Single-phase Thyristor Unit

20 A/30 A/45 A/
60 A/80 A/100 A

THV-10

Host Communication Instruction Manual

RKC® RKC INSTRUMENT INC.

IMR02W06-E2

NOTICE

Thank you for purchasing this RKC product. In order to achieve maximum performance and ensure proper operation of the instrument, carefully read all the instructions in this manual. Please place the manual in a convenient location for easy reference.

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.
- Various symbols are used on the equipment, and they have the following meaning.

  : Warning (Instrument display)
  This symbol is attached to parts that require care when handling this product in order to protect the operator. Carefully read the cautions in this manual before using the instrument.

  : High temperature caution (Instrument display)
  Do not touch the heat radiation fin while the power is turned on or just after the power is turned off as it may be at high temperatures. If touched, burning may result.

- 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.

 : This mark indicates that all precautions should be taken to avoid fire.

 : This mark indicates that all precautions should be taken to avoid electric shock.

⚠ 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.

When the withstand voltage test or each test is performed, please contact RKC sales office or the agent. If you make a mistake in the test method, the instrument failure may result.

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.

⚠ WARNING

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.

⚠ 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.
- 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 control panel. All high-voltage connections such as power supply terminals must be enclosed in the control 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.
- Always use this product at the rated power supply voltage, load current and power frequency.
- 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.
- If this product is used for phase control, higher harmonic noise may be generated. Therefore in this case, take such measures as separating the power line from the high-voltage line for load drive.
- 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
											

A	B (b)	C	c	D (d)	E	F	G	H	I	J	K
											

L	M	N (n)	O (o)	P	Q	R	S	T	t	U	u
											

V	W	X	Y	Z	Degree	／	Prime	＊ (Asterisk)
								

		Dim lighting
		Bright lighting

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
20 A/30 A/45 A/ 60 A/ 80 A/100 A THV-10 Installation Manual	IMR02W01-E☐	This manual is enclosed with instrument. This manual explains the mounting and wiring.
20 A/30 A/45 A/ 60 A/ 80 A/100 A THV-10 Quick Operation Manual	IMR02W04-E☐	This manual is enclosed with instrument. This manual explains the basic key operation, mode menu, and data setting.
20 A/30 A/45 A/ 60 A/ 80 A/100 A THV-10 Instruction Manual	IMR02W05-E☐	This manual describes installation, wiring, operation of each function, and troubleshooting.
20 A/30 A/45 A/ 60 A/ 80 A/100 A THV-10 Host Communication Instruction Manual	**IMR02W06-E2**	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 8 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
☐	I want to know the features of the host communication	1. OUTLINE
☐	I want to know how to connect to the host computer	2. WIRING
☐	I want to know how to connect to the loader communication device	2. WIRING
☐	I want to know how to set up the communication parameters	3. PARAMETER SETTING
☐	I want to know the content of RKC communication protocol	4. RKC COMMUNICATION PROTOCOL
☐	I want to know the content of Modbus protocol	5. MODBUS PROTOCOL
☐	I want to know how to read the table	6. COMMUNICATION DATA LIST
☐	I want to check RKC communication data identifier, data attribute, data range and factory set values	6. COMMUNICATION DATA LIST
☐	I want to check Modbus data register address, data attribute, data range and factory set values	6. COMMUNICATION DATA LIST
☐	I want to know how to cope with errors	7. TROUBLESHOOTING
☐	I want to know the specification of the host communication	8. SPECIFICATIONS
☐	I want to see the table of ASCII/JIS 7-bit code	A. APPENDIX

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1 OUTLINE

This chapter describes the host communication of THV-10.

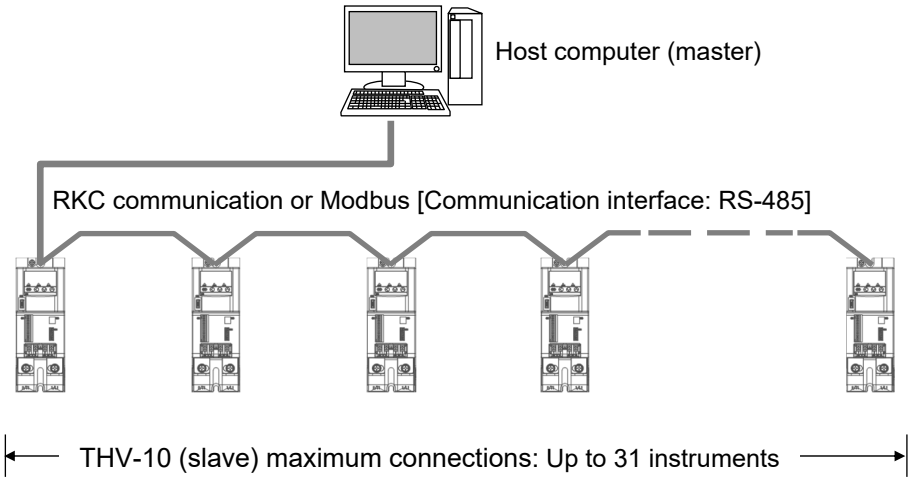
The communication function makes it possible to monitor and set the data of THV-10 from a host computer. The THV-10 interfaces with the host computer via Modbus or RKC communication (ANSI X3.28-1976 subcategories 2.5 and A4) protocols. Communication function is available only when optional communication function has been specified by model code at the time of ordering.
In addition, the THV-10 is equipped standard with a loader communication connector. Therefore, loader communication is possible. For reference purposes, the Modbus protocol identifies the host computer as master, the THV-10 as slave.

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

Communication interface: RS-485

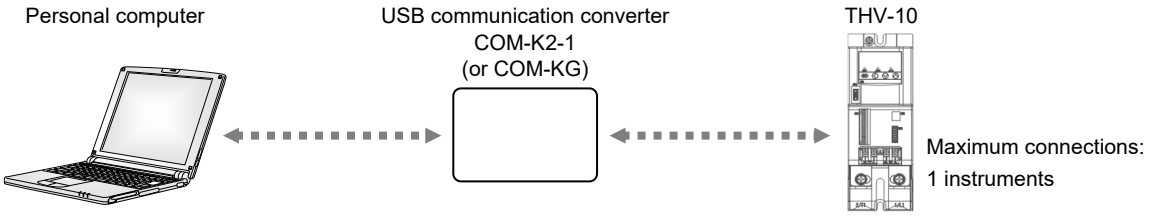
● Multi-drop connection

One host computer (master) can communicate with up to 31 THV-10s.



■ Loader Communication

Loader communication allows THV-10 data to be set from a personal computer.
By saving the data that was set using our "Communication Tool PROTEM2" to a computer, the data can be transferred to other THV-10, allowing setup to be accomplished much more quickly than when the data is set in each THV-10 using the front panel keys.
RKC USB communication converter COM-K2-1 or COM-KG (sold separately) is required for the loader communication.



NOTE

The Loader communication is only for parameter setup. Not used for data logging during operation.

Loader communication can be used on a THV-10 even when the Communication function (optional) is not installed.

The loader communication supports the RKC communication protocol (Based on ANSI X3.28-1976 subcategories 2.5 and A4).

■ Communication Tool PROTEM2

PROTEM2 is an integrated configuration support software to manage parameter setting and measured values of our controllers (including THV-10).

The PROTEM2 can be downloaded from the official RKC website.
Check our website for more details and operating environment of the PROTEM2.

PROTEM2 can be used with RKC communication protocol and Modbus protocol.
PROTEM2 can also be used for loader communication and a host communication.

MEMO

2 WIRING

This chapter describes how to connect to the host computer.

2.1 Wiring Cautions

⚠ WARNING

- To prevent electric shock and 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, turn off the power of the instrument and peripheral equipment before connecting or disconnecting.
- To prevent electric shock or instrument failure, never touch any section other than those instructed in this manual.

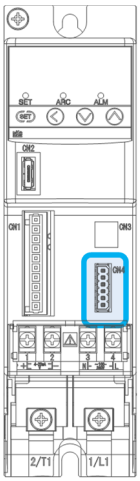
- Connect the connectors to the correct position and in the correct orientation. If you forcibly push in the connector incorrectly, the pins may bend and cause a malfunction.
- Connect and disconnect the connectors in parallel. If you move the connectors excessively up/down/left/right when connecting or disconnecting, the pins may bend and cause a malfunction.
- When you disconnect the connectors, hold the connector part. Disconnecting the connectors by pulling the cable may cause a malfunction.
- To prevent malfunction, never touch the contact section of a connector with bare hands or with hands soiled with oil or the like.
- To prevent malfunction, connect the cables with connectors securely. If the connector has a fixing screw, fix it firmly with the screw.
- To prevent damage to cables, do not bend cables over with excessive force.
- If the area is susceptible to noise, attach ferrite cores to both ends of the communication connection cable. Install the ferrite cores as close to the connectors as possible.

2.2 Wiring for Host Communication

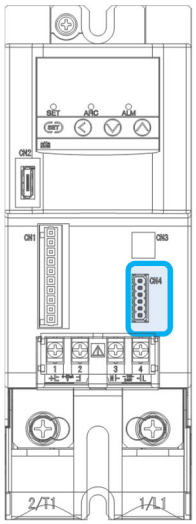
Host communication is used for a connection to a host computer via RS-485.

■ Pin number and signal details

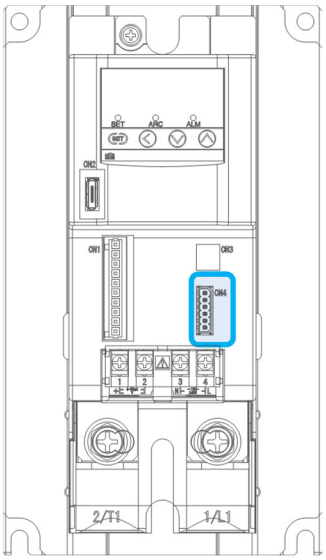
(20A/30A type)



(45A/60A type)



(80A/100A type)



RS-485

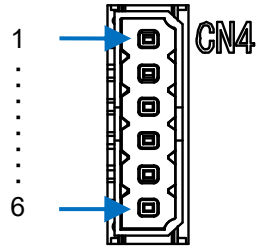
Pin number	Symbol	Signal name
1	SG	Signal ground
2	SG	Signal ground
3	T/R (A)	Send data/Receive data
4	T/R (A)	Send data/Receive data
5	T/R (B)	Send data/Receive data
6	T/R (B)	Send data/Receive data

Pin numbers 1 and 2, pin numbers 3 and 4, and pin numbers 5 and 6 are connected internally.

