Module Type Controller

SRJ

Instruction Manual
J-TI
J-CVM

RKC INSTRUMENT INC.

IMS01X03-E5

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

⎓ : Direct current (J-TI)

⏚ : Protective earth (PE) terminal (J-CVM)

⚠ : Safety precaution

This symbol is used where the instruction manual needs to be consulted for the safety of both the operator and the equipment. Carefully read the cautions in this manual before using the instrument. This symbol denotes caution for the connectors. Be sure to read “3. WIRING” in the installation manual before using the product.

- 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
(Temperature control input module J-TI/SSR unit J-CVM)

⚠ 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 (Temperature control input module J-TI)

⚠ 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 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.
- 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.
- 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.
- Do not connect modular connectors to telephone line.

■ ⚠ CAUTION (SSR unit J-CVM)

⚠ 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 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.
- 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.
- For proper operation of this instrument, provide adequate ventilation for heat dissipation.
- 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.

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.

■ Abbreviation symbols

These abbreviations are used in this manual:

Abbreviation symbols	Name	Abbreviation symbols	Name
PV	Measured value	TC (input)	Thermocouple (input)
SV	Set value	RTD (input)	Resistance temperature detector (input)
MV	Manipulated output value	LBA	Control loop break alarm
AT	Autotuning	LBD	LBA deadband

Document Configuration

There are three 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
J-TI Installation Manual	IMS01X01-E☐	This manual is enclosed with J-TI. This manual explains the mounting and wiring.
J-CVM Installation Manual	IMS01X02-E☐	This manual is enclosed with J-CVM. This manual explains the mounting and wiring.
SRJ Instruction Manual	**IMS01X03-E5**	This manual you are reading now. This manual explains the following contents. – Outline – Installation – Wiring – Communication protocol – Function – Communication data – Troubleshooting – Specifications

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 10 chapters and an appendix.
If you are looking for handling information, you may be able to find one in the following table of contents.

	What do you want to do?	See the following section for more details
□	I want to check the features, the instrument, the model code and the external appearance.	1. OUTLINE
□	I want to check the pre-operational procedure.	1. OUTLINE
□	I want to check the mounting caution and how to mount and remove.	2. MOUNTING *
□	I want to check the external and mounting dimensions.	2. MOUNTING *
□	I want to check precautions for wiring and connection, connector configuration, and how each connector is wired.	3. WIRING *
□	I want to check how to replace the heater's fuse.	3. WIRING
□	I want to know how to connect to the host computer	3. WIRING
□	I want to check how to connect a J-TI to a J-CVM.	3. WIRING
□	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 check the RKC communication identifier, Modbus register address, data attribute, data range and factory set value.	6. COMMUNICATION DATA LIST
□	I want to know what to do when I use the instrument for the first time.	7. OPERATION AND FUNCTION DESCRIPTION
□	I want to check how to use and configure each function.	7. OPERATION AND FUNCTION DESCRIPTION
□	I want to check the error code.	8. TROUBLESHOOTING *
□	I want to know what actions I should take in case of errors.	8. TROUBLESHOOTING
□	I want to check the instrument information (ROM version, model code, instrument number).	8. TROUBLESHOOTING
□	I want to know the specification of the instrument.	9. SPECIFICATIONS *
□	I want to check communication data that is initialized or changed when settings are changed.	10. COMMUNICATION DATA THAT ARE INITIALIZED/ MODIFIED WHEN SETTING IS CHANGED
□	I want to see the table of ASCII/JIS 7-bit code	A. APPENDIX

* Checking is possible using a concise manual supplied with the product.

Contents

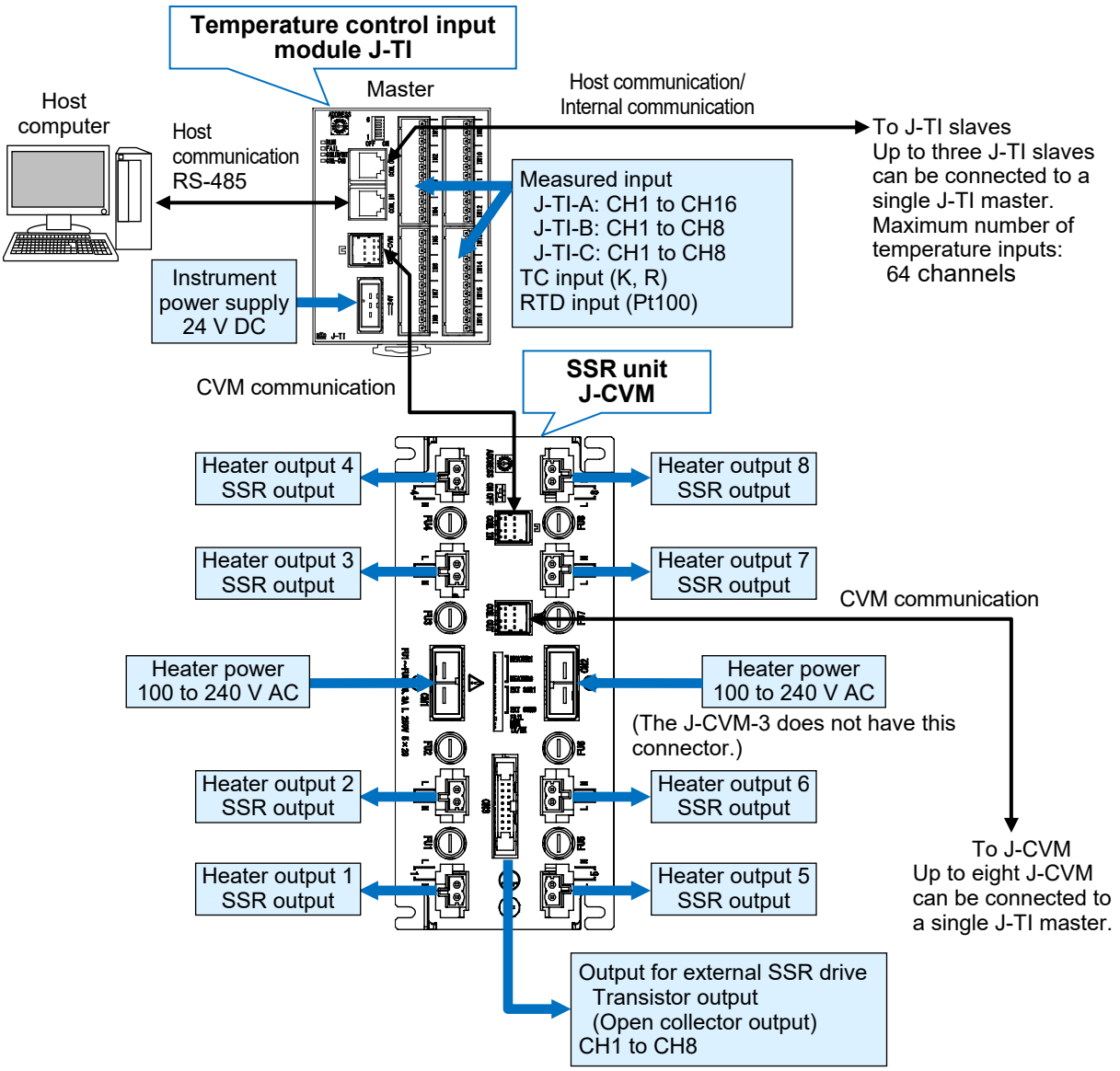
MEMO

1 OUTLINE

This chapter describes features, system configuration, package contents, model code, etc.

1.1 Features

The SRJ is a module type controller for performing heater control. It consists of a temperature control input module J-TI for performing temperature input and control, and the SSR unit J-CVM for performing heater output.



☞ For details on the maximum system configuration, refer to **1.2 System Configuration (P. 1-5)**.

Separator type helps save cable wiring

The wiring work is minimized due to the following features.

- The distributed arrangement of the SSR unit J-CVM in the heater part enables direct connection to the heater.
- A multi-drop connection of the temperature control input module J-TI and the SSR unit J-CVM is possible through one cable.
- All inputs and outputs can be connected via connectors.

Equipped with a maximum 5 A SSR

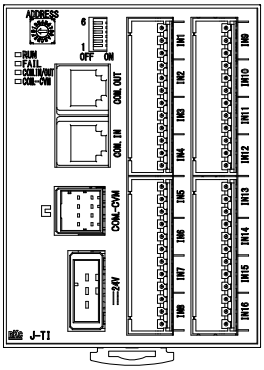
The SSR unit J-CVM is equipped with eight SSRs having a maximum capacity of 5 A (when J-CVM-5 is used). In addition, there are eight transistor outputs (open collector outputs) for external SSR drive.

Equipped with a host communication port

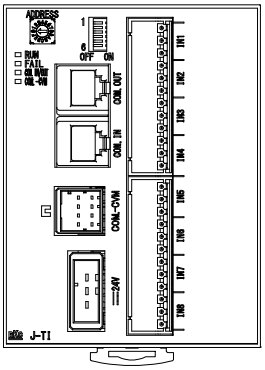
Host communication can be performed with higher-level devices, such as a host computer or operation panel, etc.

■ Temperature control input module

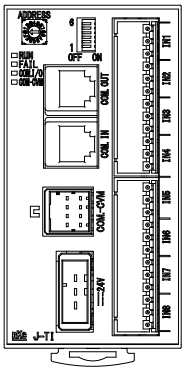
J-TI-A



J-TI-B



J-TI-C (Slim type)



The J-TI is a temperature input and control module designed for heater control system. This module can control the output of the SSR unit through communication.
Since up to three JT-I slaves can be added for one JT-I master, a maximum of 64-channel temperature input is possible.

Number of the temperature input channels:
- J-TI-A: 16 channels
- J-TI-B: 8 channels
- J-TI-C: 8 channels

Input type:
- Thermocouple (TC) input: K, R
- RTD input: Pt100

Host communication
- Interface: Based on RS-485, EIA standard
- Protocol: RKC communication, Modbus
- Maximum connections: J-TI master: 4 modules
  (Up to four J-TI masters can be connected to a single host computer.)
  J-TI slave: 12 modules
  (Up to three J-TI slaves can be connected to a single J-TI master.)

CVM communication
- Interface: Based on RS-485, EIA standard
- Protocol: Special communication
- Maximum connections: 8 units (Up to eight J-CVM can be connected to a single J-TI master.)

NOTE

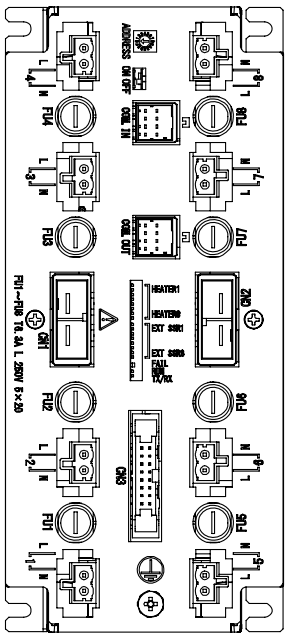
Always connect the host computer to the J-TI master. If the host computer is connected to a J-TI slave, communication errors may cause malfunction or damage.

NOTE

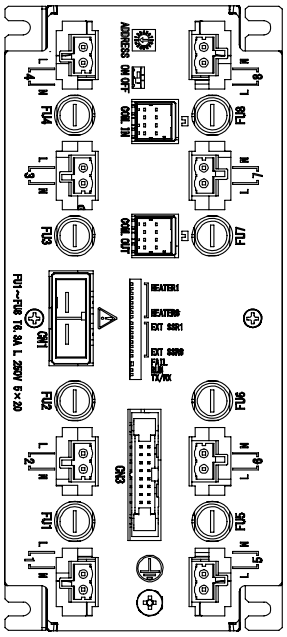
Always connect the J-CVM to a J-TI master. If a J-CVM is connected to a J-TI slave, it will not be able to communicate.

■ SSR unit

J-CVM-5



J-CVM-3



The J-CVM is an SSR output unit designed for heater control system.
In addition, an "Output for external SSR drive" is provided for driving the external SSR.
The J-CVM is connected to the J-TI master. Up to eight J-CVMs can be connected to a single J-TI master.

Heater output
- SSR output
- Allowable load current: J-CVM-3: 3 A/point
  J-CVM-5: 5 A/point

Output for external SSR drive
- Transistor output (Open collector output)
- Allowable load current: 50 mA/point

CVM communication (Inter-unit communication)
- Interface: Based on RS-485, EIA standard
- Protocol: Special communication

NOTE

Always connect the J-CVM to a J-TI master.
If a J-CVM is connected to a J-TI slave, it will not be able to communicate.

1.2 System Configuration

Up to four J-TI masters can be connected to a single host computer. Also, up to three J-TI slaves and eight J-CVMs can be connected to a single J-TI master.
Setting the address setting switch of a JT-I to "0, 4, 8, C" makes it the master J-TI, and the J-TIs having the three addresses following each master address are the slave JT-Is.

☞ For the address setting switch of the J-TI, refer to **3.4.3 Communication address setting [J-TI] (P. 3-24)**.

■ Communications

J-TI (Temperature control input module):

- The J-TI can send or receive data to or from the host computer either through RKC communication (based on ANSI X3.28-1976 subcategories 2.5 and B1), or by Modbus. RS-485 is used as the communication interface.
- The control-related communication data is sent or received between the J-TI master and the JT-I slaves through internal communication.

☞ For the connections of J-TI, refer to **3.4.5 Connecting the J-TI master and the host computer (P. 3-28)** and **3.4.6 Connecting J-TI to J-TI (P. 3-32)**.

J-CVM (SSR unit):

- The J-CVM can send or receive data to or from the J-TI master through CVM communication (Special communication, RS-485). The J-CVM can communicate only with the J-TI master.

☞ For the connections of J-CVM, refer to **3.5.3 Connecting the J-TI master and J-CVM (P. 3-39)**.

■ Power supply

J-TI (Temperature control input module):

- The J-TI instrument power supply is input from the respective J-TI power connector.
  Power supply voltage: 20.4 to 26.4 V DC [Including power supply voltage variation] (Rating 24 V DC)
  Current consumption (at maximum load):
  J-TI (alone): 160 mA max. (at 24 V DC) Rush current: 20 A or less
  When eight J-CVM is connected to a J-TI master: 5.04 A max. (at 24 V DC)

☞ For the J-TI power connector, refer to ■ **Power connector (P. 3-5)** in Section **3.2.2**.

J-CVM (SSR unit):

- The J-CVM instrument power supply (including the output for external SSR drive) is supplied from the J-TI master.
  Current consumption (at maximum load):
  When transistor output is not used: 210 mA max. (at 24 V DC)/Unit
  When eight J-CVM is connected: 1.68 A max. (at 24 V DC)
  When transistor output is used: 610 mA max. (at 24 V DC)/Unit
  When eight J-CVM is connected: 4.88 A max. (at 24 V DC)
- The power supply for the J-CVM heater output is input from the heater power connector.
  Power supply voltage: 35 to 264 V AC (50/60 Hz) [Including power supply voltage variation]
  (Rating: 100 to 240 V AC)
  Current consumption (at maximum load):
  J-CVM-3: 3 A/point J-CVM-5: 5 A/point

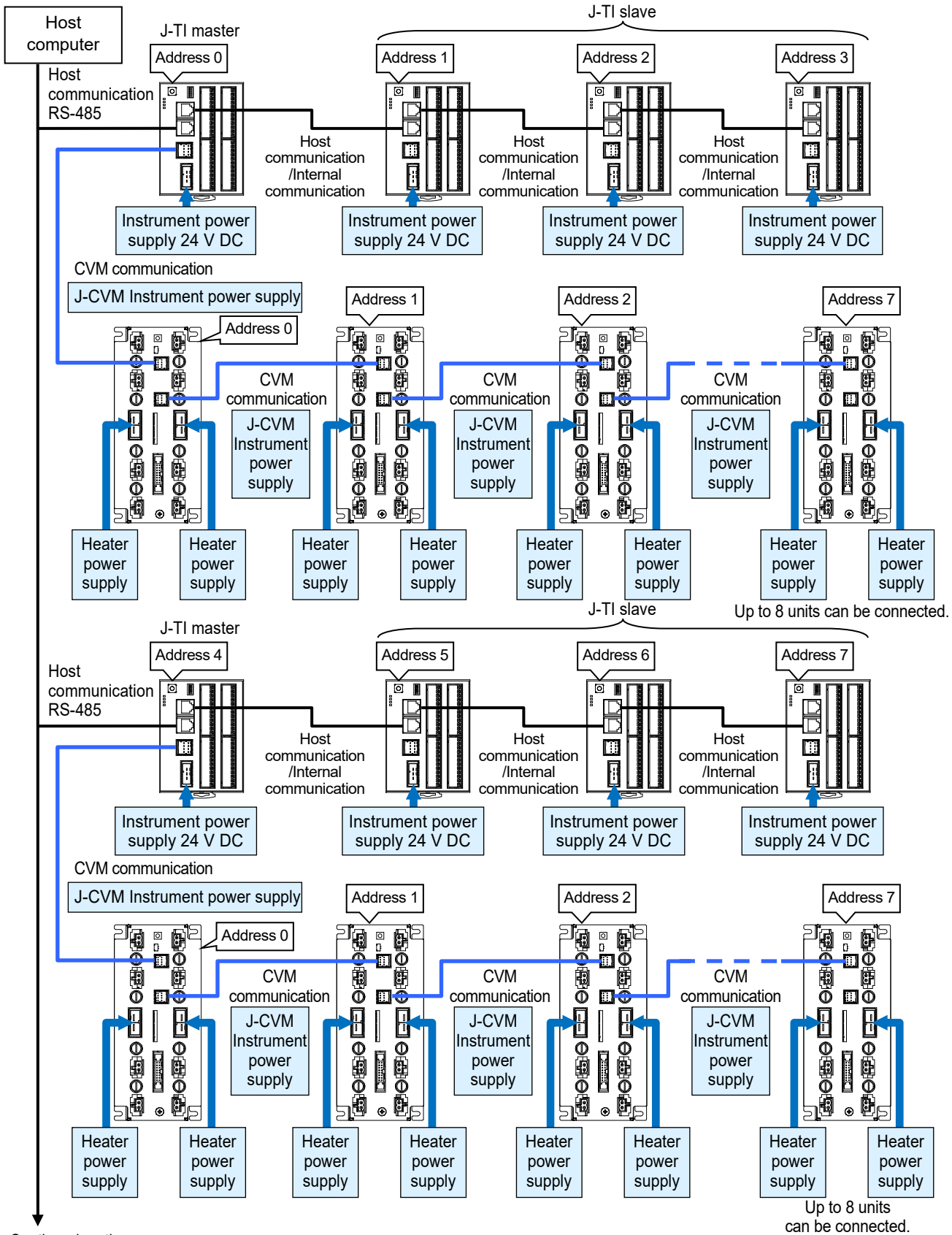
☞ For the heater power connector of the J-CVM, refer to ■ **Heater power connector (CN1, CN2) (P. 3-14)** in Section **3.3.2**.

■ Temperature input channels corresponding to heater outputs 1 to 8

The temperature input channels corresponding to the heater outputs 1 to 8 are assigned on the address setting switch of the J-CVM.

☞ For the address setting switch of the J-CVM, refer to **3.5.1 Address setting (assignment of temperature input channels) [J-CVM] (P. 3-35)**.

■ Example of System Configuration



Heater power supply: Rating 100 to 240 V AC
There is one heater power connector in the case of J-CVM-3.

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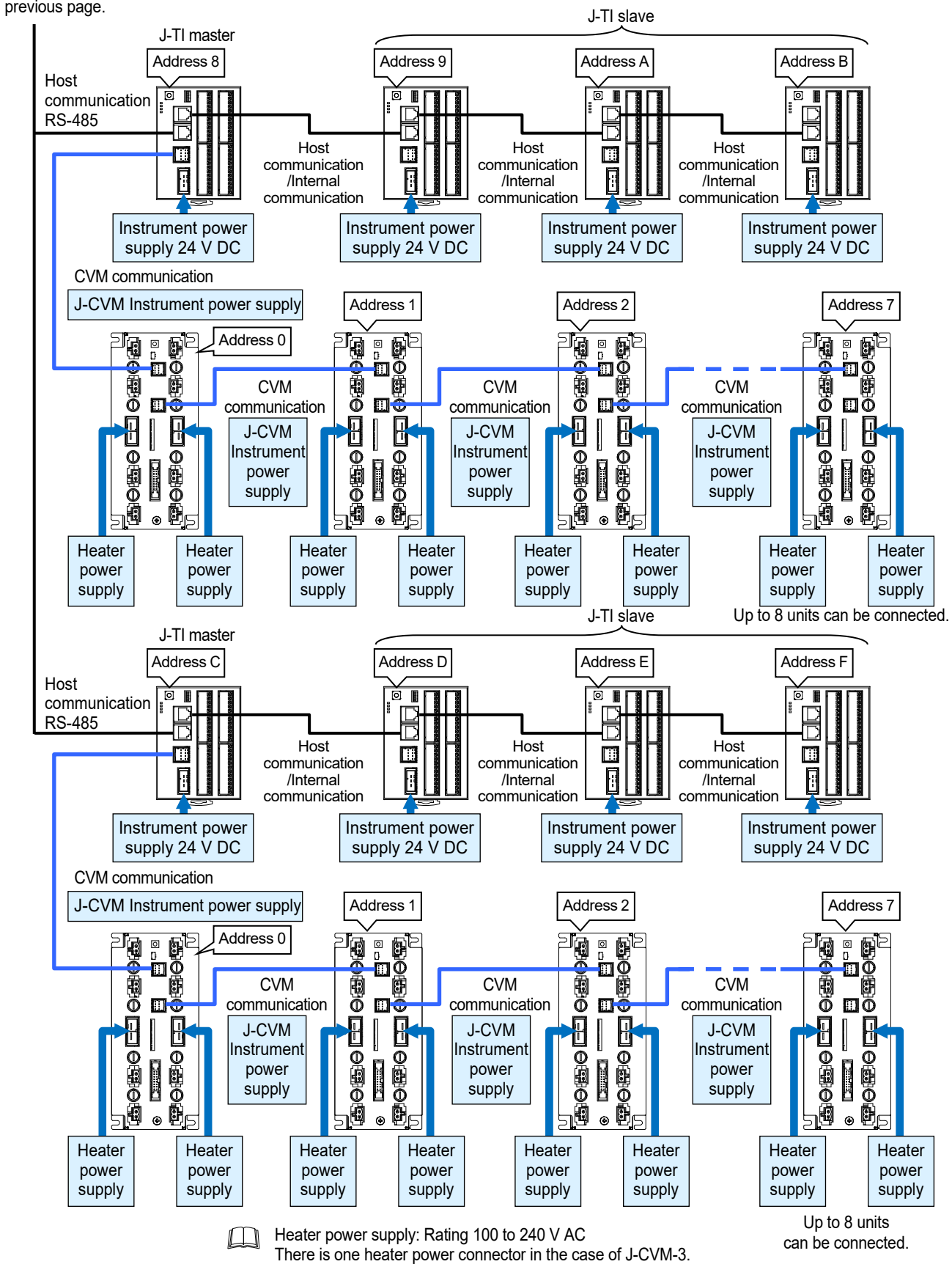


Heater power supply: Rating 100 to 240 V AC
There is one heater power connector in the case of J-CVM-3.

■ Switching between host communication/internal communication

Depending on whether the J-TI is a master or slave, switching between Host communication/Internal communication is performed by the communication setting switch of the J-TI.

- The J-TI master connected to a host computer is switched to “Host communication.”
- The J-TI slave connected to a J-T (master or slave) is switched to “Internal communication.”

☞ For the communication setting switch of the J-TI, refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

■ Termination resistor

J-TI (Temperature control input module):

If a communication error occurs frequently as a result of the usage environment and the communication distance, connect a termination resistor to the J-TI as well as its partner device. Since the termination resistor of the J-TI (120 Ω 1/2 W) is installed on the J-TI, switch to “ON: Termination resistor ON” with the communication setting switch to add the termination resistor.

- The most distant J-TI from the host computer is set to “Host communication termination resistor ON.”
- The J-TIs at both ends in internal communication are set to “Internal communication termination resistor ON.”

☞ For the termination resistor of the J-TI, refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

J-CVM (SSR unit):

If a communication error occurs frequently as a result of the usage environment and the communication distance, connect a termination resistor to the J-CVM.

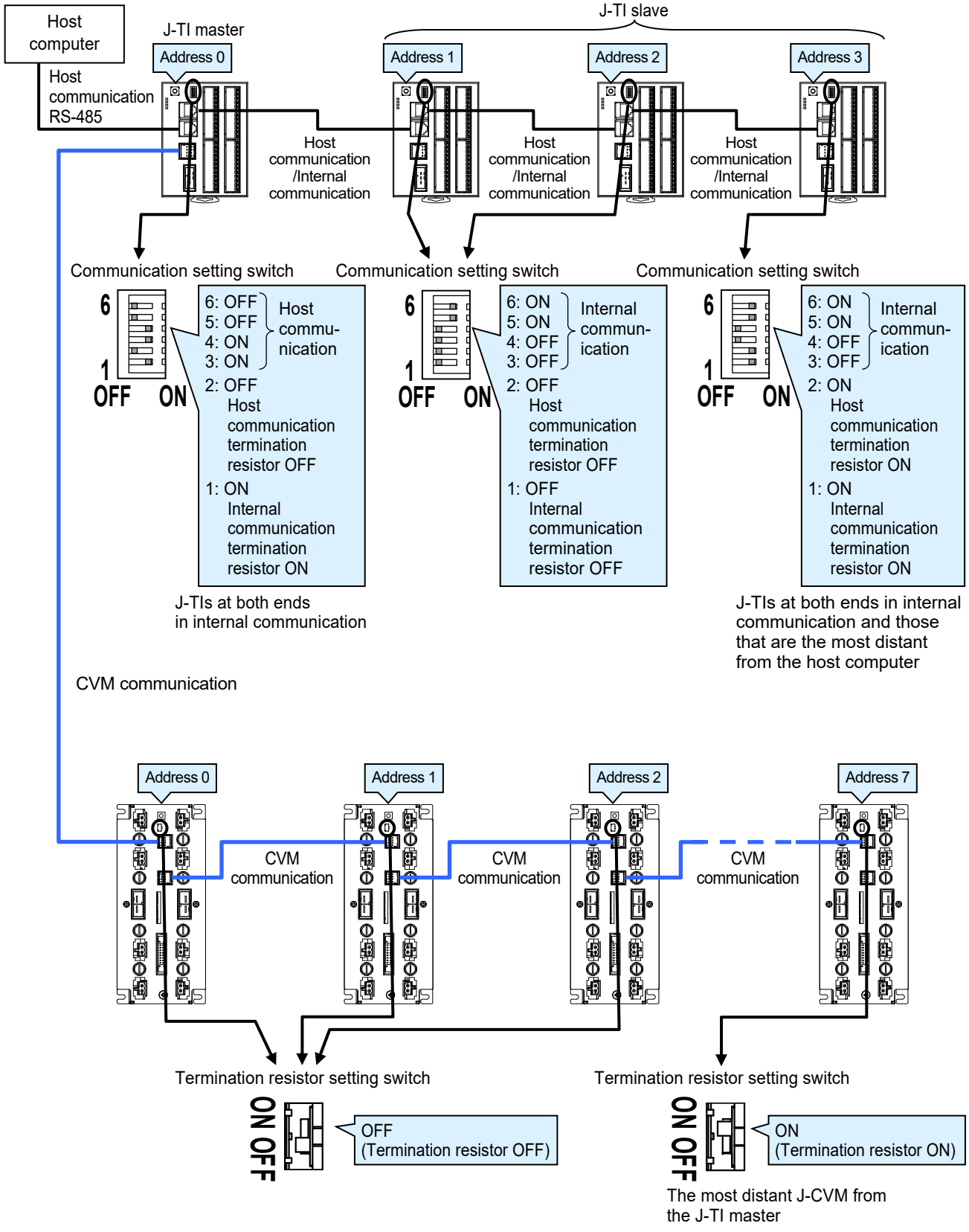
Since the termination resistor of the J-CVM (120 Ω 1/2 W) is installed on the J-CVM, switch to “ON: Termination resistor ON” with the termination resistor setting switch to add the termination resistor.

- The most distant J-CVM from the J-TI master is set to “Termination resistor ON.”

☞ For the termination resistor of the J-TI, refer to **3.5.2 Termination resistor setting [J-CVM] (P. 3-37)**.

■ Switch setting example

Example: When three J-TI slaves and eight J-CVMs are connected to a J-TI master (address 0).



1.3 Checking the Product

Before using this product, check each of the following:

- Model code
- Check that there are no scratches or breakage in external appearance (case, front panel, or terminal, etc.)
- Check that all of the items delivered are complete. (Refer to below)

1.3.1 Accessories

■ J-TI (Temperature control input module)

Accessories	Q'TY	Remarks
□ J-TI	1	————
□ Connector for TI section	J-TI-A:16 J-TI-B: 8 J-TI-C: 8	Supplied for the TI section with a connector (delivered installed on the J-TI)
□ J-TI Installation Manual (IMS01X01-E□)	1	Enclosed with instrument

If any of the above are missing, damaged, or if your manual is incomplete, please contact RKC sales office or the agent.

■ J-CVM (SSR unit)

Accessories	Q'TY	Remarks
□ J-CVM	1	————
□ SSR output connector	8	Supplied for the SSR output section with a connector (delivered installed on the J-CVM)
□ Strain relief plate	8	Supplied for the SSR output section with a connector
□ J-CVM Installation Manual (IMS01X02-E□)	1	Enclosed with instrument

If any of the above are missing, damaged, or if your manual is incomplete, please contact RKC sales office or the agent.

■ J-TI (Temperature control input module)/J-CVM (SSR unit)

Accessories	Q'TY	Remarks	
□ **SRJ Instruction Manual (IMS01X03-E5)**	1	This manual (sold separately)	This manual can be downloaded from the official RKC website.

1.3.2 Optional (sold separately)

Accessories	Q'TY	Remarks
□ Power supply cable W-CF-P01-AC-□□□□□ □□□□□: Cable length (unit: mm)	Depending on the order quantity	For J-TI power connector Terminal processing: Connector at one end and one open end
□ Power supply cable W-CF-P02-AC-□□□□□ □□□□□: Cable length (unit: mm)	Depending on the order quantity	For J-CVM heater power connector Terminal processing: Connector at one end and one open end
□ Output cable for transistor W-CF-S01-AC-□□□□□ □□□□□: Cable length (unit: mm)	Depending on the order quantity	For transistor output for external SSR drive connector Terminal processing: Connector at one end and one open end
□ Connecting cable W-CF-N01-AA-□□□□□ □□□□□: Cable length (unit: mm)	Depending on the order quantity	For connecting a J-TI and J-CVM, and for increasing the number of J-CVM Terminal processing: Double-end connector
□ Communication cable W-BF-02-□□□□□ □□□□□: Cable length (unit: mm)	Depending on the order quantity	For J-TI multi-drop connection Terminal processing: Double-end modular connector 6-pin
□ Communication cable W-CF-C01-AY3-□□□□□ □□□□□: Cable length (unit: mm)	Depending on the order quantity	RS-485 for host communication connector Terminal processing: Modular connector and spade lug

1.4 Model Code

Check that the product received is correctly specified by referring to the following model code list:
If the product is not identical to the specifications, please contact RKC sales office or the agent.

1.4.1 J-TI (Temperature control input module)

■ Suffix code

J-TI - □ - □□□ - □□□ ✱ N / □
(1) (2) (3) (4) (5)

Specification		Suffix code				
		(1)	(2)	(3)	(4)	(5)
Type	16 channels	**A**				
	8 channels	**B**				
	8 channels (Slim type)	**C**				
Measured input and Range (CH1 to CH8)	Refer to Input range code table (P. 1-12)		□□□			
Measured input and Range (CH9 to CH16)	Refer to Input range code table (P. 1-12) "NNN" for the J-TI-B and the J-TI-C (8 channels)			□□□		
Output type	None (J-CVM output only)				**N**	
Connector for TI section	None					**N**
	TI section with a connector					**C**

☞ For the initial setting code, refer to ■ **Initial setting code (P. 1-13)**.

● Input range code table

TC input

Input type	Code	Range
K	**K09**	0.0 to 400.0 °C
	K10	0.0 to 800.0 °C
	K11	0.0 to 1300.0 °C
R	**R10**	0.0 to 1700.0 °C

RTD input

Input type	Code	Range
Pt100	**D40**	0.0 to 400.0 °C
	D41	0.0 to 600.0 °C
	D42	0.0 to 800.0 °C

The input range can be changed later within the range of the input range table even if the input range is specified at the time of order. For details, refer to **7.3.1 Changing input (P. 7-6)**.

■ Initial setting code

Initial setting code tells the factory to ship with each parameter preset to the values detailed as specified by the customer.

□ □ N N - □
(1) (2) (3)

Specification		Initial setting code		
		(1)	(2)	(3)
Event 1 type	None	N		
	Event 1 type Refer to Event type code table (P. 1-13)	□		
Event 2 type	None		N	
	Event 2 type Refer to Event type code table (P. 1-13)		□	
Communication protocol	RKC communication (ANSI X3.28-1976)			1
	Modbus			2

● Event type code table

Code	Type
A	Deviation high
B	Deviation low
C	Deviation high/low
D	Band
E	Deviation high with hold action
F	Deviation low with hold action
G	Deviation high/low with hold action

Code	Type
H	Process high
J	Process low
K	Process high with hold action
L	Process low with hold action
Q	Deviation high with re-hold action
R	Deviation low with re-hold action
T	Deviation high/low with re-hold action

When the initial setting code is not specified, the instrument is delivered configured as follows.
Event 1 type: Deviation high with hold action
Event 2 type: Deviation low with hold action
Communication protocol: Modbus

1.4.2 J-CVM (SSR unit)

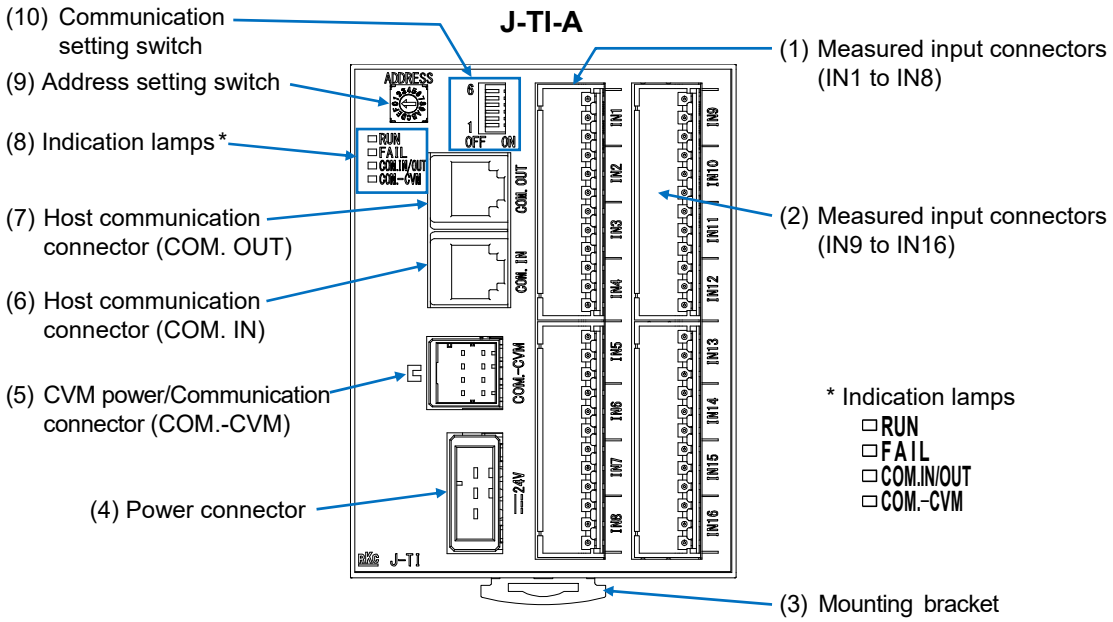
■ Suffix code

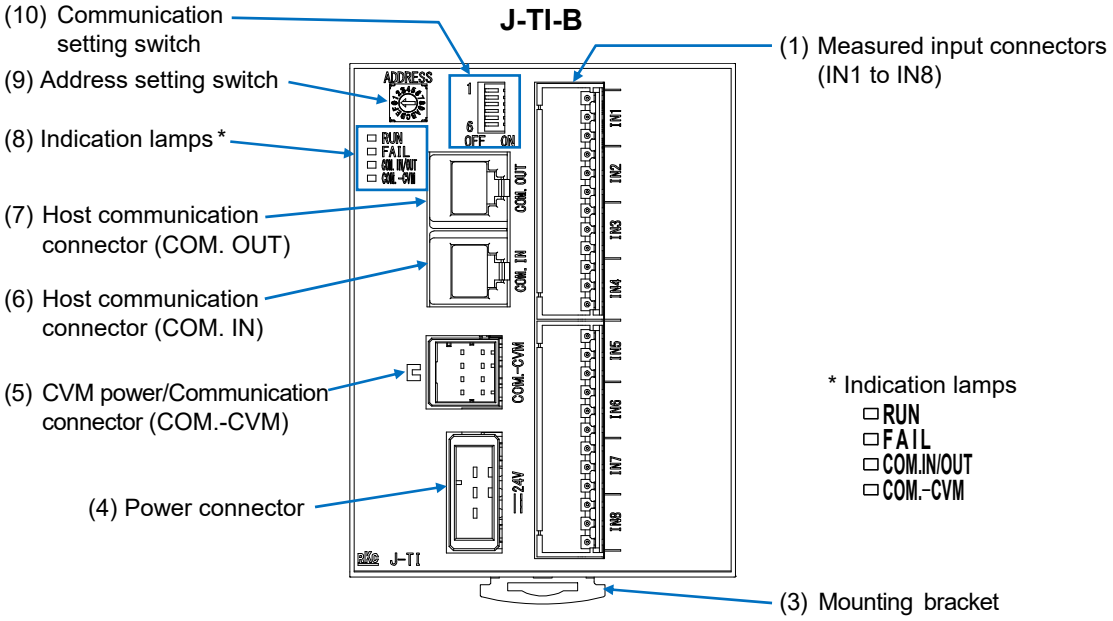
J-CVM - □ / □
(1) (2)

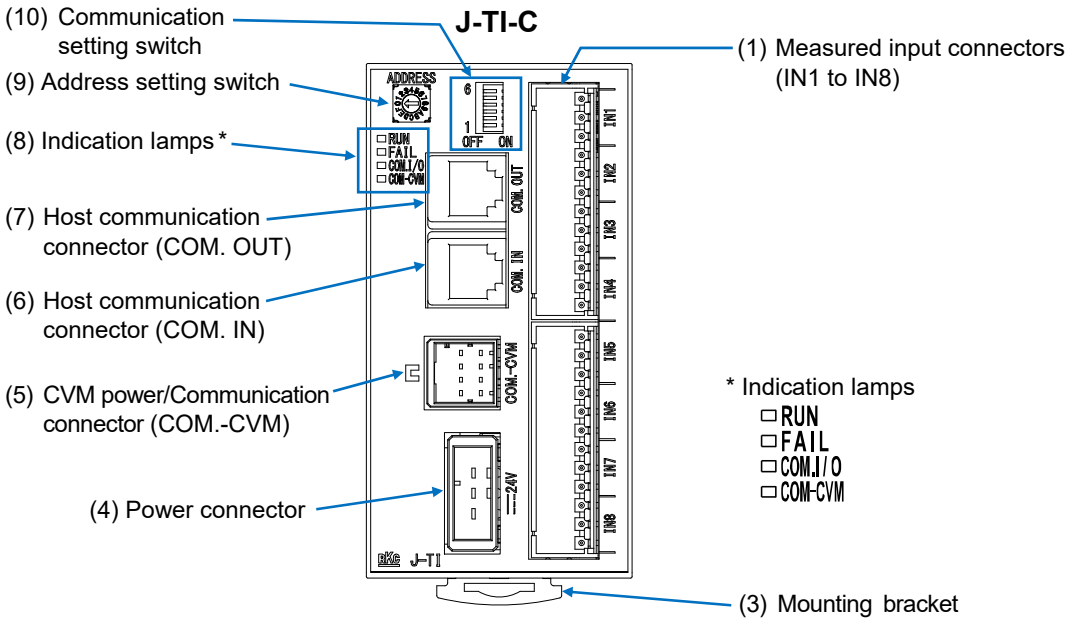
Specification		Suffix code (1)	Suffix code (2)
Maximum load current	3 A Heater power connector: 1 SSR output (Heater output): 8 channels	**3**	
	5 A Heater power connector: 2 SSR output (Heater output): 8 channels	**5**	
Connector for SSR output section (Heater output)	None		**N**
	SSR output section with a connector		**C**

1.5 Parts Description

1.5.1 J-TI (Temperature control input module)



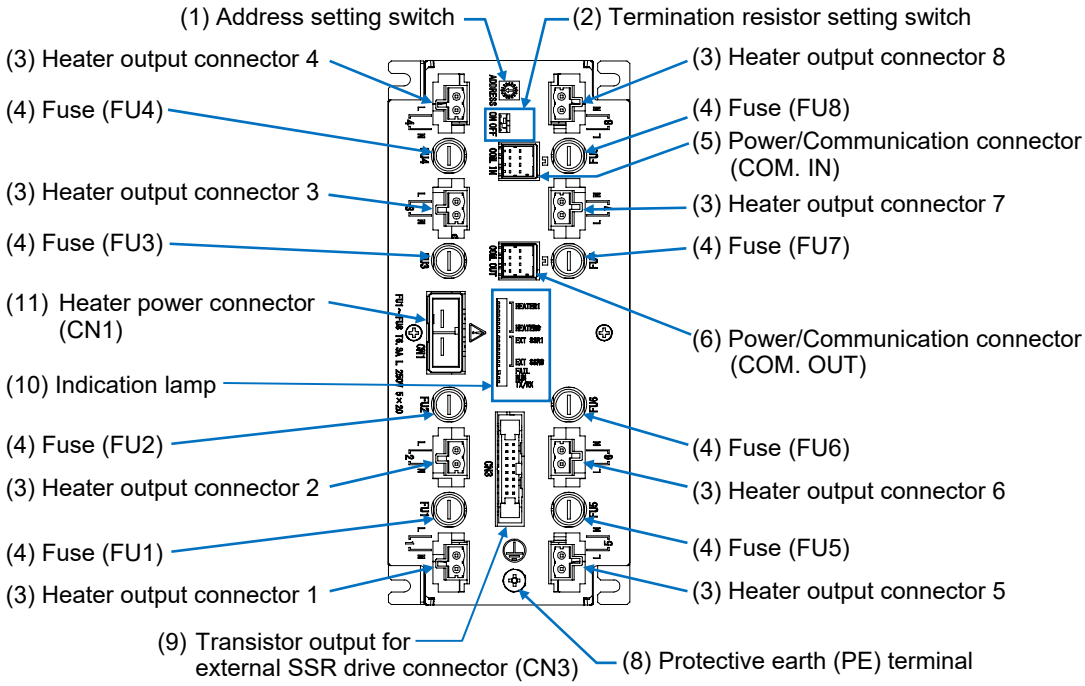




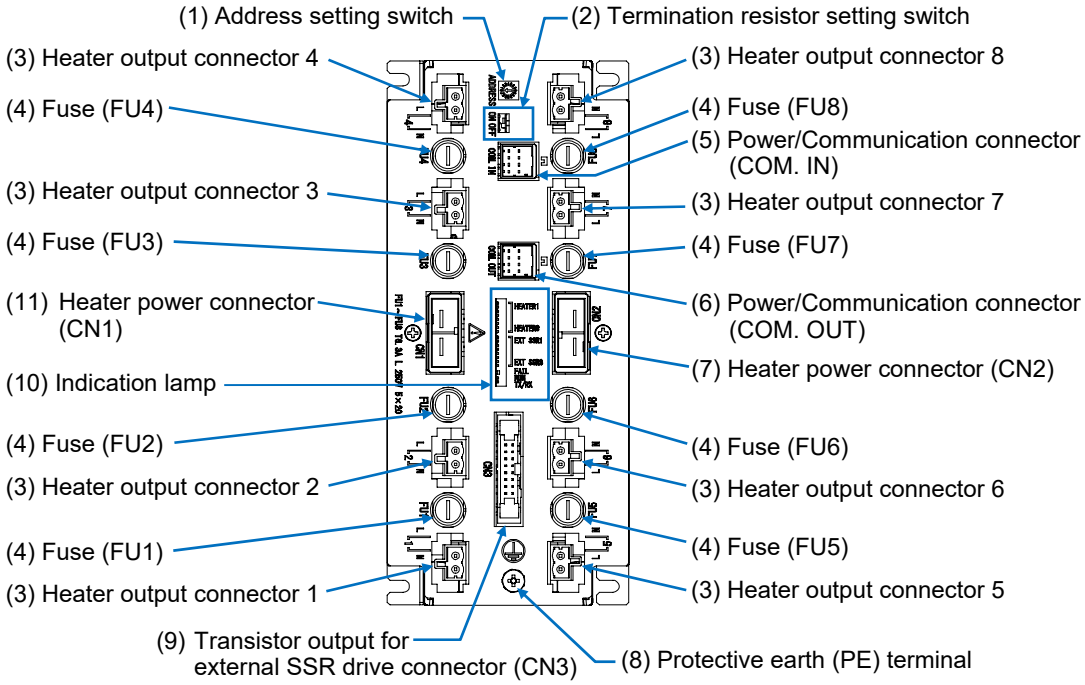
(1)	Measured input connectors (IN1 to IN8)		Connector for connecting the measured inputs (CH1 to CH8). (Refer to P. 3-7)
(2)	Measured input connectors (IN9 to IN16) [Only J-TI-A]		Connector for connecting the measured inputs (CH9 to CH16). (Refer to P. 3-7)
(3)	Mounting bracket		Mounting bracket for securing the module on DIN rail. (Refer to P. 2-4)
(4)	Power connector		Connector for connecting the instrument power supply. (Refer to P. 3-5)
(5)	CVM power/Communication connector (COM.-CVM)		Connector for connecting the J-CVM. Used for communicating with the J-CVM and supplying power to the J-CVM. (Refer to P. 3-39)
(6)	Host communication connector (COM. IN)		Connector for connecting the host computer or J-TI. (Refer to P. 3-28)
(7)	Host communication connector (COM. OUT)		Connector for adding more J-TI. (Refer to P. 3-28)
(8)	Indication lamps	RUN	RUN [Green]: Lights during normal operation.
		FAIL	FAIL [Red]: Lights when instrument error.
		COM.IN/OUT or COM.I/O	Host communication (COM.IN/OUT or COM.I/O) [Orange]: Flashing during host communication data send and receive.
		COM.-CVM or COM-CVM	CVM communication (COM.-CVM or COM-CVM) [Orange]: Flashing during CVM communication data send and receive.
(9)	Address setting switch		Switch for setting the J-TI communication address. If you set the address setting switch, the communication address used in the actual program is decided. (Refer to P. 3-24)
(10)	Communication setting switch		Switch for selecting host communication or internal communication, and setting the termination resistor. (Refer to P. 3-26)

1.5.2 J-CVM (SSR unit)

J-CVM-3



J-CVM-5



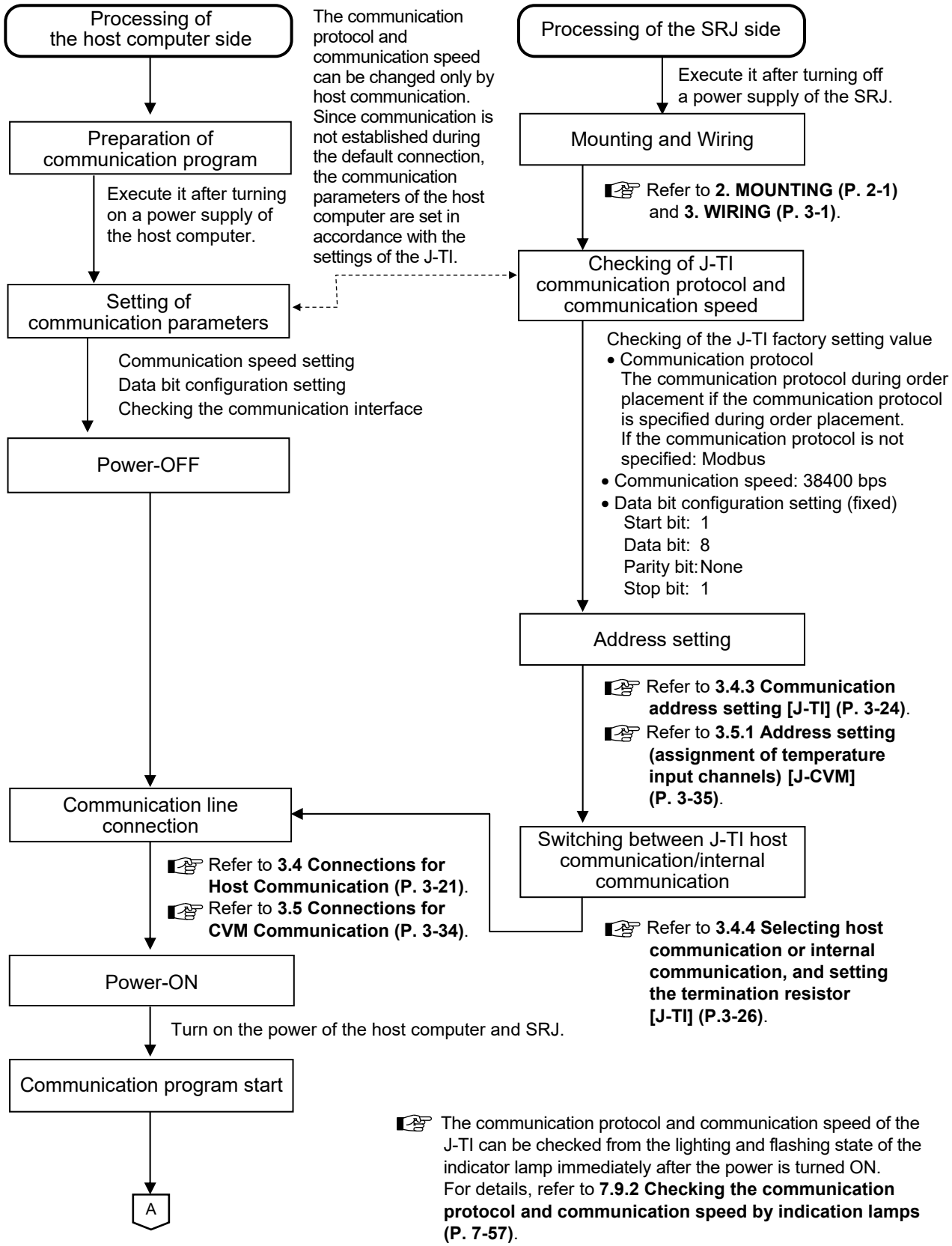
(1)	Address setting switch	Switch for setting the J-CVM address. If you set the address, the temperature input channels corresponding to the heater outputs 1 to 8 will be assigned. (Refer to P. 3-35)
(2)	Termination resistor setting switch	Switch for setting the termination resistor. (Refer to P. 3-37)

(3)	Heater output connectors (1 to 8)		Connectors for connecting the heater output (SSR output). Allowable load current: J-CVM-3: 3 A/point J-CVM-5: 5 A/point (Refer to P. 3-16)
(4)	Fuses (FU1 to FU8)		Fuses for short-circuit protection. The fuse is contained in the fuse folder. (Refer to P. 3-20)
(5)	Power/Communication connector (COM. IN)		Connector for connecting the J-TI master or J-CVM. Used for communicating with the J-TI master and also for the input of the instrument power supply from the J-TI master. (Refer to P. 3-40)
(6)	Power/Communication connector (COM. OUT)		Connector for adding more J-CVM. Used for communicating with the J-TI master and also for the output of the instrument power supplied from the J-TI master. (Refer to P. 3-40)
(7)	Heater power connector (CN2) [Only J-CVM-5]		Connector for connecting the heater power supply. (Refer to P. 3-14)
(8)	Protective earth (PE) terminal		Terminal for connecting to the earth line. (Refer to P. 3-12)
(9)	Transistor output for external SSR drive connector (CN3)		Connector for connecting the transistor outputs for external SSR drive output (open collector output). (Refer to P. 3-18)
(10)	Indication lamps	HEATER1 to HEATER8	HEATER1 to HEATER8 [Green]: Lights when heater outputs are turned on.
		EXT SSR1 to EXT SSR8	EXT SSR1 to EXT SSR8 [Green]: Lights when transistor outputs (for external SSR drive) are turned on.
		FAIL	FAIL [Red]: Lights when instrument error.
		RUN	RUN [Green]: Flashes during normal operation. Lights when self-diagnostic error occurs.
		TX/RX	TX/RX [Orange]: Flashing during unit communication data send and receive
(11)	Heater power connector (CN1)		Connector for connecting the heater power supply. (Refer to P. 3-14)

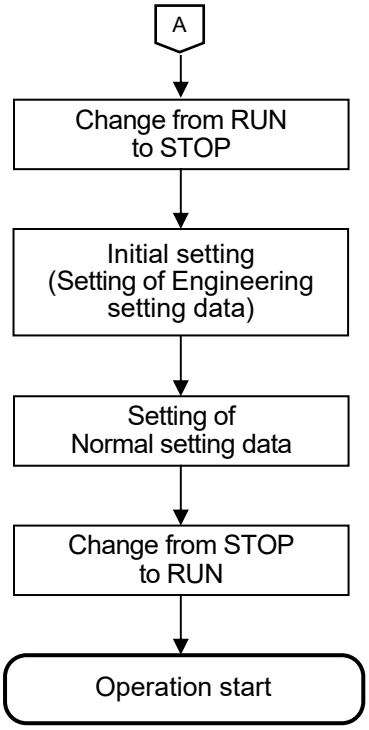
1.6 Handling Procedure to Operation

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

■ Procedure flowchart



☞ The communication protocol and communication speed of the J-TI can be checked from the lighting and flashing state of the indicator lamp immediately after the power is turned ON. For details, refer to **7.9.2 Checking the communication protocol and communication speed by indication lamps (P. 7-57)**.



