² 3: Thermocouple S ² 4: Thermocouple B ² 5: Thermocouple E ² 6: Thermocouple N ² 7: Thermocouple T ² 8: Thermocouple C (W5Re/W26Re) ² 9: Thermocouple PL II ² 10: Thermocouple U ² 11: Thermocouple L ² 12: RTD Pt100 ² 13: RTD JPt100 ² 14: Voltage 0 to 5 V DC or Current 0 to 20 mA DC ^{2,3} 15: Voltage 1 to 5 V DC or Current 4 to 20 mA DC ^{2,3} 16: Voltage 0 to 10 V DC ²	Factory set value varies depending on the instrument specification.
47	Display unit selection ¹	0034	52	R/W	0: °C 1: °F	0
48	Decimal point position setting ¹	0035	53	R/W	0: No digit below decimal point 1: 1 digit below decimal point 2: 2 digits below decimal point 3: 3 digits below decimal point	Factory set value varies depending on the instrument specification.
49	Setting limiter [high limit] ¹	0036	54	R/W	–1999 to +9999 • Set the Setting limiter by referring to the “A.3 Input Range Code Tables” (P. A-4). • This instrument sets the input range with the Setting limiter. Please note that changing the Setting limiter will also change the input range.	Factory set value varies depending on the instrument specification.
50	Setting limiter [low limit] ¹	0037	55	R/W		Factory set value varies depending on the instrument specification.

¹ This communication data will be RO when this instrument is in the RUN state.

² Input type (TC/RTD to voltage/current inputs or voltage/current inputs to TC/RTD) cannot be changed because the hardware is different.

³ For the current input specification, a resistor of 250 Ω must be connected between the input terminals.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
51	Selection of output logic calculation ¹ (Output logic operation selection)	0038	56	R/W	1: OUT1: Control output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (Energized) 2: OUT1: Heat-side control output OUT2: Cool-side control output 3: OUT1: Control output OUT2: Alarm 1 output (De-energized) ⁴ 4: OUT1: Control output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (Energized) 5: OUT1: Control output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (De-energized) 6: OUT1: Control output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (De-energized) 7: OUT1: Control output OUT2: Not output ³ 8: OUT1: Control output OUT2: Alarm 1 output only (Energized) ⁴ 9: OUT1: Alarm 1 output (Energized) OUT2: Alarm 2 output (Energized) 10: OUT1: Alarm 1 output (Energized) OUT2: Alarm 2 output (De-energized) 11: OUT1: Alarm 1 output (De-energized) OUT2: Alarm 2 output (De-energized) 12: OUT1: Transmission output OUT2: Control output 13: OUT1: Transmission output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (Energized) 14: OUT1: Transmission output OUT2: <i>OR</i> output of Alarm 1 and Alarm 2 (De-energized) 15: OUT1: Transmission output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (Energized) 16: OUT1: Transmission output OUT2: <i>AND</i> output of Alarm 1 and Alarm 2 (De-energized) 17: OUT1: Transmission output OUT2: Alarm 1 output (Energized) 18: OUT1: Transmission output OUT2: Alarm 1 output (De-energized) 19: OUT1: Cool-side control output (In case of direct action or reverse action, it is OFF). OUT2: Heat-side control output	Factory set value varies depending on the instrument specification. ²

¹ This communication data will be RO when this instrument is in the RUN state.

² Factory set value when an Output assignment code is not specified at the time of ordering:

The output assignment code is set to either of the following according to the control action specified at the time of ordering.

- PID action with autotuning: 1
- Heat/Cool PID action with autotuning: 2

³ The alarm can be checked via communication or by lamp lighting.