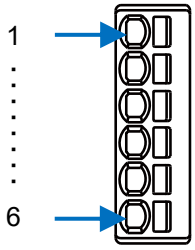
Communication connector [CN4] (Optional)

① Socket side connector: PTSM 0,5/ 6-HV-2,5-SMD WH R44 (manufactured by Phoenix Contact)
② Plug side connector: PTSM 0,5/ 6-P-2,5 WH (manufactured by Phoenix Contact)

① Socket side connector

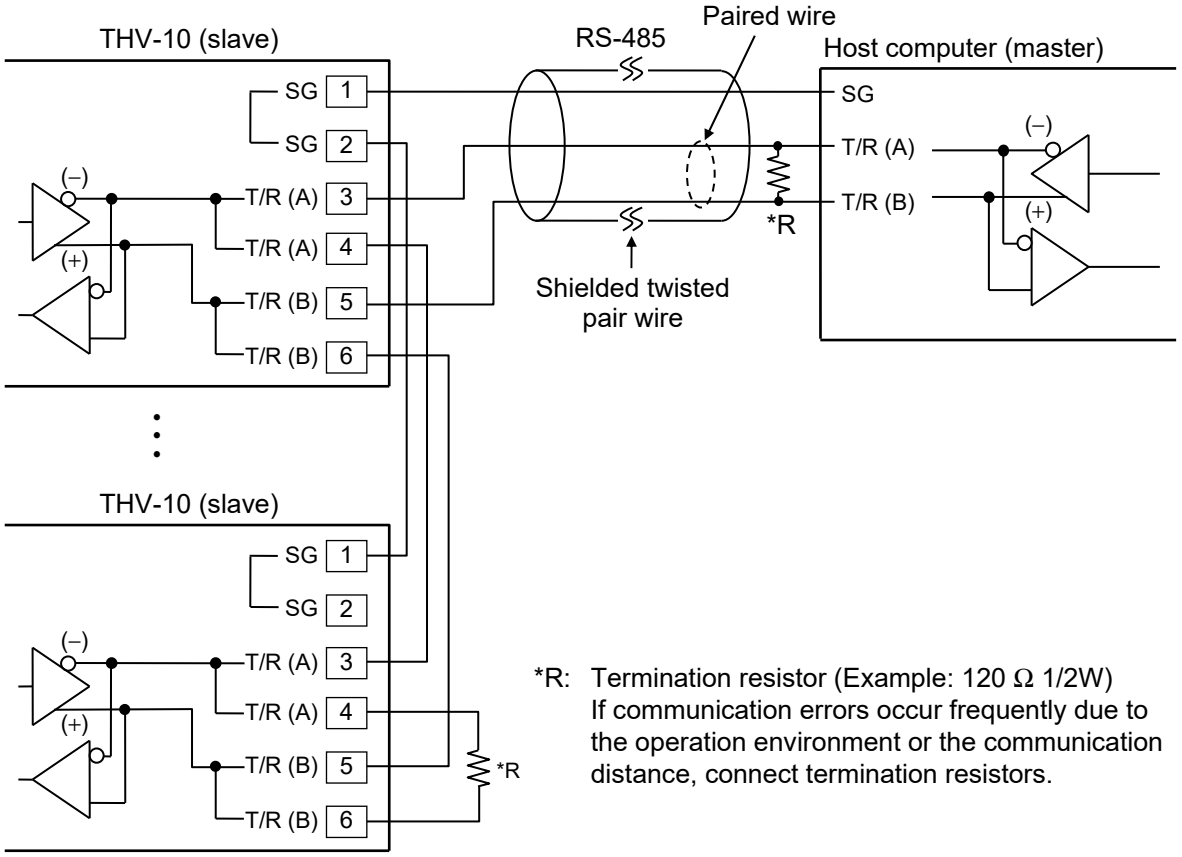


② Plug side connector



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

● Wiring example



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

Maximum connections: Up to 31 instruments

NOTE

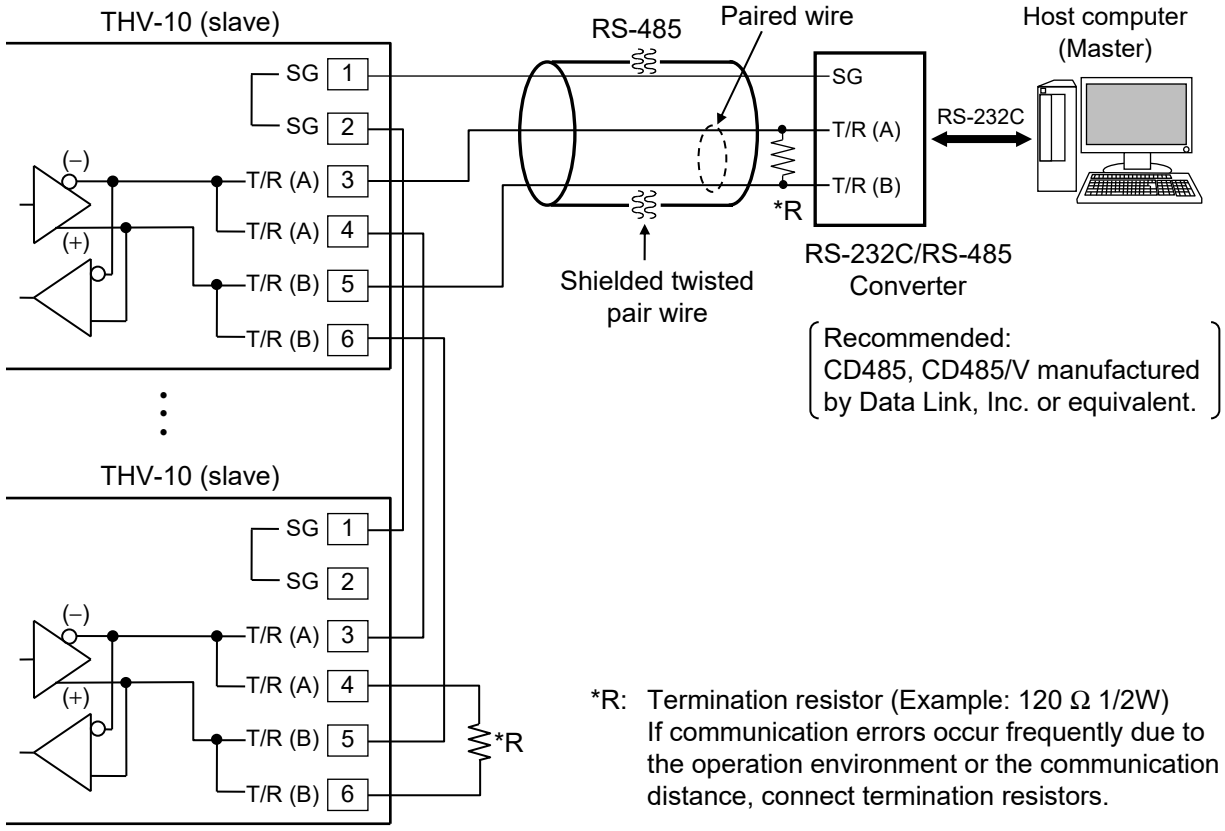
Pin numbers 1 and 2, 3 and 4, and 5 and 6 of the communication connector are connected internally.
Make sure that pin numbers 2, 4, and 6 do not come into contact with other signal wires.

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.

● Wiring example



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

Maximum connections: Up to 31 instruments

NOTE

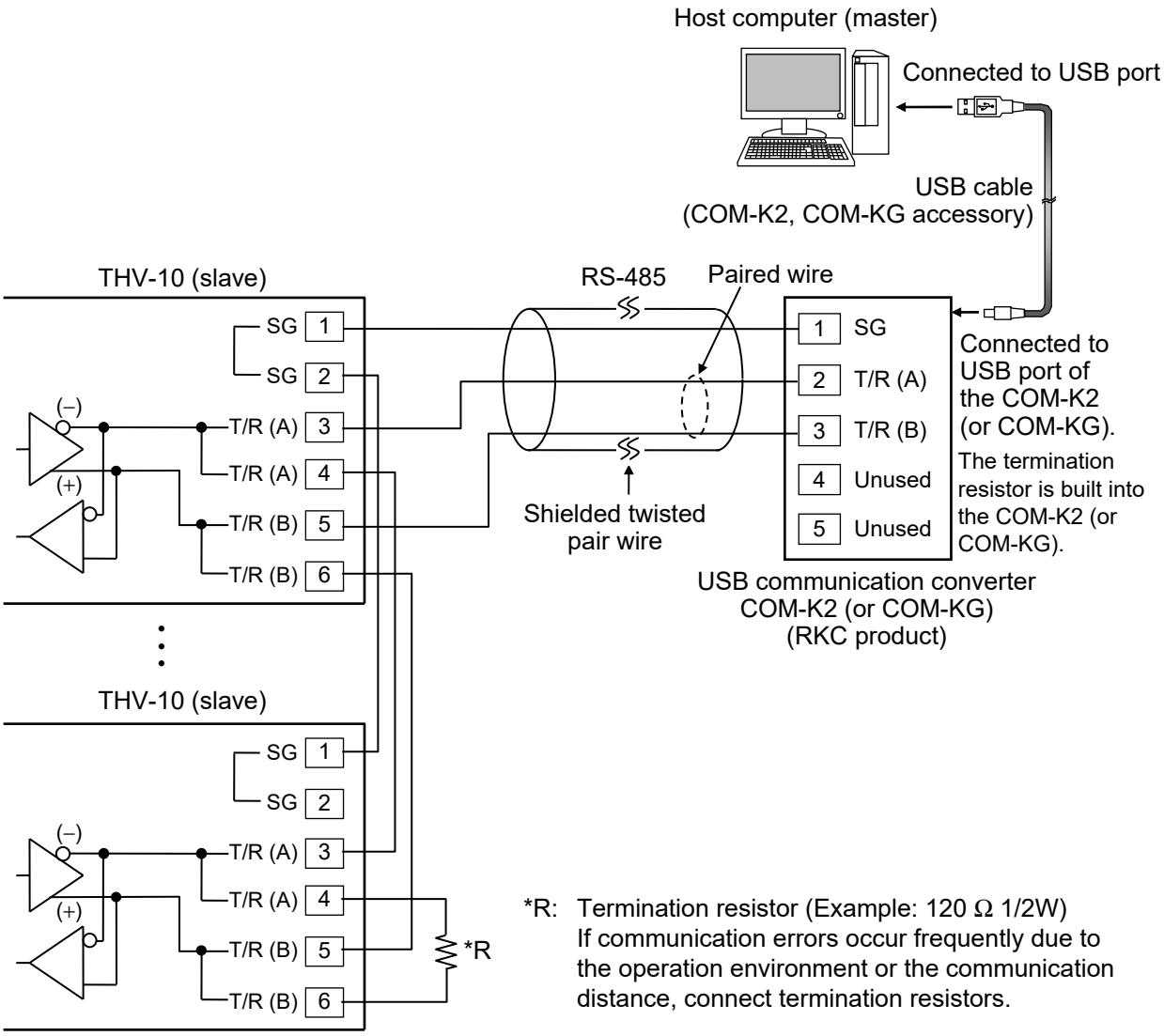
Pin numbers 1 and 2, 3 and 4, and 5 and 6 of the communication connector are connected internally.
Make sure that pin numbers 2, 4, and 6 do not come into contact with other signal wires.

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

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

Connect the USB communication converter between the host computer and the THV-10.

● Wiring example



Maximum connections: Up to 31 instruments

NOTE

Pin numbers 1 and 2, 3 and 4, and 5 and 6 of the communication connector are connected internally.
Make sure that pin numbers 2, 4, and 6 do not come into contact with other signal wires.

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

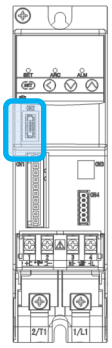
☞ Recommended USB communication converter: C**OM-K2** or **COM-KG (RKC product)**
For the COM-K2, refer to the **COM-K2 Instruction Manual**.
For the COM-KG, refer to the **COM-KG Instruction Manual**.

2.3 Connections for Loader Communication

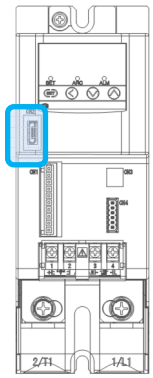
■ Position of loader communication connector

The loader communication connector is located on the front of the THV-10.

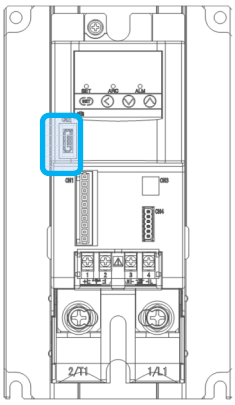
(20A/30A type)



(45A/60A type)



(80A/100A type)

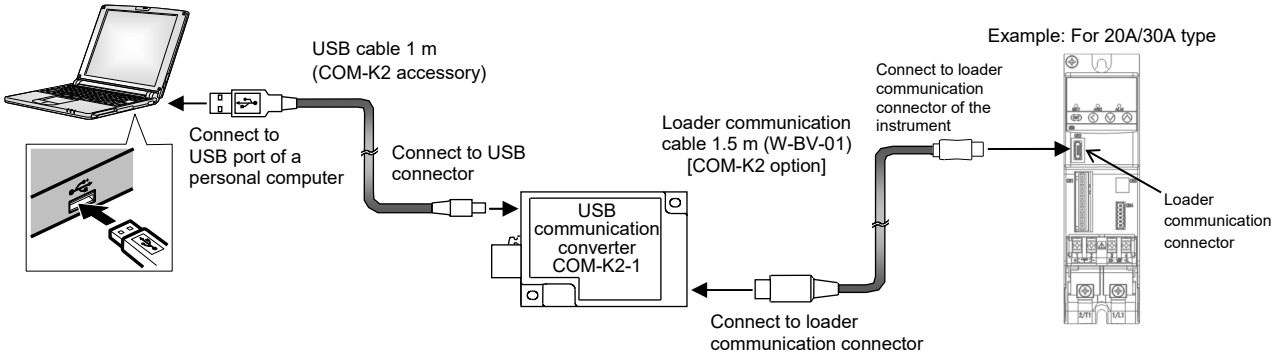


■ Wiring method

Connect the THV-10, COM-K2-1 (or COM-KG) [RKC product, sold separately], and personal computer using a USB cable and a loader communication cable. Make sure the connectors are oriented correctly when connecting.

