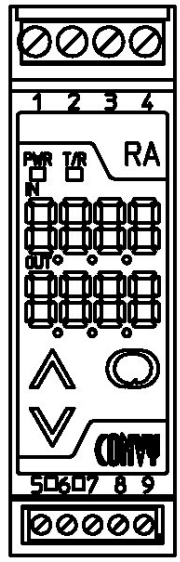
REMOTE I/O

RA SERIES

INSTRUCTION MANUAL



CONVY

Preface

Thank you for purchasing the (ONYU Remote I/O RA series.
This manual contains instructions for the mounting, functions, operations and notes when operating the RA series. To prevent accidents arising from the misuse of this instrument, please ensure the operator receives this manual.

Notes

- This instrument should be used in accordance with the specifications described in the manual. If it is not used according to the specifications, it may malfunction or cause fire.
- Be sure to follow the warnings, cautions and notices. If they are not observed, serious injury or malfunction may occur.
- Specifications, external appearance of the RA series and the contents of this instruction manual are subject to change without notice.
- Care has been taken to assure that the contents of this instruction manual are correct, but if there are any doubts, mistakes or questions, please inform our sales department.
- This instrument is designed to be installed on a DIN rail within a control panel. If it is not, measures must be taken to ensure that the operator does not touch power terminals or other high voltage sections.
- Any unauthorized transfer or copying of this document, in part or in whole, is prohibited.
- Shinko Technos CO., LTD. is not liable for any damages or secondary damages incurred as a result of using this product, including any indirect damages.

SAFETY PRECAUTIONS (Be sure to read these precautions before using our products.)
The safety precautions are classified into categories: “Warning” and “Caution”.
Depending on circumstances, procedures indicated by ⚠ Caution may be linked to serious results, so be sure to follow the directions for usage.

⚠ Warning Procedures which may lead to dangerous conditions and cause death or serious injury, if not carried out properly.

⚠ Caution Procedures which may lead to dangerous conditions and cause superficial to medium injury or physical damage or may degrade or damage the product, if not carried out properly.

⚠ Warning

- To prevent an electric shock or fire, only Shinko or qualified service personnel may handle the inner assembly.
- To prevent an electric shock, fire or damage to the instrument, parts replacement may only be undertaken by Shinko or qualified service personnel.

⚠ Safety precautions

- To ensure safe and correct use, thoroughly read and understand this manual before using this instrument.
- This instrument is intended to be used for industrial machinery, machine tools and measuring equipment. Verify correct usage after consulting purpose of use with our agency or main office. (Never use this instrument for medical purposes with which human lives are involved.)
- External protection devices such as protection equipment against excessive temperature rise, etc. must be installed, as malfunction of this product could result in serious damage to the system or injury to personnel. Also proper periodic maintenance is required.
- This instrument must be used under the conditions and environment described in this manual. Shinko Technos Co., Ltd. does not accept liability for any injury, loss of life or damage occurring due to the instrument being used under conditions not otherwise stated in this manual.

Caution with respect to Export Trade Control Ordinance

To avoid this instrument from being used as a component in, or as being utilized in the manufacture of weapons of mass destruction (i.e. military applications, military equipment, etc.), please investigate the end users and the final use of this instrument.
In the case of resale, ensure that this instrument is not illegally exported.

1. Installation precautions

⚠ Caution

This instrument is intended to be used under the following environmental conditions (IEC61010-1): Overvoltage category Ⅱ, Pollution degree 2
Ensure the mounting location corresponds to the following conditions:

- A minimum of dust, and an absence of corrosive gases
- No flammable, explosive gases
- No mechanical vibrations or shocks
- No exposure to direct sunlight, an ambient temperature of -5 to 55℃ (23 to 131℉) that does not change rapidly
- An ambient non-condensing humidity of 35 to 85%RH
- No large capacity electromagnetic switches or cables through which large current is flowing
- No water, oil or chemicals or where the vapors of these substances can come into direct contact with the unit
- When installing this unit within a control panel, take note that ambient temperature of this unit as well as the control panel must not exceed 55℃. Otherwise the life of electronic components (especially electrolytic capacitor) may be shortened.

Note • Do not install this instrument near flammable material even though the case of this instrument is made of flame-resistant resin.
Avoid setting this instrument directly on flammable material.

2. Wiring precautions

⚠ Caution

- Do not leave bits of wire in the instrument, because they could cause fire or malfunction.
- When wiring terminals, use ferrules with an insulation sleeve and crimping pliers made by Phoenix Contact GMBH & CO. applicable to terminals.
- Tighten the terminal screw within the specified torque. If excessive force is applied to the screw when tightening, the screw or case may be damaged.
- This instrument has no built-in power switch, circuit breaker or fuse. It is necessary to install them near the instrument.
  (Recommended fuse: Time-lag fuse, rated voltage 250V AC, rated current 2A)
- For wiring of AC power source, be sure to use exclusive terminals as described in this manual. If AC power source is connected to incorrect terminals, the unit will burn out.
- For a 24V DC power source, do not confuse polarity.
- Do not apply a commercial power source to the sensor connected to the input terminal nor allow the power source to come into contact with the sensor, as the input circuit may burn out.
- Use a thermocouple, compensating lead wire and 3-wire system RTD according to the sensor input specifications of this unit.
- When using DC voltage and current input, do not confuse polarity when wiring.
- Keep the input wire (TC, RTD, etc.), power line and communication line away from one another.

3. Running and maintenance precautions

⚠ Caution

- Do not touch live terminals. This may cause electric shock or problems in operation.
- Turn the power supply to the instrunment OFF when retightening the terminal or cleaning. Working or touching the terminal with the power switched ON may result in severe injury or death due to Electric Shock.
- Use a soft, dry cloth when cleaning the instrument.
  (Alcohol based substances may tarnish or deface the unit.)
- As the display section is vulnerable, do not strike or scratch it with a hard object or press hard on it.

Characters used in this manual

Indication	-1	0	1	2	3	4	5	6	7	8	9	℃	℉
Number, ℃/℉	-1	0	1	2	3	4	5	6	7	8	9	℃	℉
Indication	A	b	c	d	E	F	G	H	I	J	K	L	M
Alphabet	A	B	C	D	E	F	G	H	I	J	K	L	M
Indication	n	o	P	q	r	S	T	U	V	W	X	Y	Z
Alphabet	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

means that no character is indicated (unlit) on the display.

--- CONTENTS ---

Page

1. Model
1.1 Model ---- 5
1.2 How to read the model label ---- 5
2. Name and functions of the sections ---- 6
3. System configuration ---- 7
4. Mounting
4.1 External dimensions ---- 7
4.2 Mounting to and removal from the DIN rail ---- 8
5. Wiring
5.1 Recommended ferrules ---- 9
5.2 Terminal arrangement and circuit configuration ---- 9
5.3 Wiring ---- 10
6. Operation flowchart ---- 12
7. Setup ---- 14
7.1 Indication after power-on ---- 15
7.2 Basic operation of settings ---- 16
7.3 Setup of the unit ---- 17
7.4 Communication parameters setting ---- 21
8. Communication
8.1 Communication procedure ---- 22
8.2 Private protocol ---- 22
8.3 Modbus protocol ---- 27
8.4 Communication command table ---- 34
9. Running
9.1 Indication after power-on ---- 41
9.2 Running ---- 43
10. Adjustment
10.1 Basic operation of adjustment ---- 44
10.2 Adjustment ---- 45
11 Specifications ---- 46
12. Troubleshooting
12.1 Indication ---- 49
12.2 Key operation ---- 50
12.3 Running ---- 50
12.4 Communication ---- 50
13. Character table ---- 51

1. Model

1.1 Model

RA series

RA □ – □			Series name: RA
Remote I/O input unit	U		Universal (*)
	E		Thermocouple
	R		RTD
	A		DC current
	V		DC voltage
	P		Potentiometer
Remote I/O output unit	O		DC voltage, DC current
Power supply		0	100 to 240V AC
		1	24V AC/DC

(*) RAU (Universal input unit) accepts all types of input (thermocouple, RTD, DC current, DC voltage and potentiometer).

(e.g.) RAU-0

Remote I/O type: Universal input, Power supply: 100 to 240V AC

Default value: Input; K -200 to 1370℃

1.2 How to read the model label

The model label is attached to the left side of the case.

[RAU, RAE, RAR, RAA, RAV, RAP]

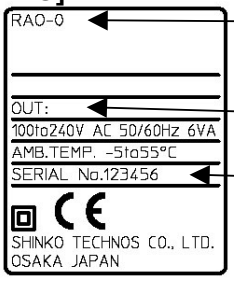
Model

Input (Enter a range selected during Input range selection.)

Serial number

(Fig. 1.2-1)

[RAO]



Model

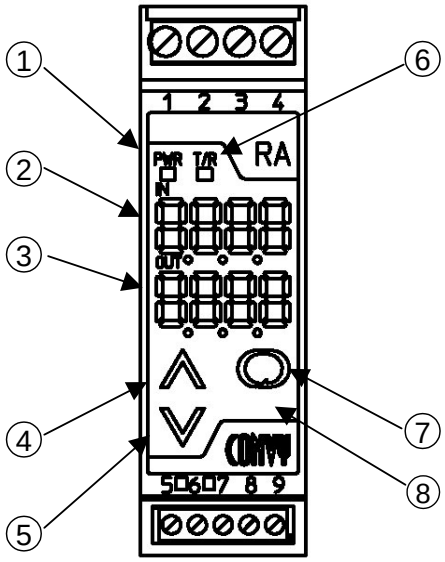
Output (Enter a range selected during Output type selection.)

Serial number

(Fig. 1.2-2)

2. Name and functions of the sections

[RAU, RAE, RAR, RAA, RAV, RAP]



(Fig.2.1)

①**Power indicator** (Green)
The green LED lights when the power to the instrument is turned on.

②**Input display** (Red)
Indicates the input value during Run mode.
Indicates characters of setting (or adjustment) item during the Setup, Communication parameter setting and Adjustment mode.

③**Input % display** (Green)
Indicates the input value (%) during Run mode.
Indicates set (or adjusted) value during the Setup, Communication parameter setting and Adjustment mode.

④**Up key** (∧):Increases the numeric value, or switches the selection items.

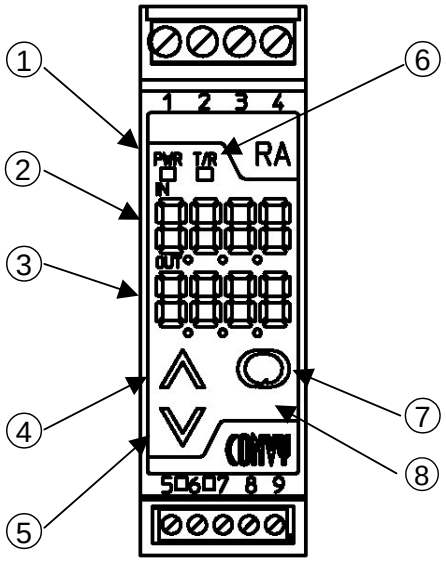
⑤**Down key** (∨): Decreases the numeric value, or switches the selection items.

⑥**Communication indicator** (Yellow)
A yellow LED lights when sending data (TX output).

⑦**Mode key** (○)
Switches the setting mode, and registers the set (or selected) value.
By holding down this key for approx. 3 seconds, the unit proceeds to the Adjustment mode.

⑧**Sub-mode key** (▭)
If the Mode key is pressed while holding down this key, the unit proceeds to the Setup mode.

[RAO]



(Fig.2.2)

①**Power indicator** (Green)
The green LED lights when the power to the instrument is turned on.

②**Setting character display** (Red)
Indicates characters of setting (or adjustment) item during the Setup, Communication parameter setting and Adjustment mode.

③**Output % display** (Green)
Indicates the output volume (%) during Run mode.
Indicates set (or adjusted) value during the Setup, Communication parameter setting and Adjustment mode.

④**Up key** (∧): Increases the numeric value, or switches the selection items.

⑤**Down key** (∨): Decreases the numeric value, or switches the selection items.

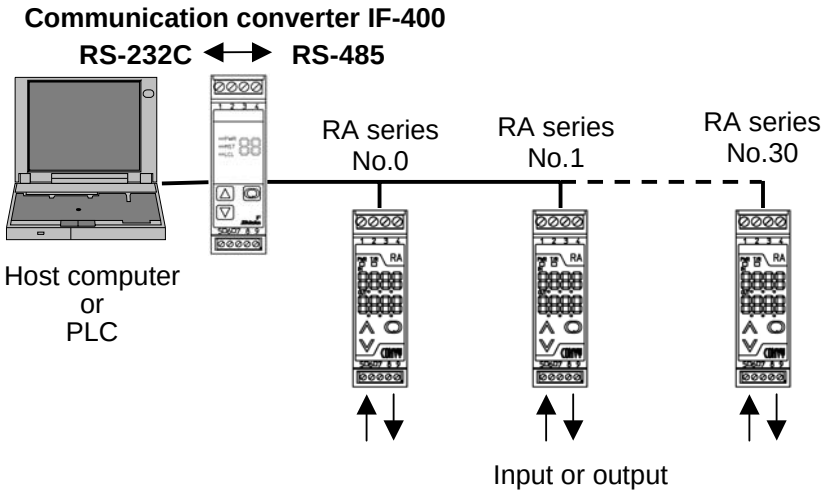
⑥**Communication indicator** (Yellow)
A yellow LED lights when sending data (TX output).

⑦**Mode key** (○)
Switches the setting mode, and registers the set (or selected) value.
By holding down this key for approx. 3 seconds, the unit proceeds to the Adjustment mode.

⑧**Sub-mode key** (▭)
If the Mode key is pressed while holding down this key, the unit proceeds to the Setup mode.