⁴ ALM2 can be checked via communication or by lamp lighting.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
52	Alarm 1 type selection *	0039	57	R/W	0: Alarm not provided 1: SV high alarm 2: SV low alarm 3: Process high alarm 4: Process low alarm 5: Deviation high alarm 6: Deviation low alarm 7: Deviation high/low alarm 8: Band alarm 9: Control loop break alarm (LBA)	Factory set value varies depending on the instrument specification.
53	Alarm 1 differential gap setting *	003A	58	R/W	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 2 (2.0) Voltage/Current inputs: 0.2
54	Alarm 1 process abnormality action selection *	003B	59	R/W	0: Normal processing 1: Forcibly turned on when abnormal	Alarm 1 not provided or LBA: 0 Alarm 1 provided: 1
55	Alarm 1 hold action selection *	003C	60	R/W	0: Without alarm hold action 1: To wait only when STOP changes to RUN at power on. 2: To wait again when STOP changes to RUN at power on or set value (SV) is changed.	Factory set value varies depending on the instrument specification.
56	Alarm 2 type selection *	003D	61	R/W	0: Alarm not provided 1: SV high alarm 2: SV low alarm 3: Process high alarm 4: Process low alarm 5: Deviation high alarm 6: Deviation low alarm 7: Deviation high/low alarm 8: Band alarm	Factory set value varies depending on the instrument specification.
57	Alarm 2 differential gap setting *	003E	62	R/W	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 2 (2.0) Voltage/Current inputs: 0.2
58	Alarm 2 process abnormality action selection *	003F	63	R/W	0: Normal processing 1: Forcibly turned on when abnormal	Alarm 2 not provided: 0 Alarm 2 provided: 1

* This communication data will be RO when this instrument is in the RUN state.

No.	Name	Register address		Attribute	Data range	Factory set value
		HEX	DEC			
59	Alarm 2 hold action selection *	0040	64	R/W	0: Without alarm hold action 1: To wait only when STOP changes to RUN at power on. 2: To wait again when STOP changes to RUN at power on or set value (SV) is changed.	Factory set value varies depending on the instrument specification.
60	Control action type selection *	0041	65	R/W	0: PID action with autotuning (Direct action) [D type] 1: PID action with autotuning (Reverse action) [F type] 2: Heat/Cool PID action with autotuning (Water cooling) [W type] 3: Heat/Cool PID action with autotuning (Air cooling) [A type]	Factory set value varies depending on the instrument specification.
61	ON/OFF action differential gap setting *	0042	66	R/W	0 (0.0) to Span (However, 9999 digits or less) Varies with the setting of the Decimal point position.	TC/RTD inputs: 2 (2.0) Voltage/Current inputs: 0.2
62	Setting change rate limiter Used/Unused *	0043	67	R/W	0: Unused 1: Used	0
63	Setting change rate limiter time *	0044	68	R/W	1 to 3600 seconds	60
64	Sampling cycle *	0045	69	R/W	0: 250 ms (0.25 seconds) 1: 500 ms (0.5 seconds)	1
65	Peak hold	0046	70	RO	Within input range (Setting limiter [low limit] to Setting limiter [high limit])	—
66	Bottom hold	0047	71	RO	Varies with the setting of the Decimal point position.	—
67	Hold reset	0048	72	R/W	0: Hold reset execution If 0 is written, the hold value is reset to return to 1.	1
68	PV ratio function selection *	0049	73	R/W	0: Disable PV ratio function 1: Enable PV ratio function	0
69	Contact input logic operation selection *	004A	74	R/W	0: DI1: STEP function DI2: RUN/STOP transfer 1: DI1: STEP function DI2: Alarm interlock release 2: DI1: Alarm interlock release DI2: RUN/STOP transfer	0
70	Alarm 1 interlock function selection *	004B	75	R/W	0: Disable Alarm 1 interlock function 1: Enable Alarm 1 interlock function	0
71	Alarm 2 interlock function selection *	004C	76	R/W	0: Disable Alarm 2 interlock function 1: Enable Alarm 2 interlock function	0
72	Undefined	004D	77	—	—	—
73	Undefined	004E	78	—	—	—

* This communication data will be RO when this instrument is in the RUN state.

MEMO

TROUBLE SHOOTING

6

This chapter describes how to cope with errors during the communication.

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 cannot solve a problem, please contact RKC sales office or the agent, on confirming the type name and specifications of the product.