NOTE

The Loader communication is only for parameter setup. Do not use for data logging or others during operation.



Connection example of loader communication (For COM-K2)

- Communication Tool PROTEM2
  Software operation environment:
  Consult the manual that you downloaded.
- Communication settings on the computer
  (The following values are all fixed)
  Communication speed: 38,400 bps
  Start bit: 1
  Data bit: 8
  Parity bit: None
  Stop bit: 1
- Communication port of host computer
  USB port: Based on USB Ver. 2.0

- The device address during loader communication is fixed at “0.” The setting of the device address is disregarded.
- The loader communication corresponds to the RKC communication protocol “Based on ANSI X3.28-1976 subcategories 2.5 and A4.”
- Loader communication can be used on a THV-10 even when the Communication function (optional) is not installed.

Recommended USB communication converter:
COM-K2-1 of COM-KG (RKC product)
For the COM-K2, refer to the **COM-K2 Instruction Manual**.
For the COM-KG, refer to the **COM-KG Instruction Manual**.

When using the loader communication, USB driver for COM-K2 must be installed on the personal computer. The USB driver can be downloaded the official RKC website. Installation of the USB driver is not necessary when the COM-KG is used on Windows 10.

When the instrument is powered off, power can be supplied to the instrument from COM-K2-1 (or COM-KG). This function is exclusive for parameter setting, and the instrument functions as follows.

- Control is stopped (Output is off).
- Host communication is stopped.
- The monitor screen display unit shows "---."

When the instrument is normally powered, the host communication can be used simultaneously.

PARAMETER SETTING

3

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

3.1 Setting the Communication Parameters

3.1.1 Description of each parameter

To establish communication between THV-10 (slave) and the host computer (master), it is necessary to set the following parameters. The communication related parameters can be found in the Function block 9 (F. 9) of Engineering mode D.

■ Function block 9 (F. 9)

No.	Symbol	Name	Data range	Description	Factory set value
—	F. 9	Function block 9	This is the first parameter of Function block No. 9		—
68	CnP	Communication protocol selection	0: RKC communication 1: Modbus	Select the communication protocol type.	When the communication protocol is specified at the time of order, the specified communication protocol will be the factory set value.
69	Add	Device address	RKC communication: 0 to 99 Modbus: 1 to 99	Do not use the same device address for more than one THV-10 in multi-drop connection.	RKC communication: 0 Modbus: 1
70	bPS	Communication speed	0: 9600 bps 1: 19200 bps 2: 38400 bps 3: 57600 bps	Set the same communication speed for both the THV-10 (slave) and the host computer (master).	0
71	bIT	Data bit configuration	0 to 11 Refer to **Data bit configuration table (P. 3-3)**	Set the same data bit configuration for both the THV-10 (slave) and the host computer (master).	0
72	Int	Interval time	0 to 250 ms	The Interval time is the waiting time between the receipt of the message from the host computer and the transmission of the reply message from THV-10. Adjust the interval time to accommodate the host computer switchover between send and receive.	10

Data bit configuration table

Set value	Data bits	Parity bit	Stop bit
0	8	None	1
1	8	None	2
2	8	Even	1
3	8	Even	2
4	8	Odd	1
5	8	Odd	2

Set value	Data bits	Parity bit	Stop bit
6	7	None	1
7	7	None	2
8	7	Even	1
9	7	Even	2
10	7	Odd	1
11	7	Odd	2

: Not settable for Modbus

Interval time

The interval time for the THV-10 should be set to secure a maximum time for host computer to finish sending the stop bit of the last character and to switch the line to receive status (to allow THV-10 to start transmission). This is the interval time. If the interval time is too short, the THV-10 may enter the send state before the host computer becomes ready to receive. In this case, communication cannot be conducted correctly.

The communication protocol, device address (slave address), communication speed, data bit configuration, and interval time can also be set by loader communication using PROTEM2. It can also be set by host communication.

3.1.2 Setting procedure

The communication related parameters can be found in the Function block 9 (F. 9) of Engineering mode D.

NOTE

Make sure to perform the following step to make the communication parameter settings valid:

• After 2 seconds have passed after setting, turn the power off and then on again.

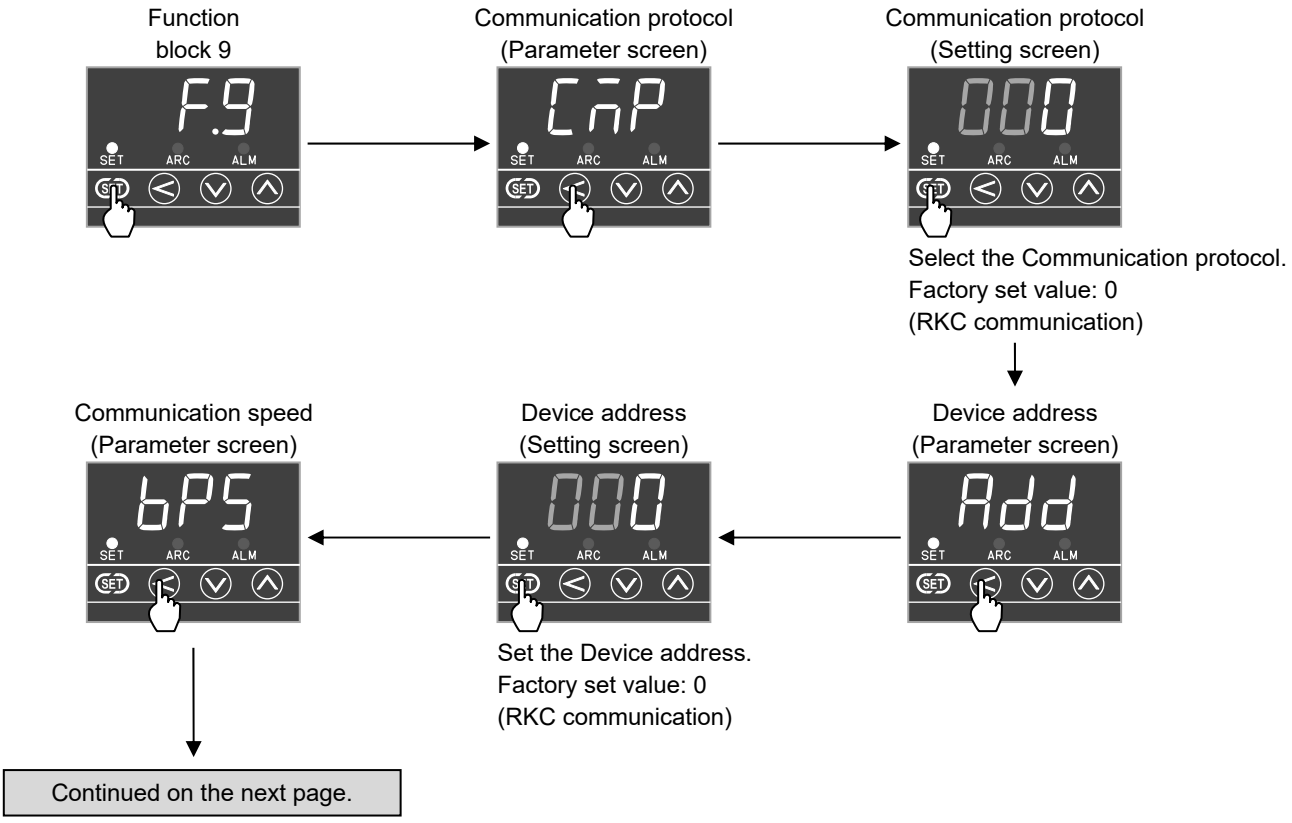
The device address of the instrument may be changed automatically from "0" to "1." For example, if communication protocol is changed from RKC protocol to Modbus when the device address is "0," the device address will be automatically changed to "1."

■ Setting procedure

The set value in Setting mode C cannot be changed while Data lock is active.
The Engineering mode D is not displayed while Data lock is active.

☞ To unlock setting, refer to **20 A/30 A/45 A/60 A/80 A/100 A THV-10 Instruction manual (IMR02W05-E□)**.

1. In Monitor mode A, press the SET key (SET) for 2 seconds to switch to Setting mode C.
2. In Setting mode C, hold down the SET key (SET) and press the Shift key (<) for 2 seconds to switch to Engineering mode D.
3. Press the UP key (^) until F.9 screen.



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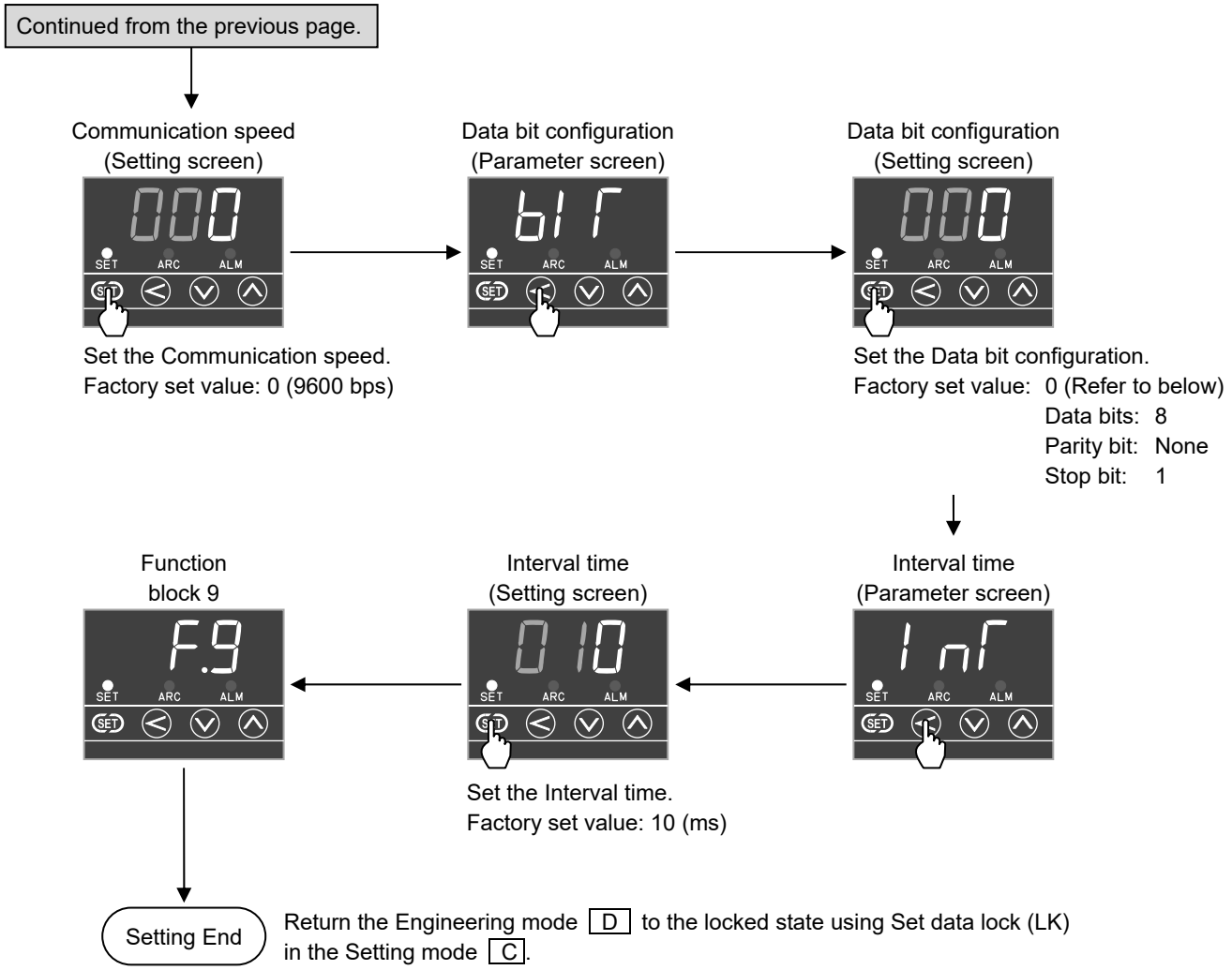

Continued from the previous page.
Communication speed
(Setting screen)
000
Set the Communication speed.
Factory set value: 0 (9600 bps)
Data bit configuration
(Parameter screen)
bIT
Data bit configuration
(Setting screen)
000
Set the Data bit configuration.
Factory set value: 0 (Refer to below)
Data bits: 8
Parity bit: None
Stop bit: 1
Interval time
(Parameter screen)
InT
Interval time
(Setting screen)
010
Set the Interval time.
Factory set value: 10 (ms)
Function
block 9
F.9
Setting End
Return the Engineering mode D to the locked state using Set data lock (LK)
in the Setting mode C.