3. System configuration

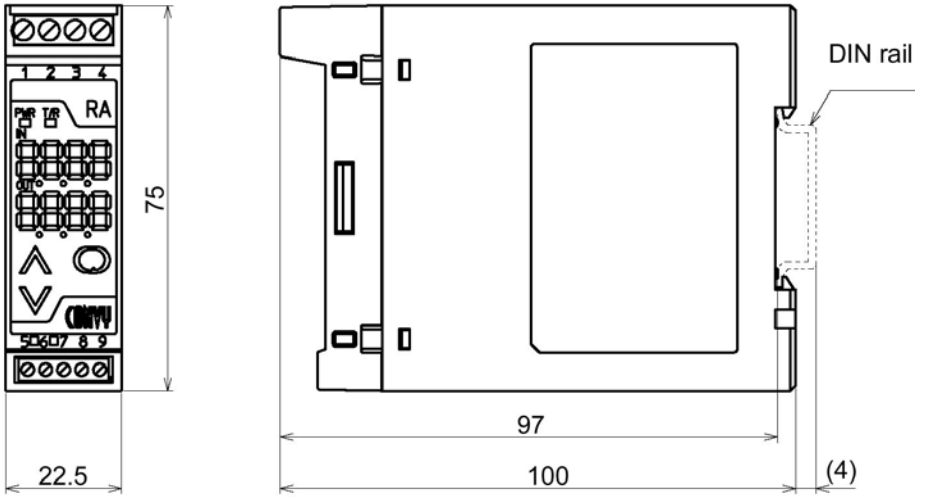
The following shows the system configuration of the RA series.
When Shinko communication converter (IF-400) is used as a repeater, up to 3 units of the repeater and up to 95 units of the RA series can be connected.
Refer to the Instruction manual for the IF-400 series for details.



(Fig. 3-1)

4. Mounting

4.1 External dimensions (unit: mm)



(Fig. 4.1-1)

4.2 Mounting to and removal from the DIN rail

⚠ Caution

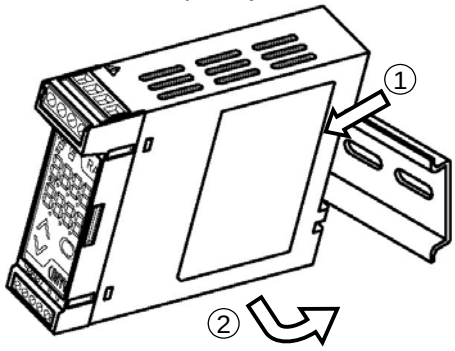
- **Mount the DIN rail horizontally.**
- **To remove this instrument, a flat bladed screwdriver is required for pulling down the release lever.**
  Never turn the screwdriver when inserting it into the release lever.
  If excessive power is applied to the lever, it may break.
- **Be sure to use commercially available fastening plates at both ends of the unit if it is in a position susceptible to vibration or shock.**

Recommended fastening plate

Manufacturer	Model
Omron corporation	End plate PFP-M
IDEC corporation	Fastening plate BNL6
Matsushita electric works, LTD.	Fastening plate ATA4806

Mounting to the DIN rail (Fig. 4.2-1)

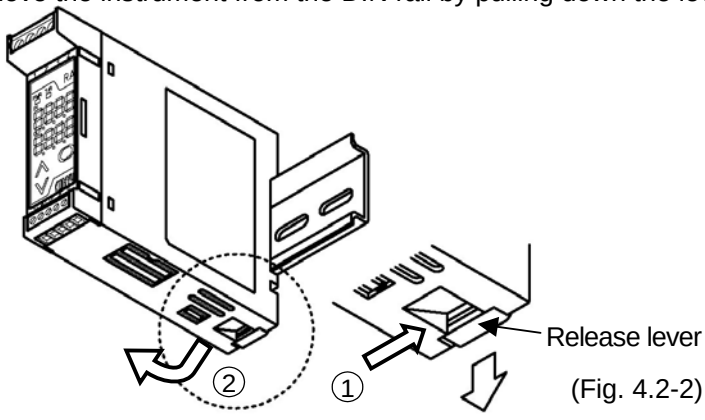
- Hook ① of the instrument on the upper side of the DIN rail.
- Making ① part of the instrument as a support, fit the lower part ② of the instrument to the DIN rail.
  The unit will be completely fixed to the DIN rail when a “Click” sound is heard.



(Fig. 4.2-1)

Removal from the DIN rail (Fig.4.2-2)

- Insert a flat bladed screwdriver into the release lever (①).
- Remove the instrument from the DIN rail by pulling down the lever (②).



(Fig. 4.2-2)

5. Wiring

⚠ Warning

Turn the power supply to the instrument off before wiring.
Working or touching the terminal with the power switched on may result in severe injury or death due to Electric Shock.

5.1 Recommended ferrules

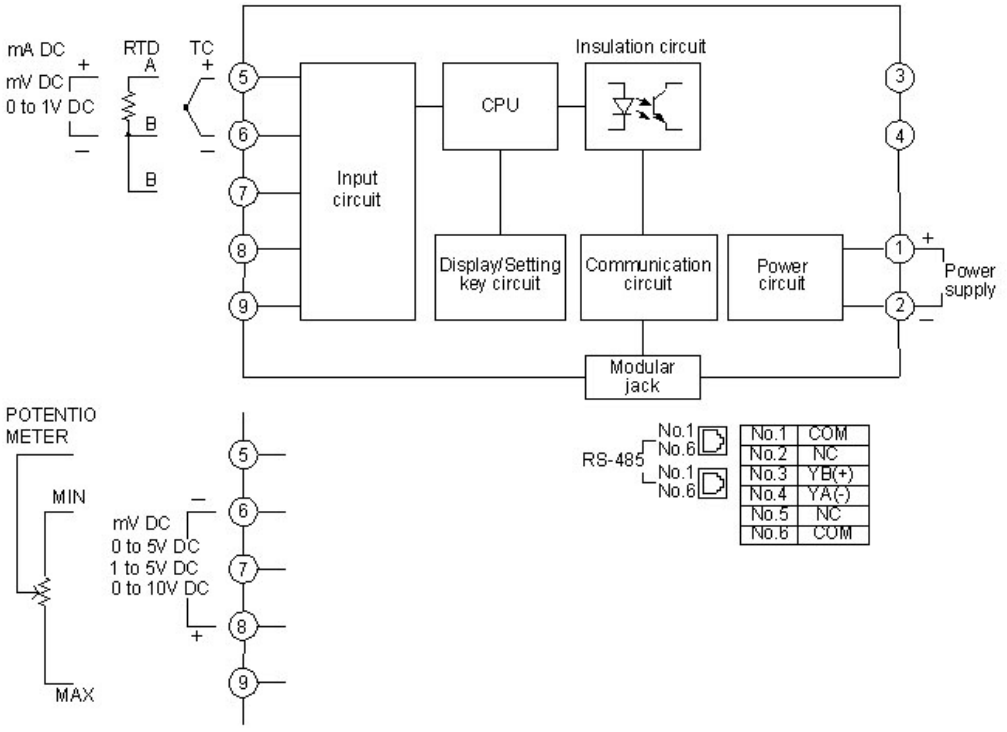
When using ferrules, use the following recommended ferrules and crimping pliers made by Phoenix Contact GMBH &CO. See (Table 5.1-1).

Take note that screw size and tightening torque differ depending on the terminal number. (Table 5.1-1)

Terminal number	Terminal screw	Ferrules with insulation sleeve	Conductor cross sections	Tightening torque	Crimping pliers
1 to 4	M2.6	AI 0.25-8 YE	0.2 to 0.25mm^2	0.5 to 0.6N•m	CRIMPFOX ZA 3 CRIMPFOX UD 6
		AI 0.34-8 TQ	0.25 to 0.34mm^2		
		AI 0.5-8 WH	0.34 to 0.5mm^2		
		AI 0.75-8 GY	0.5 to 0.75mm^2		
		AI 1.0-8 RD	0.75 to 1.0mm^2		
		AI 1.5-8 BK	1.0 to 1.5mm^2		
5 to 9	M2.0	AI 0.25-8 YE	0.2 to 0.25mm^2	0.22 to 0.25N•m	
		AI 0.34-8 TQ	0.25 to 0.34mm^2		
		AI 0.5-8 WH	0.34 to 0.5mm^2		

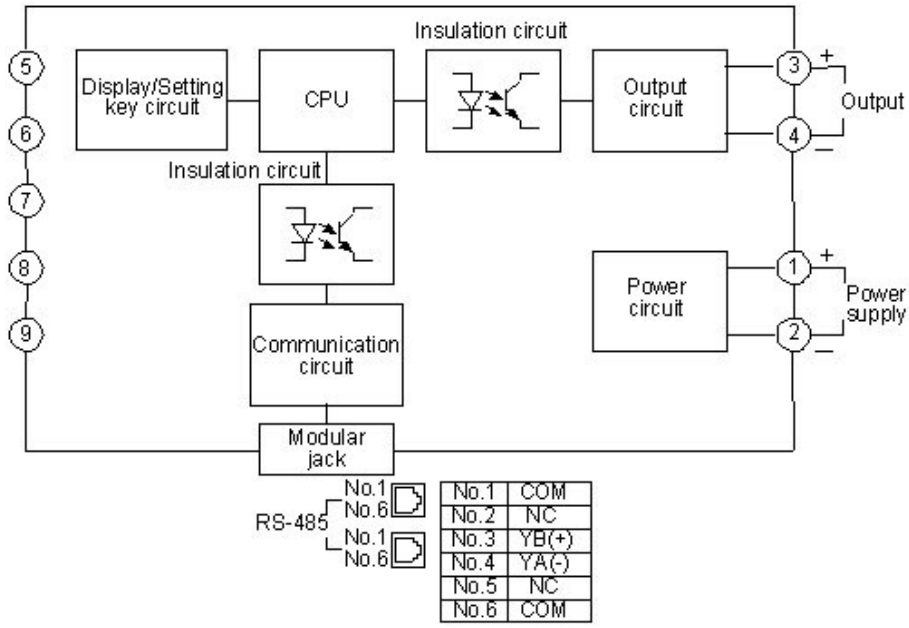
5.2 Terminal arrangement and circuit configuration

[RAU, RAE, RAR, RAA, RAV, RAP]



(Fig. 5.2-1)

[RAO]



(Fig. 5.2-2)

5.3 Wiring

⚠ Warning

- For 100 to 240V AC, if AC power source is connected to incorrect terminals, this instrument will burn out.
- For a 24V DC power source, do not confuse polarity when wiring.

5.3.1 Power supply wiring

Use terminals ①(+) and ②(-) for the power supply to the instrument. (Fig. 5.2-1, 5.2-2)

5.3.2 Input, Output wiring

[RAU, RAE, RAR, RAA, RAV, RAP]

Terminals to connect are different depending on the input specifications. (Fig. 5.2-1)
For the RAU (DC current input), RAA: Use terminals ⑤(+), ⑥(-) for input wiring and shunt resistor (sold separately) connection. (See Table 5.3.2-1)
(Table 5.3.2-1)

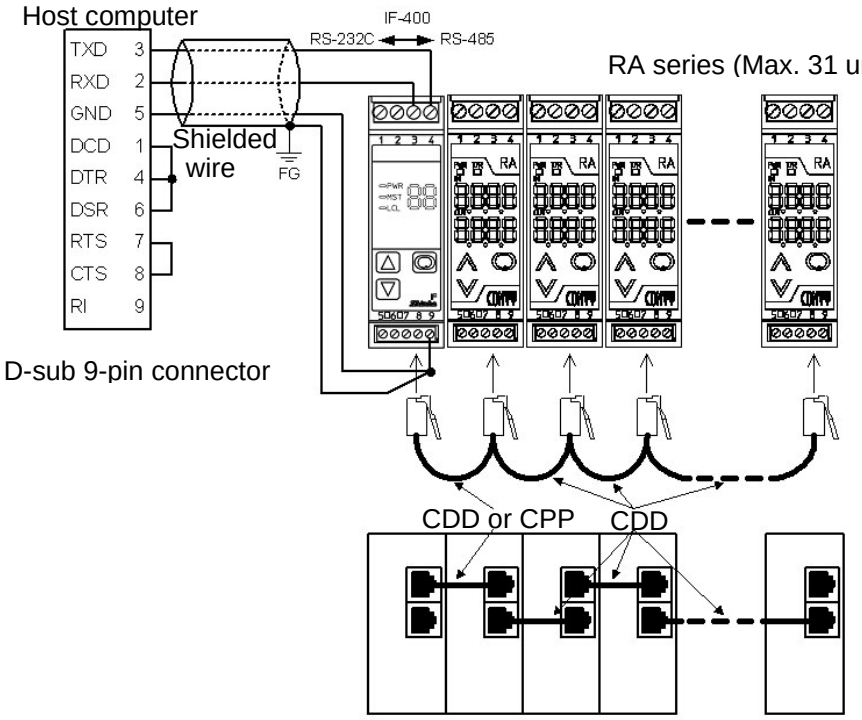
Input	Shunt resistor	
	Model	Specification
4 to 20mA DC, 0 to 20mA DC, 0 to 16mA DC	RES-S02-050	50Ω ±0.1%
2 to 10mA DC, 0 to 10mA DC	RES-S02-100	100Ω ±0.1%
1 to 5mA DC	RES-S02-200	200Ω ±0.1%
0 to 1mA DC	RES-S02-01K	1kΩ ±0.1%

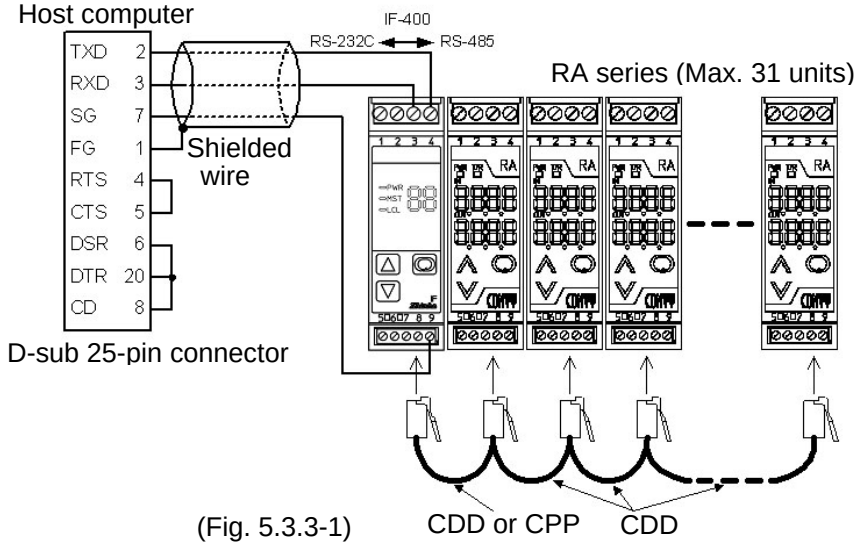
[RAO]

Use terminals ③(+) and ④(-) for the output wiring. (Fig. 5.2-2)

5.3.3 Communication wiring

Wire the communication line, referring to (Fig.5.3.3-1)
When using Shinko communication converter (IF-400) as a repeater, up to 3 units of the repeater and up to 95 units of the RA series can be connected.
Refer to the Instruction manual for the IF-400 for details.