Change the setting to “0 STOP (Control stop)” by RUN/STOP transfer.

Set Engineering setting data based on an operating condition.
☞ Refer to **7.1 Setup Procedures Prior to Running the Instrument (P. 7-2)**.

Set Normal setting data for operation.
☞ Refer to **7.1 Setup Procedures Prior to Running the Instrument (P. 7-2)**.

Change the setting to “1: RUN (Control run)” by RUN/STOP transfer.

2 MOUNTING

This chapter describes mounting cautions, dimensions and mounting procedures.

2.1 J-TI (Temperature Control Input Module)

2.1.1 Mounting cautions

⚠ WARNING

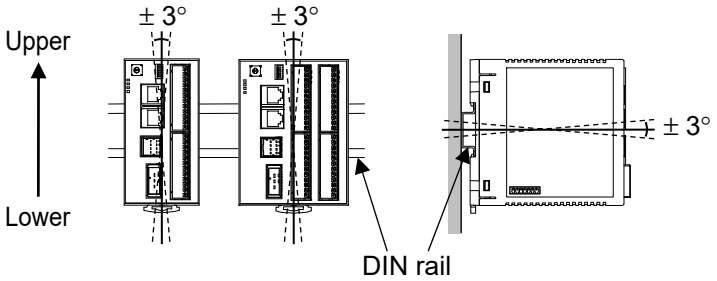
To prevent electric shock or instrument failure, always turn off the power before mounting or removing the instrument.

(1) This instrument is intended to be used under the following environmental conditions.
(IEC 61010-1) [POLLUTION DEGREE 2]

(2) Use this instrument within the following environment conditions:
- Allowable ambient temperature: −10 to +55 °C
- Allowable ambient humidity: 5 to 95 %RH
  (Absolute humidity: MAX.W.C 29 g/m^3 dry air at 101.3 kPa)
- Installation environment conditions: Indoor use, Altitude up to 2000 m

(3) Avoid the following conditions when selecting the mounting location:
- Rapid changes in ambient temperature which may cause condensation.
- Corrosive or inflammable gases.
- Direct vibration or shock to the mainframe.
- Water, oil, chemicals, vapor or steam splashes.
- Excessive dust, salt or iron particles.
- Excessive induction noise, static electricity, magnetic fields or noise.
- Direct air flow from an air conditioner.
- Exposure to direct sunlight.
- Excessive heat accumulation.

(4) Mount this instrument in the panel considering the following conditions:
- Ensure at least 25 mm space on top and bottom of the instrument for maintenance and environmental reasons.
- Do not mount this instrument directly above the equipment that generates large amount of heat (heaters, transformers, thyristor units, large-wattage resistors.)
- If the ambient temperature rises above 55 °C, cool this instrument with a forced air fan, cooler, etc. Cooled air should not blow directly on this instrument.
- In order to improve safety and the immunity to withstand noise, mount this instrument as far away as possible from high voltage equipment, power lines, and rotating machinery.
- High voltage equipment: Do not mount within the same panel.
- Power lines: Separate at least 200 mm.
- Rotating machinery: Separate as far as possible.
- Mount the J-TI in the direction shown below. (Datum plane ± 3°)

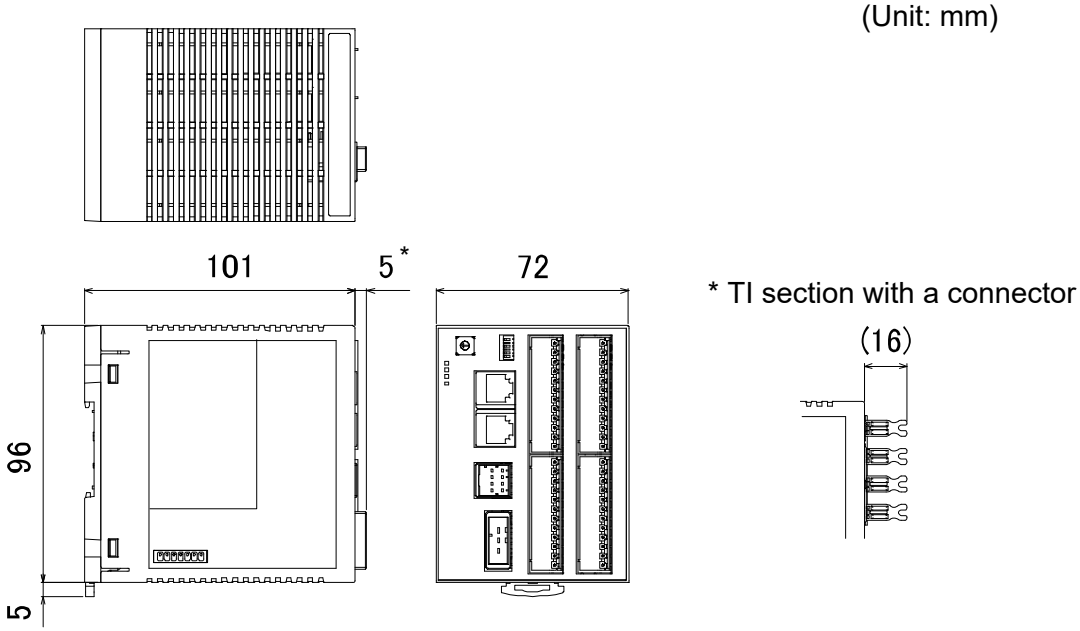


(5) In case this instrument is connected to a supply by means of a permanent connection, a switch or circuit-breaker shall be included in the installation. This shall be in close proximity to the equipment and within easy reach of the operator. It shall be marked as the disconnecting device for the equipment.

2.1.2 Dimensions

■ J-TI-A, J-TI-B

(Unit: mm)

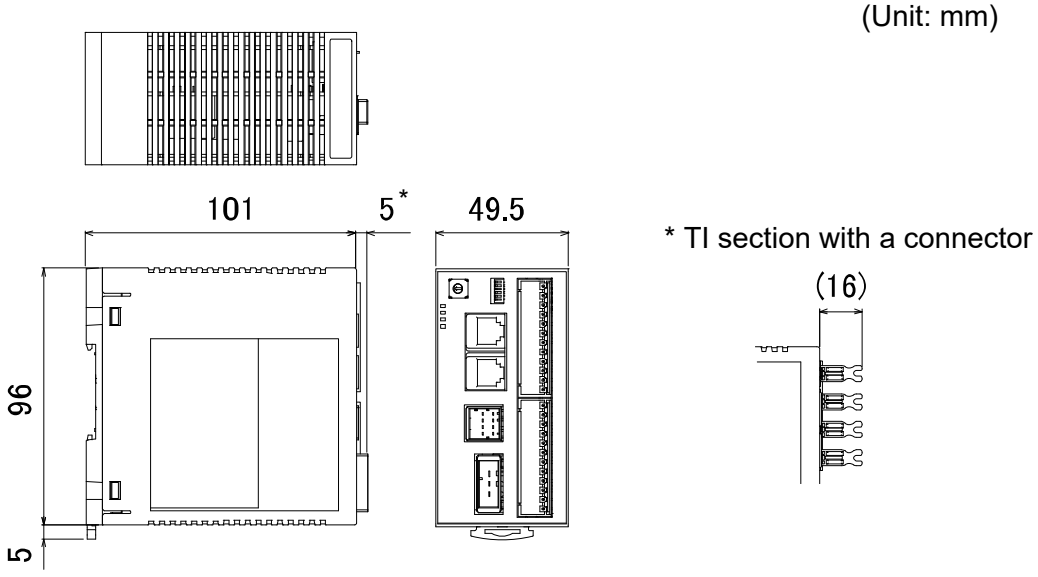


J-TI-A is used in the figures for explanation, but the same dimensions also apply to J-TI-B.

Mounting depth:
Space (bending length of each cable) for connecting cables must be considered when installing.

■ J-TI-C

(Unit: mm)



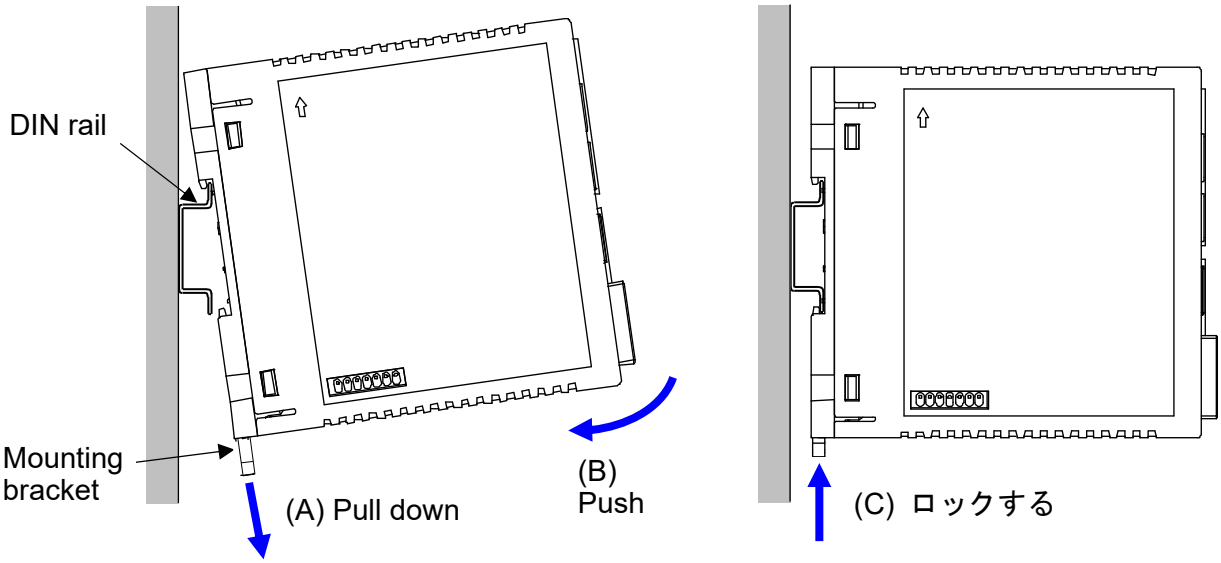
Mounting depth:
Space (bending length of each cable) for connecting cables must be considered when installing.

2.1.3 DIN rail mounting and removing

■ Mounting procedures

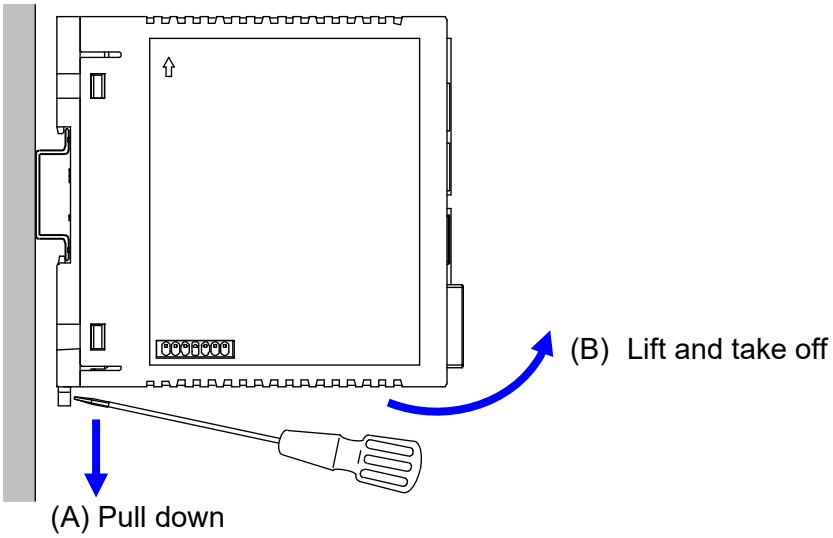
1. Pull down the mounting bracket at the bottom of the module (A). Attach the hooks on the top of the module to the DIN rail and push the lower section into place on the DIN rail (B).

2. Slide the mounting bracket up to secure the module to the DIN rail (C).



■ Removal procedures

Pull down a mounting bracket with a blade screwdriver (A). Lift the module from bottom, and take it off (B).



2.2 J-CVM (SSR Unit)

2.2.1 Mounting cautions

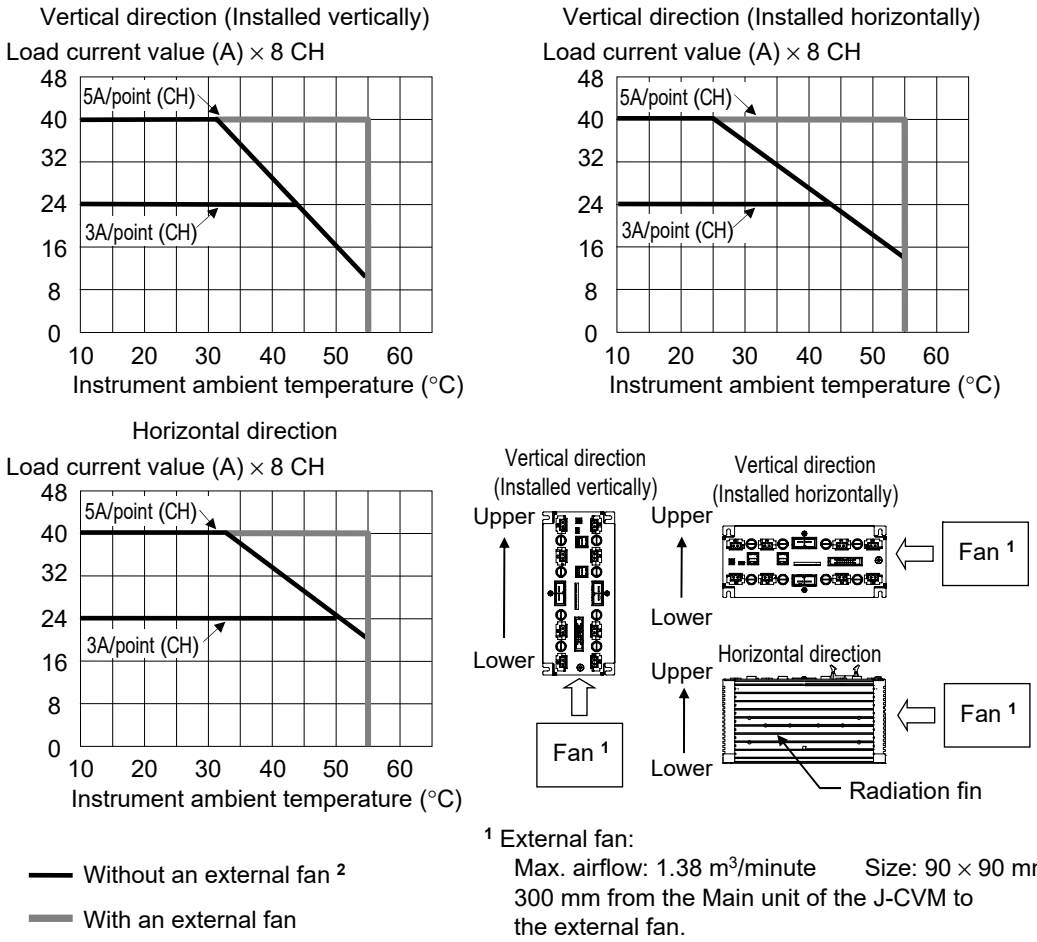
⚠ WARNING

To prevent electric shock or instrument failure, always turn off the power before mounting or removing the instrument.

(1) This instrument is intended to be used under the following environmental conditions.
(IEC 61010-1) [POLLUTION DEGREE 2]

(2) Use this instrument within the following environment conditions:
- Allowable ambient temperature: −10 to +55 °C
(Allowable load current decreases according to the ambient temperature around the instrument as shown in the following derating curve. Ensure that the ambient temperature does not exceed 55 °C.)

[Derating curve]



— Without an external fan [2]

— With an external fan

[1] External fan:
Max. airflow: 1.38 m^3/minute Size: 90 × 90 mm
300 mm from the Main unit of the J-CVM to the external fan.

[2] The J-CVM-5 (Allowable load current: 5 A per channel) does not satisfy the UL requirements when it is used without an external fan. To comply with UL's requirements, this instrument must be forced air cooled by the external fan.

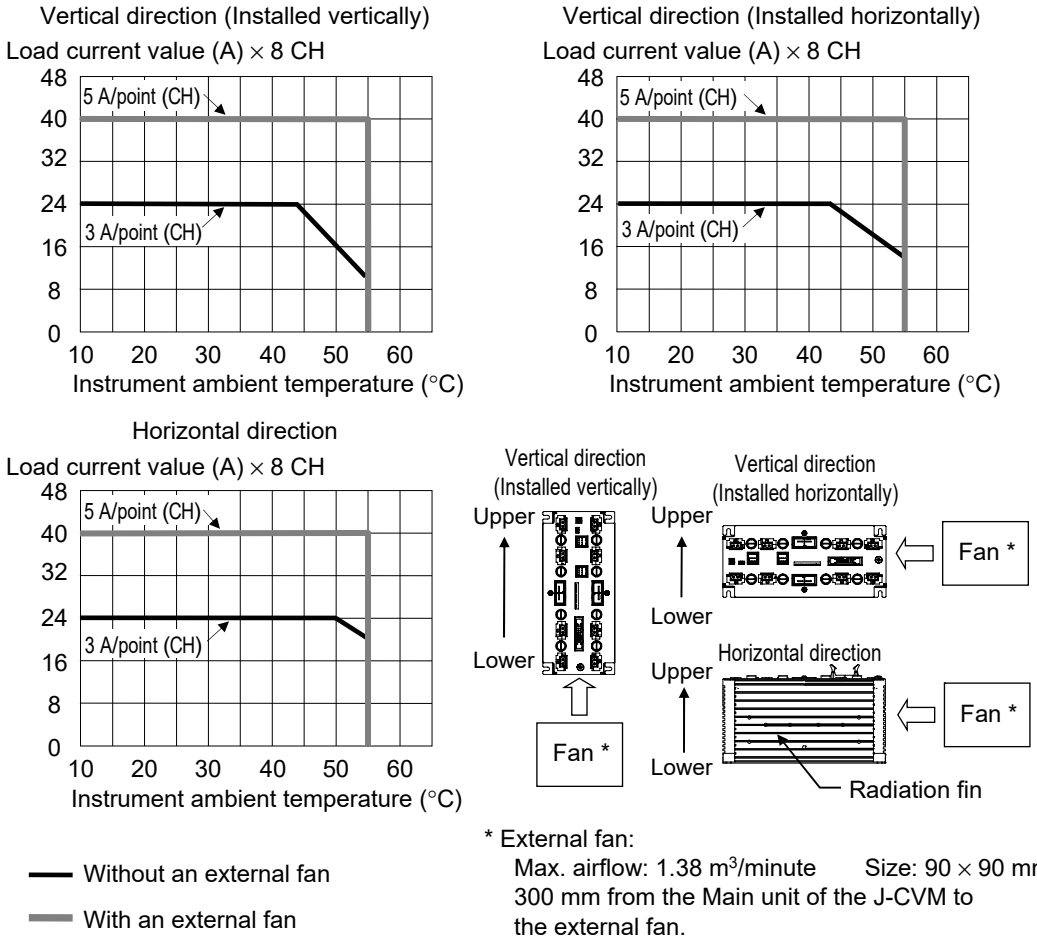
☞ For details, refer to the **Caution for Compliance with UL (P. 2-6)**.

Caution for Compliance with UL

The J-CVM conforms to UL standards. However, to satisfy the UL requirements, the instrument must be used in the following ambient temperature range and the installation environmental condition.

- Allowable ambient temperature: −10 to +55 °C
  (Allowable load current decreases according to the ambient temperature around the instrument as shown in the following derating curve. Ensure that the ambient temperature does not exceed 55 °C.)

[Derating curve]



* External fan:
Max. airflow: 1.38 m^3/minute Size: 90 × 90 mm
300 mm from the Main unit of the J-CVM to the external fan.

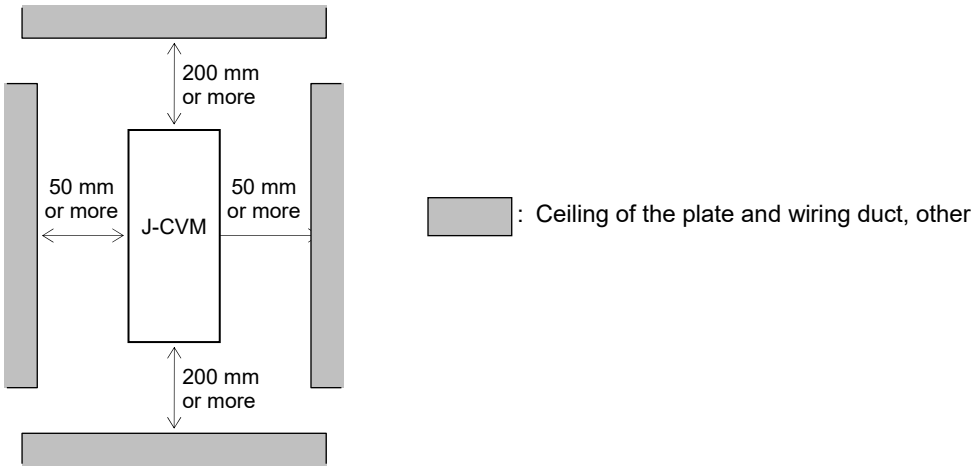
J-CVM-5 (Allowable load current: 5 A/point):
This instrument must be used in the forced air cooled environment.
External fan: Max. airflow: 1.38 m3/minute Size: 90 × 90 mm
300 mm from the Main unit of the J-CVM to the external fan.

J-CVM-3 (Allowable load current: 3 A/point):
This instrument must be used in an environment where the relation between the ambient temperature and the load current is satisfied like a derating curve.

- Allowable ambient humidity: 5 to 95 %RH
  (Absolute humidity: MAX.W.C 29 g/m^3 dry air at 101.3 kPa)
- Installation environment conditions: Indoor use, Altitude up to 2000 m

(3) Avoid the following conditions when selecting the mounting location:
- Rapid changes in ambient temperature which may cause condensation.
- Corrosive or inflammable gases.
- Direct vibration or shock to the mainframe.
- Water, oil, chemicals, vapor or steam splashes.
- Excessive dust, salt or iron particles.
- Excessive induction noise, static electricity, magnetic fields or noise.
- Direct air flow from an air conditioner.
- Exposure to direct sunlight.
- Excessive heat accumulation.

(4) Mount this instrument in the panel considering the following conditions:
- During the control operation, the radiation fin becomes hot (100 °C or less).
  For safety reasons always install the fin inside the instrumentation panel or the control panel to avoid accidental contact by the operator.
- Secure at least 200 mm spacing above and below and at least 50 mm spacing on the left and the right of the instrument for wiring, maintenance and environmental reason.



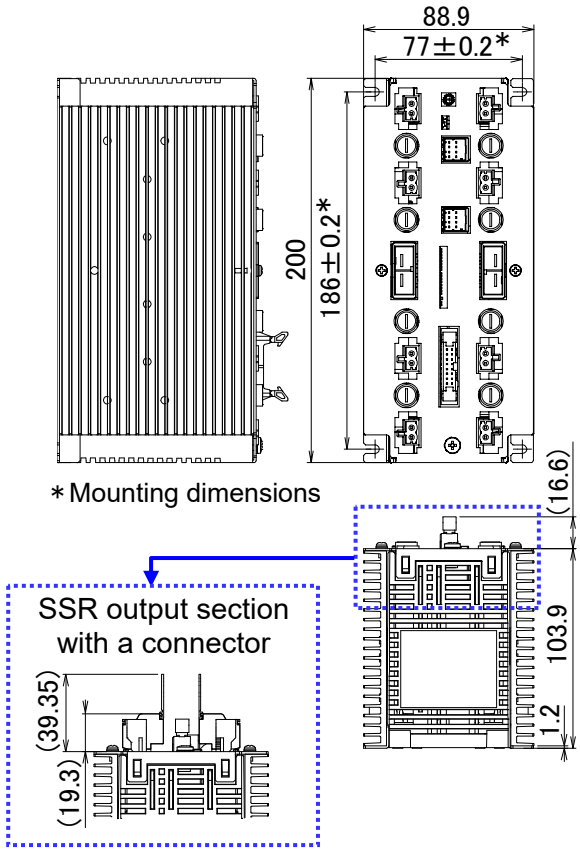
- Do not mount this instrument directly above the equipment that generates large amount of heat (heaters, transformers, thyristor units, large-wattage resistors.)
- In order to improve safety and the immunity to withstand noise, mount this instrument as far away as possible from high voltage equipment, power lines, and rotating machinery.
  High voltage equipment: Do not mount within the same panel.
  Power lines: Separate at least 200 mm.
  Rotating machinery: Separate as far as possible.

(5) In case this instrument is connected to a supply by means of a permanent connection, a switch or circuit-breaker shall be included in the installation. This shall be in close proximity to the equipment and within easy reach of the operator. It shall be marked as the disconnecting device for the equipment.

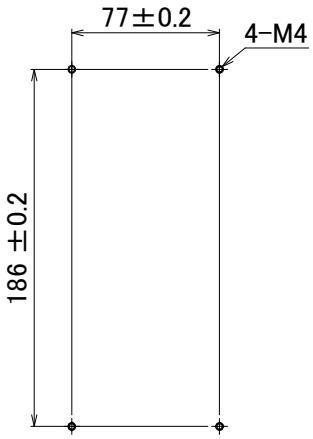
2.2.2 Dimensions

(Unit: mm)

Dimensions



Mounting dimensions

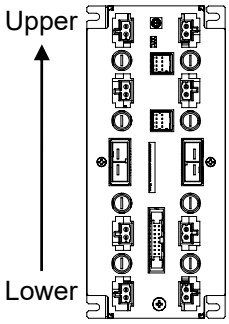


J-CVM-5 is used in the figures for explanation, but the same dimensions also apply to J-CVM-3.

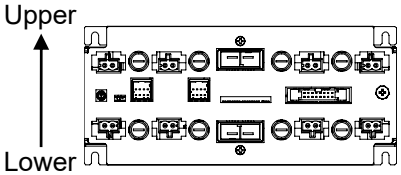
Mounting depth:
Space (bending length of each cable) for connecting cables must be considered when installing.

Mount this instrument in the direction shown below.

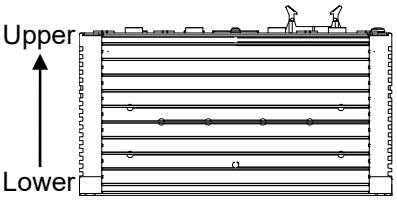
Vertical direction
(Installed vertically)



Vertical direction
(Installed horizontally)



Horizontal direction



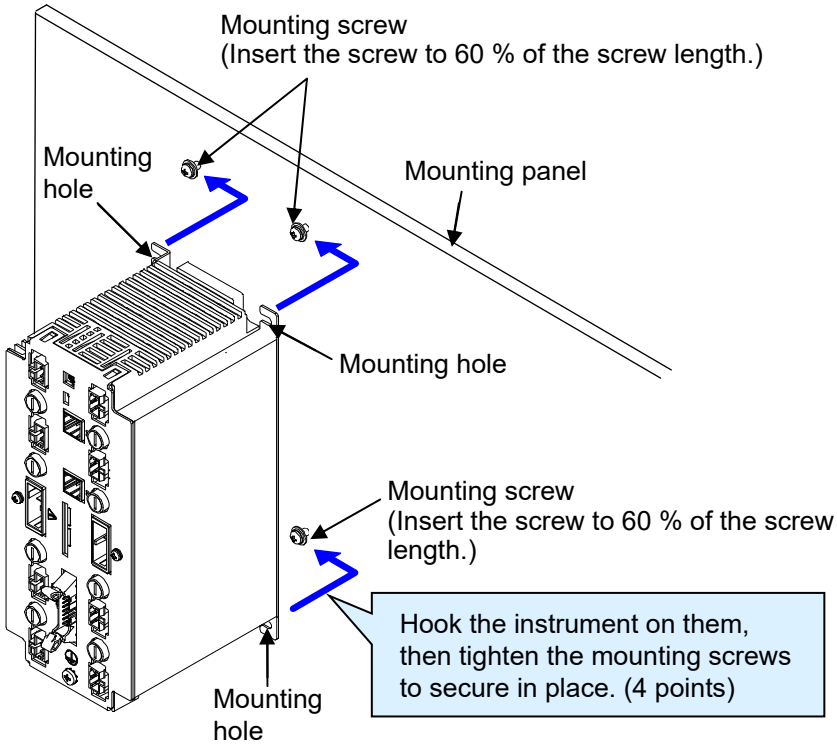
2.2.3 Mounting and removing

■ Mounting procedures

1. Refer to the external and mounting dimensions and make 4 holes for screws on the mounting panel.

2. Turn in the mounting screw into the mounting hole (4 points) to 60 % of the screw length.
Hook the mounting hole of the instrument on the inserted mounting screw.

3. Ensure that the instrument is installed horizontally, and tighten the mounting screw to secure in place.
Recommended tightening torque: 1.91 N·m (19.48 kgf·cm)



The customer needs to provide the mounting screws.
M4 size pan-head screws with captive washer and spring washer
(Length: 8 mm or longer) ····· 4 pcs

Recommended thickness of the mounting panel: 1.2 mm or more
(Choose a panel material of right strength and right thickness)

■ Removal procedures

To remove the instrument, reverse the mounting procedure.

MEMO

3 WIRING

This chapter describes wiring precautions, connector configuration, etc. for this instrument.

3.1 Connecting Cautions

⚠ WARNING

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

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

3.2 J-TI (Temperature Control Input Module)

3.2.1 Wiring cautions [J-TI]

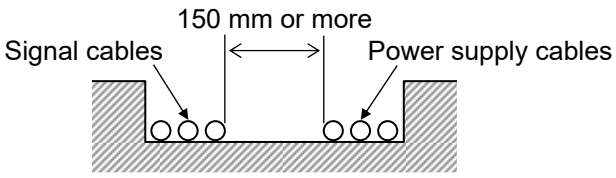
⚠ WARNING

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.

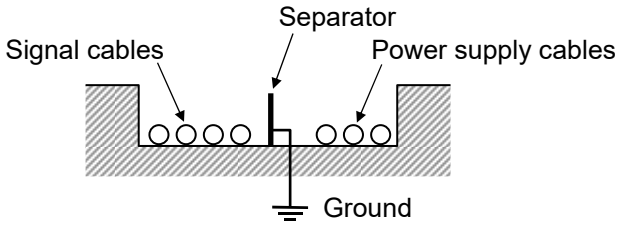
■ Input wiring

- For thermocouple input, use the appropriate compensation wire.
- For RTD input, use low resistance lead wire with no difference in resistance between the three lead wires.
- To avoid noise induction, keep input signal wire away from instrument power line, load lines and power lines of other electric equipment.

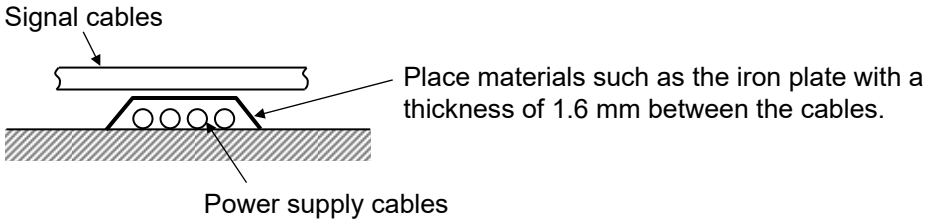
Example: Keep 150 mm or more between the cables



Example: Locate separator

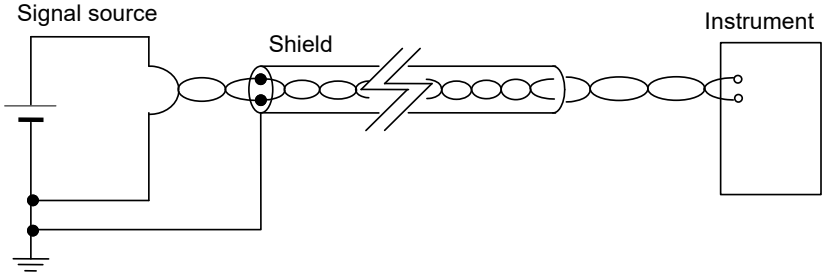


Example: Cross the cables at a right angle



- Use independent ducts for the input/output wires and power circuits inside and outside the panel.
- If input/output wires have to be placed in the same duct as the power circuits, use shielded wires. Ground the shield to reject any noise generated by the floating capacitance between the cores and shield or by a grounding potential.

Example: When signal source is grounded, ground the shield to the signal source side.

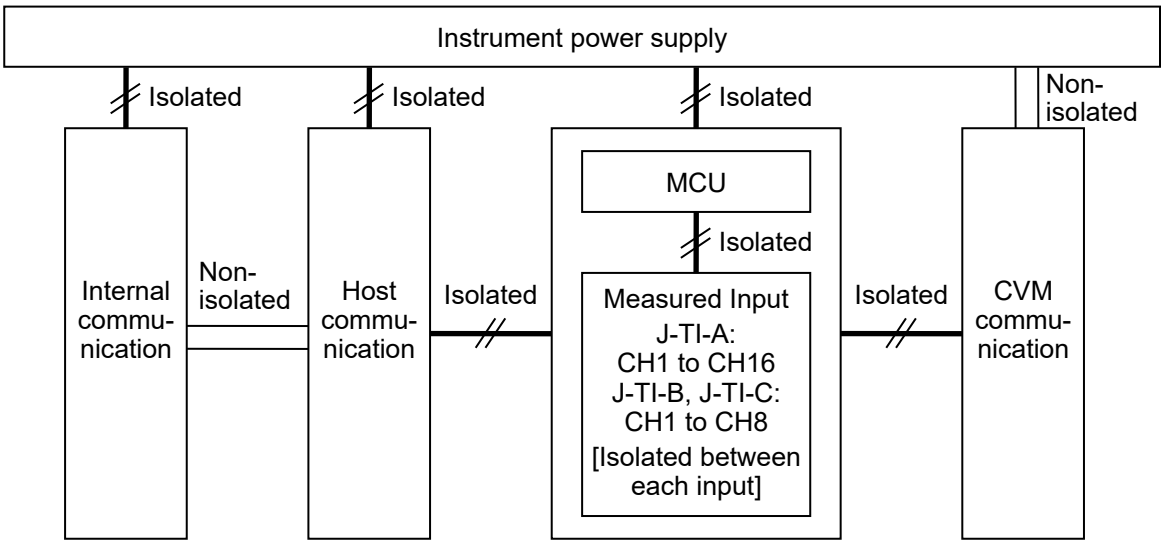


■ Power supply wiring

- If there is electrical noise in the vicinity of the instrument that could affect operation, use a noise filter.
  – Shorten the distance between the twisted power supply wire pitches to achieve the most effective noise reduction.
  – Always install the noise filter on a grounded panel. Minimize the wiring distance between the noise filter output and the instrument power supply terminals to achieve the most effective noise reduction.
  – Do not connect fuses or switches to the noise filter output wiring as this will reduce the effectiveness of the noise filter.
- Power supply wiring must be twisted and have a low voltage drop.
- For an instrument with 24 V power supply input, supply power from "SELV" circuit defined as IEC 60950-1.
- A suitable power supply should be considered in end-use equipment. The power supply must be in compliance with a limited-energy circuits (maximum available current of 5.04 A).

■ Isolations of the instrument

For the Input/Output isolation block of this instrument, refer to the following:



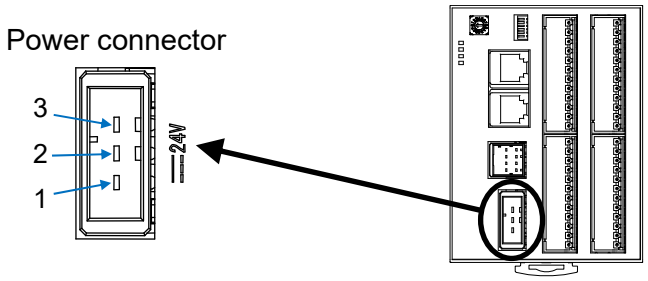
3.2.2 Connector configurations [J-TI]

Details of each connector is described in the following.

The customer needs to provide the connectors and cables. To obtain connectors and cables (sold separately), contact the RKC sales office or an agent.

■ Power connector

Connector for connecting the instrument power supply.



Pin number and signal name

Pin No.	Description
3	Unused
2	GND
1	24 V DC (for the instrument)

Wire tensile strength: 0.75 N (0.076 kgf) or more

Recommended receptacle housing:
D-3000 Series 3P (X type)
1-178288-3 (TE Connectivity)
Tab header (J-TI side):
D-3000 Series 3P Horizontal Type (X type)
1-178293-3 (TE Connectivity)

- Power supply voltage for the indicator must be within the range shown below to assure control accuracy.
  Power supply voltage: 20.4 to 26.4 V DC [Including power supply voltage variation] (Rating 24 V DC)
  Current consumption (at maximum load):
  J-TI (alone): 160 mA max. (at 24 V DC) Rush current: 20 A or less

Current consumption of J-TI Master connected to J-CVM (at maximum load)

No. of J-CVM connections	Transistor output for external SSR drive of J-CVM	
	When unused	When used*
1	370 mA max.	770 mA max.
2	580 mA max.	1.38 A max.
3	790 mA max.	1.99 A max.
4	1.00 A max.	2.60 A max.

No. of J-CVM connections	Transistor output for external SSR drive of J-CVM	
	When unused	When used*
5	1.21 A max.	3.21 A max.
6	1.42 A max.	3.82 A max.
7	1.63 A max.	4.43 A max.
8	1.84 A max.	5.04 A max.

* Calculated as load current of transistor output for external SSR drive = 400 mA (50 mA × 8 channels) per J-CVM

For the Transistor output for external SSR drive, refer to **■ Transistor output for external SSR drive connector (CN3) (P. 3-18)**.

J-TI master current consumption calculation method

J-TI master current consumption = Maximum current consumption of a single J-TI unit (160 mA) + (Maximum current consumption of a single J-CVM unit (210 mA) × No. of J-CVM connections) + Maximum current consumption of transistor output for driving external SSR *

* Aggregate value for J-CVMs connected to J-TI master

- If there is electrical noise in the vicinity of the instrument that could affect operation, use a noise filter.
- Power supply wiring must be twisted and have a low voltage drop.
- For an instrument with 24 V power supply input, supply power from “SELV” circuit defined as IEC 60950-1.
- A suitable power supply should be considered in end-use equipment. The power supply must be in compliance with a limited-energy circuits (maximum available current of 5.04 A).

J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

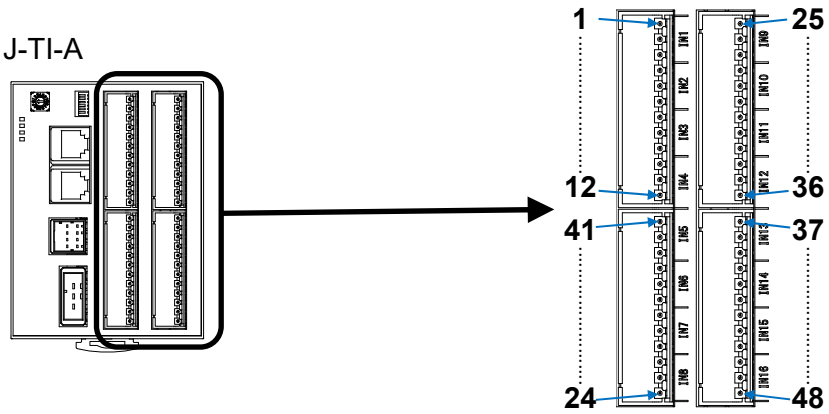
W-CF-P01-AC power supply cable (RKC product) can be used as power supply cable (sold separately).
Cable type: W-CF-P01-AC-□□□□□ (RKC product, Sold separately)
[□□□□□: cable length (Unit: mm)]

■ Measured input connectors (IN)

Connector for connecting the measured inputs.

● J-TI-A (16 channels)

Measured input connectors (IN1 to IN16)



< Pin number and signal name >

TC input

Pin No.	Description		Pin No.	Description	
1	Unused	IN1	25	Unused	IN9
2	TC (+)		26	TC (+)	
3	TC (–)		27	TC (–)	
4	Unused	IN2	28	Unused	IN10
5	TC (+)		29	TC (+)	
6	TC (–)		30	TC (–)	
7	Unused	IN3	31	Unused	IN11
8	TC (+)		32	TC (+)	
9	TC (–)		33	TC (–)	
10	Unused	IN4	34	Unused	IN12
11	TC (+)		35	TC (+)	
12	TC (–)		36	TC (–)	
13	Unused	IN5	37	Unused	IN13
14	TC (+)		38	TC (+)	
15	TC (–)		39	TC (–)	
16	Unused	IN6	40	Unused	IN14
17	TC (+)		41	TC (+)	
18	TC (–)		42	TC (–)	
19	Unused	IN7	43	Unused	IN15
20	TC (+)		44	TC (+)	
21	TC (–)		45	TC (–)	
22	Unused	IN8	46	Unused	IN16
23	TC (+)		47	TC (+)	
24	TC (–)		48	TC (–)	

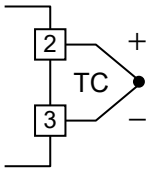
Recommended female connectors:
2091-1103/002-000 (WAGO)
Male headers (J-TI side):
2091-1432 (WAGO)

Wire tensile strength:
0.75 N (0.076 kgf) or more

For thermocouple input, use the appropriate compensation wire.

- **Wiring example (For IN1)**

TC input



RTD input

Pin No.	Description		Pin No.	Description	
1	RTD (A)	IN1	25	RTD (A)	IN9
2	RTD (B)		26	RTD (B)	
3	RTD (B)		27	RTD (B)	
4	RTD (A)	IN2	28	RTD (A)	IN10
5	RTD (B)		29	RTD (B)	
6	RTD (B)		30	RTD (B)	
7	RTD (A)	IN3	31	RTD (A)	IN11
8	RTD (B)		32	RTD (B)	
9	RTD (B)		33	RTD (B)	
10	RTD (A)	IN4	34	RTD (A)	IN12
11	RTD (B)		35	RTD (B)	
12	RTD (B)		36	RTD (B)	
13	RTD (A)	IN5	37	RTD (A)	IN13
14	RTD (B)		38	RTD (B)	
15	RTD (B)		39	RTD (B)	
16	RTD (A)	IN6	40	RTD (A)	IN14
17	RTD (B)		41	RTD (B)	
18	RTD (B)		42	RTD (B)	
19	RTD (A)	IN7	43	RTD (A)	IN15
20	RTD (B)		44	RTD (B)	
21	RTD (B)		45	RTD (B)	
22	RTD (A)	IN8	46	RTD (A)	IN16
23	RTD (B)		47	RTD (B)	
24	RTD (B)		48	RTD (B)	

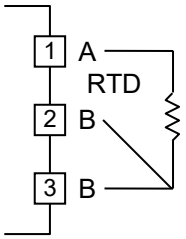
Recommended female connectors:
2091-1103/002-000 (WAGO)
Male headers (J-TI side):
2091-1432 (WAGO)

Wire tensile strength:
0.75 N (0.076 kgf) or more

For RTD input, use low resistance lead wire with no difference in resistance between the three lead wires.

- **Wiring example (For IN1)**

RTD input



- To avoid noise induction, keep input signal wire away from instrument power line, load lines and power lines of other electric equipment.
- The input types are as follows (specify when ordering).

TC input

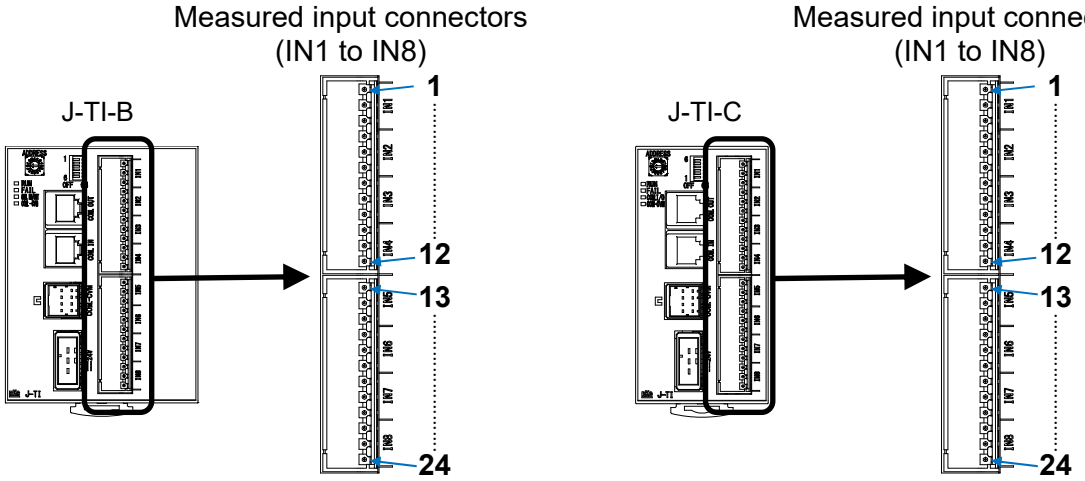
Type	Code	Range
K	K09	0.0 to 400.0 °C
	K10	0.0 to 800.0 °C
	K11	0.0 to 1300.0 °C
R	R10	0.0 to 1700.0 °C

RTD input

Type	Code	Range
Pt100	D40	0.0 to 400.0 °C
	D41	0.0 to 600.0 °C
	D42	0.0 to 800.0 °C

- Input type can be changed at **Input range number (P. 7-6)** of the Engineering setting data.

● J-TI-B (8 channels), J-TI-C (8 channels)



< Pin number and signal name >

TC input

Pin No.	Description	
1	Unused	IN1
2	TC (+)	
3	TC (–)	
4	Unused	IN2
5	TC (+)	
6	TC (–)	
7	Unused	IN3
8	TC (+)	
9	TC (–)	
10	Unused	IN4
11	TC (+)	
12	TC (–)	
13	Unused	IN5
14	TC (+)	
15	TC (–)	
16	Unused	IN6
17	TC (+)	
18	TC (–)	
19	Unused	IN7
20	TC (+)	
21	TC (–)	
22	Unused	IN8
23	TC (+)	
24	TC (–)	

RTD input

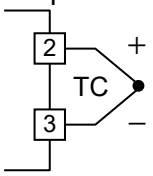
Pin No.	Description	
1	RTD (A)	IN1
2	RTD (B)	
3	RTD (B)	
4	RTD (A)	IN2
5	RTD (B)	
6	RTD (B)	
7	RTD (A)	IN3
8	RTD (B)	
9	RTD (B)	
10	RTD (A)	IN4
11	RTD (B)	
12	RTD (B)	
13	RTD (A)	IN5
14	RTD (B)	
15	RTD (B)	
16	RTD (A)	IN6
17	RTD (B)	
18	RTD (B)	
19	RTD (A)	IN7
20	RTD (B)	
21	RTD (B)	
22	RTD (A)	IN8
23	RTD (B)	
24	RTD (B)	

Recommended female connectors:
2091-1103/002-000 (WAGO)
Male headers (J-TI side):
2091-1432 (WAGO)

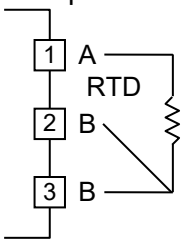
Wire tensile strength:
0.75 N (0.076 kgf) or more

• Wiring example (For IN1)

TC input



RTD input



- For thermocouple input, use the appropriate compensation wire.
- For RTD input, use low resistance lead wire with no difference in resistance between the three lead wires.

- To avoid noise induction, keep input signal wire away from instrument power line, load lines and power lines of other electric equipment.
- The input types are as follows (specify when ordering).

TC input

Type	Code	Range
K	K09	0.0 to 400.0 °C
	K10	0.0 to 800.0 °C
	K11	0.0 to 1300.0 °C
R	R10	0.0 to 1700.0 °C

RTD input

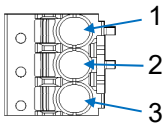
Type	Code	Range
Pt100	D40	0.0 to 400.0 °C
	D41	0.0 to 600.0 °C
	D42	0.0 to 800.0 °C

- Input type can be changed at **Input range number (P. 7-6)** of the Engineering setting data.

● J-TI with a connector for TI section (J-TI-□-□□□-□□□*N/C)

J-TI with a connector for TI section is supplied with the following female connector at the time of shipment.