3.2 Communication Requirements

■ Processing times during data send/receive

When the host computer is using either the polling or selecting procedure for communication, the following processing times are required for THV-10 to send data:
– Response wait time after THV-10 sends BCC in polling procedure
– Response wait time after THV-10 sends ACK or NAK in selecting procedure

Response send time is the time when interval time is set at 0 ms (when used at 50 Hz).

RKC communication (Polling procedure) processing times

Procedure details	Time
Response send time after THV-10 receives ENQ	9.76 ms max.
Response send time after THV-10 receives ACK	11.04 ms max.
Response send time after THV-10 receives NAK	11.04 ms max.
Response send time after THV-10 sends BCC	352 μs max.

RKC communication (Selecting procedure) processing times

Procedure details	Time
Response send time after THV-10 receives BCC	10.04 ms max.
Response wait time after THV-10 sends ACK	16.24 ms max.
Response wait time after THV-10 sends NAK	16.64 ms max.

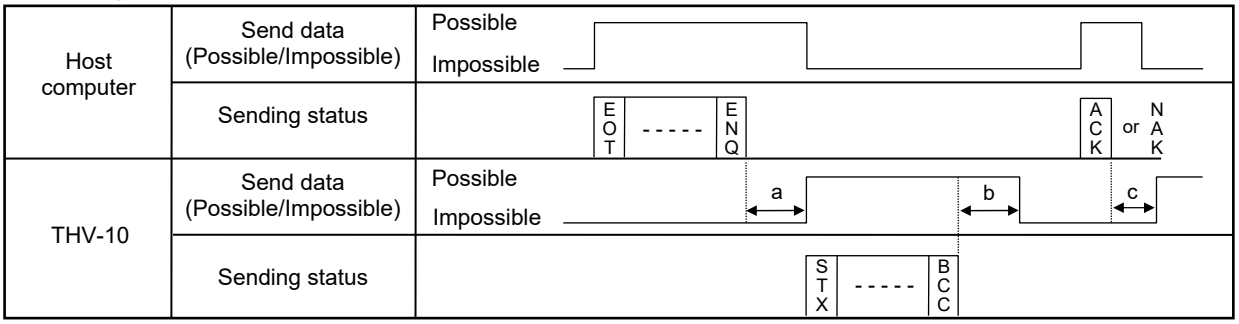
Modbus processing times

Procedure details	Time
Read holding registers [03H] Response send time after the slave receives the query message	12.88 ms max.
Preset single register [06H] Response send time after the slave receives the query message	11.44 ms max.
Diagnostics (loopback test) [08H] Response send time after the slave receives the query message	11.52 ms max.
Preset multiple registers (Write multiple registers) [10H] Response send time after the slave receives the query message	11.84 ms max.

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

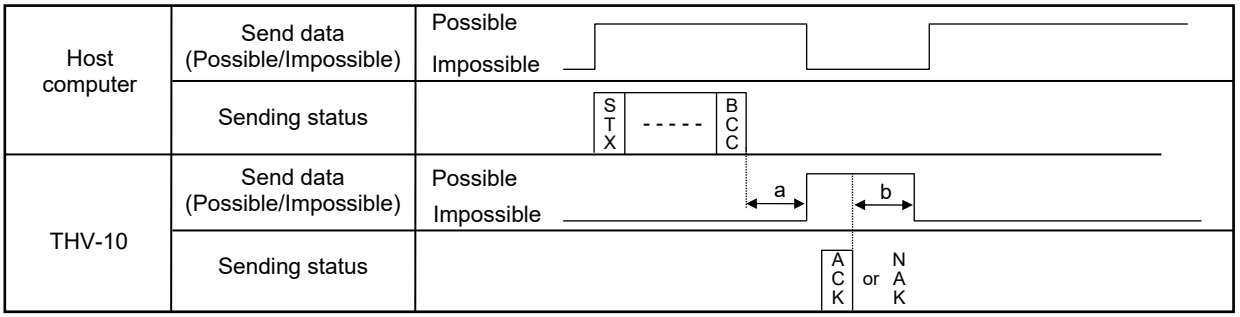
RS-485 communication is conducted through a single transmission line. Therefore, the switching between transmission and reception requires precise timing.

● Polling procedures



a: Response send time after the THV-10 receives [ENQ] + Interval time
b: Response send time after the THV-10 sends BCC
c: Response send time after the THV-10 receives [ACK] + Interval time or
Response send time after the THV-10 receives [NAK] + Interval time

● Selecting procedures



a: Response send time after the THV-10 receives BCC + Interval time
b: Response wait time after the THV-10 sends ACK or Response wait time after the THV-10 sends NAK

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

The following processing times are required for the THV-10 to process data:
– In polling procedure, Response wait time after the THV-10 sends BCC
– In selecting procedure, Response wait time after the THV-10 sends ACK or NAK

■ Fail-safe

A transmission error may occur if the transmission line is disconnected, shorted or set to the high-impedance state. In order to prevent the above errors, 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.

MEMO

RKC COMMUNICATION PROTOCOL

4

This chapter describes the RKC communication protocol.

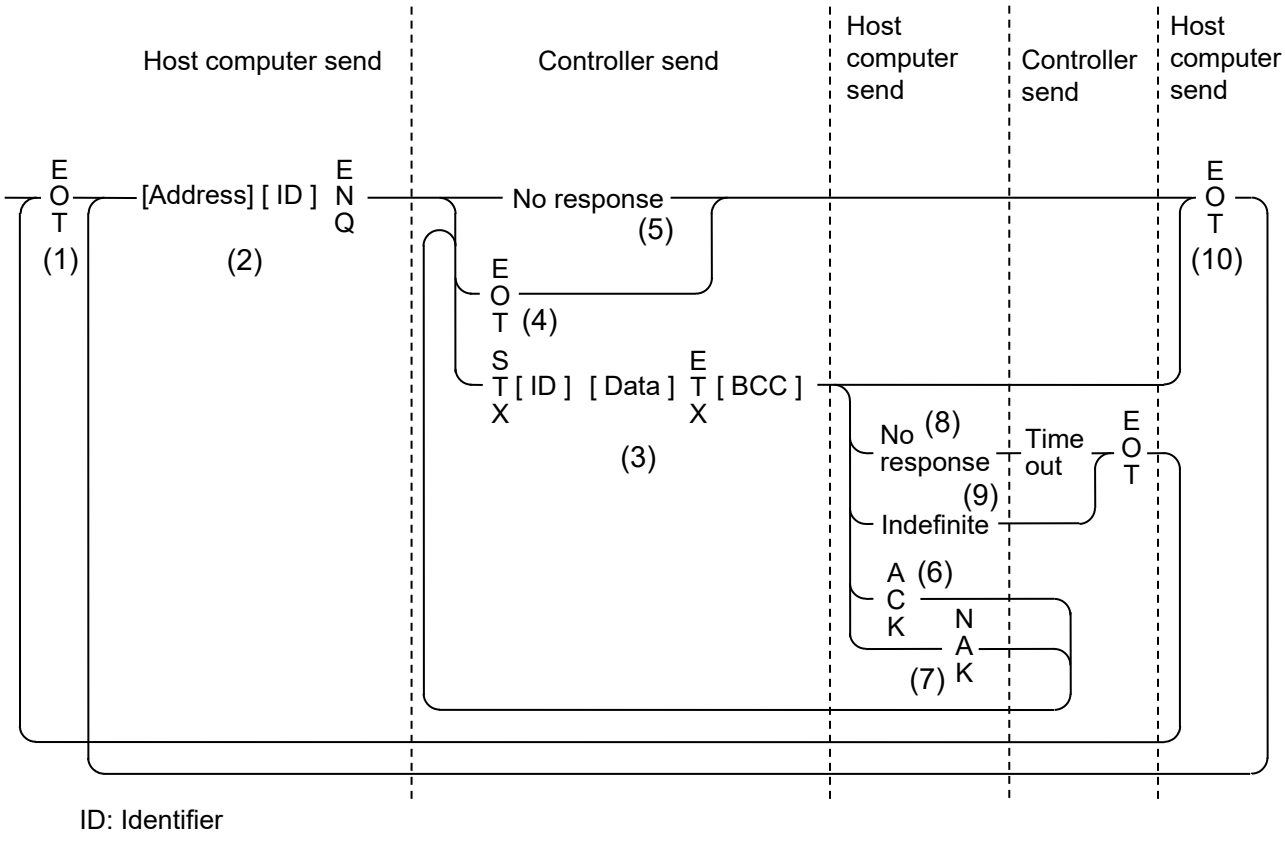
The RKC communication uses the Polling/Selecting method to establish a data link. The basic procedure follows ANSI X3.28-1976 subcategories 2.5 and A4 basic mode data transmission control procedure (Fast selecting is the selecting method used in this controller).
In this chapter THV-10 are called controllers.

- 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 used in communication is 7-bit JIS/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 parentheses 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 software 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:



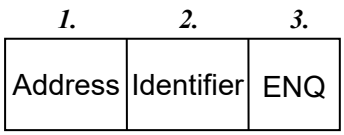
4.1.1 Polling procedures

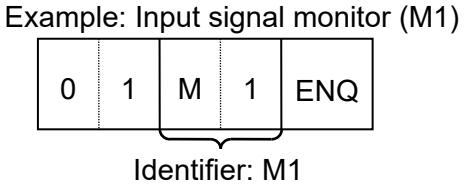
(1) Data link initialization

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

(2) Data sent from host computer - Polling sequence

The host computer sends the polling sequence in the following type of format:





1. Address (2 digits)
The device address specifies the controller to be polled and each controller must have its own unique device address.
This data is a device address of the controller to be selected and must be the same as the device address set value in item **3.1 Setting the Communication Parameters (P. 3-2).**


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

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


For details on identifiers, refer to **6.2 THV-10 Communication Data [RKC Communication/Modbus] (P. 6-4)**.

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.	*2.*	*3.*	*4.*	*5.*
STX	Identifier	Data	ETX	BCC

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

2. Identifier (2 digits)
The identifier indicates the type of data (measured value, status and set value) sent to the host computer.

☞ For details on identifiers, refer to **6.2 THV-10 Communication Data [RKC Communication/Modbus] (P. 6-4)**.

3. Data (digits: 7 digits)
Data which is indicated by an identifier of the controller. It is expressed in decimal ASCII code including a minus sign (−) and a decimal point. Data is not zero-suppressed.

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

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

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

Example:

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

BCC＝4DH ⊕ 31H ⊕ 30H ⊕ 30H ⊕ 31H ⊕ 30H ⊕ 30H ⊕ 2EH ⊕ 30H ⊕ 03H＝50H
(⊕: *Exclusive OR*)
Value of BCC becomes 50H.