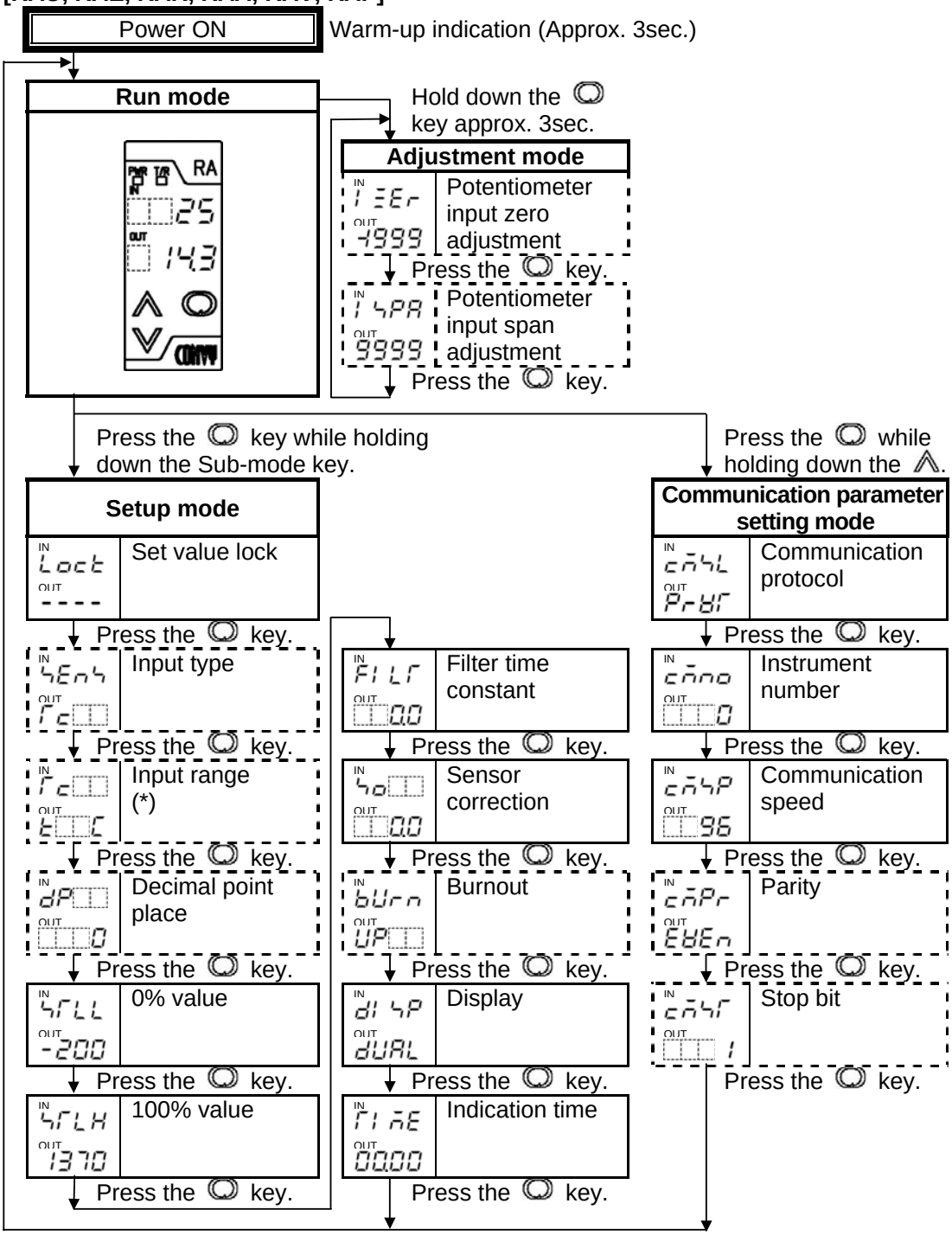
(Fig. 5.3.3-1)

Shielded wire

Connect only one side of the shielded wire to the FG terminal so that current cannot flow to the shielded wire.
If both sides of the shielded wire are connected to the FG terminal, the circuit will be closed between the shielded wire and the ground. As a result, current will run through the shielded wire and this may cause noise.
Be sure to ground FG terminal.
Recommended cable: OTSC-VB 2PX0.5SQ (made by Onamba Co., Ltd.) or equivalent

6. Operation flowchart

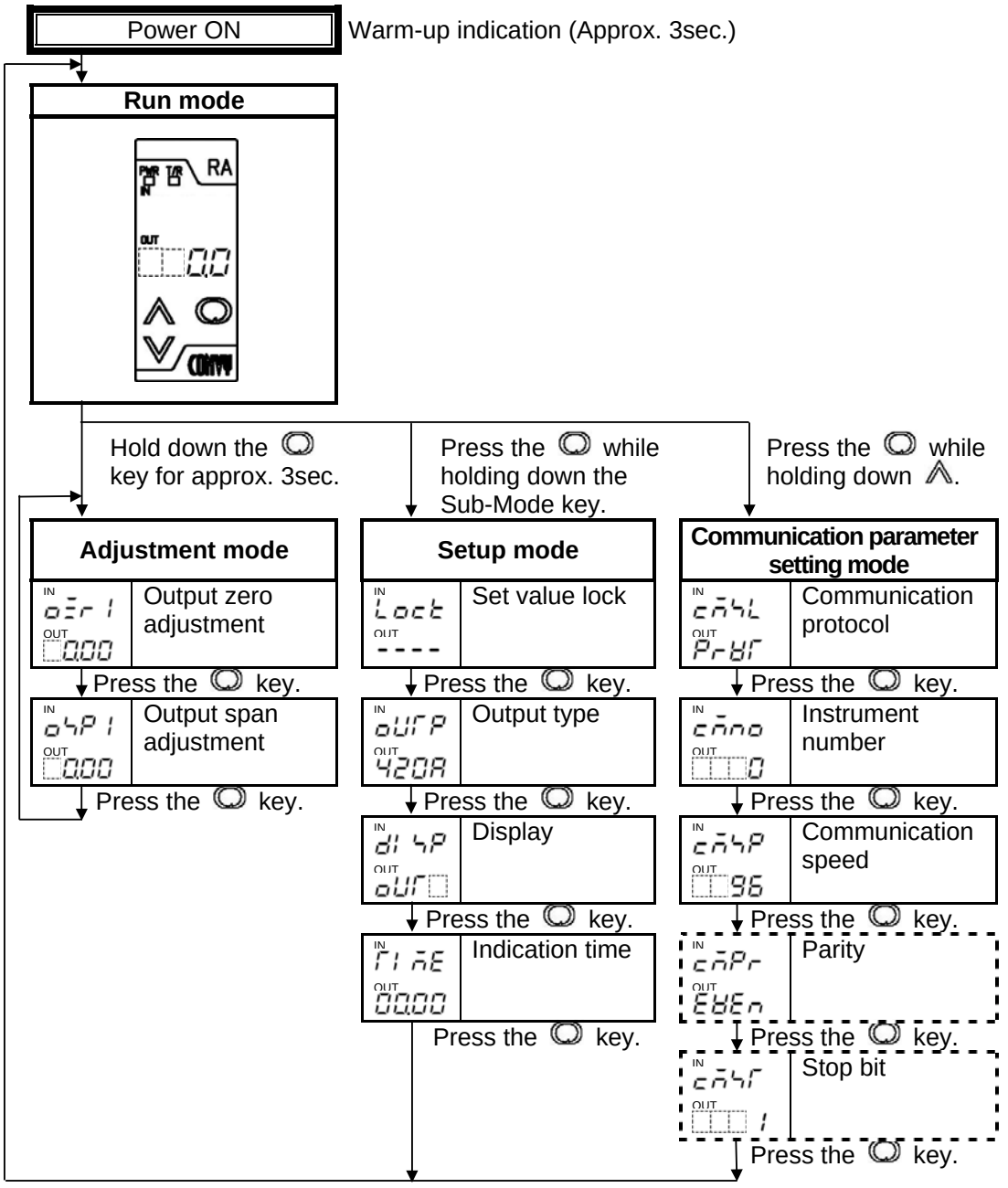
[RAU, RAE, RAR, RAA, RAV, RAP]



- The items with dotted lines are not indicated depending on the specification.
- Adjustment mode is available for the RAP or RAU potentiometer input type.
  To return from Adjustment to Run mode, hold down the key for approx. 3 sec. From any setting item in Adjustment mode, it is possible to return to Run mode.

(*) Selected item differs depending on the Input type.

[RAO]



- The items with dotted lines are not indicated depending on the specification.
- To return from Adjustment to Run mode, hold down the key for approx. 3sec. From any setting item in Adjustment mode, it is possible to return to Run mode.

7. Setup

Setup and communication parameter setting should occur before using this unit.
Default value: (Table 7-1), (Table 7-2), (Table 7-3)
If the users' specification is the same as the default value of the instrument, or if setup has already been completed, it is not necessary to set up the instrument.
Proceed to Chapter "8. Communication".

Setup [RAU, RAE, RAR, RAA, RAV, RAP]

(Table 7-1)

Setting item	Default value	
Set value lock	Unlock	
Input type	Thermocouple (Available only for RAU)	
Input range	RAU, RAE	K –200 to 1370℃
	RAR	Pt100 –200 to 850℃
	RAA	4 to 20mA DC –1999 to 9999
	RAV	1 to 5V DC –1999 to 9999
	RAP	Not available
Decimal point place	No decimal point	
0% value	RAU, RAE, RAR	-200℃
	RAA, RAV, RAP	-1999
100% value	RAU, RAE	1370℃
	RAR	850℃
	RAA, RAV, RAP	9999
Filter time constant	0.0sec	
Sensor correction	0.0℃	
Burnout	Upscale (Available for RAE, RAR, or when thermocouple or RTD is selected during RAU input type selection)	
Display	Input value/Input % display	
Indication time	00.00 (continuous)	

Setup [RAO]

(Table 7-2)

Setting item	Default value
Set value lock	Unlock
Output type	4 to 20mA DC
Display	Output % display
Indication time	00.00 (continuous)

Communication parameter setting

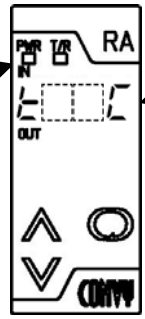
(Table 7-3)

Setting item	Default value
Communication protocol	Private
Instrument number	0
Communication speed	9600bps
Parity	Even (Not available if Private protocol is selected during Communication protocol selection.)
Stop bit	1 (Not available if Private protocol is selected during Communication protocol selection.)

7.1 Indication after power-on

After power supply to the unit is turned on, warm-up status below (Fig. 7.1-1, 7.1-2) is indicated for approx. 3sec.

[RAU, RAE, RAR, RAA, RAV, RAP]



Lights when power-on.

Indicates the input range.
Indicates E C for the RAU (Default: K, -200 to 1370℃).

(Fig. 7.1-1)

[RAO]

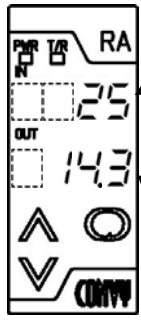
Lights when power-on.

Indicates the output type.
Indicates 4 20A in the case of “4 to 20mA DC”.

(Fig. 7.1-2)

After the warm-up indication, the unit switches to the Run mode (Fig. 7.1-3, 7.1-4) as shown below.

[RAU, RAE, RAR, RAA, RAV, RAP]

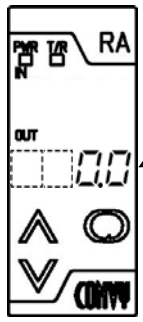


Indicates the input value.
Indicates the input value for the RAU (thermocouple). (Default: K, -200 to 1370℃)
Indicates - - - - when nothing is connected to the input terminals.

Indicates the input value in a percentage form (%).

(Fig. 7.1-3)

[RAO]



Indicates the output value in a percentage form (%).

(Fig. 7.1-4)

7.2 Basic operation of settings

Settings are conducted in the Setup and Communication parameter setting mode.

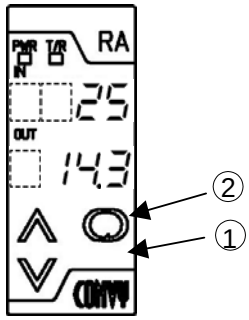
To enter the Setup mode, press the ○ key while holding down the Sub-mode key in the Run mode. (Fig. 7.2-1)

To enter the Communication parameter setting mode, press the ○ key while holding down the ∧ key in the Run mode.

To set (or select) each item, use the ∧ or ∨ key, and register the value with the ○ key. (Fig. 7.2-2)

Setup mode operation example (RAU)

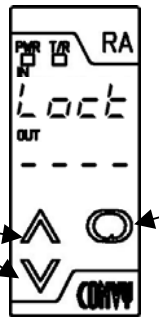
(1) Run mode



To enter the Setup mode, press the ② ○ key while holding down the ① Sub-mode key in the Run mode.

(Fig. 7.2-1)

(2) Setup mode



Sets (or selects) each setting item.

Proceeds to each setting (or selection) item, and registers the set (or selected) value.

(Fig. 7.2-2)

7.3 Setup of the unit

The following shows all setting items. To set up the unit, refer to the following.

[RAU, RAE, RAR, RAA, RAV, RAP] (For the RAO, see p.20.)