Female connectors: 2091-1103/002-000 (WAGO)
With gripping plate and sliding connector release



Wire tensile strength: 0.75 N (0.076 kgf) or more

< Pin number and signal name >

TC input

Pin No.	Description
1	Unused
2	TC (+)
3	TC (–)

RTD input

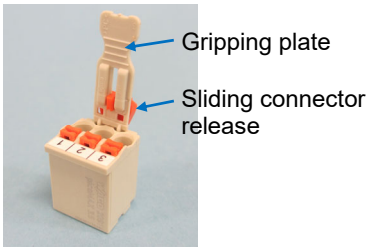
Pin No.	Description
1	RTD (A)
2	RTD (B)
3	RTD (B)

- Connection method: CAGE CLAMP®S
- Conductor size
  Solid: 0.2 to 1.5 mm^2
  Fine-stranded: 0.2 to 1.5 mm^2
  0.25 to 0.75 mm^2 (with insulated ferrule)
  0.25 to 1.5 mm^2 (with uninsulated ferrule)
- AWG: 24 to 14
  AWG14 may not be available depending on the diameter of the cable jacket.
- Strip length: 8 to 9 mm/0.31 to 0.35 in
- Operating tools: 2.5 × 0.4 mm blade (WAGO 210-719 screwdriver)
  A small screwdriver can be used for wiring.

Avoid whisker wiring (exposed wiring).

< Disconnecting female connector >

1. Push down sliding connector release to open the locking latch.
2. While holding down the Sliding connector release, hold the cable and the Gripping plate and pull out the connector from the unit.



■ Host communication connector (COM. IN, COM. OUT)

COM. IN: Connector for connecting the host computer or J-TI.
COM. OUT: Connector for adding more J-TI.

For the Host communication connector, refer to **3.4.5 Connecting the J-TI master and the host computer (P. 3-28)**.

■ CVM power/Communication connector (COM.-CVM)

Connector for connecting the J-CVM. Used for communicating with the J-CVM and supplying power to the J-CVM.

For the CVM power/Communication connector, refer to **3.5.3 Connecting the J-TI master and J-CVM (P. 3-39)**.

3.3 J-CVM (SSR Unit)

3.3.1 Wiring cautions [J-CVM]

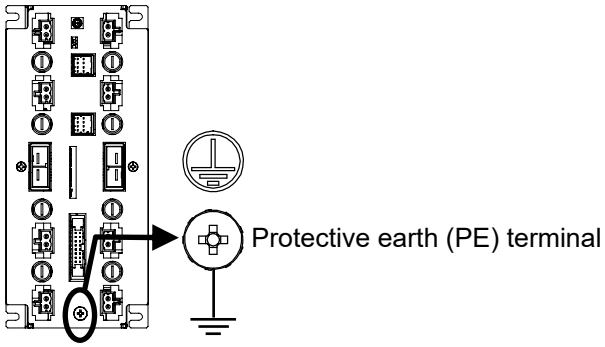
> **⚠ WARNING**
>
> To prevent electric shock or instrument failure, do not turn on the power until all wiring is completed. Make sure that the wiring is correct before applying power to the instrument.

■ Power supply wiring

- If there is electrical noise in the vicinity of the instrument that could affect operation, use a noise filter.
  - Shorten the distance between the twisted power supply wire pitches to achieve the most effective noise reduction.
  - Always install the noise filter on a grounded panel. Minimize the wiring distance between the noise filter output and the instrument power supply terminals to achieve the most effective noise reduction.
  - Do not connect fuses or switches to the noise filter output wiring as this will reduce the effectiveness of the noise filter.
- Power supply wiring must be twisted and have a low voltage drop.
- The heater power supply is not provided with an overcurrent protection device. For safety install an overcurrent protection device (such as a fuse) with adequate breaking capacity close to each heater power connector.
  - Fuse type: Fast-blow fuse (IEC certified and UL approved)
  - Fuse rating: Rated voltage: 250 V AC
    Rated current: 30 A

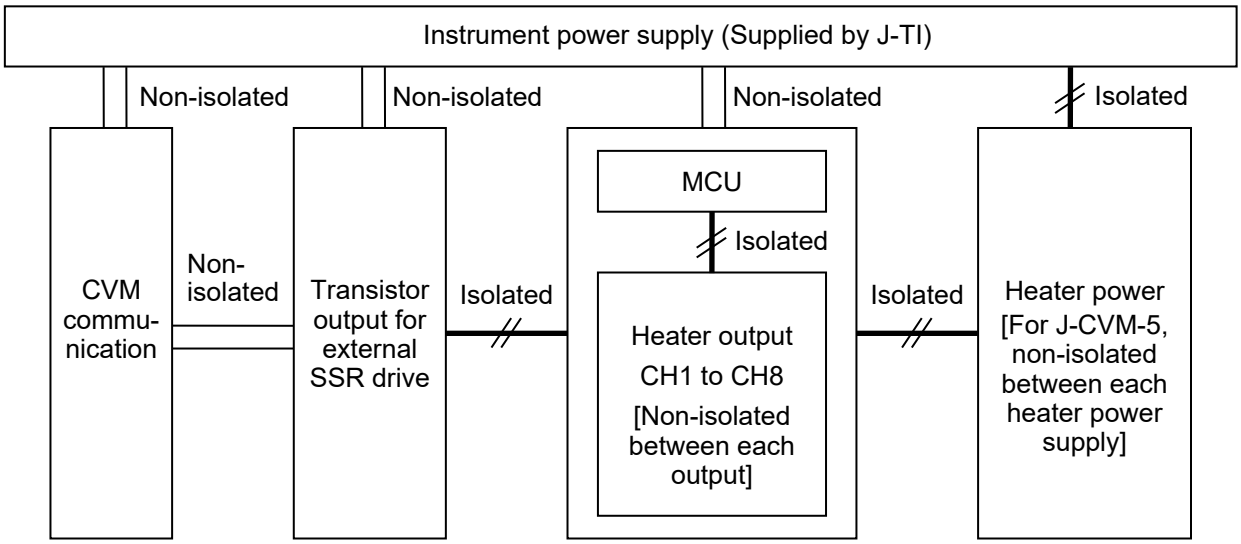
■ Protective earth (PE) wiring

- Connect the protective earth (PE) terminal of the J-CVM to ground to prevent electric shock.
  - Ground no other devices to the location where you ground this instrument.
  - Avoid sharing earth lines with electric motors, motorized equipment, and other equipment that uses large amounts of electrify.
  - In the earth system, be careful to earth each point and not to create an earth loop.
  - Use wire of at least 8.0 mm^2 for earth lines.
  - Screw size: M4 × 8 (Binding head screw with toothed washer)
    Recommended tightening torque: 1.2 N·m (12.24 kgf·cm)



■ Isolations of the instrument

For the Input/Output isolation block of this instrument, refer to the following:



3.3.2 Connector configurations [J-CVM]

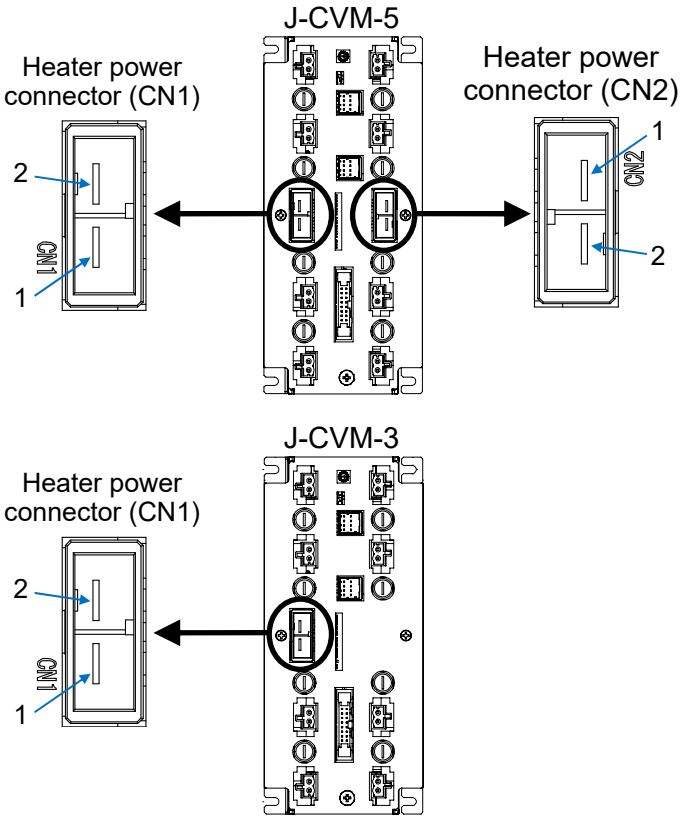
Details of each connector is described in the following.

The customer needs to provide the connectors and cables. To obtain connectors and cables (sold separately), contact the RKC sales office or an agent.

■ Heater power connector (CN1, CN2)

Connector for connecting the heater power supply.

Number of connectors: J-CVM-3: 1 pcs (Maximum load current: 3 A/point)
J-CVM-5: 2 pcs (Maximum load current: 5 A/point)



Pin number and signal name

Pin No.	Description
1	Heater power L
2	Heater power N

Wire tensile strength: 0.5 N (0.05 kgf) or more

Recommended receptacle housing:
D-5000 Series 2P (X type)
1-179958-2 (TE Connectivity)
Tab header (J-CVM side):
D-5000 Series 2P Horizontal Type (X type)
1-353079-2 (TE Connectivity)

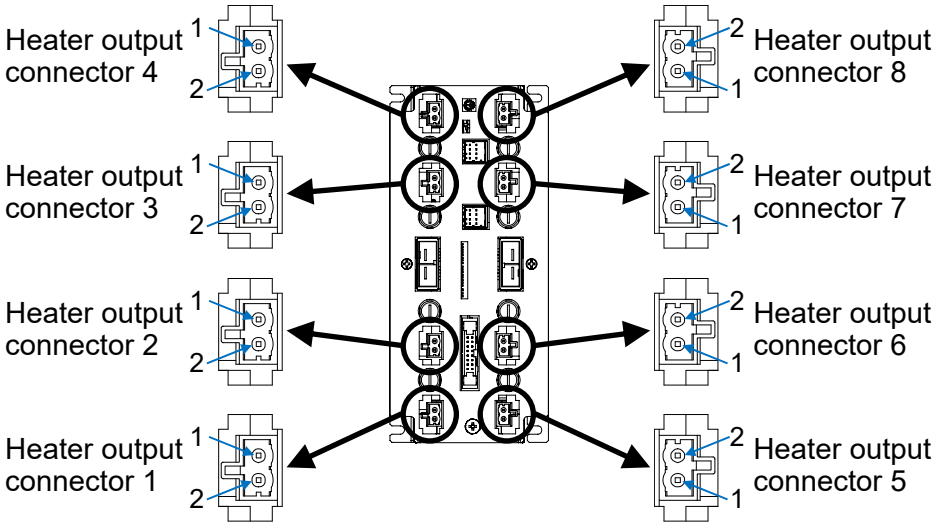
- The heater power supply for indicator must be within the range shown below to assure control accuracy
  Power supply voltage: 35 to 264 V AC (50/60 Hz) [Including power supply voltage variation]
  (Rating: 100 to 240 V AC)
  Current consumption (at maximum load): J-CVM-3: 3 A/point, J-CVM-5: 5 A/point
- The heater power supply is not provided with an overcurrent protection device. For safety install an overcurrent protection device (such as a fuse) with adequate breaking capacity close to each heater power connector.
  Fuse type: Fast-blow fuse (IEC certified and UL approved)
  Fuse rating: Rated voltage: 250 V AC
  Rated current: 30 A

- If there is electrical noise in the vicinity of the instrument that could affect operation, use a noise filter.
- Power supply wiring must be twisted and have a low voltage drop.

W-CF-P02-AC heater power supply cable (RKC product) can be used as heater power supply cable (sold separately).
Cable type: W-CF-P02-AC-□□□□□ (RKC product, Sold separately)
[□□□□□: cable length (Unit: mm)]

■ Heater output connector (1 to 8)

Connectors for connecting the heater output.



Pin number and signal name

Pin No.	Description
1	L
2	N

Male headers (J-CVM side):
721-432/001-000 (WAGO)

Wire tensile strength:
1 N (0.1 kgf) or more

NOTE

The connector pins (male header pins) on the SSR output section without a connector are bare and accessible. Always install a female connector to prevent electric shock even if the output is not used.

NOTE

For a safety operation of the units, customers must choose from any one of the following connectors when a female connector is required.

- **Female connector 721-2102/037-000 (WAGO)**
- **Female connector 721-102/037-000 (WAGO)**
- **Female connector 2721-102/037-000 (WAGO)**

- Output type is SSR output.

  Output method: AC output (Zero-cross method)
  Allowable load current: J-CVM-3: 3 A/point
  J-CVM-5: 5 A/point
  Load voltage: 35 to 264 V AC (50/60 Hz) [Including power supply voltage variation]
  (Rating: 100 to 240 V AC)
  OVERVOLTAGE CATEGORY II
  Minimum load current: 100 mA
  Voltage drop at ON: 1.5 V or less (at maximum load current)
  Leakage current at OFF: 5 mA or less (at 200 V AC)
  Output current: J-CVM-3: 3 A max.
  J-CVM-5: 5 A max.
  Output voltage: 33.5 to 264 V AC

- Assignment of temperature input channels corresponding to the heater outputs (1 to 8) can be done on the address setting switch. For the address setting switch, refer to **3.5.1 Address setting (assignment of temperature input channels) [J-CVM] (P. 3-35)**.

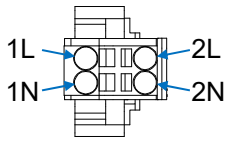
J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

● J-CVM with a connector for SSR output section (J-CVM-☐/C)

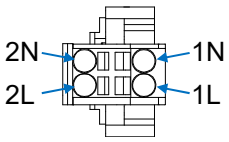
J-CVM with a connector for SSR output section is supplied with the following female connector at the time of shipment.

Female connectors: 721-2102/037-000-L1L2 (WAGO)
2-conductor spring clamps with locking lever 2 pole

Heater output connector 1 to 4



Heater output connector 5 to 8



Wire tensile strength:
1 N (0.1 kgf) or more

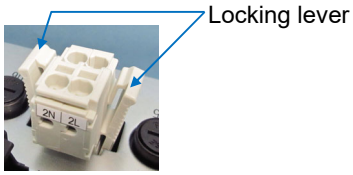
Pin number and signal name

Pin No.	Description
1L	L
2L	
1N	N
2N	

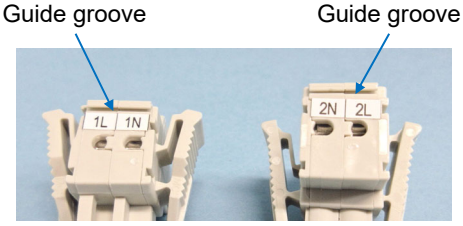
- Connection method: CAGE CLAMP®
- Conductor size
  - Solid: 0.2 to 2.5 mm^2
  - Fine-stranded: 0.2 to 2.5 mm^2
  - 0.25 to 1.5 mm^2 (with ferrule and plastic collar)
  - 0.25 to 2.5 mm^2 (with ferrule, without plastic collar)
- AWG: 24 to 12
- Strip length: 9 to 10 mm/0.35 to 0.39 in
- Operating tools: 3.5 × 0.5 mm blade (WAGO 210-720 screwdriver)
  A small screwdriver can be used for wiring.

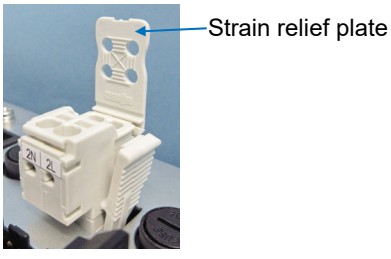
Avoid whisker wiring (exposed wiring).

To remove a female connector, while holding the locking lever with fingers to release the lock, pull out the connector.



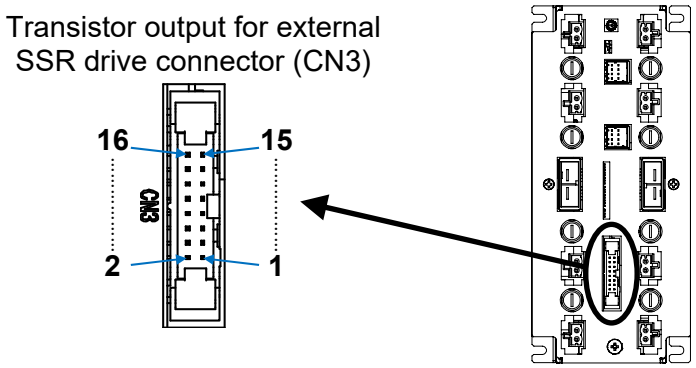
Use the supplied Strain relief plate if needed.
To mount a strain relief plate on the female connector, slide it into the guide groove (at the upper part of the connector) from the side of the connector.





■ Transistor output for external SSR drive connector (CN3)

Connector for connecting the transistor outputs for external SSR drive output.



Pin number and signal name

Pin No.	Description
1	CH1
2	CH2
3	CH3
4	CH4
5	CH5
6	CH6
7	CH7
8	CH8

Pin No.	Description
9	+24 V
10	+24 V
11	+24 V
12	+24 V
13	+24 V
14	+24 V
15	+24 V
16	+24 V

Recommended socket:
HIF3MAW-16D-2.54
(HIROSE ELECTRIC)
Pin header (J-CVM side):
HIF3MAW-16PA-2.54DS
(HIROSE ELECTRIC)

Wire tensile strength:
4 N (0.4 kgf) or more

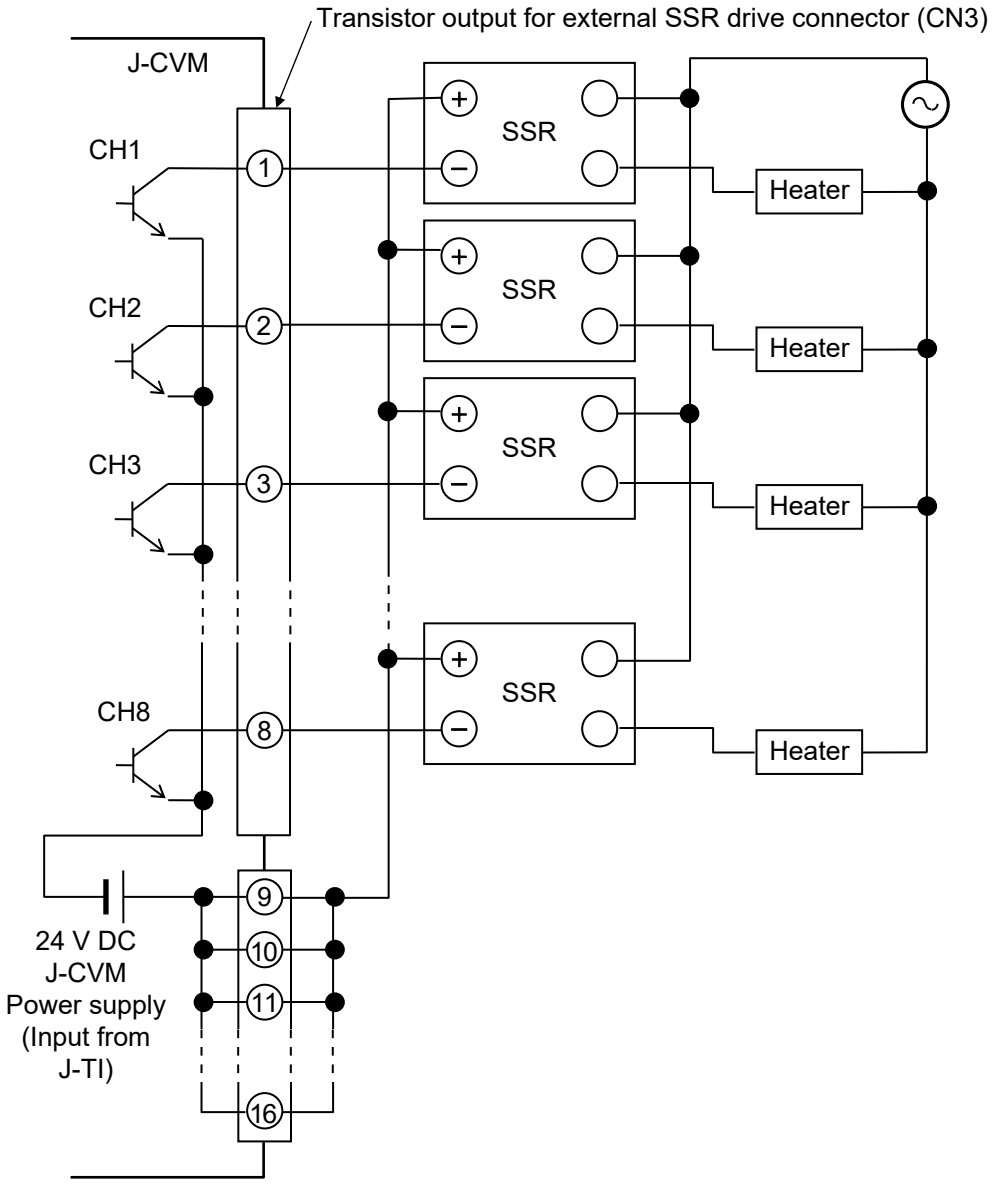
- Output type is transistor output (open collector output).
  Output method: Sink type
  Allowable load current: 50 mA/ point
  Load voltage: 40 V DC or less
  Voltage drop at ON: 2 V or less (at allowable load current)
  Leakage current at OFF: 5 µA or less
  Overcurrent protection: None
- Temperature input channel numbers, which are assigned to transistor outputs for external SSR (CH1 to CH8), are set through communication "Transistor output selection."
  For RKC communication: Identifier VP
  For Modbus communication: Address 0280 to 028F (HEX), 640 to 655 (DEC)

  For the Transistor output selection, refer to **7.7.1 Using a transistor output for driving an external SSR (P. 7-29)**.

J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

W-CF-S01-AC output cable for transistor (RKC product) can be used as connecting cable (sold separately).
Cable type: W-CF-S01-AC-□□□□□ (RKC product, Sold separately)
[□□□□□: cable length (Unit: mm)]

● **Transistor output for external SSR drive wiring example**



■ Power/Communication connector (COM. IN, COM. OUT)

COM. IN: Used to connect the J-TI master or J-CVM.
Inputs communication with the J-TI master and instrument power from the J-TI master.

COM. OUT: Connector for adding more J-CVM.
Outputs communication with the J-TI master and instrument power supplied by the J-TI master.

☞ For the Power/Communication connector, refer to **3.5.3 Connecting the J-TI master and J-CVM (P. 3-39)**.

3.3.3 Fuse replacement [J-CVM]

To prevent shorting, a fuse (5 × 20 mm Fast-blow fuse) is built in the J-CVM. If the fuse is blown, replace it in accordance with the following cautions and procedures.

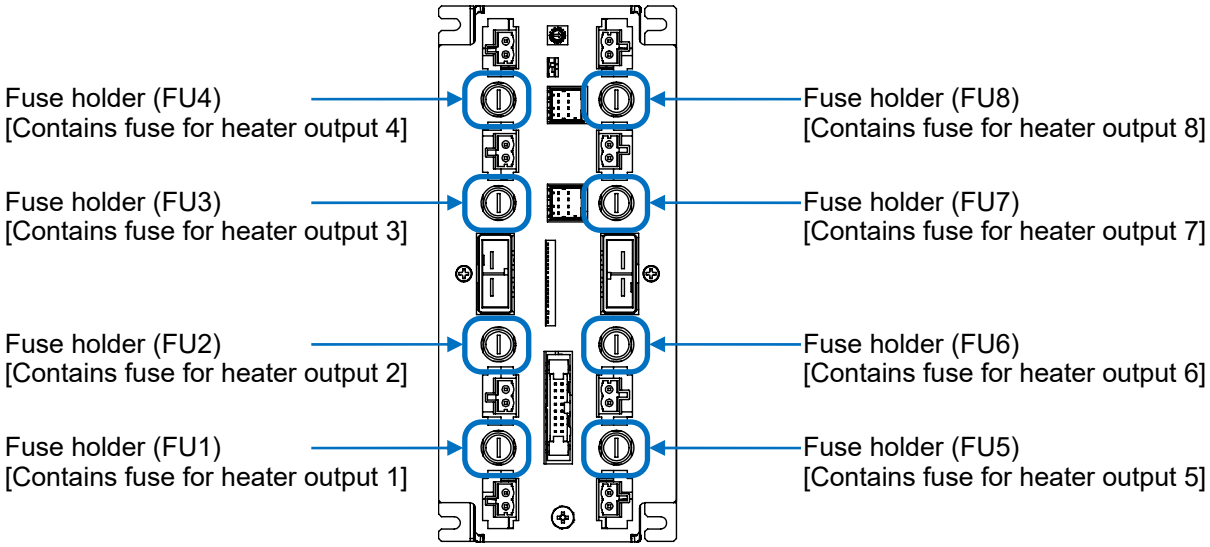
⚠ WARNING

- To prevent electric shock or instrument failure, replace the fuse after turning off the power.
- To prevent burn injury, power off and allow the instrument to cool down before attempting access to the internal part of the instrument.
- Use the recommended fuses. Do not use fuse other than specified to prevent fire and failure of the instrument.

■ Replacement procedures

1. Make sure the instrument is disconnected from power supply and the instrument is cooled down enough.

2. Using a flathead screwdriver, turn the lid of the fuse holder to the left to unlock.



J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

3. Remove a fuse from the fuse holder.

4. Install a new fuse.

Recommended fuse model type	021806.3MXP (Llittelfuse)	021606.3MXP (Llittelfuse)
Fuse type	5 × 20 mm Time-lag fuse	5 × 20 mm Fast-blow fuse
Fuse rating	Rated voltage: 250 V AC Rated current: 6.3 A	

5. Using a flathead screwdriver, turn the cover of the fuse holder to the right, while pressing lightly.

3.4 Connections for Host Communication

The J-TI interfaces with the host computer via Modbus or RKC communication (ANSI X3.28-1976 subcategories 2.5 and B1) protocols. The communication interface used for both protocols is RS-485.

⚠ WARNING

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

NOTE

The communication protocol and communication speed can be changed only by host communication. Since communication is not established during the default connection, set the host computer in accordance with the settings of the J-TI.

– Factory set value of J-TI –

Communication protocol:	**When the communication protocol is specified at the time of order, the specified communication protocol will be the factory set value.** **If the communication protocol is not specified: Modbus**
Communication speed:	**38400 bps**
Data bit configuration (fixed):	**Start bit: 1** **Data bit: 8** **Parity bit: None** **Stop bit: 1**

NOTE

Always connect the host computer to the J-TI master. If the host computer is connected to a J-TI slave, communication errors may cause malfunction or damage. If the J-TI is set in the following way, it becomes a J-TI master.

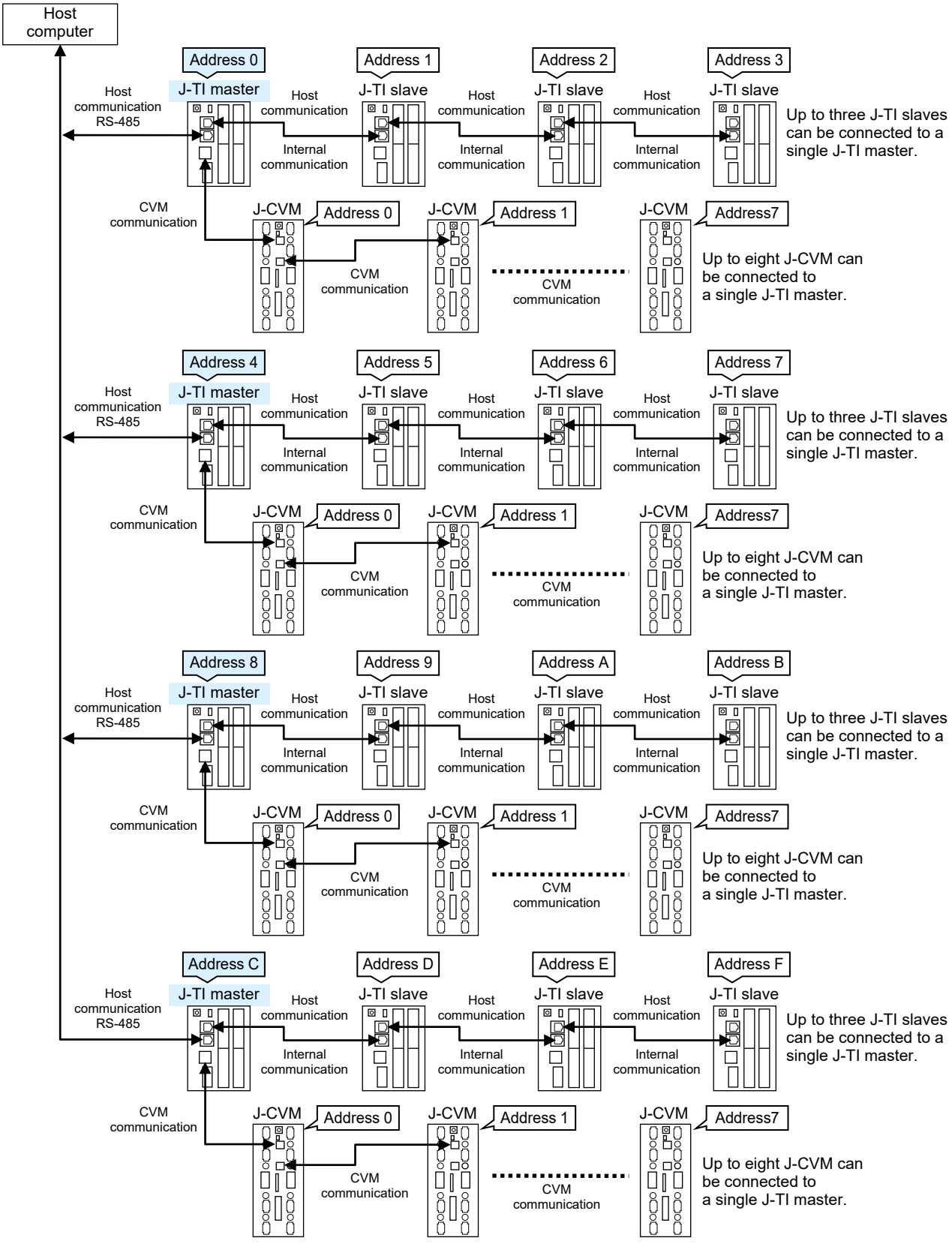
Host communication or internal communication transfer of communication setting switch (P. 3-26): Host communication

Set value of Address setting switch (P. 3-24): 0, 4, 8 and C (Master address)

The communication protocol and communication speed of the J-TI can be checked from the lighting and flashing state of the indicator lamp immediately after the power is turned ON. For details, refer to **7.9.2 Checking the communication protocol and communication speed by indication lamps (P.7-57)**.

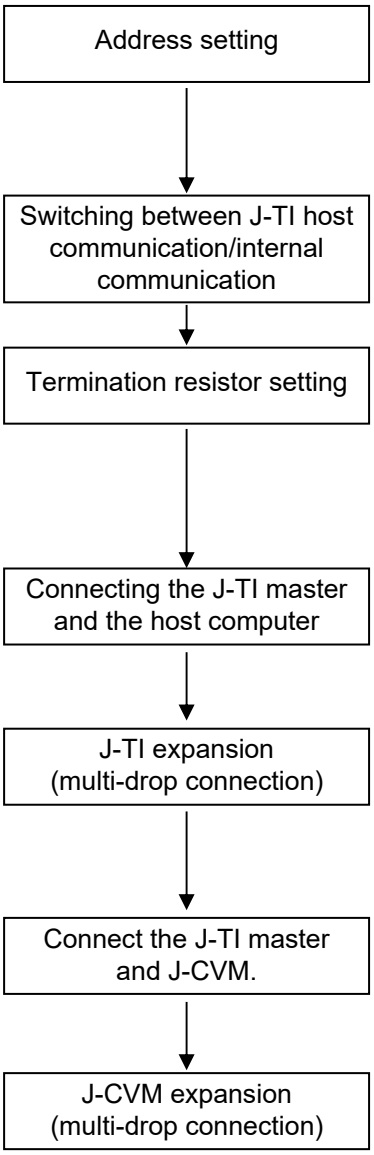
3.4.1 System Configuration

Up to four J-TI masters can be connected to a single host computer. Also, up to three J-TI slaves and eight J-CVMs can be connected to a single J-TI master.
Setting the J-TI's address setting switch to 0, 4, 8 or C turns it into a master, and three J-TI addresses connected to each master become slaves. The control-related communication data is sent or received between the J-TI master and the JT-I slaves through internal communication. Also, J-CVM communication is possible with a J-TI master only (CVM communication).



3.4.2 Connection procedure

Host communication and CVM communication connections are carried out as follows.



Set the addresses for the J-TI and the J-CVM.

☞ Refer to **3.4.3 Communication address setting [J-TI] (P. 3-24)**.

☞ Refer to **3.5.1 Address setting (assignment of temperature input channels) [J-CVM] (P. 3-35)**.

Switch between J-TI host communication/internal communication.

☞ Refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

If a communication error occurs frequently as a result of the usage environment and the communication distance, connect a termination resistor to each of the J-TI, its partner device, and the J-CVM.

☞ Refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

☞ Refer to **3.5.2 Termination resistor setting [J-CVM] (P. 3-37)**.

Connect the J-TI master and the host computer.

☞ Refer to **3.4.5 Connecting the J-TI master and the host computer (P. 3-28)**.

Connect J-TI to J-TI.

☞ Refer to **3.4.6 Connecting J-TI to J-TI (P. 3-32)**.

☞ Refer to **3.4.7 Host computer and J-TI multi-drop connection example (RS-485) (P. 3-33)**.

Connect the J-TI master and J-CVM.

☞ Refer to **3.5.3 Connecting the J-TI master and J-CVM (P. 3-39)**.

Connect the J-CVM and J-CVM.

☞ Refer to **■ J-TI master and J-CVM connection example (P. 3-41)**.

NOTE

The communication protocol and communication speed can be changed only by host communication. Since communication is not established during the default connection, set the host computer in accordance with the settings of the J-TI.

– Factory set value of J-TI –

Communication protocol: **When the communication protocol is specified at the time of order, the specified communication protocol will be the factory set value.**
If the communication protocol is not specified: Modbus

Communication speed: **38400 bps**

Data bit configuration (fixed): **Start bit: 1**
Data bit: 8
Parity bit: None
Stop bit: 1

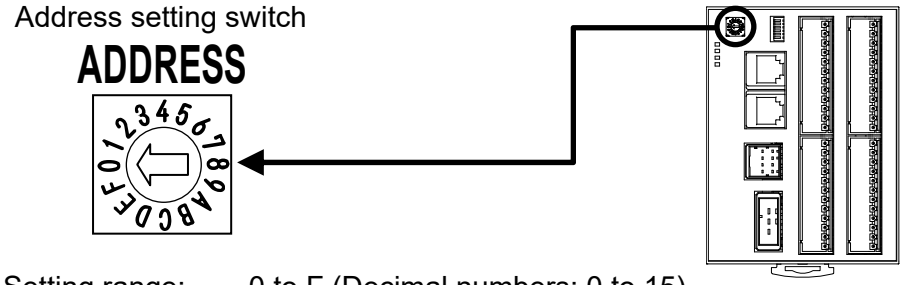
The communication protocol and communication speed of the J-TI can be checked from the lighting and flashing state of the indicator lamp immediately after the power is turned ON. For details, refer to **7.9.2 Checking the communication protocol and communication speed by indication lamps (P. 7-57)**.

3.4.3 Communication address setting [J-TI]

When using two or more J-TI on the same line, set the communication address individually.
Set the Communication address of J-TI by **address setting switch**. For this setting, use a small blade screwdriver. The data changes become valid when the power is turned on again.
If you set the address setting switch, the communication address used in the actual program is decided.

NOTE

When connecting more than one J-TI on the same communication line, set each address of J-TI by using Address setting switch to avoid overlapping addresses. Overlapped communication addresses may cause instrument failure or malfunction.



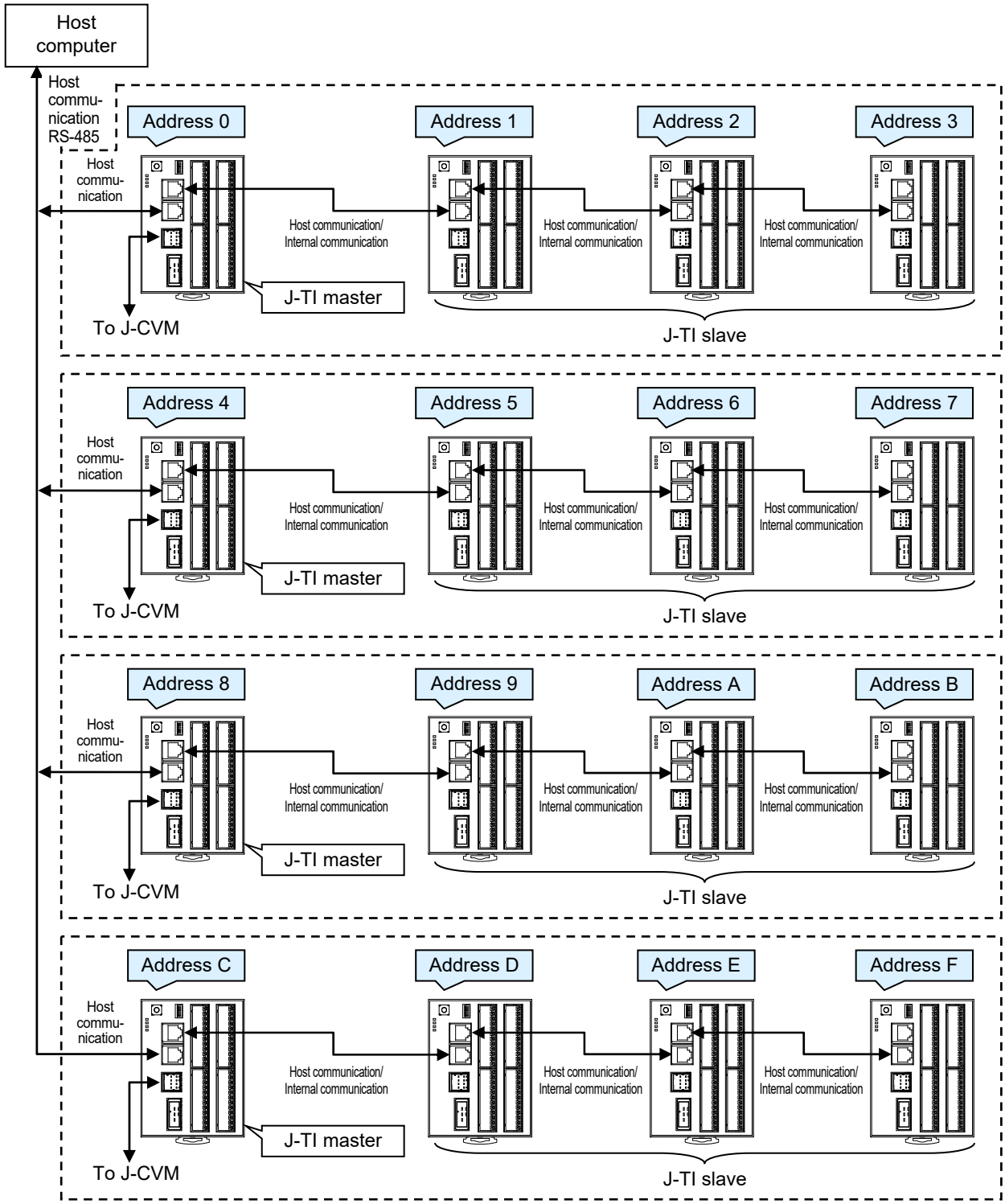
Setting range: 0 to F (Decimal numbers: 0 to 15)
Factory set value: 0

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

J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

■ Possible communication address combination settings

Up to four J-TI masters can be connected to a single host computer. Up to three J-TI slaves can be connected to a single J-TI master. Communication address must be between 0 and 3, 4 and 7, 8 and B, or C and F. Addresses 0, 4, 8 and C are used for masters. The J-TI connected to the J-CVM and the host computer must be set with one of 0, 4, 8 or C (as master address).

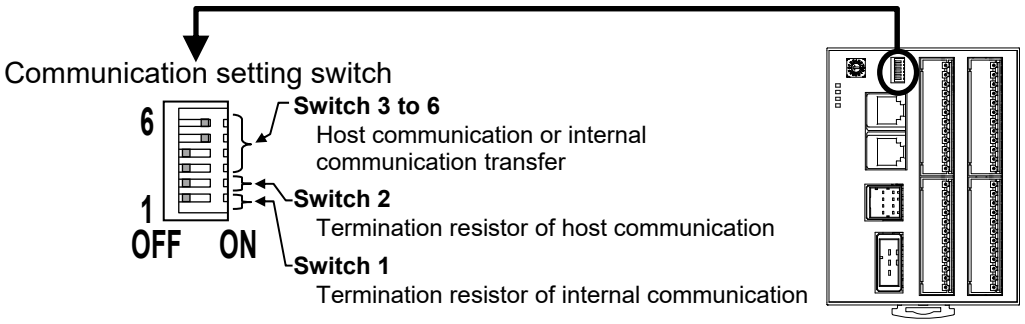


J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

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

3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI]

Select host communication or internal communication, and set the termination resistor, using the **communication setting switch**.
Use a small flathead screwdriver for the setting. Settings take effect immediately.



3	4	5	6	Host communication or internal communication transfer
OFF	OFF	ON	ON	Internal communication [Factory set value] (the J-TI slave connected to the J-TI)
ON	ON	OFF	OFF	Host communication (the J-TI connected to a host computer)
Other setting combinations				Do not set this one

2	Termination resistor of host communication
OFF	Termination resistor OFF [Factory set value] (for any J-TI other than the J-TI at termination* in host communication)
ON	Termination resistor ON (for the J-TI at termination* in host communication)

* The most distant J-TI from the host computer.

1	Termination resistor of internal communication
OFF	Termination resistor OFF [Factory set value] (for any J-TI other than the J-TIs at both ends in internal communication)
ON	Termination resistor ON (for the J-TIs at both ends in internal communication)

📖 J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

● Host communication or internal communication transfer

- The J-TI master connected to the host computer is switched to “Host communication.”
- The J-TI slave connected to a J-TI (master or slave) is switched to “Internal communication.”

● Termination resistor setting

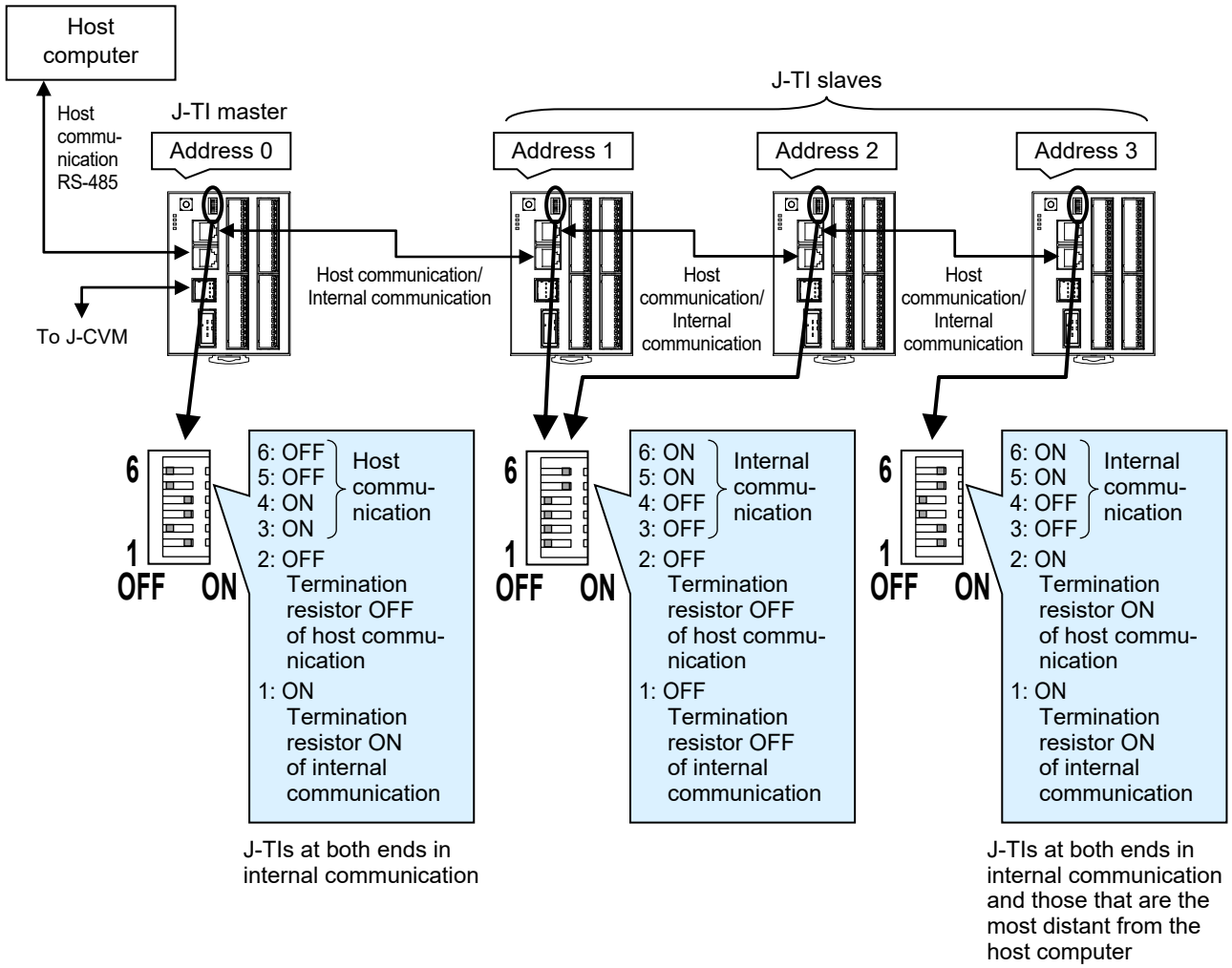
If communication errors occur frequently due to the operation environment or the communication distance, connect termination resistors to the J-TI and the other party unit. Since the termination resistor of the J-TI (120 Ω 1/2 W) is installed on the J-TI, switch to “ON: Termination Resistor ON.”

When connecting more than one J-TI on the same communication line,

- The most distant J-TI from the host computer is set to “Host communication termination resistor ON.”
- The J-TIs at both ends in internal communication are set to “Internal communication termination resistor ON.”

■ Setting example for communication setting switch

Example: When three J-TI slaves are connected to a single J-TI master (address 0)



J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

3.4.5 Connecting the J-TI master and the host Computer

Connect the host computer to the J-TI master's host communication connector COM.IN.

NOTE

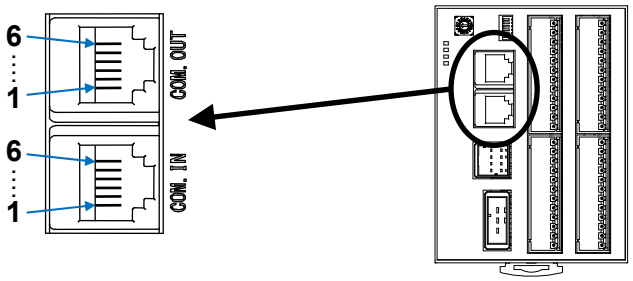
Always connect the host computer to the J-TI master. If the host computer is connected to a J-TI slave, communication errors may cause malfunction or damage. If the J-TI is set in the following way, it becomes a J-TI master.

Host communication or internal communication transfer of communication setting switch (P. 3-26): Host communication
Set value of Address setting switch (P. 3-24): 0, 4, 8 and C (Master address)

■ Host communication connector pin numbers and signal name (COM. IN, COM. OUT)

COM. IN: Connector for connecting the host computer or J-TI.
COM. OUT: Connector for adding more J-TI.

Host communication connector



COM. OUT

Pin No.	Description
6	Signal ground SG
5	RS-485 Send/Receive data T/R (A)
4	RS-485 Send/Receive data T/R (B)
3	Signal ground SG
2	Internal communication
1	Internal communication

Recommended connector:
The 6-pin type modular connector, TM4P-66P (HIROSE ELECTRIC)

Wire tensile strength: 1.5 N (0.15 kgf) or more

COM. IN

Pin No.	Description
6	Signal ground SG
5	RS-485 Send/Receive data T/R (A)
4	RS-485 Send/Receive data T/R (B)
3	Signal ground SG
2	RS-485 Send/Receive data T/R (B) or Internal communication *
1	RS-485 Send/Receive data T/R (A) or Internal communication *

Recommended connector:
The 6-pin type modular connector, TM4P-66P (HIROSE ELECTRIC)

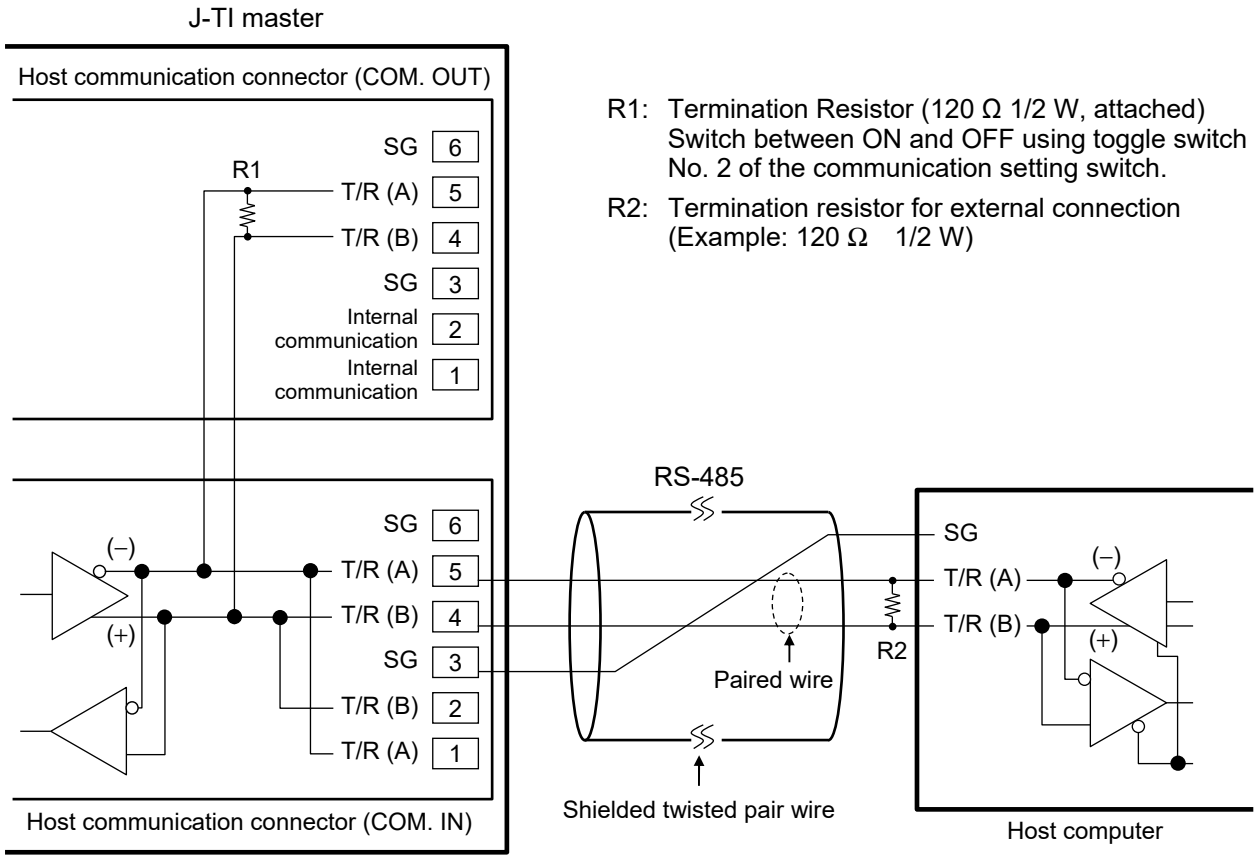
Wire tensile strength: 1.5 N (0.15 kgf) or more

* Switch using the host communication/internal communication transfer switch of the communication setting switch (P. 3-26). If connected to a host computer, set to "Host communication."