(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 data is not sent from the host computer even if the data link is initialized
- When all the data has been sent

(5) No response from the controller

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

(6) ACK (Acknowledgment)

An acknowledgment ACK is sent by the host computer when data received is correct. When the controller receives ACK from the host computer, the controller will send any remaining data of the next identifier without additional action from the host computer.

☞ For the identifier, refer to **6.2 THV-10 communication data [RKC communication/Modbus] (P. 6-4).**

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

(7) NAK (Negative acknowledge)

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

(8) No response from host computer

When the host computer does not respond within approximately three seconds after the controller sends data, the controller sends EOT to terminate the data link. (Time out: Approx. 3 seconds)

(9) Indefinite response from host computer

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

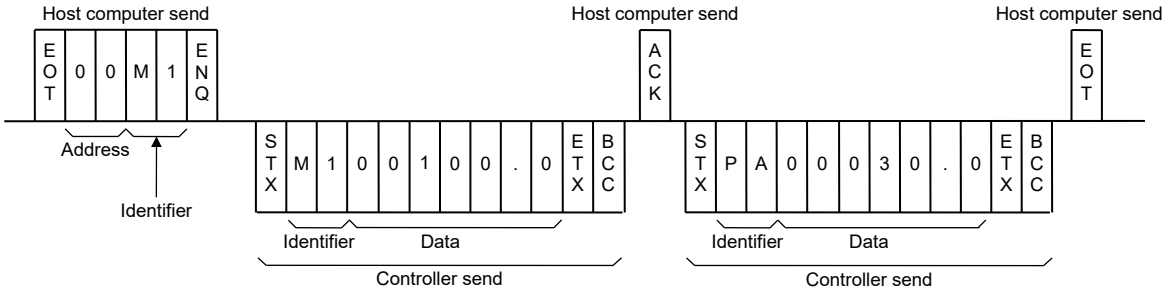
(10) EOT (Data link termination)

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

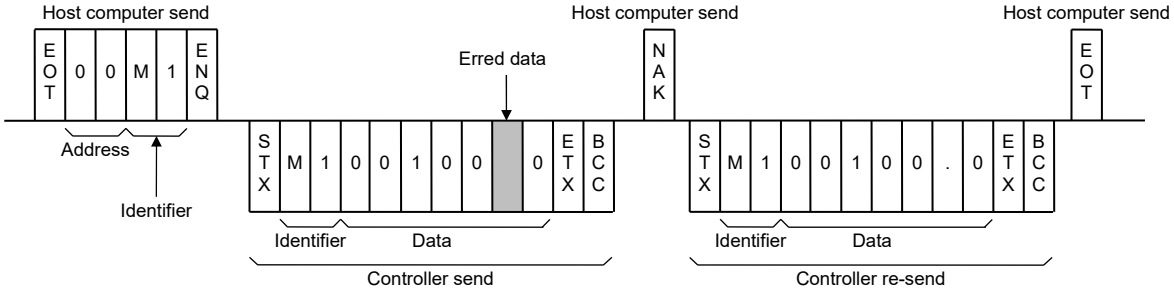
4.1.2 Polling procedure example (when the host computer requests data)

Example: Read Input signal monitor (M1) from the controller

■ **Normal transmission**

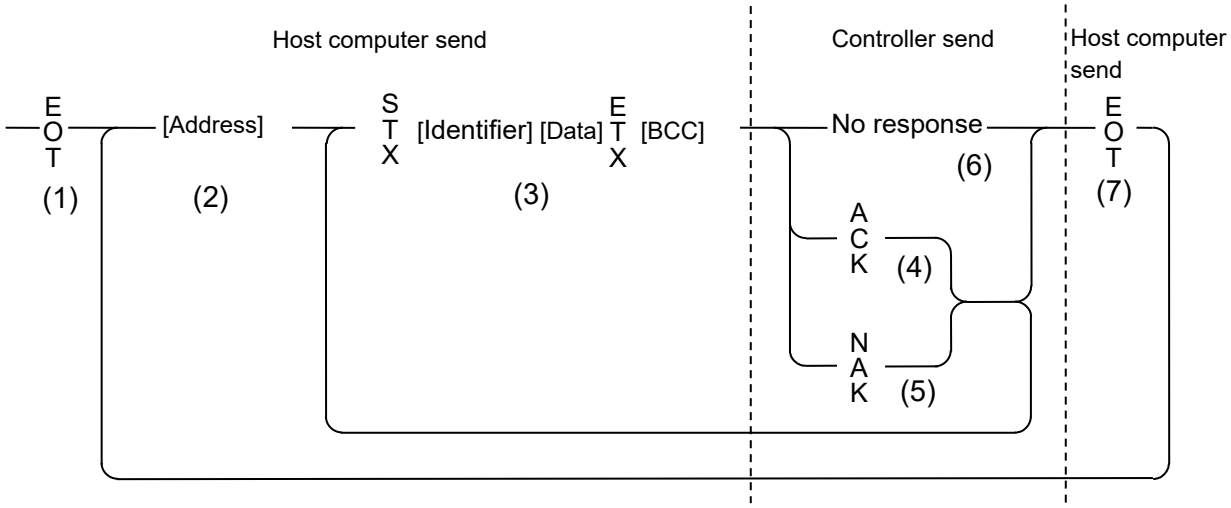


■ **Error transmission**



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.

- Address (2 digits)
  This data is a device address of the controller to be selected and must be the same as the device address set value in item **3.1 Setting the Communication Parameters (P. 3-2)**.

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

(3) Data sent from the host computer

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

	1.	*2.*		
STX	Identifier	Data	ETX	BCC

☞ For the STX, ETX and BCC, refer to **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.

☞ For details, refer to **6.2 THV-10 Communication Data [RKC Communication/Modbus] (P. 6-4)**.

2. Data (7 digits)
Data which is indicated by an identifier of the controller is expressed in decimal ASCII code including a minus sign (–) and a decimal point. The data can be zero-suppressed.

● About numerical data

Receivable data

- The controller can receive zero-suppressed data and whole number data (data without decimal fraction).

  Example: Even if the data –1.5 is sent by the host as –001.5, –01.5, –1.5, –1.50, or –1.500, the controller can receive the data correctly.

- When the host computer sends data containing a decimal point for the item without a decimal point, the controller receives a message with the value that is cut off below the decimal point.

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

Send data	0.5	100.5
Receive data	0	100

- The controller receives a value truncated to a specified number of decimal places. The digits smaller than that will be cut off.

  Example: When setting range is –10.00 to +10.00, the controller will receive as follows:

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

Unreceivable data

The controller sends a NAK when received a following data.

+	Plus sign and data with a plus sign
–	Only minus sign (without a number)
.	Only decimal point (period)
–.	Only minus sign and a decimal point

(4) ACK (Acknowledgment)

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

(5) NAK (Negative acknowledge)

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

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

(6) No response from controller

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

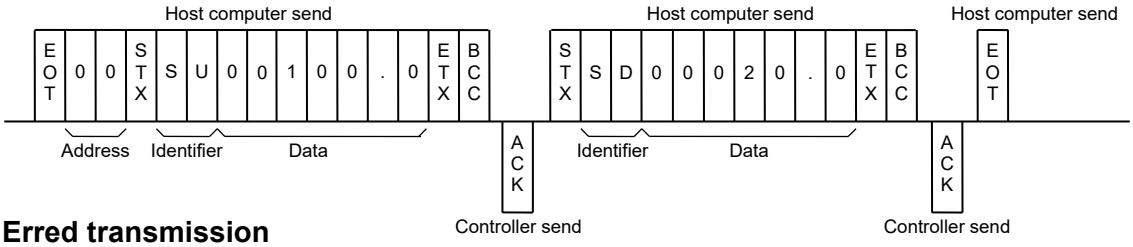
(7) EOT (Data link termination)

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

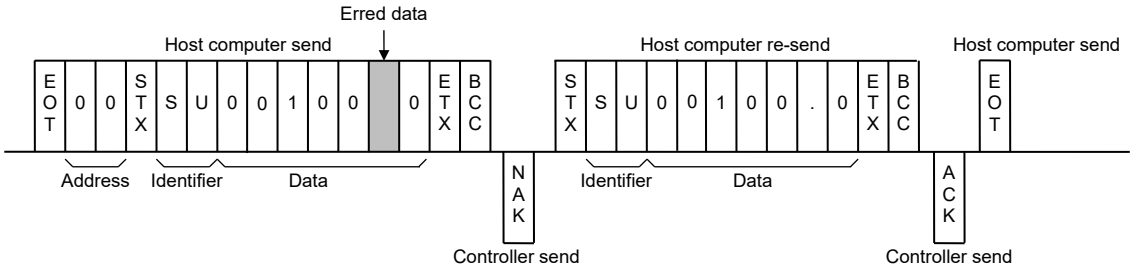
4.2.2 Example of selecting procedure (when the host computer sends the set values)

Example: Write soft-start time data to the controller

■ **Normal transmission**



■ **Erred transmission**



MODBUS PROTOCOL

5

This chapter describes the Modbus protocol.

In this chapter a host computer is called Master and THV-10 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 software 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 THV-10.

Master does not communicate with the slave when the address is set to "0."

For details, refer to **3.1 Setting the Communication Parameters (P. 3-2).**

Although all connected slave units receive the query message sent from the master, only the slave with the slave address coinciding with the query message will accept the message.

■ Function code

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

For details, refer to **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 Register Read and Write (P. 5-8)** and **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ 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 number)	Function	Description
03H	Read holding registers	Input signal monitor, Phase angle ratio monitor, Current value monitor, etc.
06H	Preset single register	Internal manual setting, Internal gradient setting, Soft-start time, Maximum load current value, Heater break alarm set value, etc. (Write single data)
08H	Diagnostics (loopback test)	loopback test
10H	Preset multiple registers (Write multiple registers)	Internal manual setting, Internal gradient setting, Soft-start time, Maximum load current value, Heater break alarm set value, etc.

Message length of each function (Unit: byte)

Function code (Hexadecimal number)	Function	Command message		Response message	
		Min	Max	Min	Max
03H	Read holding registers	8	8	5	255
06H	Preset single register	8	8	5	8
08H	Diagnostics (loopback test)	8	8	5	8
10H	Preset multiple registers (Write multiple registers)	11	255	5	8

5.3 Communication Mode

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

Items	Description
Data bit length	8-bit (Binary)
Start mark of message	Unused
End mark of message	Unused
Message length	Refer to **5.2 Function Code**
Data time interval	Less than 24-bit time *
Error check	CRC-16 (Cyclic Redundancy Check)

* When sending a command message from the master, set intervals of data configuring one message to time shorter than the 24-bit time. If time intervals become time longer than the 24-bit time the relevant slave assumes that message sending from the master is terminated and there is no response.

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.
- In the response message of the Preset Multiple Registers (Write Multiple Registers), the slave returns the slave address, the function code, starting number, and number of holding registers in the multi-query message.

(2) Abnormal case response

- If the query message from the master is defective, except for transmission error, the slave returns the error response message without any action.

Slave address
Function code
Error code
Error check (CRC-16)

Error response message

- If the self-diagnostic function of the slave detects an error, the slave will return an error response message to all query messages.
- The function code of each error response message is obtained by adding 80H to the function code of the query message.

Error code	Contents
1	Function code error (An unsupported function code was specified)
2	When the mismatched address is specified.
3	• The maximum number (Read from a read holding register or write to Preset multiple registers [Write multiple registers]) has been exceeded. • The setting of the number of data (the number of requested byte) is not set to a double of the requested number of data at the time of “Preset multiple registers (Write multiple registers)” • A value exceeding the setting range is written

(3) No response

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

- The slave address in the command message does not coincide with its address settings.
- The slave address reception fails
- The CRC code of the master does not coincide with that of the slave.
- Transmission error such as overrun, framing, parity etc., is found in the query message.
- Data time interval in the query message from the master exceeds 24-bit time.