Display	Name, Function, Setting range	Default value
IN Lock OUT ----	**Set value lock selection**	Unlock
	Locks the set values to prevent setting errors. ----: Unlock Lock: Lock (None of the set values and adjusted values can be changed.)	
IN SEnS OUT Tc□□	**Input type selection**	Thermocouple
	Selects an input type. Available only for the RAU. Tc□□: Thermocouple rTd□: RTD dcA□: DC current dcV□: DC voltage PoT□: Potentiometer (Input range selection item is not indicated.)	
IN Tc□□ OUT t□□C	**Thermocouple input range selection**	K, -200 to 1370℃ (RAU, RAE)
	Selects the input range of thermocouple. Available for the RAU (thermocouple input) and RAE. t□□C: K -200 to 1370℃ t□2C: K (*) -200 to 200℃ t□4C: K (*) 0 to 400℃ J□□C: J -200 to 1000℃ J□2C: J (*) -200 to 200℃ J□4C: J (*) 0 to 400℃ r□□C: R -50 to 1760℃ S□□C: S -50 to 1760℃ b□□C: B 0 to 1820℃ E□□C: E -200 to 800℃ T□□C: T (*) -200 to 400℃ n□□C: N -200 to 1300℃ PL2C: PL-Ⅱ 0 to 1390℃ c□□C: W5Re/W26Re 0 to 2315℃ d□□C: W3Re/W25Re 0 to 2315℃	
	t□□F: K -328 to 2498℉ t□2F: K (*) -328 to 392℉ t□4F: K (*) 32 to 752℉ J□□F: J -328 to 1832℉ J□2F: J (*) -328 to 392℉ J□4F: J (*) 32 to 752℉ r□□F: R -58 to 3200℉ S□□F: S -58 to 3200℉ b□□F: B 32 to 3308℉ E□□F: E -328 to 1472℉ T□□F: T (*) -328 to 752℉ n□□F: N -328 to 2372℉ PL2F: PL-Ⅱ 32 to 2534℉ c□□F: W5Re/W26Re 32 to 4199℉ d□□F: W3Re/W25Re 32 to 4199℉	

IN rTd□ OUT Pr□C	**RTD input range selection**	Pt100, -200 to 850℃ (RAU, RAR)
	Selects RTD input range. Available for the RAU (RTD input) and RAR. Pr□C: Pt100 -200 to 850℃ Pr 1C: Pt100 (*) -100 to 100℃ JPrC: JPt100 -200 to 500℃ Pr□F: Pt100 -328 to 1562℉ Pr 1F: Pt100 (*) -148 to 212℉ JPrF: JPt100 -328 to 932℉	
IN dcA□ OUT 420A	**DC current input range selection**	4 to 20mA DC -1999 to 9999 (RAU, RAA)
	Selects DC current input range. Available for the RAU (DC current input) and RAA. 420A: 4 to 20mA DC -1999 to 9999 020A: 0 to 20mA DC -1999 to 9999 0 16A: 0 to 16mA DC -1999 to 9999 2 10A: 2 to 10mA DC -1999 to 9999 0 10A: 0 to 10mA DC -1999 to 9999 1□5A: 1 to 5mA DC -1999 to 9999 0□ 1A: 0 to 1mA DC -1999 to 9999	
IN dcb□ OUT 0 1nb or 1□5b	**DC voltage input range selection**	0 to 10mV DC -1999 to 9999 (RAU) 1 to 5V DC -1999 to 9999 (RAV)
	Selects DC voltage input range. Available for the RAU (DC voltage input) and RAV. 0 1nb: 0 to 10mV DC -1999 to 9999 -1 1nb: -10 to 10mV DC -1999 to 9999 05nb: 0 to 50mV DC -1999 to 9999 06nb: 0 to 60mV DC -1999 to 9999 00 1b: 0 to 100mV DC -1999 to 9999 0□ 1b: 0 to 1V DC -1999 to 9999 0□5b: 0 to 5V DC -1999 to 9999 1□5b: 1 to 5V DC -1999 to 9999 0 10b: 0 to 10V DC -1999 to 9999	
IN dP□□ OUT □□□0	**Decimal point place selection**	No decimal point
	Selects the decimal point place. Available for the RAU (DC current, DC voltage, potentiometer input), RAA, RAV and RAP. Available for the RAU, RAE and RAR when (*) range is selected during Input range selection. For thermocouple and RTD input, “No decimal point” or “1 digit after decimal point” can be selected. □□□0: No decimal point □□0.0: 1 digit after decimal point □0.00: 2 digits after decimal point 0.000: 3 digits after decimal point	

IN SCLL OUT -200	**0% value setting**	RAU, RAE, RAR: -200℃ RAA, RAV, RAP: -1999
	Sets a value to be indicated on the Input display when an input is 0%. Refer to **[0%, 100% value setting example]** below. Setting range: Thermocouple, RTD: Input range low limit to 100% value DC current, DC voltage, potentiometer: -1999 to 100% value	
IN SCLH OUT 1370	**100% value setting**	RAU, RAE: 1370℃ RAR: 850℃ RAA, RAV, RAP: 9999
	Sets a value to be indicated on the Input display when an input is 100%. Refer to **[0%, 100% value setting example]** below. Setting range: Thermocouple, RTD: 0% value to Input range high limit DC current, DC voltage, potentiometer: 0% value to 9999	
IN FILT OUT 0.0	**Filter time constant setting**	0.0 seconds
	Sets the filter time constant. Reduces input fluctuation caused by noise. Setting range: 0.0 to 10.0 seconds	
IN Sn□□ OUT 0.0	**Sensor correction setting**	0.0℃
	Sets the sensor correction value. Input value = Current input value + Sensor correction value Setting range: Thermocouple, RTD: -100.0 to 100.0℃ (℉) DC current, DC voltage, potentiometer: -1000 to 1000	
IN bURn OUT UP□□	**Burnout selection**	Upscale
	Selects either Upscale (110.0%) or Downscale (-10.0%) output when input is burnt out. Available for the RAU (thermocouple, RTD input), RAE and RAR. Setting range: UP□□: Upscale doUn: Downscale	
IN dISP OUT dUAL	**Display selection**	Input/Input % display
	Selects the display to be indicated. dUAL: Input/Input % display In□□: Input display oUT□: Input % display nonE: No indication (Power and communication indicators are lit.)	
IN TIME OUT 00.00	**Indication time setting**	00.00 (Continuous)
	Sets the indication time of the display after the final key operation. Not available if “No indication” is selected during Display selection (Power and communication indicators are lit). After the indication time has elapsed, the displays go off (Power and communication indicators are lit.). If power is turned on again, or if any one of the ∧, ∨, ◎ or Sub-mode key is pressed while displays are unlit, the displays will light again. Setting range: 00.00: Continuous 00.01 (1 second) to 60.00 (60 minutes) (Minute.Second)	

[0%, 100% value setting example]

(e.g.) RAU (DC current input), or RAA: 4 to 20mA DC input,
0% value: 100.0, 100% value: 300.0

Input	4mA DC (0%)	12mA DC (50%)	20mA DC (100%)
Input display	100.0	200.0	300.0
Input % display	0.0	50.0	100.0

[RAO]

Set up the unit referring to the following.

Display	Name, Function, Setting range	Default value
IN Lock OUT ----	**Set value lock selection**	Unlock
	Locks the set values to prevent setting errors. ----: Unlock Lock: Lock (None of the set value and adjusted value can be changed.)	
IN oUtP OUT 420A	**Output type selection**	4 to 20mA DC
	Selects the output type. 420A: 4 to 20mA DC 020A: 0 to 20mA DC 0 12A: 0 to 12mA DC 0 10A: 0 to 10mA DC 1□5A: 1 to 5mA DC 0□ 1V: 0 to 1V DC 0□5V: 0 to 5V DC 1□5V: 1 to 5V DC 0 10V: 0 to 10V DC	
IN di SP OUT oUt□	**Display selection**	Output % display
	Selects the display to be indicated. oUt□: Output % display nonE: No indication (Power and Communication indicators are lit.)	
IN tIME OUT 00.00	**Indication time setting**	00.00 (Continuous)
	Sets the indication time of the display after the final key operation. Not available if No indication is selected during Display selection (power and communication indicators are lit) After the indication time has elapsed, the displays go off (Power and communication indicators are lit.). If power is turned on again, or if the ∧, ∨, ○ or Sub-mode key is pressed while displays are unlit, the displays will light again. Setting range: 00.00: Continuous 00.01 (1 second) to 60.00 (60 minutes) [Minute.Second]	

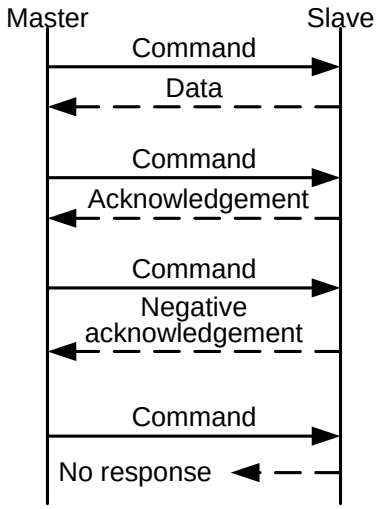
7.4 Communication parameters setting

Display	Name, Function, Setting range	Default value
IN cHnL OUT PrUr	**Communication protocol selection**	Private
	Selects the communication protocol. PrUr: Private nodA: Modbus ASCII nodr: Modbus RTU	
IN cnno OUT 0	**Instrument number setting**	0
	Sets the instrument number individually to each instrument when communicating by connecting plural instruments. Setting range 0 to 95	
IN cHsP OUT 96	**Communication speed selection**	9600bps
	Selects a communication speed equal to that of the host computer. 24: 2400bps 48: 4800bps 96: 9600bps 192: 19200bps	
IN cnPr OUT EUEn	**Parity selection**	Even
	Selects the parity. Not available if Private protocol is selected during Communication protocol selection. nonE: No parity EUEn: Even odd: Odd	
IN cHsr OUT 1	**Stop bit selection**	1
	Selects the stop bit. Not available if Private protocol is selected during Communication protocol selection. 1: 1 2: 2	

8. Communication

8.1 Communication procedure

Communication starts with command transmission from the host computer (hereafter Master) and ends with the response of the RA series (hereafter Slave).



(Fig. 8-1)

- **Response with data**
  When the master sends the reading command, the slave responds with the corresponding set value or current status.
- **Acknowledgement**
  When the master sends the setting command, the slave responds by sending the acknowledgement after processing is terminated.
- **Negative acknowledgement**
  When the master sends a non-existent command or value out of the setting range, the slave returns a negative acknowledgement.
- **No response**
  The slave will not respond to the master in case of the following.
  - Global address (Private protocol) is set.
  - Broadcast address (Modbus protocol) is set.
  - Communication error (Framing error, Parity error)
  - Checksum error (Private protocol)
  - LRC discrepancy (Modbus ASCII mode)
  - CRC-16 discrepancy (Modbus RTU mode)

Communication timing of the RS-485

Slave side

When the slave starts transmission through the communication line, the slave is arranged so as to provide an idle status (mark status) **transmission period of 1 or more characters** before sending the response to ensure the synchronization on the receiving side.

The slave is arranged so as to disconnect the transmitter from the communication line **within a 1 character transmission period** after sending the response.

Master side (Notice on programming)

Set the program so that the master can disconnect the transmitter from the communication line **within a 1 character transmission period** after sending the command in preparation for reception of the response from the slave.

To avoid a collision of transmissions between the master and the slave, send the next command after carefully checking that the master received the response.

8.2. Private protocol

8.2.1 Transmission mode

Private protocol is composed of ASCII codes.

Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.

Data format Start bit : 1 bit
Data bit : 7 bits
Parity : Even
Stop bit : 1 bit

Error detection: Checksum

8.2.2 Command configuration

All commands are composed of ASCII.
The data (set value, decimal number) is represented with hexadecimal figures.
The negative numbers are represented with 2's complement.
Numbers (1, 2, 4) below the command represent the number of characters.

(1) Setting command

Header (02H)	Address	20H	Command type(50H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(2) Reading command

Header (02H)	Address	20H	Command type(20H)	Data item	Checksum	Delimiter (03H)
1	1	1	1	4	2	1

(3) Response with data

Header (06H)	Address	20H	Command type(20H)	Data item	Data	Checksum	Delimiter (03H)
1	1	1	1	4	4	2	1

(4) Acknowledgement

Header (06H)	Address	Checksum	Delimiter (03H)
1	1	2	1

(5) Negative acknowledgement

Header (15H)	Address	Error code	Checksum	Delimiter (03H)
1	1	1	2	1

Header : Control code to represent the beginning of the command or the response.
ASCII codes are used.
Setting command, Reading command : STX (02H) fixed
Response with data, Acknowledgement: ACK (06H) fixed
Negative acknowledgement : NAK (15H) fixed

Address (Instrument number): Numbers by which the master discerns each slave.
Instrument number 0 to 94 (00H to 5EH) and Global address 95 (5FH)
The numbers (20H to 7EH) are used by giving 20H of bias.
95 (7FH) is called Global address, which is used when the same command is sent to all the slaves connected. However, a response is not returned.

Command type: Code to discern Setting command (50H) and Reading command (20H)

Data item : Data classification of the command object
Composed of hexadecimal 4 digits.
(Refer to 8.4 Communication command table.)

Data : The contents of data (set value) differ depending on the setting command.
Composed of hexadecimal 4 digits.
(Refer to 8.4 Communication command table.)

Checksum : 2-character data to detect communication errors.
(Refer to 8.2.3 Checksum calculation.)

Delimiter : Control code to represent the end of command. 03H fixed

Error code : Represents an error type. Composed of hexadecimal 1 digit.
1 (31H)-----Non-existent command
2 (32H)-----Not used
3 (33H)-----Setting outside the setting range
4 (34H)-----Unsettable status
5 (35H)-----During setting mode by keypad operation

8.2.3 Checksum calculation

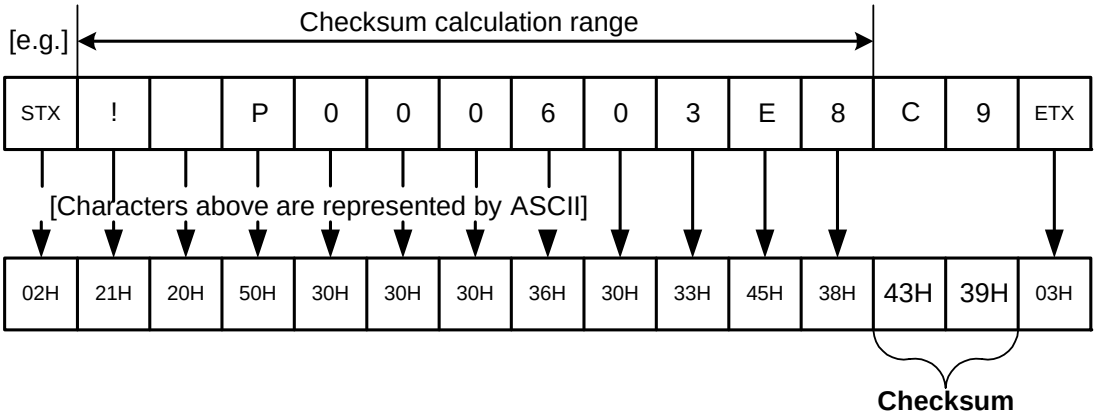
Checksum is used to detect receiving errors in the command or data.
Set the program for the master side as well to calculate the checksum of the response data from the slaves so that the communication errors can be checked.