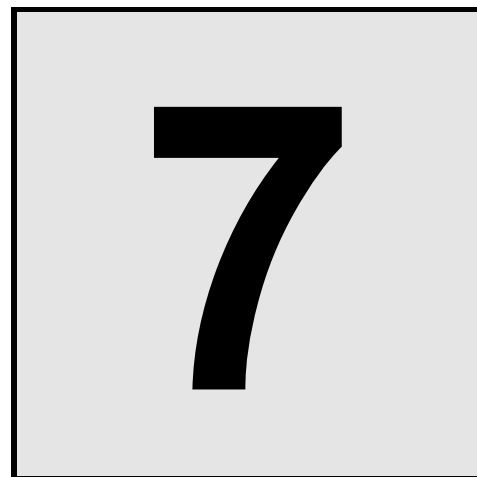
6.1 RKC Communication

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 configuration with those of the host computer	Confirm the settings and set them correctly
	Wrong address setting	
	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)	
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 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

6.2 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	
	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 code error (Specifying nonexistent function code)	Confirm the function code
Error code 2	An illegal register was specified for the starting address at the time of reading from a holding register (03H).	Confirm the address of holding register
	Written to a read-only (RO) data.	
	Written to an illegal 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.

SPECIFICATIONS



This chapter describes the specification of the host communication.

7.1 RKC Communication

Interface:	Based on RS-485, EIA standard
Connection method:	2-wire system, half-duplex multi-drop connection
Communication distance:	1 km max. (The maximum communication distance will be affected by the surrounding conditions.)
Synchronous method:	Start/Stop synchronous type
Communication speed:	2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps
Data bit configuration:	Start bit: 1 Data bit: 7 or 8 Parity bit: None, Odd or Even Stop bit: 1 or 2
Protocol:	ANSI X3.28-1976 subcategories 2.5 and A4 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 ($120\ \Omega$ 1/2 W)
Xon/Xoff control:	None
Maximum connections:	31 instruments (32 instruments maximum including a host computer)
Signal logic:	RS-485

Signal logic	Logic
$V(A) - V(B) \geq 2\text{ V}$	0 (SPACE)
$V(A) - V(B) \leq -2\text{ V}$	1 (MARK)

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

7.2 Modbus

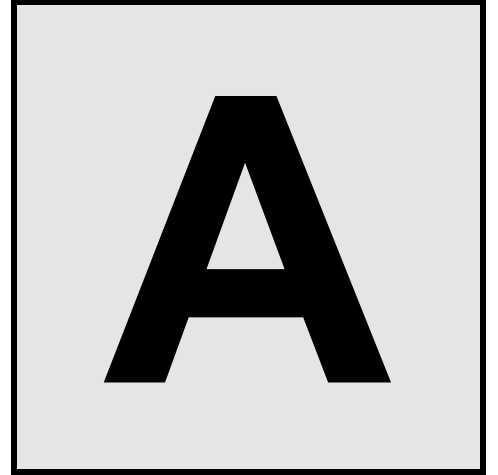
Interface:	Based on RS-485, EIA standard
Connection method:	2-wire system, half-duplex multi-drop connection
Communication distance:	1 km max. (The maximum communication distance will be affected by the surrounding conditions.)
Synchronous method:	Start/Stop synchronous type
Communication speed:	2400 bps, 4800 bps, 9600 bps, 19200 bps, 38400 bps, 57600 bps
Data bit configuration:	Start bit: 1 Data bit: 8 (Byte data corresponding to binary data or bit.) Parity bit: None, 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 data written exceeds the setting range, 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:	31 instruments (32 instruments maximum including a host computer)
Signal logic:	RS-485

Signal logic	Logic
$V(A) - V(B) \geq 2\text{ V}$	0 (SPACE)
$V(A) - V(B) \leq -2\text{ V}$	1 (MARK)