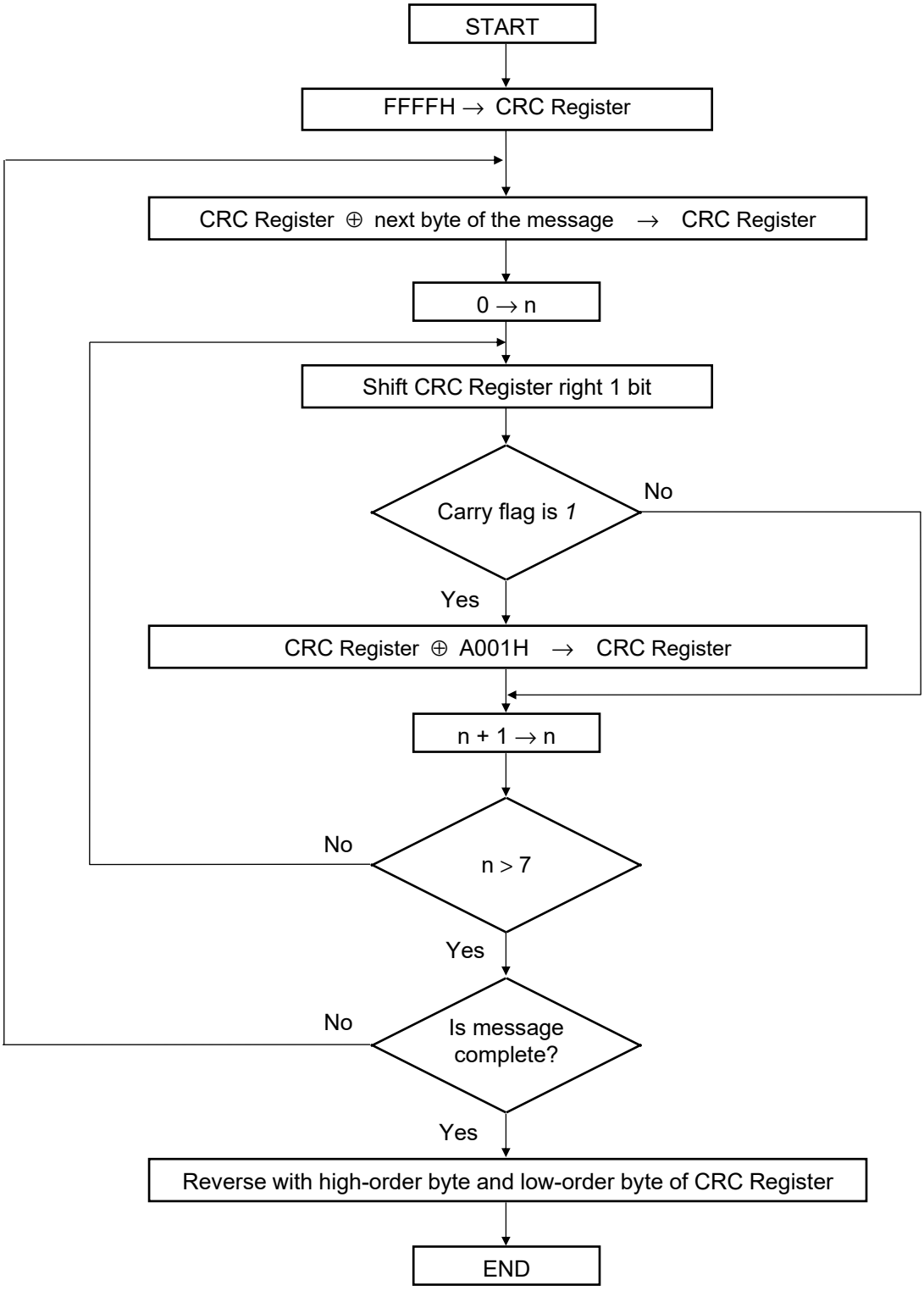
5.5 Calculating CRC-16

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 FFFFH to a 16-bit CRC register.
2. *Exclusive OR* (⊕) the first byte (8 bits) of the message with the CRC register. Return the result to the CRC register.
3. Shift the CRC register 1 bit to the right.
4. If the carry flag is 1, *exclusive OR* the CRC register with A001 hexadecimal and return the result to the CRC register. If the carry flag is 0, repeat step ***3***.
5. Repeat step ***3*** and ***4*** until there have been 8 shifts.
6. *Exclusive OR* the next byte (8 bits) of the message with the CRC register.
7. Repeat step ***3*** through ***6*** for all bytes of the message (except the CRC).
8. The CRC register contains the 2 byte CRC error code. When they are appended to the message, the low-order byte is appended first, followed by the high-order byte.

■ The flow chart of CRC-16



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

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

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

uint16 calculate_crc（byte *z_p, unit16 z_message_length）

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

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

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

5.6 Register Read and Write

■ Read holding registers [03H]

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

[Example] The contents of the four holding registers from 0000H to 0003H are the read out from slave address 2.

Query message

Slave address		02H	
Function code		03H	
Starting number	High	00H	First holding register address
	Low	00H	
Quantity	High	00H	The setting must be between 1(0001H) and 94 (005EH).
	Low	04H	
CRC-16	High	44H	
	Low	3AH	

Normal response message

Slave address		02H	
Function code		03H	
Number of data		08H	→ Number of holding registers × 2
First holding register contents (First data)	High	00H	
	Low	62H	
Next holding register contents (Next data)	High	00H	
	Low	14H	
Next holding register contents (Next data)	High	00H	
	Low	00H	
Next holding register contents (Next data)	High	00H	
	Low	00H	
CRC-16	High	E9H	
	Low	56H	

Error response message

Slave address		02H
80H + Function code (+ denotes a logical add)		83H
Error code		03H
CRC-16	High	F1H
	Low	31H

■ Preset single register [06H]

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

[Example] Data is written into the holding register 0072H of slave address 1.

Query message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	72H
Write data	High	00H
	Low	01H
CRC-16	High	39H
	Low	C8H

} Any data within the range

Normal response message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	72H
Write data	High	00H
	Low	01H
CRC-16	High	39H
	Low	C8H

} Contents will be the same as query message data.

Error response message

Slave address		01H
80H + Function code (+ denotes a logical add)		86H
Error code		02H
CRC-16	High	C3H
	Low	A1H

■ Diagnostics (Loopback test) [08H]

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

Example: Loopback test for slave address 1

Query message

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

Normal response message

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

Error response message

Slave address		01H
80H + Function code (+ denotes a logical add)		88H
Error code		03H
CRC-16	High	06H
	Low	01H

■ Preset multiple registers (Write multiple registers) [10H]

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

Example: Data is written into the two holding registers from 0070H to 0071H of slave address 1.

Query message

Slave address		01H	
Function code		10H	
Starting number	High	00H	First holding register address
	Low	70H	
Quantity	High	00H	The setting must be between 1 (0001H) and 94 (005EH).
	Low	02H	
Number of data		04H	→ Number of holding registers × 2
Data to first register	High	00H	Any pertinent data
	Low	01H	
Data to next register	High	00H	
	Low	00H	
CRC-16	High	E3H	
	Low	DCH	

Normal response message

Slave address		01H
Function code		10H
Starting number	High	00H
	Low	70H
Quantity	High	00H
	Low	02H
CRC-16	High	30H
	Low	0AH

Error response message

Slave address		01H
80H + Function code (+ denotes a logical add)		90H
Error code		02H
CRC-16	High	CDH
	Low	C1H

5.7 Caution for Handling Communication Data

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

  FFFFH represents –1.

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

  Example 1: When Internal manual set value is 5.0%, 5.0 is processed as 50,
  50 = 0032H

Internal manual set value	High	00H
	Low	32H

  Example 2: When Base-up set value is –9.9%, –9.9 is processed as –99,
  – 99 = 0000H – 0063H = FF9DH

Base-up set value	High	FFH
	Low	9DH

- In our communication a variable is handled as a single word.
  - A variable is handled as a two-byte data.
  - Each variable occupies one register address.

- If data (holding register) exceeding the accessible address range is accessed, an error response message is returned.
- Any attempt to write to an unused item is not processed as an error. Data cannot be written into an unused item.
- If data range error occurs during data writing (Write Action), it is not processed as an error. Normal data is written in data register but data with error is not written; therefore, it is recommended to confirm data of changed items after the data setting.
- Communication items not existing in the product because of the specifications are handled as “0” when the data is read in. If write action to this item is performed, no error message is indicated and no data is written.
- Commands should be sent at time intervals of 24 bits after the master receives the response message.

6 COMMUNICATION DATA LIST

This chapter describes communication data.

6.1 How to Read the Table

This part describes how to read the data map.

(1) (2) (3) (4) (5) (6) (7) (8)

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
1	Input signal monitor	**M1**	7	0000	0000	RO	0.0 to 100.0%	—
2	Phase angle ratio monitor	**PA**	7	0001	0001	RO	0.0 to 100.0%	—

(1) No.: Communication data number

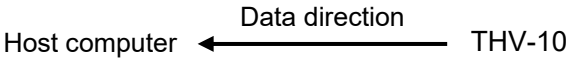
(2) Name: Communication data name
[Screen number.□□]: Screen number used in parameter select setting.

(3) Identifier: Identifier for RKC communication

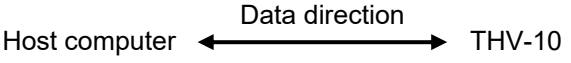
(4) Digits: Number of digits for RKC communication

(5) Register address: Register address for Modbus communication
(HEX: Hexadecimal number, DEC: Decimal number)

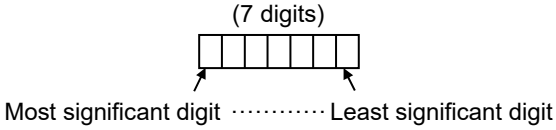
(6) Attributes: A method of how communication data items are read or written when viewed from the host computer is described.
RO: Read only data



R/W: Read and Write data allowed



(7) Data range: Read or write range of communication data
• **ASCII code data**



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

The communication data include “Normal setting data” and “Engineering mode data.”

Normal setting data: No. 1 to 23

Engineering mode data: Nos. 24 to 94

Engineering mode data is locked upon factory shipping. When locked, the attribute is RO (read data only allowed).

⚠ WARNING

Communication data in the Engineering mode [D] should be set according to the application before setting any parameter related to operation. Once the communication data in the Engineering mode [D] are set correctly, no further changes need to be made to parameters for the same application under normal conditions. If they are changed unnecessarily, it may result in malfunction or failure of the instrument. RKC will not bear any responsibility for malfunction or failure as a result of improper changes in the Engineering mode [D].

NOTE

To set data in Engineering mode [D], it is necessary to unlock it. To unlock Engineering mode [D], use the set data lock (RKC communication identifier: LK, Modbus Register address: 0010H).

6.2 THV-10 Communication Data [RKC comunication/Modbus]

The following table shows communication identifiers of RKC communication and register address of Modbus.