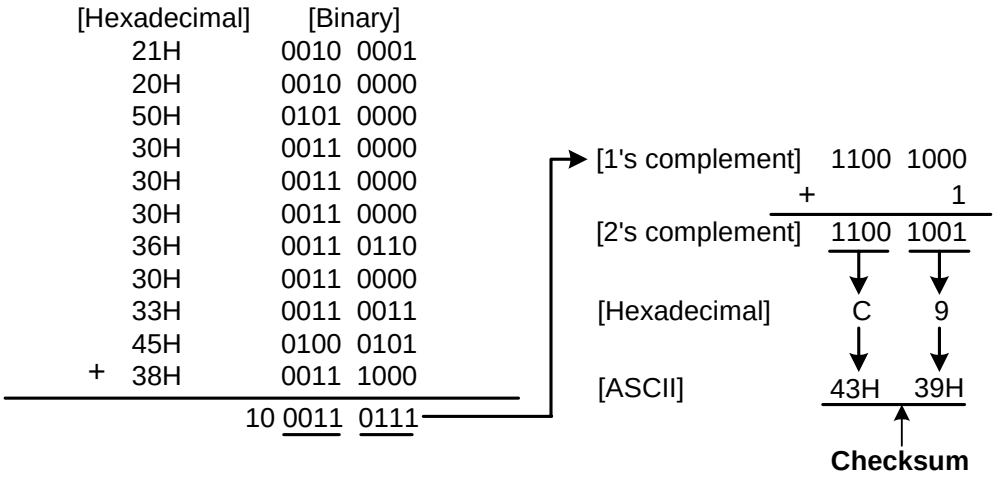
The ASCII code (hexadecimal) corresponding to the characters which range from the address to that before the checksum is converted to binary notation, and the total value is calculated.
The lower 2-digit of the total value are converted to 2's complements, and then to hexadecimal figures, that is, ASCII code for the checksum.

Checksum calculation example

100% setting: 1000℃ (03E8H)
Address (instrument number): 1 (21H)

- 1's complement: Reverse each binary bit. 0 will become 1 and vice versa.
- 2's complement: Add 1 to 1's complements.





8.2.4 Command example

(1) Setting (Address 1, 0% value)

• Setting command from the master [When setting 0% value to 0℃ (0000H)]

Header	Address		Command type
(02H)	(21H)	(20H)	(50H)

Data item [0005H]	Data [0000H]	Checksum	Delimiter
(30H 30H 30H 35H)	(30H 30H 30H 30H)	(45H 41H)	(03H)

• Response from the slave in normal status

Header	Address	Checksum	Delimiter
(06H)	(21H)	(44H 46H)	(03H)

• Negative acknowledgement from the slave during setting mode by keypad

Header	Address	Error code	Checksum	Delimiter
(15H)	(21H)	(35H)	(41H 41H)	(03H)

(2) Setting (Address 1, 100% value)

• Setting command from the master [When setting 100% value to 1000℃ (03E8H)]

Header	Address		Command type
(02H)	(21H)	(20H)	(50H)

Data item [0006H]	Data [03E8H]	Checksum	Delimiter
(30H 30H 30H 36H)	(30H 33H 45H 38H)	(43H 39H)	(03H)

• Response from the slave in normal status

Header	Address	Checksum	Delimiter
(06H)	(21H)	(44H 46H)	(03H)

• Negative acknowledgement from the slave in case of a value is out of range

Header	Address	Error code	Checksum	Delimiter
(15H)	(21H)	(33H)	(41H 43H)	(03H)

(3) Reading (Address 1, input value)

• Reading command from the master

Header	Address		Command type	Data item [0080H]	Checksum	Delimiter
(02H)	(21H)	(20H)	(20H)	(30H 30H 38H 30H)	(44H 37H)	(03H)

• Response from the slave in normal status [27℃ (001BH)]

Header	Address		Command type
(06H)	(21H)	(20H)	(20H)

Data item [0080H]	Data [001BH]	Checksum	Delimiter
(30H 30H 38H 30H)	(30H 30H 31H 42H)	(30H 34H)	(03H)

• Negative acknowledgement from the slave in case of non-existent command

Header	Address	Error code	Checksum	Delimiter
(15H)	(21H)	(31H)	(41H 45H)	(03H)

(4) Reading (Address 1, 100% value)

• Reading command from the master

Header	Address		Command type	Data item [0006H]	Checksum	Delimiter
(02H)	(21H)	(20H)	(20H)	(30H 30H 30H 36H)	(44H 39H)	(03H)

• Response from the slave in normal status [When 100% value is 1000℃ (03E8H)]

Header	Address		Command type
(06H)	(21H)	(20H)	(20H)

Data item [0006H]	Data [03E8H]	Checksum	Delimiter
(30H 30H 30H 36H)	(30H 33H 45H 38H)	(46H 39H)	(03H)

(5) Setting (Address 1, Output MV) (for RAO)

• Setting command from the master

[When setting the Output MV to 5000 (50.00%) (1388H)]

Header	Address		Command type
(02H)	(21H)	(20H)	(50H)

Data item [000EH]	Data [1388H]	Checksum	Delimiter
(30H 30H 30H 45H)	(31H 33H 38H 38H)	(43H 36H)	(03H)

• Response from the slave in normal status

Header	Address	Checksum	Delimiter
(06H)	(21H)	(44H 46H)	(03H)

8.3 Modbus protocol

8.3.1 Transmission mode

There are 2 transmission modes (ASCII and RTU) in Modbus protocol.

8.3.2 ASCII mode

Hexadecimal (0 to 9, A to F), which is divided into high order (4-bit) and low order (4-bit) out of 8-bit binary data in command is transmitted as ASCII characters.

Data format Start bit : 1 bit
Data bit : 7 bits
Parity : Even (Odd, No parity) Selectable
Stop bit : 1 bit (2 bits) Selectable

Error detection : LRC (Longitudinal Redundancy Check)

Data interval : 1 second or less (Max.1sec of interval between characters)

(1) Message configuration

ASCII mode message is configured to start by [: (colon)(3AH)] and end by [CR (carriage return) (0DH) + LF (Line feed)(0AH)].

Header (:)	Slave address	Function code	Data	Error check LRC	Delimiter (CR)	Delimiter (LF)

Slave address

Slave address is an individual instrument number on the slave side and is set within the range 0 to 95 (00H to 5FH).

The master identifies slaves by the slave address of the requested message.

The slave informs the master which slave is responding to the master by placing its own address in the response message.

Slave address 0 (00H, broadcast address) can identify all the slaves. However, slaves do not respond.

Function code

The function code is the command code for the slave to undertake the following action types.

Function code	Contents
03 (03H)	Reading the set value and information from slaves
06 (06H)	Setting to slaves

Function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master.

When acknowledgement is returned, the slave simply returns the original function code.

When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.

For example, when the master sends request message setting 10H to function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.

For negative acknowledgement, the exception code below is set to the data of the response message and returned to the master in order to inform it of what kind of error has occurred.

Exception code	Contents
1 (01H)	Illegal function (Non-existent function)
2 (02H)	Illegal data address (Non-existent data address)
3 (03H)	Illegal data value (Value out of the setting range)
17 (11H)	Illegal setting (Unsettable status)
18 (12H)	Illegal setting (During setting mode by keypad operation)

Data

Data differs depending on the function code.
A request message from the master is composed of data item, number of data and setting data. (Refer to 8.4 Communication command table.)
A response message from the slave is composed of number of bytes, data and exception code in negative acknowledgement.
Only one piece of data can be dealt with per message.
Therefore the number of data for ASCII mode is fixed as (30H 30H 30H 31H).
Effective range of data is –32768 to 32767 (8000H to 7FFFH).

Error check: 2-character data to detect communication errors
Refer to "(2) Error check of ASCII mode" below.

(2) Error check of ASCII mode

After calculating LRC (Longitudinal Redundancy Check) from the slave address to the end of data, the calculated 8-bit data is converted to two ASCII characters and are appended to the end of message.

How to calculate LRC

① Create a message in RTU mode.
② Add all the values from the slave address to the end of data. This is assumed as X.
③ Make a complement for X (bit reverse). This is assumed as X.
④ Add a value of 1 to X. This is assumed as X.
⑤ Set X as an LRC to the end of the message.
⑥ Convert the whole message to ASCII characters.

(3) Message example of ASCII mode

① **Setting (Address 1, 0% value)**

• A request message from the master [When setting 0% value to 0℃ (0000H)]

Header	Slave address	Function code	Data item [0005H]	Data [0000H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 35H)	(30H 30H 30H 30H)	(46H 34H)	(0DH 0AH)

• Response message from the slave in normal status

Header	Slave address	Function code	Data item [0005H]	Data [0000H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 35H)	(30H 30H 30H 30H)	(46H 34H)	(0DH 0AH)

• Response message from the slave in exception status (during setting mode by keypad)
The function code MSB is set to 1 for the response message in exception (error) status, and 86H (38H 36H) is returned.
The exception code 12H (31H 32H: During setting mode by keypad) is returned.

Header	Slave address	Function code	Exception code [12H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(38H 36H)	(31H 32H)	(36H 37H)	(0DH 0AH)

② **Setting (Address 1, 100% value)**

• A request message from the master [When setting 100% value to 1000℃ (03E8H)]

Header	Slave address	Function code	Data item [0006H]	Data [03E8H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 36H)	(30H 33H 45H 38H)	(30H 38H)	(0DH 0AH)

• Response message from the slave in normal status

Header	Slave address	Function code	Data item [0006H]	Data [03E8H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 36H)	(30H 30H 30H 36H)	(30H 33H 45H 38H)	(30H 38H)	(0DH 0AH)

• Response message from the slave in exception (error) status (Value out of the setting range)

The function code MSB is set to 1 for the response message in exception (error) status, and 86H (38H 36H) is returned.

The exception code 03H (30H 33H: Value out of the setting range) is returned.

Header	Slave address	Function code	Exception code [03H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(38H 36H)	(30H 33H)	(37H 36H)	(0DH 0AH)

③ **Reading (Address 1, input value)**

• A request message from the master

The number of data means the data items to be read, and it is fixed as 1 (30H 30H 30H 31H).

Header	Slave address	Function code	Data item [0080H]	Number of data [0001H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 33H)	(30H 30H 38H 30H)	(30H 30H 30H 31H)	(37H 42H)	(0DH 0AH)

• Response message from the slave in normal status [500℃ (01F4H)]

The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (30H 32H).

Header	Slave address	Function code	Number of response byte [02H]	Data [01F4H]	Error check LRC	Delimiter CR+LF
(3AH)	(30H 31H)	(30H 33H)	(30H 32H)	(30H 31H 46H 34H)	(30H 35H)	(0DH 0AH)

• Response message from the slave in exception (error) status (Data item is mistaken)
The function code MSB is set to 1 for the response message in exception (error) status, and 83H (38H 33H) is returned.
The exception code 02H (30H 32H: Non-existent data address) is returned.

Header	Slave address	Function code	Exception code	Error check	Delimiter
(3AH)	(30H 31H)	(38H 33H)	[02H] (30H 32H)	LRC (37H 41H)	CR+LF (0DH 0AH)

④ **Reading (Address 1, 100% value)**

• A request message from the master
The number of data means the data items to be read, and it is fixed as 1 (30H 30H 30H 31H).

Header	Slave address	Function code			
(3AH)	(30H 31H)	(30H 33H)			
	Data item [0006H] (30H 30H 30H 36H)	Number of data [0001H] (30H 30H 30H 31H)	Error check LRC (46H 35H)	Delimiter CR+LF (0DH 0AH)	

• Response message from the slave in normal status [When 100% value is set to 1000℃ (03E8H)]
The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (30H 32H).

Header	Slave address	Function code	Number of response byte		
(3AH)	(30H 31H)	(30H 33H)	[02H] (30H 32H)		
	Data [03E8H] (30H 33H 45H 38H)	Error check LRC (30H 46H)	Delimiter CR+LF (0DH 0AH)		

⑤ **Setting (Address 1, Output MV)** (for RAO)

• A request message from the master
[When setting the Output MV to 5000 (50.00%) (1388H)]

Header	Slave address	Function code			
(3AH)	(30H 31H)	(30H 36H)			
	Data item [000EH] (30H 30H 30H 45H)	Data [1388H] (31H 33H 38H 38H)	Error check LRC (35H 30H)	Delimiter CR+LF (0DH 0AH)	

• Response message from the slave in normal status

Header	Slave address	Function code			
(3AH)	(30H 31H)	(30H 36H)			
	Data item [000EH] (30H 30H 30H 45H)	Data [1388H] (31H 33H 38H 38H)	Error check LRC (35H 30H)	Delimiter CR+LF (0DH 0AH)	

8.3.3 RTU mode

8-bit binary data in command is transmitted as it is.

Data format Start bit : 1 bit
Data bit : 8 bits
Parity : No parity (Even/Odd) Selectable
Stop bit : 1 bit (2 bits) Selectable

Error detection : CRC-16 (Cyclic Redundancy Check)

Data interval : 3.5 characters transmission time or less
To transmit continuously, an interval between characters which consist of one message, must be within 3.5 character transmission times.

(1) Message configuration

RTU mode is configured to start after idle time is processed for more than 3.5 character transmission and end after idle time is processed for more than 3.5 character transmission.

3.5 idle characters	Slave address	Function Code	Data	Error check CRC-16	3.5 idle characters

Slave address

Slave address is an individual instrument number on the slave side and is set within the range 0 to 95 (00H to 5FH).
The master identifies slaves by the slave address of the requested message.
The slave informs the master which slave is responding to the master by placing its own address in the response message.
Slave address 0 (00H, broadcast address) can identify all the slaves. However slaves do not respond.

Function code

The function code is the command code for the slave to undertake the following action types

Function code	Contents
03 (03H)	Reading the set value and information from slaves
06 (06H)	Setting to slaves

Function code is used to discern whether the response is normal (acknowledgement) or if any error (negative acknowledgement) has occurred when the slave returns the response message to the master.
When acknowledgement is returned, the slave simply returns the original function code.
When negative acknowledgement is returned, the MSB of the original function code is set as 1 for the response.
For example, when the master sends request message setting 10H to function code by mistake, slave returns 90H by setting the MSB to 1, because the former is an illegal function.
For negative acknowledgement, the exception code below is set to the data of the response message and returned to the master in order to inform it of what kind of error has occurred.

Exception code	Contents
1 (01H)	Illegal function (Non-existent function)
2 (02H)	Illegal data address (Non-existent data address)
3 (03H)	Illegal data value (Value out of the setting range)
17 (11H)	Illegal setting (Unsettable status)
18 (12H)	Illegal setting (During setting mode by keypad operation)

Data

Data differs depending on the function code.
A request message from the master side is composed of data item, number of data and setting data. (Refer to 8.4 Communication command table)
A response message from the slave side is composed of number of bytes, data and exception code in negative acknowledgement.
Only one piece of data can be dealt with per message. Therefore the number of data for RTU mode is fixed as (0001H). The number of response byte is 02H.
Effective range of data is –32768 to 32767 (8000H to 7FFFH).