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

MEMO

APPENDIX



A.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

A.2 Input Type Table

Input type		Setting range
Thermocouple	K	–199 to +1372 °C (–326 to +2502 °F)
		–199.9 to +999.9 °C (–199.9 to +999.9 °F)
	J	–199 to +1200 °C (–326 to +2192 °F)
		–199.9 to +999.9 °C (–199.9 to +999.9 °F)
	R	0 to 1769 °C (0 to 3216 °F)
	S	0 to 1769 °C (0 to 3216 °F)
	B	0 to 1820 °C (0 to 3308 °F)
	E	0 to 1000 °C (0 to 1832 °F)
	N	0 to 1300 °C (0 to 2372 °F)
		0.0 to 999.9 °C (0.0 to 999.9 °F)
	T	–199 to +400 °C (–326 to +752 °F)
		–199.9 to +400.0 °C (–199.9 to +752.0 °F)
	C (W5Re/W26Re)	0 to 2320 °C (0 to 4208 °F)
	PL II	0 to 1390 °C (0 to 2534 °F)
RTD	Pt100 (JIS/IEC) ¹ JPt100 (JIS)	–199.9 to +649.0 °C (–199.9 to +999.9 °F)
Voltage ²	0 to 5 V DC	–1999 to +9999 (programmable scale)
	1 to 5 V DC	
	0 to 10 V DC	
Current ^{2,3}	0 to 20 mA DC	–1999 to +9999 (programmable scale)
	4 to 20 mA DC	

¹ IEC (International Electrotechnical Commission) is equivalent to JIS, DIN and ANSI.

² In case of voltage/current inputs, SLH can be set below SLL.

³ For the current input specification, a resistor of 250 Ω must be connected between the input terminals.

A.3 Input Range Code Tables

Input Range Code Table 1

Input type		Input range	Code		Input range	Code	
			Input	Range		Input	Range
Thermocouple	K	0 to 200 °C	K	01	0 to 800 °F	K	A1
		0 to 400 °C	K	02	0 to 1600 °F	K	A2
		0 to 600 °C	K	03	0 to 2502 °F	K	A3
		0 to 800 °C	K	04	0.0 to 800.0 °F	K	A4
		0 to 1000 °C	K	05	20 to 70 °F	K	A9
		0 to 1200 °C	K	06	−199.9 to +999.9 °F	K	B2
		0 to 1372 °C	K	07			
		−199.9 to +300.0 °C	K	08			
		0.0 to 400.0 °C	K	09			
		0.0 to 800.0 °C	K	10			
		0 to 100 °C	K	13			
		0 to 300 °C	K	14			
		0 to 450 °C	K	17			
		0 to 500 °C	K	20			
		0.0 to 200.0 °C	K	29			
		0.0 to 600.0 °C	K	37			
		−199.9 to +800.0 °C	K	38			
	J	0 to 200 °C	J	01	0 to 800 °F	J	A1
		0 to 400 °C	J	02	0 to 1600 °F	J	A2
		0 to 600 °C	J	03	0 to 2192 °F	J	A3
		0 to 800 °C	J	04	0 to 400 °F	J	A6
		0 to 1000 °C	J	05	0 to 300 °F	J	A7
		0 to 1200 °C	J	06	−199.9 to +999.9 °F	J	A9
		−199.9 to +300.0 °C	J	07	0.0 to 800.0 °F	J	B6
		0.0 to 400.0 °C	J	08			
		0.0 to 800.0 °C	J	09			
		0 to 450 °C	J	10			
		0.0 to 200.0 °C	J	22			
		0.0 to 600.0 °C	J	23			
		−199.9 to +600.0 °C	J	30			
	R	0 to 1600 °C *	R	01	0 to 3200 °F *	K	A1
		0 to 1769 °C *	R	02	0 to 3216 °F *	K	A2
		0 to 1350 °C *	R	04			
	S	0 to 1600 °C *	S	01	0 to 3200 °F *	S	A1
		0 to 1769 °C *	S	02	0 to 3216 °F *	S	A2
	B	400 to 1800 °C	B	01	800 to 3200 °F	B	A1
		0 to 1820 °C *	B	02	0 to 3308 °F *	B	A2
	E	0 to 800 °C	E	01	0 to 1600 °F	E	A1
		0 to 1000 °C	E	02	0 to 1832 °F	E	A2
	N	0 to 1200 °C	N	01	0 to 2300 °F	N	A1
		0 to 1300 °C	N	02	0 to 2372 °F	N	A2
		0.0 to 800.0 °C	N	06	0.0 to 999.9 °F	N	A5

* Accuracy is not guaranteed below 399 °C (751 °F) or less for types R, S and B.