J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

■ Connection to the RS-485 port of the host computer

Example: When pin numbers 4 and 5 are used



R1: Termination Resistor (120 Ω 1/2 W, attached)
Switch between ON and OFF using toggle switch No. 2 of the communication setting switch.

R2: Termination resistor for external connection
(Example: 120 Ω 1/2 W)

NOTE

If the communication/internal communication transfer switch of the communication setting switch (P. 3-26) is set to host communication, pins number 1 and 5, 2 and 4 of the host communication connector (COM. IN) are connected to the circuit internally.
Do not connect pins number 1 and 2 to other signal lines.

If communication errors occur frequently due to the operation environment or communication distance, install a termination resistor (R2) and change the setting of the termination resistor (R1) installed in J-TI to "Termination resistor ON."

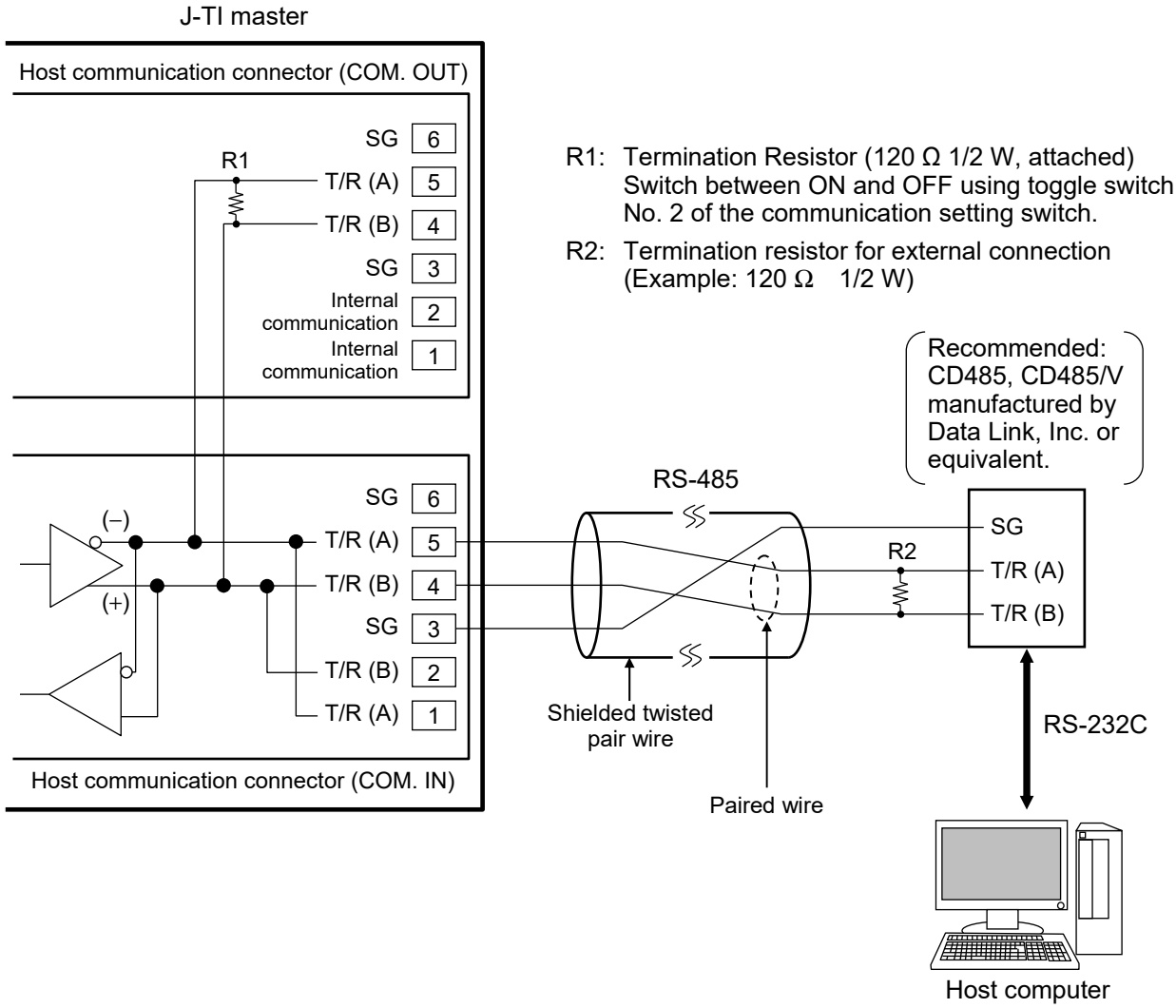
The user must prepare the communication cable and external resistor.

For the termination resistor of the J-TI, refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

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

Connect an automatic received signal switching type RS-232C/RS-485 converter between the host computer and the J-TI master.

Example: When pin numbers 4 and 5 are used



NOTE

If the communication/internal communication transfer switch of the communication setting switch (P. 3-26) is set to host communication, pins number 1 and 5, 2 and 4 of the host communication connector (COM. IN) are connected to the circuit internally.
Do not connect pins number 1 and 2 to other signal lines.

If communication errors occur frequently due to the operation environment or communication distance, install a termination resistor (R2) and change the setting of the termination resistor (R1) installed in J-TI to "Termination resistor ON."

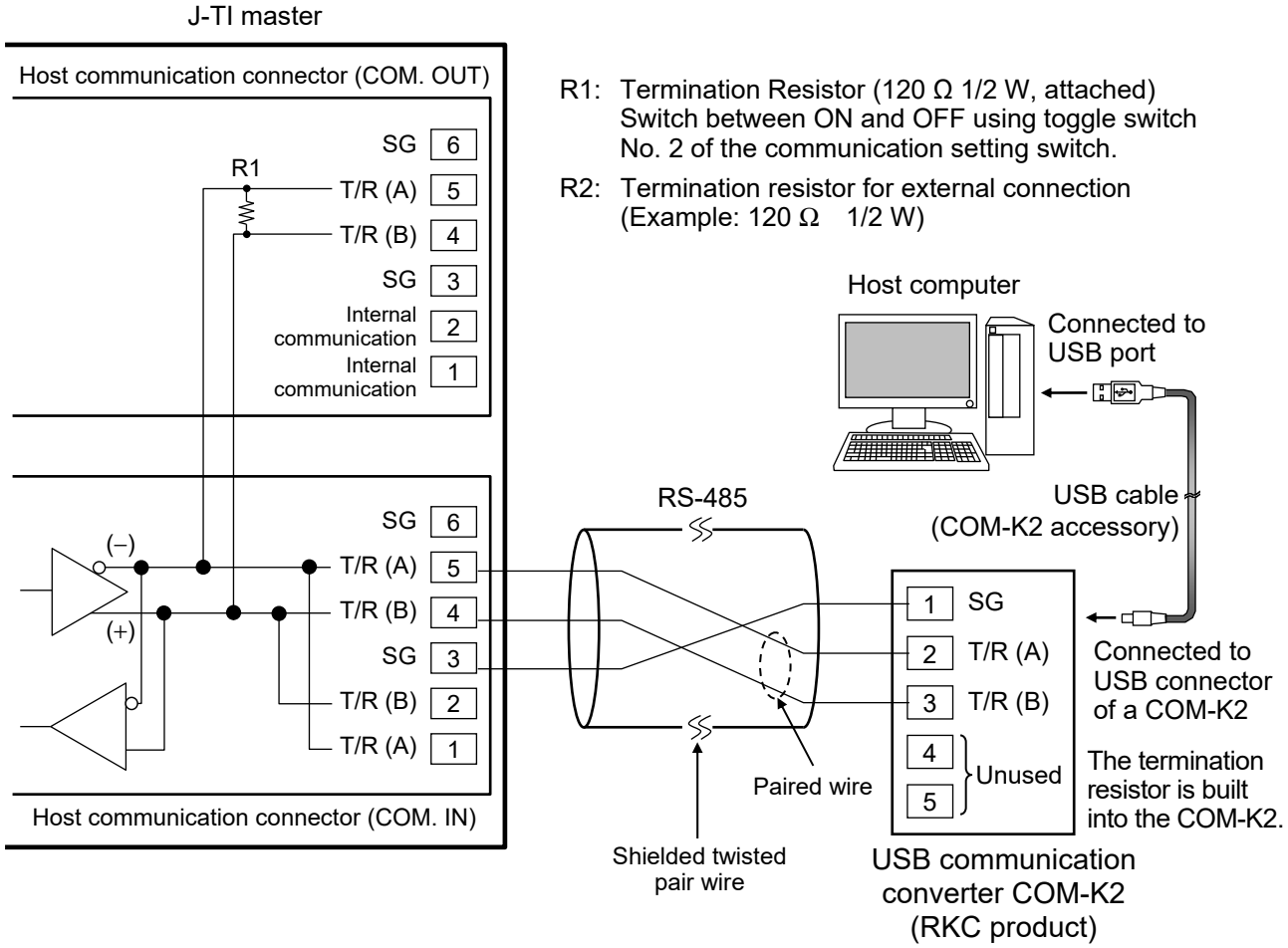
The user must prepare the communication cable and external resistor.

For the termination resistor of the J-TI, refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

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

Connect the USB communication converter between the host computer and the J-TI master.

Example: When pin numbers 4 and 5 are used



NOTE

If the communication/internal communication transfer switch of the communication setting switch (P. 3-26) is set to host communication, pins number 1 and 5, 2 and 4 of the host communication connector (COM. IN) are connected to the circuit internally.
Do not connect pins number 1 and 2 to other signal lines.

If communication errors occur frequently due to the operation environment or communication distance, install a termination resistor (R2) and change the setting of the termination resistor (R1) installed in J-TI to "Termination resistor ON."

The user must prepare the communication cable and external resistor.

A previous version of COM-K (version 1) can be also used. However, if communication tool PROTEM2 is used using a COM-K, the PROTEM2 will not be supported by Windows 8 or later.

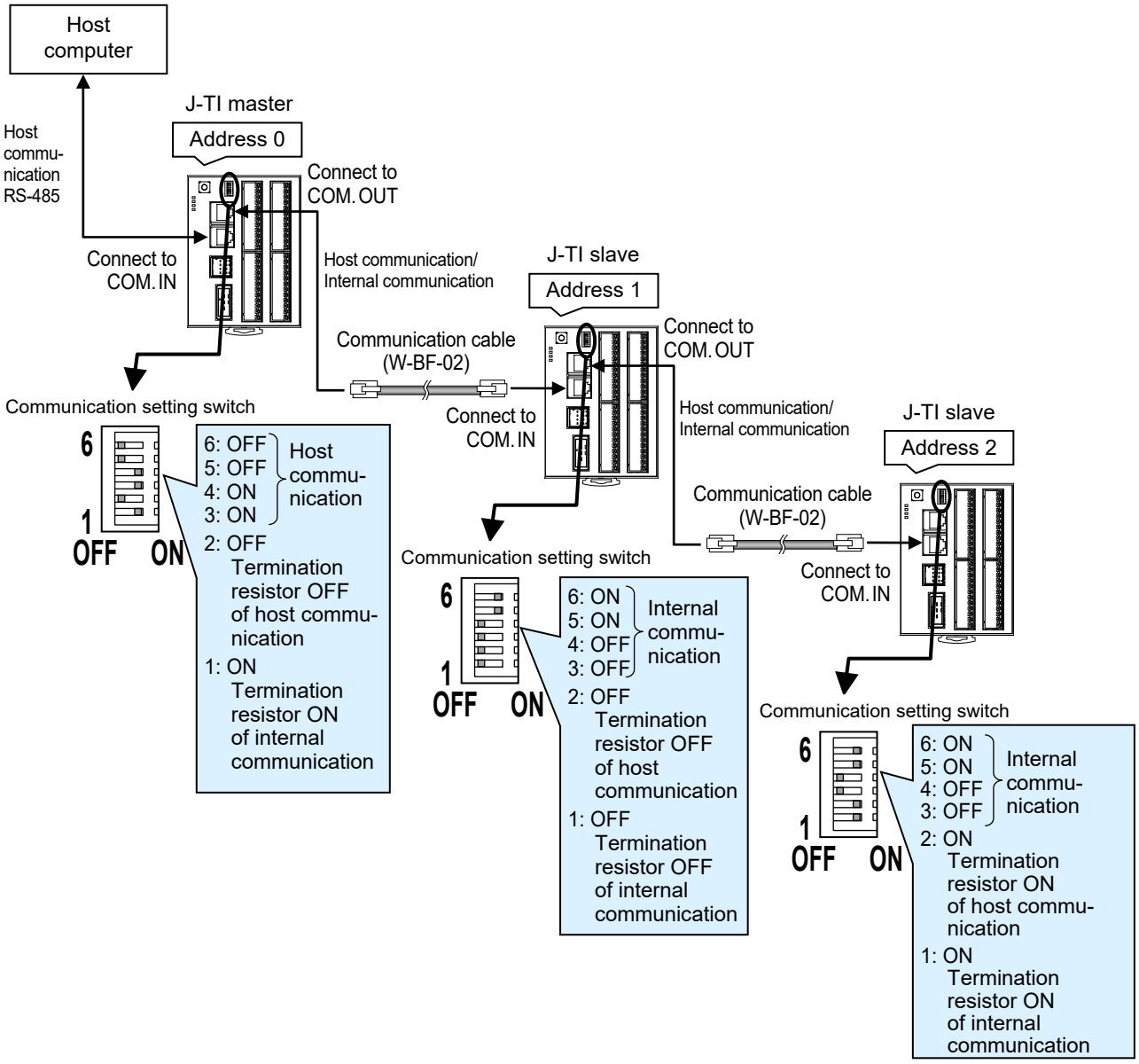
For the termination resistor of J-TI, refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

Recommended USB communication converter: **COM-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**.

3.4.6 Connecting J-TI to J-TI

To connect a J-TI to another J-TI, use the J-TI host communication connector COM. IN and COM. OUT. Also, up to three J-TI slaves can be connected to a single J-TI master.

Example: When connecting 2 pcs of J-TI slave to the J-TI master (Address 0)



W-BF-02* communication cable (RKC product) can be used as communication cable for connecting J-TI to J-TI (sold separately). If noise is a factor, customer should use a twisted pair cable (not included) or something to that effect.

* Shield of the cable are connected to SG (No. 6 pin) of the J-TI modular connector.

Cable type: W-BF-02-□□□□□ (RKC product, sold separately)
[□□□□□: Cable length (Unit: mm)]

J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

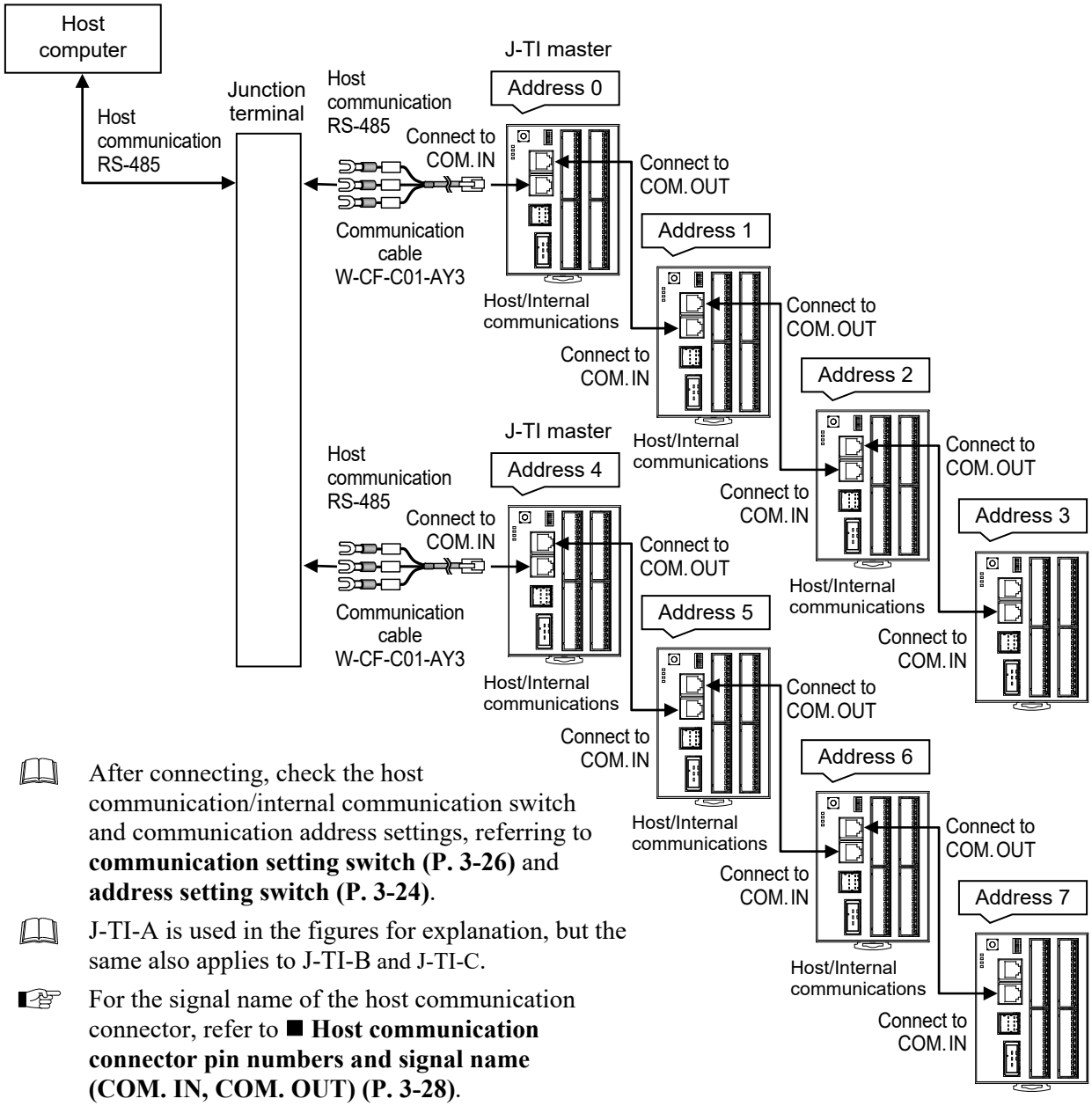
For details of the communication setting switch, refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

For the signal name of the host communication connector, refer to ■ **Host communication connector pin numbers and signal name (COM. IN, COM. OUT) (P. 3-28)**.

3.4.7 Host computer and J-TI multi-drop connection example (RS-485)

Up to four J-TI masters can be connected to a single host computer. Also, up to three J-TI slaves can be connected to a single J-TI master. This shows an example connected using a junction terminal.

Example: When the host computer is connected to two J-TI masters, which are each connected to three J-TI slaves



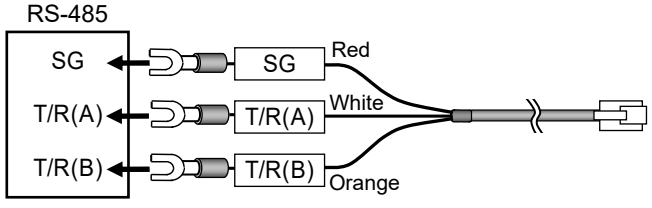
After connecting, check the host communication/internal communication switch and communication address settings, referring to **communication setting switch (P. 3-26)** and **address setting switch (P. 3-24)**.

J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

For the signal name of the host communication connector, refer to ■ **Host communication connector pin numbers and signal name (COM. IN, COM. OUT) (P. 3-28)**.

W-CF-C01-AY3 communication cable (RKC product) can be used as communication cable for connecting J-TI to the host computer (sold separately). If noise is a factor, customer should use a twisted pair cable (not included) or something to that effect.

Cable type: W-CF-C01-AY3-□□□□□ (RKC product, sold separately)
[□□□□□: Cable length (Unit: mm)]



3.5 Connections for CVM Communication

The J-CVM interfaces with the J-TI master via CVM communication (special communication, RS-485). Also, instrument power is supplied by the J-TI. Up to eight J-CVMs can be connected to the J-TI master.

⚠ WARNING

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

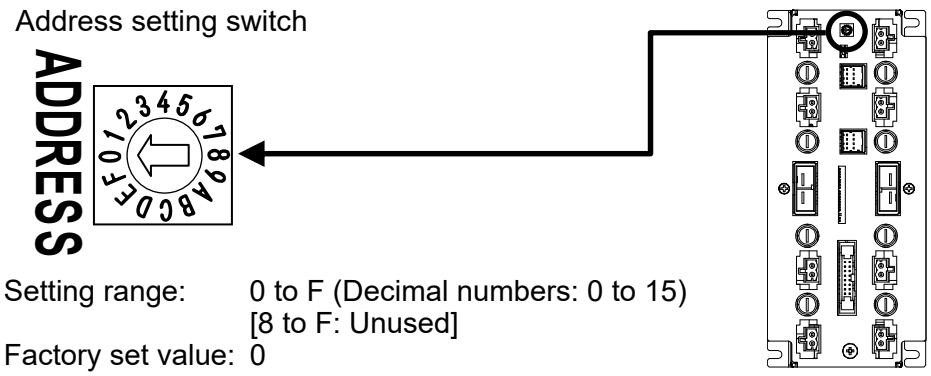
3.5.1 Address setting (assignment of temperature input channels) [J-CVM]

When using two or more J-CVM on the same line, set the communication address individually.
If you set the address, the temperature input channels corresponding to the heater outputs 1 to 8 will be assigned.
Set the Communication address of J-CVM by Address setting switch. For this setting, use a small blade screwdriver. The data changes become valid when the power is turned on again.

NOTE

When connecting more than one J-CVM on the same communication line, set each address of J-CVM by using Address setting switch to avoid overlapping addresses.

If addresses are duplicated, a self-diagnostic error "Error code 2 (CVM address duplication or setting error)" will be raised by the J-TI connected to the J-CVM. For the Self-diagnostic error, refer to 8.1 Self-diagnostic error (P. 8-2).



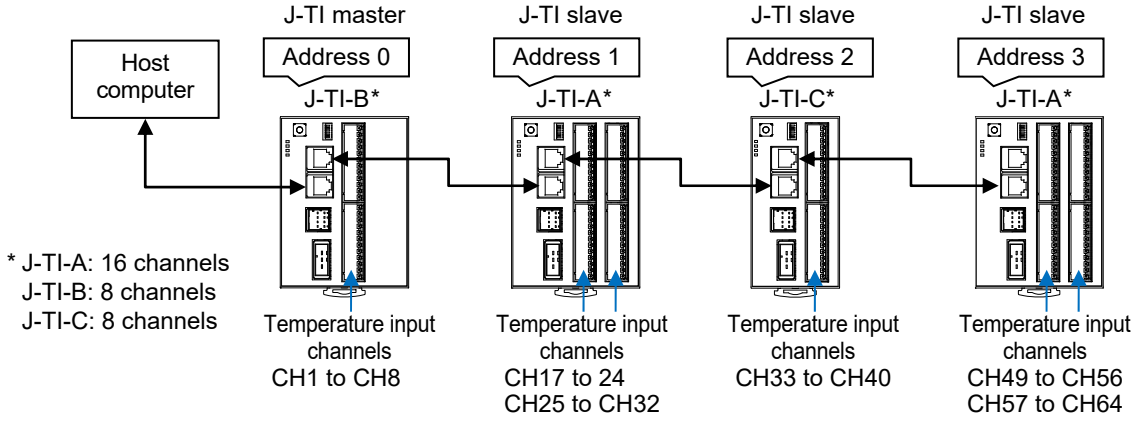
Setting range: 0 to F (Decimal numbers: 0 to 15)
[8 to F: Unused]
Factory set value: 0

Set value	Temperature input channel numbers to assigned
0	CH1 to CH8
1	CH9 to CH16 (Assignable only for the J-TI-A)
2	CH17 to CH24
3	CH25 to CH32 (Assignable only for the J-TI-A)
4	CH33 to CH40
5	CH41 to CH48 (Assignable only for the J-TI-A)
6	CH49 to CH56
7	CH57 to CH64 (Assignable only for the J-TI-A)
8 to F	**Do not set this one**

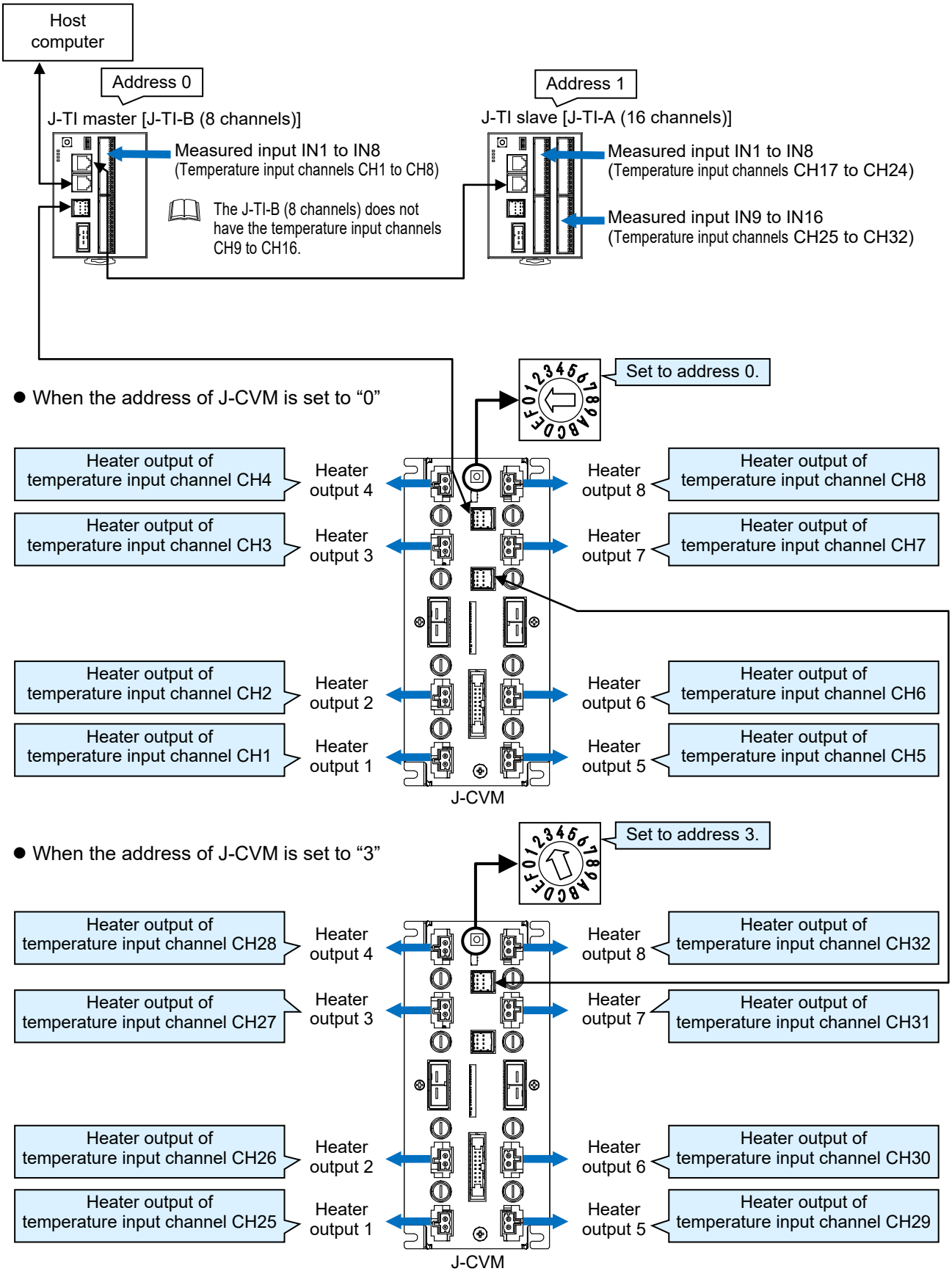
J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

Temperature input channel number is automatically assigned in order of smaller communication address number of J-TI.

Example: When three J-TI slaves are connected to a single J-TI master (address 0)



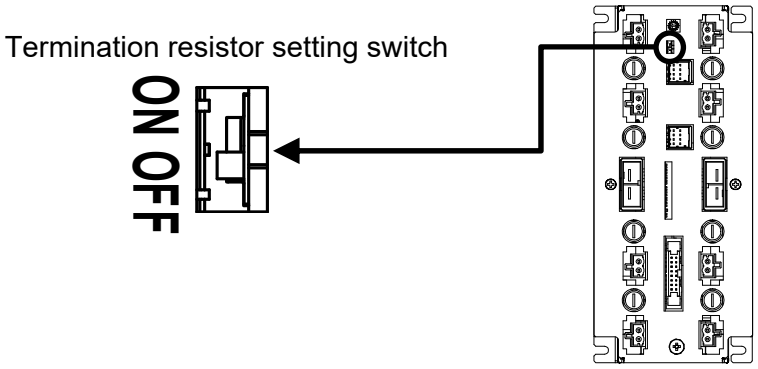
Example: When a single J-TI slave and two J-CVMs are connected to a J-TI master (address 0)



3.5.2 Termination resistor setting [J-CVM]

If communication errors occur frequently due to the operation environment or the communication distance, connect termination resistors.
The termination resistor (120 Ω 1/2 W) of J-CVM is installed on the instrument. To use the termination resistor, change the setting of the **Termination resistor setting switch** to "ON: Termination resistor ON."
For this setting, use a small blade screwdriver.
Settings take effect immediately.

When connecting more than one J-CVM on the same communication line, set "Termination resister ON" to the most distant J-CVM from the J-TI master.

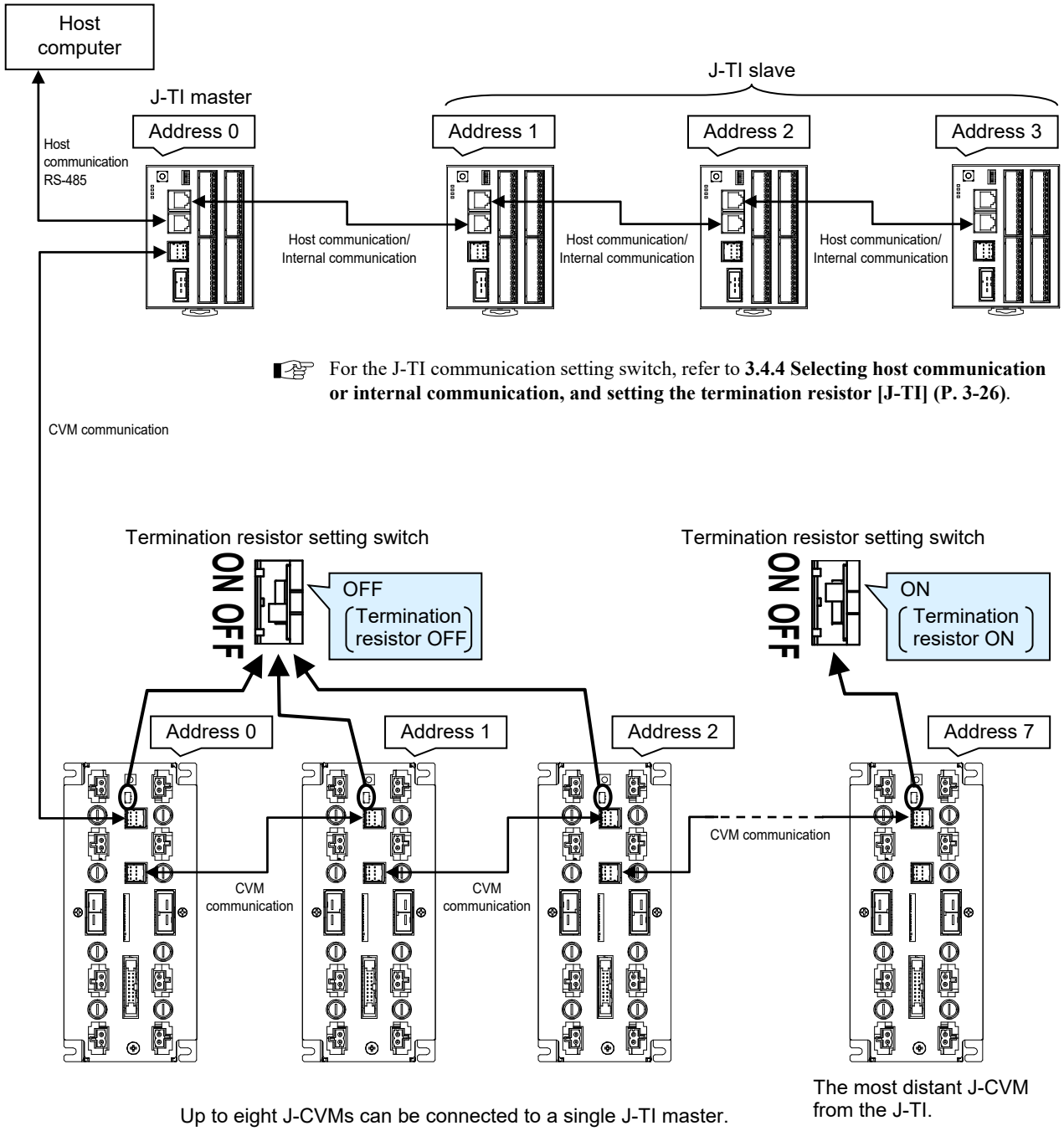


Setting	Termination resistor
OFF	Termination resistor OFF [Factory set value] (If the J-CVM is other than a termination* via communication)
ON	Termination resistor ON (If the J-CVM is a termination* via communication)

* The most distant J-CVM from the J-TI.

J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

Example: When three J-TI slaves and eight J-CVMs are connected to a J-TI master (address 0)
(When temperature input channels CH1 to CH64 are assigned to the heater outputs)



☞ For the J-TI communication setting switch, refer to **3.4.4 Selecting host communication or internal communication, and setting the termination resistor [J-TI] (P. 3-26)**.

J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

3.5.3 Connecting the J-TI master and J-CVM

The J-TI master and J-CVM are connected using the J-TI master's CVM power/Communication connector COM.-CVM and the J-CVM's Power/Communication connector COM. IN. Up to eight J-CVMs can be connected to a single J-TI master.
To connect a J-CVM to another J-CVM, use the J-CVMs' Power/Communication connectors COM. IN and COM. OUT.

NOTE

When connecting a J-TI to a J-CVM (J-CVM to J-CVM), use a shield cable and ensure it is firmly connected to ground.

NOTE

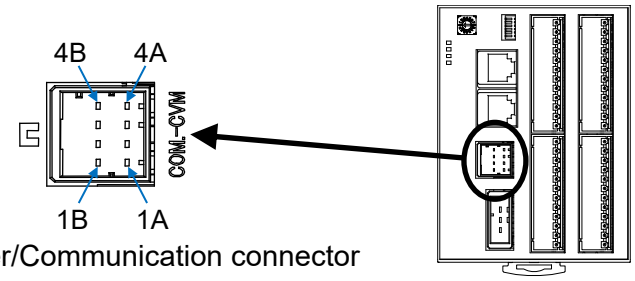
Always connect the J-CVM to a J-TI master. If a J-CVM is connected to a J-TI slave, it will not be able to communicate. If the J-TI is set in the following way, it becomes a J-TI master.

Host communication or internal communication
transfer of communication setting switch (P. 3-26): Host communication
Set value of Address setting switch (P. 3-24): 0, 4, 8 and C (Master address)

■ Connector pin number and signal details

● CVM power/Communication connector of the J-TI (COM.-CVM)

Used to connect the J-CVM. Used for communicating with the J-CVM and supplying power to the J-CVM.



CVM power/Communication connector

CVM power/RS-485

Pin No.	Description
4B	24 V DC (+)
3B	24 V DC (+)
2B	GND
1B	GND
4A	24 V DC (+)
3A	RS-485 Send/Receive data T/R (B)
2A	RS-485 Send/Receive data T/R (A)
1A	Signal ground SG (GND)

Recommended receptacle housing:
D-2100 Series 8P (X type)
1-1318119-4
(TE Connectivity)
Tab header (J-CVM side):
D-2100 Series 8P Horizontal Type
(X type) 1376009-1
(TE Connectivity)

Wire tensile strength:
2 N (0.2 kgf) or more

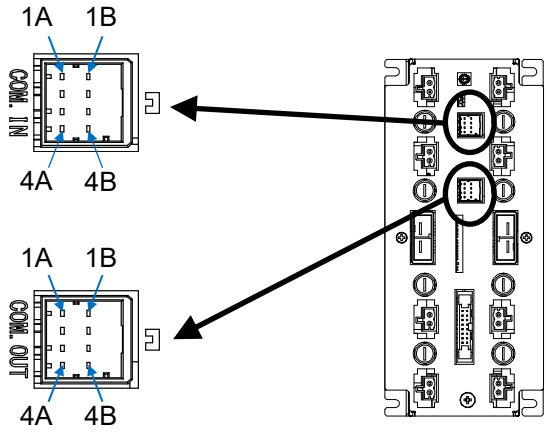
J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

● Power/Communication connector of the J-CVM (COM. IN, COM. OUT)

COM. IN: Used to connect the J-TI master or J-CVM.
Inputs communication with the J-TI master and instrument power from the J-TI master.

COM. OUT: Connector for adding more J-CVM.
Outputs communication with the J-TI master and instrument power supplied by the J-TI master.

Power/Communication connector (COM. IN)



Power/Communication connector (COM. OUT)

Power/RS-485

Pin No.	Description
1A	Signal ground SG (GND)
2A	RS-485 Send/Receive data T/R (A)
3A	RS-485 Send/Receive data T/R (B)
4A	24 V DC (+)
1B	GND
2B	GND
3B	24 V DC (+)
4B	24 V DC (+)

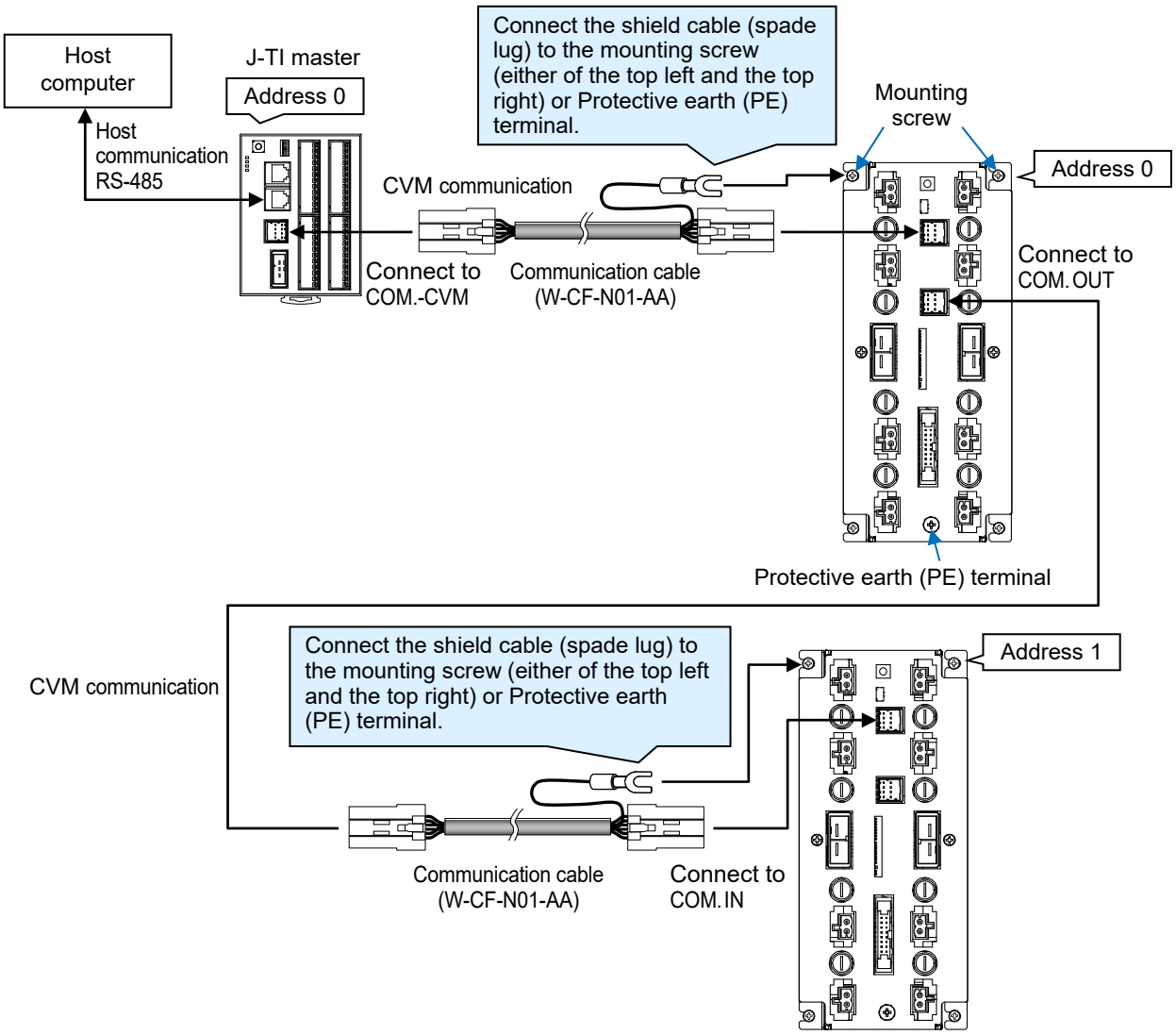
Recommended receptacle housing:
D-2100 Series 8P (X type)
1-1318119-4
(TE Connectivity)
Tab header (J-CVM side):
D-2100 Series 8P Horizontal Type
(X type) 1376009-1
(TE Connectivity)

Wire tensile strength:
2 N (0.2 kgf) or more

📖 J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

■ J-TI master and J-CVM connection example

Example: When connecting two J-CVM to the J-TI master (address 0)



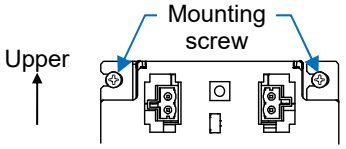
J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.

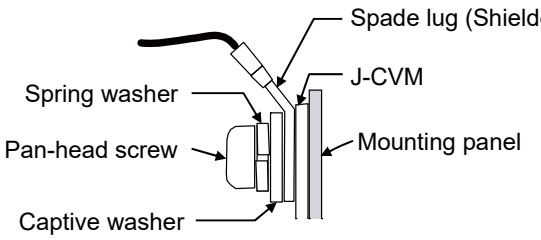
J-CVM-5 is used in the figures for explanation, but the same also applies to J-CVM-3.

W-CF-N01-AA connecting cable for J-CVM (RKC product) can be used as connecting cable (sold separately).

Cable type: W-CF-N01-AA-□□□□□ (RKC product, Sold separately)
[□□□□□: Cable length (Unit: mm)]

Connect the shield cable (spade lug) to the mounting screw (either of the top left and the top right) or Protective earth (PE) terminal.





MEMO

RKC COMMUNICATION PROTOCOL

4

This chapter describes the RKC communication protocol.

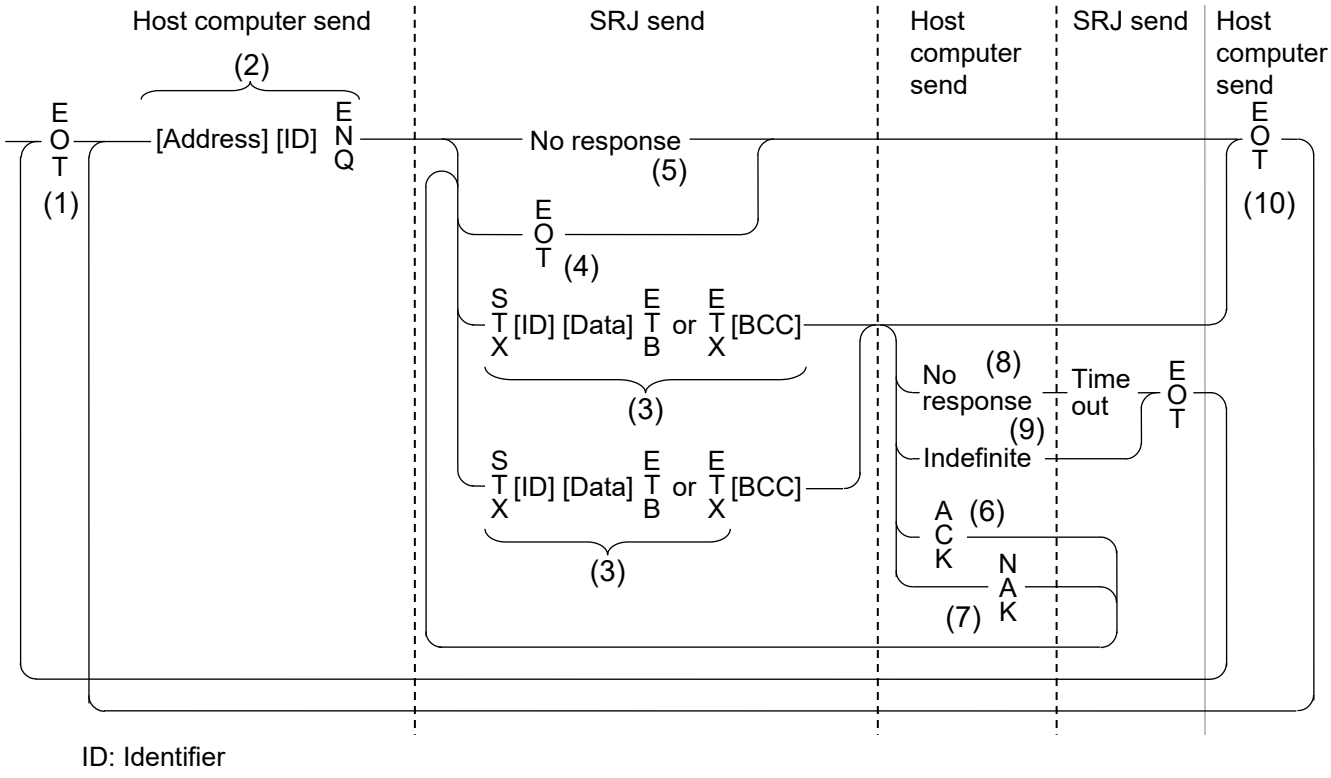
RKC communication uses the Polling/Selecting method to establish a data link. The basic procedure follows ANSI X3.28-1976 subcategories 2.5 and B1 basic mode data transmission control procedure (Fast selecting is the selecting method used in SRJ).

- 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 SRJ responds according to queries and commands from the host.
- The code used in communication is 7-bit ASCII code including transmission control characters.
  Transmission control characters used in SRJ:
  EOT (04H), ENQ (05H), ACK (06H), NAK (15H), STX (02H), ETB (17H), ETX (03H)
  ( ): Hexadecimal

Data send/receive state can be monitored by using our communication tool PROTEM2.
The communication tool PROTEM2 can be downloaded from the RKC official website.

4.1 Polling

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



* When the transmission data (from STX to BCC) of the same identifier is divided by ETB into blocks, the transmission of the remaining data resumes from the divided data following the STX.

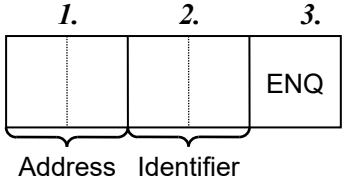
4.1.1 Polling procedures

(1) Data link initialization

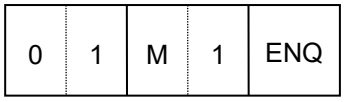
Host computer sends EOT to the SRJs to initiate data link before polling sequence.

(2) Data sent from host computer - Polling sequence

The host computer sends the polling sequence in the following format.



Example:



1. Address (2 digits)
This data is a module address of the SRJ for polled and must be the same as the J-TI communication address set value in item **3.4.3 Communication address setting [J-TI] (P. 3-24)**.

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

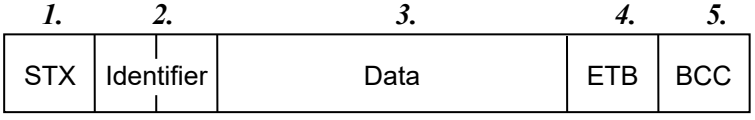
2. Identifier (2 digits)
The identifier specifies the type of data that is requested from the SRJ. Always attach the ENQ code to the end of the identifier.

☞ For the details of the identifier, refer to **6.2 J-TI Communication Data [RKC Communication/ Modbus] (P. 6-4)**.

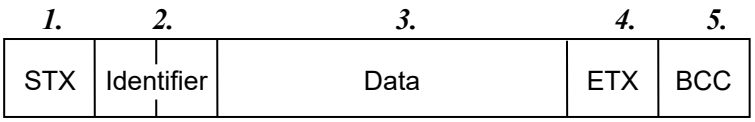
3. ENQ
The ENQ is the transmission control character that indicates the end of the polling sequence.
The host computer then must wait for a response from the SRJ.

(3) Data sent from the SRJ

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



or



📖 When the transmission data (from STX to BCC) of the same identifier is divided by ETB into blocks, the transmission of the remaining data resumes from the divided data following the STX.

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 the details of the identifier, refer to **6.2 J-TI Communication Data [RKC Communication/ Modbus] (P. 6-4)**.

3. Data
Data which is indicated by an identifier of SRJ, consisting of channel numbers, data, etc.
Each channel number and data are delimited by a space (20H). The data and the next channel number are delimited by a comma (2CH).

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

4. ETB
Transmission control character indicating the end of the block.

5. ETX
Transmission control character indicating the end of the text.

6. 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 ETB or ETX, not including STX.

Example:

STX	M	1	0	1				1	5	0	.	0	ETX	BCC
	4DH	31H	30H	31H	20H	20H	20H	31H	35H	30H	2EH	30H	03H	←

Hexadecimal numbers

BCC = 4DH ⊕ 31H ⊕ 30H ⊕ 31H ⊕ 20H ⊕ 20H ⊕ 20H ⊕ 31H ⊕ 35H ⊕ 30H ⊕ 2EH ⊕ 30H ⊕ 03H = 74H
(⊕: *Exclusive OR*)
Value of BCC becomes 74H

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

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

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

(5) No response from the SRJ

The SRJ 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 SRJ receives ACK from the host computer, the SRJ will send any remaining data of the next identifier without additional action from the host computer.
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 SRJ, it sends a negative acknowledgment NAK to the SRJ. The SRJ 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 SRJ sends data, the SRJ sends EOT to terminate the data link (time-out time: about 3 seconds).