Error check: 16 bit data to detect communication errors.
Refer to "(2) Error check of RTU mode" below.

(2) Error check of RTU mode

After calculating CRC-16 (Cyclic Redundancy Check) from the slave address to the end of the data, the calculated 16-bit data is appended to the end of message in sequence from low order to high order.

How to calculate CRC

In the CRC system, the information is divided by polynomial series. The remainder is added to the end of the information and transmitted. The generation of polynomial series is as follows.
(Generation of polynomial series: $X^{16} + X^{15} + X^{2} + 1$)

① Initialize the CRC-16 data (assumed as X) (FFFFH).
② Calculate exclusive OR (XOR) with the 1st data and X. This is assumed as X.
③ Shift X one bit to the right. This is assumed as X.
④ When a carry is generated as a result of the shift, XOR is calculated by X of ③ and the fixed value (A001H). This is assumed as X.
If a carry is not generated, go to step ⑤.
⑤ Repeat steps ③ and ④ until shifting 8 times.
⑥ XOR is calculated with the next data and X. This is assumed as X.
⑦ Repeat steps ③ to ⑤.
⑧ Repeat steps ③ to ⑤ up to the last data.
⑨ Set X as CRC-16 to the end of message in sequence from low order to high order.

(3) Message example of RTU mode

① **Setting (Address 1, 0% value)**

• A request message from the master [(When setting 0% value to 0℃ (0000H))

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0005H)	Number of data (0000H)	Error check CRC-16 (99CBH)	3.5 idle characters

• Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0005H)	Number of data (0000H)	Error check CRC-16 (99CBH)	3.5 idle characters

• Response message from the slave in exception (error) status (during setting mode by keypad operation)
The function code MSB is set to 1 for the response message in exception (error) status, and 86H is returned.
The exception code (12H: During setting mode by keypad operation) is returned.

3.5 idle characters	Slave address (01H)	Function code (86H)	Exception code (12H)	Error check CRC-16 (C26DH)	3.5 idle characters

② **Setting (Address 1, 100% value)**

• A request message from the master [When setting 100% value to 1000℃ (03E8H)]

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0006H)	Number of data (03E8H)	Error check CRC-16 (6975H)	3.5 idle characters

• Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (0006H)	Number of data (03E8H)	Error check CRC-16 (6975H)	3.5 idle characters

• Response message from the slave in exception (error) status (Value out of the setting range)

The function code MSB is set to 1 for the response message in exception (error) status, and 86H is returned.

The exception code (03H: Value out of the setting range) is returned.

3.5 idle characters	Slave address (01H)	Function code (86H)	Exception code (03H)	Error check CRC-16 (0261H)	3.5 idle characters

③ **Reading (Address 1, input value)**

• A request message from the master

The number of data means the data items to be read, and it is fixed as 1 (0001H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (0080H)	Number of data (0001H)	Error check CRC-16 (85E2H)	3.5 idle characters

• Response message from the slave in normal status [500℃ (01F4H)]

The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (02H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Number of response byte (02H)	Number of data (01F4H)	Error check CRC-16 (B853H)	3.5 idle characters

• Response message from the slave in exception (error) status (When data item is mistaken)

The function code MSB is set to 1 for the response message in exception (error) status, and 83H is returned.

The exception code (02H: Non-existent data address) is returned.

3.5 idle characters	Slave address (01H)	Function code (83H)	Exception code (02H)	Error check CRC-16 (C0F1H)	3.5 idle characters

④ **Reading (Address 1, 100% value)**

• A request message from the master

The number of data means the data items to be read, and it is fixed as 1 (0001H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Data item (0006H)	Number of data (0001H)	Error check CRC-16 (640BH)	3.5 idle characters

• Response message from the slave in normal status [When 100% value is set to 1000℃ (03E8H)]

The number of response bytes means the number of bytes of the data which has been read, and it is fixed as 2 (02H).

3.5 idle characters	Slave address (01H)	Function code (03H)	Number of response byte (02H)	Number of data (03E8H)	Error check CRC-16 (B8FAH)	3.5 idle characters

⑤ **Setting (Address 1, Output MV) (for RAO)**

• A request message from the master

[When setting the Output MV to 5000 (50.00%) (1388H)]

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (000EH)	Number of data (1388H)	Error check CRC-16 (E55FH)	3.5 idle characters

• Response message from the slave in normal status

3.5 idle characters	Slave address (01H)	Function code (06H)	Data item (000EH)	Number of data (1388H)	Error check CRC-16 (E55FH)	3.5 idle characters

8.4 Communication command table

[RAU, RAE, RAR, RAA, RAV, RAP]

Private command type	Modbus function code	Data item		Data
20H/50H	03H/06H	0001H	Set value lock	0000H: Unlock 0001H: Lock
20H/50H	03H/06H	0002H	Input type (Available for RAU)	0000H: Thermocouple 0001H: RTD 0002H: DC current 0003H: DC voltage 0004H: Potentiometer
20H/50H	03H/06H	0003H	Input range [Available for RAU (TC input) and RAE]	0000H: K -200 to 1370℃ 0001H: K -200 to 200℃ (*1) 0002H: K 0 to 400℃ (*1) 0003H: J -200 to 1000℃ 0004H: J -200 to 200℃ (*1) 0005H: J 0 to 400℃ (*1) 0006H: R -50 to 1760℃ 0007H: S -50 to 1760℃ 0008H: B 0 to 1820℃ 0009H: E -200 to 800℃ 000AH: T -200 to 400℃ (*1) 000BH: N -200 to 1300℃ 000CH: PL-Ⅱ 0 to 1390℃ 000DH: W5Re/W26Re 0 to 2315℃

Private command type	Modbus function code	Data item		Data
20H/50H	03H/06H	0003H	Input range [Available for RAU (TC input) and RAE]	000EH: W3Re/W25Re 0 to 2315℃ 000FH: K -328 to 2498℉ 0010H: K -328 to 392℉ (*1) 0011H: K -32 to 752℉ (*1) 0012H: J -328 to 1832℉ 0013H: J -328 to 392℉ (*1) 0014H: J -32 to 752℉ (*1) 0015H: R -58 to 3200℉ 0016H: S -58 to 3200℉ 0017H: B 32 to 3308℉ 0018H: E -328 to 1472℉ 0019H: T -328 to 752℉ (*1) 001AH: N -328 to 2372℉ 001BH: PL-Ⅱ 32 to 2534℉ 001CH: W5Re/W26Re 32 to 4199℉ 001DH: W3Re/W25Re 32 to 4199℉
20H/50H	03H/06H	0003H	Input range [Available for RAU (RTD input) and RAR]	0000H: Pt100 -200 to 850℃ 0001H: Pt100 -100 to 100℃ (*1) 0002H: JPt100 -200 to 500℃ 0003H: Pt100 -328 to 1562℉ 0004H: Pt100 -148 to 212℉ (*1) 0005H: JPt100 -328 to 932℉
20H/50H	03H/06H	0003H	Input range [Available for RAU (DC current input) and RAA]	0000H: 4 to 20mA -1999 to 9999 0001H: 0 to 20mA -1999 to 9999 0002H: 0 to 16mA -1999 to 9999 0003H: 2 to 10mA -1999 to 9999 0004H: 0 to 10mA -1999 to 9999 0005H: 1 to 5mA -1999 to 9999 0006H: 0 to 1mA -1999 to 9999
20H/50H	03H/06H	0003H	Input range [Available for RAU (DC voltage input) and RAV]	0000H: 0 to 10mV -1999 to 9999 0001H: -10 to 10mV -1999 to 9999 0002H: 0 to 50mV -1999 to 9999 0003H: 0 to 60mV -1999 to 9999 0004H: 0 to 100mV -1999 to 9999 0005H: 0 to 1V -1999 to 9999 0006H: 0 to 5V -1999 to 9999 0007H: 1 to 5V -1999 to 9999 0008H: 0 to 10V -1999 to 9999
20H/50H	03H/06H	0004H	Decimal point Place (*2)	0000H: No decimal point 0001H: 1 digit after decimal point 0002H: 2-digit after decimal point 0003H: 3-digit after decimal point
20H/50H	03H/06H	0005H	0% value	Set value, Decimal point ignored
20H/50H	03H/06H	0006H	100% value	Set value, Decimal point ignored
20H/50H	03H/06H	0007H	Filter time constant	Set value, Decimal point ignored

Private command type	Modbus function code	Data item		Data
20H/50H	03H/06H	0008H	Sensor correction	Set value, Decimal point ignored
20H/50H	03H/06H	000BH	Burnout	0000H: Upscale 0001H: Downscale
20H/50H	03H/06H	000CH	Display	0000H: Input /Input % display 0001H: Input display 0002H: Input % display 0003H: No indication
20H/50H	03H/06H	000DH	Indication time	Set value, Decimal point ignored
50H	06H	0042H	Potentiometer input zero adjustment (*3)	0000H: No action 0001H: Adjustment
50H	06H	0043H	Potentiometer input span adjustment (*3)	0000H: No action 0001H: Adjustment
50H	06H	0070H	Key operation change flag clearing	0000H: No action 0001H: All clearing
20H	03H	0080H	Input value	Input value, Decimal point ignored
20H	03H	0081H	Input value	Input value, Decimal point ignored Fixed scale: 0 to 1000
20H	03H	0082H	Unit status flag 0000 0000 0000 0000 2^0: Input burnout (Overrange) 0: Normal, 1: Overrange 2^1: Input burnout (Underrange) 0: Normal, 1: Underrange $2^{2\ to\ 13}$: Not used, Always 0 2^{14}: Memory (EEPROM) defective 0: Normal, 1: Defective 2^{15}: Change in key operation 0: No, 1: Yes		
20H	03H	00A1H	Unit specification flag 0000 0000 0000 0000 2^0: Model, Always 1 2^1: Model, Always 0 $2^{2\ to\ 4}$: Unit input type 0: RAU 1: RAE 2: RAR 3: RAA 4: RAV 5: RAP 2^5: Communication function, Always 1 $2^{6\ to\ 15}$: Not used, Always 0	
20H	03H	00A3H	Key operation change item reading (*4)	Data item code

(*1): For data item 0004H (Decimal point place selection), “No decimal point” or “1 digit after decimal point” can be selected.

(*2): Selectable for RAU (DC current, DC voltage, potentiometer input), RAA, RAV and RAP.
Selectable for RAU, RAE and RAR when (*1) is selected during Input range selection.
For thermocouple and RTD input, “No decimal point” or “1 digit after decimal point” can be selected.

(*3): Adjustable for the RAU (potentiometer input) and RAP

(*4): Data item 00A3H (Key operation change item reading):
Data items will be returned from the smallest one in sequence.
Once the changed item is read, the change flag for that item will be cleared.

[RAO]

Private command type	Modbus function code	Data item		Data
20H/50H	03H/06H	0001H	Set value lock	0000H: Unlock 0001H: Lock
20H/50H	03H/06H	0009H	Output type	0000H: 4 to 20mA 0001H: 0 to 20mA 0002H: 0 to 12mA 0003H: 0 to 10mA 0004H: 1 to 5mA 0005H: 0 to 1V 0006H: 0 to 5V 0007H: 1 to 5V 0008H: 0 to 10V
20H/50H	03H/06H	000CH	Display	0000H: Not used 0001H: Not used 0002H: Output % display 0003H: No indication
20H/50H	03H/06H	000DH	Indication time	Set value, Decimal point ignored
20H/50H	03H/06H	000EH	Output MV	Set value, Decimal point ignored 0 to 10000 (0.00 to 100.00%)
50H	06H	0040H	Output zero adjustment	Set value, Decimal point ignored
50H	06H	0041H	Output span adjustment	Set value, Decimal point ignored
50H	06H	0070H	Key operation change flag clearing	0000H: No action 0001H: All clearing

Private command type	Modbus function code	Data item	Data
20H	03H	0082H	Unit status flag 0000 0000 0000 0000 2^0: Not fixed 2^1: Not fixed $2^{2\ to\ 13}$: Not used, Always 0 2^{14}: Memory (EEPROM) defective 0: Normal, 1: Defective 2^{15}: Change in key operation 0: No, 1: Yes
20H	03H	00A1H	Unit specification flag 0000 0000 0000 0000 2^0: Model, Always 0 2^1: Model, Always 1 $2^{2\ to\ 4}$: Unit output type Always 0 2^5: Communication function, Always 1 $2^{6\ to\ 15}$: Not used, Always 0
20H	03H	00A3H	Key operation change item reading (*1)	Data item code

(*1): Data item 00A3H (Key operation change item reading):
Data item will be returned from the smallest one in sequence.
Once the changed item is read, the change flag for that item will be cleared.

● **Data**

Notes on the setting command and reading command

- Convert the data (set value, decimal) to hexadecimal figures. The negative number is represented by 2's complement.
- When connecting plural units, the address (instrument number) must not be duplicated.

Setting command

- The settable range is the same as the one by keypad operation.
- When the data (set value) has a decimal point, the whole number without a decimal point is used. The data (set value, decimal) is converted to hexadecimal figures.
- It's possible to set the value by the setting command even if the set value is locked.
- The instrument number and communication speed of the slave cannot be set by communication function.
- When sending a command by Global address [95 (7FH)], the same command is sent to all the slaves connected. However, the response is not returned.
- The memory can store up to 1,000,000 (one million) entries. If the number of setting times exceeds the limit, it cannot memorize the data. So frequent transmission via communication is not recommended.

Reading command

- When the data (set value) has a decimal point, the response (hexadecimal figures) is returned as a whole number without a decimal point.

● Notes on programming monitoring software

How to speed up the scan time

When monitoring plural units of the RA series, set the program so that requisite minimum pieces of data such as input value (0080H), current output MV (000EH) (RAO), status flag (0082H), etc. can be read. For other data, set the program so that they can be read only when their set value has changed. This will speed up the scan time.

How to read the set value change by the front keypad operation

If any set value is changed by the keypad operation, the unit sets the [Status flag (0082H) 2^{15}: Change in key operation] to [Yes (1)].

There are 2 methods of reading the set value change by the front keypad as follows.

Reading method 1

(1) On the software side, check that [Status flag (0082H) 2^{15}: Change in key operation] has been set to [Yes (1)], then read all set values.