Input Range Code Table 1

Input type		Input range	Code		Input range	Code	
			Input	Range		Input	Range
Thermocouple	T	–199.9 to +400.0 °C *	T	01	–199.9 to +752.0 °F *	T	A1
		–199.9 to +100.0 °C *	T	02	–100.0 to +200.0 °F	T	A2
		–100.0 to +200.0 °C	T	03	–100.0 to +400.0 °F	T	A3
		0.0 to 350.0 °C	T	04	0.0 to 450.0 °F	T	A4
					0.0 to 752.0 °F	T	A5
	C (W5Re/W26Re)	0 to 2000 °C	W	01	0 to 4000 °F	W	A1
		0 to 2320 °C	W	02			
	PL II	0 to 1300 °C	A	01	0 to 2400 °F	A	A1
		0 to 1390 °C	A	02	0 to 2534 °F	A	A2
		0 to 1200 °C	A	03			
	U	–199.9 to +600.0 °C *	U	01	–199.9 to +999.9 °F *	U	A1
		–199.9 to +100.0 °C *	U	02	–100.0 to +200.0 °F	U	A2
		0.0 to 400.0 °C	U	03	0.0 to 999.9 °F	U	A3
	L	0 to 400 °C	L	01	0 to 800 °F	L	A1
		0 to 800 °C	L	02	0 to 1600 °F	L	A2
RTD	Pt100	–199.9 to +649.0 °C	D	01	–199.9 to +999.9 °F	D	A1
		–199.9 to +200.0 °C	D	02	–199.9 to +400.0 °F	D	A2
		–100.0 to +50.0 °C	D	03	–199.9 to +200.0 °F	D	A3
		–100.0 to +100.0 °C	D	04	–100.0 to +100.0 °F	D	A4
		–100.0 to +200.0 °C	D	05	–100.0 to +300.0 °F	D	A5
		0.0 to 50.0 °C	D	06	0.0 to 100.0 °F	D	A6
		0.0 to 100.0 °C	D	07	0.0 to 200.0 °F	D	A7
		0.0 to 200.0 °C	D	08	0.0 to 400.0 °F	D	A8
		0.0 to 300.0 °C	D	09	0.0 to 500.0 °F	D	A9
		0.0 to 500.0 °C	D	10			
	JPt100	–199.9 to +649.0 °C	P	01			
		–199.9 to +200.0 °C	P	02			
		–100.0 to +50.0 °C	P	03			
		–100.0 to +100.0 °C	P	04			
		–100.0 to +200.0 °C	P	05			
		0.0 to 50.0 °C	P	06			
		0.0 to 100.0 °C	P	07			
		0.0 to 200.0 °C	P	08			
		0.0 to 300.0 °C	P	09			
		0.0 to 500.0 °C	P	10			

* Accuracy is not guaranteed below –100.0 °C (–148.0 °F) or less for types T and U.

Input Range Code Table 2

Input type		Input range	Code	
			Input	Range
Voltage	0 to 5 V DC	0.0 to 100.0 %	4	01
	0 to 10 V DC		5	01
	1 to 5 V DC		6	01
Current	0 to 20 mA DC		7	01
	4 to 20 mA DC		8	01



For the current input specification, a resistor of 250 Ω must be connected between the input terminals.

MEMO



RKC INSTRUMENT INC.

HEADQUARTERS: 16-6, KUGAHARA 5-CHOME, OHTA-KU TOKYO 146-8515 JAPAN

PHONE: 03-3751-9799 (+81 3 3751 9799)

E-mail: info@rkcinst.co.jp

Website: <https://www.rkcinst.co.jp/english/>