(9) Indefinite response from host computer

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

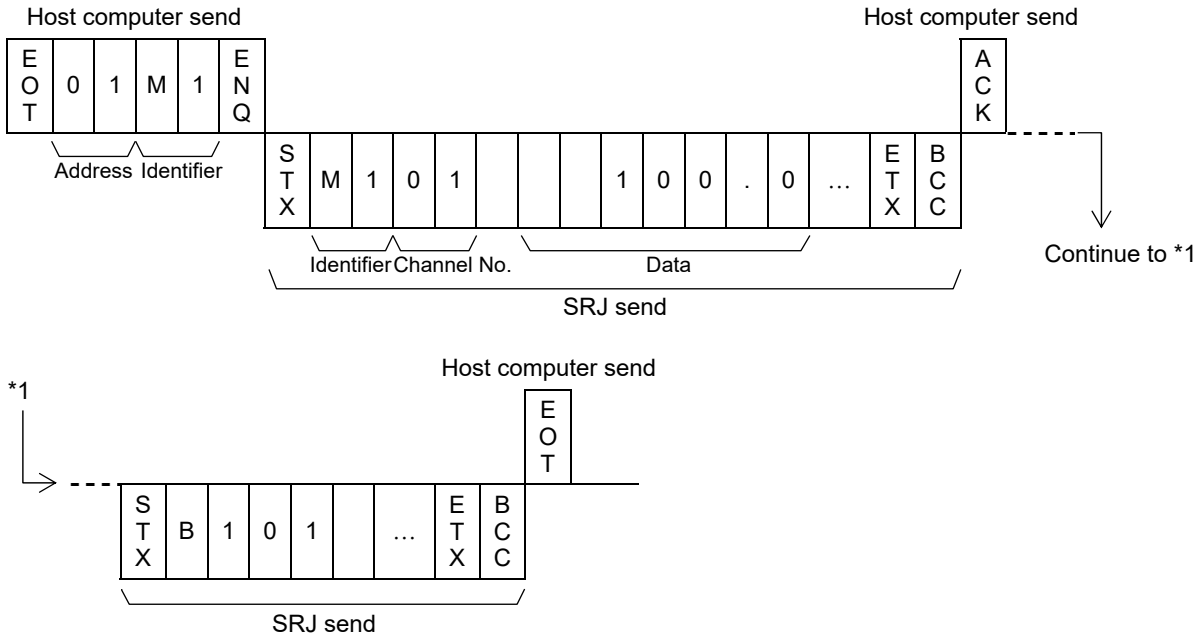
(10) EOT (Data link termination)

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

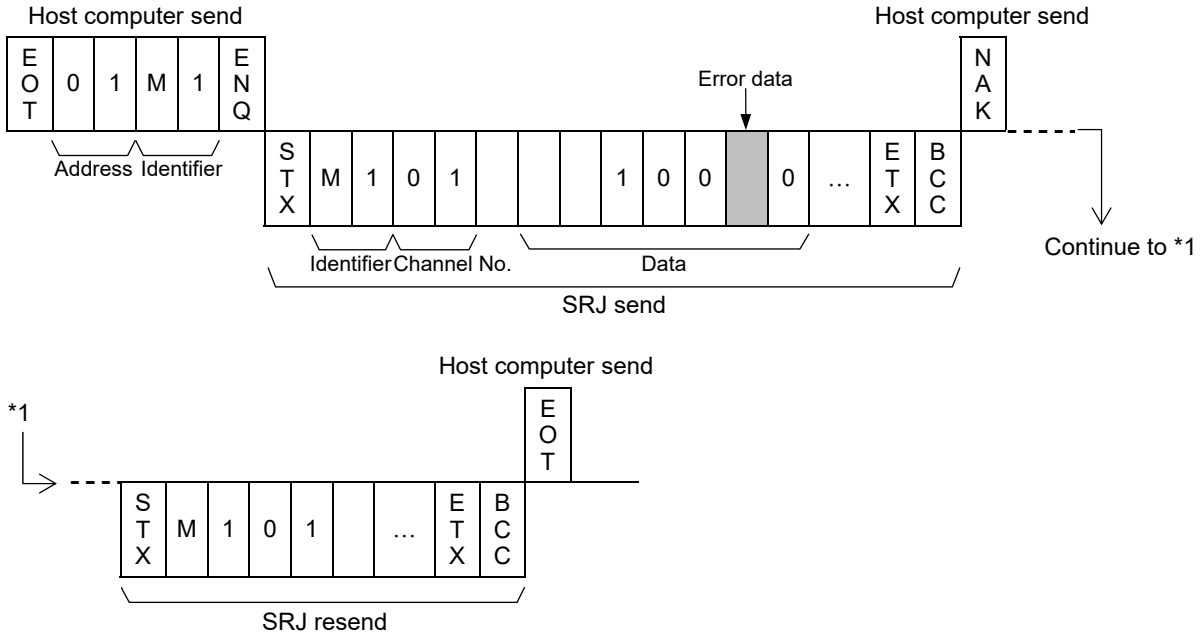
4.1.2 Polling procedure example (when the host computer requests data)

(1) When the monitored items are polled [Example: Measured value (PV) M1]

■ Normal transmission

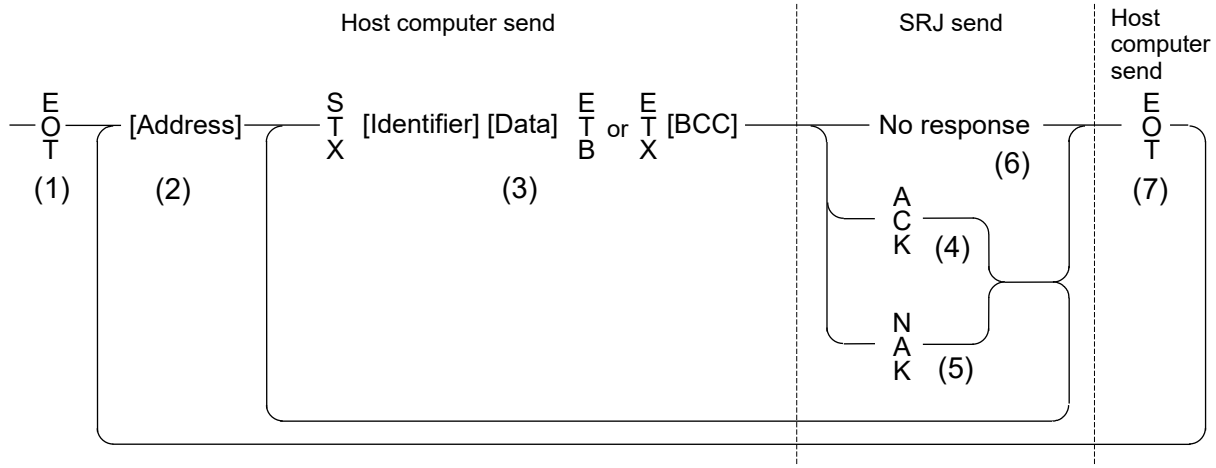


■ Error transmission



4.2 Selecting

Selecting is the action where the host computer requests one of the connected SRJ 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 SRJ 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 module address of the SRJ to be selected and must be the same as the J-TI communication address set value in item **3.4.3 Communication address setting [J-TI] (P. 3-24)**.

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:

STX	Identifier	Data	ETB	BCC

or

STX	Identifier	Data	ETX	BCC

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

When the transmission data (from STX to BCC) of the same identifier is divided by ETB into blocks, the transmission of the remaining data resumes from the divided data following the STX.

About numerical data:

Receivable data

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

  <Example> For example, even if the data −1.5 is sent by the host as −001.5, −01.5, −1.5, −1.50, −1.500, the SRJ receives the data as -1.5.

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

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

Send data	0.5	100.5
Receive data	0	100

- The SRJ 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 SRJ receives as a following.

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

Unreceivable data

The SRJ sends NAK when received a following data.

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

(4) ACK (Acknowledgment)

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

(5) NAK (Negative acknowledge)

If the SRJ 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 SRJ will send NAK in the following cases:

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

(6) No response from SRJ

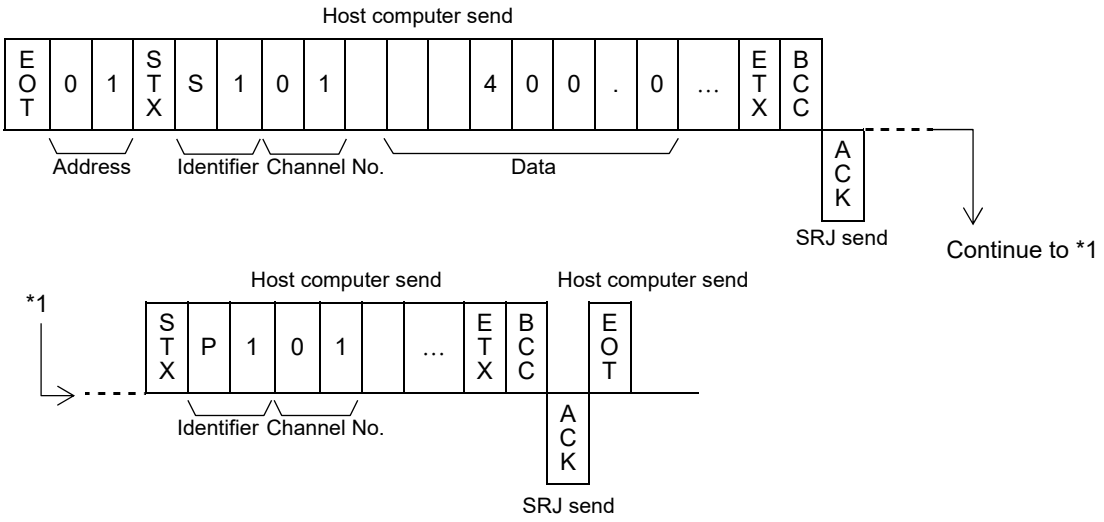
The SRJ does not respond when it can not receive the selecting address, STX, ETB, ETX or BCC.

(7) EOT (Data link termination)

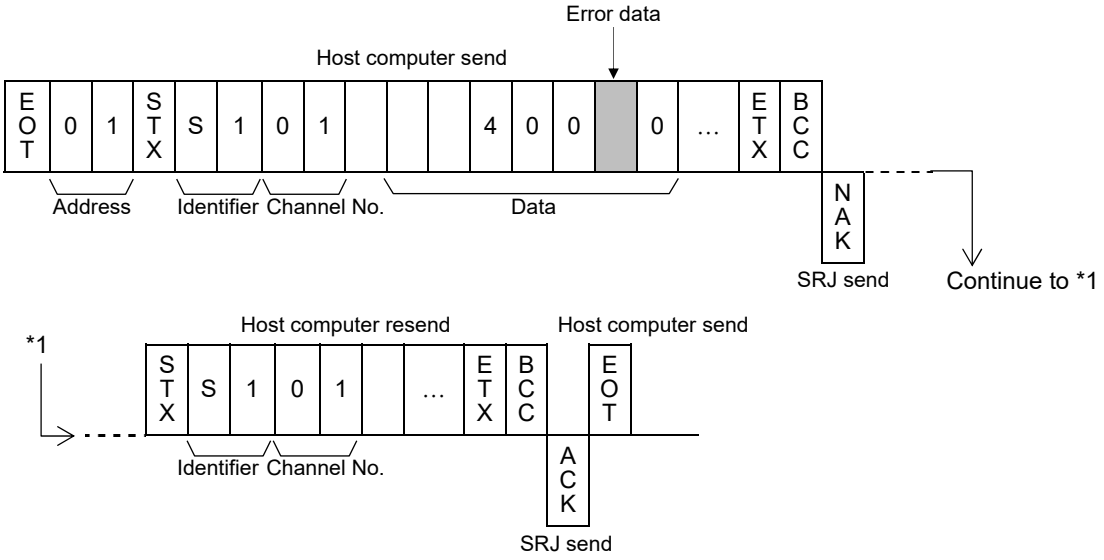
The host computer sends EOT when there is no more data to be sent from the host computer or there is no response from the SRJ.

4.2.2 Selecting procedure example (when the host computer sends data)

■ Normal transmission

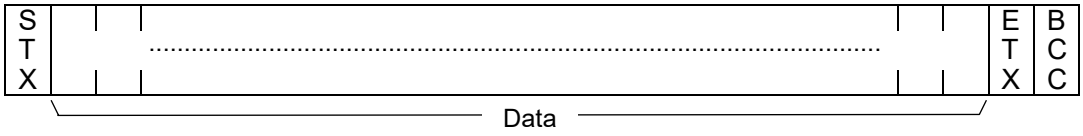


■ Error transmission



4.3 Communication Data Structure

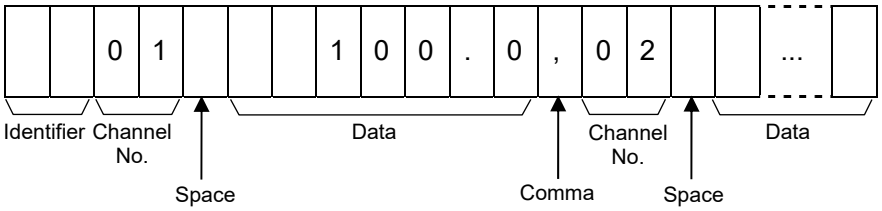
■ Data description (Transmission/Receive data structure)



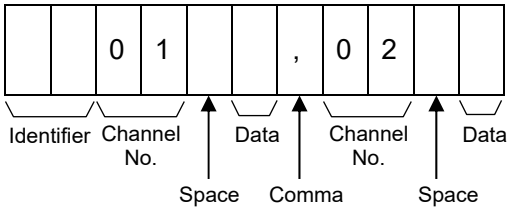
Part of the data above is shown below.

Data for each channel

Data length 7 digits

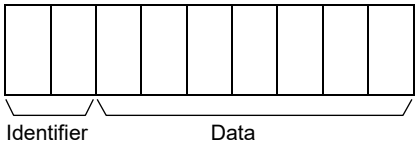


Data length 1 digit

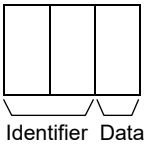


Data for each module (Without channel)

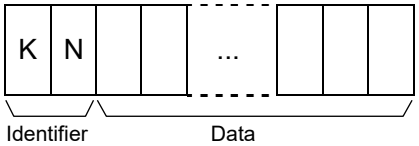
Data length 7 digits



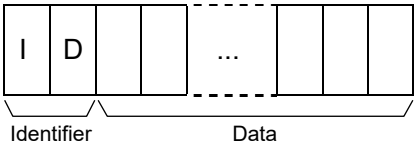
Data length 1 digit



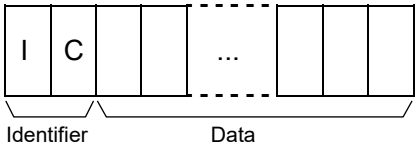
Data length 10 digits
(Instrument number monitor)



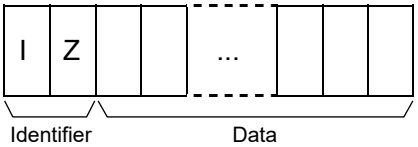
Data length 18 digits
(Model code monitor)



Data length 6 digits
(Instrument setting code monitor)



Data length 21 digits
(Special order number monitor)



4.4 Communication Requirements

■ Processing times during data send/receive

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

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

RKC communication (Polling procedure) processing times

Procedure details	Time
Response send time after SRJ receives ENQ	7.00 ms max.
Response send time after SRJ receives ACK	6.68 ms max.
Response send time after SRJ receives NAK	6.90 ms max.

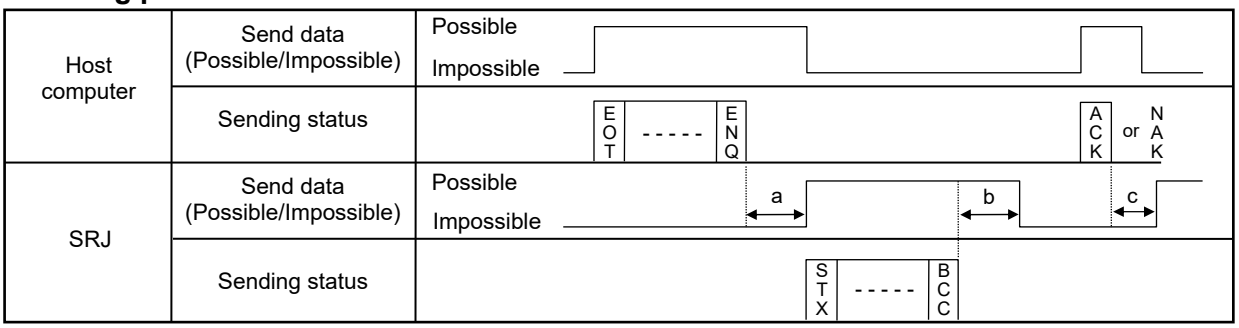
RKC communication (Selecting procedure) processing times

Procedure details	Time
Response send time after SRJ receives BCC	7.22 ms max.

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

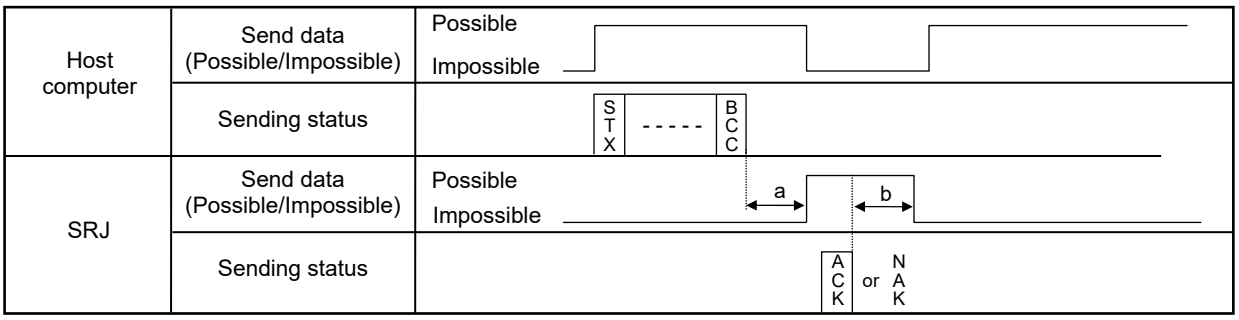
RS-485 communication is conducted through two wires, therefore, the transmission and reception of data requires precise timing.

● Polling procedure



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

● Selecting procedure



a: Response send time after the SRJ receives BCC + Interval time
b: Response wait time after the SRJ sends ACK or Response wait time after the SRJ 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 SRJ to process data:
– In polling procedure, Response wait time after the SRJ sends BCC
– In selecting procedure, Response wait time after the SRJ sends ACK or NAK

■ Fail-safe

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

MEMO

MODBUS PROTOCOL

5

This chapter describes the Modbus protocol.

In this chapter a host computer is called Master and SRJ 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 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

No. 1 to 16 set by the address setting switch on the front panel of the J-TI.

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

☞ For details, refer to **3.4.3 Communication address setting [J-TI] (P. 3-24)**.

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 **6.2 J-TI Communication Data [RKC communication/Modbus] (P. 6-4)**.

■ 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 (PV) value monitor, Event state monitor, etc.
06H	Preset single register	Set value (SV), Event set value, PID constants, PV bias, etc. (Write single data)
08H	Diagnostics (loopback test)	loopback test
10H	Preset multiple registers (Write multiple registers)	Set value (SV), Event set value, PID constants, PV bias, etc. (Write multiple consecutive data)

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	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	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**.
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) 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 the Error response message is based on the logical OR of the function code of query message and "80H."

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 resister or write to Preset multiple resisters [Write multiple registers]) has been exceeded. • When the data written exceeds the setting range
4	Self-diagnostic error response

(3) No response

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

- The slave address in the query message does not coincide with any slave address settings.
- The slave address could not be received.
- 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.
- 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 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***.

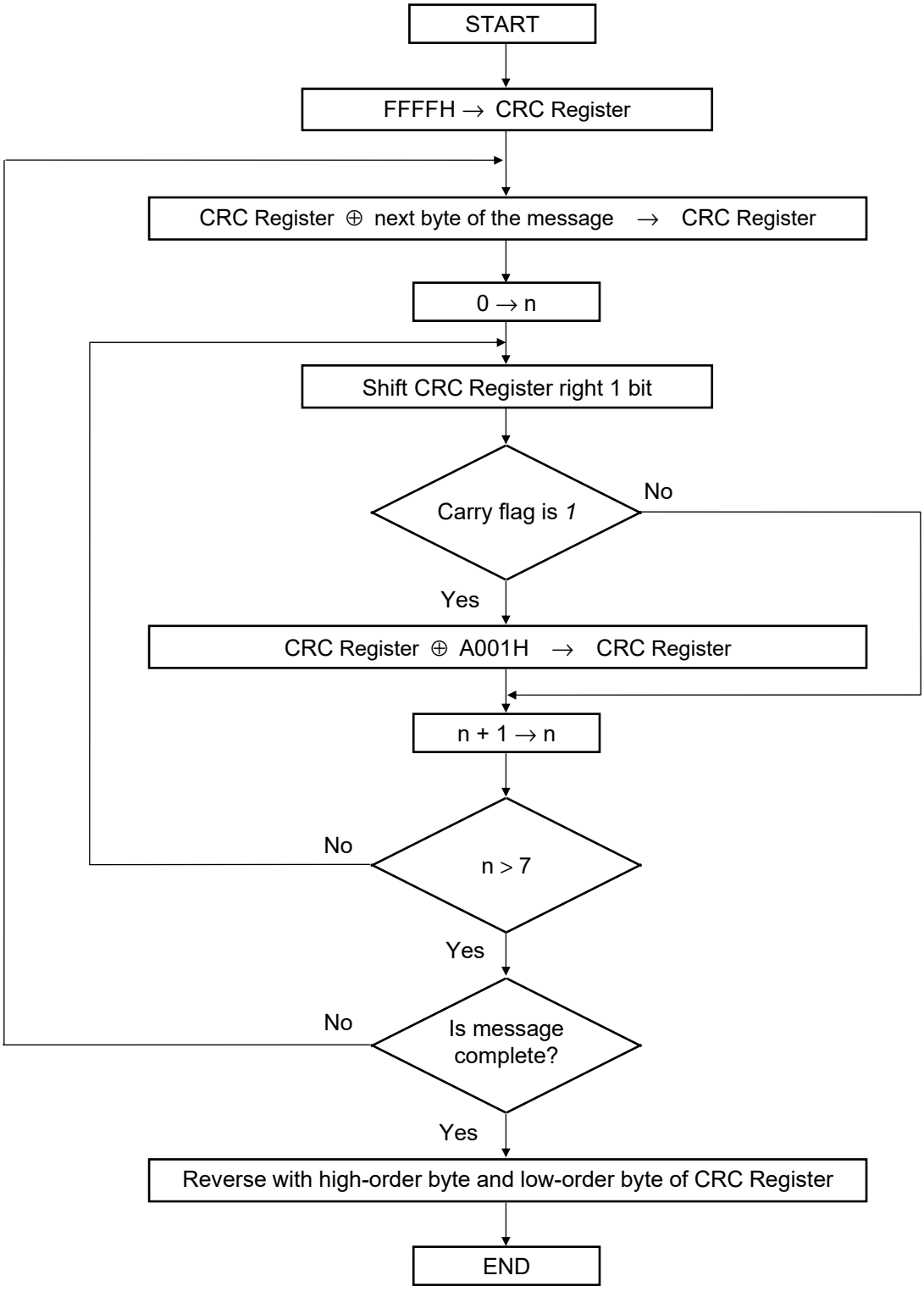
5. Repeat step ***3*** and ***4*** until there have been 8 shifts.

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 125 (007DH).
	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 0080H of slave address 1.

Query message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	80H
Write data	High	00H
	Low	64H
CRC-16	High	89H
	Low	C9H

} Any data within the range

Normal response message

Slave address		01H
Function code		06H
Holding register number	High	00H
	Low	80H
Write data	High	00H
	Low	64H
CRC-16	High	89H
	Low	C9H

} 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 (the SRJ).

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 0080H to 0081H of slave address 1.

Query message

Slave address		01H	
Function code		10H	
Starting number	High	00H	First holding register address
	Low	80H	
Quantity	High	00H	The setting must be between 1 (0001H) and 123 (007BH).
	Low	02H	
Number of data		04H	→ Number of holding registers × 2
Data to first register	High	00H	Any pertinent data
	Low	64H	
Data to next register	High	00H	
	Low	64H	
CRC-16	High	BBH	
	Low	FBH	

Normal response message

Slave address		01H
Function code		10H
Starting number	High	00H
	Low	80H
Quantity	High	00H
	Low	02H
CRC-16	High	40H
	Low	20H

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 Manipulated output value monitor [heat-side] is 5.0 %, 5.0 is processed as 50,
  50 = 0032H.

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

  Example 2: When Set value (SV) is −20.0 °C, −20.0 is processed as −200,
  −200 = 0000H − 00C8H = FF38H.

Set value (SV)	High	FFH
	Low	38H

- 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.
- Read data of unused item is “0.”
- Any attempt to write to an unused item is not processed as an error. Data cannot be written into an unused item.
- If an error (the required count is outside the data setting range, the set value is outside the data setting range) occurs during writing of data, an error response message is returned. 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.

5.8 Processing Times During Data Send/Receive

For SRJ, the processing times below are required when sending/receiving data.

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

Modbus processing times

Procedure details	Time
Read holding registers [03H] Response send time after the slave receives the query message	8.52 ms max.
Preset single register [06H] Response send time after the slave receives the query message	5.00 ms max.
Diagnostics (loopback test) [08H] Response send time after the slave receives the query message	5.68 ms max.
Preset multiple registers (Write multiple registers) [10H] Response send time after the slave receives the query message	14.76 ms max.

■ Fail-safe

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

MEMO

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) (9) (10) (11)

No.	Name	ID	CH	Register address		Dig.	Attr.	Structure	Data range	Factory set value	See
				HEX	DEC						
1	Measured value (PV)	**M1**	CH1 ⋮ CH16	0000 ⋮ 000F	0 ⋮ 15	7	RO	C	Input scale low to Input scale high (Low limit of input range to High limit of input range)	—	

(1) No.: Communication data number

(2) Name: Communication data name

(3) ID (Identifier): Identifier for RKC communication

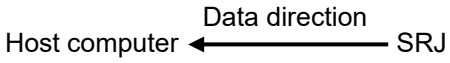
(4) CH: Channel number of data of Communication address

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

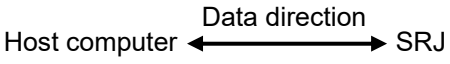
(6) Dig. (Digits): Number of digits for RKC communication

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

RO: Read only data



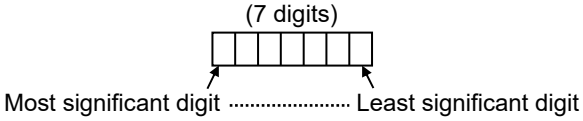
R/W: Read and Write data



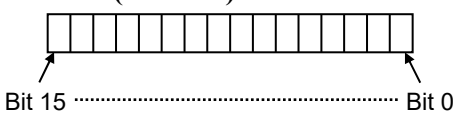
(8) Structure: C: Data for each channel
Data is sent on a channel by channel basis.
M: Data for each module (J-TI-A: 16 channels, J-TI-B and J-TI-C: 8 channels)
Data is sent on a module by module basis.

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

- **ASCII code data (RKC communication)**



- **16-bit data (Modbus)**



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

(11) See (Reference page): Pages to refer to for description of communication data.

CH9 to CH16 of J-TI-B and J-TI-C (8-channel type) are as follows.
Operation mode: "0: Unused"
Communication data except in the operation mode: Invalid *
* Communication data in CH9 to CH16 are equal to the factory set values for CH1 to CH8. When the data is written, it is written properly, but not used.

Communication data includes both Normal setting data and Engineering setting data.
Normal setting data: No. 1 to 41, 51 and 52
Engineering setting data: No. 42 to 50, 53 to 55
(Communication data with a ◆ mark in the name column.)

The attribute of the data in the Engineering setting data is RO (read only) during RUN (control).

⚠ WARNING

Communication data in the Engineering setting data should be set according to the application before setting any parameter related to operation. Once the communication data in the Engineering setting data is 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 setting data.

NOTE

Communication data in Engineering setting data is settable only when the controller is in STOP mode. However, only checking can be made even in the RUN state.

Concerning the cautions for when the data is changed, refer to **10. COMMUNICATION DATA THAT ARE INITIALIZED/MODIFIED WHEN SETTING IS CHANGED (P. 10-1)**.

6.2 J-TI Communication Data [RKC Communication/Modbus]

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

No.	Name	ID	CH	Register address		Dig.	Attr.	Structure	Data range	Factory set value	See
				HEX	DEC						
1	Measured value (PV)	**M1**	CH1 ⋮ CH16	0000 ⋮ 000F	0 ⋮ 15	7	RO	C	Input scale low to Input scale high (Low limit of input range to High limit of input range)	—	7-9
2	Burnout state monitor	**B1**	CH1 ⋮ CH16	0010 ⋮ 001F	16 ⋮ 31	1	RO	C	0: OFF 1: ON	—	7-13
3	Event 1 state monitor	**AA**	CH1 ⋮ CH16	0020 ⋮ 002F	32 ⋮ 47	1	RO	C	0: OFF 1: ON	—	7-23
4	Event 2 state monitor	**AB**	CH1 ⋮ CH16	0030 ⋮ 003F	48 ⋮ 63	1	RO	C	0: OFF 1: ON	—	7-23
5	Control loop break alarm (LBA) state monitor	**AP**	CH1 ⋮ CH16	0040 ⋮ 004F	64 ⋮ 79	1	RO	C	0: OFF 1: ON	—	7-27
6	Manipulated output value monitor [heat-side]	**O1**	CH1 ⋮ CH16	0050 ⋮ 005F	80 ⋮ 95	7	RO	C	–5.0 to +105.0 %	—	7-33
7	Set value (SV) monitor	**MS**	CH1 ⋮ CH16	0060 ⋮ 006F	96 ⋮ 111	7	RO	C	Input scale low to Input scale high (Low limit of input range to High limit of input range)	—	7-14
8	Error code	**ER**	—	0070	112	7	RO	M	RKC communication 0 to 31 The error state is assigned as a bit image in binary numbers. Transmission data from the SRJ is replaced with ASCII code in decimal number. Bit 0: Data back-up error Bit 1: CVM address duplication or setting error Bit 2: Module configuration error Bit 3: Adjustment data error Bit 4: A/D conversion error Bit 5 to Bit 7: Unused Data 0: OFF 1: ON Modbus 0 to 31 0: Normal +1: Data back-up error +2: CVM address duplication or setting error +4: Module configuration error +8: Adjustment data error +16: A/D conversion error When multiple items are applicable, they are summed up.	—	8-3

No.	Name	ID	CH	Register address		Dig.	Attr.	Struc-ture	Data range	Factory set value	See
				HEX	DEC						
—	Unused	—	—	0071 ⋮ 007F	113 ⋮ 127	—	—	—	—	—	—
9	Set value (SV)	**S1**	CH1 ⋮ CH16	0080 ⋮ 008F	128 ⋮ 143	7	RW	C	Input scale low to Input scale high (Low limit of input range to High limit of input range)	0.0	7-14
10	Proportional band [heat-side]	**P1**	CH1 ⋮ CH16	0090 ⋮ 009F	144 ⋮ 159	7	RW	C	0.0 to Input span (Unit: °C) 0.0: ON/OFF control	10.0	7-44
11	Integral time [heat-side]	**I1**	CH1 ⋮ CH16	00A0 ⋮ 00AF	160 ⋮ 175	7	RW	C	1 to 3600 seconds	240	7-44
12	Derivative time [heat-side]	**D1**	CH1 ⋮ CH16	00B0 ⋮ 00BF	176 ⋮ 191	7	RW	C	0 to 3600 seconds 0: PI action	60	7-44
13	Control response parameter	**CA**	CH1 ⋮ CH16	00C0 ⋮ 00CF	192 ⋮ 207	1	RW	C	0: Slow 1: Medium 2: Fast [When the P or PD action is selected, this setting becomes invalid]	2	7-39
14	PV bias	**PB**	CH1 ⋮ CH16	00D0 ⋮ 00DF	208 ⋮ 223	7	RW	C	–Input span to +Input span	0.0	7-7
15	Event 1 set value	**A1**	CH1 ⋮ CH16	00E0 ⋮ 00EF	224 ⋮ 239	7	RW	C	• Deviation high, Deviation low –Input span to +Input span • Deviation high/low, Band 0.0 to Input span • Process high, Process low Input scale low to Input scale high (Low limit of input range to High limit of input range)	0.0	7-23
16	Event 2 set value	**A2**	CH1 ⋮ CH16	00F0 ⋮ 00FF	240 ⋮ 255	7	RW	C	• Deviation high, Deviation low –Input span to +Input span • Deviation high/low, Band 0.0 to Input span • Process high, Process low Input scale low to Input scale high (Low limit of input range to High limit of input range)	0.0	7-23
17	Operation mode	**EI**	CH1 ⋮ CH16	0100 ⋮ 010F	256 ⋮ 271	1	RW	C	0: Unused (Neither monitor nor control is performed.) 1: Monitor (Only data monitor is performed.) 2: Monitor + Event function (Data monitor and event action [including LBA] are performed.) 3: Control (Control is performed.)	3	7-35

No.	Name	ID	CH	Register address		Dig.	Attr.	Structure	Data range	Factory set value	See
				HEX	DEC						
18	Autotuning (AT)	**G1**	CH1 ⋮ CH16	0110 ⋮ 011F	272 ⋮ 287	1	RW	C	0: PID control 1: Start Autotuning When the Autotuning (AT) is finished, the J-TI will automatically return to "0: PID control." When the Autotuning (AT) startup conditions are not satisfied: RKC communication: NAK response Modbus: Error response message Function code 3 (When a value exceeding the setting range is written)	0	7-40
19	Auto/Manual transfer	**J1**	CH1 ⋮ CH16	0120 ⋮ 012F	288 ⋮ 303	1	RW	C	0: Auto mode 1: Manual mode	0	7-50
20	Manual manipulated output value	**ON**	CH1 ⋮ CH16	0130 ⋮ 013F	304 ⋮ 319	7	RW	C	−5.0 to +105.0 % When "Running" is set in the Auto mode: RKC communication: NAK response Modbus: Normal response (Same action as writing to RO)	0.0	7-51
21	Output limiter high [heat-side]	**OH**	CH1 ⋮ CH16	0140 ⋮ 014F	320 ⋮ 335	7	RW	C	Output limiter low [heat-side] + 1 digit to +105.0 %	100.0	7-32
22	Output limiter low [heat-side]	**OL**	CH1 ⋮ CH16	0150 ⋮ 015F	336 ⋮ 351	7	RW	C	−5.0 % to Output limiter high [heat-side] −1 digit	0.0	7-32
23	Proportional cycle time [heat-side]	**T0**	CH1 ⋮ CH16	0160 ⋮ 016F	352 ⋮ 367	7	RW	C	1 to 100 seconds This settings are only effective for CH1 of the J-TI master. Settings made on channels other than CH1 of the J-TI master are ignored. J-TI master: J-TI module of the communication address 0, 4, 8 or C	2	7-33
24	PV digital filter	**F1**	CH1 ⋮ CH16	0170 ⋮ 017F	368 ⋮ 383	7	RW	C	0 to 100 seconds 0: Filter OFF	0	7-8
25	Hot/Cold start	**XN**	CH1 ⋮ CH16	0180 ⋮ 018F	384 ⋮ 339	1	RW	C	0: Hot start 1 1: Hot start 2 2: Cold start	1	7-52
26	Start determination point	**SX**	CH1 ⋮ CH16	0190 ⋮ 019F	400 ⋮ 415	7	RW	C	0.0 to Input span 0.0: Operation starts from any start state selected by Hot/Cold start	0.0	7-53
27	RUN/STOP transfer	**SR**	—	01A0	416	1	RW	M	0: STOP (Control stop) 1: RUN (Control start)	1	7-34

No.	Name	ID	CH	Register address		Dig.	Attr.	Struc-ture	Data range	Factory set value	See
				HEX	DEC						
—	Unused	—	—	01A1 ⋮ 01AF	417 ⋮ 431	—	—	—	—	—	—
28	Input error determination point (high)	**AV**	CH1 ⋮ CH16	01B0 ⋮ 01BF	432 ⋮ 447	7	RW	C	Input error determination point (low) to Input scale high [Input error determination point (low) to High limit of input range]	Input scale high (High limit of input range)	7-12
29	Input error determination point (low)	**AW**	CH1 ⋮ CH16	01C0 ⋮ 01CF	448 ⋮ 463	7	RW	C	Input scale low to Input error determination point (high) [Low limit of input range to Input error determination point (high)]	Input scale low (Low limit of input range)	7-12
30	Action (high) at input error	**WH**	CH1 ⋮ CH16	01D0 ⋮ 01DF	464 ⋮ 479	1	RW	C	0: Control continues (with the latest output) 1: Manipulated output value at input error (Manual mode) The Operation mode is switched to the Manual mode and the Manipulated output at Input error is output. 2: Manipulated output value at input error (Auto mode) The Operation mode remains in the Auto mode and the Manipulated output at Input error is output. When the error is recovered, the operation mode is switched to the PID control.	0	7-12
31	Action (low) at input error	**WL**	CH1 ⋮ CH16	01E0 ⋮ 01EF	480 ⋮ 495	1	RW	C		0	7-12
32	Manipulated output value at input error	**OE**	CH1 ⋮ CH16	01F0 ⋮ 01FF	496 ⋮ 511	7	RW	C	–5.0 to +105.0 % Actual output value is restricted by the Output limiter.	0.0	7-13
—	Unused	—	—	0200 ⋮ 021F	512 ⋮ 543	—	—	—	—	—	—
33	AT bias	**GB**	CH1 ⋮ CH16	0220 ⋮ 022F	544 ⋮ 559	7	RW	C	–Input span to +Input span	0.0	7-42
—	Unused	—	—	0230 ⋮ 024F	560 ⋮ 591	—	—	—	—	—	—
34	Control loop break alarm (LBA) usage selection	**HP**	CH1 ⋮ CH16	0250 ⋮ 025F	592 ⋮ 607	1	RW	C	0: Unused 1: Used	0	7-26
35	Control loop break alarm (LBA) time	**C6**	CH1 ⋮ CH16	0260 ⋮ 026F	608 ⋮ 623	7	RW	C	1 to 7200 seconds	480	7-26
36	LBA deadband (LBD)	**V2**	CH1 ⋮ CH16	0270 ⋮ 027F	624 ⋮ 639	7	RW	C	0.0 to Input span	0.0	7-27

No.	Name	ID	CH	Register address		Dig.	Attr.	Structure	Data range	Factory set value	See
				HEX	DEC						
37	Transistor output selection	**VP**	CH1 ⋮ CH16	0280 ⋮ 028F	640 ⋮ 655	7	RW	C	0 No assignment 1: CH1 to CH8 2: CH9 to CH16 * 3: CH17 to CH24 4: CH25 to CH32 * 5: CH33 to CH40 6: CH41 to CH48 * 7: CH49 to CH56 8: CH57 to CH64 * * Assignable only for the J-TI-A These settings are only effective for CH1 to CH8 of the J-TI master. Settings made on channels other than CH1 to CH8 of the J-TI master are ignored. CH1 to CH8 of the J-TI master correspond to address 0 to 7 of the J-CVM. J-TI master: J-TI module of the communication address 0, 4, 8 or C	0	7-29
—	Unused	—	16	0290 ⋮ 02EF	656 ⋮ 751	—	—	—	—		—
38	Decimal point position monitor	**XU**	CH1 ⋮ CH16	02F0 ⋮ 02FF	752 ⋮ 767	1	RO	C	0: No decimal place 1: One decimal place	—	7-6
39	Input scale high monitor	**XV**	CH1 ⋮ CH16	0300 ⋮ 03FF	768 ⋮ 783	7	RO	C	High limit of input range	—	7-6
40	Input scale low monitor	**XW**	CH1 ⋮ CH16	0310 ⋮ 031F	784 ⋮ 799	7	RO	C	Low limit of input range	—	7-6
41	ROM version	**Z0**	—	02A0	672	7	RO	M	Version of ROM built in the instrument	—	7-59
42	Input range number ◆	**XI**	CH1 ⋮ CH16	0320 ⋮ 032F	800 ⋮ 815	7	RW	C	• TC input 0: K 0.0 to 400.0 °C 1: K 0.0 to 800.0 °C 2: K 0.0 to 1300.0 °C 3: R 0.0 to 1700.0 °C • RTD input 10: Pt100 0.0 to 400.0 °C 11: Pt100 0.0 to 600.0 °C 12: Pt100 0.0 to 800.0 °C When the input range is switched, wait for three seconds or more before running the system.	Note	7-6
43	Control action ◆	**XE**	CH1 ⋮ CH16	0330 ⋮ 033F	816 ⋮ 831	1	RW	C	0: Brilliant II PID control (direct action) 1: Brilliant II PID control (reverse action)	1	7-37

◆ : Engineering setting data

Note: Same as the input range of the input range code specified at the time of order.

No.	Name	ID	CH	Register address		Dig.	Attr.	Structure	Data range	Factory set value	See
				HEX	DEC						
44	Event 1 differential gap ◆	**HA**	CH1 ⋮ CH16	0340 ⋮ 034F	832 ⋮ 847	7	RW	C	0.0 to Input span	2.0	7-21
45	Event 2 differential gap ◆	**HB**	CH1 ⋮ CH16	0350 ⋮ 035F	848 ⋮ 863	7	RW	C	0.0 to Input span	2.0	7-21
46	Event 1 type ◆	**XA**	CH1 ⋮ CH16	0360 ⋮ 036F	864 ⋮ 879	1	RW	C	0: None 1: Process high [a] 2: Process low [a] 3: Deviation high [b] 4: Deviation low [b] 5: Deviation high/low [b] 6: Band [b] [a] Event hold action is available. [b] Event hold and re-hold action is available.	Note 1	7-16
47	Event 2 type ◆	**XB**	CH1 ⋮ CH16	0370 ⋮ 037F	880 ⋮ 895	1	RW	C	0: None 1: Process high [a] 2: Process low [a] 3: Deviation high [b] 4: Deviation low [b] 5: Deviation high/low [b] 6: Band [b] [a] Event hold action is available. [b] Event hold and re-hold action is available.	Note 2	7-16

◆ : Engineering setting data

Note 1: If the Event type is specified by the initial setting code when ordering, that Event type will be the factory set value.
If the Event type is not specified: 3

Note 2: If the Event type is specified by the initial setting code when ordering, that Event type will be the factory set value.
If the Event type is not specified: 4

No.	Name	ID	CH	Register address		Dig.	Attr.	Structure	Data range	Factory set value	See
				HEX	DEC						
48	Event 1 hold action ◆	**WA**	CH1 ⋮ CH16	0380 ⋮ 038F	896 ⋮ 911	7	RW	C	RKC communication 0 to 3 The Event hold action type is assigned as a bit image in binary numbers. Transmission data from the SRJ is replaced with ASCII code in decimal number. Bit 0: with/without hold action Bit 1: with/without re-hold action Bit 2 to Bit 7: Unused Data 0: None 1: Supplied Setting hold or re-hold action on the event that is not available with hold and re-hold actions will just be ignored.	Note	7-18
									Modbus 0: Hold action OFF 1: Hold action ON 2: Re-hold action ON 3: Hold action ON+Re-hold action ON Setting hold or re-hold action on the event that is not available with hold and re-hold actions will just be ignored.		
49	Event 2 hold action ◆	**WB**	CH1 ⋮ CH16	0390 ⋮ 039F	912 ⋮ 927	7	RW	C	RKC communication 0 to 3 The Event hold action type is assigned as a bit image in binary numbers. Transmission data from the SRJ is replaced with ASCII code in decimal number. Bit 0: with/without hold action Bit 1: with/without re-hold action Bit 2 to Bit 7: Unused Data 0: None 1: Supplied Setting hold or re-hold action on the event that is not available with hold and re-hold actions will just be ignored.	Note	7-18
									Modbus 0: Hold action OFF 1: Hold action ON 2: Re-hold action ON 3: Hold action ON+Re-hold action ON Setting hold or re-hold action on the event that is not available with hold and re-hold actions will just be ignored.		7-18
50	Event timer ◆	**DF**	CH1 ⋮ CH16	03A0 ⋮ 03AF	928 ⋮ 943	7	RW	C	0 to 255 seconds	0	7-22

◆ : Engineering setting data

Note: If the Event type is specified by the initial setting code when ordering, the factory set value of Event hold action differs depending on the Event type.
If the Event type is not specified: 1

No.	Name	ID	CH	Register address		Dig.	Attr.	Struc-ture	Data range	Factory set value	See
				HEX	DEC						
51	Interval time	**ZX**	—	03B0	944	7	RW	M	0 to 100 ms In the case of RKC communication, the set value of the interval time is disabled, and the interval time operates at 6 ms.	0	7-58
—	Unused	—	—	03B1 ⋮ 03BF	945 ⋮ 959	—	—	—	—	—	—
52	Operation mode holding setting	**X2**	—	03C0	960	1	RW	M	0: Not hold Initialize the operation mode to "1: Monitor" 1: Hold	1	7-54
—	Unused	—	—	03C1 ⋮ 08FF	961 ⋮ 2303	—	—	—	—	—	—
53	Communication protocol selection ◆	**IX**	—	0900	2304	7	RW	M	0: RKC communication 1: Modbus The data changes become valid when the power is turned on again.	Note	7-55
—	Unused	—	—	0901 ⋮ 090F	2305 ⋮ 2319	—	—	—	—	—	—
54	Communication speed ◆	**IR**	—	0910	2320	7	RW	M	0: 19200 bps 1: 38400 bps The data changes become valid when the power is turned on again.	1	7-56
—	Unused	—	—	0911 ⋮ 091F	2321 ⋮ 2335	—	—	—	—	—	—
55	Sampling cycle selection ◆	**TZ**	—	0920	2336	7	RW	M	0: 0.25 seconds 1: 1 second The data changes become valid when the power is turned on again.	1	7-9
—	Unused	—	—	0921 ⋮ 092F	2337 ⋮ 2351	—	—	—	—	—	—

◆ : Engineering setting data

Note: When the communication protocol is specified at the time of order, the specified communication protocol will be the factory set value.
If the communication protocl is not specified: 1

No.	Name	ID	CH	Register address		Dig.	Attr.	Struc-ture	Data range	Factory set value	See
				HEX	DEC						
56	Instrument number monitor	**KN**	—	—	—	10	RO	M	Instrument number	—	7-59
57	Model code monitor	**ID**	—	—	—	18	RO	M	Model code	—	7-59
58	Initial setting code monitor	**IC**	—	—	—	6	RO	M	Initial setting code	—	7-59
59	Special order number monitor	**IZ**	—	—	—	21	RO	M	Special order number	—	7-59

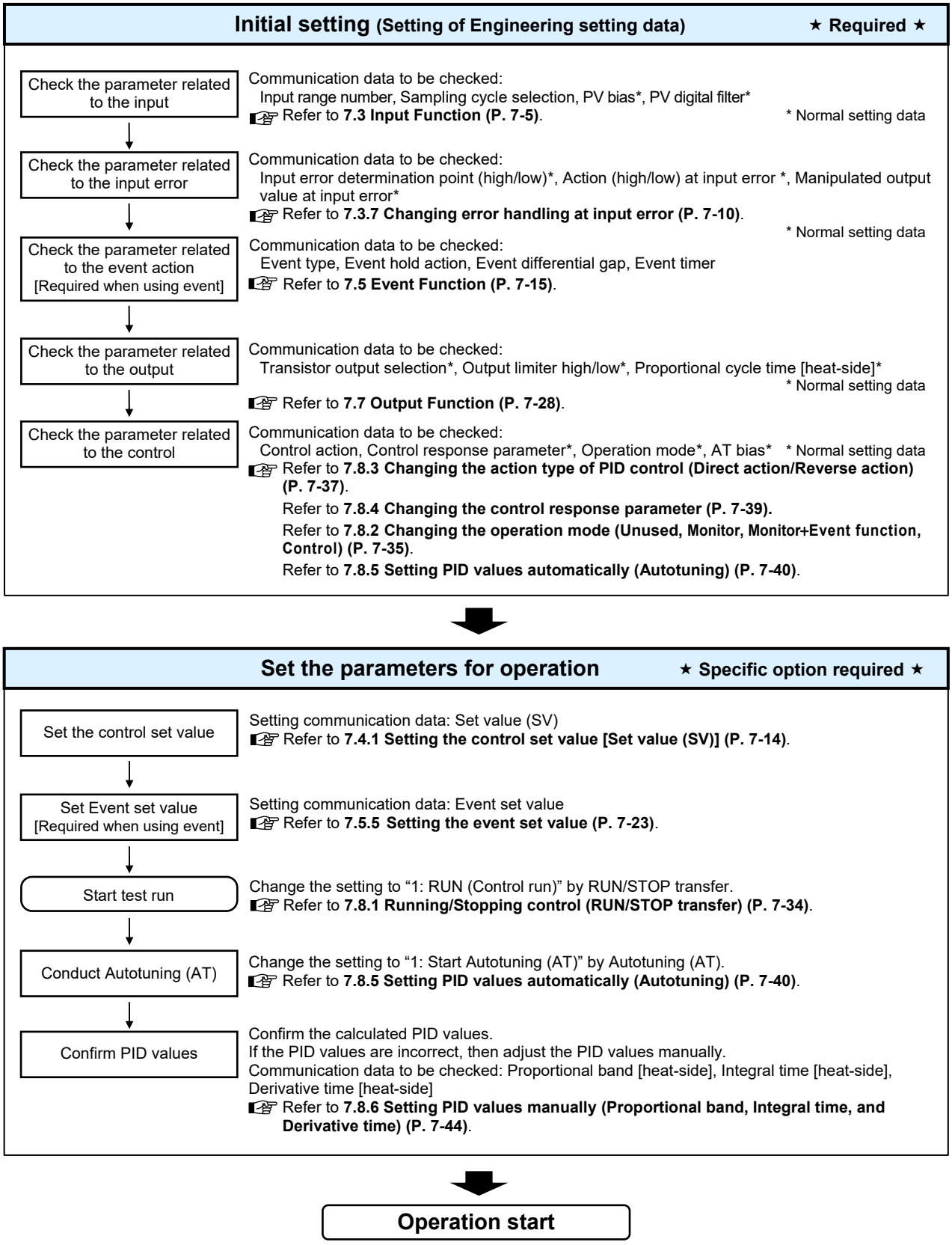
OPERATION AND FUNCTION DESCRIPTION

7

This chapter describes precautions for operation, initial settings before first time use, and communication data settings and functions required for operation.