(2) Clear the [Status flag (0082H) 2^{15}: Change in key operation], by setting the [Key operation change flag clearing (0070H)] to [All clearing (0001H)].

If [Key operation change flag clearing (0070H)] is set to [All clearing (0001H)] during the setting mode of the unit, Error code 5 (35H, Private protocol) or Exception Code 18 (12H, Modbus protocol) will be returned as a negative acknowledgement. [Status flag (0082H) 2^{15}: Change in key operation] cannot be cleared.
Set a program so that all set values can be read until acknowledgement is returned.

Reading method 2

(1) On the software side, check that [Status flag (0082H) 2^{15}: Change in key operation] has been set to [Yes (1)], then set the [Key operation change flag clearing (0070H)] to [All clearing (0001H)].

(2) Set the program depending on the acknowledgement or negative acknowledgement as follows.
When acknowledgement is returned;
Consider it as settings completed, and read all set values.

When Error code 5 (35H, Private protocol) or Exception code 18 (12H, Modbus protocol) is returned as a negative acknowledgement;
Consider it as during setting mode, and read the requisite minimum pieces of data such as input value (0080H), current output MV (000EH) (RAO), status flag (0082H), etc., then return to step (1).

Thus, programs which do not affect the scan time can be created using the methods described above, even if set values on the monitoring software will not be updated until settings are complete.

● When communicating with a PLC

Command example (Private protocol) when communicating with a Mitsubishi PLC (FX series, etc.)

• Reading (Top D register: D100)

Address 1, Input value reading

Sending Data	(STX)(!)( )( )(0)(0)(8)(0)(D)(7)(ETX)		
Command		Register	Code
Header (STX)	02H	D100(LSB)	02H
Address	1	D100(MSB)	21H
Sub address	20H	D101(LSB)	20H
Command type	20H	D101(MSB)	20H

Data item	&H80	D102(LSB)	30H
		D102(MSB)	30H
		D103(LSB)	38H
		D103(MSB)	30H
Checksum		D104(LSB)	44H
		D104(MSB)	37H
Delimiter (ETX)	03H	D105(LSB)	03H

Communication setting [MOVP H0C86 D8120]
Reading + Setting [RS D100 K11 D108 K26]
Reading only [RS D100 K11 D106 K26]

1 [MOV H2102 D100]
2 [MOV H2020 D101]
3 [MOV H3030 D102]
4 [MOV H3038 D103]
5 [MOV H3744 D104]
6 [MOV H03 D105]

• **Setting (Top D register: D120)**

Address 1, 100% value setting (When setting 100% value to 1000℃ [03E8H])

Sending Data	(STX)(!)( )(P)(0)(0)(0)(6)(0)(3)(E)(8)(C)(9)(ETX)		
Command		Register	Code
Header (STX)	02H	D120(LSB)	02H
Address	1	D120(MSB)	21H
Sub address	20H	D121(LSB)	20H
Command type	P	D121(MSB)	50H
Data item	&H6	D122(LSB)	30H
		D122(MSB)	30H
		D123(LSB)	30H
		D123(MSB)	36H
Data item	1000	D124(LSB)	30H
		D124(MSB)	33H
		D125(LSB)	45H
		D125(MSB)	38H
Checksum		D126(LSB)	43H
		D126(MSB)	39H
Delimiter (ETX)	03H	D127(LSB)	03H

Reading + Setting [RS D120 K15 D128 K26]
Reading only [RS D120 K15 D128 K22]

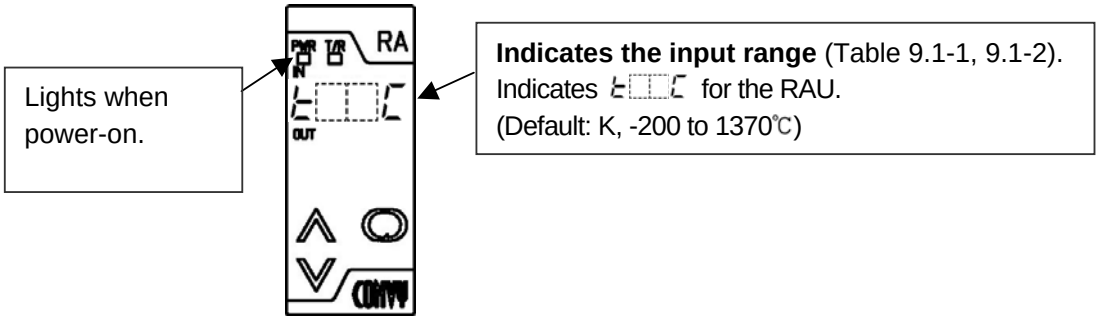
1 [MOV H2102 D120]
2 [MOV H5020 D121]
3 [MOV H3030 D122]
4 [MOV H3630 D123]
5 [MOV H3330 D124]
6 [MOV H3845 D125]
7 [MOV H3943 D126]
8 [MOV H03 D127]

9. Running

9.1 Indication after power-on

After the power supply to the unit is turned on, the following warm-up status is indicated for 3 seconds (Fig. 9.1-1, 9.1-2).

[RAU, RAE, RAR, RAA, RAV, RAP]



(Fig. 9.1-1)

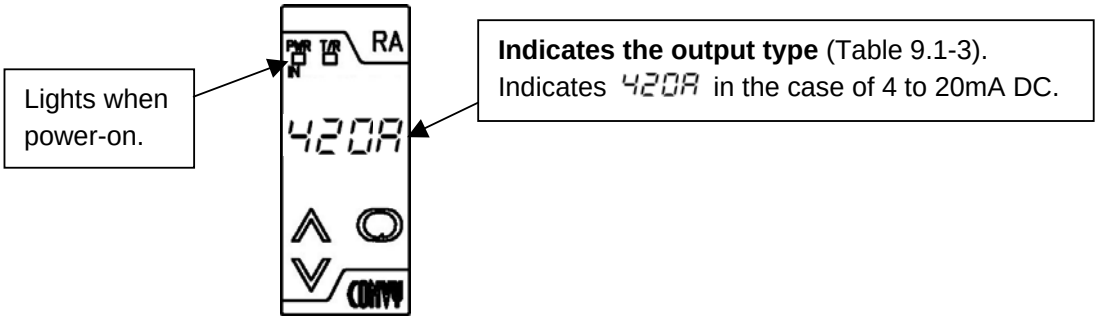
(Table 9.1-1)

Input	Input display	
	℃	℉
K	E□□C: -200 to 1370℃	E□□F: -328 to 2498℉
K	E□2C: -200 to 200℃	E□2F: -328 to 392℉
K	E□4C: 0 to 400℃	E□4F: 32 to 752℉
J	J□□C: -200 to 1000℃	J□□F: -328 to 1832℉
J	J□2C: -200 to 200℃	J□2F: -328 to 392℉
J	J□4C: 0 to 400℃	J□4F: 32 to 752℉
R	r□□C: -50 to 1760℃	r□□F: -58 to 3200℉
S	S□□C: -50 to 1760℃	S□□F: -58 to 3200℉
B	b□□C: 0 to 1820℃	b□□F: 32 to 3308℉
E	E□□C: -200 to 800℃	E□□F: -328 to 1472℉
T	t□□C: -200 to 400℃	t□□F: -328 to 752℉
N	n□□C: -200 to 1300℃	n□□F: -328 to 2372℉
PL-Ⅱ	PL2C: 0 to 1390℃	PL2F: 32 to 2534℉
W5Re/W26Re	c□□C: 0 to 2315℃	c□□F: 32 to 4199℉
W3Re/W25Re	d□□C: 0 to 2315℃	d□□F: 32 to 4199℉
Pt100	Pt□□C: -200 to 850℃	Pt□□F: -328 to 1562℉
Pt100	Pt 1C: -100 to 100℃	Pt 1F: -148 to 212℉
JPt100	JPt□C: -200 to 500℃	JPt□F: -328 to 932℉
4 to 20mA DC	420A: -1999 to 9999	
0 to 20mA DC	020A: -1999 to 9999	
0 to 16mA DC	0 16A: -1999 to 9999	
2 to 10mA DC	2 10A: -1999 to 9999	
0 to 10mA DC	0 10A: -1999 to 9999	
1 to 5mA DC	1□5A: -1999 to 9999	
0 to 1mA DC	0□ 1A: -1999 to 9999	

(Table 9.1-2)

Input	Input display
0 to 10mV DC	0 10U: -1999 to 9999
-10 to 10mV DC	-10U: -1999 to 9999
0 to 50mV DC	050U: -1999 to 9999
0 to 60mV DC	060U: -1999 to 9999
0 to 100mV DC	00.1U: -1999 to 9999
0 to 1V DC	0 1U: -1999 to 9999
0 to 5V DC	0 5U: -1999 to 9999
1 to 5V DC	1 5U: -1999 to 9999
0 to 10V DC	0 10U: -1999 to 9999

[RAO]



(Fig. 9.1-2)

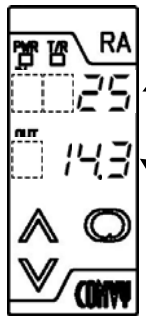
(Table 9.1-3)

Output	Output % display
4 to 20mA DC	420A
0 to 20mA DC	020A
0 to 12mA DC	0 12A
0 to 10mA DC	0 10A
1 to 5mA DC	1 5A
0 to 1V DC	0 1U
0 to 5V DC	0 5U
1 to 5V DC	1 5U
0 to 10V DC	0 10U

9.2 Running

After the warm-up indication, the unit switches to the Run mode as shown in (Fig. 9.2-1, 9.2-2).

[RAU, RAE, RAR, RAA, RAV, RAP]



Indicates the input value.
For the RAU (Default, K: -200 to 1370 ℃), an input value from the thermocouple is indicated.
If nothing is connected to the input terminals, then "- - - -" is indicated.

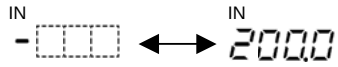
The input value is indicated in a percentage form (%).

(Fig. 9.2-1)

- **Indication when input value is -200.0 (-2000) or less**

  When the range has a decimal point: For the indication of -200.0 or less (up to –10% output volume), the input value and the minus (-) sign are indicated alternately.
  When DC current or voltage input is selected: The indication of -2000 or less is the same as the above.

  (e.g.) Indication of -200.0



- **Indication when input value is 10000 or more**

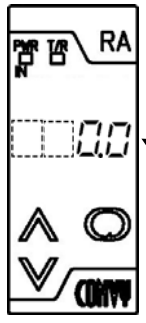
  When DC current or voltage input is selected: For the indication of 10000 or more (up to 110% output volume), the lower 4 digits of input value are flashing.

  (e.g.) Indication of 10020

- **Underrange, Overrange and Sensor burnout indication**

  The following will be indicated regardless of the Display selection.
  Underrange : "- - - -" flashes on the Input display.
  Overrange : " " flashes on the Input display.

[RAO]



The output value is indicated in a percentage form (%).

(Fig. 9.2-2)

10. Adjustment

For the RAU (potentiometer input) and RAP, perform Potentiometer input zero and Potentiometer input span adjustment.
Connect a Dial resistor to the input terminals of this instrument.

For the RAO, perform Output zero and Output span adjustment.
Connect a digital multimeter to output terminals.

10.1 Basic operation of adjustment

Adjustment can be conducted in the Adjustment mode.
To enter the Adjustment mode, hold down the ◎ key for approx. 3 seconds in the Run mode. (Fig. 10.1-1)

[RAU (potentiometer input), RAP]

Potentiometer input zero adjustment: The value is automatically adjusted with the ∨ key.
Pressing the ◎ key registers the value.
Potentiometer input span adjustment: The value is automatically adjusted with the ∧ key.
Pressing the ◎ key registers the value.

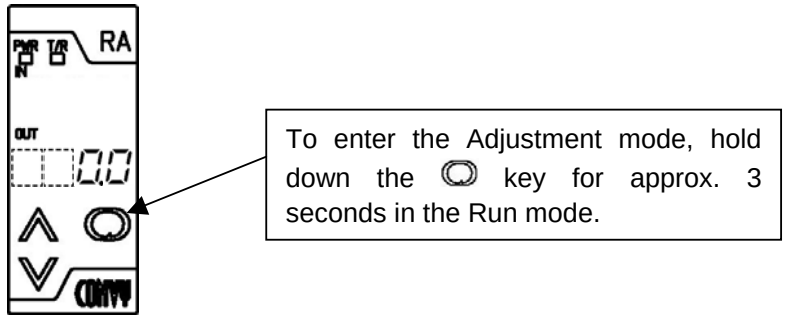
[RAO]

Output adjustment: Use the ∧ or ∨ key, and register the value with the ◎ key. (Fig. 10.1-2)

To revert to the Run mode, hold down the ◎ key again for approximately 3 seconds.

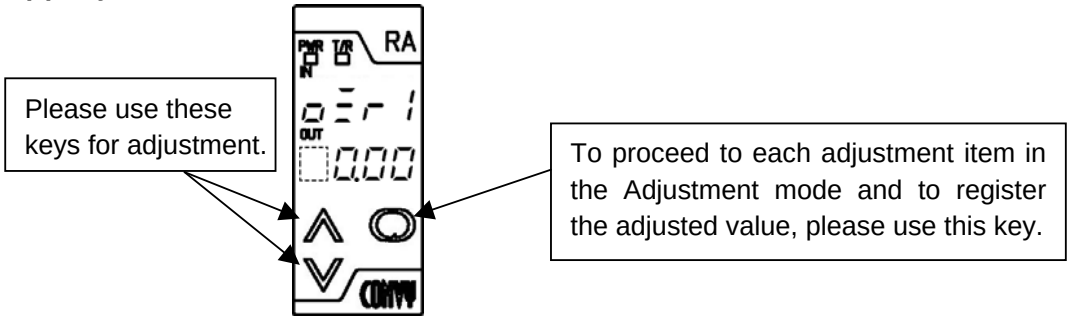
Adjustment mode operation example (RAO)

(1) Run mode



(Fig. 10.1-1)

(2) Adjustment mode



(Fig. 10.1-2)

10.2 Adjustment

The following shows all adjusting items. For adjustment, refer to the explanation of each item below.

[RAU (potentiometer input), RAP]

Display	Name, Function, Setting range	Default value
IN I ZEr OUT -999	**Potentiometer input zero adjustment**	-1999
	Performs potentiometer input zero adjustment. Available for the RAU (potentiometer input) and RAP. Set the potentiometer to the Minimum side, and press the ⩛ key once. Automatically adjustment is performed.	
IN I SPA OUT 9999	**Potentiometer input span adjustment**	9999
	Performs potentiometer input span adjustment. Available for the RAU (potentiometer input) and RAP. Set the potentiometer to the Maximum side, and press the ⩓ key once. Automatically adjustment is performed.	