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
1	Input signal monitor	**M1**	7	0000	0000	RO	0.0 to 100.0%	—
2	Phase angle ratio monitor	**PA**	7	0001	0001	RO	0.0 to 100.0%	—
3	CT input monitor	**CT**	7	0002	0002	RO	0.0 to 40.0 A (20 A type) 0.0 to 40.0 A (30 A type) 0.0 to 90.0 A (45 A type) 0 to 120 A (60 A type) 0 to 160 A (80 A type) 0 to 200 A (100 A type)	—
4	Power value monitor	**PO**	7	0003	0003	RO	0.0 to 7.5 kW (20 A type) 0.0 to 11.3 kW (30 A type) 0.0 to 17.0 kW (45 A type) 0.0 to 22.6 kW (60 A type) 0.0 to 30.2 kW (80 A type) 0.0 to 37.8 kW (100 A type)	—
5	Powor frequency monitor	**IF**	7	0004	0004	RO	40 to 70 Hz	—
6	Control input monitor	**M2**	7	0005	0005	RO	0.0 to 100.0%	—
7	External gradient set value monitor	**EG**	7	0006	0006	RO	0.0 to 100.0%	—
8	External manual set value monitor	**EM**	7	0007	0007	RO	0.0 to 100.0%	—
9	Contact input state monitor	**DI**	7	0008	0008	RO	0: Contact open 1: Contact closed	—
10	Alarm monitor	**AL**	7	0009	0009	RO	0 to 191 0: No alaram 1: Heater break alarm 1 2: Thyristor break-down alarm 1 4: Heater break alarm 2 8: Thyristor break-down alarm 2 16: Power supply frequency abnormal 32: Over current alarm 128: FAIL If two or more alarms have occurred, the sum of the error numbers is displayed.	—
11	Error code	**ER**	7	000A	0010	RO	1: Adjustment data error 2: Back-up error 4: A/D conversion error When two or more errors occur at the same time, those error codes are summed up.	—
12	Internal manual set value [Screen number 1]	**IM**	7	000B	0011	R/W	0.0 to 100.0% If the power is turned off, internal manual set value is reset to “0.0.”	0.0
13	Internal gradient set value [Screen number 2]	**IG**	7	000C	0012	R/W	0.00 to 2.00	1.00
14	Soft-start time [Screen number 3]	**SU**	7	000D	0013	R/W	0.0 to 199.9 seconds (0.0: Soft-start function unused)	0.1

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
15	Soft-down time [Screen No. 4]	**SD**	7	000E	0014	R/W	0.0 to 199.9 seconds (0.0: Soft-down function unused)	0.1
16	Load power supply voltage [Screen No. 5]	**LP**	7	000F	0015	R/W	85 to 264 V	220
17	Set data lock [Screen No. 6]	**LK**	7	0010	0016	R/W	Least significant digit: Setting mode [C] 2nd digit: Engineering mode [D] 3rd digit: Parameter select mode [B] 4th digit to 7th digit: Unused Data 0, 2 to 9: Locked 1: Unlocked	101
18	Maximum load current value [Screen No. 7]	**MC**	7	0011	0017	R/W	0.0 to 32.0 A (20 A type)	20.0
							0.0 to 32.0 A (30 A type)	30.0
							0.0 to 55.0 A (45 A type)	45.0
							0 to 70 A (60 A type)	60
							0 to 90 A (80 A type)	80
							0 to 110 A (100 A type)	100
19	Heater break alarm 1 setting [Screen No. 8]	**H1**	7	0012	0018	R/W	Type 1 and Non-linear resistance heater break alarm: 0 to 100% of the reference current* Type 2: 0 to 100% of Maximum load current value 0: Heater break alarm 1 unused * The reference current is the load current value that is assumed for the output phase angle of this instrument.	20
20	Thyristor break-down detection 1 setting [Screen No. 9]	**TB**	7	0013	0019	R/W	Type 1 and Non-linear resistance heater break alarm: 0 to 100% of the reference current* Type 2: 0 to 100% of Maximum load current value 0: Thyristor break-down 1 unused * The reference current is the load current value that is assumed for the output phase angle of this instrument.	20
21	Heater break alarm 2 setting [Screen No. 10]	**H2**	7	0014	0020	R/W	Type 1 and Non-linear resistance heater break alarm: 0 to 100% of the reference current* Type 2: 0 to 100% of Maximum load current value 0: Heater break alarm 2 unused * The reference current is the load current value that is assumed for the output phase angle of this instrument.	15

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
22	Thyristor break-down detection 2 setting [Screen No. 11]	**TC**	7	0015	0021	R/W	Type 1 and Non-linear resistance heater break alarm: 0 to 100% of reference current* Type 2: 0 to 100% of Maximum load current value 0: Thyristor break-down 2 unused * The reference current is the load current value that is assumed for the output phase angle of this instrument.	15
23	Current limit value setting [Screen No. 12]	**CL**	7	0016	0022	R/W	0.0 to 32.0 A (20 A type)	32.0
							0.0 to 32.0 A (30 A type)	32.0
							0.0 to 55.0 A (45 A type)	55.0
							0 to 70 A (60 A type)	70
							0 to 90 A (80 A type)	90
							0 to 110 A (100 A type)	110

Nos. 24 to 94 are Engineering mode data.

⚠ WARNING

Communication data in the Engineering mode [D] should be set according to the application before setting any parameter related to operation. Once the communication data in the Engineering mode [D] are set correctly, no further changes need to be made to parameters for the same application under normal conditions. If they are changed unnecessarily, it may result in malfunction or failure of the instrument. RKC will not bear any responsibility for malfunction or failure as a result of improper changes in the Engineering mode [D].

NOTE

To set data in Engineering mode [D], it is necessary to unlock it. To unlock Engineering mode [D], use the set data lock (RKC communication identifier: LK, Modbus Register address: 0010H).

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
24	Contact input (DI) function assignment [Screen No. 13]	**C1**	7	0017	0023	R/W	0: No function 1: Control method Open: Phase control Closed: Zero-cross control 2: Input signal transfer Open: Auto setting Closed: Manual setting 3: Manual input Open: External manual mode Closed: Internal manual mode 4: RUN/STOP transfer Open: STOP Closed: RUN 5: Soft-start, Soft-down enable/disable Open: Enabled Closed: Disabled 6: Heater break alarm enable/disable Open: Enabled Closed: Disabled 7: Over current alarm enable/disable Open: Enabled Closed: Disabled 8: Set data lock enable/disable Open: Enabled Closed: Disabled	0
25	Control method [Screen No. 14]	**CM**	7	0018	0024	R/W	0: Phase control 1: Zero-cross control (continuous) 2: Zero-cross control (input synchronous type)	0
26	Input signal type selection [Screen No. 15]	**XI**	7	0019	0025	R/W	0: 4 to 20 mA DC 1: 1 to 5 V DC 2: 0 to 10 V DC, 0/12 V DC	Based on model code
27	Input signal transfer [Screen No. 16]	**DA**	7	001A	0026	R/W	0: Auto mode 1: Manual mode	0
28	Manual mode transfer [Screen No. 17]	**AM**	7	001B	0027	R/W	0: External manual mode 1: Internal manual mode	0

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
29	RUN/STOP transfer [Screen No. 18]	**RS**	7	001C	0028	R/W	0: STOP (Output OFF) 1: RUN (Output ON)	1
30	Soft-start, Soft-down enable/disable [Screen No. 19]	**SF**	7	001D	0029	R/W	0: Disabled 1: Enabled (Except switching from STOP to RUN) 2: Enabled	2
31	Heater break alarm enable/disable [Screen No. 20]	**HF**	7	001E	0030	R/W	0: Disabled 1: Enabled	1
32	Over current alarm enable/disable [Screen No. 21]	**OF**	7	001F	0031	R/W	0: Disabled 1: Enabled	1
33	Output mode for phase control [Screen No. 22]	**OS**	7	0020	0032	R/W	0: Proportional phase angle to input 1: Proportional voltage to input 2: Proportional square voltage (electric power) to input 3: Constant current control (optional) 4: Power proportional control (optional)	2
34	Output limiter high [Screen No. 23]	**LH**	7	0021	0033	R/W	0.0 to 100.0% (Output limiter high ≧ Output limiter low)	100.0
35	Output limiter low [Screen No. 24]	**LL**	7	0022	0034	R/W	0.0 to 100.0% (Output limiter high ≧ Output limiter low)	0.0
36	Output limiter high at operation start [Screen No. 25]	**LS**	7	0023	0035	R/W	0.0 to 100.0%	50.0
37	Output limiter high time at operation start [Screen No. 26]	**LT**	7	0024	0036	R/W	0 to 600 seconds	0
38	Base-up set value [Screen No. 27]	**BU**	7	0025	0037	R/W	–9.9 to +100.0%	0.0
39	Minimum output phase angle adjustment [Screen No. 28]	**Mo**	7	0026	0038	R/W	Output phase angle 5.0 to 15.0%	5.0
40	SCR trigger signal setting [Screen No. 29]	**SC**	7	0027	0039	R/W	Phases of the supply voltage for the instrument and the supply voltage for the load 0: Same phase 1: Opposite phase	0
41	Alarm output logic [Screen No. 30]	**L1**	7	0028	0040	R/W	0 to 191 0: No output 1: Heater break alarm 1 2: Thyristor break-down alarm 1 4: Heater break alarm 2 8: Thyristor break-down alarm 2 16: Power frequency abnormal 32: Over current alarm 128: FAIL (De-energized fixed) To select multiple alarm outputs, set the sum of the relevant alarm outputs.	0
42	Selection of energized/ de-energized alarm outpu [Screen No. 31]	**NA**	7	0029	0041	R/W	0: Energized 1: De-energized When the set value of the alarm output logic is 128 or more, the alarm will function as “1: de-energized.”	0

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
43	Alarm type selection [Screen No. 32]	**A1**	7	002A	0042	R/W	0: Type 1 (constant resistance type, deviation alarm) 1: Type 2 (linearity resistor type, absolute value alarm) 2: Non-linear resistance heater break alarm (Non-linear resistance type, deviation alarm) In the case of Zero-cross control (continuous, input synchronous type), alarm is operated as Type 2 regardless of the set value.	0
44	Number of alarm 1 determination [Screen No. 33]	**N1**	7	002B	0043	R/W	1 to 1000 times	30
45	Number of alarm 2 determination [Screen No. 34]	**N2**	7	002C	0044	R/W	1 to 1000 times	300
46	Alarm enable/disable during STOP [Screen No. 35]	**SA**	7	002D	0045	R/W	0: Disabled 1: Enabled	0
47	Default display selection [Screen No. 36]	**DM**	7	002E	0046	R/W	0: Input signal monitor 1: CT input monitor 2: Power frequency monitor 3: Power value monitor If whichever of 1, 2, or 3 is attempted to be set on the THV-10 without a built-in current transformer CT, the display will go back to "0: Input signal monitor."	0
48	Display off timer [Screen No. 37]	**DT**	7	002F	0047	R/W	0 to 1000 seconds (0: Constantly lit)	0
49	Integrated operation time (upper 3 digits) [Screen No. 38]	**WH**	7	0030	0048	RO	0 to 999 (Display resolution: 1000 hours)	0
50	Integrated operation time (lower 3 digits) [Screen No. 39]	**WL**	7	0031	0049	RO	0 to 999 (Display resolution: 1 hour)	0
51	ROM version (High-order) [Screen No. 40]	**VR**	7	0032	0050	RO	Fixed value (Version number)	Fixed value
52	ROM version (Low-order) [Screen No. 41]	**VQ**	7	0033	0051	RO	Fixed value (Running number)	Fixed value
53	Automatic calculation time for knee points [Screen No. 42]	**HT**	7	0034	0052	R/W	0 to 1000 seconds (0: Automatic detection function of knee points unused)	20
54	Automatic detection of knee points [Screen No. 43]	**HU**	7	0035	0053	R/W	0: OFF 1: ON 2: Aborted (The data "2" is read only)	0
55	Phase angle ratio at knee point 1 [Screen No. 44]	**K1**	7	0036	0054	R/W	0 to 100%	18
56	Current value at knee point 1 [Screen No. 45]	**R1**	7	0037	0055	R/W	0.0 to 32.0 A (20 A type)	3.6
							0.0 to 32.0 A (30 A type)	5.4
							0.0 to 55.0 A (45 A type)	8.1
							0 to 70 A (60 A type)	11
							0 to 90 A (80 A type)	14
							0 to 110 A (100 A type)	18