7.1 Setup Procedures Prior to Running the Instrument

Start communication program then preset parameters required for operation by following the procedures below. Communication data includes both Normal setting data and Engineering setting data. For initial setting, set the Engineering setting data and Normal setting data described in the procedure below.



The basic setting flow is described at Setup Procedures Prior to Running the Instrument in the previous page. To use functions other than the functions described in the setting flow, refer to the proper reference page listed in the table below.

Functions	Reference page
Control loop break alarm (LBA)	**7.6 Control Loop Break Alarm (LBA) Function (P. 7-24)**
ON/OFF action	**7.8.7 Controlling with ON/OFF action (P. 7-48)**
Manual control	**7.8.8 Controlling with manual control (P. 7-49)**
Start action at recovering power failure (power OFF from ON)	**7.8.9 Changing the action at power ON (Hot/Cold start, Operation mode holding setting) (P. 7-52)**
Host communication function	**7.9 Communication Function (P. 7-55)**

Before setting the Engineering setting data for Initial setting, read and understand the warning below.

⚠ WARNING

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

NOTE

Engineering setting data are settable only when the controller is in STOP mode. However, only checking can be made even in the RUN state.

☞ For the handling procedures before starting communication program, refer to **1.6 Handling Procedure to Operation (P. 1-19)**.

7.2 Operating Precautions

Before starting the operation, check the following items.

■ Power ON

When turning ON the instrument for the first time, the instrument starts based on the following conditions:

Operation mode: Control
RUN/STOP transfer: RUN (control start) [Factory set value]
RUN lamp [Green]: J-TI: Lights
J-CVM: Flashes

■ Action at input error

If the input signal wiring is short-circuited, the instrument determines that burnout has occurred.

Burnout direction: Upscale
Output at input error: Control output:
According to the contents set by "Action (high/low) at input error"

■ Checking the each communication data

The settings for the SV and all communication data should be appropriate for the controlled system.
There are parameters (Engineering setting communication data), which can not be changed when the instrument is in RUN mode. Change the RUN/STOP mode from RUN to STOP when a change for the parameters in Engineering setting is necessary.

☞ For the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Operation at power failure

A power failure of 20 ms or less will not affect the control action. When a power failure of more than 20 ms occurs the instrument assumes that the power has been turned off.
During recovery from a power outage state (when the power is turned ON from OFF), the operation is resumed according to the contents set in the following communication data.

– Hot/Cold start
– Start determination point
– Operation mode holding setting

☞ For details, refer to **7.8.9 Changing the action at power ON (Hot/Cold start, Operation mode holding setting) (P. 7-52)**.

■ Event hold action

- The event hold action is activated when the power is turned on or when transferred from STOP mode to RUN mode.
- The event re-hold action is activated when not only the SV is changed, but also the power is turned on or when transferred from STOP mode to RUN mode.

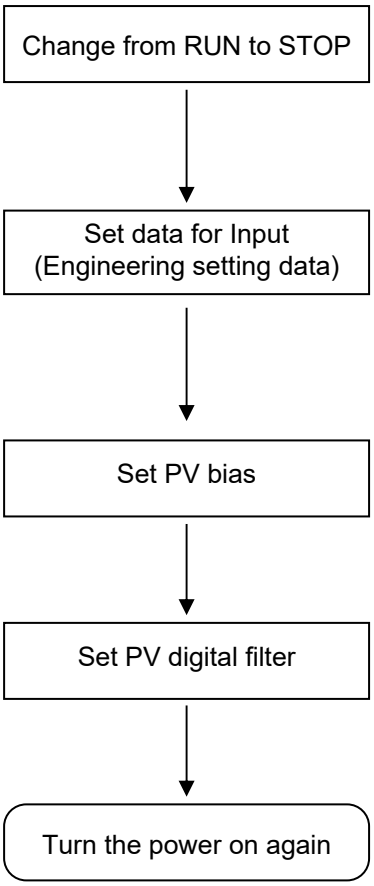
☞ For details, refer to **■ Event hold action, Event re-hold action (P. 7-18)**.

7.3 Input Function

■ Setting procedure of the data related to Input

To set the data related to Input, follow the procedure below.

📖 Input operates only for the channels set to "1: Monitor," "2: Monitor + Event function," or "3: Control" at **Operation mode (P. 7-36)**.



Change the setting to "0: STOP (Control stop)" by **RUN/STOP transfer**.
Setting range: 0: STOP (Control stop)
1: RUN (Control start)

☞ Refer to ■ **RUN/STOP transfer (P. 7-34)**.

Set the data related to input based on requirement.
(Engineering setting data)

☞ Refer to ■ **Input range number (P. 7-6)**.

☞ Refer to ■ **Sampling cycle selection (P. 7-9)**.

Set the bias added to the measured value to perform sensor correction at **PV bias**.
Setting range: –Input span to +Input span

☞ Refer to ■ **PV bias (P. 7-7)**.

Set the time of the first-order lag filter at **PV digital filter**.
Setting range: 0 to 100 seconds (0: Unused)

☞ Refer to ■ **PV digital filter (P. 7-8)**.

If the sampling cycle is set from **Sampling cycle selection**, turn OFF the power once and then turn it ON again.
The data set in the **Sampling cycle selection** is enabled by turning OFF the power and then turning it ON again.

7.3.1 Changing input

Measured input can be changed at Input range number. Set the input according to the sensor and the application.

■ Input range number

Number indicating the input range. The input range can be changed.

NOTE

If you change the input range number, several types of communication data, such as the set values (SV), etc. are initialized. Therefore, you need to make the settings again. For details on the communication data that is initialized when you change the input range number, refer to 10. COMMUNICATION DATA THAT ARE INITIALIZED/MODIFIED WHEN SETTING IS CHANGED (P. 10-1).

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Input range number	**XI**	CH1 ⋮ CH16	0320 ⋮ 032F	• TC input 0: K 0.0 to 400.0 °C 1: K 0.0 to 800.0 °C 2: K 0.0 to 1300.0 °C 3: R 0.0 to 1700.0 °C • RTD input 10: Pt100 0.0 to 400.0 °C 11: Pt100 0.0 to 600.0 °C 12: Pt100 0.0 to 800.0 °C When the input range is switched, wait for 3 seconds or more before running the system.	Same as the input range of the input range code specified at the time of order.

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.3.2 Checking the decimal point position and scale range of the input

You can check the decimal point position, upper-limit value, and lower-limit value of the measured inputs.

■ Decimal point position monitor, Input scale high/low monitor

Decimal point position monitor: Decimal point position of the input range.
Input scale high/low monitor: Upper-limit value and lower-limit value of input range.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Decimal point position monitor	**XU**	CH1 ⋮ CH16	02F0 ⋮ 02FF	0: No decimal place 1: One decimal place	Same as the decimal point position of the input range specified at the time of order.
Input scale high monitor	**XV**	CH1 ⋮ CH16	0300 ⋮ 03FF	High limit of input range	High limit of input range specified at the time of order.
Input scale low monitor	**XW**	CH1 ⋮ CH16	0310 ⋮ 031F	Low limit of input range	Low limit of input range specified at the time of order.

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.3.3 Correcting input

PV bias can be used for Input correction. The PV bias is used to compensate the individual variations of the sensors or correct the difference between the Measured value (PV) of other instruments.

■ PV bias

PV bias adds bias to the Measured value (PV).

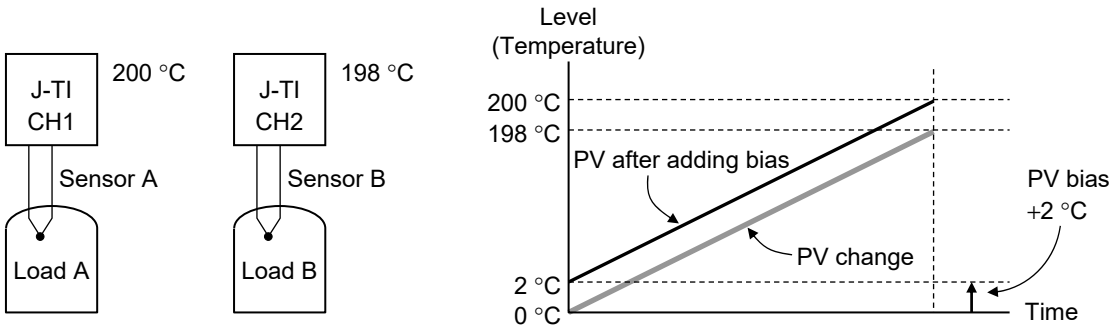
- **Setting example of PV bias:**

  When measuring the same type of load by using different sensors, the Measured value (PV) will be displayed differently based on the features of sensors:

  J-TI CH1: 200 °C J-TI CH2: 198 °C

  To correct the Measure value (PV) of J-TI CH2, add bias of +2 °C by PV bias:

  Displayed value = Measured value (PV) + PV bias = 198 °C + 2 °C = 200 °C



- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
PV bias	**PB**	CH1 ⋮ CH16	00D0 ⋮ 00DF	–Input span to +Input span	0.0

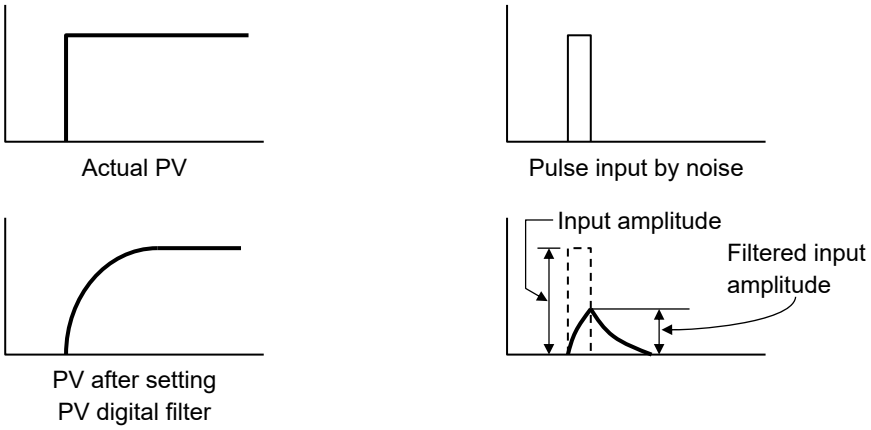
☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.3.4 Preventing the input flicker

To prevent the input flicker, PV digital filter with the first-order lag calculation is provided.

■ PV digital filter

PV digital filter is software designed to reduce variance of PV caused by noise. Effect of Input noise can be reduced by setting time constant of PV digital filter based on the controlled object requirement and its level of noise. Setting a value too small leads to a poor result of PV digital filter; just as an input response will be poor when setting a value too large.



● **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
PV digital filter	**F1**	CH1 ⋮ CH16	0170 ⋮ 017F	0 to 100 seconds 0: Filter OFF	0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.3.5 Changing the input sampling cycle

You can change the sampling time during capturing measured inputs.

■ Sampling cycle selection

Sampling time during capturing measured inputs.
The control computing cycle is also changed along with a change in the sampling cycle.

NOTE

The set data is enabled by turning OFF the power and then turning it ON again.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Sampling cycle selection	**TZ**	—	0920	0: 0.25 seconds 1: 1 second	1

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.3.6 Checking measured value (PV)

You can check the input value of J-TI.

■ Measured value (PV)

Measured value (PV) is an input value of the J-TI.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Measured value (PV)	**M1**	CH1 ⋮ CH16	0000 ⋮ 000F	Input scale low to Input scale high (Low limit of input range to High limit of input range)	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

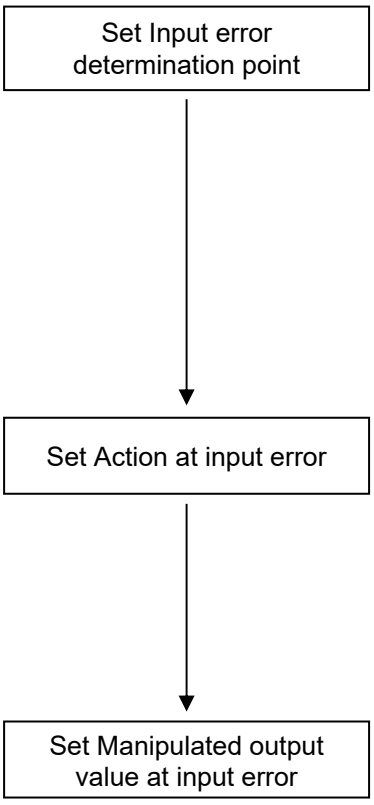
7.3.7 Changing error handling at input error

The measures for input errors can be selected from Input error determination point, Action at input error, and Manipulated output value at input error.

■ Setting procedure of the data related to input error

To set the data related to input error, follow the procedure below.

📖 Error handling at input error operates only for the channels set to "1: Monitor," "2: Monitor + Event function," or "3: Control" at **Operation mode (P. 7-36)**.



Set Input error determination point by **Input error determination point (high/low)**.

Setting range:

Input error determination point (high):

Input error determination point (low) to Input scale high
[Input error determination point (low) to High limit of input range]

Input error determination point (low):

Input scale low to Input error determination point (high)
[Low limit of input range to Input error determination point (high)]

☞ Refer to ■ **Input error determination point (high/low) (P. 7-12)**.

Set **Action (high/low) at input error** to select the output to be produced when an input error occurs.

Setting range:

0: Control continues (with the latest output)
1: Manipulated output value at input error (Manual mode)
2: Manipulated output value at input error (Auto mode)

☞ Refer to ■ **Action (high/low) at input error (P. 7-12)**.

Set the manipulated output value at input error, and the manipulated output value that is output when the setting of action (high) at input error or action (low) at input error is "1: Manipulated output value at input error (Manual mode)" or "2: Manipulated output value at input error (Auto mode)."

Setting range:

−5.0 to +105.0 %
Actual output values become those restricted by the output limiter.

☞ Refer to ■ **Manipulated output value at input error (P. 7-13)**.

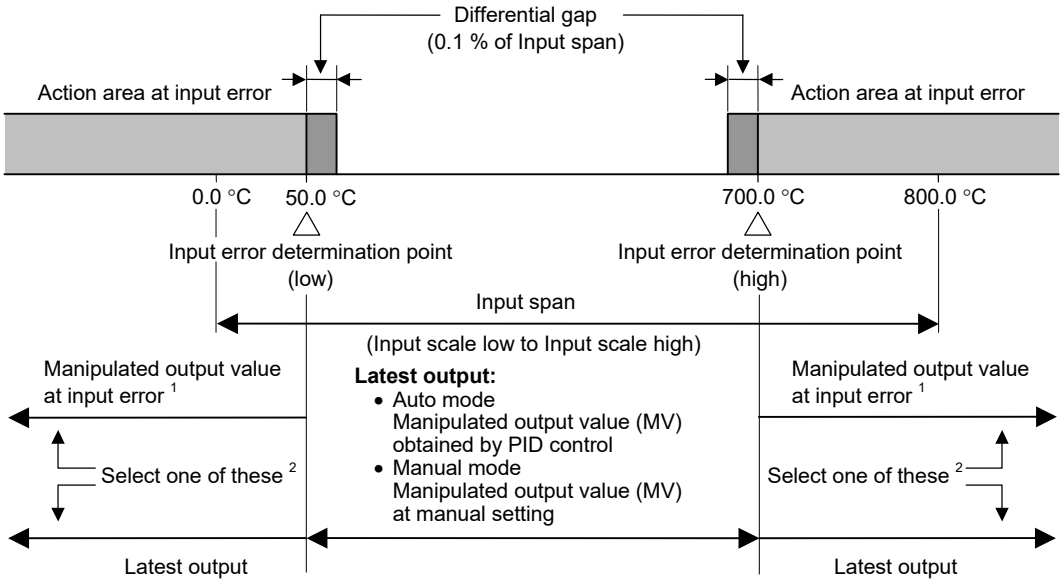
■ Input error determination point and Action at input error

If the Measured value (PV) exceeds the Input error determination point (high or low), the action predefined at “Action (high and low) input error” will be taken.

NOTE

In manual mode and control stop mode, action and output will not be taken for input errors.

Example: Input range: 0.0 to 800.0 °C
Input error determination point (high): 700.0 °C
Input error determination point (low): 50.0 °C



[1] Manipulated output action at input error

- When the setting of Action (high/low) at input error is “1: Manipulated output value at input error (Manual mode)”:
  Switch the Operation mode to the Manual mode just when determined to be at input error to output the manipulated output value set by the "Manipulated output value at input error."
- When the setting of Action (high/low) at input error is “2: Manipulated output value at input error (Auto mode)”:
  When the instrument judges that the input error has occurred, the instrument produces the manipulated output set at “Manipulated output value at input error,” while keeping the Auto mode. When the instrument returns from the error, the mode is switched to the PID control.

[2] Manipulated output value at input error can be selected at Action (high/low) at input error.

■ Input error determination point (high/low)

Input error determination point (high):

If the Measured value (PV) is above the Input error determination point (high), Action (high) at input error will be taken.

Input error determination point (low):

If the Measured value (PV) is below the Input error determination point (low), Action (low) at input error will be taken.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Input error determination point (high)	**AV**	CH1 ⋮ CH16	01B0 ⋮ 01BF	Input error determination point (low) to Input scale high [Input error determination point (low) to High limit of input range]	Input scale high (High limit of input range)
Input error determination point (low)	**AW**	CH1 ⋮ CH16	01C0 ⋮ 01CF	Input scale low to Input error determination point (high) [Low limit of input range to Input error determination point (high)]	Input scale low (Low limit of input range)

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

☞ For details of action for input error, refer to **■ Input error determination point and Action at input error (P. 7-11)**.

■ Action (high/low) at input error

The output selected at Action (high/low) at input error is produced if the Measured value (PV) exceeds the Input error determination point (high) or goes below the Input error determination point (low).

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Action (high) at input error	**WH**	CH1 ⋮ CH16	01D0 ⋮ 01DF	0: Control continues (with the latest output) 1: Manipulated output value at input error (Manual mode) The Operation mode is switched to the Manual mode and the Manipulated output at Input error is output. 2: Manipulated output value at input error (Auto mode) The Operation mode remains in the Auto mode and the Manipulated output at Input error is output. When the error is recovered, the operation mode is switched to the PID control.	0
Action (low) at input error	**WL**	CH1 ⋮ CH16	01E0 ⋮ 01EF		0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

☞ For details of action for input error, refer to **■ Input error determination point and Action at input error (P. 7-11)**.

■ Manipulated output value at input error

The manipulated output value that is output when the setting of action (high/low) at input error is "1: Manipulated output value at input error (Manual mode)" or "2: Manipulated output value at input error (Auto mode)", and the Measured value (PV) becomes equal to or more than the Input error determination point (high), or equal to or less than the Input error determination point (low).

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Manipulated output value at input error	**OE**	CH1 ⋮ CH16	01F0 ⋮ 01FF	−5.0 to +105.0 % Actual output value is restricted by the Output limiter.	0.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

☞ For details of action for input error, refer to ■ **Input error determination point and Action at input error (P. 7-11)**.

7.3.8 Checking the input break state

You can check the input break state.

■ Burnout state monitor

Burnout state monitor: Monitor a state in input break.
Burnout direction: Upscale (fixed)

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Burnout state monitor	**B1**	CH1 ⋮ CH16	0010 ⋮ 001F	0: OFF 1: ON	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.4 Setting Function

7.4.1 Setting the control set value [Set value (SV)]

After finishing the initial settings, set the control target value, SV.

■ Set value (SV)

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

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Se t value (SV)	**S1**	CH1 ⋮ CH16	0080 ⋮ 008F	Input scale low to Input scale high (Low limit of input range to High limit of input range)	0.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.4.2 Changing the control set value [Set value (SV)]

You can check the target value of the control temperature to be used in the operation.

■ Set value (SV) monitor

This value is a monitor of the Set value (SV) that is a desired value for control.

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Se t value (SV) monitor	**MS**	CH1 ⋮ CH16	0060 ⋮ 006F	Input scale low to Input scale high (Low limit of input range to High limit of input range)	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

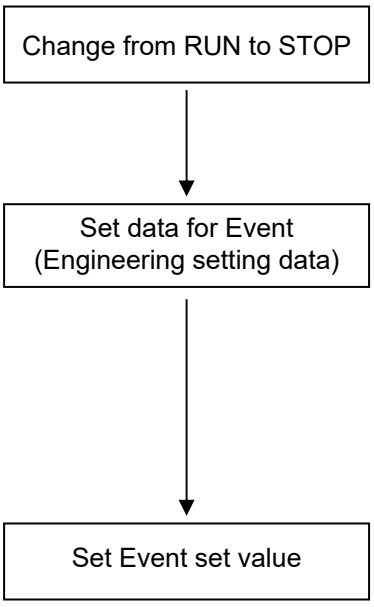
7.5 Event Function

Event function sets up the event status when the Measured value (PV) or the deviation reaches the Event set values.

■ Setting procedure of Event

To set the data related to event 1 to 2, follow the procedure below

📖 Event operates only for the channels set to "2: Monitor + Event function," or "3: Control" at **Operation mode (P. 7-36)**.



Change the setting to "0: STOP (Control stop)" by **RUN/STOP transfer**.
Setting range: 0: STOP (Control stop)
1: RUN (Control start)

☞ Refer to ■ **RUN/STOP transfer (P. 7-34)**.

Set the data related to event based on requirement.
(Engineering setting data)

☞ Refer to ■ **Event type (P. 7-17)**.

☞ Refer to ■ **Event hold action, Event re-hold action (P. 7-18)**.

☞ Refer to ■ **Event differential gap (P. 7-21)**.

☞ Refer to ■ **Event timer (P. 7-22)**.

Set the Event set value.
Setting range:

- Deviation high, Deviation low: −Input span to +Input span
- Deviation high/low, Band: 0.0 to Input span
- Process high, Process low: Input scale low to Input scale high (Low limit of input range to High limit of input range)

☞ Refer to ■ **Event 1 set value (P. 7-23)**.

7.5.1 Changing event type

There are 6 types of event in total.

- **Event type**

Set value	Event type	Initial setting code
0	None	N
1	Process high [1]	H, K (With hold action)
2	Process low [1]	J, L (With hold action)
3	Deviation high [2]	A, E (With hold action), Q (With re-hold action)
4	Deviation low [2]	B, F (With hold action), R (With re-hold action)
5	Deviation high/low [2]	C, G (With hold action), T (With re-hold action)
6	Band [2]	D

[1] Event hold action is available.
[2] Event hold and re-hold action is available.

Diagrams of the event action type are shown in the following:

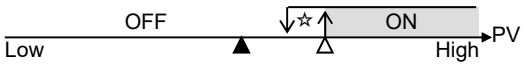
ON: Event action turned on
OFF: Event action turned off (▲: Set value (SV) △: Event set value ☆: Event differential gap)

Deviation action:

When the deviation (PV – SV) reaches the Event set value, event ON occurs.

Deviation high

(Event set value is greater than 0.)

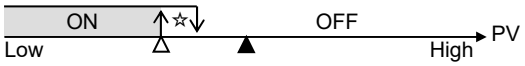


(Event set value is less than 0.)

Deviation low

(Event set value is greater than 0.)

(Event set value is less than 0.)



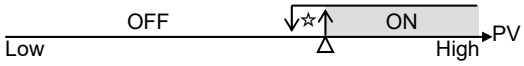
Deviation high/low

Band

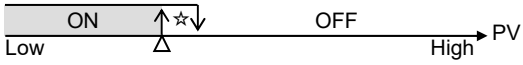
Input value action:

When the Measured value (PV) reaches the Event set value, event ON occurs.

Process high



Process low



■ Event type

Event action types can be selected.

NOTE

If you change an Event type, the data range of the Event set value for which the Event type is changed changes according to the setting. Therefore, you need to make the settings again. For details, refer to 10. COMMUNICATION DATA THAT ARE INITIALIZED/MODIFIED WHEN SETTING IS CHANGED (P. 10-1).

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Event 1 type	**XA**	CH1 ⋮ CH16	0360 ⋮ 036F	0: None 1: Process high [a] 2: Process low [a] 3: Deviation high [b] 4: Deviation low [b] 5: Deviation high/low [b] 6: Band [b] [a] Event hold action is available. [b] Event hold and re-hold action is available.	If the Event type is specified by the initial setting code when ordering, that Event type will be the factory set value. If the Event type is not specified: 3
Event 2 type	**XB**	CH1 ⋮ CH16	0370 ⋮ 037F	0: None 1: Process high [a] 2: Process low [a] 3: Deviation high [b] 4: Deviation low [b] 5: Deviation high/low [b] 6: Band [b] [a] Event hold action is available. [b] Event hold and re-hold action is available.	If the Event type is specified by the initial setting code when ordering, that Event type will be the factory set value. If the Event type is not specified: 4

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.5.2 Adding hold action to the event action

This instrument can be added hold action and re-hold action to the Event action.

Some event actions may not be available with hold and re-hold actions. Setting hold or re-hold action on the event that is not available with hold and re-hold actions will just be ignored.

Refer to ■ **Event type (P. 7-17)** for those events that are available with hold or re-hold action.

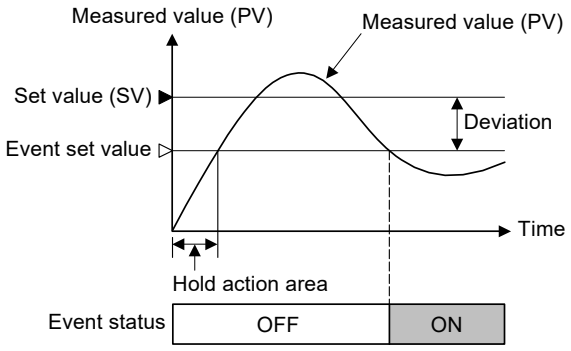
■ Event hold action, Event re-hold action

● Event hold action

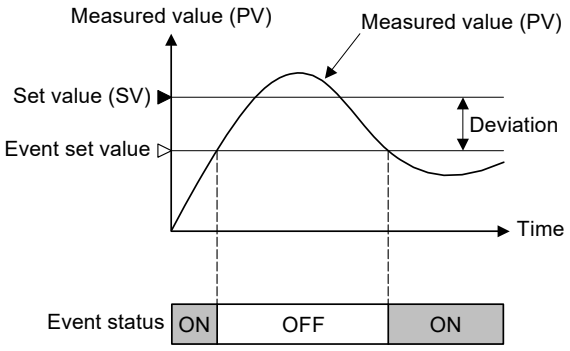
When Event hold action is ON, the Event action is suppressed at start-up or STOP to RUN until the Measured value (PV) has entered the non-event range.

- At power ON
- Transferred from STOP to RUN

[With hold action]



[Without hold action]



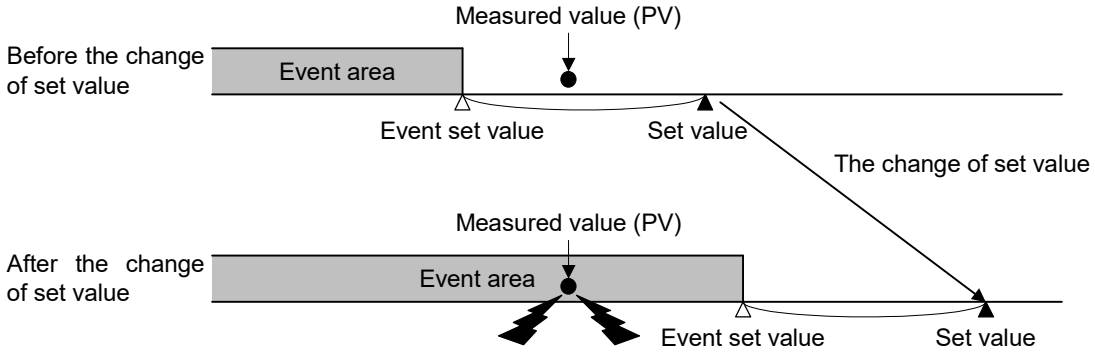
● Event re-hold action

When Event re-hold action is ON, the event action is also suppressed at the Set value (SV) change until the Measured value (PV) has entered the non-event range.

Action condition	Hold action	Re-hold action
When the power is turned on	Works	Works
When transferred from STOP (control STOP) to RUN (control RUN)	Works	Works
When the Set value (SV) is changed	Does not work	Works

Example: When Event 1 type is the deviation low

When re-hold action is OFF and event output type is deviation, the event output is produced due to the Set value (SV) change. The re-hold action suppresses the alarm output until the measured value has entered the non-event range again.



NOTE

When high alarm with hold action/re-hold action is used for Event function, alarm does not turn on while hold action is in operation. Take measures to prevent overheating which may occur if the control device fails.

● **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Event 1 hold action	**WA**	CH1 ⋮ CH16	0380 ⋮ 038F	RKC communication 0 to 3 The Event hold action type is assigned as a bit image in binary numbers. Transmission data from the SRJ is replaced with ASCII code in decimal number Bit 0: with/without hold function Bit 1: with/without re-hold function Bit 2 to Bit 7: Unused Data 0: None 1: Supplied Modbus 0: Hold action OFF 1: Hold action ON 2: Re-hold action ON 3: Hold action ON+Re-hold action ON	If the Event type is specified by the initial setting code when ordering, the factory set value of Event hold action differs depending on the Event type. If the Event type is not specified: 1
Event 2 hold action	**WB**	CH1 ⋮ CH16	0390 ⋮ 039F	RKC communication 0 to 3 The Event hold action type is assigned as a bit image in binary numbers. Transmission data from the SRJ is replaced with ASCII code in decimal number Bit 0: with/without hold function Bit 1: with/without re-hold function Bit 2 to Bit 7: Unused Data 0: None 1: Supplied Modbus 0: Hold action OFF 1: Hold action ON 2: Re-hold action ON 3: Hold action ON+Re-hold action ON	If the Event type is specified by the initial setting code when ordering, the factory set value of Event hold action differs depending on the Event type. If the Event type is not specified: 1

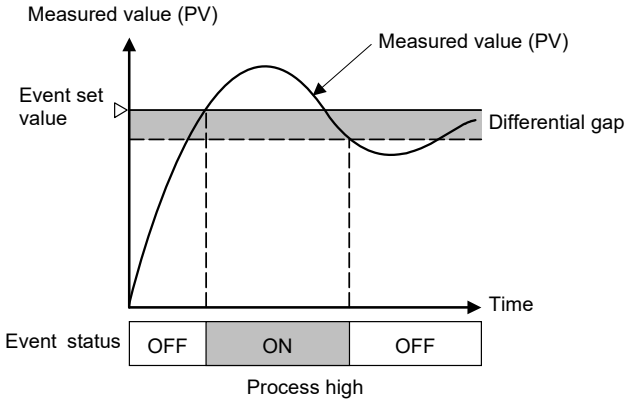
☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

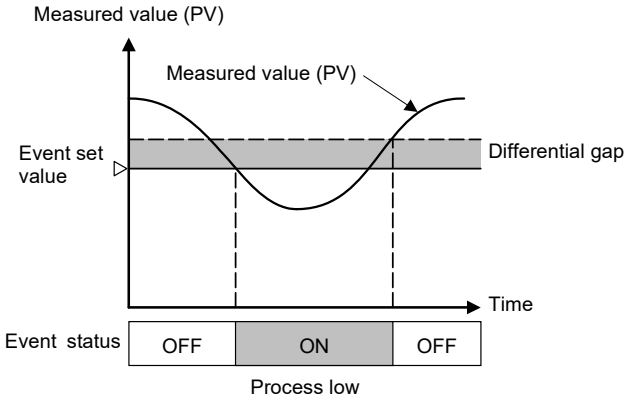
7.5.3 Setting a differential gap in event action

In this instrument, a differential gap can be set for the event operation.

■ Event differential gap

It prevents chattering of event output due to the measured value fluctuation around the Event set value.





● **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Event 1 differential gap	**HA**	CH1 ⋮ CH16	0340 ⋮ 034F	0.0 to Input span	2.0
Event 2 differential gap	**HB**	CH1 ⋮ CH16	0350 ⋮ 035F	0.0 to Input span	2.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

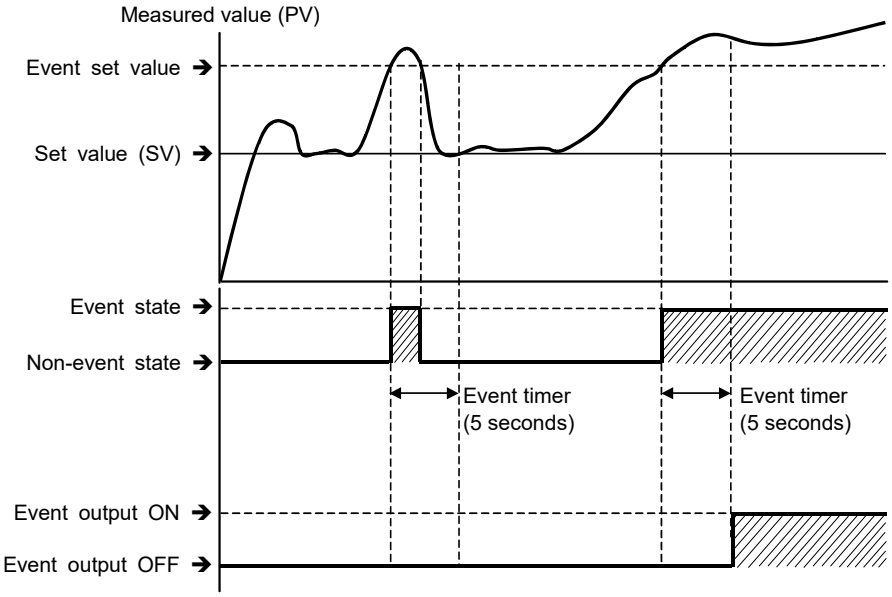
7.5.4 Preventing event from turning on due to a transient abnormal input

Event timer can be used to prevent event from turning on for the event state shorter than the set time.

■ Event timer

When an event condition becomes ON, the output is suppressed until the Event timer set time elapses. If the event output is still ON after time is up, the output will resume.

Example: When the setting of Event timer is 5 seconds



The Event timer is also activated for the following reasons:
- When set to the event state simultaneously with power turned on
- When set to the event state simultaneously with control changed to RUN (control start) from STOP (control stop)

In the event wait state, no event output is turned on even after the Event timer preset time has elapsed.

The Event timer is reset for the following reasons:
- When power failure occurs while the Event timer is being activated
- When control is changed to STOP (control stop) from RUN (control start) while the Event timer is being activated
- Cancellation of Event state

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Event timer	**DF**	CH1 ⋮ CH16	03A0 ⋮ 03AF	0 to 255 seconds	0

For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.5.5 Setting the event set value

After finishing the initial settings, set the event set values if they are used.

■ Event set value

Event set value is the set value for Event action.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Event 1 set value	**A1**	CH1 ⋮ CH16	00E0 ⋮ 00EF	• Deviation high, Deviation low –Input span to +Input span • Deviation high/low, Band 0.0 to Input span • Process high, Process low Input scale low to Input scale high (Low limit of input range to High limit of input range)	0.0
Event 2 set value	**A2**	CH1 ⋮ CH16	00F0 ⋮ 00FF	• Deviation high, Deviation low –Input span to +Input span • Deviation high/low, Band 0.0 to Input span • Process high, Process low Input scale low to Input scale high (Low limit of input range to High limit of input range)	0.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.5.6 Checking event ON state

The event ON state can be checked.

■ Event state monitor

Monitor an ON/OFF state of the event.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Event 1 state monitor	**AA**	CH1 ⋮ CH16	0020 ⋮ 002F	0: OFF 1: ON	—
Event 2 state monitor	**AB**	CH1 ⋮ CH16	0030 ⋮ 003F	0: OFF 1: ON	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.6 Control Loop Break Alarm (LBA) Function

The Control loop break alarm (LBA) function is used to detect a load (heater) break or a failure in the external actuator (power controller, magnet relay, etc.), or a failure in the control loop caused by an input (sensor) break. The LBA function is activated when control output reaches 0 % (low limit with output limit function) or 100 % (high limit with output limit function). LBA monitors variation of the Measured value (PV) for the length of LBA time. When the LBA time has elapsed and the PV is still within the alarm determination range, the LBA will be ON.

[Alarm action]

LBA determination range: 2 °C (fixed)

- **Heating control**

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

LBA function is not available:
- during Autotuning (AT).
- When the Operation mode is “0: Unused”, “1: Monitor”
- in the STOP mode.
- When the Control loop break alarm (LBA) usage selection is “0: Unused”

If the Control loop break alarm (LBA) setting time does not match the controlled object requirements, the Control loop break alarm (LBA) setting time should be lengthened. If setting time is not correct, the Control loop break alarm (LBA) will malfunction by turning on or off at inappropriate times or not turning on at all.

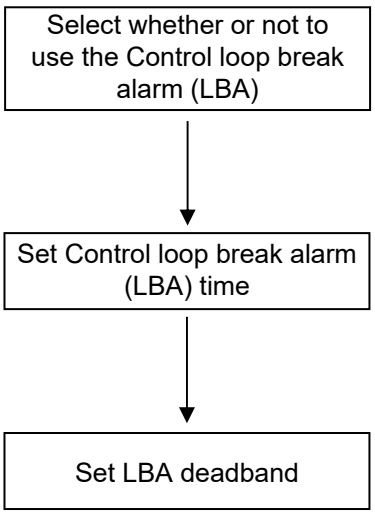
If the Autotuning (AT) is used, the Control loop break alarm (LBA) time is automatically set twice as large as the integral time. The Control loop break alarm (LBA) time will not change even if the integral time is changed.

If the Control loop break alarm (LBA) function detects an error occurring in the control loop, but cannot specify the location, the control loop should be checked. The Control loop break alarm (LBA) function does not detect the location which causes alarm status. If Control loop break alarm (LBA) alarm is ON, check each device or wiring in the control loop.

■ Setting procedure for Control loop break alarm (LBA)

Set Control loop break alarm (LBA) as follows:

📖 Control loop break alarm (LBA) operates only for the channels set to "2: Monitor + Event function" or "3: Control" at **Operation mode (P. 7-36)**.



Select whether or not to use the Control loop break alarm (LBA) under **Control loop break alarm (LBA) usage selection**.
Setting range: 0: Unused
1: Used

☞ Refer to ■ **Control loop break alarm (LBA) usage selection (P. 7-26)**.

Set the time of Control loop break alarm (LBA) at **Control loop break alarm (LBA) time**.
Setting range: 1 to 7200 seconds

☞ Refer to ■ **Control loop break alarm (LBA) time (P. 7-26)**.

Set the deadband of LBA at **LBA deadband**.
Setting range: 0.0 to Input span

☞ Refer to ■ **LBA deadband (LBD) (P. 7-27)**.

7.6.1 Using control loop break alarm (LBA)

You can set the time period for monitoring whether or not to use the Control loop break alarm (LBA), and the amount of change in the Measured value (PV).

■ Control loop break alarm (LBA) usage selection

Select whether or not to use the Control loop break alarm (LBA).

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Control loop break alarm (LBA) usage selection	**HP**	CH1 ⋮ CH16	0250 ⋮ 025F	0: Unused 1: Used	0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Control loop break alarm (LBA) time

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

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Control loop break alarm (LBA) time	**C6**	CH1 ⋮ CH16	0260 ⋮ 026F	1 to 7200 seconds	480

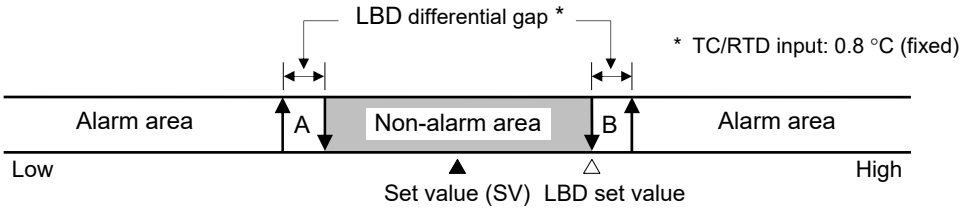
☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.6.2 Setting an area where the control loop break alarm (LBA) state does not occur

You can set an area (LBA dead band) where the Control loop break alarm (LBA) state does not occur in this instrument.

■ LBA deadband (LBD)

The Control loop break alarm (LBA) may malfunction due to external disturbances. To prevent malfunction due to external disturbance, LBA deadband (LBD) sets a neutral zone in which Control loop break alarm (LBA) is not activated. When the Measured value (PV) is within the LBA deadband (LBD) area, Control loop break alarm (LBA) will not be activated. If the LBA deadband (LBD) setting is not correct, the LBA will not work correctly.



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

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
LBA deadband (LBD)	**V2**	CH1 ⋮ CH16	0270 ⋮ 027F	0.0 to Input span	0.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.6.3 Checking the control loop break alarm (LBA) ON state

You can check the Control loop break alarm (LBA) ON state.

■ Control loop break alarm (LBA) state monitor

Monitor the ON/OFF state of the Control loop break alarm (LBA).

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Control loop break alarm (LBA) state monitor	**AP**	CH1 ⋮ CH16	0040 ⋮ 004F	0: OFF 1: ON	—

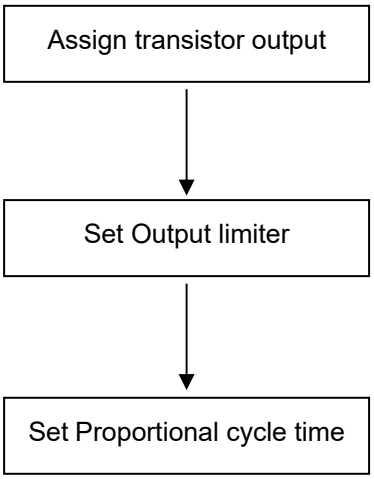
☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.7 Output Function

■ Setting procedure of the data related to Output

To set the data related to Output, follow the procedure below.

📖 Output operates only for the channels set to “3: Control” at **Operation mode (P. 7-36)**.



If you use a transistor output for external SSR driving, the temperature input channels are assigned by transistor output selection.

☞ Refer to ■ **Transistor output selection (P. 7-29)**.

Set the output limiter upper limit/lower limit, if necessary.

☞ Refer to ■ **Output limiter high/low (P. 7-32)**.

Set the proportional cycle time [heat-side], if necessary.

☞ Refer to ■ **Proportional cycle time [heat-side] (P. 7-33)**.

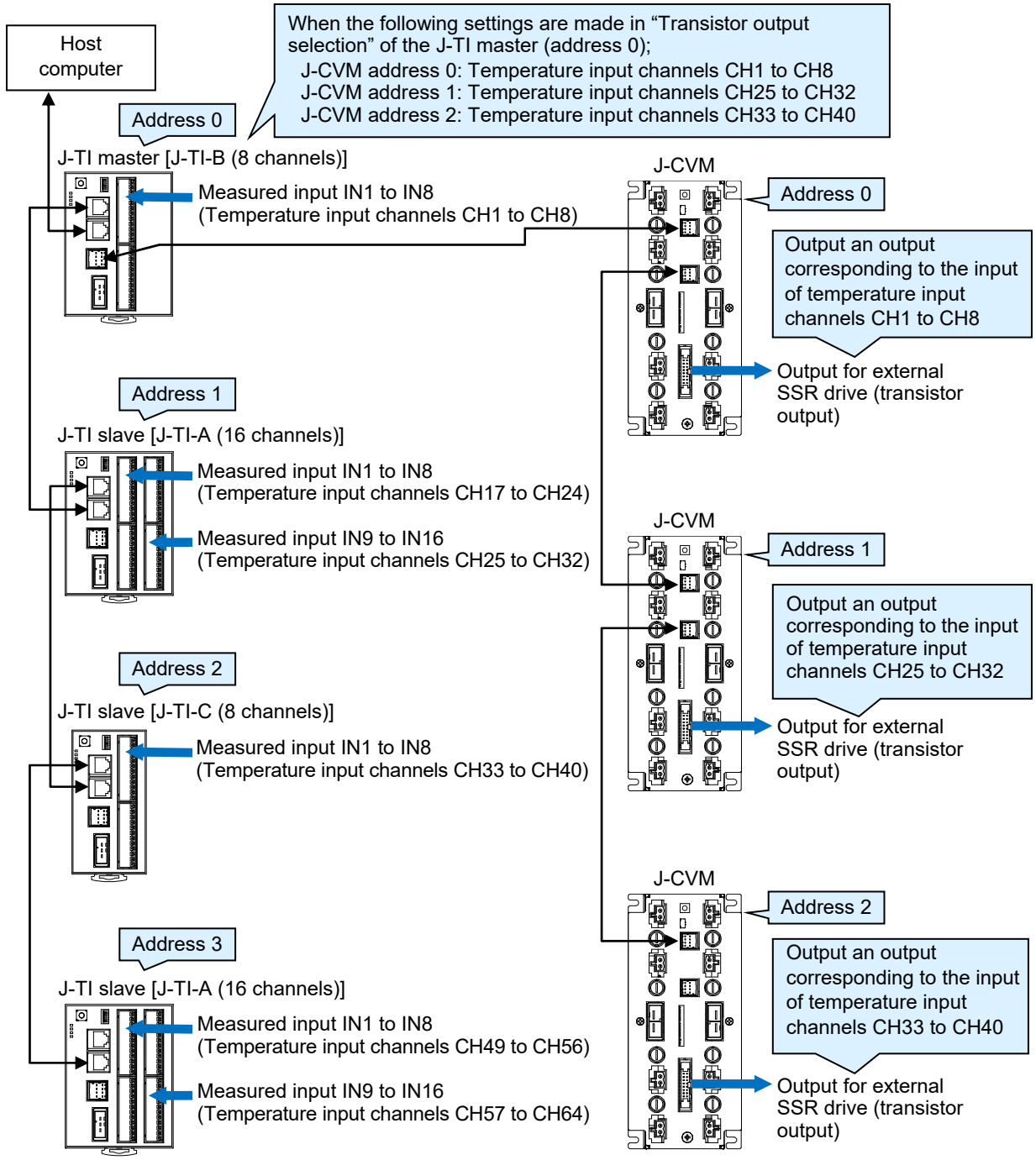
7.7.1 Using a transistor output for driving an external SSR

You can output a transistor output for driving an external SSR from a transistor output for external SSR drive connector (CN3) of the J-CVM.

■ Transistor output selection

The temperature input channels of the J-TI are assigned to the transistor output for external SSR drive of the J-CVM. The transistor output for external SSR drive can be used by assigning the temperature input channels.

Example: When three J-TI slaves and three J-CVMs are connected to a J-TI master (address 0)



● Communication data

Transistor output selection setting are only effective for CH1 to CH8 of the J-TI master. Settings made on channels other than CH1 to CH8 of the J-TI master are ignored.
CH1 to CH8 of the J-TI master correspond to address 0 to 7 of the J-CVM.
For the J-TI master, refer to **3.4.3 Communication address setting [J-TI] (P. 3-24)**.

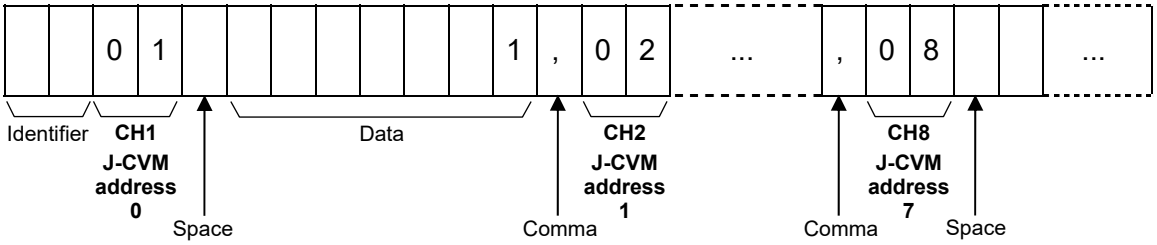
Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Transistor output selection	**VP**	CH1 ⋮ CH16	0280 ⋮ 028F	0 No assignment 1: CH1 to CH8 2: CH9 to CH16 * 3: CH17 to CH24 4: CH25 to CH32 * 5: CH33 to CH40 6: CH41 to CH48 * 7: CH49 to CH56 8: CH57 to CH64 * * Assignable only for the J-TI-A	0

For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

CH1 to CH8 of transistor output selection correspond to address 0 to 7 of the J-CVM.

• RKC communication

Data length 7 digits



• Modbus

Modbus register address (HEX)	Channel number of J-TI master	Address of J-CVM
0280	CH1	Address 0
0281	CH2	Address 1
0282	CH3	Address 2
0283	CH4	Address 3
0284	CH5	Address 4
0285	CH6	Address 5
0286	CH7	Address 6
0287	CH8	Address 7
0288 to 028F	CH9 to CH16	Ignored even if set

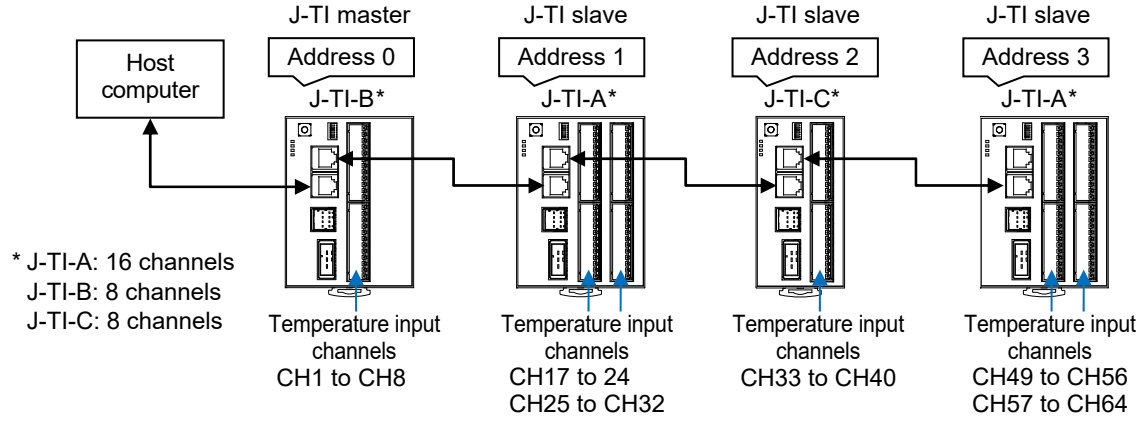
- **Assignment record table set by the customer (serves as a duplicate copy when data is initialized.)**

Address of J-CVM	J-TI temperature input channel numbers corresponding to heater outputs 1 to 8 of the J-CVM	User setting value J-TI temperature input channel numbers assigned to the transistor output for external SSR drive connector (CN3) of the J-CVM
Address 0	CH1 to CH8	
Address 1	CH9 to CH16	
Address 2	CH17 to CH24	
Address 3	CH25 to CH32	
Address 4	CH33 to CH40	
Address 5	CH41 to CH48	
Address 6	CH49 to CH56	
Address 7	CH57 to CH64	

☞ Assignment of J-TI temperature input channel numbers corresponding to heater outputs 1 to 8 is performed by the address setting switch. For details, refer to **3.5.1 Address setting (assignment of temperature input channels) [J-CVM] (P. 3-35)**.

🕮 Temperature input channel number is automatically assigned in order of smaller communication address number of J-TI.