[RAO]

Display	Name, Function, Setting range	Default value
IN oZr I OUT 0.00	**Output zero adjustment**	0.00%
	Adjusts output zero. Input the 0% value, using the Output MV setting command (000EH), then adjust the value with the ⩓ or ⩛ key while viewing the output value on the digital multimeter. When the output range low limit is zero, (even if zero adjustment results in a negative value), output value will not be negative. Setting range: -5.00 to 5.00% Effective range of adjustment differs depending on the output types. 4 to 20mA DC -5 to 5% 0 to 20mA DC 0 to 5% 0 to 12mA DC 0 to 5% 0 to 10mA DC 0 to 5% 1 to 5mA DC -5 to 5% 0 to 1V DC 0 to 5% 0 to 5V DC 0 to 5% 1 to 5V DC -5 to 5% 0 to 10V DC 0 to 5%	
IN oSP I OUT 0.00	**Output span adjustment**	0.00%
	Adjusts output span. Input the 100% value, using the Output MV setting command (000EH), then adjust the value with the ⩓ or ⩛ key while viewing the output value on the digital multimeter. Setting range: -5.00 to 5.00% Effective range of adjustment is 95 to 105%.	

11. Specifications

[RAU, RAE, RAR, RAA, RAV, RAP]

Input specifications

RAU (thermocouple), RAE

Input resistance: 1MΩ or more

External resistance: 100Ω or less, However, B: 40Ω or less

Burnout: Upscale, Downscale

Input signal:

Thermocouple	Input range	
K	-200 to 1370℃	-328 to 2498℉
J	-200 to 1000℃	-328 to 1832℉
R	-50 to 1760℃	-58 to 3200℉
S	-50 to 1760℃	-58 to 3200℉
B	0 to 1820℃	32 to 3308℉
E	-200 to 800℃	-328 to 1472℉
T	-200 to 400℃	-328 to 752℉
N	-200 to 1300℃	-328 to 2372℉
PL-Ⅱ	0 to 1390℃	32 to 2534℉
W5Re/W26Re	0 to 2315℃	32 to 4199℉
W3Re/W25Re	0 to 2315℃	32 to 4199℉

Minimum input span: 50℃ (100℉)

RAU [RTD (3-wire)], RAR

Input detection current: Approx. 0.2mA

Allowable lead wire resistance: 10Ω or less per wire

Burnout: Upscale, Downscale

Input signal:

RTD	Input range	
Pt100	-200 to 850℃	-328 to 1562℉
JPt100	-200 to 500℃	-328 to 932℉

Minimum input span: 50℃ (100℉)

RAU (DC current), RAA

Input	Shunt resistor
4 to 20mA DC	50Ω
0 to 20mA DC	
0 to 16mA DC	
2 to 10mA DC	100Ω
0 to 10mA DC	
1 to 5mA DC	200Ω
0 to 1mA DC	1kΩ

Connect shunt resistor (sold separately) between input terminals.

Name	Model	Specification
Shunt resistor	RES-S02-050	50Ω ±0.1%
	RES-S02-100	100Ω ±0.1%
	RES-S02-200	200Ω ±0.1%
	RES-S02-01K	1kΩ ±0.1%

RAU (DC voltage), RAV

Input	Input resistance	Allowable signal source resistance
0 to 10mV DC	1MΩ	20Ω or less
-10 to 10mV DC		40Ω or less
0 to 50mV DC		200Ω or less
0 to 60mV DC		
0 to 100mV DC		
0 to 1V DC		2kΩ or less
0 to 5V DC		1kΩ or less
1 to 5V DC		
0 to 10V DC		

RAU (potentiometer), RAP
Whole resistance value: 100Ω to 10kΩ
Reference voltage: 1.0V DC

Performance

Conversion accuracy RAU (thermocouple input), RAE:
Within ±0.1% of each input span
R, S input, -50 to 200℃ (-58 to 392℉): Within ±6℃ (12℉)
B input, 0 to 300℃ (32 to 572℉): Accuracy is not guaranteed.
K, J, E, T, N input, 0℃ (32℉) or less: Within ±0.4% of each input span
RAU (RTD input), RAR : Within ±0.1% of each input span
RAU (DC current input), RAA : Within ±0.1%
RAU (DC voltage input), RAV : Within ±0.1%
RAU (potentiometer input), RAP: Within ±0.1%

Cold junction temperature compensation:
Within ±1℃ at -5 to 55℃ [RAU (thermocouple input), RAE]

Indicating accuracy: Within ±1 digit of conversion accuracy
Conversion time: 250ms
Response time: 0.5sec (typ.) (0 → 90%)
Temperature coefficient: ±0.015%/℃
Insulation resistance: Input - Communication - Power 10MΩ or more, at 500V DC
Dielectric strength: Input - Communication - Power 2.0kV AC for 1 minute

General structure

Case: Flame-resistant resin, Color: Light gray
Panel: Membrane sheet
Communication: Modular jack
Setting: Setting by the front key
Indication:
Input display : 7-segment Red LED display 4 digits
Character size, 7.4 x 4.0mm (H x W)
Input % display : 7-segment Green LED display 4digits
Character size, 7.4 x 4.0mm (H x W)
Power indicator : Green LED
Communication indicator : Yellow LED

[RAO]

Output specifications

DC current

Output	Allowable load resistance	Zero adjustment range	Span adjustment range
4 to 20mA DC	700Ω or less	-5 to 5%	95 to 105%
0 to 20mA DC	700Ω or less	0 to 5%	95 to 105%
0 to 12mA DC	1.2kΩ or less	0 to 5%	95 to 105%
0 to 10mA DC	1.2kΩ or less	0 to 5%	95 to 105%
1 to 5mA DC	2.4kΩ or less	-5 to 5%	95 to 105%

DC voltage

Output	Allowable load resistance	Zero adjustment range	Span adjustment range
0 to 1V DC	100Ω or more	0 to 5%	95 to 105%
0 to 5V DC	500Ω or more	0 to 5%	95 to 105%
1 to 5V DC	500Ω or more	-5 to 5%	95 to 105%
0 to 10V DC	1kΩ or more	0 to 5%	95 to 105%

When the output range lower limit is zero, (even if zero adjustment results in a negative value), output value will not be negative.

Performance

Conversion accuracy	Within ±0.1%
Indicating accuracy	Within ±1 digit of Conversion accuracy
Response time	0.5sec (typ.) (0 →▶ 90%)
Temperature coefficient	±0.015%/℃
Insulation resistance	Output - Communication - Power 10MΩ or more, at 500V DC
Dielectric strength	Output - Communication - Power 2.0kV AC for 1 minute

General structure

Case	Flame-resistant resin, Color: Light gray
Front panel	Membrane sheet
Communication	Modular jack
Setting	Setting by the front key
Indication	Setting character display : 7-segment Red LED display 4 digits Character size, 7.4 x 4.0mm (H x W) Output % display : 7-segment Green LED display 4 digits Character size, 7.4 x 4.0mm (H x W) Power indicator : Green LED Communication indicator: Yellow LED

Common specifications (RAU, RAE, RAR, RAA, RAV, RAP, RAO)

Communication

Cable length	Maximum 1.2km Cable resistance: Within 50Ω
Communication line	EIA RS-485
Communication method	Half-duplex communication start-stop synchronous
Communication protocol	Private, Modbus ASCII, Modbus RTU (Selectable by keypad)
Communication speed	2400, 4800, 9600, 19200bps (Selectable by keypad)
Code form	ASCII, binary
Parity	Even, Odd, No parity (Selectable by keypad)
Stop bit	1, 2 (Selectable by keypad)
Error correction	Command request repeat system
Error detection	Parity check, Checksum (Private protocol) LRC (Modbus ASCII), CRC-16 (Modbus RTU)
Data format	Data format differs depending on the communication protocol.

Communication protocol	Private	Modbus ASCII	Modbus RTU
Start bit	1	1	1
Data bit	7	7 or 8	8
Parity	Yes (Even)	Yes (Even, Odd) No parity	Yes (Even, Odd) No parity
Stop bit	1	1 or 2	1 or 2

Installation specifications

Power supply	100 to 240V AC 50/60Hz, 24V AC/DC 50/60Hz
Allowable voltage range	100 to 240V AC: 85 to 264V AC, 24V AC/DC: 20 to 28V AC/DC
Power consumption	Approx. 6VA
Ambient temperature	-5 to 55℃ (23 to 131℉)
Ambient humidity	35 to 85%RH (Non-condensing)
Weight	Approx. 120g
Mounting	DIN rail
External dimensions	W22.5 x H75 x D100mm

Attached functions

- **Power failure countermeasure**
  The setting data is backed up in the non-volatile IC memory.
- **Self-diagnosis**
  The CPU is monitored by a watchdog timer, and when an abnormal status is found on the CPU, the unit is switched to warm-up status.
- **Cold junction compensation**
  Available only for the RAU (thermocouple input) and RAE.
  This detects the temperature at the connecting terminal between the thermocouple and the instrument, and always maintains it at the same status as when the reference junction is located at 0℃ (32℉).

12. Troubleshooting

If any malfunctions occur, refer to the following items after checking the power supply to the master and slaves.

12.1 Indication

Problem	Presumed cause and solution
Input display is flashing "----", or "----".	• The sensor may be burnt out. Change each sensor. • Check whether the sensor is securely connected to the input terminals of the instrument. Ensure that the sensor terminals are securely connected to the input terminals of the instrument. • Check the input signal source. • Check whether polarity of thermocouple or compensating lead wire is correct. Check whether codes (A, B, B) of the RTD agree with the instrument terminals. Ensure that they are wired properly.
The indication of the Input display is abnormal or unstable.	• Check whether the sensor input and temperature unit (℃/℉) setting are correct. Ensure that sensor type and temperature unit (℃/℉) are set properly. (p.17, 18) • Check whether the sensor correcting value is suitable. Set it to a suitable value. (p.19) • AC leaks into the sensor circuit. Use an ungrounded type sensor. • There may be equipment that interferes with or makes noise near the unit. Keep equipment that interferes with or makes noise away from the unit.

12.2 Key operation

Problem	Presumed cause and solution
Setting or adjustment is impossible.	• “Lock” is selected during Set value lock selection. Select “Unlock”. (p.17)
For 0% and 100% value setting, the setting indication does not change within the input range even if the ∧ or ∨ key is pressed, and new values are unable to be set.	• 0% value and 100% value may be set at the point where the value does not change. Set them to suitable values. (p.19)

12.3 Running

Problem	Presumed cause and solution
Input value does not change.	• The sensor may be out of order. Change the sensor. • Check whether input and output wires are securely connected to the I/O terminals of the unit. Ensure that input and output wires are securely connected to the I/O terminals of the unit. • Check whether the wiring of input and output is correct.
Does not output anything.	• Check whether Output MV setting command (000EH) is suitable. Ensure that Output MV setting command (000EH) has been set to a suitable value. (p.37) • Check whether a suitable output has been selected during Output type selection. (p.20)

12.4 Communication

Problem	Presumed cause and solution
Communication failure	• The connection or wiring of the communication cable is not secure. • Burnout or imperfect contact on the communication cable and the connector. (p.11) • Communication speed of the slave does not coincide with that of the master. (p.21) • The data bit, parity and stop bit of the master do not accord with those of the slave. (p.21) • The instrument number of the slave does not coincide with that of the command. (p.21) • The instrument numbers are duplicated in multiple slaves. (p.21) • Make sure that the program is appropriate for the transmission timing (p.22)
Although communication is occurring, the response is 'NAK'.	• Check that a non-existent command code has not been sent. (p.34-38) • The setting command data exceeds the setting range of the slave.

13. Character table

All setting items are indicated in the following tables, however, some items will not be indicated depending on the specifications.

●Setup mode

[RAU, RAE, RAR, RAA, RAV, RAP]

Display	Setting item	Default value	Data
Lock	Set value lock	Unlock	
SEnS	Input type	Thermocouple (RAU)	
Tc□	Thermocouple input range	K –200 to 1370℃ (RAU, RAE)	
rTd□	RTD input range	Pt100 –200 to 850℃ (RAU, RAR)	
dcA□	DC current input range	4 to 20mA DC -1999 to 9999 (RAU, RAA)	
dcb□	DC voltage input range	0 to 10mV DC -1999 to 9999 (RAU) 1 to 5V DC -1999 to 9999 (RAV)	
dP□	Decimal point place	No decimal point	
SrLL	0% value	RAU, RAE, RAR: -200℃ RAA, RAV, RAP: -1999	
SrLH	100% value	RAU, RAE: 1370℃ RAR: 850℃ RAA, RAV, RAP: 9999	
FILT	Filter time constant	0.0sec	
So□	Sensor correction	0.0℃	
bUrn	Burnout	Upscale	
diSP	Display	Input/Input % display	
TIME	Indication time	00.00 (Continuous)	

[RAO]

Display	Setting item	Default value	Data
Lock	Set value lock	Unlock	
oUTP	Output type	4 to 20mA DC	
diSP	Display	Output % display	
TIME	Indication time	00.00 (Continuous)	

●Communication parameter setting mode

Display	Setting item	Default value	Data
cnSL	Communication protocol	Private	
cnno	Instrument number	0	
cnSP	Communication speed	9600bps	
cnPr	Parity	Even	
cnST	Stop bit	1	

●Adjustment mode

[RAU (Potentiometer input), RAP]

Display	Setting item	Default value	Data
i ZEr	Potentiometer input zero adjustment	-1999	
i SPA	Potentiometer input span adjustment	9999	

[RAO]

Display	Setting item	Default value	Data
oZr 1	Output zero adjustment	0.00%	
oSP 1	Output span adjustment	0.00%	

***** Inquiry *****

For any inquiries about this unit, please contact our agency or the shop where you purchased the unit after checking the following.

[Example]
- Model ---------- RA□–□
- Serial number ---------- No. xxxxxx

In addition to the above, please let us know the details of the malfunction, if any, and the operating conditions.

SHINKO TECHNOS CO.,LTD.
OVERSEAS DIVISION

Reg. Office : 2-5-1, Senbahigashi, Minoo, Osaka, Japan
URL : http://www.shinko-technos.co.jp Tel : 81-72-727-6100
E-mail : overseas@shinko-technos.co.jp Fax: 81-72-727-7006

No.RA1E1 2006.03