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
57	Phase angle ratio at knee point 2 [Screen No. 46]	**K2**	7	0038	0056	R/W	0 to 100%	36
58	Current value at knee point 2 [Screen No. 47]	**R2**	7	0039	0057	R/W	0.0 to 32.0 A (20 A type)	7.2
							0.0 to 32.0 A (30 A type)	10.8
							0.0 to 55.0 A (45 A type)	16.2
							0 to 70 A (60 A type)	22
							0 to 90 A (80 A type)	29
							0 to 110 A (100 A type)	36
59	Phase angle ratio at knee point 3 [Screen No. 48]	**K3**	7	003A	0058	R/W	0 to 100%	56
60	Current value at knee point 3 [Screen No. 49]	**R3**	7	003B	0059	R/W	0.0 to 32.0 A (20 A type)	11.2
							0.0 to 32.0 A (30 A type)	16.8
							0.0 to 55.0 A (45 A type)	25.2
							0 to 70 A (60 A type)	34
							0 to 90 A (80 A type)	45
							0 to 110 A (100 A type)	56
61	Protection function for control of primary side of a transformer [Screen No. 50]	**TF**	7	003C	0060	R/W	0: Protection function for control of primary side of a transformer disable 1: Protection function for control of primary side of a transformer enable	0
62	Determination set value in case of a break on the secondary side of the transformer [Screen No. 51]	**TA**	7	003D	0061	R/W	0 to 100% of reference current value	70
63	Output limiter setting in case of a break on the secondary side of the transformer [Screen No. 52]	**TL**	7	003E	0062	R/W	15.0 to 50.0% of phase angle	15.0
64	Soft-start time in case of break on the secondary side of the transformer [Screen No. 53]	**TU**	7	003F	0063	R/W	0.1 to 100.0 seconds	0.1
65	Retransmission output type [Screen No. 54]	**Ao**	7	0040	0064	R/W	0: No retransmission output 1: Manipulated output value 2: CT input monitor (optional) 3: Power value monitor (optional)	Based on model code
66	Retransmission output scale high [Screen No. 55]	**HV**	7	0041	0065	R/W	0.0 to 100.0% (Retransmission output scale high≧ Retransmission output scale low)	100.0
67	Retransmission output scale low [Screen No. 56]	**HW**	7	0042	0066	R/W	0.0 to 100.0% (Retransmission output scale high≧ Retransmission output scale low)	0.0
68	Communication protocol [Screen No. 57]	**IS**	7	0043	0067	R/W	0 RKC communication 1: Modbus	Based on model code
69	Device address [Screen No. 58]	**IP**	7	0044	0068	R/W	RKC communication: 0 to 99 Modbus: 1 to 99	Based on model code
70	Communication speed [Screen No. 59]	**IR**	7	0045	0069	R/W	0: 9600 bps 2: 38400 bps 1: 19200 bps 3: 57600 bps	0

<table>
<tr><th rowspan="2">No.</th><th rowspan="2">Name</th><th rowspan="2">Identifier</th><th rowspan="2">Digits</th><th colspan="2">Register address</th><th rowspan="2">Attribute</th><th rowspan="2">Data range</th><th rowspan="2">Factory set value</th></tr>
<tr><th>HEX</th><th>DEC</th></tr>
<tr><td>71</td><td>Data bit configuration
[Screen No. 60]</td><td>IQ</td><td>7</td><td>0046</td><td>0070</td><td>R/W</td><td>0 to 11
<table><tr><th>Set value</th><th>Data bits</th><th>Parity bits</th><th>Stop bits</th></tr><tr><td>0</td><td>8</td><td>None</td><td>1</td></tr><tr><td>1</td><td>8</td><td>None</td><td>2</td></tr><tr><td>2</td><td>8</td><td>Even</td><td>1</td></tr><tr><td>3</td><td>8</td><td>Even</td><td>2</td></tr><tr><td>4</td><td>8</td><td>Odd</td><td>1</td></tr><tr><td>5</td><td>8</td><td>Odd</td><td>2</td></tr><tr><td>6</td><td>7</td><td>None</td><td>1</td></tr><tr><td>7</td><td>7</td><td>None</td><td>2</td></tr><tr><td>8</td><td>7</td><td>Even</td><td>1</td></tr><tr><td>9</td><td>7</td><td>Even</td><td>2</td></tr><tr><td>10</td><td>7</td><td>Odd</td><td>1</td></tr><tr><td>11</td><td>7</td><td>Odd</td><td>2</td></tr></table>RKC communication: 0 to 11
Modbus: 0 to 5</td><td>0</td></tr>
<tr><td>72</td><td>Interval time
[Screen No. 61]</td><td>IT</td><td>7</td><td>0047</td><td>0071</td><td>R/W</td><td>0 to 250 ms</td><td>10</td></tr>
<tr><td>73</td><td>Parameter select setting 1</td><td>JA</td><td>7</td><td>0048</td><td>0072</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>14
(Control method)</td></tr>
<tr><td>74</td><td>Parameter select setting 2</td><td>JB</td><td>7</td><td>0049</td><td>0073</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>3
(Soft-start time)</td></tr>
<tr><td>75</td><td>Parameter select setting 3</td><td>JC</td><td>7</td><td>004A</td><td>0074</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>4
(Soft-down time)</td></tr>
<tr><td>76</td><td>Parameter select setting 4</td><td>JD</td><td>7</td><td>004B</td><td>0075</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>2
(Internal gradient set value)</td></tr>
<tr><td>77</td><td>Parameter select setting 5</td><td>JE</td><td>7</td><td>004C</td><td>0076</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>23
(Output limiter high)</td></tr>
<tr><td>78</td><td>Parameter select setting 6</td><td>JF</td><td>7</td><td>004D</td><td>0077</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>24
(Output limiter low)</td></tr>
<tr><td>79</td><td>Parameter select setting 7</td><td>JG</td><td>7</td><td>004E</td><td>0078</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>27
(Base-up set value)</td></tr>
<tr><td>80</td><td>Parameter select setting 8</td><td>JH</td><td>7</td><td>004F</td><td>0079</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>22
(Output mode for phase control)</td></tr>
<tr><td>81</td><td>Parameter select setting 9</td><td>JI</td><td>7</td><td>0050</td><td>0080</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>1
(Internal manual set value)</td></tr>
<tr><td>82</td><td>Parameter select setting 10</td><td>JJ</td><td>7</td><td>0051</td><td>0081</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>13
(Contact input (DI) function assignment)</td></tr>
<tr><td>83</td><td>Parameter select setting 11</td><td>JK</td><td>7</td><td>0052</td><td>0082</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>7
(Maximum load current value)</td></tr>
<tr><td>84</td><td>Parameter select setting 12</td><td>JL</td><td>7</td><td>0053</td><td>0083</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>8
(Heater break alarm 1 setting)</td></tr>
<tr><td>85</td><td>Parameter select setting 13</td><td>JM</td><td>7</td><td>0054</td><td>0084</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>33
(Number of alarm 1 determination)</td></tr>
<tr><td>86</td><td>Parameter select setting 14</td><td>JN</td><td>7</td><td>0055</td><td>0085</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>32
(Alarm type selection)</td></tr>
<tr><td>87</td><td>Parameter select setting 15</td><td>JO</td><td>7</td><td>0056</td><td>0086</td><td>R/W</td><td>0 to 61 (Screen No.)
0: No registration</td><td>30
(Alarm output logic selection)</td></tr>
</table>

No.	Name	Identifier	Digits	Register address		Attribute	Data range	Factory set value
				HEX	DEC			
88	Parameter select setting 16	**JP**	7	0057	0087	R/W	0 to 61 (Screen No.) 0: No registration	10 (Heater break alarm 2 setting)
89	Parameter select setting 17	**JQ**	7	0058	0088	R/W	0 to 61 (Screen No.) 0: No registration	12 (Current limit value setting)
90	Parameter select setting 18	**JR**	7	0059	0089	R/W	0 to 61 (Screen No.) 0: No registration	31 (Selection of energized/ de-energized alarm output)
91	Parameter select setting 19	**JS**	7	005A	0090	R/W	0 to 61 (Screen No.) 0: No registration	50 (Protection function for control of primary side of a transformer)
92	Parameter select setting 20	**JT**	7	005B	0091	R/W	0 to 61 (Screen No.) 0: No registration	51 (Determination set value in case of a break on the secondary side of the transformer)
93	Parameter select setting 21	**JU**	7	005C	0092	R/W	0 to 61 (Screen No.) 0: No registration	52 (Output limiter setting in case of a break on the secondary side of the transformer)
94	Parameter select setting 22	**JV**	7	005D	0093	R/W	0 to 61 (Screen No.) 0: No registration	53 (Soft-start time in case of break on the secondary side of the transformer)

7 TROUBLE SHOOTING

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.

7.1 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 bit 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)	
	Communication protocol setting is wrong	Set “0: RKC communication” at Communication protocol referring to **3.1 Setting the Communication Parameters (P. 3-2)**.
EOT return	The specified identifier is invalid	Confirm the identifier is correct or that with the correct function is specified. Otherwise correct it
	Error in the data format	Reexamine the communication program
NAK return	Error occurs on the line (parity bit error, framing error, etc.)	Confirm the cause of error, and solve the problem appropriately. (Confirm the transmitting data, and resend data)
	BCC error	
	The data exceeds the setting range	Confirm the setting range and transmit correct data
	The specified identifier is invalid	Confirm the identifier is correct or that with the correct function is specified. Otherwise correct it

7.2 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	
	Communication protocol setting is wrong	Set the communication protocol to "1: Modbus" referring to **3.1 Setting the Communication Parameters (P. 3-2)**.
Error code 1	Function code error (Specifying nonexistent function code)	Confirm the function code
Error code 2	When the mismatched address is specified.	Confirm the address of holding register
Error code 3	• The maximum number (Read from a read holding register or write to Preset multiple registers [Write multiple registers]) has been exceeded. • The setting of the number of data (the number of requested byte) is not set to a double of the requested number of data at the time of "Preset multiple registers (Write multiple registers)" • A value exceeding the setting range is written	Confirm the setting data

8

SPECIFICATIONS

This chapter describes the specification of the host communication.

8.1 RKC Communication

Interface: Based on RS-485, EIA standard

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

Synchronization method: Start/Stop synchronous type

Communication speed: 9600 bps, 19200 bps, 38400 bps, 57600 bps

Protocol: ANSI X3.28-1976 subcategories 2.5 and A4
Polling/Selecting type

Data bit configuration: Start bit: 1
Data bit: 7 or 8
Parity bit: None, Odd or Even
Stop bit: 1 or 2

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

Communication code: ASCII 7-bit code

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

Xon/Xoff control: None

Maximum number of connections: Up to 31 controllers

Signal voltage and Signal logic: RS-485

Signal voltage	Signal logic
V (A) – V (B) ≥ 1.5 V	0 (SPACE)
V (A) – V (B) ≤ –1.5 V	1 (MARK)

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

Maximum transmission distance: 1.2 km (This is the maximum value specified in the standard and actual value depends on the product specification.)

8.2 Modbus

Interface: Based on RS-485, EIA standard

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

Synchronization method: Start/Stop synchronous type

Communication speed: 9600 bps, 19200 bps, 38400 bps, 57600 bps

Data bit configuration:
Start bit: 1
Data bit: 8
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)
10H (Preset multiple registers [Write multiple registers])

Error check method: CRC-16

Error code:
1: Function code error
2: When the mismatched address is specified.
3: • The maximum number (Read from a read holding register or write to Preset multiple registers [Write multiple registers]) has been exceeded.
• The setting of the number of data (the number of requested byte) is not set to a double of the requested number of data at the time of "Preset multiple registers (Write multiple registers)"
• Data written exceeds the setting range
4: Self-diagnostic error response

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

Xon/Xoff control: None

Maximum number of connections: Up to 31 controllers

Signal voltage and signal logic: RS-485

Signal voltage	Signal logic
V (A) − V (B) ≥ 1.5 V	0 (SPACE)
V (A) − V (B) ≤ −1.5 V	1 (MARK)

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

Maximum transmission distance: 1.2 km (This is the maximum value specified in the standard and actual value depends on the product specification.)

8.3 Loader Communication

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

Synchronous method: Start/Stop synchronous type

Communication speed: 38400 bps

Data bit configuration: Start bit: 1
Data bit: 8
Parity bit: None
Stop bit: 1
Number of communication data digits: 7 (fixed)

Error control: Horizontal parity (BCC check)

Communication code: ASCII 7-bit code

Termination resistor: None

Xon/Xoff control: None

Maximum connections: 1 point

Connection method: Exclusive cable W-BV-01

Interval time: 10 ms

When the instrument is powered off, power can be supplied to the instrument from COM-K2 or COM-KG.
This function is exclusive for parameter setting, and the instrument functions as follows.
- Control is stopped (Output is off).
- Host communication is stopped.
- The display shows "---."

While the instrument is powered by COM-K2 or COM-KG, if power is applied to the instrument, the instrument will be reset and starts for normal operation.

When the instrument is normally powered, the host communication can be used simultaneously.

APPENDIX A

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

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