Example: When three J-TI slaves are connected to a single J-TI master (address 0)

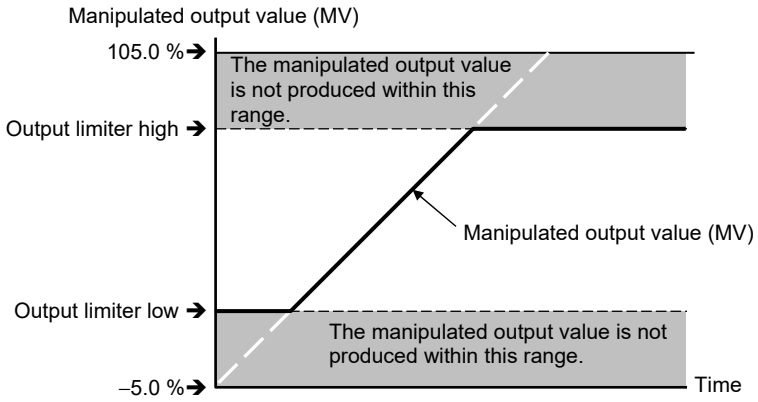


7.7.2 Limiting Output

Use output limiter to limit the output.

■ Output limiter high/low

This is the function which restricts the high and low limits of Manipulated output values (MV).



Output limiter is also effective in ON/OFF control.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Output limiter high [heat-side]	**OH**	CH1 ⋮ CH16	0140 ⋮ 014F	Output limiter low [heat-side]+1 digit to +105.0 %	100.0
Output limiter low [heat-side]	**OL**	CH1 ⋮ CH16	0150 ⋮ 015F	–5.0 % to Output limiter high [heat-side]–1 digit	0.0

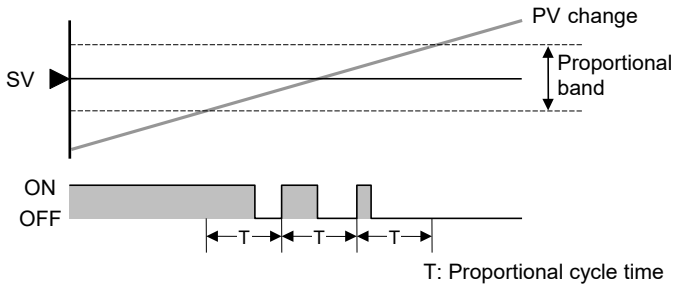
For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.7.3 Changing proportional cycle time

In the time-proportional operation, you can change a constant cycle of turning the Manipulated output value (MV) ON/OFF when the Measured value (PV) is within the range of the Proportional band.

■ Proportional cycle time [heat-side]

Manipulated output value turns ON and OFF in a certain cycle (Proportional cycle time) when the Measured value (PV) reaches within the Proportional band at Time proportioning action. More precise control can be achieved by shortening Proportional cycle time, however, the life of operating unit (Relay etc.) can be shortened based on the feature of the specific controlled object.



● Communication data

Proportional cycle time [heat-side] settings are only effective for CH1 of the J-TI master. Settings made on channels other than CH1 of the J-TI master are ignored.
For the J-TI master, refer to **3.4.3 Communication address setting [J-TI] (P. 3-24)**.

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Proportional cycle time [heat-side]	**T0**	CH1 ⋮ CH16	0160 ⋮ 016F	1 to 100 seconds	2

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.7.4 Checking the manipulated value (MV)

The manipulated value can be checked.

■ Manipulated output value monitor [heat-side]

Heat-side output value during PID control.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Manipulated output value monitor [heat-side]	**O1**	CH1 ⋮ CH16	0050 ⋮ 005F	–5.0 to +105.0 %	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.8 Control Function

7.8.1 Running/Stopping control (RUN/STOP transfer)

You can select whether to start (RUN) or stop (STOP) control.
The factory set value is RUN. As soon as the controller is powered on, control is started.

■ State of the instrument when it is set to STOP (control stop) or RUN (control start)

☞ For details on the instrument state in each operation mode (unused, monitor, monitor + event function, control) as seen from the RUN/STOP state, refer to **7.8.2 Changing the operation mode (Unused, Monitor, Monitor + Event function, Control) (P. 7-35)**.

● STOP (Control stop)

Control output	Manipulated output value (MV) OFF (0 %) • J-CVM heater output OFF • Transistor output for external SSR drive of J-CVM OFF
Autotuning	AT canceled (PID constants are not updated.)

● RUN (Control start)

Operation when transferred to RUN from STOP is in accordance with the Hot/Cold start selection setting.

☞ For the Hot/Cold start, refer to ■ **Hot/Cold start (P. 7-52)** in **7.8.9 Changing the action at power ON (Hot/Cold start, Operation mode holding setting)**.

■ RUN/STOP transfer

Use to transfer the RUN (control RUN) or STOP (control STOP).

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
RUN/STOP transfer	**SR**	—	01A0	0: STOP (Control stop) 1: RUN (Control start)	1

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.8.2 Changing the operation mode (Unused, Monitor, Monitor + Event function, Control)

This mode is used to select "Unused," "Monitor," "Monitor + Event function," or "Control" for each channel.

Operation mode

Set value	Operation mode	Contents
0	Unused	Neither monitor nor control is performed. Communication data other than the operation mode is disabled.
1	Monitor	Only data monitor is performed.
2	Monitor + Event function	Data monitor and event action (including LBA) are performed.
3	Control	Control is performed. [Factory set value]

📖 Whether or not to hold the operation mode state before power OFF at power ON or while recovering from power failure can be selected from the operation mode holding setting.
For the operation mode holding setting, refer to ■ **Operation mode holding setting (P. 7-54)** in **7.8.9 Changing the action at power ON (Hot/Cold start, Operation mode holding setting)**.

■ Instrument action states in each operation mode from the RUN/STOP state

RUN/STOP state	Instrument action	Operation mode (Factory set value: Control)			
		Unused	Monitor	Monitor + Event function	Control
RUN	Monitor of Measured value (PV)	"0" is displayed	PV is displayed		
	Event function	Event function disabled		Event function enabled	
	Control output	Output OFF (0 %)			Computed control output value
STOP	Monitor of Measured value (PV)	"0" is displayed	PV is displayed		
	Event function	Event function disabled			
	Control output	Output OFF (0 %)			

RUN: Control start STOP: Control stop

☞ For the RUN/STOP, refer to **7.8.1 Running/Stopping control (RUN/STOP transfer) (P. 7-34)**.

Instrument action states depending on the operation mode and RUN/STOP switching

Operation mode	RUN/STOP state	Instrument action state	
Monitor + Event function	STOP ↓ RUN	Event function	Action conforming to the setting of **Event hold action (P. 7-20)** *
Control	STOP ↓ RUN	Event function	Action conforming to the setting of **Event hold action (P. 7-20)** *1
		Control output	Output an output value in accordance with the following communication data settings • **Hot/Cold start (P. 7-52)** • **Start determination point (P. 7-53)**
Unused or Monitor ↓ Monitor + Event function	RUN	Event function	Action conforming to the setting of **Event hold action (P. 7-20)** *
		Control output	Output an output value in accordance with the following communication data settings • **Hot/Cold start (P. 7-52)** • **Start determination point (P. 7-53)**
Unused or Monitor ↓ Control	RUN	Event function	Action conforming to the setting of **Event hold action (P. 7-20)** *
Monitor + Event function ↓ Control	RUN	Control output	Output an output value in accordance with the following communication data settings • **Hot/Cold start (P. 7-52)** • **Start determination point (P. 7-53)**

* Since the Control loop break alarm (LBA) does not have a hold action, an action in accordance with the event type is performed.

■ Operation mode

Use to select the operation mode.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Operation mode	**EI**	CH1 ⋮ CH16	0100 ⋮ 010F	0: Unused (Neither monitor nor control is performed.) 1: Monitor (Only data monitor is performed.) 2: Monitor + Event function (Data monitor and event action [including LBA] are performed.) 3: Control (Control is performed.)	3

For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.8.3 Changing the action type of PID control (Direct action/Reverse action)

Brilliant II PID control is used as the PID control in this instrument. There are two types of actions of PID control, which can be changed.

- PID control (Direct action)
- PID control (Reverse action)

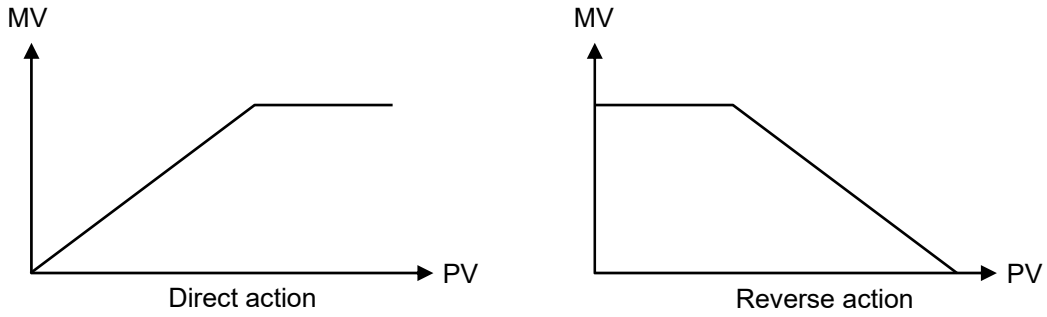
☞ In addition to PID control, ON/OFF action is performed as the control action of this instrument. For ON/OFF action, refer to **7.8.7 Controlling with ON/OFF action (P. 7-48)**.

● PID control (Direct action)

The Manipulated output value (MV) increases as the Measured value (PV) increases.
This action is used generally for cooling control.

● PID control (Reverse action)

The Manipulated output value (MV) decreases as the Measured value (PV) increases.
This action is used generally for heating control.



■ Control action

Use to select the control action type.

● Communication data

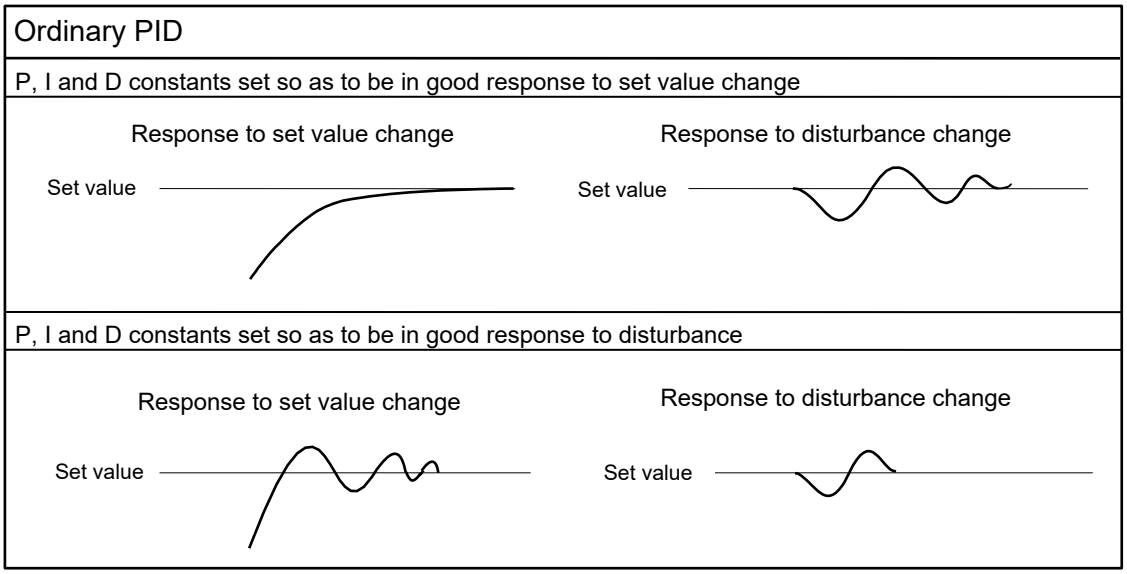
Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Control action	**XE**	CH1 ⋮ CH16	0330 ⋮ 033F	0: Brilliant II PID control (direct action) 1: Brilliant II PID control (reverse action)	1

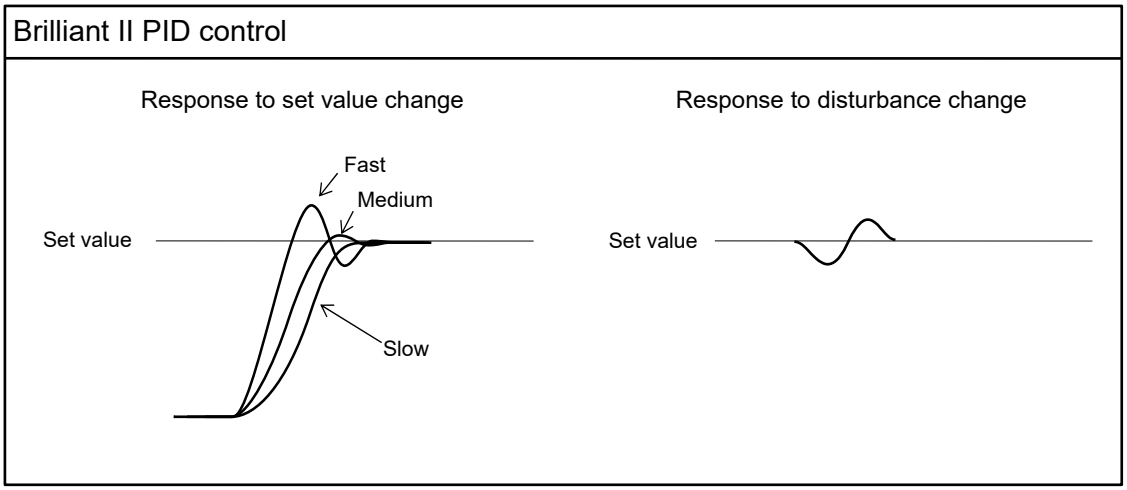
☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Brilliant II PID control

PID control is a control method of achieving stabilized control result by setting P (Proportional band), I (Integral time) and D (Derivative time) constants, and is widely used. However, with this PID control, if P, I and D values are set to focus on "better response to control set value change," "response to external disturbance" deteriorates. In contrast, if PID values are set to focus on "better response to external disturbance," "response to control set value change" deteriorates.

In brilliant II PID control a form of "Response to setting" can be selected from among **Fast**, **Medium** and **Slow** with PID constants remaining unchanged so as to be in good "Response to disturbances."

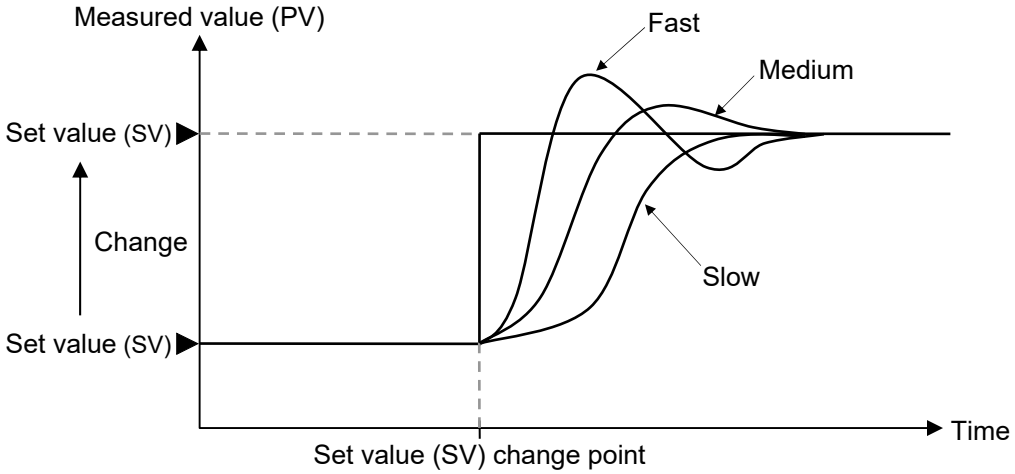




7.8.4 Changing the control response parameter

In brilliant II PID control a form of "Response to setting" can be selected from among **Fast**, **Medium** and **Slow** with PID constants remaining unchanged so as to be in good "Response to disturbances."
Select "Fast" to quicken the response of the controlled object to the change in Set value (SV). When the response speed level is "Fast," overshoot will occur. To avoid overshoot, select "Slow."

Fast	Selected when rise time needs to be shortened (operation needs to started fast). However in this case, slight overshooting may not be avoided.
Medium	Middle between "Fast" and "Slow." Overshooting when set to "Medium" becomes less than that when set to "Fast."
Slow	Selected when no overshooting is allowed. Used when material may be deteriorated if the temperature becomes higher that the set value.



When the P or PD action is selected, this setting becomes invalid.

■ Control response parameter

Use to select the Control response parameter.

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Control response parameter	**CA**	CH1 ⋮ CH16	00C0 ⋮ 00CF	0: Slow 1: Medium 2: Fast [When the P or PD action is selected, this setting becomes invalid]	2

For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.8.5 Setting PID values automatically (Autotuning)

The Autotuning (AT) automatically measures, computes and sets the optimum PID values. The Autotuning (AT) can be used for PID control.

Communication data computed by Autotuning (AT):

- Proportional band (P)
- Integral time (I)
- Derivative time (D)
- Control loop break alarm (LBA) time (The LBA time is automatically set to twice the value of the Integral time)

■ Caution for using the Autotuning (AT)

When a temperature change (UP and/or Down) is 1 °C or less per minute during Autotuning (AT), Autotuning (AT) may not be finished normally. In that case, adjust the PID values manually. Manual setting of PID values may also be necessary if the set value is around the ambient temperature or is close to the maximum temperature achieved by the load.

■ Requirements for Autotuning (AT) start

Start the Autotuning (AT) when all following conditions are satisfied:
The Autotuning (AT) function can start from any state after power on, during a rise in temperature or in stable control.

Operation state	RUN/STOP transfer	RUN
	Auto/Manual transfer	Auto mode
	Autotuning (AT) setting	PID control (State before starting AT)
	Operation mode setting	Control
Communication data setting	Output limiter high ≥ 0.0 %, Output limiter low ≤ 100.0 %	
Input value state	The Measured value (PV) is not underscale or over-scale.	
	The Measured value (PV) is not inside the Input error range. [Input error range: Input error determination point (high) ≥ Measured value (PV), Input error determination point (low) ≤ Measured value (PV)]	

■ Requirements for Autotuning (AT) cancellation

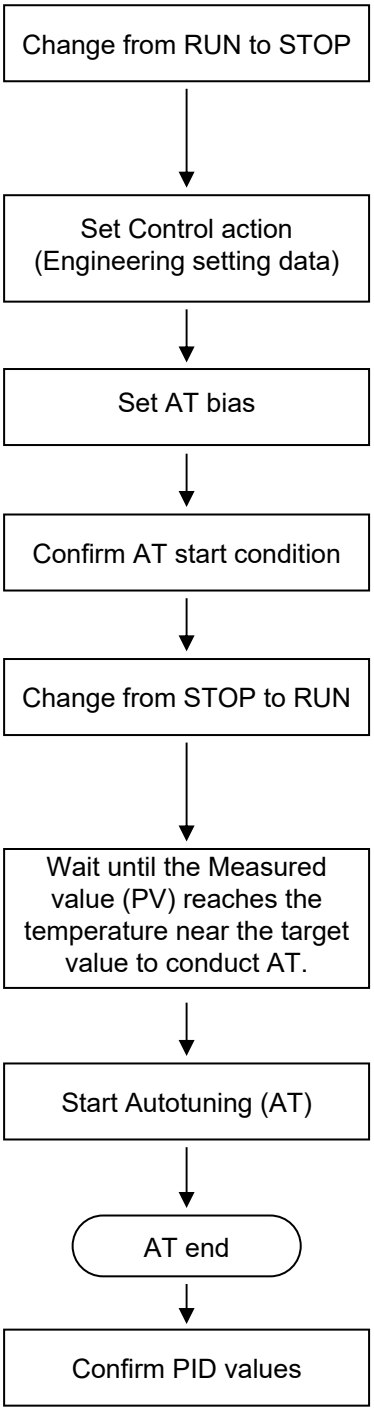
If the Autotuning (AT) is canceled according to any of the following conditions, the controller immediately changes to PID control. The PID values will be the same as before Autotuning (AT) was activated.

Cancellation due to settings change	When the RUN/STOP mode is changed to the STOP mode.
	When the PID/AT transfer is changed to the PID control.
	When the Auto/Manual mode is changed to the Manual mode.
	When changed to unused, monitor, or the monitor + event function.
	When the Set value (SV) is changed.
	When the PV bias, PV ratio, or PV digital filter is changed.
	When the AT bias is changed.
	When the Output limiter high or low is changed.
Cancellation due to an input error	When the Measured value (PV) goes to underscale or over-scale.
	When the Measured value (PV) has entered the Input error range. [Input error range: Input error determination point (high) ≥ Measured value (PV), Input error determination point (low) ≤ Measured value (PV)]
Cancellation due to a timeout	Output state has not been changed (ON to OFF, OFF to ON) for more than two hours.
Power failure	When the power failure lasts more than 20 ms.
Instrument error	When the instrument is in FAIL state.

■ Operation procedure of Autotuning (AT)

Refer to the operation procedure below for Autotuning (AT).

📖 Autotuning (AT) can be conducted for only the channel set to "3: control" at **Operation mode (P. 7-36)**.



Change the setting to "0: STOP (Control stop)" by **RUN/STOP transfer**.
Setting range: 0: STOP (Control stop)
1: RUN (Control start)

☞ Refer to ■ **RUN/STOP transfer (P. 7-34)**.

Set the data required for control such as Control action.

☞ Refer to ■ **Control action (P. 7-37)**.

☞ Refer to ■ **Control response parameter (P. 7-39)**.

Set the AT bias based on requirement.

☞ Refer to ■ **AT bias (P. 7-42)**.

Confirm the AT start condition.

☞ Refer to ■ **Requirements for Autotuning (AT) start (P. 7-40)**.

Change the setting to "1: RUN (Control start)" by **RUN/STOP transfer**.
Setting range: 0: STOP (Control stop)
1: RUN (Control start)

☞ Refer to ■ **RUN/STOP transfer (P. 7-34)**.

The Autotuning (AT) can be executed when the Measured value (PV) reaches a temperature near the target value.

Set to "1: Start Autotuning (AT)" at **Autotuning (AT)**. Then start Autotuning (AT). The setting of **Autotuning (AT)** is automatically returned to "0: PID control" when PID values are calculated and set.

☞ Refer to ■ **Autotuning (AT) (P. 7-43)**.

Confirm the PID values computed by Autotuning.
If PID values are not correct for the application, adjust the values manually.

☞ Refer to ■ **Proportional band [heat-side] (P. 7-47)**.

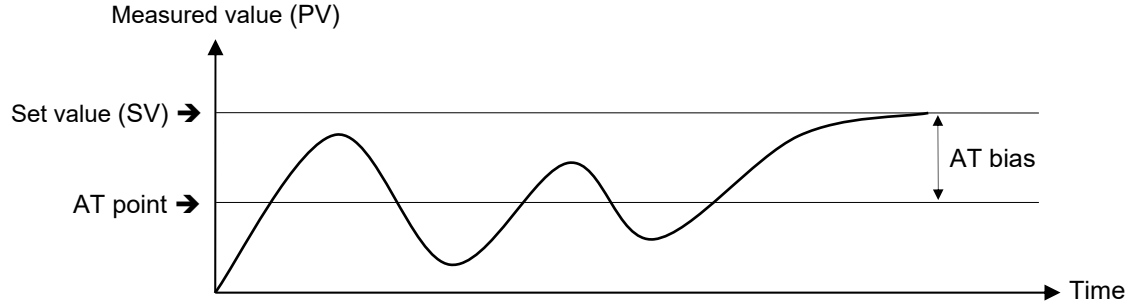
☞ Refer to ■ **Integral time [heat-side] (P. 7-47)**.

☞ Refer to ■ **Derivative time [heat-side] (P. 7-47)**.

■ AT bias

Use to set a bias to move the set value only when Autotuning is activated.
The AT bias is used to prevent overshoot during Autotuning in the application which does not allow overshoot even during Autotuning. RKC Autotuning method uses ON/OFF control at the set value to compute the PID values. However, if overshoot is a concern during Autotuning, the desired AT bias should be set to lower the set point during Autotuning so that overshoot is prevented.

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



● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
AT bias	**GB**	CH1 ⋮ CH16	0220 ⋮ 022F	–Input span to +Input span	0.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Autotuning (AT)

You can switch between Autotuning (AT) start or stop.

📖 The Autotuning (AT) can be used for PID control (Direct action/Reverse action).

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Autotuning (AT)	**G1**	CH1 ⋮ CH16	0110 ⋮ 011F	0: PID control 1: Start Autotuning (AT) When the Autotuning (AT) is finished, the J-TI will automatically return to "0: PID control." When the Autotuning (AT) startup conditions are not satisfied: RKC communication: NAK response Modbus: Error response message Function code 3 (When a value exceeding the setting range is written)	0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Communication data computed by Autotuning (AT)

Refer to the following relevant locations for items calculated by Autotuning (AT).

Proportional band [heat-side], Integral time [heat-side], and Derivative time [heat-side]:

Refer to **7.8.6 Setting PID values manually (Proportional band, Integral time, and Derivative time) (P. 7-44)**.

Control loop break alarm (LBA) time:

Refer to **■ Control loop break alarm (LBA) time (P. 7-26)** in **7.6.1 Using control loop break alarm (LBA)**.

7.8.6 Setting PID values manually (Proportional band, Integral time, and Derivative time)

To perform PID control, communication data of PID values shown below need to be set up.
While the PID constant can be set automatically with the Autotuning (AT) function, it can also be set manually.

- Proportional band (P)
- Integral time (I)
- Derivative time (D)

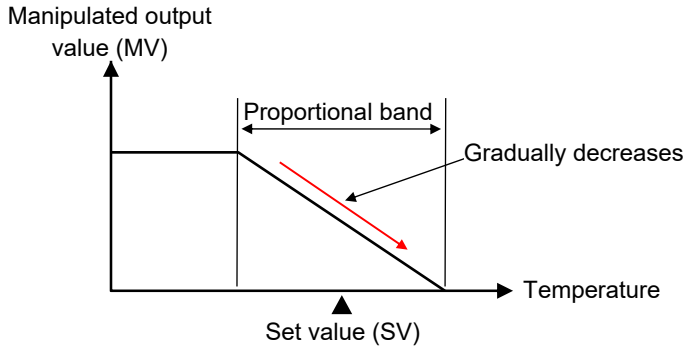
☞ For Autotuning (AT) function, refer to **7.8.5 Setting PID values automatically (Autotuning) (P. 7-40)**.

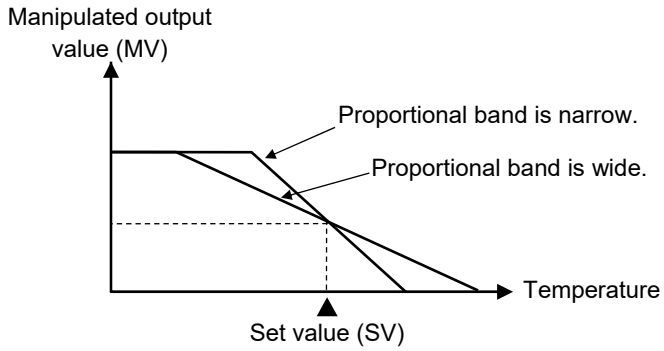
Critical parameters of PID control such as Proportional action (Proportional band: P), Integral action (Integral time: I), and Derivative action (Derivative time: D) are explained below.
Note that this explanation is based on the reverse action (heating control). With the direct action (cooling control), the output increases as the measured value increases.

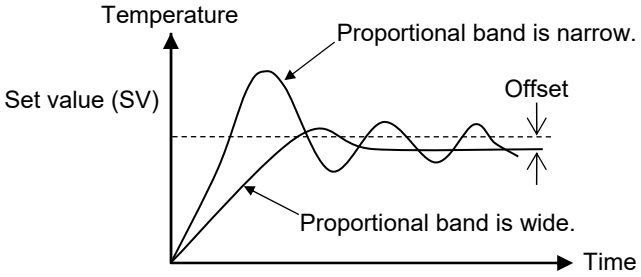
● Proportional action

In the ON/OFF control action, the manipulated output is turned on and off repeatedly, resulting in oscillatory control.
To eliminate this oscillation, control is performed by producing Manipulated output value (MV) proportional to the deviation between the Set value (SV) and the Measured value (PV).
Technically a zone called "Proportional band" is established around the Set value (SV) and when the Measured value (PV) enters the proportional band, the Manipulated output value (MV) is gradually reduced.
The Measured value (PV) stabilizes within the Proportional band at the equilibrium point, but in many cases the stabilized temperature does not match the Set value (SV).
This deviation between the Set value (SV) and the stabilized temperature is called "Offset."
With a narrower proportional band the control result becomes closer to that of the ON/OFF control (oscillatory).
With a wider proportional band the output is gradually reduced to stabilize quicker, however, often with a larger offset.

☞ For ON/OFF action, refer to **7.8.7 Controlling with ON/OFF Action (P. 7-48)**.







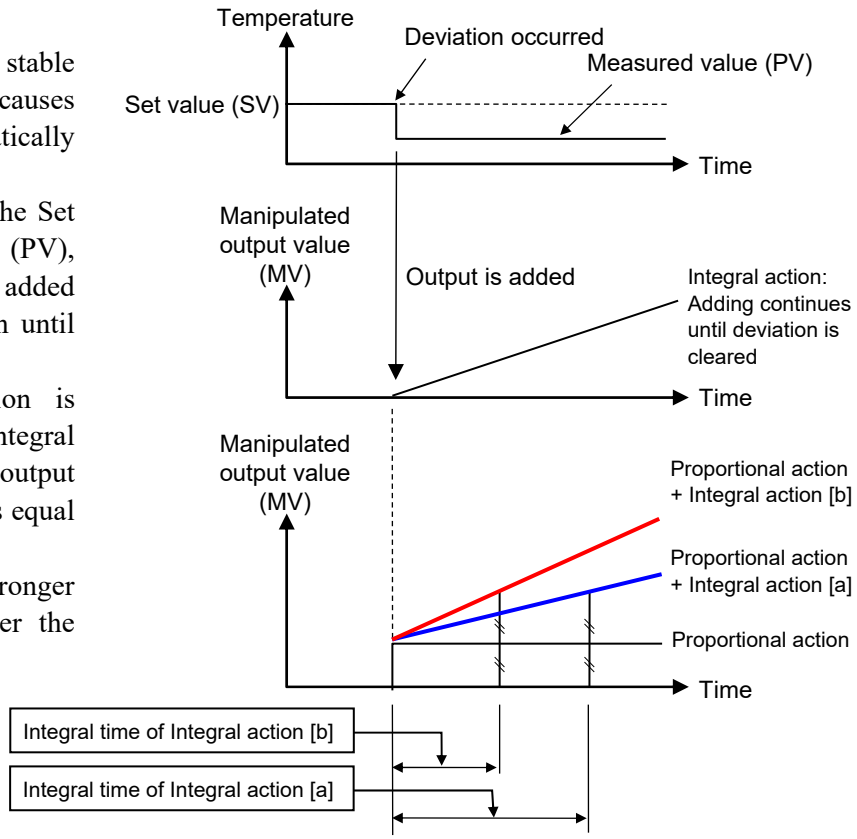
● Integral action

Proportional action provides more stable control than ON/OFF control, but causes offset. This offset can be automatically corrected by Integral action.

As long as deviation exists between the Set value (SV) and the Measured value (PV), the Manipulated output value (MV) is added according to the size of the deviation until no deviation exists.

The strength of the Integral action is expressed in the Integral time. The Integral time is the time till the Manipulated output value (MV) by the Integral action gets equal to that by the Proportional action.

The shorter the Integral time, the stronger the integral effect is, and the longer the weaker.



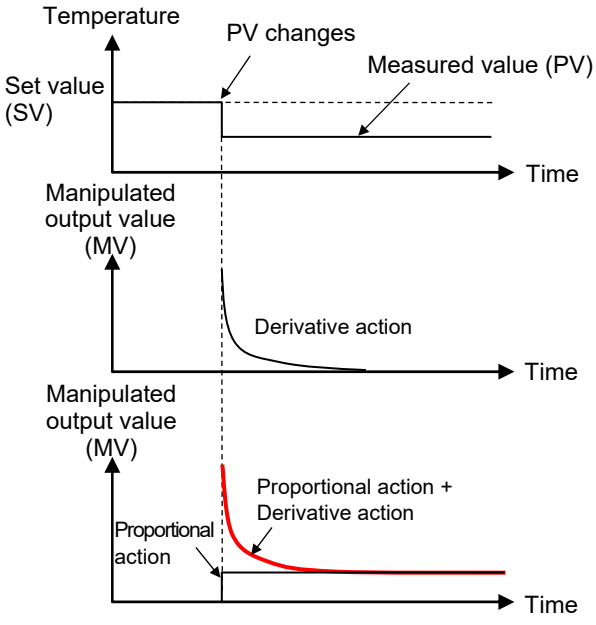
● Derivative action

The Derivative action allows the Manipulated output value (MV) proportional to the changing rate (speed) of the Measured value (PV) to be produced to prevent a fluctuation of the Measured value (PV) before it happens.

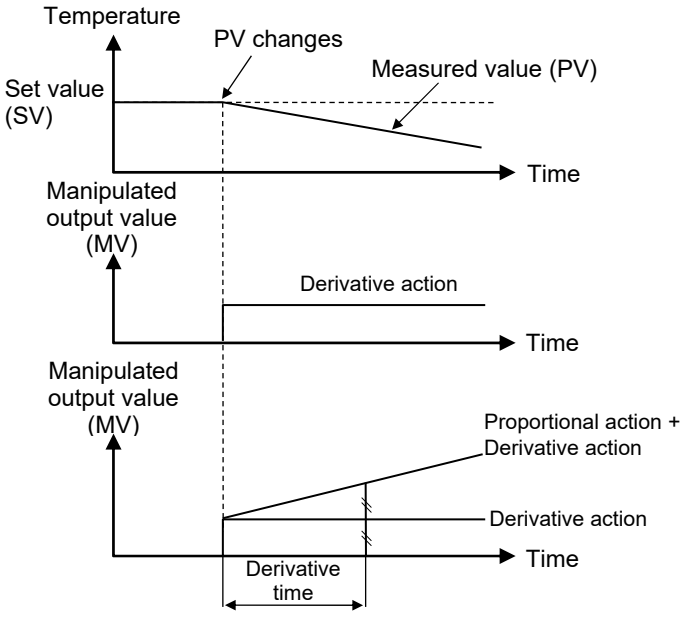
The strength of the Derivative action is expressed in the Derivative time. The Derivative time is the time until the Manipulated output value (MV) by the Proportional action gets equal to the Manipulated output value (MV) by the Derivative action when the Measured value (PV) changes at a constant rate.

The longer the Derivative time is, the stronger the Derivative effect is, and the shorter the weaker.

The Derivative effect, if set too strong, produces large Manipulated output (MV) against a small change of the Measured value (PV), thus causing hunting and resulting in unstable control.



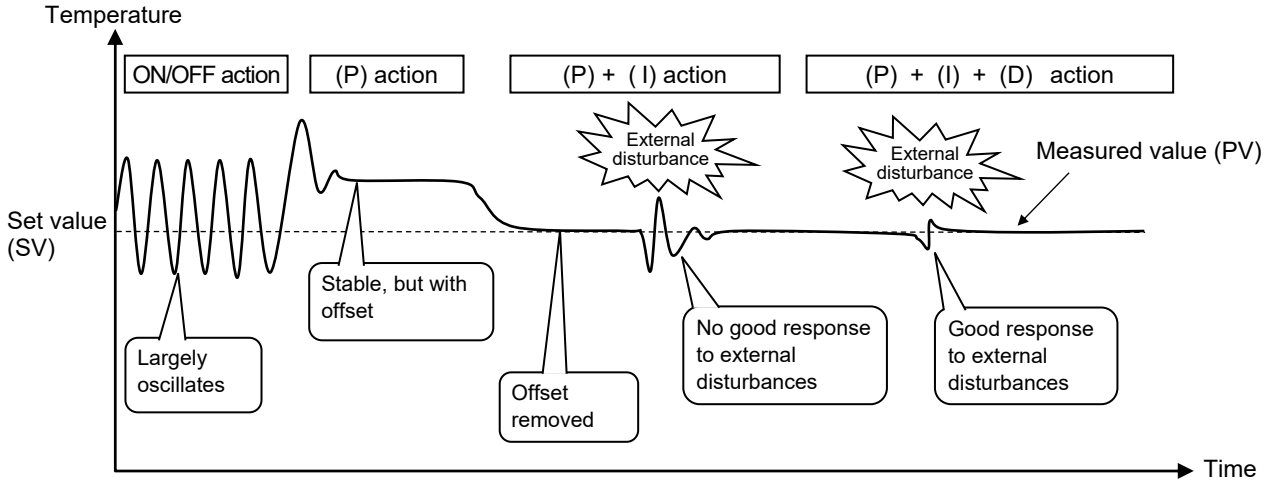
PV changes stepwise



PV gradually changes (PV changes at a constant rate)

● Outline of effect of PID

The following figure shows control behaviors under various control actions; ON/OFF control, proportional control (P), Proportional + Integral action (PI action), and Proportional + Integral + Derivative actions (PID control).



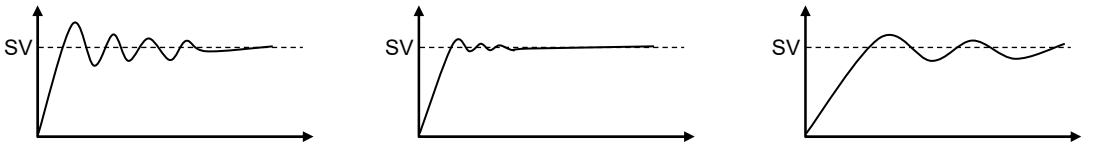
● Adjusting PID parameters (Applications controlled with PID control)

In some applications PID values calculated and obtained through Autotuning (AT) may not be appropriate. In such a case the PID values need to be adjusted manually.
Attempt this adjustment referring to the following.

The sample here shows a general tendency. Control results depend on the controlled object and combinations of control constants.

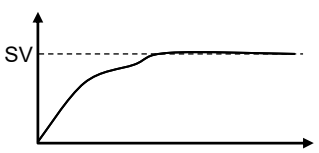
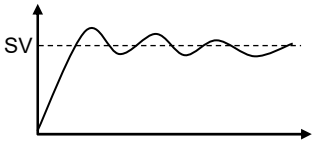
[Adjustment of Proportional band (P)]

Setting the proportional band as small as possible enables the Set value (SV) to be reached faster without overshoot. However, if the proportional band is set too narrow, it will cause hunting and the manipulated output (MV) will become oscillating.



Proportional band is set too narrow | Proportional band is appropriately set | Proportional band is set too wide

[Adjustment of Integral time (I) and Derivative time (D)]

Made larger (wider, longer)	Made smaller (narrower, shorter)
Overshoot, undershoot and hunting are suppressed. Setting the value too long may need longer time till the Set value (SV) is reached. 	Starts up quickly. Setting the value too short may cause overshoot, undershoot or hunting. 

■ Proportional band [heat-side]

Use to set the Proportional band [heat-side] of the P, PI, PD and PID control.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Proportional band [heat-side]	**P1**	CH1 ⋮ CH16	0090 ⋮ 009F	0.0 to Input span (Unit: °C) 0.0: ON/OFF control	10.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Integral time [heat-side]

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

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Integral time [heat-side]	**I1**	CH1 ⋮ CH16	00A0 ⋮ 00AF	1 to 3600 seconds	240

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Derivative time [heat-side]

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

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Derivative time [heat-side]	**D1**	CH1 ⋮ CH16	00B0 ⋮ 00BF	0 to 3600 seconds 0: PI action	60

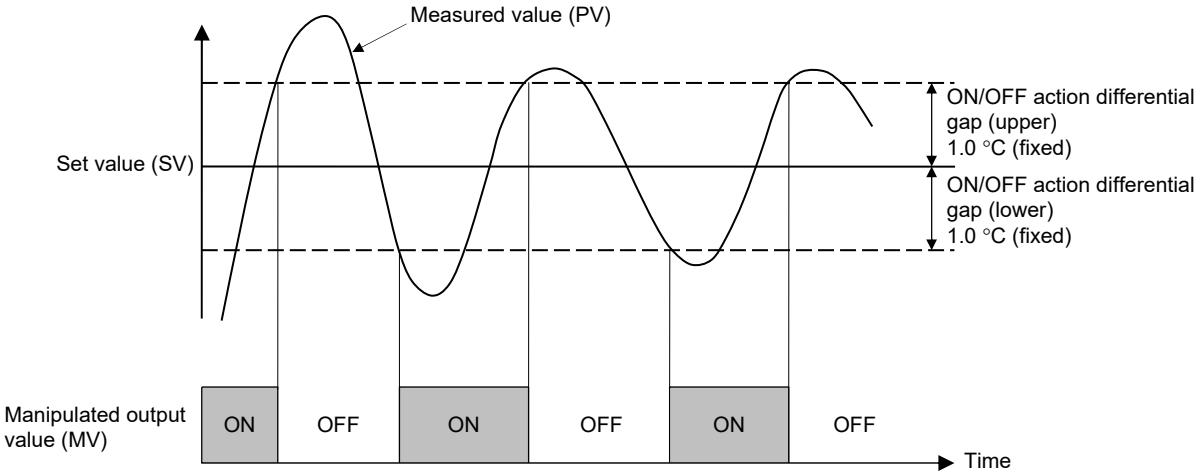
☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.8.7 Controlling with ON/OFF action

ON/OFF control is possible when the Proportional band [heat-side] is set to "0." In ON/OFF control, the Manipulated output value (MV) is turned on or off depending on the Measured value (PV) whether it is above or below the Set value (SV).

When the Measured value (PV) is above the Set value (SV), the Manipulated output value (MV) is turned OFF, and when the Measured value (PV) is below the Set value (SV), the Manipulated output value (MV) is turned ON. **To use the ON/OFF control, set the Proportional band [heat-side] to "0."**

In the ON/OFF control the output is turned on and off around the Set value (SV) and the output may be turned on and off too frequently for a small change of temperature. This is called "chattering" and may reduce the life of the output relay. In order to prevent this, an ON/OFF differential gap is set.



This explanation applies to "Reverse action" (heating control).

The value of the ON/OFF action differential gap is a deviation from the Set value (SV).
Both the upper and lower sides of the Set value (SV) are set to 1.0 °C.
When the Set value (SV) is set to 100 °C in the case of the Reverse action (heating control), the Manipulated output value (MV) turns OFF if the Measured value (PV) exceeds 101 °C, and the Manipulated output value (MV) turns ON if the Measured value (PV) falls below 99 °C.

● Cooling control with ON/OFF action

After "0: PID control (direct action)" is set at "Control action", the ON/OFF action for the Cooling side (direct action) can be controlled by setting zero to the Proportional band [heat-side]. The action is the same as above, but the ON/OFF position of the Manipulated output value (MV) becomes opposite.
The ON/OFF differential gap is also set in the same manner.

■ Proportional band [heat-side]

Use to set the Proportional band [heat-side] of the P, PI, PD and PID control. ON/OFF control is possible when the Proportional band [heat-side] is set to "0.0."

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Proportional band [heat-side]	**P1**	CH1 ⋮ CH16	0090 ⋮ 009F	0.0 to Input span (Unit: °C) 0.0: ON/OFF control	10.0

For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.8.8 Controlling with manual control

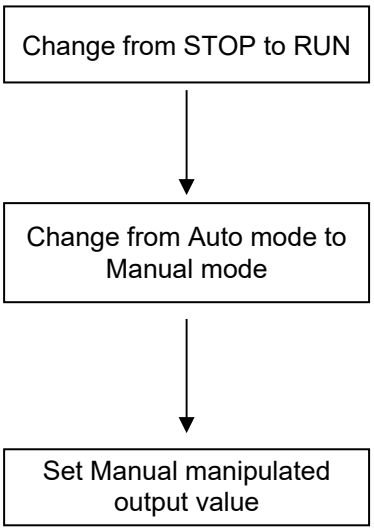
To conduct the Manual control, you need to select the Manual mode using the Auto/Manual transfer. When you switch to the manual mode, you can change the manipulated output value * manually.

* Manual manipulated output value
(RKC communication identifier: ON, Modbus register address: 0130H to 013FH)

■ Setting procedure of the data related to Auto/Manual transfer

To set the data related to Auto/Manual transfer, follow the procedure below.

Auto/Manual transfer operates only for the channels set to "3: Control" at **Operation mode (P. 7-36)**.



Change the setting to "1: RUN (Control start)" by **RUN/STOP transfer**.
Setting range: 0: STOP (Control stop)
1: RUN (Control start)

☞ Refer to ■ **RUN/STOP transfer (P. 7-34)**.

Change the setting to "1: Manual mode" by **Auto/Manual transfer**.
Setting range: 0: Auto mode
1: Manual mode

☞ Refer to ■ **Auto/Manual transfer (P. 7-50)**.

Set the output value of the manual control at **Manual manipulated output value**.
Setting range: –5.0 to +105.0 %

☞ Refer to ■ **Manual manipulated output value (P. 7-51)**.

■ Auto/Manual transfer

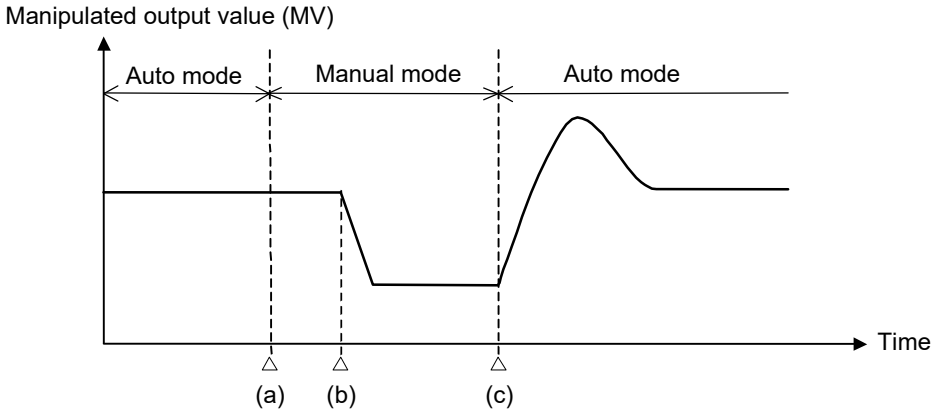
Use to transfer the Auto mode or Manual mode.

Auto mode: Automatic control is performed.

Manual mode: The manipulated output value * can be manually changed.
* Manual manipulated output value
(RKC communication identifier: ON, Modbus register address: 0130H to 013FH)

● Balanceless/bumpless function

This function is used to prevent overload caused by the Manipulated output value (MV) suddenly changing when Auto mode is transferred to Manual mode and vice versa.



(a) Transfer from Auto mode to Manual mode.
When the mode is transferred to Manual mode, the Manipulated output value used in Auto mode will be used as the manual output value in Manual mode.

(b) The manipulated output value is changed (Manual mode function).

(c) Transfer from Manual mode to Auto mode.
When the mode is transferred to Auto mode, the controller starts PID control based on the MV used in Manual mode.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Auto/Manual transfer	**J1**	CH1 ⋮ CH16	0120 ⋮ 012F	0: Auto mode 1: Manual mode	0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Manual manipulated output value

Use to set the output value in the Manual control. In the Manual mode, the Manipulated output value (MV) can be manually set.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Manual manipulated output value	**ON**	CH1 ⋮ CH16	0130 ⋮ 013F	−5.0 to +105.0 % When "Running" is set in the Auto mode: RKC communication: NAK response Modbus: Normal response (Same action as writing to RO)	0.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.8.9 Changing the action at power ON (Hot/Cold start, Operation mode holding setting)

When restarting following a power failure (power OFF from ON), the start action can be selected by the following communication data:

– Hot/Cold start
– Start determination point
– Operation mode holding setting

■ Hot/Cold start

The control start mode at power recovery after more than 20 ms power failure can be selected as follows. The operation of this instrument is not affected by a power failure of 20 ms or less.

Action when power failure recovers	Operation mode when power failure recovers (Auto/Manual)	Output value when power failure recovers	
Hot start 1	Same as that before power failure	Near the output value before power failure occurs	
Hot start 2	Same as that before power failure	Auto mode	Computed control output value (The result of control computation varies with the control response parameter.)
		Manual mode	Output limiter low
Cold start	Manual mode	Output limiter low	

Factory set value: Hot start 1

📖 When setting to "1: RUN (Control start)" by RUN/STOP transfer, the action of the channels set to "3: Control" at **Operation mode** is based on the Start mode selected at Hot/Cold start.

● Communication data

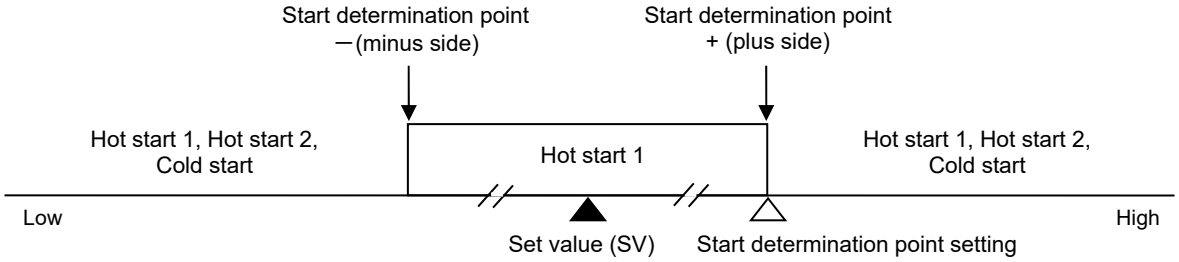
Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Hot/Cold start	**XN**	CH1 ⋮ CH16	0180 ⋮ 018F	0: Hot start 1 1: Hot start 2 2: Cold start	1

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Start determination point

Determination point of Hot start 1 is set.
Determination point of start is a deviation setting from the Set value (SV).

- The start state is determined according to the Measured value (PV) level [deviation from set value] at power recovery.
- When a Measured value (PV) is between the determination points on the + (plus) and − (minus) sides, always started from Hot start 1 when recovered.
- When a Measured value (PV) is out of the determination points or the Start determination point is set at "0," operation starts from any start state selected by Hot/Cold start.



● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Start determination point	**SX**	CH1 ⋮ CH16	0190 ⋮ 019F	0.0 to Input span 0.0: Operation starts from any start state selected by Hot/Cold start	0.0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Operation mode holding setting

Set whether or not to hold the Operation mode (unused, monitor, monitor + event function, control) state before power OFF at power ON or while recovering from power failure.

Control RUN/STOP hold setting	Operation mode state at power ON or recovering from power failure	Output value when power failure recovers
Not holding	Start with monitor	Manipulated output value at STOP mode
Holding	Start with the operation mode state (unused, monitor, monitor + event function, or control) before power OFF or power failure.	The output value produced is based on the settings of the following communication data: • **Hot/Cold start** • **Start determination point**

Factory set value: Holding

☞ For the Operation mode, refer to **7.8.2 Changing the operation mode (Unused, Monitor, Monitor + Event function, Control) (P. 7-35)**.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Operation mode holding setting	**X2**	—	03C0	0: Not holding Initialize the operation mode to "1: Monitor" 1: Holding	1

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.9 Communication Function

You can change the communication protocol, communication speed, and interval time.

NOTE

Note that if you carelessly change the setting of the communication protocol and communication speed, you may not be able to perform communication. If you are not able to perform communication, match the setting of the host computer with the setting of the J-TI.

☞ If you cannot perform communication, refer to **7.9.2 Checking the communication protocol and communication speed by indication lamps (P. 7-57)** for details on the method of checking the J-TI communication protocol and communication speed.

7.9.1 Changing the communication protocol and the communication speed

You can change the communication protocol and communication speed.

■ Communication protocol selection

Use to select the communication protocol type.

NOTE

The set data is enabled by turning OFF the power and then turning it ON again.

NOTE

Set the communication protocol to the same value as the host computer to be connected. Moreover, to connect and use several J-TIs on the same line, make the same setting for the communication protocol of all J-TIs.

● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Communication protocol selection	**IX**	—	0900	0: RKC communication 1: Modbus	When the communication protocol is specified at the time of order, the specified communication protocol will be the factory set value. If the communication protocol is not specified: 1

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Communication speed

Set the communication speed.

NOTE

The set data is enabled by turning OFF the power and then turning it ON again.

NOTE

Set the communication speed to the same value as the host computer to be connected. Moreover, to connect and use several J-TIs on the same line, make the same setting for the communication speed of all J-TIs.

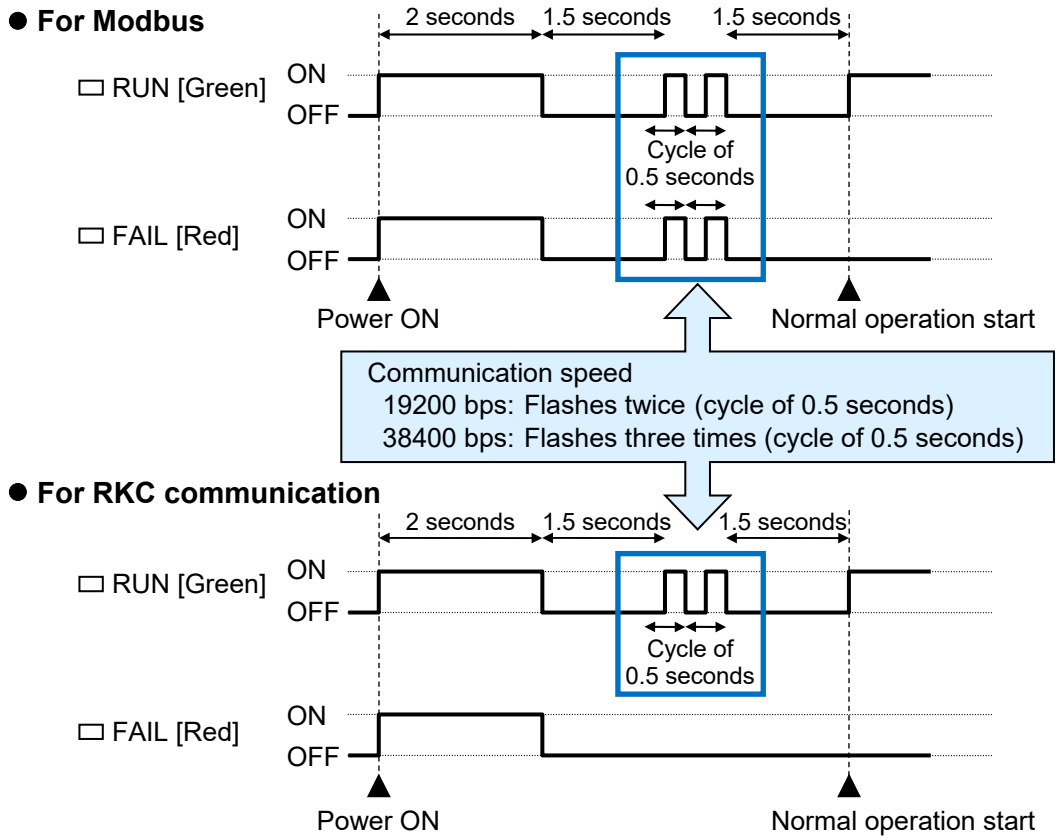
● Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
The following items are Engineering setting data. [Writable in the STOP mode, RO (data read only) during RUN]					
Communication speed	**IR**	—	0910	0: 19200 bps 1: 38400 bps	1

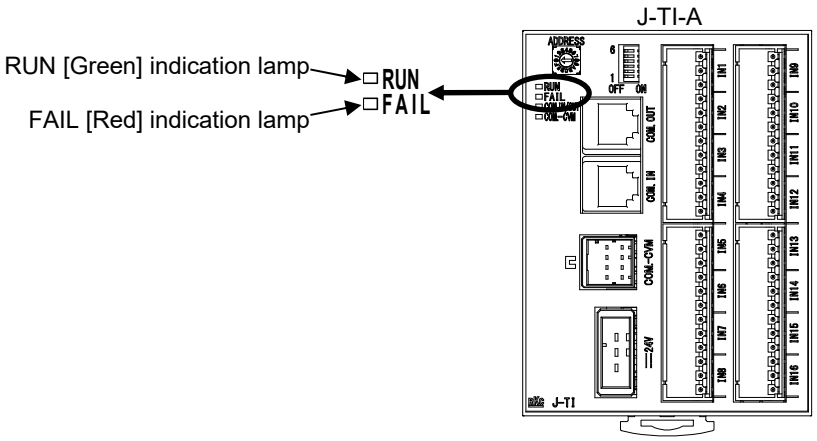
☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

7.9.2 Checking the communication protocol and communication speed by indication lamps

You can check the communication protocol and communication speed depending on the lighting or flashing state of the RUN [Green] lamp and FAIL [Red] lamp immediately after the instrument power is turned ON.



The RUN [Green] lamp and FAIL [Red] lamp are present on the J-TI front panel.
J-TI-A is used in the figures for explanation, but the same also applies to J-TI-B and J-TI-C.



7.9.3 Changing the communication interval time

The communication interval time can be changed.

■ Interval time

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 SRJ. Adjust the interval time when the switchover between send and receive is not appropriate.

- **Communication data**

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Interval time	**ZX**	—	03B0	0 to 100 ms	0

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

📖 In the case of RKC communication, the set value of the interval time is disabled, and the interval time operates at 6 ms.

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

7.10 Checking Information Regarding the Instrument Such as ROM Version, Etc.

You can monitor the following information concerning this instrument (J-TI).
If a problem occurs, we request you to notify the model and specification of the instrument at the time of contacting our sales office or distributor, but, we can check the ROM version, model code, instrument number, initial setting code, and special order number of the instrument by communication.

■ ROM version display

Version of the ROM installed on this instrument (J-TI).

● Communication data

Name	Identifier	Digits	Modbus register address (HEX)	Data range	Factory set value
ROM version display	**Z0**	7	02A0	Version of ROM built in the instrument	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Model code monitor, Instrument number monitor, Initial setting code monitor, and Special order number monitor

Model code, instrument number, initial setting code, and special order number of this instrument (J-TI).
Can be checked only through RKC communication.

● Communication data

Name	Identifier	Digits	Modbus register address (HEX)	Data range	Factory set value
Instrument number monitor	**KN**	10	—	Instrument number	—
Model code monitor	**ID**	18	—	Model code	—
Initial setting code monitor	**IC**	6	—	Initial setting code	—
Special order number monitor	**IZ**	21	—	Special order number	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

🕮 If the information described above cannot be checked through RKC communication, check the MODEL (model), S/N (instrument number), and CODE (model code) from the rating plate on the instrument side panel.

🕮 The information about the J-CVM cannot be checked through RKC communication. Check the MODEL (model), S/N (instrument number), and CODE (model code) from the rating plate on the J-CVM bottom panel.

MEMO

8 TROUBLESHOOTING

This chapter describes self-diagnostic error and countermeasures for errors.

8.1 Self-diagnostic Error

This section describes the self-diagnostic error.

8.1.1 J-TI (Temperature control input module)

The self-diagnostic error contents during a failure can be checked from the error code.

■ Communication data

Name	Identifier	CH	Modbus register address (HEX)	Data range	Factory set value
Error code	**ER**	—	0070	RKC communication: 0 to 31 Error status is assigned to each bit in the binary number. Send data from the SRJ be changed to decimal ASCII code from the bit image in binary numbers. Bit 0: Data back-up error Bit 1: CVM address duplication or setting error Bit 2: Module configuration error Bit 3: Adjustment data error Bit 4: A/D conversion error Bit 5 to Bit 7: Unused Data 0: OFF 1: ON	—
				Modbus: 0 to 31 0: Normal +1: Data back-up error +2: CVM address duplication or setting error +4: Module configuration error +8: Adjustment data error +16: A/D conversion error When multiple items are applicable, they are summed up.	

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Action during the occurrence of a J-TI self-diagnostic error

Error code*	Self-diagnostic items	Error displays	Communication status to the CVM
Error code 1	Data back-up error • Back-up action is abnormal. • Data write failure	FAIL [red] lamp: ON RUN [green] lamp: ON	Output value 0 % (Self-diagnostic error)
Error code 2	CVM address duplication or setting error • J-CVM address error	FAIL [red] lamp: OFF RUN [green] lamp: ON	Control RUN
Error code 4	Module configuration error • Model code error (Occurs when the number of input channels does not match the model)	FAIL [red] lamp: ON RUN [green] lamp: ON	Output value 0 % (Self-diagnostic error)
Error code 8	Adjustment data error • Adjusted data range is abnormal.		
Error code 16	A/D conversion error • Error in A/D conversion circuit is detected.		

* If several errors occur, the calculated sum of the error codes is taken into consideration.

< Solution >

Error code 1, 4, 8 or 16:

Turn off the power of the J-TI once. If the J-TI is restored to normal after the power of J-TI is turned on again, then probable cause may be external noise source affecting the control system. Check for the external noise source. If an error occurs after the power of J-TI is turned again, the J-TI must be repaired or replaced. Please contact RKC sales office or the agent.

Error code 2:

A CVM address duplicate setting error can be recovered by turning ON the J-CVM again after setting the correct J-CVM address.

If any of the following errors occur, all action of the J-TI is stopped.
In such a case, it is not possible to check the error contents based on the error code.

Communication at error	Self-diagnostic items	Error displays	Communication status to the CVM
Communication: Stop	Watchdog timer • Part of the internal program stops running.	FAIL [red] lamp: ON RUN [green] lamp: OFF	Communication: Stop (Instrument abnormality)
	Power supply voltage monitoring • Decrease of power supply voltage	FAIL [red] lamp: OFF RUN [green] lamp: OFF	

< Solution >

Turn off the power of the J-TI once. If an error is repeated after the power of the J-TI is turned on again, the J-TI may need to be repaired or replaced. Please contact RKC sales office or the agent.

Priority order of display (indication lamp) during an error

Higher ↑	Power supply voltage monitoring
	Watchdog timer
	Data back-up error/Module configuration error/Adjustment data error/A/D conversion error
Lower	CVM address duplication or setting error

8.1.2 J-CVM (SSR unit)

■ Action during the occurrence of a J-CVM self-diagnostic error

Communication at error	Self-diagnostic items	Error displays	Instrument status
Normal operation	Stack overflow • Stack area of stack pointer overflows	RUN [green] lamp: ON	All output OFF (Self-diagnostic error)
	Communication error • A message from host communication is not received for a fixed period of time (5 seconds) or longer • A reception error, CRC error, received message error occurs continuously for 10 times or more		
	Wrong rotary switch setting • The set value of the address setting switch of the J-CVM is 8 or more		

< Solution >

Communication error:

The error is recovered when data is received normally after removing the cause of the communication error.

Wrong rotary switch setting:

The error is recovered by turning ON the J-CVM again after setting the set value of the address setting switch of the J-CVM to a value between 0 and 7.

Stack overflow:

Turn off the power of the J-CVM once. If the J-CVM is restored to normal after the power of J-CVM is turned on again, then probable cause may be external noise source affecting the control system. Check for the external noise source. If an error occurs after the power of J-CVM is turned again, the J-CVM must be repaired or replaced. Please contact RKC sales office or the agent.

If any of the following errors occur, all action of the J-CVM is stopped.

Communication at error	Self-diagnostic items	Error displays	Instrument status
Communication: Stop	Internal RAM error • Setting data read/write failure	FAIL [red] lamp: ON	All output OFF (Instrument abnormality)
	Watchdog timer error • Part of the internal program stops running.		
	Power supply voltage monitoring • Decrease of power supply voltage		

< Solution >

Turn off the power of the J-CVM once. If an error is repeated after the power of the J-CVM is turned on again, the J-CVM may need to be repaired or replaced. Please contact RKC sales office or the agent.

Since power is supplied to the J-CVM from the J-TI, the power supply to the J-CVM is turned ON/OFF according to the method described below.

- Remove or insert the Power/Communication connector (COM. IN, COM. OUT).
- Turn the J-TI power supply ON/OFF.

8.2 Solutions for Problems

This section explains possible causes and solutions of the errors. For any inquiries or to confirm the specifications of the product, please contact RKC sales office or the agent.

If the instrument needs to replaced, always strictly observe the warnings below.

⚠ WARNING

- To prevent electric shock or instrument failure, always turn off the system power before replacing the instrument.
- To prevent electric shock or instrument failure, always turn off the power before mounting or removing the instrument.
- To prevent electric shock or instrument failure, do not turn on the power until all 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.

NOTE

When replacing the instrument, be sure to use the same model as that before replacement. You must reset the entire data when replacing the instrument.

8.2.1 J-TI (Temperature control input module)

■ J-TI

Problem	Possible cause	Solution
RUN [green] lamp does not light up	Power not being supplied.	Check external breaker etc.
	Power supply terminal connection is not correct.	Connect power supply correctly by referring to ■ **Power connector (P. 3-5)**.
	Power connector contact defect.	Confirm the power connector connection condition and connect correctly.
	Supply voltage is not correct.	Apply proper power supply voltage by referring to ■ **General specifications (P. 9-9)**.
COM.IN/OUT or COM.I/O [orange] lamp does not flash	Wrong connection, no connection or disconnection of the communication cable	Confirm the connection method or condition and connect correctly.
	Breakage, wrong wiring, or imperfect contact of the communication cable	Confirm the wiring or connector and repair or replace the wrong one.
	Host computer misconnection	Check the host computer connection, and connect correctly.
	CPU section defect	Replace J-TI
COM.-CVM or COM-CVM [orange] lamp does not flash	Wrong connection, no connection or disconnection of the connecting cable	Confirm the connection method or condition and connect correctly.
	Breakage, wrong wiring, or imperfect contact of the connecting cable	Confirm the wiring or connector and repair or replace the wrong one.
	CPU section defect	Replace J-TI
	J-CVM communication circuit defect	Replace J-CVM
FAIL [red] lamp is lit: FAIL status	For details on the possible causes and solutions of the errors, refer to ■ **Action during the occurrence of a J-TI self-diagnostic error (P. 8-3)** in Section **8.1.1**.	

■ Input related errors

Problem	Possible cause	Solution
Measured value (PV) display is unstable	Noise source is present near the instrument.	Separate the noise source from the instrument.
		Set the appropriate value at **PV digital filter (P. 7-8)** according to the input response.
	The connector block of the instrument (with thermocouple input) is directly exposed to the air flow from an air conditioner.	Do not directly expose the connector block to the air from the air conditioner.
Measured value (PV) display differs from the actual value	Wrong sensor is used.	Check the instrument specification and use a proper sensor.
	Input range number setting is wrong.	Make proper setting by referring to ■ **Input range number (P. 7-6)**.
	Connection between the sensor (thermocouple) and the instrument is made with a cable other than compensating wire.	Be sure to use a compensating wire.
	For RTD input, leadwire resistance in three wires between the sensor and the instrument is different from one another.	Use a leadwire with the same resistance among three leadwires.
	PV bias is set.	Set PV bias to "0.0" by referring to ■ **PV bias (P. 7-7)**. However, this is limited only to when the PV bias setting can be changed.

How to check the input

- When the input is configured as Thermocouple input:
  Short the measured input connectors between "+ (positive)" and "– (negative)", and if temperature around the ambient temperature of the measured input connector is displayed, the J-TI is working properly.
- When the input is configured as RTD input:
  Insert a 100 Ω resister across the measured input connectors A-B. Short the measured input connectors between B-B. If the J-TI shows measured value around 0 °C, the J-TI is working fine.

■ Control related errors

Problem	Possible cause	Solution
Control is abnormal	Supply voltage is not correct.	Apply proper power supply voltage by referring to ■ **General specifications (P. 9-9)**.
	Disconnection of sensor or sensor wire.	Turn off the power or STOP the operation by "RUN/STOP transfer" and repair the sensor or replace it.
	The sensor is not wired correctly.	Conduct correct wiring of sensor by referring to ■ **Measuerd input connector (IN) (P. 3-7)**.
	Wrong sensor is used.	Check the instrument specification and use a proper sensor.
	Input range number setting is wrong.	Make proper setting by referring to ■ **Input range number (P. 7-6)**.
	Sensor insertion depth is insufficient.	Check the sensor insertion. If insertion is loose, firmly insert the sensor.
	Sensor insertion position is wrong.	Insert the sensor at the specified location
	Input signal wires are not separated from instrument power and/or load wires.	Separate input signal wires from instrument power and load wires.
	Noise source is present near the instrument.	Separate the noise source from the instrument.
	Inappropriate PID constants.	Set appropriate PID constants. Execute autotuning by referring to **7.8.5 Setting PID values automatically (Autotuning) (P. 7-40)**.
	The J-CVM channel setting is incorrect.	Check the J-CVM address settings, and set correctly.
Control is unstable	Inappropriate PID constants.	Set appropriate PID constants. Execute autotuning by referring to **7.8.5 Setting PID values automatically (Autotuning) (P. 7-40)**.
		Check the "Response to setting." Set an appropriate response parameter by referring to ■ **Control response parameter (P. 7-39).**
	Proportional cycle time [heat-side] setting is not appropriate.	Set an appropriate value to CH1 of the J-TI master, referring to the ■ **Proportional cycle time [heat-side] (P.7-33)**. (The proportional cycle time [heat-side] set here for CH1 of the J-TI master is used at all channels in common.) Settings made on channels other than CH1 of the J-TI master are ignored.)

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Problem	Possible cause	Solution
Autotuning (AT) cannot be activated	Requirements for performing the Autotuning (AT) are not satisfied.	Satisfy the requirements for performing the Autotuning (AT) by referring to **7.8.5 Setting PID values automatically (Autotuning) (P. 7-40)**.
Autotuning (AT) aborted	Requirements for aborting the Autotuning (AT) are established.	Identify causes for Autotuning (AT) abort by referring to **7.8.5 Setting PID values automatically (Autotuning) (P. 7-40)** and then remove them. Then, execute Autotuning (AT) again
Optimum PID values cannot be obtained by Autotuning (AT)	Autotuning (AT) does not match the characteristics of the controlled object.	Set PID constants manually by referring to **7.8.6 Setting PID values manually (P. 7-44)**.
Autotuning (AT) cannot be finished normally	Temperature change of the process is too slow (1 °C or less per minute for temperature rise and fall)	Set PID constants manually by referring to **7.8.6 Setting PID values manually (P. 7-44)**.
	Autotuning (AT) was executed around the ambient temperature or close to the maximum temperature achieved by the load.	
Measured value (PV) overshoots or undershoots	Proportional band is narrow. Proportional (P) constant is small.	Increase Proportional (P) value within the acceptable limit of response delay.
	Integral time is short. Integral (I) constant is small.	Increase Integral (I) value within the acceptable limit of response delay.
	Derivative time is short. Derivative (D) constant is small.	Increase Derivative (D) value within the acceptable limit of process stability.
	The instrument is configured for ON/OFF control.	Change the control mode to Proportional control or PID control.
Output does not rise over (or goes below) a certain value	Output limiter is set.	Change the Output limiter setting by referring to ■ **Output limiter high/low (P. 7-32)**. However, this is limited only to when the Output limiter setting can be changed.

■ Event related errors

Problem	Possible cause	Solution
Event function is abnormal	Event function is different from the specification.	Change the Event action type by referring to ■ **Event type (P. 7-17)** after the instrument specification is confirmed.
	Setting of Event differential gap is not appropriate.	Set the appropriate Event differential gap by ■ **Event differential gap (P. 7-21)**.

■ Control loop break alarm (LBA) related errors

Problem	Possible cause	Solution
Control loop break alarm (LBA) is not generated under the alarm condition	LBA is set to "Unused."	Set an appropriate value by referring to ■ **Control loop break alarm (LBA) usage selection (P. 7-26)**.
	LBA time setting is not appropriate.	Set an appropriate value by referring to ■ **Control loop break alarm (LBA) time (P. 7-26)**.
	LBA deadband (LBD) setting is not appropriate.	Set an appropriate value by referring to ■ **LBA deadband (LBD) (P. 7-27)**.
	Autotuning (AT) is in execution.	Wait for Autotuning (AT) to finish or abort Autotuning (AT).
	The instrument stays in control stop (STOP).	Switch the mode to RUN (control start) by referring to ■ **RUN/STOP transfer (P. 7-34)**. Attempt this only when the mode is allowed to be transferred to RUN (control start).
	LBA does not match the characteristics of the process (controlled object).	Try another type of alarm.
Control loop break alarm (LBA) is generated under the no alarm condition	LBA time setting is not appropriate.	Set an appropriate value by referring to ■ **Control loop break alarm (LBA) time (P. 7-26)**.
	LBA deadband (LBD) setting is not appropriate.	Set an appropriate value by referring to ■ **LBA deadband (LBD) (P. 7-27)**.
	LBA does not match the characteristics of the process (controlled object).	Try another type of alarm.

■ 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.
	Communication setting (communication speed, data bit configuration) is different from a host computer.	Check setting and make a proper setting.
	Address setting is wrong	
	Data format is wrong	Review communication program
	Transmission line is not set to receive state after data send (for RS-485)	
	Communication protocol setting is wrong.	Refer to■ **Communication protocol selection (P. 7-55)**, and set Communication protocol to "0: RKC communication."
EOT return	Invalid communication identifiers	Check if communication identifiers are correct and if there are any identifiers for unsupplied functions.
	Data format is wrong	Review communication program
NAK return	Communication error occurred (parity bit error, framing error, etc.)	Identify the error and take necessary actions (e.g. check of transmitted data, retransmission)
	BCC error occurred	
	Data is out of the setting range	Check the setting range and correct the data.
	Invalid communication identifiers	Check if communication identifiers are correct and if there are any identifiers for unsupplied functions.

■ 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.
	Communication setting (communication speed, data bit configuration) is different from a host computer.	Check setting and make a proper setting.
	Address setting is wrong	
	Transmission error detected. (Overrun error, framing error, parity error, or CRC-16 error)	Retransmit after time-out or Review program on master side

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Problem	Possible cause	Solution
No response	Time interval between the data that composes a message is more than 24-bit time.	Retransmit after time-out or Review program on master side
	Communication protocol setting is wrong.	Refer to■ **Communication protocol selection (P. 7-55)**, and set Communication protocol to "1: Modbus."
Error code: 1	Function cod error (Specifying nonexistent function code)	Confirm the function code
Error code: 2	When the mismatched address is specified.	Confirm the address of holding register
Error code: 3	• When the specified number of data items in the query message exceeds the maximum number of data items available. • When the data written exceeds the setting range	Confirm the setting data
Error code: 4	Self-diagnostic error	Turn off the power of the J-TI once. If the same error occurs when the power of the J-TI is turned back on, please contact RKC sales office or the agent.

8.2.2 J-CVM (SSR unit)

■ J-CVM

Problem	Possible cause	Solution
RUN [green] lamp does not flash	Power/Communication connector contact defect.	Confirm the Power/Communication connector connection condition and connect correctly.
	The power supply voltage is not supplied from the J-TI	Check the JT-I power supply voltage and supply regular power supply voltage.
TX/RX [orange] lamp does not flash	Wrong connection, no connection or disconnection of the connecting cable	Confirm the connection method or condition and connect correctly.
	Breakage, wrong wiring, or imperfect contact of the connecting cable	Confirm the wiring or connector and repair or replace the wrong one.
	J-TI communication circuit defect	Replace J-TI
FAIL [red] lamp is lit: FAIL status RUN [green] lamp is lit: Self-diagnostic error	For details on the possible causes and solutions of the errors, refer to ■ **Action during the occurrence of a J-CVM self-diagnostic error (P. 8-4)** in Section **8.1.2**.	

8.3 Verifying Instrument Information

If a problem occurs, we request you to notify the model and specification of the instrument at the time of contacting our sales office or distributor, but, we can check the ROM version, model code, instrument number, initial setting code, and special order number of the instrument by communication.

■ ROM version display

Version of the ROM installed on this instrument (J-TI).

● Communication data

Name	Identifier	Digits	Modbus register address (HEX)	Data range	Factory set value
ROM version display	**Z0**	7	02A0	The installed ROM version is displayed.	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

■ Model code monitor, Instrument number monitor, Initial setting code monitor, and Special order number monitor

Model code, instrument number, initial setting code, and special order number of this instrument (J-TI).
Can be checked only through RKC communication.

● Communication data

Name	Identifier	Digits	Modbus register address (HEX)	Data range	Factory set value
Instrument number monitor	**KN**	10	—	Instrument number	—
Model code monitor	**ID**	18	—	Model code	—
Initial setting code monitor	**IC**	6	—	Initial setting code	—
Special order number monitor	**IZ**	21	—	Special order number	—

☞ For details of the communication data, refer to **6. COMMUNICATION DATA LIST (P. 6-1)**.

🕮 If the information described above cannot be checked through RKC communication, check the MODEL (model), S/N (instrument number), and CODE (model code) from the rating plate on the instrument side panel.

🕮 The information about the J-CVM cannot be checked through RKC communication. Check the MODEL (model), S/N (instrument number), and CODE (model code) from the rating plate on the J-CVM bottom panel.

9 SPECIFICATIONS

This chapter describes specifications.

9.1 J-TI (Temperature Control Input Module)

■ Measured input

Number of inputs: J-TI-A: 16 points (Isolated between each input)
J-TI-B: 8 points (Isolated between each input)
J-TI-C: 8 points (Isolated between each input)

Input type: Thermocouple (TC) input: K, R (JIS-C1602-1995)
RTD input: Pt100 (JIS-C1604-1997), 3-wire system

Input range: **Thermocouple (TC) input**

Input type	Measured range
K	0.0 to 400.0 °C 0.0 to 800.0 °C 0.0 to 1300.0 °C
R	0.0 to 1700.0 °C

RTD input

Input type	Measured range
Pt100	0.0 to 400.0 °C 0.0 to 600.0 °C 0.0 to 800.0 °C

Sampling cycle: 0.25 seconds or 1 seconds (configurable)

Influence of signal source resistance (TC input):
Approx. 0.1 μV/Ω (Converted depending on TC types)

Influence of input lead (RTD input):
Approx. 0.01 %/Ω of span (10 Ω or less per wire)

Input impedance (TC input):
1 MΩ or more

Measured current (RTD input):
Approx. 210 μA

Action at input break: TC input: Upscale
RTD input: Upscale

Action at input short circuit (RTD input):
Downscale

Action at input error:
- Input error determination point (high), Input error determination point (low)
  Input range low to Input range high
- Action (high) at input error, Action (low) at input error
  "Control continues" or "Manipulated output value at input error" (selectable)
- Manipulated output value at input error
  −5.0 to +105.0 %

Measured input correction: PV bias: − Input span to + Input span
PVdigital filter (First order lag digital filter):
0 to 100 seconds (0: Filter OFF)

Allowable input voltage: −2.3 to +2.3 V DC

■ Performance

Reference performance (Performance under the standard performance condition)

• Measured input (PV): Accuracy:

Input type	Input range	Accuracy
K	0 °C or more, Less than 333 °C	±1.0 °C
	333 °C or more	±(0.3 % of Reading + 1 digit)
R	0 °C or more, Less than 400 °C	±4.0 °C
	400 °C or more	±2.0 °C
Pt100	Less than 266 °C	±0.8 °C
	266 °C or more	±(0.3 % of Reading + 1 digit)

Display accuracy:
Is equal to the above accuracy with the value below the minimum resolution rounded up.

Noise elimination ratio: Series mode: 60 dB or more (50/60 Hz)
Common mode: 120 dB or more (50/60 Hz)

Resolution: 1/1048576 (Performance of A/D converter)

Cold-junction temperature compensation error:
±1.0 °C (5 to 40 °C)
±1.5 °C (−10 to +5 °C, between 40 to 55 °C)

Close horizontal mounting error:
±1.5 °C

Operating influence (Variation under the operating condition)

• Influence ambient temperature:
TC input: ±0.037 °C/°C
RTD input: ±0.067 °C/°C

• Influence of power supply voltage:
±0.3 °C (20.4 to 26.4 V DC)

• Influence of vibration: Frequency range: 10 to 150 Hz
Maximum amplitude: 0.075 mm
Maximum acceleration: 9.8 m/s^2
Each direction of XYZ axes

■ Control

● Brilliant II PID control

Overshoot suppression function: Reset feedback (RFB) method

Proportional band: 0.0 to Input span (Unit: °C)
0.0: ON/OFF action

Integral time: 1 to 3600 seconds

Derivative time: 0 to 3600 seconds
0: OFF (PI action)

Control response parameter: Slow, Medium and Fast (3-step selection)

Manipulated output value at STOP:
Control output turns OFF

Direct action/Reverse action transfer:
Selectable

● Manual control

Setting range of Manual manipulated output value:
−5.0 to +105.0 %

● Mode switching

Auto/Manual transfer: Bidirectional bumpless Auto/Manual transfer (switching between PID control output and manual output).

RUN/STOP transfer: Used to switch the mode between RUN and STOP.
When switching the mode from STOP to RUN, the action is the same as that at power on.

RUN: PID control, Manual control and Event function are activated.
STOP: PID control, Manual control and Event function are deactivated, and the output is set to the minimum.

● Autotuning (AT)

Tuning method: Computed by Limit cycle system

AT bias: −Input span to +Input span

AT cycle: 2 cycles

■ Event function

Number of event: 2 points/channel

Event type:
Process high [1]
Process low [1]
Deviation high [2]
Deviation low [2]
Deviation high/low [2]
Band [2]

[1] Event hold action is available.

[2] Event hold and re-hold action is available.

Setting range:

a) Process high, Process low
Event setting: Same as measured range
Differential gap: 0.0 to Input span

b) Deviation high, Deviation low
Event setting: –Input span to +Input span
Differential gap: 0.0 to Input span

c) Deviation high/low, Band
Event setting: 0.0 to Input span
Differential gap: 0.0 to Input span

Additional function:

Hold action:
a) without hold action
b) with hold action
(When power is turned on; when transferred from STOP to RUN)
c) with re-hold action
(When power is turned on; when transferred from STOP to RUN; when SV changed)

Event timer: 0 to 255 seconds

■ Control loop break alarm (LBA)

Control loop break alarm (LBA) time:
1 to 7200 seconds

LBA deadband (LBD): 0.0 to Input span

■ Host communication

● RKC communication

Interface: Based on RS-485, EIA standard

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

Synchronous method: Start/Stop synchronous type

Communication speed: 19200 bps, 38400 bps

Protocol: ANSI X3.28-1976 subcategories 2.5 and B1
Polling/Selecting type

Data bit configuration: Start bit: 1
Data bit: 8
Parity bit: None
Stop bit: 1

Error control: Horizontal parity (BCC check)

Communication code: ASCII 7-bit code

Termination resistor: Set by the J-TI communication setting switch (120 Ω 1/2 W)

Xon/Xoff control: None

Maximum connections: J-TI master: 4 modules
(Up to four J-TI masters can be connected to a single host computer.)
J-TI slave: 12 modules
(Up to three J-TI slaves can be connected to a single J-TI master.)

Signal logic: RS-485

Signal logic	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.)

● Modbus

Interface: Based on RS-485, EIA standard

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

Synchronous method: Start/Stop synchronous type

Communication speed: 19200 bps, 38400 bps

Data bit configuration:
Start bit: 1
Data bit: 8
Parity bit: None
Stop bit: 1

Protocol: Modbus-RTU

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

Termination resistor: Set by the J-TI communication setting switch (120 Ω 1/2 W)

Maximum connections:
J-TI master: 4 modules
(Up to four J-TI masters can be connected to a single host computer.)
J-TI slave: 12 modules
(Up to three J-TI slaves can be connected to a single J-TI master.)

Signal logic: RS-485

Signal logic	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.)

■ CVM communication

Interface: Based on RS-485, EIA standard

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

Synchronous method: Start/Stop synchronous type

Communication speed: 38400 bps

Data bit configuration:
Start bit: 1
Data bit: 8
Parity bit: None
Stop bit: 1

Protocol: Special communication

Termination resistor: Set by the J-CVM termination resistor setting switch

Maximum connections: 8 units (Up to eight J-CVM can be connected to a single J-TI master.)

■ Self-diagnostic function

Self-diagnostic items:

Self-diagnostic items	Communication at error	Error displays	Communication status to the CVM
Data back-up error	Error code 1	FAIL [red] lamp: ON RUN [green] lamp: ON	Output value: 0 % (Self-diagnostic error)
CVM address duplication or setting error	Error code 2	FAIL [red] lamp: OFF RUN [green] lamp: ON	Control RUN
Module configuration error	Error code 4	FAIL [red] lamp: ON RUN [green] lamp: ON	Output value: 0 % (Self-diagnostic error)
Adjustment data error	Error code 8		
A/D conversion error	Error code 16		
Watchdog timer	Communication: Stop	FAIL [red] lamp: ON RUN [green] lamp: OFF	Communication: Stop (Instrument abnormality)
Power supply voltage monitoring		FAIL [red] lamp: OFF RUN [green] lamp: OFF	

■ General specifications

Power supply voltage: 20.4 to 26.4 V DC [Including power supply voltage variation]
(Rating: 24 V DC)

Current consumption (at maximum load):

J-TI (alone): 160 mA max. (at 24 V DC)
Rush current: 20 A or less

When eight J-CVM is connected to a J-TI:
5040 mA max. (at 24 V DC)

Insulation resistance:

	①	②	③	④
① Grounding				
② Power supply, CVM communication	20 MΩ or more at 500 V DC			
③ Measured input	20 MΩ or more at 500 V DC	20 MΩ or more at 500 V DC	20 MΩ or more at 500 V DC	
④ Communication	20 MΩ or more at 500 V DC	20 MΩ or more at 500 V DC	20 MΩ or more at 500 V DC	

Ground is connected to the DIN-rail.

Withstand voltage:

Time: 1 min.	①	②	③	④
① Grounding				
② Power supply, CVM communication	1500 V AC			
③ Measured input	1000 V AC	1500 V AC	500 V AC	
④ Communication	1000 V AC	1000 V AC	1000 V AC	

Power failure handling:

Power failure: A power failure of 20 ms or less will not affect the control action (Rating: 24V DC)

Memory backup: Backed up by non-volatile memory
Number of writing: Approx. One trillion (10^{12}) times
Data storage period: Approx. 10 years

Power failure recovery:

Hot/Cold start:

a) Hot start 1
Operation is resumed from the state before the power failure and from the output before the failure.

b) Hot start 2
Operation is resumed from the state before the power failure. In case of Manual mode, the operation starts from the Output limiter low limit.
In Auto mode, the output value calculated with the control response parameter

c) Cold start
Regardless of the operation mode before power failure, operation is started in the manual mode, and the output value is 0%.

Start determination point:

0.0 to Input span
(0.0: Action conforms to the Hot/Cold start)
Unit: same as the reading

Update and backup of set value:

Internal update:
Enabled in approx. 1 sampling hour after change in numeric value
Saving to the memory:
Saved to the memory in approx. 1 sampling hour after change in numeric value

■ Environment Condition

● Operating environmental conditions

Ambient temperature: −10 to +55 °C

Ambient humidity: 5 to 95 %RH (Absolute humidity: MAX.W.C 29 g/m^3 dry air at 101.3 kPa)

Vibration:
Frequency range: 10 to 150 Hz
Maximum amplitude: 0.075 mm
Maximum acceleration: 9.8 m/s^2
Each direction of XYZ axes

Shock:
Free fall from 50 mm in height
Each direction of XYZ axes (In non-energization)

● Reference operating conditions

Reference temperature: 23 °C ±2 °C

Temperature variation: ±5 °C/h

Reference humidity: 50 % ±10 %RH

Magnetic field: Geomagnetism

Power supply voltage: Alternating current, Direct current: Reference value ±1 %

Preheat/Stabilizing time: 60 munutes or more

● Transportation and Storage environment conditions

Vibration:

Number of vibration [Hz]	Level		Attenuation slope [dB/oct]
	(m/s^2)^2/Hz	[g^2(1)/Hz]	
3	0.048	(0.0005)	—
3 to 6	—	—	+13.75
6 to 18	1.15	(0.012)	—
18 to 40	—	—	–9.34
40	0.096	(0.001)	—
40 to 200	—	—	–1.29
200	0.048	(0.0005)	—

The effective value of the acceleration is 5.8 m/s^2 [0.59 g (1)] within the number of vibration.

NOTE: (1) g = 9.806658 m/s^2

Shock: Height 80 cm or less

Temperature: –40 to +70 °C

Humidity:
Less than 5 to 95 %RH (Non condensing)
Absolute humidity: MAX.W.C 35 g/m^3 dry air at 101.3 kPa

■ Mounting and Structure

Mounting method: DIN rail mounting

Mounting orientation: Datum plane±3°

Case color: Black

Case material: PC (Flame retardancy: UL94 V-0)

Base material: PC (Flame retardancy: UL94 V-0)

Panel sheet material: PC

Weight:
J-TI-A (16 channels type): Approx. 295 g
J-TI-B (8 channels type): Approx. 250 g
J-TI-C (8 channels type): Approx. 220 g

Dimensions:
J-TI-A, J-TI-B: Instrument: 72 mm × 101 mm × 106 mm (W × H × D)
Case only: 72 mm × 96 mm × 101 mm (W × H × D)
J-TI-C Instrument: 49.5 mm × 101 mm × 106 mm (W × H × D)
Case only: 49.5 mm × 96 mm × 101 mm (W × H × D)

■ Standard

● Safety standards

UL: UL 61010-1

cUL: CAN/CSA-C22.2 No.61010-1

● Other approved standards

CE marking:
LVD: EN61010-1
EMC: EN61000-3-2
EN61326-1
RoHS: EN IEC 63000

● Environment Condition

Overvoltage category: OVERVOLTAGE CATEGORY II

Pollution degree: POLLUTION DEGREE 2

Altitude: Altitude up to 2000 m (Indoor use)

9.2 J-CVM (SSR Unit)

■ Output

Number of output: 16 points

Assign output:
HEATER1 to HEATER8: Heater output (SSR output)
EXT SSR1 to EXT SSR8: Output for external SSR drive (transistor output)

Output type:

• SSR output (heater output)

Output method:	AC output (zero-cross methed)
Allowable load current	J-CVM-3: 3 A/point (Natural cooling)
	J-CVM-5: 5 A/point (Forced air cooling using an external fan)
Load voltage:	35 to 264 V AC [Including power supply voltage variation] (Rating: 100 to 240 V AC), 50/60 Hz OVERVOLTAGE CATEGORY II
Minimum load current:	100 mA
Voltage drop at ON:	1.5 V or less (at maximum load current)
Leakage current at OFF:	5 mA or less (at 200 V AC)
Fuse type:	5 × 20 mm Fast-blow fuse
Fuse rating:	Rated voltage: 250 V AC Rated current: 6.3 A
Recommended fuse model type:	
	021806.3MXP (Littelfuse) [Time-lag fuse]
	021606.3MXP (Littelfuse) [Fast-blow fuse]

• Transistor output (Open collector output) [Output for external SSR drive]

Output method:	Sink type
Allowable load current:	50 mA/point
Load voltage:	40 V DC or less
Voltage drop at ON:	2 V or less (at allowable load current)
Leakage current at OFF:	5 μA or less
Overcurrent protection:	None

■ CVM communication (Inter-unit communication)

Interface: Based on RS-485, EIA standard

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

Synchronous method: Start/Stop synchronous type

Communication speed: 38400 bps

Data bit configuration:
Start bit: 1
Data bit: 8
Parity bit: None
Stop bit: 1

Protocol: Special communication

Termination resistor: Set by the J-CVM termination resistor setting switch

Maximum connections: 8 units (Up to eight J-CVM can be connected to a single J-TI master.)

■ Self-diagnostic function

Self-diagnostic items:

Self-diagnostic items	Communication at error	Error displays	Output at error
Stack overflow	Normal operation	RUN [green] lamp: ON	All output OFF (Self-diagnostic error)
Communication error			
Wrong rotary switch setting *			
Internal RAM error	Communication: Stop	FAIL [red] lamp: ON	All output OFF (Instrument abnormality)
Power supply voltage monitoring			
Watchdog timer error			

* Rotary switch: Address setting switch of J-CVM

■ General specifications

Instrument power supply: Power supply voltage: 20.4 to 26.4 V DC [Including power supply voltage variation] (Rating: 24 V DC)

Current consumption (at maximum load):

When Output for external SSR drive (transistor output) is not used:
210 mA max. (at 24 V DC)/Unit
When eight J-CVM is connected:
1.68 A max. (at 24 V DC)

When Output for external SSR drive (transistor output) is used:
610 mA max. (at 24 V DC)/Unit
When eight J-CVM is connected:
4.88 A max. (at 24 V DC)

Rush current: 12.6 A or less (at 24 V DC)

Power supply connector for load:

Power supply voltage: 35 to 264 V AC (50/60 Hz)
[Including power supply voltage variation]
(Rating: 100 to 240 V AC)

Current consumption (at maximum load):
J-CVM-3: 3 A/point
J-CVM-5: 5 A/point

Insulation resistance:

	①	④
① Protective earth (PE), Heat sink		
② Heater power supply, Heater output	20 MΩ or more at 500 V DC	
③ Communication, Transistor output for external SSR drive and Instrument power supply	20 MΩ or more at 500 V DC	20 MΩ or more at 500 V DC

Withstand voltage:

Time: 1 min.	①	②
① Protective earth (PE), Heat sink		
② Heater power supply, Heater output	1500 V AC	
③ Communication, Transistor output for external SSR drive and Instrument power supply	1500 V AC	2300 V AC

Power failure handling:
Power failure: A power failure of 20 ms or less will not affect the control action (Rating: 24 V DC)
Memory backup: Backed up by non-volatile memory
Number of writing: Approx. 1,000,000 times
Data storage period: Approx. 10 years

■ Environment Condition

● Operating environmental conditions

Ambient temperature: –10 to +55 °C
As shown in the derating curve in **2.2.1 Mounting cautions (P. 2-5)**, the allowable load current decreases according to the ambient temperature around the instrument. Also, ensure that the ambient temperature does not exceed 55 °C.

Ambient humidity: 5 to 95 %RH (Absolute humidity: MAX.W.C 29 g/m^3 dry air at 101.3 kPa)

Vibration: Frequency range: 10 to 150 Hz
Maximum amplitude: 0.075 mm
Maximum acceleration: 9.8 m/s^2
Each direction of XYZ axes

Shock: Free fall from 50 mm in height

● Reference operating conditions

Reference temperature: 23 °C ± 2 °C

Temperature variation: ±5 °C/h

Reference humidity: 50 % ± 10 %RH

Magnetic field: Geomagnetism

Power supply voltage: Alternating current, Direct current: Reference value ±1 %

● Transportation and Storage environment conditions

Vibration:

Number of vibration [Hz]	Level		Attenuation slope [dB/oct]
	(m/s^2)^2/Hz	[g^2(1)/Hz]	
3	0.048	(0.0005)	—
3 to 6	—	—	+13.75
6 to 18	1.15	(0.012)	—
18 to 40	—	—	–9.34
40	0.096	(0.001)	—
40 to 200	—	—	–1.29
200	0.048	(0.0005)	—

The effective value of the acceleration is 5.8 m/s^2 [0.59 g (1)] within the number of vibration.
NOTE: (1) g = 9.806658 m/s^2

Shock: Height 60 cm or less

Temperature: –40 to +70 °C

Humidity: Less than 5 to 95 %RH (Non condensing)
Absolute humidity: MAX.W.C 35 g/m^3 dry air at 101.3 kPa

■ Mounting and Structure

Mounting method: Wall mounting (Screws used: M4 size)

Mounting orientation: Datum plane±90°

Case color: Bluish white

Case material: Polyphenylene ether (PPE) GF20 (Flame retardancy UL94 V-1)

Weight: J-CVM-3/C: Approx. 1450 g
J-CVM-5/C: Approx. 1460 g

Dimensions: J-CVM-3: 200 mm × 89 mm × 105 mm (W × H × D)
J-CVM-5: 200 mm × 89 mm × 105 mm (W × H × D)
The depth does not include projecting objects such as the connectors.
For the Maximum dimensions, refer to Dimensions (P. 2-8).

■ Standard

● Safety standards

UL: UL 61010-1

cUL: CAN/CSA-C22.2 No.61010-1

● Other approved standards

CE marking: LVD: EN61010-1
EMC: EN61326-1
RoHS: EN IEC 63000

● Environment Condition

Protection against electric shock:
Class I

Overvoltage category: OVERVOLTAGE CATEGORY II

Pollution degree: POLLUTION DEGREE 2

Altitude: Altitude up to 2000 m (Indoor use)

MEMO

COMMUNICATION DATA THAT ARE INITIALIZED/ MODIFIED WHEN SETTING IS CHANGED

10

This chapter describes the communication data that are initialized/modified when setting is changed.

NOTE
Make sure all settings are recorded before changing the set values.

NOTE
Check all set values after having changed the settings.

10.1 When Input Range Number Is Changed

If you change the input range number, the following communication data of the channel for which the input range number is changed is initialized*.

* Settings are reset to the factory preset values.

Input range number [Data type: Engineering setting data]
RKC communication identifier: XI
Modbus register address (HEX): 0320H to 032FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Set value (SV)	**S1**	0080 to 008F	0
	Proportional band [heat-side]	**P1**	0090 to 009F	10.0
	PV bias	**PB**	00D0 to 00DF	0.0
	Event 1 set value	**A1**	00E0 to 00EF	0.0
	Event 2 set value	**A2**	00F0 to 00FF	0.0
	Start determination point	**SX**	0190 to 019F	0.0
	Input error determination point (high)	**AV**	01B0 to 01BF	Input scale high (high limit value of input range)
	Input error determination point (low)	**AW**	01C0 to 01CF	Input scale low (low limit value of input range)
	AT bias	**GB**	0220 to 022F	0.0
	LBA deadband (LBD)	**V2**	0270 to 027F	0.0
	Decimal point position monitor	**XU**	02F0 to 02FF	Decimal point position same as input range
	Input scale high monitor	**XV**	0300 to 03FF	High limit value of input range
	Input scale low monitor	**XW**	0310 to 031F	Low limit value of input range

10.2 When Event 1 type Is Changed

If you change the Event 1 type, the data range of the Event 1 set value for which the Event 1 type is changed changes according to the setting. When the Event 1 set value of the changed channel is out of the changed data range, it is limited to the minimum value or maximum value of the data range.

Event 1 type [Data type: Engineering setting data]
RKC communication identifier: XA
Modbus register address (HEX): 0360H to 036FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Data range
Normal setting data	Event 1 set value	**A1**	00E0 to 00EF	• Deviation high, Deviation low –Input span to +Input span • Deviation high/low, Band 0.0 to Input span • Process high, Process low Input scale low to Input scale high (Low limit of input range to High limit of input range)

10.3 When Event 2 type Is Changed

If you change the Event 2 type, the data range of the Event 2 set value for which the Event 2 type is changed changes according to the setting. When the Event 2 set value of the changed channel is out of the changed data range, it is limited to the minimum value or maximum value of the data range.

Event 2 type [Data type: Engineering setting data]
RKC communication identifier: XB
Modbus register address (HEX): 0370H to 037FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Data range
Normal setting data	Event 2 set value	**A2**	00F0 to 00FF	• Deviation high, Deviation low –Input span to +Input span • Deviation high/low, Band 0.0 to Input span • Process high, Process low Input scale low to Input scale high (Low limit of input range to High limit of input range)

10.4 When Set Value (SV) Is Changed

If you change the Set value (SV), the communication data "Autotuning (AT)" of the channel for which the Set value (SV) is changed is initialized*. * Settings are reset to the factory preset values.

Set value (SV) [Data type: Normal setting data]
RKC communication identifier: S1
Modbus register address (HEX): 0080H to 008FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Autotuning (AT)	**G1**	0110 to 011F	0 (PID control)

10.5 When PV Bias Is Changed

If you change the PV bias, the communication data "Autotuning (AT)" of the channel for which the PV bias is changed is initialized*. * Settings are reset to the factory preset values.

PV bias [Data type: Normal setting data]
RKC communication identifier: PB
Modbus register address (HEX): 00D0H to 00DFH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Autotuning (AT)	**G1**	0110 to 011F	0 (PID control)

10.6 When Operation Mode Is Changed

If you change the Operation mode, the communication data "Autotuning (AT)" of the channel for which the Operation mode is changed is initialized*. * Settings are reset to the factory preset values.

Operation mode [Data type: Normal setting data]
RKC communication identifier: EI
Modbus register address (HEX): 0100H to 010FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Autotuning (AT)	**G1**	0110 to 011F	0 (PID control)

10.7 When Auto/Manual Transfer Is Changed

If you change the Auto/Manual transfer, the communication data "Autotuning (AT)" of the channel for which the Auto/Manual transfer is changed is initialized*. * Settings are reset to the factory preset values.

Auto/Manual transfer [Data type: Normal setting data]
RKC communication identifier: J1
Modbus register address (HEX): 0120H to 012FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Autotuning (AT)	**G1**	0110 to 011F	0 (PID control)

10.8 When Output Limiter High/Low Is Changed

If you change the output limiter upper limit or output limiter lower limit, the communication data "Autotuning (AT)" of the channel for which the output limiter is changed is initialized*.

* Settings are reset to the factory preset values.

Output limiter high [heat-side] [Data type: Normal setting data]
RKC communication identifier: OH
Modbus register address (HEX): 0140H to 014FH
Output limiter low [heat-side] [Data type: Normal setting data]
RKC communication identifier: OL
Modbus register address (HEX): 0150H to 015FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Autotuning (AT)	**G1**	0110 to 011F	0 (PID control)

10.9 When PV Digital Filter Is Changed

If you change the PV digital filter, the communication data "Autotuning (AT)" of the channel for which the PV digital filter is changed is initialized*. * Settings are reset to the factory preset values.

PV digital filter [Data type: Normal setting data]
RKC communication identifier: F1
Modbus register address (HEX): 0170H to 017FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Autotuning (AT)	**G1**	0110 to 011F	0 (PID control)

10.10 When AT Bias Is Changed

If you change the AT bias, the communication data “Autotuning (AT)” of the channel for which the AT bias is changed is initialized*. * Settings are reset to the factory preset values.

AT bias [Data type: Normal setting data]
RKC communication identifier: GB
Modbus register address (HEX): 0220H to 022FH

Data type	Name	RKC communication identifier	Modbus register address (HEX)	Initial value
Normal setting data	Autotuning (AT)	**G1**	0110 to 011F	0 (PID control)

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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